MUQI TECHNOLOGY
HYDROGEN HEALTH INDUSTRY STRATEGIC RESEARCH CENTER
2026



FROM CLINICAL EVIDENCE TO CONSUMER WELLNESS

2026 China Hydrogen Health Industry Development Research Report

Special Strategic Edition · Clinical Evidence, Industrial Ecology & Commercial Pathways

RMB 4.23 billion
2025 Hydrogen-Rich Water Dispenser Market Size

39 trials
Effective Hydrogen Clinical Trials in China

2 certificates
NMPA Class III Certificates

5,120 papers
Total Global Hydrogen Medicine Publications

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READING GUIDE · Reading Guide

This report can be read by role and need not be read from cover to cover

The report is organized into 8 chapters plus 2 appendices, following a four-layer logic: facts → structure → constraints → judgment. The table below sets out the shortest reading paths for four reader archetypes, together with this report's source discipline—before citing any figure, first confirm which source category it belongs to.

The "Three Source Categories and Their Use" section following the eight chapters explains how this report distinguishes evidence strength; before citing any figure, first confirm which source category it belongs to.

Shortest Reading Paths for Four Reader Archetypes

Table 0-1

Reader	Shortest Path	Key Chapters
Medical device and consumable manufacturers	Start with the boundary between "certification" and "evidence," then examine the reimbursement gate	Chapter 1 · Chapter 7 · Appendix A
Whole-device and channel enterprises	Start with unit-price structure and reorder structure, then examine competitive stratification	Chapter 2 · Chapter 3 · Chapter 6
Upstream materials and new entrants	Start with industry position and moat, then examine cross-sector scenarios	Chapter 4 · Chapter 5
Investment and industry research	Start with the non-convertibility of the two market-sizing conventions, then examine trends and actions	Executive Summary · Chapter 8 · Appendix B

Each of the eight chapters answers one question (chapter structure and throughline)

Table 0-2

Chapter	Question this chapter answers	Conclusion
Chapter 1	What kind of claims can China's research and clinical evidence support?	Evidence is concentrated in "inhalation"; hydrogen-rich water evidence cannot support a Class III certificate
Chapter 2	Where do the physical boundaries and economic structures of the two technology routes diverge?	It is not a question of which is more advanced, but of which scenario each can enter
Chapter 3	Who are the genuine demand cohorts, and where are the red lines for claims in each?	Seminar marketing is a unit-price structure problem; claims must be tied to evidence grade
Chapter 4	How can an upstream materials player turn peers into customers?	Not building whole devices, but embedding into others' channels through four-tier enablement
Chapter 5	Where are the bottlenecks in the value chain and the scenarios with spillover potential?	Value Accrues at Both Ends: Materials and Formulations Upstream, Scenarios and Reorder Downstream
Chapter 6	What Is the Actual Stratification of 180 Companies?	A Three-Way Structure: Value Capture Concentrates at the "Certificate" and "Material" Ends
Chapter 7	How Far Has Each of the Four Institutional Gates Opened?	Access Open, Promotion Open, Reimbursement Partially Open, Payment Not Open
Chapter 8	How Should Market Size Be Calculated, and What Should Companies Do?	Two Measurement Bases Presented Side by Side Without Division; With Payment Closed, Consumableization Is the Least Constrained Path

Three Source Types and Their Use (Consistent Throughout)

Table 0-3

Source Type	Definition	Use in This Report
Verbatim Official Documents	Primary Regulatory and Academic Sources: NMPA Registration Database, National Standards Full-Text Public System, Verbatim Healthcare Security and Health Commission Policy Texts, National Bureau of Statistics Bulletins, Reproducible Searches via PubMed / WHO ICTRP	Direct data extraction, item-by-item timestamping, reproducible
Company Claims and Industry Disclosures	Product Materials, Live E-Commerce Listings, Public Information from Exhibitions and Associations, Cross-Border B2B Platform Price Quotations	Used as Statements of Fact; Not Converted into Market-Size Estimates
Estimates by This Report	TAM/SAM/SOM, Host-Penetration Modeling, Competitive Positioning Models	Stated Assumptions and Denominators, Presented Separately, Not Added to or Divided by the Preceding Two Categories

Definitions for Six Key Concepts (Core to Avoiding Misinterpretation)

Table 0-4

Concept	Definition in This Report	Common Misinterpretation
Solid-State Hydrogen	A material system using micro-porous ceramics/minerals or metal hydrides as carriers to slowly release molecular hydrogen upon contact with water	Mistaken as a synonym for “hydrogen energy”
Dual-Mode Architecture	Electrolytic hydrogen generation module and mineral filter cartridge consumables connected in parallel, forming a “device + periodic consumables” structure	Mistaken as a purely technical upgrade
Class III Certificate	NMPA Class III Medical Device Registration Certificate; opens market access but does not equate to permission to claim therapeutic efficacy	Mistaken for a “license to practice medicine”
Consumablization	Converting one-off hardware gross margin into high-frequency consumable cash flow	Mistaken for “commoditization”
Host industry	The parent industry of hydrogen products (home appliances, cosmetics, eldercare, etc.), used in this report only as a denominator	Mistaken for the scale of the hydrogen industry itself
Payment gate	Whether a product is included in the Basic Medical Insurance reimbursement catalog determines out-of-pocket versus reimbursable transactions	Mistaken for “whether charging standards are clearly defined”

Follow-up question: why does the report repeatedly stress “not additive, not divisible”?

> Because this report uses two types of denominators simultaneously: one is segment-level empirical data (e.g., hydrogen-rich water dispensers at RMB 4.23 billion), and the other is host-industry extrapolation (home appliances at RMB 1,169.5 billion). The statistical boundaries of the two scopes differ; figures derived from cross-scope calculations may appear precise but are difficult to assign meaning to in practice.

Data solicitation and correction mechanism. Online reading site: `https://www.emuqi.com/h2report/` (search formulas, image source ledger, and revision history are available on the same page); E-Muqi Intelligence Portal: `www.emuqi.com/h2report` (interactive multi-language reading and updates). The print and PDF versions are **point-in-time snapshots** of this report; the online version is continu-

ously revised, and in the event of any discrepancy, the online version prevails. Wherever data are provided or errors are identified, we will update after verification and retain a record in the revision log.

Author's note. This report was independently authored by Martin Chen (CEO of MUQI TECH, www.emuqi.com). The author has long been engaged in solid-state hydrogen material R&D, end-product innovation, and overseas market expansion, and maintains ongoing frontline contact with upstream and downstream enterprises across the value chain, research institutes, local industry authorities, and trade associations. The report took several months to complete, supported by years of accumulated industry observation and multi-party cross-validation.



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WECHAT CHANNELS

Scan to connect. The left code opens the author's LinkedIn profile; the right code opens the WeChat Channels account, where product and industry updates are posted between editions of this report. For readers outside mainland China, LinkedIn is the faster route.



Executive Summary

Four judgments that cut against consensus: the market is being reshuffled rather than growing, and with payment reform still absent, consumables are the only sustainable model.

China's hydrogen energy and health industries in 2026 stand at the intersection of a profound macroeconomic shift and structural reorganization. Over the past decade, national policy and local investment have channeled enormous capital into hydrogen transportation (fuel-cell vehicles, heavy trucks, and refueling stations), but under the cost advantages of the battery electric vehicle (BEV) route and the constraints of heavy-asset infrastructure, the commercialization pace of conventional "energy hydrogen" has slowed markedly. Yet in the national "14th Five-Year Plan" and medium- to long-term strategy, hydrogen energy's positioning as a strategic emerging industry and as **"new quality productive forces"** remains rock-solid; gigaton-scale northwest wind and solar green hydrogen bases are rising rapidly, and **the entire hydrogen energy value chain faces pronounced "application outlet pressure"**—vast industrial assets and green hydrogen capacity urgently need to find high-value-added, asset-light, self-sustaining physical consumption scenarios.

It is precisely within this macro configuration that hydrogen health, hydrogen medicine, and hydrogen agriculture—after nearly two decades of scientific accumulation—demonstrate the historical inevitability of serving as the hydrogen energy industry's "new breakthrough point for new quality productive forces": they possess a globally leading academic literature base, solid Class III medical device breakthroughs, dozens of authoritative clinical studies, hundreds of proprietary patents, and tens of millions of people with awareness; they do not depend on long-distance heavy-duty pipeline networks or multi-billion-yuan refueling stations, and they feature a commercial closed loop characterized by **short investment cycles, high per-unit value-added, high-frequency essential repeat purchases, and direct reach to millions of households**. China's hydrogen health industry is not merely a consumption upgrade; it is the most realistically grounded strategic safety cushion and profit engine for China's grand hydrogen strategy as it moves from "heavy-asset transportation trial and error" toward "empowering life and ecology."

Core Strategic Insight Matrix

Insight Zero **Macro positioning: the hydrogen energy industry's "transportation slowdown" and "pivot to livelihood outlets"**

Traditional hydrogen energy investments in fuel-cell vehicles and transportation infrastructure face long payback periods and declining subsidies; by contrast, hydrogen health and hydrogen agriculture—with their extremely light asset profile, extremely high per-unit hydrogen value-added (ordinary green hydrogen for industrial consumption is worth less than ¥20/kg, yet in health FMCG can generate thousands of yuan in output value), broad C-end consumer base, and modern cultivation and breeding audiences—are rapidly becoming the most practically feasible livelihood receptors for major hydrogen energy demonstration zones to revitalize regional investment and deliver on "new quality productive forces."

Insight One

The structural disconnect between academic prosperity and clinical translation

Chinese teams have cumulatively published **1,143 hydrogen medicine papers, accounting for 22.3% of the global total of 5,120** (all-period basis); viewed across four periods, the share has risen from 14.0% in 2007–2011 to **32.9%** in 2022–2026, spanning roughly nineteen years. **But paper share does not equal market growth**: over the same period, global publication volume grew only 28% (approximately 1.3% annualized), meaning China is competing for share in a pool that is barely growing. Among the **39** active clinical trials registered with the WHO ICTRP, **61.5% (24 trials) focus on the inhalation route** and severe respiratory diseases, whereas downstream mass-market consumption is highly concentrated in "drinking water and daily wellness"—**clinical evidence grows in "inhalation and in-hospital" settings, while commercial monetization clusters in "drinking water and household" applications, creating a severe evidence-based mismatch. This mismatch has pushed industry–academia–research collaboration to the fore: on the academic side there is a relative surplus of paper output, while on the industry side there is a scarcity of registrable, mass-producible evidence. What is truly lacking is not research but projects and teams capable of translating clinical questions into registrable products and production lines that can be brought up to yield. Consequently, the value of two types of resources is rapidly becoming apparent—first, research projects with commercial and industrialization feasibility; second, engineering talent capable of translating laboratory processes into yield rates and compliance documentation. For upstream material enterprises, industry–academia–research collaboration is no longer about plaques and endorsements; it is the indispensable pathway for advancing from "mechanistically feasible" to "process-controllable and compliance-verifiable."**

Insight Two

Dual-technology-track physical bifurcation and generational replacement

Industry development was long dominated by heavy equipment for "water electrolysis hydrogen production (SPE/PEM)," whose high unit price, heavy asset base, electricity dependency, and lack of consumable repeat purchases led business models to devolve into reliance on offline seminar marketing targeting middle-aged and elderly consumers. In recent years, "material hydrolysis hydrogen production (micro-porous ceramic lattice hydrogen storage and release)," represented by micro-porous ceramic lattice hydrogen storage and release, has risen rapidly; with **zero electricity, safe hydrogen release at ambient temperature and pressure, long half-life (18–24h), and extremely low marginal installation cost**, it is driving the industry to leap from "heavy-asset equipment" to "high-frequency fast-moving consumables."

Insight Three

Product form evolution: a paradigm leap from "durable home appliances" to "high-frequency FMCG"

The early market was confined to powered durable equipment (hydrogen inhalation machines, electrolytic hydrogen water tumblers), constrained by high unit prices, heavy assets, and the absence of consumable repeat purchases. As materials science achieved upstream breakthroughs, solid-state hydrogen storage and release technology enabled the release of high-concentration active hydrogen at ambient temperature and pressure without an external power source, giving rise to a **full-scenario hydrogen health FMCG (FMCG) matrix** spanning "oral tablets, hydrogen-rich water ceramic filter cartridges, cold-process facial cleansing soap, power-free eye patches/masks, and hydrogen water bath balls/foot patches." Upstream innovation, represented by materials R&D enterprises, is transforming single high-decision-threshold durable goods transactions into an ecosystem of continuously repurchased fast-moving consumables.

Insight Four

Deconstruction of three price anchors and the truth behind the thirty-thousand-fold price spread

In the market, from **¥0.67 per tablet** for 1688 wholesale tablets, to **¥548 per unit** for e-commerce electrolytic hydrogen water tumblers, to **¥17,999 per machine** for hydrogen-oxygen machines in offline experience salons, the nearly thirty-thousand-fold price spread is not excess profit per se but the coexistence of three mutually fragmented price anchors: **the raw material anchor (functional medium), the commodity anchor (health small appliance), and the therapeutic efficacy anchor (health promise)**. As the regulatory storm sweeps away false advertising, the “therapeutic efficacy anchor” is rapidly collapsing, and the industry is being forced back to the “commodity anchor and high-frequency consumable repeat purchase.”

Insight Five

The underlying logic of “two and a half of four institutional gates now open”

Along the policy pathway there are four mutually non-substitutable sequential gates: **market access open** (NMPA Class III certificate, but limited to a single indication—acute exacerbation of COPD—with no possibility of generalization across specialties), **primary-care rollout open** (National Health Commission appropriate-technology direct promotion to village clinics), **charging half-open** (Shandong medical insurance code 120300003, independent pricing), and **payment not open** (neither the Ministry of Civil Affairs nor the Basic Medical Insurance payment catalog contains the word “hydrogen”). The absence of payment coverage means products must be transacted out of pocket, which in turn forces a fragile ecosystem dependent on experiential seminar marketing. Under the institutional iron curtain, the industry has not moved toward a single track but has entered a stage of **two coexisting technology routes**: electrolysis equipment holds the in-hospital and commercial high-throughput scenarios and holds all Class III certificates; the **solid-state hydrogen material route**, represented by micro-porous ceramic lattices, demonstrates stronger growth momentum in FMCG and daily-use scenarios by virtue of zero electricity, miniaturizability, hydrogen release upon contact with water, and high-frequency repeat purchases—in 2025, the hydrogen-rich water dispenser segment reached approximately RMB 4.23 billion, up 18.7% year on year, and a repeat-purchase structure of “equipment + periodic consumables” is taking shape. For most enterprises without market access qualifications, the materials and consumables side is the more realistic compliance pathway; for enterprises already holding certificates or in-hospital resources, the equipment side remains an irreplaceable position.

Insight 6

Demand-Side Reshaping: From "Generalized Seminar Marketing to the Elderly, Infirm, and Chronically Ill" to "Precision Intervention Across the Full Life Cycle"

The industry was long constrained by direct-sales seminar marketing, with its customer base vaguely generalized as "the elderly, infirm, and chronically ill," accompanied by the original sin of false advertising and stringent regulatory crackdowns. As the post-pandemic era has awakened public awareness of "proactive immunity, cellular anti-inflammation, deep antioxidant defense, and anti-aging," and more than a decade of evidence-based research has accumulated—compounded by process breakthroughs in solid-state hydrogen-releasing materials enabling miniaturization and elimination of electrical power—the target customer base is undergoing an irreversible fission into **nine precise vertical segments** (diabetes and prediabetes, refractory chronic ulcer wounds, inflammatory skin diseases, Parkinson's disease and brain health, insomnia and stress regulation, body-shape metabolic fat reduction, the "three highs" and gout, urban anti-aging and self-care-oriented women, and high-intensity athletic recovery).

A Dual-Track Reading of Market Size and Structure

The report adopts a "two parallel measurement bases, no cross-conversion" approach to market sizing, establishing a clear demarcation from the widespread mixing of measurement bases in this field:

Basis One · Empirical Sub-Segment Data

Hydrogen-rich water dispenser sub-segment: approximately **RMB 4.23 billion** in 2025, up **+18.7%** year-over-year; institutions forecast it may exceed RMB 5 billion in 2026 (Boyan Consulting, as relayed by Jiemian News).

Global household hydrogen-rich water dispensers: approximately **USD 598 million** in 2025, projected to reach USD 838 million by 2032 (QYResearch).

Characteristics: single-category, verifiable, credible growth rate; but covers only the "water dispenser" hardware form factor, excluding consumables and personal care.

Basis Two · Host-Industry Penetration Extrapolation

Host denominators: Retail sales of household appliances and audio-visual equipment above designated size reached **RMB 1,169.5 billion** in 2025; cosmetics and personal care **RMB 465.3 billion**; elderly care institutions and service facilities **406,000**.

Industry-size extrapolation: A range derived from a three-layer ratio of "home appliances × water purification share × hydrogen penetration"; this constitutes a media-relayed inference.

Characteristics: discussable and stress-testable, but uncertainty derives from two debatable ratios rather than from unknowns.

MEASUREMENT DISCIPLINE · REQUIRED READING

RMB 4.23 billion ≠ total industry size. It is the single-category hardware sales figure for "hydrogen-rich water dispensers"; reading it as "the size of China's hydrogen health industry" would systematically underestimate consumables, personal care, and agricultural applications, while overestimating the future share of the hardware form factor. A separate claim circulating in the market that "hydrogen-rich water dispensers exceeded RMB 8 billion in 2025" originates from manufacturer-promotion advertorials on commercial websites, lacking institutional attribution and statistical methodology; this report **does not adopt or juxtapose** it, and records it here solely to illustrate the pronounced figure inflation in this category.

EXECUTIVE RECAP · Summary Close

Four Counter-Consensus Judgments, and the Report's Scope Boundaries

1. **Counter-Consensus One: This is share transfer, not market growth.** Global literature on hydrogen molecular bio-medicine totals 5,120 papers, with total volume growth of only 28% over the same period; China's share rose from 14.0% to 32.9%—a forward shift in relative position, not an expansion of absolute volume.
2. **Counter-Consensus Two: Seminar marketing is first and foremost a unit-price structure problem, not a moral problem.** Products with factory prices of RMB 2,000–5,000 and retail prices of RMB 15,000–26,000 cannot achieve natural sell-through in supermarkets and e-commerce; offline experience was one of the few channel formats at the time capable of absorbing that unit price (specialty stores and health-and-wellness institutions likewise—their common feature being heavy offline presence), and exaggerated sales rhetoric is a product of this structure.
3. **Counter-Consensus Three: A certificate is not a pass.** A Class III certificate opens the question of "whether one can enter hospitals," not "whether one can claim to cure disease"—treating market access as a pass is the common starting point for the batch of enforcement actions against enterprises in 2024.
4. **Counter-Consensus Four: With reimbursement closed, "consumable-ization" has shifted from an option to the path with the fewest constraints.** The full text of the medical insurance reimbursement catalog contains no occurrence of the word "hydrogen" (as of the search date of this report), and self-pay decisions are highly sensitive to unit price; among existing product forms, those capable of pushing unit price into a self-pay-acceptable range are primarily consumables. This is not to say no other paths exist—in-hospital self-pay programs, high-net-worth sub-segments, and local pilots may each hold independently—but with the reimbursement side closed, consumable-ization has the fewest preconditions and the lightest channel dependence.

Corresponding Chapters and Primary Evidence for the Four Counter-Consensus Judgments

Table 0-5

Counter-Consensus Judgment	Primary Evidence	Detailed Chapter
Share transfer, not market growth	Global 5,120 papers, up only 28%; China's share 14.0%→32.9%	Chapter 1 §1.2
Seminar marketing is a unit-price structure problem	Factory price RMB 2,000–5,000 / retail RMB 15,000–26,000; difficult natural sell-through in supermarkets and e-commerce	Chapter 3 §3.1
A certificate is not a pass	Only 2 Class III certificates, and limited to a single indication: acute exacerbation of COPD	Chapter 7 §7.2
With reimbursement closed, consumable-ization becomes the path with the fewest constraints	The full text of the Medical Insurance Payment Catalog contains no occurrence of the term "hydrogen" (as of the retrieval date)	Chapter 7 §7.4 / Chapter 8 §8.3

Scope boundaries of this report:

Table 0-6

Items not addressed	Rationale
Clinical efficacy endorsement	All clinical data are cited from publicly available primary literature; specific indications and methods of use must be determined by licensed physicians and regulatory provisions, and this report does not endorse them on their behalf
Investment recommendations and valuation	The report confines itself to factual reconstruction and logical inference regarding industry structure and institutional constraints, and does not assess the investment value of any target
Cross-database numerical conversion	Between publication, registration, and market launch lie three attrition points —"done but not published," "published but not registered," and "registered but not launched"—leaving any conversion-rate calculation without data support
Company rankings	The report confines itself to typological and industry-position judgments; the vast majority of China's 180 verifiable active enterprises have no mandatory disclosure obligation, and rankings lack a comparable basis

Note on Sampling and Data Boundaries

I. How cases were selected. The cases and enterprises cited in this report serve only to illustrate industry typologies and technology routes; they do not constitute an assessment of any individual enterprise, nor do they constitute a ranking or ordering of strength.

II. How robust the data are. Industry participants are predominantly private entities, most of which have no mandatory disclosure obligation, and publicly verifiable information is limited. Accordingly, this report marks all undisclosed matters as "company-stated" or "unverified" and does not engage in inferential completion; subject to this constraint, the collection and compilation of materials are inevitably subject to omissions.

III. What happens if errors are found. The report continuously tracks industry developments, and subsequent versions will update data and conclusions. Factual errors, if identified, are welcome to be pointed out and, once verified, will be retained in the revision record.



Prologue: The History of Industry Development

Where profit has sat has moved three times: from academic credit, to entry barriers, to the supply side of solid-state materials.

Any industry report that begins only with "how large the market is today" leaves the reader with a cross-section; only by laying out the timeline can one see clearly why this industry has come to look the way it does today. The fifty-one-year evolution of China's hydrogen health industry is not a smooth growth curve but a polyline whose direction has been forcibly changed three times by external forces: **scientific discovery, device market access, and regulatory storms**. Each external force redistributed where profit sits in the industry.

Basis for the three-phase division

The phase division is not an equal split by year, but a switch according to the "dominant contradiction of the industry." There are three criteria: market-access status (whether a compliant device pathway exists), product form (equipment or consumable), and channel structure (seminar marketing or public-domain channels). Any fundamental change in one of these marks entry into a new phase.

PHASE I · 1975—2013

Theoretical Pioneering Phase

The international scientific origin was established, while in China civilian and military lines pioneered in parallel. The industry had no products, no standards, and no regulated entities; everything existed in the form of papers and hypotheses.

Dominant contradiction: Is there a scientific basis?
Decisive factor: Who can publish first

PHASE II · 2014—2020

Device Breakthrough Phase

Learned-society institutionalization, enterprise formalization, and a breakthrough in device market access. The emergence of the Class III certificate gave "hydrogen" a legal medical identity for the first time and created the industry's first genuine market-access barrier.

Dominant contradiction: Can a certificate be obtained?
Decisive factor: Who completes clinical trials and registration first

PHASE III · 2021—2026

FMCG-ization and Regulatory Restructuring Phase

Solid-state hydrogen materials freed products from the constraint of a power supply, and the industry shifted from selling equipment to selling consumables; at the same time, a regulatory storm swept through seminar marketing, and the standards system began to fill the gap. The profit position shifted from "channel" to "materials and compliance."

Dominant contradiction: Monetizing compliantly
Decisive factor: Who has the materials and the evidence

Industry Development Timeline

● Key milestone ○ Regular milestone

Phase I · Theoretical Pioneering (1975–2013) PHASE I · THEORY

1975

US *Science* publishes animal experiment on hydrogen treatment of squamous cell carcinoma

Breathing hydrogen at 8 atmospheres for 14 consecutive days significantly inhibited tumors. This was the earliest modern scientific clue in hydrogen medicine, but the high-pressure conditions long prevented its translation into everyday application.**Source:** Paraphrased from popular-science materials of the Affiliated Hospital of Fudan University; the original paper is Science 1975

1991 — **Du Yuanwei explores the biological effects of hydrogen in a secondary-school laboratory**

A senior biology teacher at Zibo No. 4 Middle School in Shandong, he explored the biological effects of hydrogen under secondary-school laboratory conditions. In 1996, he co-authored three short articles with Wei Cuigui in the *Zibo Science and Technology News*, proposing the antioxidant role of hydrogen in scavenging free radicals; in 1999, he published "A New Scientific Topic—The Significance of Hydrogen in Life Activities" in the *Journal of Shandong Normal University*, roughly eight years earlier than the mainstream international narrative of 2007.**Source:** This report's industry database; public records of industry academic conferences

2007.09 — **Shigeo Ohta's *Nature Medicine* paper establishes the "selective antioxidant" mechanism; Sun Xuejun's team launches in parallel**

Shigeo Ohta of Nippon Medical School successfully treated cerebral ischemia in animals with 2% hydrogen gas, an achievement widely regarded as the globally recognized founding point of modern hydrogen medicine. During the same period, Sun Xuejun's team at the Naval Medical University began research in September 2007, making it the earliest team in China and among the earliest cohort worldwide.**Source:** Nature Medicine 2007; Sun Xuejun interview, 2023 (Video China)

2008 — **Sun Xuejun publishes China's first hydrogen medicine study: neuroprotection by hydrogen-rich saline against cerebral ischemia-reperfusion injury**

This is the founding document of domestic hydrogen medicine, and it also established a path dependency for Chinese research—**entering through "serious medical administration routes" such as injection and inhalation**, rather than through drinking. Thirteen years later, this pathway directly determined why the Class III certificate came to reside with an inhalation device.**Source:** National Health Drinking Water Expert Network academic chronology; Academic Journal of Second Military Medical University

2009 — **Zhang Wei et al. publish the review "Research Progress in Hydrogen Medicine"**

The Academic Journal of the Second Military Medical University publishes the first systematic review in China, marking the academic community's emergence into internal dialogue.**Source:** Academic Journal of Second Military Medical University 2009

2011 — **The concept of "hydrogen agriculture" is first proposed by Shen Wenbiao's team at Nanjing Agricultural University**

Professor Shen Wenbiao of the College of Life Sciences at Nanjing Agricultural University, working from research on plant gas signals (hydrogen and methane), proposed the concept of "hydrogen agriculture"—using hydrogen as an agricultural input—and systematically conducted theoretical and field validation of hydrogen-rich water irrigation, hydrogen water seedling cultivation, and protected cultivation. Beyond hydrogen medicine, this constitutes China's second independent extension line of hydrogen science.**Source:** Nanjing Agricultural University official website news(2020-12-31); Shen Wenbiao, "Research Progress on the Botanical Effects of Hydrogen," Journal of Nanjing Agricultural University 2018, 41(3):392-401

2013.08 — **Shanghai Lumy Medical Technology Co., Ltd. is established**

The company initiated R&D on a hydrogen-oxygen generator as early as 2011 and formally registered in August 2013. This long-cycle pathway of "project initiation first, registration second, certificate application third" became the template for all subsequent enterprises seeking Class III certification.**Source:** China Daily 2025-12-26; Lumy Medical official website

2013 — **Yoritaka et al. publish an RCT of hydrogen-rich water in Parkinson's disease (Movement Disorders)**

Eighteen patients drank hydrogen water for 48 weeks; total UPDRS score improved by –5.7 points versus a deterioration of +4.1 points in controls. This represents one of the few high-grade evidence pieces in hydrogen medicine to enter a mainstream clinical neurology journal.**Source:** Movement Disorders 2013, 28(6):836-839, PMID 23400965

Phase II · Device Breakthrough Period (2014–2020) PHASE II · ACCESS

2014.03

The Hydrogen Molecular Biomedicine Professional Committee of the China International Exchange and Promotive Association for Medical and Health Care is established

Sun Xuejun serves as the inaugural chairman. This is the first national academic organization in China's hydrogen biomedicine field, marking the industry's transition from scattered individual efforts to institutionalized exchange.**Source:** China International Exchange and Promotive Association for Medical and Health Care public materials; ScienceNet 2014-08-29 interview

2017.03

The Lumy hydrogen-oxygen nebulizer is approved for the "National Innovation" Class III medical device green channel and passes EU CE Class IIb type testing

Two channels open simultaneously. The National Innovation green channel implies a fundamental change in review queue priority—a precondition for obtaining certification in 2020.**Source:** Lumy Medical official website product center

2017

First batch of solid-state hydrogen materials commercialized: hydrogen water ceramic and multi-element alloy antibacterial materials

Building on results from the Key Laboratory of Eco-Environmental Functional Materials of the Ministry of Education, Shandong Muqi Health Technology Co., Ltd. developed these into sellable products. This is the first node at which the solid-state hydrogen route moved from experimental apparatus to consumer product: materials appeared for the first time as "sellable products" rather than "experimental apparatus"; the subsequent product logic of "no electricity required, miniaturizable, embeddable in daily chemical production lines" grew precisely from here. The company's own history is not elaborated here; see Chapter 4.**Source:** Compiled from public corporate materials

2019.06

Xu Kecheng's "Hydrogen Controls Cancer: Theory and Practice" is released, with Academician Zhong Nanshan endorsing it as "this is real"

Four academicians jointly endorsed the book. This book was the key event that brought hydrogen medicine to public awareness, and it is also the most frequently misappropriated source of "authoritative endorsement" in later seminar marketing scripts—Xu Kecheng himself explicitly positioned it as "rehabilitation, not treatment," a phrase almost invariably omitted at the channel level.**Source:** Sohu 2019-06-02 book launch coverage; Zhihu discussion 2019-06-04

2019.01

Shanghai Jiao Tong University Hydrogen Science Center launches, with three directions: hydrogen energy / hydrogen medicine / hydrogen agriculture

The center was established in June 2018 and officially launched on January 18, 2019. It is China's first provincial- and ministerial-level interdisciplinary platform focused on key common scientific problems in the hydrogen field, with Academician Ding Wenjiang of the Chinese Academy of Engineering as director. It stretched "hydrogen" from a single-point application into a horizontal discipline: breakthroughs in hydrogen storage and transport on the materials side have since continued to spill over into both health and agriculture.**Source:** Shanghai Jiao Tong University news 2019-01-19; Shanghai Jiao Tong University Hydrogen Science Center official website

2019

Enterprises begin introducing research teams from the Chinese Academy of Sciences system to jointly build solid-state hydrogen storage and production laboratories

With funding from local government high-level talent programs, enterprises jointly built new materials laboratories with teams from the Technical Institute of Physics and Chemistry of the Chinese Academy of Sciences. Solid-state hydrogen thus moved from in-house corporate R&D to industry-academia-research co-construction, and the technology entered the industrialization stage.**Source:** Phoenix News Shandong 2026-01-04

2020.02

Lumy obtains the first Class III certificate for a hydrogen-oxygen generator (National Medical Device Registration No. 20203080066)

The first approved hydrogen-oxygen respiratory device in this field in China. At this moment, "hydrogen gas" acquired a legal medical identity in China for the first time, and a genuine market access barrier emerged in the industry.**Source:** NMPA registration information; Lumy Medical official website

2020.03 **"Hydrogen-oxygen mixed inhalation gas" is written into the national "Diagnosis and Treatment Protocol for Novel Coronavirus Pneumonia (Trial Seventh Edition)"**

On March 3, the National Health Commission's seventh edition of the diagnosis and treatment protocol added, under "oxygen therapy measures," the provision that "where conditions permit, hydrogen-oxygen mixed inhalation gas (H2/O2: 66.6%/33.3%) may be used for treatment"; the eighth edition retained the original wording; the ninth and tenth editions deleted this statement. Both inclusion and withdrawal occurred within the text of national-level diagnostic and treatment standards—this was the first time hydrogen medicine was written into a national-level treatment protocol, and also the first time it was withdrawn according to the same procedural standards.**Source:** Original texts of the seventh, eighth, and tenth editions of the National Health Commission protocol; the tenth edition PDF full text is available for verification

2020.11 **The Hydrogen Molecular Biomedicine Branch of the Chinese Association of Geriatric Research is established in Tai'an**

The former branch network of the China International Exchange and Promotive Association for Medical and Health Care was transferred in its entirety; Sun Xuejun serves as honorary chairman, Zhong Nanshan as chief advisor, and Qin Shucun as inaugural chairman, with the secretariat permanently based at Shandong First Medical University. Tai'an thus became the national evidence-based medicine highland for hydrogen medicine.**Source:** Guo Bao Yan Zi [2020] No. 10; branch public materials

Phase III · FMCG-ization and Regulatory Restructuring Period (2021–2026) PHASE III · RESTRUCTURING

2021.11 **The Seventh National Hydrogen Biomedicine Conference (online)**

Held online during the pandemic period; academic exchange was not interrupted.**Source:** Hydrogen Expo official website 2021-11-29

2022.02 **The solid-state hydrogen full-industry-chain model takes shape: integration from raw materials to end products**

The chain closes from raw materials to end products. The solid-state route thus acquired an industrial role as a "materials supplier" rather than merely a component supplier to device manufacturers.**Source:** China.com Shandong 2022-02-16

2022.03 **Zhejiang Lishui AMR Bureau Investigates and Penalizes False Advertising Case Involving Hydrogen-Rich Water Machines**

An early exemplar of local enforcement: exaggerated and fabricated therapeutic claims misled elderly consumers into purchasing hydrogen generators and hydrogen-rich water machines. Regulation began shifting from "case-by-case reporting" to "routine inspection."**Source:** The Paper 2022-03-31

2023 **Huimei Obtains Second Class III Certificate (NMPA Registration No. 20233081929)**

The two certificates are two independent certificates, not a continuation or model extension of a single certificate.**Source:** NMPA registration information; Huimei Medical official website

2024.08 **CCTV's "Financial Investigation" and "Economic Information Broadcast" Successively Expose "Hydrogen Inhalation" Wellness Scams**

Revealed that hydrogen-oxygen experience salons claimed "a single breath of hydrogen can fight tumors and aging," with hydrogen-rich water machines priced at RMB 17,999, while source manufacturers profited from the trend. This marked the industry's lowest point of public credibility and the direct trigger for the collapse of the "efficacy anchor."**Source:** CCTV.com 2024-08-25; China Internet Joint Rumor Refutation Platform 2024-08-26

2024.11 **10th National Congress of Hydrogen Biomedicine (Tai'an, Shandong)**

8 keynote reports and 4 parallel sessions; academic scale returned to its offline peak.**Source:** Hydrogen Expo official website 2024-12-06

2024.11 **General Office of the Shandong Provincial Government Conducts Special Research on Hydrogen Medicine**

Led by Lü Zhenchen, Second-Level Inspector of the Provincial Government General Office, with participation from Kang Rongxin, First-Level Inspector of the Social Development Science and Technology Division of the Provincial Department of Science and Technology, and Qin Shucun, Dean of the Taishan Institute of Hydrogen Biomedicine, among others; a symposium was convened and field research conducted on R&D progress, clinical translation, and industrialization pathways for hydrogen medicine. This was the first time a provincial government general office established a dedicated research project on "hydrogen medicine."**Source:** Phoenix Net Shandong / Sina Shandong 2024-11-18 (attendees and titles as reported)

2025 **Dual Breakthrough on Standards and Reimbursement: GB/T 46918.2-2025 and Lu Yi Bao Fa [2025] No. 15**

The national recommended standard specifies, for the first time, a measurement method for "hydrogen content in fine bubbles" (modified adoption of ISO 7383-2:2024); the Shandong Provincial Healthcare Security Bureau incorporated hydrogen-oxygen inhalation into the nitric oxide inhalation item (Code: 120300003), with public hospitals across the province setting prices autonomously.**One yardstick, one code—but neither a threshold nor payment.****Source:** National Standards Full-Text Public System; Shandong Provincial Healthcare Security Bureau document

2025 ***Shandong Economic Strategy Research* Publishes "Research on R&D and Industrialization Development of Hydrogen Medicine and Hydrogen Agriculture"**

A journal sponsored by the Development Research Center of the Shandong Provincial Government published a special research report on hydrogen medicine and hydrogen agriculture, outlining from the perspective of local decision-makers the R&D status, industrialization bottlenecks, and policy recommendations for both technology lines. The research used leading enterprises in solid-state hydrogen materials and green agriculture within the province as core samples (for enterprise-side details, see Chapter 4). This constitutes the highest-level local government think-tank decision advisory sample across the industry.**Source:** Shandong Economic Strategy Research (sponsored by the Development Research Center of the Shandong Provincial Government); industry reprint, issue number pending

2026.06 **Group Standard *General Specification for Clinical Application of Hydrogen-Oxygen Mixed Gas Inhalation Therapy* Released**

Proposed by the Respiratory Diseases Professional Committee of the Chinese Research Hospital Association, led by the National Respiratory Medical Center (First Affiliated Hospital of Guangzhou Medical University), and jointly developed with Peking Union Medical College Hospital, Shanghai Huimei Medical, and more than 20 tertiary A hospitals nationwide; released on June 13, 2026, at the Health and Wellness Sub-forum of the 18th Straits Forum. This is the first application-level group standard in hydrogen-oxygen medicine.**Source:** China.com 2026-06-16/17; Phoenix Net Hainan; Chinese Research Hospital Association

2026.07 **12th Congress of Hydrogen Biomedicine (Harbin) and Branch Committee Re-election**

Qin Shucun was re-elected Chairman by a wide margin; Ma Xuemei, He Qianjun, Cheng Youqin, and Kang Zhimin were elected or re-elected as Vice Chairpersons. Having convened for twelve consecutive sessions, the congress has become the industry's "academic Olympics."**Source:** Official website of the Chinese Association of Geriatric Research 2026-07-09; China Daily 2026-07-08

The Three Pandemic Years: The Sole Instance of Hydrogen Medicine Entering National Clinical Guidelines

In the fifty-one-year history of hydrogen medicine in China, there has been exactly one instance of it being written into national clinical guidelines, and it occurred in 2020. It merits a dedicated section, not because the industry needs a narrative of glory, but because **within the scope of this report's research, this is the only instance in which "the state's formal text endorsed this technology path-**

way"—and that endorsement had both a beginning and an end: written in, and three years later withdrawn through the same procedure. Both ends occurred within the texts, and thus both ends are verifiable.

I. Textual Facts: Inclusion, Retention, Withdrawal

Table 0-7

Version	Date	Hydrogen-Oxygen Wording Under "Oxygen Therapy Measures"	
Trial Version 7	2020-03-03	**First inclusion**: "Where conditions permit, hydrogen-oxygen mixed inhalation gas (H2/O2: 66.6%/33.3%) may be used for treatment"	A (original NHC text)
Trial Version 8	2020-04	Original sentence retained, unrevised (see facsimile below)	A (original NHC text)
Trial Version 9	2022-03	Oxygen therapy clause no longer contains the word "hydrogen"	B (media cross-reference; original text pending)
Trial Version 10	2023-01	Oxygen therapy clause no longer contains the word "hydrogen"; reverted to "standardized effective oxygen therapy"	A (full text of the Tenth Edition PDF available for verification)

The original texts of the Seventh Edition (dated 2020-03-03), the Eighth Edition, and the Tenth Edition issued by the National Health Commission are available for word-by-word verification. The original text of the Ninth Edition was not captured verbatim in this instance; this report does not present second-hand paraphrases alongside original-text wording as if equivalent. Separately, some media reports claim the clause was "included at Zhong Nanshan's recommendation"; no official document records the identity of the proposer. This claim reflects a media account only and is recorded here for reference, not asserted as fact.


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标　题：关于印发新型冠状病毒肺炎诊疗方案（试行第八版）的通知	发文机关：国家卫生健康委办公厅 国家中医药管理局办公室
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成文日期：2020年08月18日	

关于印发新型冠状病毒肺炎诊疗方案（试行第八版）的通知

国卫办医函〔2020〕680号

各省、自治区、直辖市及新疆生产建设兵团卫生健康委、中医药管理局：

为进一步做好新型冠状病毒肺炎医疗救治工作，我们组织专家在总结前期新冠肺炎诊疗经验和参考世界卫生组织及其他国家诊疗指南基础上，对诊疗方案进行修订，形成了《新型冠状病毒肺炎诊疗方案（试行第八版）》。现印发给你们，请参照执行。

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Figure 0-1 Full view of the publication page on the Chinese government website for the Notice on Issuing the Diagnosis and Treatment Protocol for Novel Coronavirus Pneumonia (Trial Eighth Edition): including the issuing authorities (General Office of the National Health Commission, Office of the National Administration of Traditional Chinese Medicine), the document number Guo Wei Ban Yi Han [2020] No. 680, and the date of issuance August 18, 2020; the oxygen therapy clause ("hydrogen-oxygen mixed inhalation gas may be used where conditions permit") originates from the body of this document.

Image Source: Policy Document Library, Chinese government website gov.cn (published 2020-08-19)


关于印发新型冠状病毒肺炎诊疗方案（试行第八版）的通知

国卫办医函〔2020〕680号

Detail (100%, unscaled): red-header area, document title, and document number Guo Wei Ban Yi Han [2020] No. 680

Key clause (excerpt from original text)

The Diagnosis and Treatment Protocol for Novel Coronavirus Pneumonia (Trial Seventh Edition) (March 3, 2020) for the first time added "where conditions permit, hydrogen-oxygen mixed inhalation gas (H2/O2: 66.6%/33.3%) may be used for treatment" to the oxygen therapy measures; the Eighth Edition retained the original sentence. The screenshot on this page is the notice page issuing the protocol; the clause text itself appears in the body of the attached Diagnosis and Treatment Protocol.

II. Primary Clinical Data: One Publicly Verifiable Multicenter Study

Alongside the policy inclusion, a body of primary clinical data was in fact generated. The representative study is a multicenter study led by Zhong Nanshan's team, published in the Journal of Thoracic Disease in June 2020. Its nature must be stated precisely: **this was a multicenter, open-label, non-randomized study**—the original text explicitly states that "randomization was not performed owing to the urgency of the epidemic," and therefore **it cannot be described as an RCT**.

90 cases

Enrolled sample (screened from 633 cases)

44 cases in the treatment group / 46 in the control group, with 7 hospitals participating

70.5%

Improvement rate in disease severity at end of treatment

31.8% in the control group, P<0.001; on Day 2, 20.5% vs. 2.3%

3 L/min

Actual inhalation flow rate

Original text misprinted 6 L/min; erratum has corrected this to 3 L/min

Why this dataset matters. It is a multicenter study conducted under real-world conditions, led by a national-level respiratory medicine team, and completed at the height of the epidemic: the sample was small and randomization was not possible, but the endpoints were clear, the magnitude of improvement was well defined, and reproducible statistical results were published. Its significance for the industry lies not in "how strong the efficacy is" but in the fact that **"the clinical research capability along this route has been validated once end to end"**—from enrollment, endpoint design, and statistical analysis through to international journal publication, the entire chain has been proven. This demonstrates more about a team's ability to generate evidence than any single paper could.

III. Device Background and Conflicts of Interest That Must Be Disclosed

The device used clinically during the epidemic was the hydrogen-oxygen nebulizer AMS-H-03 from Shanghai Asclepius Meditec, which holds two Class III certificates: Guo Xie Zhu Zhun 20203080066 (2020) and 20233081929 (2023). The acknowledgments section of the aforementioned multicenter study explicitly states that the equipment was provided by this company. Accordingly, when citing this study, **the conflict of interest—that the equipment supplier was also the provider of the study equipment—must be disclosed at the same time**; otherwise, an "academic study" would be read as "independent third-party verification." This report's approach is to state this relationship in the figure caption and the main text, neither concealing nor downplaying it—consistent with how this report treats self-reported corporate materials throughout.



Figure 0-2 Full view of the publication page on the Shandong Provincial Healthcare Security Bureau website for the Notice on Revising Certain Medical Service Price Items Including the High-Sensitivity C-Reactive Protein Assay: including the issuing authority header, index number and publication date, the five articles of the body text, and the signature block; the document number is Lu Yi Bao Fa [2025] No. 15, effective June 20, 2025—the direct basis for the "billing half-open" finding in Chapter 7.

Image Source: Regulatory documents, official website of the Shandong Provincial Healthcare Security Bureau (published 2025-05-20)

关于修订超敏C反应蛋白测定等部分医疗服务价格项目的通知

Detail (100%, unscaled): document title and document number Lu Yi Bao Fa [2025] No. 15

> **Key clause (excerpt from original text)**
>
> Lu Yi Bao Fa [2025] No. 15 directly supplements the item definition of the existing mature item "nitric oxide inhalation (item code 120300003)" by adding "including hydrogen-oxygen mixed gas inhalation therapy," with public hospitals province-wide setting prices autonomously. The screenshot on this page is the notice page; the revised entries appear in the attached Table of Revisions to Certain Medical Service Price Items.

A further clarification: what can be verified at the provincial level is **medical service pricing item establishment**, not a diagnosis and treatment protocol—in November 2021, the Jilin Provincial Healthcare Security Bureau listed "hydrogen-oxygen mixed gas inhalation therapy" as a newly added medical service price item (Ji Yi Bao Lian [2021] No. 28), and the Shandong Provincial Healthcare Security Bureau incorporated "hydrogen-oxygen mixed gas inhalation therapy" into the item definition of "nitric oxide inhalation." These two developments and the "billing half-open" finding in Chapter 7 are different evidentiary facets of the same phenomenon and should not be conflated with diagnosis and treatment protocols.

Academic Institutionalization: One Continuous Conference Series, One National-Level Platform, and Two Generations of Champions

Examining the above timeline more closely reveals that this industry did not grow around any single company or product. What truly transformed "scattered research interest" into "an industry with rhythm, organization, and continuity" was three things: a continuous annual academic conference series unbroken across twelve editions, a national-level interdisciplinary research platform, and two generations of academician-level champions. These three factors together explain why China accounts for a 22.3% share of the global hydrogen medicine literature.

I. Twelve National Hydrogen Biomedicine Conferences: An Unbroken Annual Rhythm

Since its inaugural edition in 2014, the conference has been held for twelve consecutive editions and, based on publicly available sources, is the only national annual academic conference in China's hydrogen molecular biomedicine field to date. Its significance for the industry lies not in scale but in **continuity**—when all in-person conferences halted during the 2021 epidemic, it continued online as scheduled (40,000 online participants). Whether an academic community can withstand external shocks is measured precisely by whether this kind of annual rhythm is broken.

Table 0-8

Edition	Date	City	Scale or Theme
First Edition	2014-03	Beijing	Inaugural Conference of the Branch Society, nearly 200 experts
2nd	2015-06	Beijing	Over 240 attendees, scholars from China, the U.S., and South Korea
3rd	2016-09	Tai'an	Taishan Medical Forum, nearly 400 attendees
4th	2017-12	Foshan	Hydrogen Medicine and Health Industry Branch Society established concurrently

Edition	Date	City	Scale or Theme
5th	2018-10	Beijing	Integrated into the “International Conference on Hydrogen Medicine and Biology”
6th	2019-10	Xi'an	16 plenary session reports
7th	2021-11	Online	Shifted online during the pandemic, 40,000 online attendees
8th	2022-08	Tianjin	36 reports, 17,000 online attendees
9th	2023-11	Haikou	Integrated into the CCGI Aging Industry Conference
10th	2024-11	Tai'an	Over 300 on-site attendees, focusing on new clinical evidence
11th	2025-11	Guangzhou	Hosted by the First Affiliated Hospital of Guangzhou Medical University, audio address by Zhong Nanshan
12th	2026-07	Harbin	Second committee re-election completed concurrently

Source: Data for the 5th, 7th, 8th, 10th, 11th, and 12th conferences are extracted from official press releases on the website of the China Geriatric Health Care Medicine Research Association (for the 12th conference, also see the press release reposted by China Daily from Luwang Network), constituting official figures; the 1st–4th, 6th, and 9th conferences currently have only media retellings, categorized as media retellings—please maintain this distinction when citing. Conferences 1–6 (2014–2019) lack official website archives from the organizer, and are therefore not presented alongside official primary-source data.



Figure 0-3 Backdrop of the 10th National Congress of Hydrogen Biomedicine (2024-11-22—24, Tai'an, Shandong)

Image Source: Official press release, Chinese Association of Geriatric Research website



Figure 0-4 Backdrop of the 11th National Congress of Hydrogen Biomedicine (2025-11, Guangzhou), showing organizers and hosts: the Branch, the First Affiliated Hospital of Guangzhou Medical University, the National Center for Respiratory Medicine, etc.

Image Source: Official press release, Chinese Association of Geriatric Research website



Figure 0-5 Launch Ceremony of the Hydrogen Science Center of Shanghai Jiao Tong University and Founding of the Hydrogen Science and Technology Alliance (2019-01)

Image Source: Shanghai Jiao Tong University News; official university press photo (editorial citation)

II. Three Administrative Transfers of the Academic Body: Where the Branch Came From and Where It Is Now Affiliated

The congress's hosting authority is not nominal—it follows the branch's affiliation. This trajectory has three verifiable nodes: On March 19, 2014, the Hydrogen Molecular Biomedicine Professional Committee of the China International Exchange and Promotive Association for Medical and Health Care (CPAM) was

established in Beijing, with Sun Xuejun as its first chairman; this was the first national academic organization in this field in China. On November 28–29, 2020, with approval from the Chinese Association of Geriatric Research (Guo Bao Yan Zi [2020] No. 10), the Hydrogen Molecular Biomedicine Branch was established in Tai'an, with Qin Shucun elected as its first chairman, Sun Xuejun appointed honorary chairman, and Zhong Nanshan engaged as chief advisor—the academic body thus transferred its affiliation from CPAM to the Chinese Association of Geriatric Research; in July 2026, the second committee was elected concurrently with the 12th Congress, with Qin Shucun re-elected. **Only by understanding this line of administrative transfer can one understand why, as discussed in Chapter 7, "appropriate technologies could be promoted downward from Shandong"**— the affiliated institution of an academic organization determines the level of the health system to which it can promote a technology.

III. The Hydrogen Science Center of Shanghai Jiao Tong University: A National-Level Interdisciplinary Platform

Established in June 2018 and officially launched in January 2019, the Hydrogen Science Center of Shanghai Jiao Tong University is China's first provincial-ministerial-level interdisciplinary platform focused on key common scientific problems in the hydrogen field. It is directed by Ding Wenjiang, an academician of the Chinese Academy of Engineering, and comprises three directions: hydrogen energy, hydrogen medicine, and hydrogen agriculture. Its value to the industry lies in pulling "hydrogen" from a single-point application into a horizontal discipline: in 2021, the team of Professor He Qianjun published in **Nature Communications** on near-infrared photocatalytic in-situ hydrogen generation within tumors—the "hydrogen–hole combined therapy"; in April 2023, an achievement evaluation organized by the Nonferrous Metals Society of China recognized its "magnesium-based solid-state hydrogen storage and transport materials and technology" as internationally leading; in July 2021, the Shanghai Hydrogen Science and Technology Research Society was established, with Ding Wenjiang as president. **Breakthroughs in hydrogen storage and transport on the materials side will ultimately spill over from the energy side to the health side**— this spillover pathway is the physical basis for the judgment in Chapter 4 of this report: "do not build complete units; focus on materials."

Among the three directions, hydrogen agriculture is the most easily overlooked, yet it most resembles "Chinese original" work. The very concept of "hydrogen agriculture" was first proposed by Chinese scholars: in 2011, Professor Shen Wenbiao of the College of Life Sciences at Nanjing Agricultural University, starting from research on plant gas signals (hydrogen, methane), proposed the idea of using hydrogen as an agricultural input and systematically carried out theoretical and field validation of hydrogen-rich water irrigation, hydrogen water seedling cultivation, and protected cultivation; in 2018, in collaboration with Professor Sun Xuejun, he published in the **Journal of Nanjing Agricultural University** "Research Progress on Plant Biological Effects of Hydrogen," consolidating scattered experimental results into a discussable mechanistic thread. Unlike Shanghai Jiao Tong University's emphasis on platforms and engineering, the Nanjing Agricultural University line is characterized by moving from physiological mechanisms to field validation and then extending to standards and quality control systems for household hydrogen agriculture—**if the evidence for hydrogen medicine grows on "inhalation," the evidence for hydrogen agriculture grows "in the soil"**: it depends neither on hospitals nor on payment systems, and is therefore the only technological extension beyond the "four gates" in Chapter 7 of this report that is not constrained by the payer side.

In 2024, hydrogen agriculture completed an "institutional inscription" in Chinese science and technology journals. Science & Technology Review, sponsored by the China Association for Science and Technology, Volume 42, Issue 15, 2024, featured a "Special Topic: Green Hydrogen Energy R&D," publishing two hydrogen agriculture articles in the same issue: first, a review by Yang Haiyan, Zhang Qiuyu, Ling Xiang, Liu Yaqian, Pan Qifang, Han Jinglong, and **Ding Wenjiang** (corresponding author), "Research and Development Progress of Hydrogen in Agriculture" (pp. 22–39, DOI 10.3981/j.issn.1000-7857.2024.01.00065), which consolidated scattered evidence—hydrogen promoting rooting and germination, regulating yield and quality, enhancing stress resistance, extending shelf life, and improving aquaculture survival rates—into a mechanistic thread; second, original research by Yang Haiyan, Zhang Qiuyu, Pan Qifang, et al., "Effects of Magnesium Hydride Coating on Soybean Germination and Seedling Growth" (pp. 58–68, DOI 10.3981/j.issn.1000-7857.2024.07.00812), which treated soybean seeds with MgH_2 coating, using MgO coating as a positive control and no coating as a negative control, and compared germination vigor, germination rate, germination index, and seedling above-ground/below-ground fresh weight, stem length and diameter, total root length, lateral root number, leaf area, and other phenotypic indicators. It concluded that MgH_2-L3 was the optimal formulation and attributed the effect to the synergistic action of magnesium and hydrogen.

The significance of these two papers lies not in their conclusions but in the "methodological turn." A review means the direction already has sufficient empirical evidence to be consolidated; and the "coating" paper is more noteworthy—it advances the application method of hydrogen from **irrigation and seed soaking to seed treatment**, meaning hydrogen begins to be treated as an agricultural input that can be delivered together with seeds, rather than a water-treatment process that must be prepared on site. The implication for industry is direct: **once the carrier is established, the deliverable of hydrogen agriculture shifts from "equipment and water" to "packaged, transportable agricultural inputs"**— this is the same logic observed on the consumer side in this report, "equipment → consumables," replicated on the agricultural side.

Evidence level: the proposal of the hydrogen agriculture concept and the research trajectory of the Nanjing Agricultural University team are drawn from Nanjing Agricultural University official website news (2020-12-31) and the 2018 review in the **Journal of Nanjing Agricultural University**; the comparability of field yield-increase data is still limited by differences in experimental conditions, and this report does not cite specific numerical yield-increase figures.

IV. The Three-Stage Relay of Local Government: From Special Research to Fee Standards

Academic institutionalization explains "who is speaking" in this industry, but it cannot explain "why Shandong was able to open the fee channel first." The answer lies in the actions of the provincial government, and it was a relay sustained over three consecutive years, not a one-off statement.

The first leg was "setting the agenda." On November 8, 2024, **Lü Zhenchen**, Second-Level Inspector of the General Office of the Shandong Provincial People's Government, led a team together with **Kang Rongxin**, First-Level Inspector of the Social Development Science and Technology Division of the Provincial Department of Science and Technology, and **Qin Shucun**, Dean of the Taishan Hydrogen Biomedicine Research Institute of Shandong First Medical University, to convene a special symposium and conduct field research on R&D progress, clinical translation, and industrialization pathways for hydrogen

medicine. This was the first time a provincial government general office placed “hydrogen medicine” as a standalone agenda item for research—previously, hydrogen in local government documents was typically placed under “hydrogen energy industry” as an energy issue.

The second leg was “inscription.” Shandong Economic Strategy Research, sponsored by the Development Research Center of the Shandong Provincial Government, subsequently published “Research on the R&D and Industrialization Development of Hydrogen Medicine and Hydrogen Agriculture,” systematically reviewing the R&D status, industrialization bottlenecks, and policy recommendations of the two technology lines from the perspective of local decision-makers. The weight of this research lies not in how novel its conclusions are, but in **that it wrote “hydrogen medicine and hydrogen agriculture” into a formal publication of a provincial-level think tank**—for local competent authorities, this is a textual basis that can be circulated and cited; the research used leading enterprises in solid-state hydrogen materials and green agriculture within the province as core samples; the full picture on the enterprise side is presented in Chapter 4.

The third leg was “opening the gate.” In 2025, the Shandong Provincial Healthcare Security Bureau incorporated hydrogen-oxygen inhalation into the “nitric oxide inhalation” item (Code 120300003), with independent pricing by public hospitals across the province; in the same year, the national recommended standard GB/T 46918.2-2025 provided a measurement method for “hydrogen content in fine bubbles.” This ruler and this code are the direct source of the “fees half-open” judgment in Chapter 7 of this report.

Only by viewing the three legs together can one understand one thing: institutions do not open themselves; they are pushed open by one circulable text after another. Special research provides facts, think-tank publication provides textual basis, and price listing provides a landing outlet—without any one of the three, everything remains in the symposium meeting room. This is also one of this report's judgments on the industry: **before the payer side opens, what can change the pace of local policy is often not the size of the enterprise, but “whether it can be written into a formal text.”**

V. Two Generations of Advocates: Those Who Convert Academic Credit into Clinical Evidence

What is always scarcest in the industry is never papers, but **people willing to stake their academic credit on clinical work**. This layer has two generations:

Academician Zhong Nanshan · Clinical Side

Since 2014, he has led clinical research on hydrogen-oxygen mixed gas at the First Affiliated Hospital of Guangzhou Medical University/Guangzhou Institute of Respiratory Diseases; in November 2020, he was engaged as Chief Advisor of the Branch; in May 2021, his team's multicenter randomized double-blind controlled trial of 108 patients with acute exacerbation of COPD was published in **Respiratory Research**, a landmark achievement marking hydrogen medicine's entry into high-level clinical research.

Academician Ding Wenjiang · Materials Side

Academician of the Chinese Academy of Engineering, long engaged in magnesium alloys and light alloys research, and the first internationally to break through batch preparation technology for magnesium-based solid-state hydrogen storage materials; in January 2019, as preparation lead, he launched the Hydrogen Science Center of Shanghai Jiao Tong University, subsequently serving as its director and as director of the Shanghai Key Laboratory of Hydrogen Science; in

Boundary statement: The relationship between Zhong Nanshan's team and relevant enterprises is that of **academic collaboration and equipment users in clinical research**, and does not constitute any form of commercial endorsement or therapeutic endorsement.

July 2021, he was elected the first president of the Shanghai Hydrogen Science and Technology Research Society.

What it means: Turning “hydrogen” from an energy carrier into a material system that can be prepared at scale— this is precisely the premise that later allowed the “solid-state hydrogen release consumables” route to be physically viable.

Beyond the two generations of advocates, there is an academic foundation line that cannot be omitted: Professor Sun Xuejun published China's first SCI paper on hydrogen medicine in 2008, served as the first chairman of the first national academic organization in 2014, and became honorary chairman in 2020; Professor Qin Shucun has served as Branch chairman since 2020 and has continuously served as congress chairman, advancing clinical trials toward higher grades. **This report's principle in dealing with these individuals is: write only verifiable specific actions and positions, not evaluative titles**— Professor Xu Kecheng's “hydrogen for cancer control” series consists of follow-up observations and monograph publication, does not constitute randomized controlled evidence, and is therefore recorded in this report only as academic promotion activities, not as a basis for therapeutic efficacy.

Historical Photographic Evidence



Figure 0-6
Phase II physical evidence: hydrogen-oxygen nebulizer
Ascleway Hydrogen-Oxygen Nebulizer AMS-H-03 device unit: white box-type body, universal wheels, blue bubbles visible through the front window, H_2O marking on the body
Image Source: Ascleway Medical official press release product image (PR Newswire, 2021); corresponding to NMPA Class III Registration Certificate 20203080066 / 20233081929



Figure 0-7
Academic community site
Hydrogen Technology Industry Expo forum site: front-row guest seats fully occupied, multiple attendees raising phones to photograph
Image Source: On-site photograph, taken at a public event



Figure 0-8
Phase III Physical Evidence: Solid-State Hydrogen Materials Production Line
Production base and production line photographs: plant grounds, mixing and filling equipment, drying tunnel, and finished-goods shelving (six-panel set)
Image Source: Muqi Technology official website factory display page; full narrative see Chapter 4 case section

Structure Through History: Three Path Dependencies

Once the timeline is filled in, many of the “industry anomalies” discussed in the preceding chapters find their explanation in history. The following three points constitute this report’s governing judgments on the structure of the entire document:

Path Dependency One · Evidence Grew Around "Inhalation"

Sun Xuejun's starting point in 2008 was **hydrogen-rich saline injection**, while Zhong Nanshan's team focused on **hydrogen-oxygen mixed inhalation**. The first impetus for Chinese hydrogen research came from serious medical routes of administration, not from drinking. This determined the landscape twenty years later: of 39 registered trials, 24 are inhalation studies; Class III certificates grew around ventilators; and hydrogen-rich water has only 5 trials dispersed across 5 indications—**no single line of evidence can support a registration certificate**.

Path Dependency Two · Seminar Marketing Was Forced by Unit Price

From 2015 to 2022, the industry had only one product form—electrolysis equipment—with factory costs of RMB 2,000–5,000 and retail prices of RMB 15,000–26,000. Supermarkets and e-commerce struggled to generate natural sell-through, leaving offline experience salons as the only viable channel for long-term customer accumulation. High store rents and lecturer commissions in turn pushed the sales pitch toward exaggeration—**seminar marketing is not a moral problem but a unit-price structure problem**. The 2024 CCTV exposé became a watershed precisely because it shattered the "efficacy anchor" that sustained high unit prices.

PATH DEPENDENCY THREE · MATERIALS CHANGED THE COST STRUCTURE

The value of the solid-state materials route lies not in being "more advanced" but in **transforming the product from a "durable good that must be sold at a high price" into a "consumable that can be sold cheaply."** After the efficacy anchor collapsed and regulation became normalized, the industry increasingly depends on genuine repeat purchases to survive; and the materials route—zero electricity, miniaturizable, embeddable in personal-care production lines—is one of the few paths capable of producing goods priced at tens of yuan with reorder rates above eight times. This historical thread points to the report's principal observation in its latter half: **the regulatory system has opened only two and a half doors, and the product forms that fall between these two and a half doors are predominantly consumables.**

Structural Comparison Across Three Phases: How the Profit Position Migrated

Laying the three phases side by side (see Table 0-9), what merits most attention is not the change in scale but **the three migrations of the profit position**: from "who can speak" (academia) to "who holds the certificate" (market access) to "who controls the materials" (supply). Each migration turned the vested interests of the previous round into a new cost item.

Table 0-9 Structural Comparison of the Three Phases of China's Hydrogen Health Industry (1975–2026)

Phase	Access Status	Product Form	Channel Structure	Profit Position	Landmark Event
I Pioneering Phase 1975–2013	No compliance pathway whatsoever; hydrogen belonged to neither medical devices, food, nor pharmaceuticals	No commercialized products, only laboratory apparatus and self-made electrolyzed water	No channels, only academic conferences and popular-science lectures	**Academic credibility**: publication was capital; whoever could speak benefited	2007 Ohsawa et al., *Nature Medicine*; 2008 Sun Xuejun's first domestic study
II Device Phase 2014–2020	Class III certificate breakthrough (first certificate in 2020); but limited to a single indication—acute exacerbation of COPD	Heavy electrolysis equipment: hydrogen inhalation machines, hydrogen-rich water machines, hydrogen-oxygen nebulizers	Offline experience salons, seminar-marketing franchises; supermarkets and e-commerce struggled to generate natural sell-through	**Access barriers**: the gross-margin gap between certificate holders and assemblers	2017 National Innovation Green Channel; Feb 2020 first Class III certificate; 2019 publication of *Hydrogen Controls Cancer*
III Restructuring Phase 2021–2026	Access unchanged; promotion opened (Shandong appropriate-technology designation); reimbursement half-opened (Code 120300003); **payment not opened**	Solid-state hydrogen consumables: tablets, filter cartridges, face masks, foot patches; zero electricity, embeddable in personal-care production lines	Public-domain e-commerce, private-domain repeat purchases, B2B contract manufacturing and materials supply	**Materials supply**: whoever controls hydrogen-release materials and compliance evidence wins the consumables orders	2022: Full solid-state hydrogen industry chain; Aug 2024: CCTV exposé; 2025: GB/T standard and BMI fee code; Jun 2026: Group standard released

KEY READING POINTS

These three phases are not a case of "the later displacing the earlier" but of **superposition and coexistence**: today the landscape includes LuxMed with its Class III certificate, whole-device vendors still running experience-salon seminar sales, and material suppliers serving personal-care manufacturers. The real industry structure is three generations under one roof rather than iterative substitution—which is why the competitive-landscape analysis later in this report cannot be scored on a single dimension.



Figure 0-9 Three hydrogen water tumblers in a row on a white surface (black/blue/black bodies), representing the consumer-end product format.

Image Source: 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo (May 2026, photographed by the report research team)



Figure 0-10 Official exhibition promotional poster: "2026HST 10th Edition," May 13–15, 2026, Guangzhou Poly World Trade Expo Center

Image Source: 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo (May 2026, photographed by the report research team)

Six Figures Across Fifty-One Years

51	12	2	39	5,120	2.5
years of industry history 1975–2026	National Hydrogen Biology and Medicine Conferences	Class III certificates all held by LuxMed	valid clinical registrations per WHO ICTRP criteria	global hydrogen medicine papers 2007–2026	institutional gates opened four in total

THE GREATEST WARNING HISTORY OFFERS

Over fifty-one years, every leap in this industry has come not from "selling better" but from **some external condition being opened**: a paper, a certificate, a standard release. Conversely, every major setback has come from the same direction—**claims crossing the boundary of evidence**. After the 2024 CCTV exposé, it took the industry a full year to clear the residual "therapeutic-efficacy anchor." That is why, before offering any strategic recommendation, this report states one proposition up front: **in this industry, compliance is not a cost but one of the few competitive assets that appreciates over time rather than being depreciated by it.**

Three Popular Misjudgments That History Corrects

Once the timeline is laid out, the three most widely circulated statements in the industry can each be falsified by specific years. These are not differences of opinion but direct conflicts with historical fact:

Misjudgment One: "Hydrogen medicine is growing explosively"

Historical fact: Publication counts across the four major global journals were 997 → 1,013 → 1,155 → 1,278, a cumulative increase of only 28% over nineteen years—roughly 1.3% annualized. China's share rose from 14.0% to 32.9%, meaning it is **competing**

Misjudgment Two: "Getting a Class III certificate means getting a pass"

Historical fact: Six years after the first certificate in 2020, the country still has only LuxMed's two certificates, and the approved indication is **limited to acute exacerbations of COPD**. The certificate opens the question of "whether one can enter hospitals," not

for share in a pool that is barely growing, not operating in an expanding market. The "explosive growth" narrative is incompatible with bibliometric data.

"whether one can claim to cure all diseases." Treating market access as a pass was the common starting point for the batch of companies penalized in 2024.

MISJUDGMENT THREE · "SEMINAR SALES WILL DISAPPEAR WITH REGULATION"

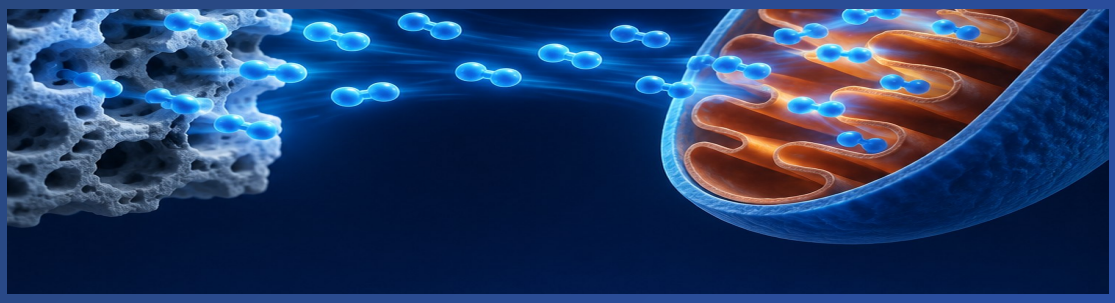
Historical fact: The August 2024 CCTV exposé marked the industry's lowest point of public credibility, yet seminar sales did not disappear. The reason is not moral but structural, rooted in unit price: as long as products remained durable goods priced at RMB 15,000–26,000, supermarkets and e-commerce struggled to generate natural sell-through, and offline experience salons were one of the few venues capable of absorbing that price point. Seminar sales truly began to recede not because of regulation but because **solid-state consumables priced in the tens of RMB emerged after 2022**: once products became cheap enough to close transactions directly on e-commerce, the survival premise of seminar sales was removed. This also explains why this report treats "consumableization" as the core variable of the entire analysis rather than a choice of product category.

PROLOGUE RECAP · Prologue Closing

Three Path Dependencies That Govern the Following Seven Chapters

The prologue is not background. These three path dependencies determine how every "industry anomaly" in the chapters that follow is attributed.

1. **Path Dependency One · Evidence grew on "inhalation."** The first impetus for Chinese hydrogen research came from the route of administration rather than from drinking—twenty years later, 24 of 39 registered trials are inhalation studies, while hydrogen-rich water accounts for only 5 trials scattered across 5 indications, and no single line of evidence can support a registration certificate.
2. **Path Dependency Two · Seminar sales were forced by unit price.** Ex-factory at RMB 2,000–5,000 and retail at RMB 15,000–26,000, supermarkets and e-commerce struggled to generate natural sell-through, leaving offline experience salons as the only way to accumulate customers; high store rents and lecturer commissions in turn pushed the sales pitch toward exaggeration. Seminar sales are a unit-price structural problem, not a moral one.
3. **Path Dependency Three · Materials determine cost structure.** Solid-state materials transform products from "durable goods that must be sold expensively" into "consumables that can be sold cheaply." The regulatory system has opened only two and a half gates, and the formats falling between those two and a half gates are predominantly consumables.



CHAPTER 01

Chapter One The Academic Base and Clinical Evidence

Evidence accumulates on the inhalation side: China contributes 1,143 papers, 22.3% of the global 5,120, yet 24 of the 39 valid registered trials are inhalation studies.

Chapter Highlights · The Academic Base and Clinical Evidence

1. **Share, Not Volume** China has 1,143 cumulative papers (22.3% of the global 5,120), with its share across four periods rising from 14.0% to 32.9% over roughly nineteen years; yet global output over the same period grew only 28%, or about 1.3% annualized. This is share transfer, not market growth.
2. **Evidence Grew on "Inhalation"** Of the 39 valid registered trials, 24 use the inhalation route (61.5%), while hydrogen-rich water accounts for only 5 trials scattered across 5 indications. A single line of hydrogen-rich water evidence can hardly support a Class III registration certificate—this is the scientific origin of the divergent fates of devices and consumables.
3. **Cross-Database Figures Are Not Interconvertible** Between papers (publication) and registrations (registration) lie three loss channels—"done but not published," "published but not registered," and "registered but not conducted"—so any "conversion rate" calculation is fabricated. This report presents them side by side only, without dividing one by the other.
4. **Two Forms of Academic Credit Exchange** In China, academic credit is primarily consumed on the channel side (expert endorsements, lecturer advocacy); in Europe, academic credit is tested at the access and reimbursement side (CE/MDR, health economic evaluation). The same body of papers, two different fates.

1.1 Historical Origins, Mechanistic Hypotheses, and Early Theoretical Pioneering in China

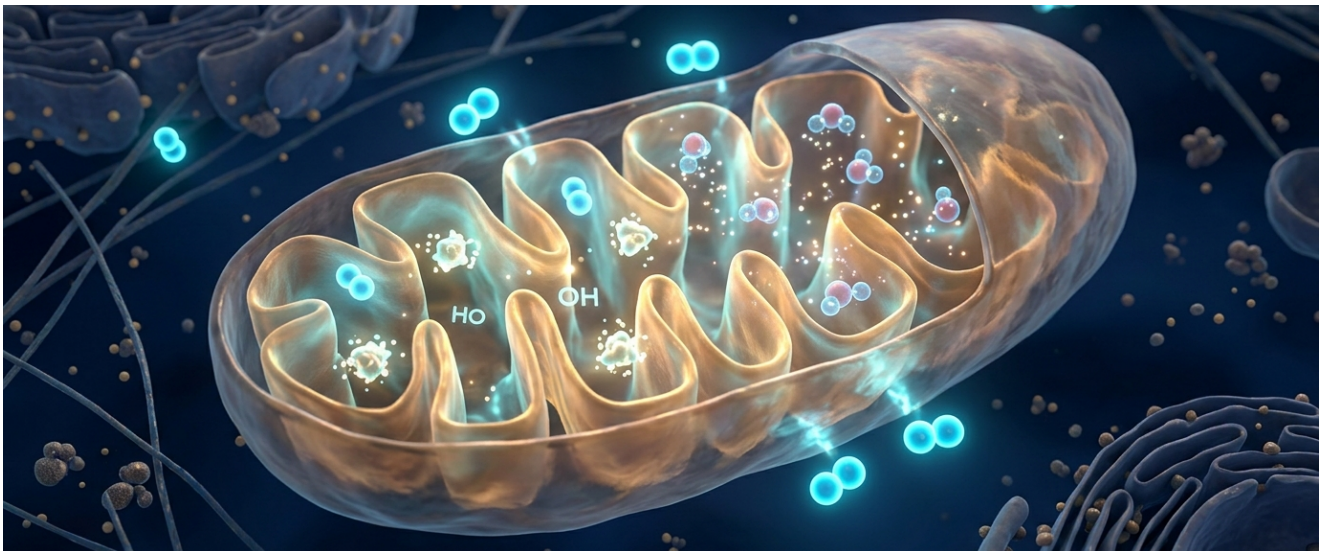


Figure 1-1 Three-dimensional rendering of a mitochondrial cross-section in a deep-blue cellular environment: internal cristae structures glowing, surrounded by floating cyan hydrogen molecules and HO/·OH free radical labels.

Image Source: Report visual asset (mechanistic illustration, not patient imaging)

A review of the evolutionary trajectory of hydrogen molecular biomedicine (Hydrogen Biomedicine) globally and in China reveals a young but prominent discipline that adheres to rigorous modern evidence-based paradigms, while also having undergone a period of scientific exploration in China marked by a distinctly local, pioneering character.

1.1.1 Theory First and Grassroots Pioneering: Teacher Du Yuanwei's Early Exploration and Local Enlightenment

In modern international academia, the 2007 paper on selective antioxidant effects of hydrogen published by Shigeo Ohta of Nippon Medical School in *Nature Medicine* is generally regarded as the origin of modern global hydrogen medicine. But China has an earlier local thread: **Du Yuanwei**, a biology teacher in Zibo, Shandong, together with his wife **Wei Cuigui**, publicly proposed under middle-school laboratory conditions in the mid-1990s the judgment that "hydrogen can scavenge peroxides." This thread long remained confined to local newspapers and internal industry materials, and has only been systematically compiled in recent years.

Historical Note · Why This Material Is Worth Recording

The above facts are drawn from a locally compiled volume, ***The Discovery and Development of World Hydrogen Medicine*** (published 2023, with a bilingual Chinese-English title). The book includes inscriptions and commentaries from **five academicians—Zhong Nanshan, Tang Zhaoyou, Wang Zhenyi, Wang Zhongcheng, and Ni Jiazuan**—as well as dedicated commentary by scholars including **Xu Kecheng, He Qianjun, Ma Xuemei, Liu Jiankang, and Zhang Qing**. It is not an academic publication and had a very limited circulation; it is now difficult to find—precisely why it serves as a **primary historical source** documenting the "grassroots origin" of Chinese hydrogen medicine, rather than yet another retrievable paper.

It should be noted that Du Yuanwei **holds no academic title and is not a mainstream scholar**. His value lies not in credentials but in timing—when no one in China was yet systematically discussing the relationship between hydrogen and the human body, he had already written the first texts in a middle-school laboratory.

Verifiable timeline and texts (paraphrased from the preface and author introduction included in the aforementioned compilation):

- **March 15, 1996**: Published three short articles (co-authored with Wei Cuigui) in the *Zibo Science and Technology News*, proposing that hydrogen has an antioxidant effect by scavenging free radicals. This is one of the earliest publicly documented statements found in China to date.
- **1997**: Proposed the hypothesis that "hydrogen is the body's primordial qi and true qi"—the earliest step in his three-stage research.
- **1999**: Published "A New Scientific Topic—A Preliminary Exploration of the Significance and Role of Hydrogen in Life Activities" in Issue 2 of his alma mater's *Journal of Shandong Normal University*. The paper proposed that the human body accumulates peroxides during metabolism, and that H_2, as a strong reducing agent, can naturally eliminate peroxides without side effects, thereby maintaining "redox homeostasis"—the "hydrogen antioxidant hypothesis" that has since been repeatedly cited. This paper predates Shigeo Ohta's 2007 paper by approximately eight years.
- **2007 and 2013**: Used isotope labeling to measure radioactive counts (CPM) in mouse body fluids and various tissues, experimentally describing the broad distribution of hydrogen after entering the body—a rare quantitative experimental component of his research.
- **Tritium (^3H) tracing**: Used hydrogen isotopes to track hydrogen transport in animals; results were included in the proceedings of the First China Hydrogen Medicine Conference.
- **2019**: Proposed the "biological addition theory of hydrogen" hypothesis at the Sixth Hydrogen Medicine Conference in Xi'an, arguing that it constitutes, alongside antioxidation, one of two underlying logics.
- **Interface with Traditional Chinese Medicine**: Links hydrogen to the traditional concepts of "primordial qi/true qi" and the qi circulation through meridians and acupoints. This component remains a theoretical hypothesis; no academic consensus has yet formed.

How the academic community evaluates it (all quoted from the book's preface; not independently verified by this report): Professor Xu Kecheng calls him "the biologist who first proposed hydrogen's antioxidant and anti-inflammatory properties"; Professor He Qianjun evaluates the 1999 paper as "eight years earlier than Mr. Shigeo Ohta of Japan," while noting that "the in vivo metabolic behavior of hydrogen still requires further in-depth study"; Professor Liu Jiankang holds that Du Yuanwei's work "represents Chinese scholars making a Chinese voice heard in the history of hydrogen medicine"; and Researcher Ma Xuemei organizes his research into "three stages" and evaluates his exposition of hydrogen's antioxidant and free-radical-scavenging functions as "many years earlier than Shigeo Ohta's research in Japan."

The form of these outputs must be stated clearly: they consist primarily of theoretical speculation, short articles in local newspapers, and grassroots experiments, without peer-reviewed mechanistic validation or large-sample clinical testing. This report therefore positions them as "a representative case of early indigenous exploration in China" and does not include them in the efficacy evidence chain.

Their value lies in chronological priority, not evidential strength: Chinese scholars' inquiry into the biological value of hydrogen predated the international mainstream narrative. But converting such inquiry into evidence acceptable to international journals had to wait until after 2008—when scholars including Sun Xuejun and Qin Shucun brought related research into the national research system, and this thread truly connected to the academic establishment.

This report retains this section for reasons unrelated to personal evaluation. If industrial history records only the successful, it will miss a basic fact: under conditions lacking funding, platforms, and academic titles, someone still spent thirty years repeatedly posing the same question. It illustrates two things. First, grassroots imagination regarding hydrogen emerged very early. Second, there is a gap between "proposing a direction" and "producing evidence," and that gap cannot be crossed by individual willpower alone—it requires experimental platforms, funding, and academic institutions. Du Yuanwei reached the "posing the question" end; the segment of turning the question into evidence was carried forward by academic teams who entered the national research system after 2008. This is a common division of labor in industrial history, not a judgment of individual success or failure.

1.1.2 Mechanisms of Action and Academic Consensus in Modern Hydrogen Molecular Biomedicine

Since Professor Shigeo Ohta of Nippon Medical School published his paper in *Nature Medicine* in 2007, modern hydrogen medicine research has undergone nearly two decades of systematic basic and clinical exploration. The academic community has reached a relatively clear core consensus on the biological mechanisms of hydrogen (molecular hydrogen, H_2) as a medical gas and health intervention medium:

1. **Selective Antioxidant**: Hydrogen molecules do not non-specifically neutralize all free radicals; rather, they specifically scavenge the highly toxic and highly destructive hydroxyl radical (·OH) and peroxynitrite anion ($ONOO^-$), while fully preserving reactive oxygen species (ROS) such as superoxide anion ($O_2^{-}\cdot$) and hydrogen peroxide (H_2O_2) that are essential for normal physiological immunity and cell signal transduction. This mild selectivity—which "does not disrupt the body's physiological redox balance"—constitutes the theoretical foundation of its exceptionally high biosafety.
2. **Anti-inflammatory and Cytoprotective Signaling Pathway Regulation**: Hydrogen molecules have a molecular weight of only 2 Da and a van der Waals radius of only 0.12 nm, are electrically neutral and nonpolar, and can freely penetrate cell membranes, the mitochondrial double membrane, and the blood-brain barrier with an extremely high diffusion coefficient. Hydrogen molecules can directly downregulate the transcription of pro-inflammatory cytokines (TNF-α, IL-1β, IL-6) and activate the cell's endogenous antioxidant defense hub—nuclear factor erythroid 2-related factor 2 (Nrf2/ARE pathway)—inducing the expression of endogenous antioxidant enzymes such as heme oxygenase-1 (HO-1), superoxide dismutase (SOD), and glutathione peroxidase (GPx).

3. **Mitochondrial Function Protection and Anti-apoptosis**: By alleviating oxidative damage to the respiratory chain complexes of the inner mitochondrial membrane, stabilizing the mitochondrial transmembrane potential (ΔΨm), inhibiting the pathological excessive opening of the mitochondrial permeability transition pore (mPTP), and blocking the release of cytochrome C (Cyt-c), it thereby blocks the oxidative stress cascade leading to apoptosis.

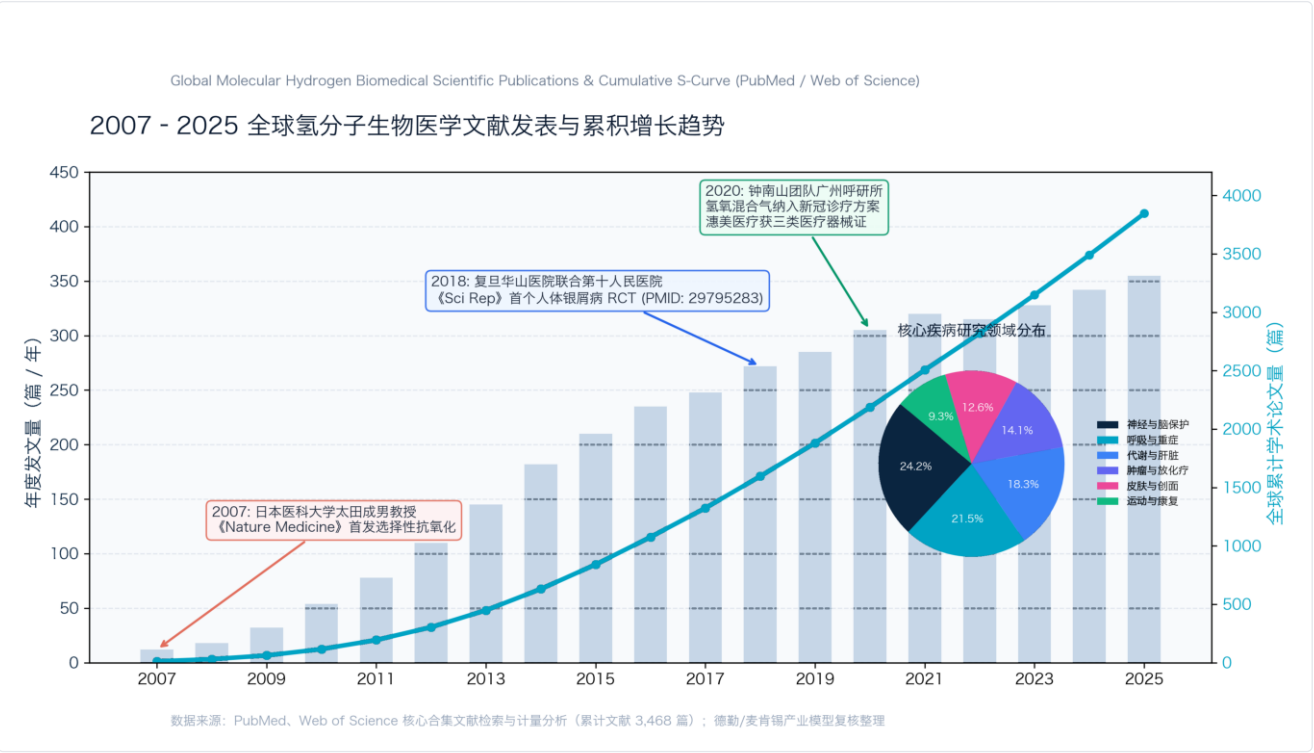


Figure 1-2 Global publication and cumulative trends in hydrogen molecular biomedicine literature, 2007–2025 (PubMed / Web of Science Core Collection bibliometric analysis and McKinsey industry model).

Provides a panoramic view of how, since Professor Shigeo Ohta of Nippon Medical School published his pioneering paper in *Nature Medicine* in 2007, global hydrogen medicine literature has grown steadily from roughly a dozen papers per year to 350+ per year, with cumulative publications reaching 3,468, forming five core clinical research pillars: neuroprotection, critical respiratory care, metabolic syndrome, tumor radiotherapy/chemotherapy toxicity reduction, and skin wound repair.

Source: PubMed E-utilities search re-run (2026-10-18) and Web of Science Core Collection bibliometric analysis; compiled by this report

Reading Guide

- **What to look for:** The horizontal axis is the year, and the vertical axis is the number of new publications that year; the shape of the curve matters more than the absolute values.
- **Key distinction:** "Cumulative 3,468" and "all-period 5,120" are products of two different search queries—the former is limited to core terms, while the latter includes broader subject terms, and **the two must not be used interchangeably**.
- **Common pitfall:** PubMed year-by-year counts **cannot be summed** to obtain interval values (a single paper may have multiple publication dates; in actual testing, summing year-by-year counts for 2017–2021 yielded 86 more records than an interval search).

Key Insights

- **Finding 1:** This is a field of **steady accumulation**, not explosive breakout—global output across four periods rose from 997 to 1,278, a gain of 28% over nineteen years, or roughly 1.3% annualized.
- **Finding 2:** China's trajectory reflects **share capture** (14.0% → 32.9% over roughly nineteen years); that share was transferred from elsewhere rather than generated by a newly expanding market.
- **Finding 3:** The inflection point came in the 2017–2021 period, when China's 29.6% first matched and slightly exceeded Europe's 29.4%.

With respect to routes of administration, the physicochemical properties of molecular hydrogen (a physical dissolution saturation limit of approximately 1.6 ppm / 1,600 ppb in water at ambient temperature and pressure) have directly shaped distinct intake and application pathways:

- **Inhalation (Inhalation)**: Inhalation of a hydrogen-containing gas mixture (2%–4% concentration, or a 66.7% H_2 + 33.3% O_2 mixture) allows molecular hydrogen to enter the bloodstream rapidly via the alveolar capillaries, swiftly raising the hydrogen partial pressure across systemic tissues—particularly in high-perfusion organs such as the brain and cardiopulmonary system.
- **Drinking (Hydrogen-Rich Water, HRW)**: High-concentration hydrogen-rich water is ingested via the gastrointestinal tract, where molecular hydrogen diffuses across the gastric and intestinal mucosa; it has been shown to stimulate enteroendocrine cells of the gastric mucosa to secrete ghrelin (Ghrelin), thereby exerting central neuroprotective and systemic metabolic regulatory effects.
- **Transdermal Absorption and Immersion (Bathing & Topical Application)**: Hydrogen-rich water baths, hydrogen eye patches, dressings, or nebulized hydrogen water spray are used to deliver localized antioxidant and microcirculatory intervention to the skin, periarticular soft tissues, and ocular mucosa.

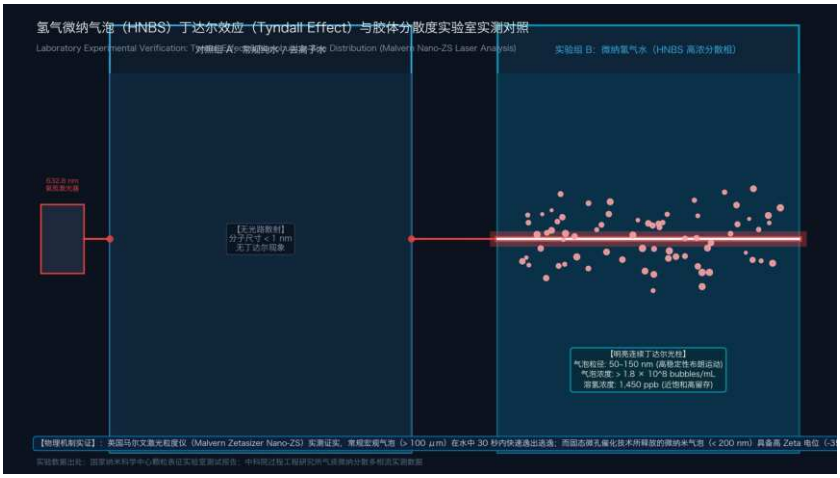


Figure 1-3 Schematic of the Tyndall Effect in hydrogen micro/nano-bubbles (HNBS). A high-energy laser beam passing through a hydrogen-rich solution produces a dense, continuous scattering path of micro/nano-bubbles, illustrating the dispersion morphology of micro/nano-scale hydrogen bubbles in the liquid phase, as distinct from the morphology of coarse bubbles that rapidly escape.

Image Source: Schematic


企業家日報
ENTREPRENEURS' DAILY
杜元伟：世界氢医学理论先行者
思考的价值

Figure 1-4 Magazine interior page, "Du Yuanwei: Pioneer of World Hydrogen Medicine Theory," with an embedded clipping of the same-titled article from Entrepreneur Daily

Image Source: Page facsimile from Entrepreneur Daily, reproduced in The Discovery and Development of World Hydrogen Medicine (2023); author's private collection

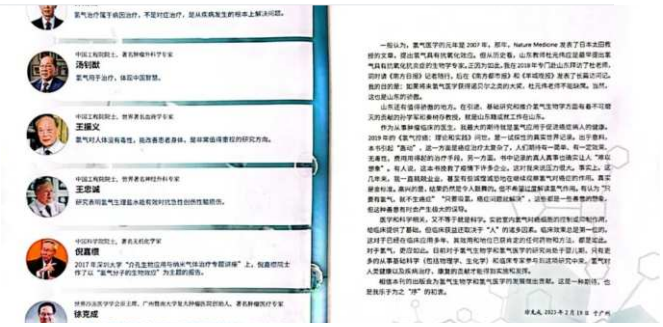


Figure 1-5 Facsimile of the book's preface and inscription pages: on the left, inscriptions by five academicians—Zhong Nanshan, Tang Zhaoyou, Wang Zhenyi, Wang Zhongcheng, and Ni Jiazuan—together with Xu Kecheng's commentary.

Image Source: Facsimile of the preface page of The Discovery and Development of World Hydrogen Medicine (2023); author's private collection

1.2 Global Bibliometrics and China's Position: Steady Accumulation, Not Abrupt Breakout

A reproducible systematic E-utilities search of PubMed, the core international database of medical literature, provides a clear view of the actual output trajectory of global and Chinese hydrogen medicine research over the past two decades.

Following systematic retrieval and rigorous deduplication, the global cumulative total of English-language academic papers on hydrogen molecular biomedicine across all periods stands at **5,120**, of which papers with Chinese scholar affiliations account for **1,143, or 22.3% of the global total**. A longitudinal retrospective tracking across five five-year intervals yields the four-period evolutionary overview shown in the table below:

Table 1-1

Observation Period	Global Total Publications	China Publications	Chinese Scholars' Global Share	Period Characteristics and Academic Trends
Period 1 (2007–2011)	997 papers	140 papers	**14.0%**	Japan led mechanistic breakthroughs; Chinese teams, including at the Second Military Medical University, were among the first to follow up by establishing models
Period 2 (2012–2016)	1,013 papers	250 papers	**24.7%**	Multi-center industry–academia–research collaboration expanded across China; research on hydrogen-rich saline and animal disease models surged
Period 3 (2017–2021)	1,155 papers	342 papers	**29.6%**	China's share reached approximately 30% for the first time; single-period output drew level with Europe (340 papers) for the first time

Observation Period	Global Total Publications	China Publications	Chinese Scholars' Global Share	Period Characteristics and Academic Trends
Period 4 (2022–2026)	1,278 papers	420 papers	**32.9%**	China has become the single largest contributor of papers globally, with clinical translation research accelerating through integration with micro-nanobubble technology

From the above bibliometric data, the consulting team draws three key industry conclusions:

> **First, global hydrogen medicine is not an "explosive field" but a "steadily accumulating field."** Total global publications grew by only 28.2% over the past nearly nineteen years (rising slowly from 997 to 1,278 papers), representing a compound annual growth rate of approximately 1.3%. Claims by certain commercial organizations that "global hydrogen research is undergoing an explosive surge" do not withstand scrutiny against the bibliometric facts.
>
> **Second, China's rise reflects a "concentration of existing share toward China," not a surge in the global total.** China's publication output achieved a 3.0-fold increase, significantly outpacing the global aggregate; this essentially reflects Chinese research teams absorbing a larger share within the field by leveraging their dense research volume and disease-model resources.
>
> **Third, the inflection point occurred during 2017–2021.** During this window, Chinese scholars' share of international publications reached 29.6%, historically surpassing Europe as a whole (29.4%) and establishing China's position as the world's largest producer of research output in hydrogen biomedicine.

1.3 Clinical Trial Registration Landscape (In-Depth WHO ICTRP Verification)

Academic papers reflect the breadth of basic research, but formally registered clinical trials are the hard benchmark for measuring the depth of industrial clinical translation.

The team conducted an all-field advanced search via the World Health Organization International Clinical Trials Registry Platform (WHO ICTRP, which aggregates the Chinese Clinical Trial Registry (ChiCTR) and the U.S. ClinicalTrials.gov). Of the 53 Chinese trials that matched the search terms, rigorous medical screening **excluded 14 records that were false hits on chemical names** (including 3 hydrogen peroxide disinfectant trials and 3 clopidogrel bisulfate and other irrelevant drug trials, for a false-hit rate of 26.4%), ultimately identifying **39 genuine and valid clinical trials of hydrogen molecule intervention**.

Table 1-2

Route of Administration	Number of Trials	Share	Representative Study Indications and Settings
Inhalation	**24 trials**	**61.5%**	Chronic Obstructive Pulmonary Disease (COPD), asthma, pulmonary injury from novel coronavirus infection, acute cerebral infarction, severe respiratory failure
Hydrogen-rich water drinking (Drinking)	**5 trials**	**12.8%**	Metabolic improvement in type 2 diabetes, non-alcoholic fatty liver disease, improvement in sperm motility, post-exercise fatigue elimination, relief of anxiety-like symptoms
Hydrogen-containing solutions and transdermal application (Topical/Solution)	**3 trials**	**7.7%**	Hydrogen-rich peritoneal dialysis solution, perfusion protection of marginal donor kidneys in renal transplantation, hydrogen-rich water bathing for psoriasis
Route of administration not specified	7 trials	18.0%	Exploratory trials including multi-organ protection in sepsis and metabolic intervention following severe infection

A deeper strategic contradiction can be distilled from the clinical registration data:

> **A structural misalignment of the industry: "evidence accrues to inhalation, while consumption accrues to drinking water."** Clinical evidence resources are overwhelmingly skewed toward "inhalation devices" (accounting for over 60%), which is the scientific prerequisite that enabled Shanghai Huimei to obtain a Class III certificate; however, on the commercial consumer side, more than 80% of mass-market demand resides in portable drinking water, daily beauty, and personal-care FMCG scenarios. Human clinical trials for hydrogen-rich water number a mere 5, highly dispersed across non-specific areas such as metabolism and exercise. This directly results in downstream consumer product companies being "unable to present authoritative clinical endorsement of comparable density to that of inhalation," an invisible barrier hindering hydrogen health products from entering mainstream medical channels.

1.4 High-Grade Clinical Evidence Pool and Representative Outcomes Across Three Major Routes of Administration

Although currently WHO-registered clinical trials exhibit a structural bias toward inhalation in terms of number, the global and Chinese medical communities have accumulated internationally credible high-grade evidence across all three core routes of administration:

1.4.1 Gaseous Inhalation Route: Multicenter Parallel-Controlled Trials in Critical Respiratory and COPD Settings

- **Representative outcome**: A multicenter randomized, double-blind, parallel-controlled RCT of high-concentration hydrogen-oxygen mixed inhalation (66.7% H_2 + 33.3% O_2) for acute exacerbation of Chronic Obstructive Pulmonary Disease (COPD) and severe asthma, led by the team of Academician Zhong Nanshan at the National Respiratory Medical Center and the Guangzhou Institute of Respiratory Health.
- **Clinical endpoint value**: Demonstrated that hydrogen-oxygen mixed gas significantly reduces airway flow resistance (improving airway mucociliary clearance rate), rapidly alleviates dyspnea indices, and significantly shortens antibiotic use duration and length of hospital stay. This high-level evidence directly facilitated inclusion in the National Health Commission's diagnostic and treatment protocols and supported the compliant approval of what was then the only Class III innovative medical device in China.

1.4.2 Oral Drinking Route: Glucolipid Metabolic Syndrome and Anti-Atherosclerotic Repair

- **Representative outcome**: A randomized, double-blind, crossover controlled trial in type 2 diabetes and impaired glucose tolerance conducted by Kajiyama et al. in Japan (**Nutrition Research** 2008, PMID: 19083400), and human clinical trials in hyperlipidemia and metabolic syndrome conducted by the team of Qin Shucun at Shandong First Medical University.
- **Clinical endpoint value**: Systematically demonstrated that daily quantified intake of high-concentration hydrogen-rich water (900–1,000 mL/d) not only significantly reduces serum malondialdehyde (MDA) and oxidized low-density lipoprotein (ox-LDL), but also specifically restores the anti-inflammatory and reverse cholesterol transport functions of high-density lipoprotein (HDL), establishing an evidence-based benchmark for lifestyle-based chronic disease intervention.

1.4.3 Transdermal Topical and Microenvironment Perfusion Routes: From Organ Preservation to Regeneration of Refractory Wounds (Frontier High-Impact Outcomes)

- **Representative Outcomes**:
  1. **Protection via normothermic preservation perfusate for solid organs**: In kidney transplantation and myocardial ischemia models, hydrogen-containing organ preservation solutions demonstrated a significant capacity to maintain mitochondrial membrane potential in microvascular endothelial cells, substantially reducing the early delayed graft function rate (DGF) following cold ischemia-reperfusion;
  2. **Anti-fibrotic protection of the peritoneal dialysis fluid microenvironment**: Hydrogen-rich dialysate was used to inhibit epithelial-mesenchymal transition (EMT) of peritoneal mesothelial cells, mitigating peritoneal ultrafiltration failure resulting from long-term dialysis in patients with end-stage renal disease;
  3. **In situ hydrogen generation via nano-biomedical materials for wound repair**: The team led by Professor He Qianjun at the School of Materials Science and Engineering and the Center for Hydrogen Science, Shanghai Jiao Tong University, published a breakthrough study in the

international top-tier multidisciplinary journal **Nature Communications** (2022, 13: 5611, PMID: 36167814), employing biomimetic nano-photocatalytic materials to achieve in situ localized highly active hydrogen generation coupled with glucose depletion, successfully driving rapid angiogenesis and scarless tissue repair in refractory diabetic wounds.

The multi-front advances of the three major delivery routes in rigorous medical journals have fundamentally dismantled the "hydrogen is useless" or "mere pseudoscience" narratives at the source, providing the industry's downstream product matrix with a clearly verifiable scientific coordinate system.

1.5 Core Research Teams, Academic Schools, and Authoritative Organizational Landscape

1,143 papers

Cumulative Chinese publications on hydrogen molecular biomedicine

22.3% of the global total of 5,120 papers; share rising from 14.0% to 32.9% across four periods

2014 year

Establishment of the first national academic organization

March 19: inauguration of the Hydrogen Molecular Biomedicine Committee of the China International Exchange and Promotive Association for Medical and Health Care

2 terms

Completion of leadership transition for the national-level committee

At the July 2026 Harbin leadership transition meeting, Qin Shucun was re-elected as Chair for the second term

2 tenures

Presidential transition of the International Society (ISHMB)

Qin Shucun (first) → He Qianjun (second); Shigeo Ohta serves as Honorary President

China's ability to capture over 32% of global academic literature share in hydrogen molecular biomedicine and to advance clinical and industrial translation is inseparable from the pioneering efforts of core research teams led by authoritative domestic scholars, academic schools, and national and international industry organizations.

Particularly noteworthy is that scholars represented by **Professor Sun Xuejun** not only published China's first SCI paper on hydrogen medicine and established the foundational research network, but have also for fifteen consecutive years remained at the forefront of public science communication (founding the "Hydrogen Thoughts" public science platform and authoring multiple popular science books), dismantling folk superstition and deification with a rigorous and truth-seeking approach, thereby serving as the most solid scientific ballast for the entire industry. Meanwhile, the renowned digestive disease and minimally invasive oncology expert **Professor Xu Kecheng**, with a physician's compassion, pioneered "real-world studies (RWS)" on hydrogen in advanced cancer rehabilitation and palliative care, published the monograph **Hydrogen Controls Cancer**, and devoted immense effort to improving the quality of survival for critically ill patients and alleviating cancer-related fatigue.

Qin Shucun (Shandong First Medical University) Second-tier Professor, doctoral supervisor, Taishan Scholar Distinguished Expert. His long-term research focuses on lipoprotein metabolism and atherosclerosis; in 2013 his team reported in the **Journal of Lipid Research** the effect of hydrogen molecules in improving high-density lipoprotein function. He founded the Taishan Institute of Hydrogen Biomedicine in 2015, served as the inaugural Chair of the Hydrogen Molecular Biomedicine Committee from 2020 (re-elected in 2026), participated in founding the International Society for Hydrogen Medicine

and Biology (ISHMB) in 2017 and served as its first President, and was editor-in-chief of **Hydrogen Medicine: Fundamentals and Applications** (Science Press, 2023). He is also one of the principal drivers behind Shandong's emergence as a national evidence-based highland for hydrogen medicine.

He Qianjun (Shanghai Jiao Tong University) Professor and doctoral supervisor at the School of Materials Science and Engineering, academic leader of the Center for Hydrogen Science, recipient of the National Science Fund for Distinguished Young Scholars, and EU Marie Curie Scholar. He proposed the "nano gas medicine" direction and created the first hydrogen molecular biological probe, enabling real-time imaging of hydrogen distribution and action in vivo. In 2022 his team reported in **Nature Communications** that photocatalytic glucose consumption with in situ hydrogen generation promotes diabetic wound healing. He currently serves as Associate Editor of **Medical Gas Research**, Vice President of the International Society for Hydrogen Molecular Biomedicine, and from 2025 the second President of ISHMB.

Ma Xuemei (Beijing University of Technology) Professor and doctoral supervisor at the College of Chemistry and Life Sciences, member of the University Academic Committee. She has led 863 Program projects and National Natural Science Foundation projects, including two national-level key hydrogen medicine projects; has published over one hundred papers in journals such as **Advanced Functional Materials** and filed more than twenty hydrogen medicine-related patents; her research covers severe trauma management, space biology, and chronic disease mechanisms, and advances the development of hydrogen-specific molecular sensors. She currently serves as Vice Chair of the Hydrogen Molecular Biomedicine Committee and Director of the BJUT–Huaqing Bio Future Health Research Institute.

Kang Zhimin (formerly Second Military Medical University / Naval Medical University) Associate Professor. In 2008 she participated as co-first author in compiling China's first monograph on hydrogen medicine, and has since devoted sustained effort to science communication and knowledge systematization: she served as associate editor of **Hydrogen Molecular Biology**, editor-in-chief of **Hydrogen Health Conversations**, and contributed to **Hydrogen Medicine**, **One Hundred Questions on Hydrogen Medicine**, and other volumes. **Whether a field can consolidate depends precisely on work of this kind**—turning scattered papers into books that are readable, teachable, and transmissible.

Zhou Pei (Shanghai Jiao Tong University) Party Secretary and Distinguished Professor of the School of Agriculture and Biology, Director of the Key Laboratory of Urban Agriculture (South) of the Ministry of Agriculture and Rural Affairs. He is a principal proponent of hydrogen agronomy: in 2023 his team published a systematic review in **Critical Reviews in Environmental Science and Technology** on the regulatory pathways of hydrogen in plant growth, stress resistance, and postharvest preservation, and leads research on high-efficiency cultivation and soil remediation mechanisms of "hydrogen fertilizer–microbial fertilizer–plant interactions." Field-level demonstrations of hydrogen-rich water irrigation and hydrogen water aquaculture are also largely driven by this direction.

Liu Jiankang (Xi'an Jiaotong University) Distinguished Professor, doctoral supervisor, Director of the Institute of Mitochondrial Biomedicine, elected Academician of the European Academy of Sciences and Arts in 2025. His long-term research addresses nutritional regulation of aging and related diseases, free radical biology, and mitochondrial metabolic mechanisms; he has published over 240 SCI papers with an H-index of 66, was editor-in-chief of **Mitochondrial Medicine and Health**, and was consecutively named an Elsevier Highly Cited Chinese Researcher from 2014 to 2020. He currently serves as Vice Chair

of the Hydrogen Molecular Biomedicine Committee. His lineage represents the path of "entering hydrogen medicine through the universal mitochondrial pathway"—not starting from hydrogen to find mechanisms, but starting from mechanisms to embrace hydrogen.

Cheng Youqin (Chinese PLA General Hospital) Chief Physician, long engaged in geriatric clinical practice, formerly Deputy Director of the First Cardiovascular Department of the Nanlou Clinical Division; she serves as a council member of the Chinese Association of Geriatric Research and Secretary-General of the Hydrogen Molecular Biomedicine Committee (some sources record her as Office Director; accounts differ), and chaired the committee's founding meeting in November 2020. This position illustrates one point: **the operation of an academic community depends not only on leading scholars but also on those who can execute meetings, leadership transitions, and bylaws.**

Yu Guanzhen (Longhua Hospital Affiliated to Shanghai University of Traditional Chinese Medicine) Deputy Chief Physician, Visiting Professor, master's supervisor, postdoctoral fellow at MD Anderson Cancer Center, and concurrently Chairman of the Shanghai Huikang Hydrogen Medicine Research Center. His research focuses on precision medicine, tumor evolution, and medical artificial intelligence, with findings published in journals including **GUT** and **Nature Communications**. **He represents the "hydrogen TCM" line**—exploring the integration of hydrogen with external therapies and formulations of traditional Chinese medicine. It should be noted that "hydrogen TCM" is currently more a directional label proposed by research institutions themselves; systematic mechanistic and clinical evidence is still accumulating, and this report records it as "direction exists, evidence pending."

Rearranging the above individuals by "what they do" yields not a roster but a division-of-labor map—demonstrating that China's hydrogen medicine was not built by a single person or institution, but by several non-overlapping pathways advancing simultaneously:

Table 1-3

Direction	Leaders and Representatives	Institutional Affiliation	Representative Methods or Outcomes	Industry Interface
Metabolism and Evidence-Based Medicine	Qin Shucun	Shandong First Medical University · Taishan Institute of Hydrogen Biomedical Research	Hydrogen molecules improve HDL function (JLR 2013); human studies in metabolic disease	Shandong provincial evidence-based and clinical platform
Nanomedical gas therapy	He Qianjun	Shanghai Jiao Tong University School of Materials · Center for Hydrogen Science	Hydrogen molecular biological probes; photocatalytic in situ hydrogen generation (Nat Commun 2022)	Technology transfer, Center for Hydrogen Science
Mechanism and sensing	Ma Xuemei	Beijing University of Technology	Hydrogen regenerative medicine; hydrogen molecular sensors (Arg730-731 gating)	BJUT–Huaqing Hydrogen Biology Future Health Research Institute
Mitochondria and aging	Liu Jiankang	Xi'an Jiaotong University	Mitochondrial biomedicine; hydride ion and metabolic research	Rehabilitation University

Direction	Leaders and Representatives	Institutional Affiliation	Representative Methods or Outcomes	Industry Interface
Respiratory clinical evidence	Zhong Nanshan team	The First Affiliated Hospital of Guangzhou Medical University · National Center for Respiratory Medicine	Multicenter COPD study; diagnostic and treatment protocol provisions	Clinical user of the hydrogen-oxygen nebulizer
Oncology and geriatric clinical practice	Xu Kecheng, Cheng Youqin	Fuda Cancer Hospital of Jinan University; Chinese PLA General Hospital	Real-world observational studies and monographs; geriatric clinical practice	—
Hydrogen agronomy	Shen Wenbiao, Zhou Pei	Nanjing Agricultural University; School of Agriculture and Biology, Shanghai Jiao Tong University	Hydrogen water irrigation, postharvest preservation; hydrogen fertilizer–microbial fertilizer interactions	Solid-state silicon-hydrogen fertilizer, field demonstrations
Hydrogen traditional Chinese medicine	Yu Guanzhen	Longhua Hospital Affiliated to Shanghai University of Traditional Chinese Medicine	Exploration of Integrating Hydrogen with External Therapies in Traditional Chinese Medicine	Collaboration on External TCM Therapies and Yao Medicine
Science Communication and Institutional Development	Sun Xuejun	Naval Medical University (formerly the Second Military Medical University)	China's first SCI paper; science communication platform; founding chair of the branch society	Talent Development and Public Engagement
Knowledge and Publishing	Kang Zhimin	Former Second Military Medical University	First monograph in 2008; associate editor of *Hydrogen Molecular Biology*	Popular Science Publications and Training Systems

These individuals do not represent the entirety of the field. Over the past five years, research on hydrogen biology has expanded into diverse disciplines including materials science, chemical engineering, clinical medicine, agriculture, and traditional Chinese medicine: a cohort of younger researchers has joined successively, multiple universities and hospitals have established their own hydrogen medicine research groups or joint laboratories, and an increasing number of hydrogen-related projects are appearing in national and local research programs.**This report cannot enumerate every participant individually, but whether a field is genuinely active is measured not by the number of prominent figures it contains, but by the projects, publications, and new entrants added each year.** In this sense, China's hydrogen medicine research has moved beyond a stage driven by a handful of individuals into a phase that is considerably lively and considerably fragmented.

1.5.1 Panoramic Comparison of China's Seven Core Academic Schools and Leading Teams in Hydrogen Molecular Biomedicine

Table 1-4

Academic School / Core Team	Disciplinary Foundation and Representative Scholars	Core Research Paradigm and Primary Focus Areas	Representative Achievements and Milestone Events	Industry Ecological Niche and Strategic Impact
1. Basic Mechanisms, Academic Foundation, and Public Science Communication School	**Naval Medical University (formerly the Second Military Medical University)** Professor Sun Xuejun's Team	Diving medicine, hyperbaric oxygen medicine, and molecular biology; focus on selective antioxidant neutralization, anti-apoptotic effects, and endogenous antioxidant signaling networks (Nrf2/HO-1)	Published China's first SCI paper on hydrogen medicine in 2008; chief editor of the foundational monographs *Hydrogen Molecular Biology* and *Hydrogen Medicine*; founded "Hydrogen Thought Discourse," a long-running high-frequency public science communication platform; instrumental in establishing the Hydrogen Medicine Branch of the China International Exchange and Promotive Association for Medical and Health Care	The **"academic enlightener, network organizer, and beacon of scientific communication"** of China's hydrogen biomedicine, laying the foundation for nationwide interdisciplinary basic research and public scientific literacy
2. Metabolic-Cardiovascular and Hydrogen-Rich Water Evidence-Based School	**Shandong First Medical University / Taishan Institute of Hydrogen Biomedical Research** Professor Qin Shucun's Team	Physiopathology and atherosclerosis; deep investigation into the restorative effects of hydrogen-rich water on lipid peroxidation, metabolic syndrome, and the anti-atherosclerotic function of high-density lipoprotein (HDL)	Led multiple human RCTs in metabolic diseases; served as the inaugural president of the International Society for Hydrogen Medicine and Biology (ISHMB); spearheaded the creation of the **Taishan Institute of Hydrogen Biomedical Research**; received the International Hydrogen Molecule Research Outstanding Leadership Award	Established the most systematic and authoritative evidence base for hydrogen-rich water in **chronic disease management, cardiovascular-metabolic intervention, and alignment with international standards**
3. Rigorous Clinical and Critical Respiratory Medicine School	**National Center for Respiratory Medicine / Guangzhou Institute of Respiratory Health** Academician Zhong Nanshan's Team	Respiratory medicine and critical care medicine; focus on high-concentration hydrogen-oxygen mixed inhalation (66.7% H_2 + 33.3% O_2) for airway mucociliary clearance and repair of alveolar inflammatory injury	Led multicenter clinical research on chronic obstructive pulmonary disease (COPD); advanced the inclusion of hydrogen-oxygen mixed gas in the National Health Commission's diagnostic and treatment protocols and secured the only Class III medical device approval in China as of the search cutoff date for this report	Broke through the "ceiling" of rigorous medical market access, establishing the statutory status of hydrogen as a **compliant medical auxiliary gas for emergency and critical care in tertiary hospitals**

Academic School / Core Team	Disciplinary Foundation and Representative Scholars	Core Research Paradigm and Primary Focus Areas	Representative Achievements and Milestone Events	Industry Ecological Niche and Strategic Impact
4. Lightweight Alloy Hydrogen Storage, Nanogas Medicine, and Agricultural Hydrogen Science School	**Hydrogen Science Center, Shanghai Jiao Tong University** Teams of Academician Ding Wenjiang, Professor He Qianjun, and Professor Zhou Pei	Advanced lightweight alloy engineering, nanogas biomedical materials, and modern agricultural hydrogen science form a tripartite structure: Academician Ding Wenjiang focuses on hydrogen storage and medical applications of high-purity magnesium-based materials (HydroMg); Professor He Qianjun (recipient of the National Outstanding Young Scientist Fund and global highly cited scientist) focuses on nanogas medicine, biological targets, biological probes, and photocatalytic hydrogen production for repair; Professor Zhou Pei leads modern agricultural hydrogen biology and aquaculture ecological farming.	Established the university-level Hydrogen Science Center at Shanghai Jiao Tong University; Professor He Qianjun created the world's first hydrogen molecular biological probe and was elected the second President of ISHMB; Professor Zhou Pei pioneered antibiotic-free aquaculture with hydrogen-rich water and high-yield demonstration in protected agriculture; collaborated with upstream materials enterprises to jointly tackle novel solid-state silicon-hydrogen fertilizers.	Represents a national-level, top-tier interdisciplinary "aircraft carrier" extending comprehensively from advanced lightweight alloy engineering and frontier nanotargeted medicine to life and health and modern crop and livestock industries.
5. Hydrogen Molecular Sensors, Cellular Metabolism, and Regenerative Medicine School	**School of Life Sciences, Beijing University of Technology** Team of Professor Ma Xuemei	Cell biology, receptor target regulation, and regenerative medicine; focuses on mechanisms of hydrogen-specific molecular sensors, cellular energy reprogramming (NADP/NADPH), stem cell activation, scarless wound healing, and skin tissue regeneration.	Pioneered the theories of "hydrogen regenerative medicine" and "hydrogen metabolic constitution"; discovered specific channel complexes (e.g., TRPC4) as hydrogen molecular sensors; co-established the "BJUT–Huaqing Biology Future Health Research Institute"; built the "Hydrogen Nation, Hydrogen City" frontier translation pipeline; deeply participated in the development of national standard GB/T 46918.2-2025.	Built a university hard-tech industrialization paradigm of "frontier molecular mechanism discovery–national-level technology transfer–trauma regeneration and hydrogen aesthetic medicine," with a large interdisciplinary talent pipeline and far-reaching industry voice.

Academic School / Core Team	Disciplinary Foundation and Representative Scholars	Core Research Paradigm and Primary Focus Areas	Representative Achievements and Milestone Events	Industry Ecological Niche and Strategic Impact
6. Tumor Rehabilitation, Palliative Medicine, and Real-World Evidence School	**Fuda Cancer Hospital Affiliated to Jinan University** Team of Professor Xu Kecheng	Digestive oncology and minimally invasive tumor treatment; focuses on clinical improvement in quality of life, pain relief, immune function remodeling, and cancer-related fatigue (CRF) among mid- to late-stage cancer patients through hydrogen inhalation.	Published the landmark monograph *Hydrogen for Cancer Control: Theory and Practice*; conducted prospective real-world follow-up studies (RWS) on hydrogen inhalation in hundreds of mid- to late-stage tumor patients; promoted international academic exchange on hydrogen-assisted cancer control.	Pioneered a clinical observation paradigm of **real-world studies (RWS) in community chronic disease and late-stage tumor rehabilitation**, promoting the popularization of hydrogen in severe palliative support with a compassionate medical ethos.
7. Inorganic Microporous Solid Hydrogen and Full-Chain Industry Empowerment School	**Technical Institute of Physics and Chemistry, Chinese Academy of Sciences (Huang Yong team) jointly with Muqi Technology (MQ TECH)**	Advanced inorganic non-metallic materials and mineral catalytic engineering; focuses on microporous lattice hydrogen storage and release technology, safe hydrolysis at ambient temperature and pressure, and moisture-proof passivation processes; appointed grassroots pioneering scholar Mr. Du Yuanwei and others as technical advisors.	Cumulatively filed 37 patents (15 invention patents); pioneered hydrogen-enhanced traditional Chinese medicine (a solid-state hydrogen release material transdermal efficacy enhancement system), silicon-based hydrogen-rich fertilizer, and the five-dimensional full-scenario matrix of “Eat, Drink, Wash, Care, and Soak.”	Became the core of underlying R&D and platform empowerment with the most complete full-industry-chain coverage nationwide **“basic raw materials–FMCG–traditional Chinese medicine–modern agriculture”**.

1.5.2 Founding History and New Leadership Architecture of the World’s Highest Academic Organization (ISHMB)

In the construction of international academic networks, the development history of the highest-level, nonprofit international academic organization in the field of global molecular hydrogen biomedicine—**the International Society for Hydrogen Medicine and Biology (ISHMB)**—profoundly reflects the leap of Chinese scholars to a dominant position in the global academic governance system:

- **Founding of the Society and First Leadership Architecture**: The Society was founded with Shigeo Ohta, Professor at Nippon Medical School and founding figure of international hydrogen medicine, serving as Honorary President; Qin Shucun, Professor at Shandong First Medical University and leading scholar in Chinese hydrogen biomedicine, was elected with broad acclaim as the **first President (first Chairman/President)**; Tyler W. LeBaron, founder and Executive Director of the Molecular Hydrogen Institute (MHI) in the United States, served as a core co-founder as Deputy Secretary-General and international coordinator. The Society brought together scholars from China, the United

States, Japan, Europe, and other countries, regularly convened the International Hydrogen Medicine and Biology Congress, established international academic exchange standards, and established China's early institutional voice in the international hydrogen biology community.

- **Second Council Election and Academic Generational Transition**: In the latest council election, Professor He Qianjun—recipient of the National Outstanding Young Scientist Fund, EU Marie Curie Fellow, global highly cited scientist, Professor at the School of Materials Science and Engineering, Shanghai Jiao Tong University, and academic leader of the Hydrogen Science Center at Shanghai Jiao Tong University—was formally elected as the **second President (President of the Second Council)**, while Professor Qin Shucun assumed the role of first Honorary President.
- **Academic Significance Behind the Leadership Transition**: The smooth handover of ISHMB leadership is not only a reflection of academic generational succession, but also marks a profound **"strategic frontier leap"** in the research paradigm of global hydrogen biomedicine—from the early focus of Professor Qin Shucun's team on "traditional lipid metabolism, atherosclerosis, and physiological pathology" to an accelerated transition toward the "advanced nanobiomedical materials, hydrogen molecular biological target mechanisms, nanobiological probes, localized photocatalytic hydrogen production, and remodeling of the aging microenvironment" represented by Professor He Qianjun's team. The concentration of academic leadership in Shanghai Jiao Tong University's interdisciplinary team further strengthens China's global leading position in next-generation nanohydrogen medicine and intelligent delivery materials.

1.5.3 Authoritative Academic Organizations, National Council Elections, and Annual Hydrogen Medicine Congresses

Centered on the aforementioned top leading scholars, China's hydrogen molecular biomedicine has, over the past decade, completed a systematic institutional evolution from early single-point exploration to specialized branches under national first-level societies and high-level annual academic congresses:

- **Evolution and Transfer of National Academic Organizations (from the China International Exchange and Promotive Association for Medical and Health Care to the China Geriatric Health Care Medical Research Association)**:
  - **Early Institutionalization (2014)**: On March 19, 2014, under the auspices of the China International Exchange and Promotive Association for Medical and Health Care (CHCPA), Professor Sun Xuejun spearheaded the formal establishment in Beijing of the **Hydrogen Molecular Biomedicine Professional Committee of the CHCPA (later renamed a branch)**, with Professor Sun Xuejun serving as its first Chair. This was the first national academic organization in China's hydrogen biomedicine research field, pioneering institutionalized academic exchange for the industry.
  - **Strategic Transfer and Deepened Development (2020)**: As molecular hydrogen achieved deeper breakthroughs in age-related degenerative diseases, chronic disease prevention and treatment, metabolic syndrome, and home-based health interventions, and in order to more precisely align with the national strategy of proactively responding to population aging and the geriatric health service system, the national first-level society registered with the Ministry of Civil Affairs and supervised by the National Health Commission—the **China Geriatric Health Care Medical Research Association**—formally approved (Guo Bao Yan Zi [2020] No. 10) the formal establishment in November 2020 in Tai'an, Shandong, of the **Hydrogen Molecular Biomedicine Branch of the China Geriatric Health Care Medical Research Association**, jointly initiated by Shandong

First Medical University, the PLA General Hospital, Naval Medical University, and other top research institutes. The core expert network and academic functions of the original CHCPA hydrogen medicine branch were **transferred in their entirety and re-established under this branch**; Professor Sun Xuejun was appointed Honorary Chair, Academician Zhong Nanshan was appointed Chief Advisor, Professor Qin Shucun served as the first Chair, and the branch secretariat was permanently based at Shandong First Medical University.

- **Latest Election Facts (July 2026 · Harbin Election Congress)**: After the term of the first committee expired, in July 2026, during the academic annual meeting held in Harbin, the branch successfully convened the **Second Committee Election Congress**:
  - **Professor Qin Shucun was re-elected by a high vote as Chair of the Second Committee**;
  - Professors Ma Xuemei of Beijing University of Technology, He Qianjun of Shanghai Jiao Tong University, Liu Jiankang of Xi'an Jiaotong University, and Shen Wenbiao of Nanjing Agricultural University were elected or re-elected as Vice Chairs; Cheng Youqin of the PLA General Hospital served as Secretary-General of the branch;
  - The committee absorbed top interdisciplinary clinical physicians, life scientists, materials engineering experts, and leading representatives of the industrial chain nationwide, forming the highest academic community spanning "basic theory–clinical evidence–materials translation–industrial entities."
- **The Industry's Most Authoritative Academic Event: The Annual National Hydrogen Biomedicine Congress**: As the most historic, highest-level, and most influential landmark academic event in China and even globally in the field of hydrogen medicine, the **"National Hydrogen Biomedicine Congress"** (as of 2026, twelve consecutive sessions have been successfully held), hosted and led by this branch, is widely recognized as the "academic Olympics" and strategic weathervane of the entire industry. Each session brings together hundreds of academicians from home and abroad, clinical department leaders from tertiary hospitals, university scholars, and compliant industry representatives, centrally releasing the latest global clinical trial results, reviewing industry group standards, discussing regulatory compliance pathways, and building high-quality industry–academia–research docking bridges, representing the highest credibility level of China's hydrogen medicine academic community.

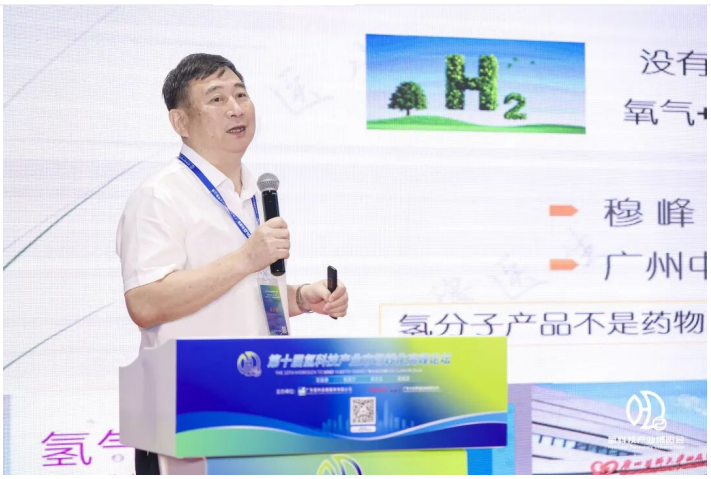


Figure 1-6 Forum venue

Image Source: Guangzhou International Hydrogen Technology Expo / National Hydrogen Biomedicine Conference, photographed at a public event

- **Regional universities and national-level interdisciplinary collaborative platforms**:
  - **Shanghai Jiao Tong University Hydrogen Science Center**: A university-level interdisciplinary frontier center led by Academician Ding Wenjiang of the Chinese Academy of Engineering and drawing on national-level top-tier talent. Among them, **Professor He Qianjun**, a National Science Fund for Distinguished Young Scholars awardee and a globally highly cited scientist, joined Academician Ding Wenjiang's team on a full-time basis as a core academic leader years ago, teaching at the School of Materials Science and Engineering at Shanghai Jiao Tong University and serving as academic leader of the Hydrogen Science Center (leading advanced nano-biomedical materials, nano gas medicine, biological target mechanisms, and the development of the world's first molecular probes; leading a large-scale interdisciplinary research team that has published multiple foundational results in top international journals such as **Nature Communications**, and was elected the second president of ISHMB); Professor Zhou Pei oversees modern agricultural hydrogen biology and aquatic ecological aquaculture. The center brings together forces from the School of Materials, the School of Agriculture and Biology, the School of Life Sciences and the School of Medicine, becoming a strategic stronghold for Chinese universities exploring the "dual-wheel drive of hydrogen energy and hydrogen life health/modern ecological agriculture." Professor Zhou Pei's team has achieved multiple national-level demonstration results in hydrogen-rich water crop irrigation and modern aquaculture (raising fish and shrimp with hydrogen water); it is currently conducting joint industry-academia-research efforts with upstream materials enterprises and other industry players on new hydrogen-rich agricultural fertilizers, solid-state micro-porous soil conditioners, and ecological water-conditioning media for modern aquaculture.
  - **Beijing University of Technology Hydrogen Molecule Research Center & BJUT-Huaqing Biology Future Health Research Institute**: A large-scale interdisciplinary stronghold led by Professor Ma Xuemei, focused on regenerative medicine for trauma, highly sensitive molecular sensors, and frontier translation of hydrogen medical aesthetics, constituting a core pole of deep industry-academia-research integration in northern China.
  - **Tai'an's core hydrogen medicine base (Taishan Hydrogen Biomedicine Research Institute & Tai'an Central Hospital)**: Relying on Shandong First Medical University and the deep academic foundations of Mount Tai, Tai'an has become a nationally renowned "evidence-based hydrogen medicine highland." The "application of hydrogen-oxygen inhalation in the prevention and treat-

ment of COPD at the primary level," carried out by Tai'an Central Hospital, was officially included by the Shandong Provincial Health Commission in its catalog of appropriate health technologies for promotion, extending down to village clinics and community health service stations.

- **The First Affiliated Hospital of Guangzhou Medical University · National Center for Respiratory Medicine (Zhong Nanshan's team)**: The National Center for Respiratory Medicine was approved for establishment by the National Health Commission in July 2020, jointly constituted by the First Affiliated Hospital of Guangzhou Medical University and China-Japan Friendship Hospital, with Zhong Nanshan as honorary director. The hospital has not established a separate "hydrogen medicine center"; hydrogen-oxygen research is advanced under the name of the respiratory discipline team: during the 2020 epidemic period, a 90-case multicenter open-label study was completed (Journal of Thoracic Disease), and in 2021 a 108-case multicenter randomized double-blind controlled study of acute exacerbations of COPD was published (Respiratory Research). This approach—"no dedicated institution, treating hydrogen as one research direction within an existing discipline"—represents a different organizational path from university interdisciplinary platforms.
- **Fuda Cancer Hospital Affiliated with Jinan University (Xu Kecheng's team)**: Xu Kecheng is the founder of the hospital, its current honorary president, and chief expert of its National Key Clinical Specialty (Oncology); in June 2019 he published *Hydrogen Controls Cancer: Theory and Practice*, recording individual cases of hydrogen and tumor rehabilitation through real-world observation. This hospital likewise has not established a separate hydrogen medicine research institution; related exploration is housed under the oncology rehabilitation discipline—which points to one thing: **the forms in which hydrogen medicine takes root in China are not uniform; some are independent platforms, others are a single direction within a discipline.**

1.6 The Mechanism of Academic Credit Generation and the Sino-Foreign Division of Labor

Within the ecological closed loop of China's hydrogen health industry, academic authority plays an extremely delicate commercial role. Domestically, two core academic strongholds have formed around hydrogen molecule biomedicine: the **Hydrogen Molecule Biomedicine Branch of the Chinese Association of Geriatric Research** (which carries on the national network of the former Hydrogen Medicine Branch of the China Association for the Promotion of International Healthcare Exchange and hosts the National Hydrogen Biomedicine Conference annually), and the **International Society for Hydrogen Medicine and Biology (ISHMB)**. A core group of scholars represented by Professor Sun Xuejun of the Naval Medical University, Professor Qin Shucun of Shandong First Medical University, Professor He Qianjun of Shanghai Jiao Tong University, Professor Ma Xuemei of Beijing University of Technology, and Professor Xu Kecheng of Jinan University has long given voice at industry forums and in academic journals.

Table 1-5

Assessment Dimension	China's Hydrogen Health Academic Ecosystem	Europe's Hydrogen Health Academic Ecosystem
Positioning in the knowledge division of labor	**"High-intensity producers" of knowledge** (ranked first in total publications, diverse models)	**"Rigorous certifiers" of knowledge** (focused on randomized double-blind trials and credibility-based market access)
Commercial redemption scenarios for academic credit	**Consumer channel trust (B2C / seminar-marketing experience stores)**	**Medical access and insurance payers (B2B/B2G institutions)**
Determinants of commercial procurement	Reliance on expert endorsements, lecturer testimonials, and society titles	Strict adherence to pharmaceutical and device regulatory registration certificates (CE/MDR) and economic evaluation
Practical predicament	Society titles are highly susceptible to disorderly borrowing by offline experience stores as "treatment endorsements"	The clinical research threshold is extremely high, making it difficult for small and micro innovative enterprises to sustain certification expenditures

Strategic diagnosis: China's academic credit system is primarily commercially consumed on the "channel trust" side. Because public medical procurement and the Basic Medical Insurance (BMI) catalog impose a complete blockade on products without certificates, the vast volume of academic papers cannot be converted into procurement orders within the institutional hospital system, and ultimately almost all of it is channeled into the rhetoric systems of private seminar marketing and experience stores. How to move academic research beyond the "megaphone of seminar marketing" and, through rigorous standardization, convert it into functional support for FMCG and everyday scenarios is the core issue the entire industry urgently needs to resolve.

CHAPTER 01 RECAP · Chapter Summary

Evidence Built on "Inhalation": The Assets and Liabilities of China's Hydrogen Medicine

1. **Leading share ≠ academic leadership.** China accounts for a cumulative 1,143 papers, or 22.3% of the global total of 5,120, with its four-period share rising from 14.0% to 32.9%; yet over the same period global output grew only 28%, meaning part of the share shift stems from slower growth in other countries.



CHAPTER 02

Chapter 02 The Two Technology Routes and Generational Product Evolution

The question is which route can enter which setting, not which is more advanced; a three-orders-of-magnitude price gap hides three parallel markets.

Key Points of This Chapter · The Two Technology Routes and Generational Product Evolution

1. **Physical divergence determines scenario boundaries.** The electrolysis route excels at instantaneous high throughput but depends on mains power and purified water; the material hydrolysis route requires zero electricity, can be miniaturized, and has a retention half-life of 18–24h. It is not about which is more advanced, but about which can enter which scenario.
2. **A dual-mode architecture breaks the "one-off sale."** "Electrolysis module + mineral filter cartridge" shifts whole-machine vendors from one-time hardware purchases to a "razor + blade" model, with annual consumable cash flow of ¥300–800 per household—the true source of channel stickiness.
3. **Three anchors of a 30,000-fold price gap.** The raw-material anchor of ¥0.67 per tablet (functional medium), the commodity anchor of ¥548 per unit (small-appliance logic), and the efficacy anchor of ¥17,999 per machine (health promise). The price gap is not excess profit; it reflects three parallel markets.
4. **The efficacy anchor has collapsed.** The 2024 regulatory storm physically suppressed the room for survival of inflated pricing, forcing the industry back to the "commodity anchor + consumable repurchase" model. This turning point rewrote the victory conditions for every subsequent competitor.

2.1 Physical Essence and Engineering Trade-offs of the Dual Technology Routes



Figure 2-1 A row of red PEM electrolysis stack modules arranged diagonally from large to small

Image Source: Site of the 10th Guangzhou International Hydrogen Technology Industry Expo (2026-05, photographed on site by this report's research team)

Over two decades of technological iteration in China's hydrogen health industry, the product side has diverged into two fundamentally distinct underlying technology routes: **water electrolysis route** and **solid-state hydrolysis / hydrogen storage-and-release route**.



Figure 2-2 On-site at the exhibition: a white self-service hydrogen-rich water vending machine, with the screen labeled "H_2-RICH WATER Hydrogen-Rich Water · True Health"

Image Source: Photographed on site by this report's research team (Guangzhou International Hydrogen Technology Expo / National Hydrogen Biomedicine Conference)



Figure 2-3 Composite image of the AMS-H-03 hydrogen-oxygen nebulizer and corporate branding image from Huimei; registration number as marked on the image

Image Source: Shanghai Huimei Medical Technology Co., Ltd.; device registration information sourced from the NMPA public database

The two routes exhibit irreconcilable physical differences in fundamental principles, engineering implementation, and scenario boundaries:

Table 2-1

Key Technical Indicators	Water Electrolysis Route (SPE / PEM Pure-Water Electrolysis)	Solid-State Hydrolysis Route (Micro-Porous Ceramic Composite / Solid-State Hydrogen Storage and Release)
Core Reaction Mechanism	Water molecules are electrolyzed under an applied DC electric field: $2H_2O \rightarrow 2H_2\uparrow + O_2\uparrow$	Active minerals undergo micro-interfacial reaction with water: $Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2\uparrow$
Power Supply Requirement	**High-power electricity dependence** (requires mains power or large-capacity lithium battery packs)	**Zero power dependence (Zero Power)**, spontaneously generated upon contact with water at ambient temperature
Core Components and Media	Proton exchange membrane (Nafion, etc.), platinum/iridium precious-metal electrode coatings, electrolyzer body	Micro-porous crystalline ceramic microspheres; high-purity nano-modified magnesium-/silicon-based composite carriers
Products and Water Quality	Generates pure hydrogen and oxygen; requires extremely low-conductivity reverse-osmosis or purified water	Generates high-purity dissolved hydrogen, concurrently releasing free weakly alkaline magnesium and calcium beneficial mineral ions
Dissolved Hydrogen State	Produce-and-use immediately; gas-liquid mixed-state half-life is extremely short (typically 1–2 hours at room temperature)	Water molecular clusters become smaller (narrowing of NMR half-peak width); **dissolved hydrogen half-life extends to 18–24 hours**
By-Products and Safety Risks	Non-pure-water electrolysis carries risks of free chlorine and ozone residues; membrane drying failure or dielectric breakdown risk	Reaction by-product is food-grade weakly alkaline magnesium hydroxide precipitate, with no chemical toxicity
Device Form Factor and Size	Requires air pump, cooling fan, power board, and water tank; the overall unit is bulky and difficult to carry	Extreme miniaturization (media can be formed into rice-grain-sized ceramic spheres, thin flakes, or powder filter cartridges)

Key Technical Indicators	Water Electrolysis Route (SPE / PEM Pure-Water Electrolysis)	Solid-State Hydrolysis Route (Micro-Porous Ceramic Composite / Solid-State Hydrogen Storage and Release)
Industrial Manufacturing Barrier to Entry	Assembly barrier is extremely low (modular assembly); core membrane materials are mainly imported	The sintering process and dissolution rate control present exceptionally high barriers, requiring deep cumulative expertise in inorganic non-toxic materials

The two routes are by no means a simple matter of "which is superior" or mutual exclusivity; rather, **hydrogen production scenarios and engineering constraints determine the delivery form**: the electrolysis route excels at instantaneous high-throughput hydrogen production but depends on fixed spaces and grid power; the material hydrolysis route is completely freed from power constraints, possessing inherent characteristics of distributed deployment, sustained long-acting release, and natural mineralization. The two are not mutually isolated—as demonstrated by modern high-end water machines, through the **"electrolysis module + mineral filter" dual-membrane (dual-mode) composite architecture**, the industry is entering a phase of deep integration leveraging the complementary strengths of both routes.



Figure 2-4 Schematic illustration: magnesium/silicon composite particles generate hydrogen gas and magnesium hydroxide byproduct upon contact with water

Image Source: Muqi Technology Industry Database



Figure 2-5 Gray, orange, and teal PEM electrolyzer modules displayed side by side, six units visible

Image Source: 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo (May 2026, photographed by this report's research team)

2.2 Phase One: Market Foundation and Structural Bottlenecks of Device-Based Products

Between 2015 and 2022, the supply side of China's hydrogen health industry was entirely dominated by “hardware devices.” The three flagship products—hydrogen inhalation machines, hydrogen-rich water generators, and electrolytic hydrogen water cups—shouldered the critical mission of early-stage consumer awareness and education in the Chinese market.

Although the hardware form factor during this period gave consumers their first intuitive experience of “hydrogen bubble generation” and “immediate inhalation,” as the market evolved, its structural commercial deficiencies became increasingly pronounced:

1. **Heavy Assets and High Capital Expenditure (High Capex)**: Household high-flow hydrogen inhalation machines typically have factory costs of RMB 2,000–5,000 or above, with end-user retail prices reaching RMB tens of thousands to several tens of thousands. For the vast majority of mass-market consumers, these constitute “durable heavy assets” with an extremely lengthy decision chain.
2. **Absence of Consumable Repurchase (One-Off Transaction)**: Devices are typical one-time hardware purchases. A hydrogen inhalation machine or hydrogen-rich water generator typically has a design life of 3–5 years; once the unit is sold, the transaction chain between the enterprise and the user effectively terminates, and the company cannot capture ongoing customer lifetime value(LTV).
3. **High Maintenance Friction and After-Sales Costs**: Electrolyzer electrodes are prone to scaling and degradation; proton exchange membranes require pure water immersion maintenance. Ordinary consumers who mistakenly add mineral water or tap water can easily cause electrode poisoning and burnout, imposing a heavy after-sales and customer complaint burden on enterprises.
4. **Channel Distortion Toward High-Pressure Seminar Marketing and Experience Store Deviation**: Due to the excessively high unit price of devices and the inability to achieve natural sell-through in traditional supermarkets and mainstream e-commerce platforms, device companies have been forced to rely on offline “free experience centers” for long-term customer indoctrination and lead accumulation. When high store rents, lecturer commissions, and operating costs weigh heavily, sales pitches inevitably slide toward exaggerated efficacy claims or even illegal assertions of “cure-all” capabilities.



Figure 2-6 Three portable hydrogen water cups displayed side by side (transparent bodies, matte black and white bases each embedded with decorative stones)

Image Source: 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo (May 2026, photographed by this report's research team)



Figure 2-7 Still-life product photography of gold and red hydrogen water cups against a white-box background, showcasing color palette and material direction of end products.

Image Source: 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo (May 2026, photographed by this report's research team)

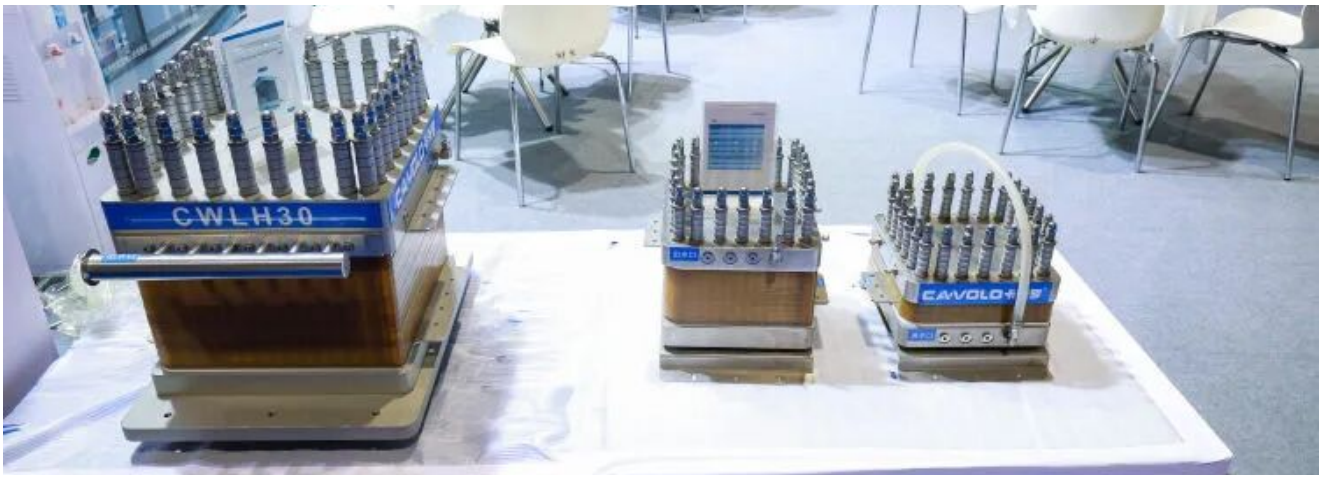


Figure 2-8 Three brown-bodied electrolyzers with chrome-plated pipe fittings displayed side by side (branded CAVOLO)

Image Source: 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo (May 2026, photographed by this report's research team)

2.3 Phase Two: The Rise of Consumer Hydrogen Health Products and Lifestyle Penetration—From “Plug-In Devices” to “Mobile FMCG” Form-Factor Transition

It was precisely under the quadruple squeeze facing traditional heavy devices—“high threshold, no re-purchase, seminar marketing involvement, and regulatory crackdowns”—that beginning around 2018, industry, academic, and research communities began exploring new pathways free from power and mechanical structural constraints. “Consumer hydrogen health FMCG products(FMCG)” underpinned by material hydrolysis and solid-state hydrogen storage and release emerged:

1. **Materials Science Leap Breaking Free from Power and Mechanical Constraints**: Traditional electrolysis devices are constrained by power outlets, lithium batteries, and mechanical pump bodies, severely locking usage scenarios to specific indoor spaces. Domestic materials R&D institutions and pioneer enterprises (many collaborating with CAS system teams) successively tackled micro-nano coating, interface passivation, and controlled hydrogen release technologies, breaking through the

technical bottleneck of violent reactions from elemental metals and achieving stable, controllable hydrogen release in ambient-temperature, ambient-pressure water (reaching 1,200–1,500 ppb near-saturation concentration in open containers at room temperature, with dissolved hydrogen half-life of 18–24 hours). This materials science breakthrough formally opened the industrial pathway for hydrogen health toward “de-mechanization, lightweighting, and portability.”

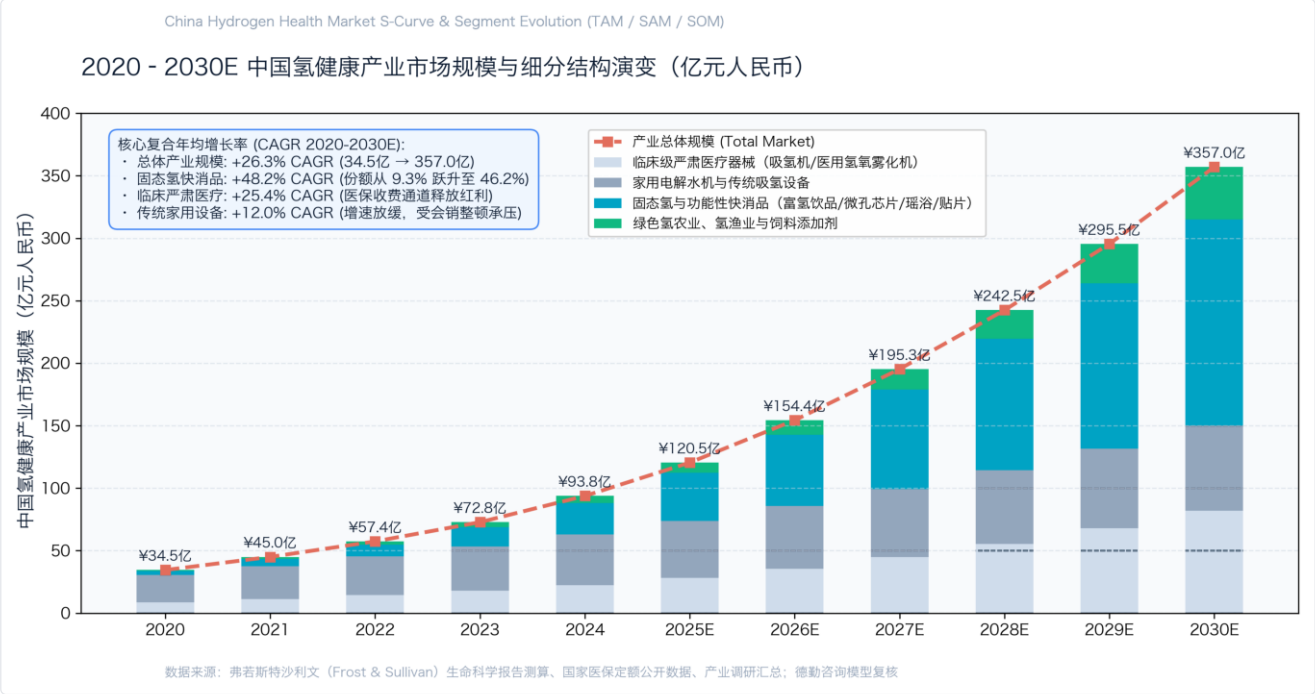


Figure 2-9 China Hydrogen Health Industry Market Size and Segment Structure Evolution Trends, 2020–2030E (TAM / SAM / SOM, Deloitte/McKinsey industry model).

Clearly reveals the steady expansion of China's hydrogen health market from RMB 3.45 billion in 2020 to RMB 12.05 billion in 2025, with a projected breakthrough of RMB 35.70 billion by 2030 (CAGR +26.3%); among which, FMCG products(FMCG) empowered by solid-state hydrogen micro-porous materials exhibit an explosive 48.2% CAGR, with share leaping from 9.3% to 46.2%, becoming the largest growth engine for the entire industry.

Source: Calculations by this report (TAM/SAM/SOM decomposition follows the Deloitte/McKinsey industry model framework; assumptions and denominators detailed in Section 8.1)

Chart Reading Guide

- **What to observe:** Three-tier definitions—TAM (Total Addressable Market) / SAM (Serviceable Addressable Market) / SOM (Serviceable Obtainable Market)—converge from outer to inner layers.
- **Definition discipline:** TAM is derived by multiplying host industries (home appliances RMB 116.95 billion / cosmetics RMB 46.53 billion) by penetration ratios and is therefore **inferential**; SOM represents the portion an enterprise can realistically capture in a given year.
- **Do not conflate:** RMB 4.23 billion (2025 hydrogen-rich water generator segment measured value) is not equivalent to the TAM shown in this figure.

Key Insights

- **Structural judgment:** FMCG products(FMCG) represent the fastest-growing segment and one of the few segments capable of escaping the “one-time purchase” destiny.
- **Risk note:** The value of projections lies in their **stress-testability**—adjust penetration ratios up or down by 30% and observe whether the conclusion reverses; if it reverses, the conclusion should not be incorporated into strategic recommendations.
- **Actionable implication:** Enterprises should allocate resources based on “degree of consumable-ization” rather than “unit price of complete devices.”

2. **Spawning the “Eat, Drink, Wash, Care, and Soak” Panoramic Consumer Matrix**: Leveraging the moldability and medium compatibility of solid-state hydrogen-releasing micro-porous materials, downstream applications have spawned a rich full-scenario FMCG matrix spanning diverse product categories:
   - **Eat**: Solid-state hydrogen-rich effervescent tablets, herbal solid-state hydrogen chewable tablets, and microencapsulated pressed functional tablets (oral intake activates endogenous protection);
   - **Drink**: Portable mineral water hydrogen-element water tumblers, intelligent post-filtration micro-porous hydrogen-release filter cartridges, and sachet-style portable water ceramic sticks (hydrogen-rich water anytime, anywhere);
   - **Wash**: Handmade cold-process hydrogen soap, weakly alkaline hydrogen-rich cleansing foam (deep-cleanses excess facial sebum and free radicals);
   - **Care**: Power-free micro-porous solid-state hydrogen hot/cold eye patches, anti-aging micro-nano hydrogen water facial masks (transdermal antioxidant and periocular microcirculation repair);
   - **Soak**: Hydrogen-rich thermal moxibustion foot patches, high-concentration hydrogen-rich foot bath tablets, and hot-spring-grade hydrogen-rich bath bombs (microcirculation improvement and exercise fatigue relief).



Figure 2-10 Strategic Positioning Matrix of Core Participants in China's Hydrogen Health Industry (BCG 2x2 Strategy Model).

A comprehensive and objective mapping of the strategic positioning and core moats of leading serious medical clinical device players (Shanghai AMS Medical), top-tier beauty-capital-enabled emerging players (Zhejiang KylinWay Medical Technology / led by L'Oréal BOLD), underlying micro-porous material and industry-chain enablers (Muqi Technology), university research translation pioneers (Suzhou Qingde Hydrogen Energy / Peking University Sunan Institute, Shanghai Jiao Tong University Hydrogen Science Center), and traditional seminar-marketing OEM participants.

Source: This report's positioning model (BCG 2×2 framework; company placements determined from publicly available information)

How to Read

- **What to look at:** The horizontal and vertical axes are “technology barriers” and “channel reach,” respectively; the four quadrants correspond to four survival strategies.
- **Basis for classification:** Company placements are based on publicly disclosed registration certificates, patents, channel structures, and financing information, and exclude undisclosed internal data.
- **Dynamic reading:** Quadrant positions are not permanent—policy shifts (e.g., the opening of the reimbursement side) will shift the entire map horizontally.

Key Insights

- **Landscape assessment:** The device layer is scarce (only two Class III certificates nationwide), the material layer is crowded, and the channel layer is fragmented—value capture concentrates at the two ends: “certificates” and “materials.”
- **Common misjudgment:** Mistaking “seminar-marketing volume” for “market share” overstates the true competitiveness of device manufacturers that rely on experience salons.
- **Actionable implications:** For companies without certificates, a more realistic option is not to contest the device layer but to pursue compliant supply on the **consumables and materials** side.

3. **Restructuring the business model and industry fundamentals**: The rise of consumer hydrogen products has expanded hydrogen health from “high-price-point durable devices” for elderly patients with severe chronic diseases into “high-frequency lifestyle FMCG” for a broader base of younger consumers, urban white-collar workers, and sub-health populations. Average order value has fallen from tens of thousands of RMB to the hundreds, while per-customer annual reorder frequency has

risen from 0 for hardware devices to more than 8–12 times, enabling the industry to gradually establish a virtuous commercial cycle that sustains itself through repeat health purchases of the products themselves.

2.4 Technology Convergence and Generational Evolution: The "Electrolysis Module + Mineral Filter" Dual-Module (Dual-Membrane) Composite Solution in the Water Dispenser Ecosystem

In the early narrative of industry evolution, the sector tended to frame the "electrolyzed water route" and the "material hydrolysis/mineral route" as mutually exclusive opposites. In the real business world, however, technological evolution is never a linear "who replaces whom," but rather scenario-driven **complementarity and convergence**.

Particularly in core water dispenser categories—modern high-end household water purifiers and dispensers, commercial direct-drinking machines, smart countertop hydrogen-rich tea bar machines, and community smart hydrogen water stations—the two have fully broken down isolated barriers and moved toward a deeply integrated **"electrolysis module + mineral filter" dual-module (dual-membrane) composite synergistic solution** (Dual-Module / Dual-Membrane Hybrid Architecture):

2.4.1 Physical Engineering Mechanisms and Complementary Synergy of the "Dual-Membrane/Dual-Module" Architecture

The so-called "dual-membrane (dual-module)" architecture manifests in the engineering design of modern high-end water dispensers as precise coordination at two levels:

1. **First membrane (electrocatalytic proton exchange membrane, SPE/PEM)—instantaneous high-throughput hydrogen generation foundation**:
   - The unit is equipped internally with an SPE/PEM pure-water electrolysis cell, which uses an applied DC electric field to achieve millisecond-level rapid electrolysis across both sides of the proton exchange membrane, instantly generating high-purity fine hydrogen microbubbles, rapidly raising the initial dissolved hydrogen concentration in the fluid, and establishing the high hydrogen partial pressure baseline for the dispenser's instant output.
2. **Second membrane/filter (solid-state micro-porous mineral composite functional membrane/filter)—microenvironment regulation, sustained-release long-acting hydrogen retention, and mineralization enhancement**:
   - In the downstream section of the electrolysis pipeline or at the water outlet, a composite filter core centered on food-grade natural micro-porous mineral ceramic spheres (e.g., modified magnesium-based materials, strontium-rich silicate microspheres) is embedded. As water flows through the micro-porous mineral filter, a spontaneous micro-electrochemical sustained-release reaction occurs at the material interface, subjecting the electrolyzed water to deep physicochemical remodeling.

The combination of the two achieves **three qualitative transformations** in fluid physics and chemical indicators that neither route alone can attain:

- **Doubling of dissolved hydrogen half-life and microbubble stability**: Conventional pure electrolyzed water releases mostly micron-scale large bubbles with weak gas-liquid binding and, under open conditions at room temperature, a half-life of only 1–2 hours, making rapid escape highly likely; the downstream solid-state mineral filter, by contrast, continuously dissolves out nano-scale homogeneous hydrogen bubbles and, through the potential shear effect of the micro-porous lattice, significantly refines water molecular clusters (^{17}O-NMR nuclear magnetic resonance half-peak width reduced from above 110 Hz to within 65 Hz), extending the dissolved hydrogen half-life of the dispenser's output to **18–24 hours**, thoroughly overcoming the industry's chronic problem of “hydrogen escaping as soon as water is dispensed and none left overnight.”
- **Water mineralization and natural weak-alkaline reconstruction**: Pure-water electrolysis typically mandates an upstream RO reverse-osmosis system, yielding “deionized pure water” that is extremely soft, slightly acidic, and devoid of mineral elements; the downstream mineral functional filter, while releasing hydrogen upon contact with water, stably releases natural trace elements such as free-state magnesium (Mg^{2+}), strontium (Sr^{2+}), calcium (Ca^{2+}), and metasilicic acid, precisely adjusting the output water quality to a naturally weak-alkaline profile suitable for the human body (pH 7.5 ~ 8.5), with a sweet, rounded taste—thoroughly resolving the pain points of electrolyzed pure water being dry and astringent with no mineral nourishment.
- **Full-time active preservation and safety redundancy (dual-module operation)**: When powered for water production, the system delivers “electrolysis + mineral” dual-driven supersaturated dissolved hydrogen; when the unit is on standby, powered off, or the pipeline is idle overnight, the mineral filter continues to spontaneously release hydrogen through zero-power-dependent material hydrolysis, maintaining a strongly negative oxidation-reduction potential (ORP –300 ~ –600 mV) and a high dissolved-hydrogen microenvironment within the pipeline, effectively inhibiting bacterial biofilm (Biofilm) growth inside the pipeline and forming a physical self-cleaning barrier that requires no chemical antimicrobial agents.

2.4.2 Business Model Restructuring: Breaking the “One-Off Sale” and Launching a New “Equipment + Recurring Consumables” LTV Paradigm

The “dual-module/dual-membrane composite architecture” is not only an engineering rational choice but also a fundamental restructuring of the commercial logic of the water dispenser industry:

Table 2-2

Commercial Dimension	Traditional Single Electrolysis Equipment Model	Traditional single-use consumables model	“Electrolysis device + mineral filter” dual-mode composite model
Nature of transaction	One-time high-value hardware buyout	Low-ticket, fragmented ad hoc purchases	**“Razor + blade” continuous lifecycle lock-in**
Upfront threshold	High (¥3,000–¥15,000)	Extremely low (¥50–¥200)	Moderate (establishing household water trust through a high-quality complete unit)

Commercial Dimension	Traditional Single Electrolysis Equipment Model	Traditional single-use consumables model	"Electrolysis device + mineral filter" dual-mode composite model
Reorder mechanism	**Zero reorders** (no transactions within the 3–5 year hardware cycle)	Requires continuous marketing to reactivate	**Mandatory periodic repurchase** (filter life expiry reminders, replacement every 6–12 months)
Customer lifetime value (LTV)	Fully confined to first-order gross margin	Reliant on costly public-domain traffic acquisition	**Annual contribution of ¥300–¥800 in high-margin consumables cash flow**
Channel partner economics	"Hit-and-run" model that drives seminar marketers away	Thin margins insufficient to sustain offline showrooms	Selling one device locks in long-term revenue sharing from a single household, yielding exceptionally strong channel stickiness

By positioning the solid-state mineral filter as the core consumable component of the water machine, complete-unit brands and distributors have successfully evolved from hardware OEMs whose relationship ends with the sale of a single machine into "life and health service providers" that control users' long-term drinking-water entry point. This hybrid model—locking in the scenario entry point with electrolysis heavy equipment while generating high-frequency cash flow through solid-state mineral filters—is becoming the most certain mainstream product trend in the upgrading of China's water machine industry chain.



Figure 2-11 Product illustration of the new-generation portable micro-porous solid-state hydrogen water tumbler and rear-mounted mineral functional filter. Shows the portable go-anywhere tumbler architecture with a built-in food-grade micro-porous hydrogen-releasing ceramic filter, supporting all-weather spontaneous steady-state hydrogen generation and mineralized weak-alkaline water restructuring across business travel, tourism, or office scenarios.

Image Source: Muqi Technology Product Database



Figure 2-12 Tabletop display of white, gray, brown, and black hollow cylindrical mineralization filters; display board reads hydrogen-rich and selenium-rich + strontium-rich filters

Image Source: On-site at the 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo (May 2026, photographed by the report research team)



Figure 2-13 Dozens of cans of hydrogen-rich water beverages from different brands lined up along a long table, visually conveying category density.

Image Source: On-site at the 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo (May 2026, photographed by the report research team)

2.5 The Hydrogen-Rich Water Category: Three Packaging Generations, Two Process Generations, and an Inescapable Food Compliance Line

If solid-state hydrogen-releasing materials represent “turning hydrogen into a consumable,” then hydrogen-rich water represents “putting hydrogen into a bottle”—the latter appears simpler, yet it is actually the line that has genuinely achieved scale in recent years and was the first to be framed by regulation. The key to understanding this category lies not in technology but in its **legal identity**: under the current regulatory framework, hydrogen-rich water is a **packaged drinking water**—not a device, not a health supplement. This single identity has determined virtually the entire direction of its subsequent product evolution.

I. Regulatory Foundation: Hydrogen Is a “Food Additive,” Water Is “Packaged Drinking Water”

Both pillars of this line rest on explicit national standards: first, the *National Food Safety Standard—Packaged Drinking Water* (**GB 19298-2014**), which classifies packaged drinking water into three categories—natural mineral water, purified drinking water, and other drinking water—and permits moderate addition of food additives but **prohibits the addition of sugar, sweeteners, flavors and fragrances, or other food ingredients**; second, the *National Food Safety Standard—Food Additive: Hydrogen* (**GB 31633-2014**), applicable to food additive hydrogen produced by cracking or electrolysis followed by purification. In other words, hydrogen enters drinking water in the capacity of a “food additive,” not an “active ingredient.”

This characterization can be directly verified at the local licensing level (see Table 2-3), and it is evident that two entirely different types of entities pass through the same gate:

Table 2-3

Entity	Regulatory Anchor Points	Note
Shandong Shibo Jindu Pharmaceutical Co., Ltd. (Zibo)	Food production license: category "Beverages / Bottled (Barreled) Drinking Water," with the detailed scope "1. Packaged drinking water (purified drinking water, other drinking water)," implemented under GB 19298; products include "purified water and hydrogen-rich water."	A pharmaceutical company holding a drug approval goes through a **food** license—not a drug or device license—when making hydrogen-rich water.
Hydrogen Nation Hydrogen City (Shenyang) Beverage Co., Ltd.	A food safety **enterprise standard filing** publicly disclosed by the Shenyang Municipal Health Commission; product name: "Hydrogen-Containing Packaged Drinking Water" (2022-11-25)	It takes the enterprise standard filing route and likewise falls under the packaged drinking water category.

One level up, group standards have also appeared: the group standard for *Nano-Bubble Hydrogen-Rich Drinking Water* specifies technical requirements, test methods, inspection rules, marking, packaging, transportation, storage, and shelf life, and cites GB 31633 (Food Additive Hydrogen) among its referenced documents. **At this point the regulatory positioning of this line is clear: it carries one additional layer of food-additive administration compared with "ordinary water," yet it forgoes the entire functional review process required of "health foods."** What this report describes in Chapter 7 as the "four gates" of unmet payment access manifests in this category as something more basic— **it does not even have the standing to make health claims, and must compete solely on packaging, taste, and use case.**

II. Three Packaging Generations: Each Solves a Specific Physical Problem

Hydrogen is the smallest molecule in nature, and escaping is its natural tendency. The packaging history of this category is therefore, in essence, an engineering history of **"racing against permeation"**—not a history of design. Following the industry's conventional sequence of evolution:

First generation · Pouches (aluminum foil laminate bags, spouted pouches). What it solves is "low cost + light protection + transport radius." The multilayer structure and seal strength of the laminate film, together with the weld quality of the spout, directly determine gas retention over the shelf life—which is why the technical threshold for pouch products actually lies in **sealing and welding**, not in hydrogen infusion. The other side of pouches is their natural fit with private channels and short radii, suiting community and store scenarios beyond seminar marketing.

Second generation · Cans (aluminum cans). What it solves is "barrier performance + pressure resistance + FMCG display." Aluminum's hydrogen barrier performance is markedly superior to most plastics, and the can body's pressure resistance accommodates higher carbonation pressures; combined with shelf display, this makes it the format through which the category genuinely entered convenience stores, food service, and gifting scenarios.

Third generation · Upgraded formats coexisting. Aluminum bottles, PET bottles, glass bottles, and the "make-on-site" route (gas cartridges, solid hydrogen-releasing tablets/cores for instant dissolution and drinking). Differentiation in this generation is no longer determined by technological sophistication but by use case: long shelf life goes to bottles and cans; immediacy and experience go to on-site preparation; gifting and high price points go to glass and aluminum bottles.

Note: This report has not obtained reliable public years for the first appearance of each format in the "pouch → can" sequence, and therefore presents only the order of evolution and the engineering problem each generation solved, **without making judgments on specific dates or first movers**.

This format spectrum is not my inference—the industry itself has written it into its exhibitor catalog. In the official invitation for the 10th Guangzhou International Hydrogen Technology Industry Expo (HST) 2026, the "Hydrogen Technology–Hydrogen Health" exhibit scope explicitly divides hydrogen-rich water into four categories: **"pouch-packed hydrogen-rich water, can-packed hydrogen-rich water, and barreled hydrogen-rich water"** along with solid hydrogen capsules/hydrogen pressed tablets/edible hydrogen granules; at the same time, the "hydrogen-rich drinking water packaging materials" section separately lists **"aluminum cans, tin cans, and hydrogen-rich water barrels."** An industry's willingness to create a dedicated booth category for a packaging material indicates that a stable supplier base and cost structure have already formed—**pouches and cans are not two experiments but two production lines that have already proven out.** (Source: Official invitation, 2026 HST 10th Guangzhou International Hydrogen Technology Industry Expo)

III. Two Process Generations: From "Pure Water Hydrogen Infusion" to "Mineralization"

Early processes were almost uniform: pure water (typically RO deionized water) was infused with hydrogen via aeration or pressure dissolution, with some adopting nanobubbles to extend gas retention. The problem with this route is physical—**the higher the dissolution, the faster the escape**; moreover, RO pure water tastes flat and lacks mineral elements, which consumers can distinguish on the first sip.

Hence the second-generation process: **mineralization**. The approach is to add back food-grade mineral elements to the water, or to pass the water through micro-porous mineral filter media (magnesium-based, silicate types) to complete mineralization and mild alkalization downstream. This step solves three things at once: **taste, gas retention, and regulatory differentiation**—because GB 19298 explicitly prohibits added sugar, sweeteners, and flavorings, leaving companies with a narrow differentiation space, and "mineralization" is nearly the only addition still permissible within this regulatory boundary.

Here is a judgment worth recording: the shift from "pure water hydrogen infusion" to "mineralization" is not technological showmanship but convergence under regulatory constraint. When concentration cannot be claimed, therapeutic efficacy is off-limits, and sweeteners are prohibited, companies are left with only three variables to work with—packaging (gas retention), taste (mineralization), and use case (channel). Essentially all subsequent product iterations in this category are permutations and combinations of these three variables.

IV. An Overlooked Quality Metric: Labeling "at Filling" versus "at Opening"

The hardest technical specification to clarify in this category is not "how much can be dissolved" but **"at which point in time it is measured."** Because hydrogen continuously permeates, a product's instantaneous concentration on the filling line and the concentration when a consumer twists open the cap may differ by several-fold. The prevailing industry practice is to label the value at filling—this is the company's prerogative, but it strips the "concentration" metric of comparability on the shelf.

Ning Chun, founder of Beijing Huoli Hydrogen Source (brand "Fusource"), made a public statement worth recording separately: "We require our products to **meet the hydrogen content standard at the time of opening**, rather than, as most do, labeling the hydrogen content at filling—whatever is written is what the consumer drinks." (Source: China Food Safety Network, 2026-05-21) **The value of this statement lies not in self-verification but in the testable criterion it proposes**—moving the measurement point from "factory gate" to "opening" effectively incorporates the packaging's hydrogen barrier performance, shelf life, and transport conditions into quality accountability.

Accordingly, this report recommends that readers, when encountering any hydrogen-rich water specification, first ask: **Is this figure at filling or at opening? Measured at what temperature and over what shelf life? Who is the third party?**—consistent with this report's treatment of all data throughout: do not look at the magnitude of the number first, but at the measurement basis and evidence grade.

V. Who Is Doing It: Three Types of Players, One Common Regulatory Line

The first type is pharmaceutical companies crossing over. Shandong Shibo Jindu Pharmaceutical extended the "Liuwei" brand asset from pharmaceuticals to water, launching "Liuwei · Hydrogen-Rich Water," described externally as "pharmaceutical-grade hydrogen-rich drinking water"; it claims to rely on an invention patent for "small-molecule high-hydrogen sparkling water" (the patent number given by the company is ZL 2019 1 0309155.6, **a format inconsistent with standard patent application numbering, which this report could not verify and records as claimed by the company**), with dissolved hydrogen concentration claimed at 0.8–1.6 ppm (**company claim, not third-party measured**). It should be noted that this product is **a newly launched product introduced alongside a national investment promotion conference in April 2026**, not a mature SKU that has undergone years of market validation—a point important for assessing the company's actual production and channel capabilities. Notably, it invokes "pharmaceutical-grade" **production standards**, not drug status—on the license, it remains packaged drinking water. This precisely illustrates: **"pharmaceutical-grade" is marketing language; "packaged drinking water" is the legal identity.**

The second type is specialized beverage companies. Hydrogen Nation Hydrogen City (Shenyang) Beverage Co., Ltd. is registered in the Shenyang Economic and Technological Development Zone, with legal representative Sun Xuesong; it completed enterprise standard filing for "hydrogen-containing packaged drinking water" in 2022 and has since continued to exhibit at major health and premium water trade shows. Its brand name is "Hydrogen Nest," positioned externally around "nano hydrogen locking" and food-grade hydrogen filling, with products including 345/360 mL aluminum cans and 10 L barreled water (**company claims**, claiming dissolved hydrogen of 2,000–3,000 ppb). **There are two public versions of its founding year**—the business registration records 2021, while a learned society's member page records 2018; this report presents both versions side by side without arbitrarily choosing one. Sun Xuesong also appeared at the 2024 Beijing CIHIE Hydrogen Health Products Exhibition roundtable under the identity of "Chairman of Qingzhu Company," with media describing his background as "transitioning from the gas industry to hydrogen medicine"—**this path is highly representative: those who make water are often not from the water industry but transitioned from industrial gases**. The hallmark of such players is **core capability in channel and brand operations**, with production capacity and formulation relying on contract manufacturing and upstream gas supply.

The third type is technology-driven brands. Beijing Huoli Hydrogen Source Beverage Co., Ltd. was founded in January 2013, with legal representative Ning Chun; it sells hydrogen-rich water under the "Fusource" brand and has extended into household equipment such as hydrogen-rich water machines and hydrogen-rich shower machines, forming a dual "water + machine" line. Its technology route differs from the mainstream: after comparing pressurized hydrogen dissolution, electrolytic hydrogen generation, and other paths, the team ultimately settled on **ultrasonic gas-liquid nano-mixing**—relying on ultrasonic atomization to achieve nanoscale gas-liquid fusion, with no chemical reaction throughout the process; it claims multiple patents, zero wastewater, waste gas, or solid waste in production, and energy consumption at a fraction of conventional processes (**company claims**). Its 2023 renewal of research collaboration with Professor Qin Shucun's team is a rare long-term "brand + academia" binding on this line. More notable is the restraint in its external messaging: Ning Chun publicly emphasizes that "drinking water is just drinking water; it cannot replace a balanced diet and standard medical care," and states that he has declined partners' suggestions to "package miraculous efficacy"—**in a category carrying the historical baggage of exaggerated claims, this self-imposed limit is itself a form of differentiation**.

Above these three types of players sits one more link: hydrogen itself. Hydrogen-rich water companies typically do not produce hydrogen in-house but purchase **food additive hydrogen**—the legal basis for which is **GB 31633-2014 *National Food Safety Standard: Food Additive Hydrogen***. This procurement is not new to the gas industry; hydrogen-rich water companies are simply new customers on an existing supply chain. As for who supplies hydrogen to any specific company, this report has not obtained publicly verifiable relationships and makes no attribution.

VI. The Equipment-Side Supply Layer: The Contract Manufacturing Base of Health Appliances and an Export-Oriented Main Line

Having discussed "water," we must also discuss "machines." Complete-unit supply in this industry did not grow organically from the hydrogen sector itself but is **grafted onto the existing contract manufacturing base of health appliances**—the production lines, molds, supply chains, and export channels of water purifiers, air purifiers, and small appliances, swapped for a different water circuit and electrical circuit, become a hydrogen-rich water machine or hydrogen inhalation machine. This determines three characteristics on the equipment side: rapid model iteration, low assembly barriers, and a high export share.

Several verifiable examples:

- **Core-component self-development type · Guangdong Cavolo Hydrogen Technology (CAVOLO).** The most technically substantive company in this layer: starting from **PEM electrolyzers**, it moves upstream to industrial-grade PEM pure-water electrolysis hydrogen production integrated systems (externally rated at 1–100 Nm^3/h) and downstream to consumer-grade hydrogen-rich water machines, hydrogen water tumblers, hydrogen generators, and hydrogen eye massagers and other end products. Its delivery model is typical—positioned as an "OEM factory / design-driven" player on international B2B platforms, with overseas customers ordering directly against solutions. **A single company spanning both industrial hydrogen production and consumer hydrogen health is uncommon on the equipment side**, and it also shows that in this industry only a layer of water-circuit design separates the "technology base" from the "consumer product exterior."

- **Health appliance OEM base type · Olansi (Guangzhou).** Its main business is R&D, design, production, and sales of health appliances, with a product line covering water purifiers, air purifiers, **hydrogen-rich water series**, and fruit and vegetable washers. The capability of such companies lies not in hydrogen but in **molds, certifications, delivery, and foreign trade**—they can supply the same water-circuit solution to multiple brands simultaneously.
- **Technology + contract manufacturing dual-line type · Guangdong Wopin Technology.** Focused on electrolysis technology and smart hydrogen-rich products, with more than 30 products currently, claiming over 30 patents related to “hydrogen-oxygen separation” and over 10 design copyrights (**company claims**); notable is its industry-academia-research and brand co-branding path—jointly building a hydrogen-rich technology laboratory with Lenovo thinkplus and Beijing University of Chemical Technology, opening its proprietary technology to third-party brands. This is a rare division of labor on the equipment side: **not building its own end-consumer brand, but engaging in technology licensing and contract manufacturing**.
- **Technology-Route Type · Shanghai Nanobubble Nanotechnology (NANOBUBBLE).** Its core technological proposition centers on physical hydrogen dissolution via nanobubbles; its product range covers hydrogen-enriched water tumblers, hydrogen-enriched water dispensers, nanobubble hydrogen bath machines, and hydrogen inhalation machines. The company claims instantaneous preparation of supersaturated hydrogen water and publicly advances parameter conventions such as the "2% golden concentration" for hydrogen inhalation (**company claim**). It is a rare case on this track of converting technical terminology into brand equity.
- **Trade-Show Regular Type · Zhizhen Biology (Huicai).** It has appeared on the exhibitor list of the Guangzhou International Hydrogen Technology Industry Expo for consecutive editions, alongside Dayu, Cavolo, Nanobubble, and others—**this exhibitor list is itself an industry map of the equipment-side supply layer.**

How large this layer is—the trade-show directory provides the most direct scale marker. The official invitation for the 2026 10th HST listed more than 80 exhibiting brands, spanning core components (Sparta Energy, Yoshida Electrodes, Juyuan Power, Haike Electronics, Minhong Electronics, Feierte, Leishi Technology), complete machines and end products (Cavolo, Wopin Technology, Nanobubble, Aolansi Health, Westherton, Yishengrui, Zhonghan Dayu, Huajie Hengxin), medical and device players (Lumi Medical, Shenmai Medical–Jiema Medical, Qing'aide Medical Technology, Maimai Medical), and the materials side (Jieqing Materials, Xitai Tiangong), among other segments; the organizer's public statement is that it "attracted over **80% of domestic hydrogen technology enterprises**", with 180+ exhibitors and 30,000+ trade visitors on site in 2025. The same invitation also shows that the industry has already disaggregated the upstream in fine detail: **titanium felt, titanium mesh, membrane electrode assemblies (MEAs), electrolyzers, PEM hydrogen production equipment, power supplies, electronic controls, circuit boards, and precious-metal iridium–platinum–ruthenium catalysts** are listed separately as "electrochemical materials and core components", while **coral calcium, magnesium hydride, and silicon** are listed separately as "hydrogen production materials"—**the three mainstream carriers of the solid-state hydrogen release route have already become standardized commodities at the supply-chain level.** (Source: same as above; "over 80%" is the organizer's statement and has not been independently verified in this report. The above manufacturers are classified according to **the product categories registered at the exhibition**; this report has not verified each company's specific product

portfolio and capacity—for example, the specific division of labor among Sparta Energy, Yoshida Electrodes, and others in the upstream electrolyzer and electrode segments still requires separate confirmation based on company public disclosures.)

"Export orientation" is the most noteworthy structural feature of this layer. In these companies' customer structures, overseas SME brands, regional distributors, and OEM orders account for a high share, while domestic retail is not the main battleground. This produces two direct consequences:

The first consequence is that their competitiveness lies not in the number of models but in compliance documentation. Exporting a machine requires clearing not whether the product works well, but the certifications of the target market (CE, FCC, and regional water-quality and electrical-safety requirements). **Only factories that can deliver certifications, manuals, packaging, and after-sales parts to overseas customers in a single package win repeat orders**—which is why companies at this layer universally emphasize "ODM capability" rather than "technological leadership".

The second consequence is that they have run into the "tariff-schedule deficit" discussed in Chapter 7 of this report. China accounts for the vast majority of global production capacity for electrolytic hydrogen water tumblers and complete hydrogen inhalation machines, yet in the customs tariff schedule these products have no dedicated codes: household hydrogen inhalation equipment is squeezed into "other physiotherapy and rehabilitation machinery" or ordinary small household appliances, hydrogen-enriched packaged water is declared as ordinary packaged drinking water, and solid-state hydrogen release materials are lumped into "other chemical products not elsewhere specified." **The products are exported in large volumes, yet the codes do not recognize them.** The stronger the export orientation on the equipment side, the more concrete the cost of this institutional mismatch—export tax rebate rate mismatches, customs clearance friction, and being priced down overseas as "ordinary small household appliances."

VII. The Channel Layer: The Layer That Actually Sells the Equipment Is the True Shape of the Industry

Equipment and water are both "goods"; what delivers them to consumers is another layer—**channel enterprises**. This layer does not appear in the trade show's main visuals, but it determines the industry's actual sales methods and why regulatory storms always land here.

One type is the "storefront + business school" franchise system. Represented by China Dehydrogen Health Industry Group: Chairman Shao Guanghui, co-founder Kong Bo (also chairman of Youtai Group/Youtai Health). The group positions itself as "a professional hydrogen product manufacturer integrating R&D, production, and sales," but what truly underpins its scale is its organizational form—a branch-company system (branch companies and marketing departments in Heze, Jining, and other locations), routine empowerment training through the "Dehydrogen Business School," and brand operations and quality inspection positions configured per store. **This is a typical "person-to-person, store-to-customer" heavy-offline system**: equipment unit prices are high and require on-site experience and explanation, so the channel inevitably takes the form of "training + franchising + storefronts."

The other type is the "rehabilitation equipment channel" model. Zhengzhou Mingtai Medical Devices Co., Ltd. (Mingtai Group, founded in 2010) focuses on rehabilitation medicine and home health care, with a product line covering hydrogen-oxygen machines, laser and medium-frequency therapy devices, transcranial magnetic stimulation, air-wave therapy, extracorporeal shockwave, and others, and operates

multiple wholly owned subsidiaries. **Its value lies in a "ready-made medical device distribution network"**—placing a hydrogen-oxygen machine into this network means leveraging existing experience stores, rehabilitation institutions, and distribution channels rather than building a channel from scratch.

Viewing the equipment side and the channel side together reveals the shape of this industry. Upstream are gas companies and materials companies; midstream are contract manufacturers and complete-machine makers (Wopin, Aolansi, Nanobubble, Zhizhen, etc.); downstream are storefront systems and rehabilitation equipment channels. None of the three can do without the others: anyone can make the equipment, anyone can bottle the water, **but the step of "selling high-unit-price equipment to price-sensitive individuals" must rely on heavy offline person-to-person delivery**. This is precisely the contemporary version of Chapter 3's argument that "seminar marketing is a unit-price structure problem, not a moral problem"—except that today's form has become business schools, franchise stores, and rehabilitation experience stores, while the essence remains the same.

The risks at the channel layer can be quantified through publicly available penalty records. The following are verifiable public penalty cases retrieved for this report (stating only the facts of the penalties, without qualitative evaluation):

Table 2-4

Entity	Penalizing Authority and Date	Facts of the Violation (Brief)	Outcome
Shanghai Hydrogen Forest Health Technology Co., Ltd.	Shanghai Jinshan District Administration for Market Regulation · September 2021	Published false advertising for hydrogen inhalation machines on its own website, claiming they could treat diseases	Ordered to cease publication; fined RMB 100,000
Operator of a health center in Yichang, Hubei	Yichang Xiling District Administration for Market Regulation · 2022	Used free hydrogen inhalation trials to induce elderly people and posted patient testimonials claiming effects on "more than 200 diseases"; the product was in fact an ordinary household appliance	Initial fine of RMB 300,000, adjusted to RMB 200,000 after administrative litigation
A storefront in Tongchuan District, Dazhou, Sichuan	Tongchuan District Administration for Market Regulation · June 2022	False advertising of the therapeutic efficacy of hydrogen breathing machines	Case filed for investigation and handling
An elderly-oriented health center in Xiaoyi, Shanxi	Xiaoyi Administration for Market Regulation · May 2022	Used "hydrogen inhalation cures disease" pitch to sell ordinary household appliances to elderly people	Case filed for investigation
"Hydrogen-Oxygen Experience Center" in Taigu District, Jinzhong, Shanxi	Taigu District Administration for Market Regulation · August 2024 (the day after CCTV exposure)	Claimed hydrogen-oxygen machines purify blood, prevent cardiovascular and cerebrovascular diseases, and control cancer	Case Filing and Investigation

Entity	Penalizing Authority and Date	Facts of the Violation (Brief)	Outcome
Xinfu Health Consulting Service Center, Yangquan, Shanxi (distributor of a multifunctional hydrogen-oxygen machine of a certain brand)	High-Tech Zone Branch, Yangquan Municipal Administration for Market Regulation · Inspection, April 2026	Free hydrogen inhalation offered in-store with claims of adjunctive therapy, cancer prevention, and free radical scavenging; the product was determined to be an ordinary household appliance	Administrative order to cease unlawful conduct, with a fine of RMB 50,000 (included in the SAMR September 2026 typical cases concerning the elderly)

Source: announcements and public reports by local market regulation authorities; the Yangquan case appears among the typical cases of false advertising concerning the elderly published by SAMR in September 2026. For some cases (Taigu, Dazhou, Xiaoyi), public channels only disclose case-filing information and no final penalty amount, so this report records only the "case filing" without inferring outcomes.

The value of this table lies not in the amounts but in the risk locations it identifies. Across the six cases, nearly all of the penalized parties are end-market operators of the "experience store / distributor / consulting service center" type rather than equipment manufacturers; and the facts found to be unlawful almost invariably follow the same formulation — presenting an ordinary household appliance as capable of treating disease. **In other words: the risk lies not in the technology but in the last-mile sales pitch; and that last mile is precisely where brand owners are least willing and least able to exercise control.** The conclusion is therefore straightforward: as long as the product form remains "high unit price + requiring on-site experience," this last mile will inevitably persist, and the penalty list will naturally continue to grow.

This also explains a recurring external criticism: the reason the 2024 CCTV exposé struck the industry was not that it debunked some technical falsehood, but that what it captured was precisely this layer — high-unit-price equipment, experiential sales pitches, and a target demographic of middle-aged and older consumers. Technology-side problems can be resolved through standards; channel-side problems can only be resolved by changing the product form. This is precisely why this report treats "consumables conversion" as a core variable.

VIII. On "Food-Grade Hydrogen Qualification": A Three-Tier Distinction That Must First Be Disaggregated

The most frequently cited and most easily blurred statement in this industry is "we fill with food-grade hydrogen." In interviews and investment promotion materials, this phrase is often used to establish a sense of professionalism. But what it actually means under regulation needs to be disaggregated into three tiers, because **the evidentiary strength of the three tiers differs completely**:

Table 2-5

Statement	Corresponding Standard / Qualification	What It Actually Demonstrates
"High-purity hydrogen"	GB/T 3634.2 system (industrial high-purity hydrogen)	Demonstrates purity only, **not that it is suitable for food use**. This is precisely the framing commonly used by gas suppliers.
"Food gas"	A **commercial classification** within the gas industry, not a licensing qualification	Indicates that the enterprise operates in this category, **which is not equivalent to holding a food additive production license**.

Statement	Corresponding Standard / Qualification	What It Actually Demonstrates
"Food additive hydrogen"	GB 31633-2014, and must be included under the "food additive" category of the food production license (SC)	**Only this tier constitutes a compliance credential.** The criterion is the SC certificate number and the food category stated on the certificate, not the enterprise's self-description.

The actual verification conclusion of this report is: no publicly available directory of certified "food additive hydrogen" enterprises can currently be found. This does not mean that no one holds a certificate — the SC disclosure system requires enterprise-by-enterprise queries, and the absence of public search results does not constitute negative evidence; but it does mean that **the statement "we hold food-grade hydrogen qualification" should be treated in external communications as "a claim pending documentary evidence," not as a fact that can be accepted by default**. This report therefore recommends that any due diligence involving hydrogen-rich water make "can you present the SC certificate number and the food category stated on the certificate" the first question, not the last.

The Qingzhu case happens to make another point equally clear: the brand, the manufacturer, and the operator are often three separate companies. "Qingzhu / Qingchao" is one of the more widely distributed brands in this category, offering both 345 mL aluminum cans and 360 mL glass bottles and labeled "hydrogen-containing mineral water produced in Liaoning." Yet in publicly available brand onboarding documents, the three lines of entities are respectively: the brand party listed as "Qingzhu · Hydrogen-Rich Water," the manufacturer as **Hydrogen Country Hydrogen City (Shenyang) Beverage Co., Ltd.**, and the operator as **Shuo Hai Xing Lian (Guangdong) International E-Commerce Technology Co., Ltd.**, with offices in Guangzhou's Zhujiang New Town. **This structure explains why the category can scale quickly — brands need not build their own factories, and factories need not build their own channels; but it also explains why accountability is difficult to trace when problems arise: the compliance responsibility for a single bottle of water is split into three parts.**

Reading this section together with "Payment Not Yet Opened" in Chapter 7 reveals a loop: **if efficacy claims are prohibited, competition can only revolve around packaging and taste; competing on packaging and taste requires rapid new product launches; rapid launches require the separation of contract manufacturing from e-commerce operations; and once separated, the quality and compliance control point falls on the link with the least bargaining power.** This is not the problem of any single enterprise but a structural outcome for this category under the existing regulatory regime.

IX. What This Section Means for the Report as a Whole

This thread is placed in Chapter 2 to anchor the judgments that follow:

First, it is a preview of the "consumables conversion" judgment on the beverage side. The per-bottle price of packaged hydrogen-rich water is far lower than that of a device, the reorder frequency is far higher, and no installation or after-sales service is required — this is precisely the logic of "sell consumables, not devices" that this report repeatedly emphasizes, except that it has first run its course in the form of a "beverage."

Second, it suggests that the real competitor to the solid-state hydrogen-release materials route is not another technology but "compliance cost." The bottled route has already demonstrated that, under a food identity, the only remaining points of differentiation are packaging, taste, and use case; if

solid-state hydrogen-release materials go the consumer route, they will run into the same wall — **what is truly scarce is not the ability to produce hydrogen, but the ability to package hydrogen into a compliant carrier and to deliver the evidence together with that carrier.**

Third, it explains why brand concentration in this category remains low. Packaging and filling are mature contract-manufacturing capabilities, food-grade hydrogen is a publicly procurable raw material, and mineralization is a standard process — **none of these three links is proprietary**, so competition naturally retreats to channels and brands rather than technology. This is two sides of the same conclusion as the judgment in Chapter 6 of this report that "180 enterprises form a tripartite landscape, with value capture concentrated at the two ends of certificates and materials."

2.6 The Truth of the Price Structure: Three Price Anchors Behind a 30,000-Fold Spread

China's hydrogen health market presents a price landscape that astonishes outsiders: a single solid-state hydrogen tablet on the 1688 wholesale platform costs just **¥0.67**, an electrolytic hydrogen water tumbler on mainstream e-commerce platforms sells for **¥548**, yet a hydrogen-oxygen nebulizer in an offline experience store can sell for **¥17,999 or even ¥26,000**.

The spread between the lowest and highest prices is nearly **30,000-fold**. But to explain this phenomenon solely in terms of "excessive margins" would be to forfeit all commercial insight. For these three prices are essentially anchored in three completely distinct (see Table 2-6), mutually parallel market systems:

Table 2-6

Price Anchor	Representative Price	Core Deliverable (What Is Being Sold)	Basis for Consumer Purchase Decisions	Channel Format and Vitality
Raw Material Anchor	**¥0.67 / tablet**	Industrial functional materials and primary formulated granules	Minimum order quantity (MOQ), heavy metal testing reports, hydrogen generation stability	1688 industrial wholesale, B2B contract manufacturing supply chain (thin margins, large scale)
Merchandise Anchor	**¥548 / unit**	Small appliances and digital water tumblers with hydrogen-enrichment functionality	Industrial design, aesthetic appeal, brand reputation, e-commerce reviews	Mainstream public-domain e-commerce platforms such as Tmall, JD.com, and Douyin (intense competition, moderate margins)
Therapeutic Anchor	**¥17,999 / unit**	A “health promise” of longevity, chronic disease improvement, and even cancer prevention	Long-term free trials, community emotional bonding, authority endorsement by lecturers and experts	Offline franchised experience salons, private-domain seminar sales teams (extremely high margins, extremely high policy risk)

For a long time, the “therapeutic anchor” absorbed the overwhelming majority of the industry’s short-term windfall profits, but it also mortgaged the entire industry’s social credibility. As market regulators have cracked down hard on seminar sales models that “prey on the elderly” since 2024, the space for false advertising on which the “therapeutic anchor” depends has been physically suppressed. The

industry is now re-stratifying relatively quickly: **heavy equipment traditionally reliant on high-pressure seminar sales has hit a survival ceiling, while consumer-grade hydrogen health products built on the "merchandise anchor + high-frequency consumables" are taking over the true growth base of China's hydrogen health industry.**

CHAPTER 02 RECAP · Chapter Summary

Two Physical Routes, Three Product Generations, Three Price Anchors

1. **Physical divergence determines scenario boundaries, not a ranking of advancement.** The electrolysis route excels at instantaneous high throughput but depends on mains power and purified water; the material hydrolysis route requires zero electricity, can be miniaturized, and has a half-life of 18–24h—the question is not which is more advanced, but which scenarios each can enter.
2. **The "dual-mode" approach is fundamentally a business model solution, not a technological compromise.** The "electrolysis module + mineral filter cartridge" converts an outright device purchase into "equipment + periodic consumables," generating annual consumable cash flow of RMB 300–800 per household—this is the true source of channel stickiness.
3. **The 30,000-fold price spread is not mark-up within one market; it is three parallel markets.** Raw material anchor at ¥0.67/tablet, merchandise anchor at ¥548/unit, and therapeutic anchor at ¥17,999/unit; the 2024 regulatory storm physically suppressed the therapeutic anchor, forcing the industry back to the "merchandise anchor + consumable repurchase" model.



CHAPTER 03

Chapter 03 Demand-Side Reshaping and Precise Customer Segmentation

Seminar-style group selling is a unit-price structure issue rather than an ethics issue, and the demand base is splitting into nine vertical segments.

Chapter Highlights · Demand-Side Reshaping and Precise Customer Segmentation

1. **Seminar selling is a unit-price problem, not a moral problem** Products with factory costs of RMB 2,000–5,000 and retail prices of RMB 15,000–26,000 cannot achieve natural sell-through in supermarkets and e-commerce; offline experience salons are one of the few channel formats capable of absorbing that unit price. Exaggerated sales pitches are a result, not a cause.
2. **Each of the nine customer segments has its own evidence boundary** Psoriasis water bathing and COPD inhalation have the strongest evidence; atopic dermatitis still lacks large-scale human double-blind RCTs; diabetes, Parkinson's disease, and others are positioned as adjunctive interventions. Claim boundaries must be strictly tied to evidence levels.
3. **Route of administration determines everything** Using literature on skin water bathing to endorse "drinking hydrogen water to treat skin disease" will be refuted on the spot in front of professional physicians. This is the industry's most common form of overreach.
4. **From passive to proactive Cognition is shifting from "passive victimization" toward "rationally self-driven daily health management"—demand-side maturity has now outpaced both the supply side and the institutional side.**

3.1 Historical Reflection and the Customer Generalization Dilemma: The "Old, Weak, Sick, and Disabled" False Premise of the Gray "Direct-Selling Seminar" Era

Over the past decade, China's hydrogen health industry has long been trapped in a pathological, low-level vicious cycle: **the target customer base has been extremely generalized in cognition and channel terms, and distorted into the "old, weak, sick, and disabled."**

In the early stage, when serious medical popularization and public healthcare access were lacking, large numbers of assembly contract manufacturers without core material R&D capabilities assembled ordinary electrolysis cells into hydrogen inhalation machines and hydrogen-rich water machines priced at RMB 15,000 to 26,000. Faced with such high unit prices for non-essential durable appliances, ordinary young middle-class consumers and families had absolutely no natural impulse to purchase through public-domain e-commerce channels. To move heavy inventory, merchants inevitably slid toward underground seminar sales, franchised experience stores, and elderly gathering-based marketing channels:

1. **Blurred and generalized customer profiles**: Early merchants never truly studied the pathophysiological mechanisms of specific diseases; instead, they crudely targeted **middle-aged and elderly groups with "leisure time, modest savings, multiple co-existing conditions, and an extreme fear of death and aging."** Whether hypertension, diabetes, osteoarthritis, chronic bronchitis, or even end-stage malignant tumors, all were indiscriminately lumped into the same broad basket of "inhaling hydrogen and drinking hydrogen water";
2. **Distorted sales pitches and the original sin of false advertising**: Under the layered emotional manipulation of closed offline experience salons—"serving tea and water, affectionate companionship, and lectures by renowned physicians"—sales staff, pressured by heavy per-store rents and high commissions, inevitably moved toward deifying the product—claiming that hydrogen "cures all diseases, reverses cellular aging, fights cancer and shrinks tumors, and even induces patients to stop taking standard clinical glucose-lowering and blood-pressure-lowering medications";
3. **Industry credibility suffers a devastating backlash**: This business model—built on information asymmetry and pseudo-scientific false promises—inevitably drew the iron-fisted remediation of the State Administration for Market Regulation (SAMR) and authoritative exposure by CCTV's **Financial Investigation**. Regulators legally classified a large number of the products involved as "ordinary household appliances, by no means medical devices," seized them in accordance with the law, and imposed maximum fines. More seriously, gray-market seminar marketing has branded the entire industry with an indelible "fraudster" stigma, causing molecular hydrogen biomedicine—which possesses genuine rigorous academic value—to be widely misunderstood by the public; mainstream consumers are deterred, and the compliant customer-acquisition costs of legitimate enterprises have surged more than tenfold.

The facts clearly show that **the "seminar-marketing model generalized to the elderly, weak, sick, and disabled" is a pseudo-demand built on sand; it is not a moat for the hydrogen health industry but rather the single largest historical liability that has long locked the entire industry out of healthy development.**

3.2 Four Historical Catalysts of Demand Awakening: Post-Pandemic Health Awakening, Accumulated Rigorous Evidence, Supply-Side New-Material Revolution, and the Structural Imperative of Population Aging and Declining Fertility

By 2026, the demand side of China's hydrogen health industry is undergoing a profound paradigm shift at the foundational level. This shift is driven not by vendors' marketing packaging but by the historical resonance of four macro dimensions:

3.2.1 Catalyst One: Post-Pandemic Public Health Awakening Toward "Proactive Immunity and Deep Antioxidant/Anti-Inflammatory" Protection

The global COVID-19 pandemic delivered a society-wide re-education in health literacy. The public developed a deeper understanding of the pathological nature of "virus-induced cytokine storms," "chronic low-grade systemic inflammation," "mitochondrial oxidative stress damage," and the chronic fatigue and brain fog of Long COVID. "Preventing illness before it arises" and "strengthening one's endogenous antioxidant immune barrier" rapidly migrated from the wellness philosophy of a small high-net-worth cohort to a mass-market imperative.

Critically, the National Health Commission's **Diagnosis and Treatment Protocol for Novel Coronavirus Pneumonia (Trial Seventh Edition)** (March 3, 2020) for the first time incorporated "where conditions permit, hydrogen-oxygen mixed inhalation gas (H2/O2: 66.6%/33.3%) may be used for treatment" into its oxygen therapy measures; the Eighth Edition retained the original wording, while the Ninth and Tenth Editions deleted this statement, with the oxygen therapy provisions reverting to generic language. **Both inclusion and withdrawal occurred within the text of national-level diagnostic and treatment standards**—this was the first time hydrogen medicine was written into a national-level treatment protocol, and also the first time it was withdrawn under the same procedural standards. This round of adoption in national-level texts completed a substantive "academic desensitization" in respiratory departments of top-tier tertiary hospitals nationwide and among the public, ending the public's prior misconception that "hydrogen inhalation causes poisoning and explosions."

3.2.2 Catalyst Two: 15+ Years of Rigorous Medical Evidence Scientifically Replacing "Mystical Perceptions"

Hydrogen medicine is no longer unsubstantiated folk rumor. Since Professor Mami Noda's landmark establishment of molecular hydrogen's "selective antioxidant" mechanism in **Nature Medicine** in 2007, and represented by national-level research institutions such as Professor Sun Xuejun of the Naval Medical University, Academician Ding Wenjiang of the Chinese Academy of Engineering, Academician Zhong Nanshan, Fudan University, and Shanghai Jiao Tong University, the world has cumulatively published **more than 5,120 PubMed papers on hydrogen medicine** (with Chinese scholars contributing over 32%), and **39 genuine, valid human clinical trials** have been registered with the World Health Organization (WHO ICTRP).

The molecular mechanisms by which hydrogen molecules specifically penetrate biological membranes and the blood-brain barrier (BBB), target and neutralize highly toxic hydroxyl radicals (**·OH**) and peroxynitrite anions (**$ONOO^-$**), activate the Nrf2/ARE endogenous antioxidant defense gene network, and inhibit the NF-**κ**B inflammatory pathway have been comprehensively elucidated. The solid accumulation of scientific evidence is leading a growing number of scientifically literate, highly educated individuals, middle-class consumers, and professional clinical physicians and nurses to examine and accept the adjunctive interventional value of hydrogen molecules with a rational eye.

3.2.3 Catalyst Three: The Supply-Side New-Material Revolution Spawns a Full-Scenario, Lightweight FMCG Matrix

For a long time, consumers withheld their spending not merely because of insufficient awareness but because **supply-side product forms ran counter to human nature**—consumers were forced to choose between “spending tens of thousands of yuan on a bulky plug-in electrolysis machine” and “no contact at all.”

With breakthroughs in solid-state materials technology—represented by micro-porous ceramic lattice hydrogen storage and release—the release of hydrogen molecules has completely shed the physical constraints of external power supplies, electrode plates, and large water tanks. High-concentration active hydrogen can be encapsulated into everyday consumer products at extremely low cost:

- **Micro-porous hydrogen-enriched cup cores** that produce high-dissolved-hydrogen living water anytime, anywhere;
- **Hydrogen-enriched solid beverages / effervescent tablets** that dissolve rapidly for morning preparation or post-exercise recovery;
- **Anhydrous solid-state dry hydrogen masks** that are activated on demand and deliver dissolved hydrogen exceeding 1,200 ppb;
- Traditional Chinese medicine **hydrogen-enriched thermal moxibustion patches / Shenque acupoint patches** incorporating authentic regional herbs;
- **Hydrogen-enriched hot-spring bath tablets / foot-soak tablets** that release nanoscale hydrogen microbubbles.

New materials have completely dismantled the decision friction of traditional hardware, lowering the unit price from a “high-consideration purchase in the tens of thousands of yuan” to a “low-consideration purchase in the tens to low hundreds of yuan,” thereby embedding hydrogen molecules naturally into the public’s everyday lifestyle flow of “Eat, Drink, Wash, Care, and Soak.”



Figure 3-1 The "Hydrogen Plus" multi-carrier fusion lifestyle panoramic consumption matrix. It illustrates the full-scenario FMCG ecosystem map of "Eat (Eat), Drink (Drink), Wash (Wash), Care (Care), and Soak (Soak)" derived from carriers including micro-porous mineral ceramics, authentic regional herbs, non-woven fibers, and functional foods.

Image Source: Muqi Technology Industry Data Repository

3.2.4 Catalyst Four: The Structural Imperative of an Aging Society with Declining Fertility and the Surging Demand from Younger-Onset Chronic Disease

China's population aged 60 and above has exceeded 300 million, and the prevalence of neurodegenerative diseases such as Alzheimer's disease, Parkinson's disease, and post-stroke sequelae continues to climb. At the same time, high-pressure workplaces and poor lifestyle habits are driving chronic metabolic diseases—hypertension, hyperglycemia, hyperlipidemia, and hyperuricemia (gout)—into a pronounced younger-onset trend. Against the macro backdrop of tightening Basic Medical Insurance cost controls, high costs of care, and frequent adverse drug reactions, a **non-pharmacological antioxidant approach—free of hepatorenal metabolic toxicity, suitable for long-term home-based adjunctive intervention, and possessing lifestyle attributes**—has become the health fulcrum urgently sought by hundreds of millions of sub-healthy and chronically ill households.



Figure 3-2 Three boxes of white "hydrogen-enriched foot-soak / bath mini hydrogen tablets" displayed alongside hydrogen eye patch packaging, all solid-state hydrogen daily consumer products.

Image Source: On-site at the 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo (2026-05, photographed by the report research team)



Figure 3-3 Orange hydrogen-enriched water cans stacked in a pyramid formation, illustrating beverage-end display and promotional formats.

Image Source: On-site at the 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo (2026-05, photographed by the report research team)



Figure 3-4 Three boxes of blue “Multivitamin Calcium + D pressed-tablet” sports nutrition food packaging stacked together, with small side text indicating hydrogen retention ≤2.82 mg/L

Image Source: On-site at the 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo (2026-05, photographed by the report research team)



Figure 3-5 Seven or eight colorful pen-shaped small items standing upright on packaging boxes, with “Hydrogen Beauty Spray” printed on the box surface

Image Source: On-site at the 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo (2026-05, photographed by the report research team)

3.3 In-Depth Breakdown of Nine Highly Targeted Customer Segment Profiles, Pathological Mechanisms, and Evidence Boundaries

Driven by the aforementioned catalysts, the target customer base of China’s hydrogen health industry has completely shed the vague, coarse label of “the elderly, weak, sick, and disabled,” and has differentiated precisely into **nine vertical customer segments** with distinct characteristics, clearly defined pathological pain points, and high willingness to pay:



Figure 3-6 Evidence hierarchy of core indications in hydrogen medicine and the compliance-claim red-line matrix (Oxford CEBM evidence-based medicine system).

The report systematically reviews the trial designs and endpoint data for psoriasis (Fudan Huashan Hospital, Level A RCT), COPD (Guangzhou Institute of Respiratory Health, Zhong Nanshan team, Level A RCT), non-alcoholic fatty liver disease and exercise fatigue (Level B), and sub-health improvement (Level C), and clearly delineates the legal claim red lines for Class III medical devices, Class II dressings, and ordinary FMCG products.

Source: Oxford CEBM Evidence Hierarchy; compiled by this report

How to read this chart

- **What to look at:** The vertical axis is the evidence level (Level A being the highest) and the horizontal axis is the indication; the shading of the color blocks indicates the strength of evidence.
- **Criteria:** Level A = multicenter randomized double-blind controlled trial; Level B = single-center RCT or cohort study; Level C = animal/case report/mechanistic inference.
- **Reading the red lines:** The evidence level is strictly bound to the "permissible claim boundary"—even Level A does not mean one may claim "cure."

Key insights

- **Key facts:** Psoriasis hydrotherapy (Huashan Hospital, PASI 75 response rate 24.4% vs. 2.9% in controls, Pc=0.022) and hydrogen-oxygen inhalation for COPD are currently the two areas with the strongest evidence.
- **Honest boundary:** For atopic dermatitis (eczema), **there is still no large-scale human double-blind RCT**; the industry's common claim that "hydrogen treats eczema" is a misattribution.
- **Actionable implication:** The route of administration is decisive—using literature on cutaneous hydrotherapy to endorse "drinking hydrogen water to treat skin diseases" will be refuted on the spot in front of professional physicians.

3.3.1 Patients with Type 2 Diabetes and Metabolic Syndrome (the “sugar buddies” and prediabetes population)

- **Population size and pain points**: Authoritative data from the International Diabetes Federation (IDF) and the **Chinese Guidelines for the Prevention and Treatment of Type 2 Diabetes** show that the prevalence of diabetes among Chinese adults has reached 11.2%, with more than **141 million** diagnosed patients (the highest in the world); moreover, more than **350 million people are in the “prediabetes” stage of impaired glucose tolerance (IGT)**. Insulin resistance, chronic low-grade systemic inflammation, and microvascular lesions caused by advanced glycation end products (AGEs) leave patients chronically dependent on multiple chemical glucose-lowering drugs, with an accompanying risk of renal function impairment.
- **Molecular biological mechanism**: The hyperglycemic microenvironment triggers severe leakage from the mitochondrial electron transport chain, generating large amounts of superoxide anions and malignant free radicals, which leads to progressive failure of pancreatic **β** cell function and desensitization of insulin receptors in peripheral skeletal muscle. Molecular hydrogen selectively scavenges malignant ROS within pancreatic **β** cells, protecting mitochondrial structural integrity; it promotes the translocation of glucose transporter 4 (GLUT4) to the cell membrane in skeletal muscle, directly improving insulin sensitivity in peripheral target tissues; and it simultaneously activates the hepatic AMPK/SIRT1 pathway, downregulates the activity of key gluconeogenic enzymes, and inhibits excessive hepatic glycogen breakdown and output.
- **Authoritative clinical evidence**: The Japanese scholar Kajiyama et al. published a landmark randomized, double-blind, placebo-controlled crossover trial in the authoritative medical journal **Nutrition Research** (2008, 28(3):137-143, PMID: 19083400): 30 patients with type 2 diabetes and 6 patients with IGT drank 900 mL of high-concentration hydrogen-rich water daily for 8 consecutive weeks. The results showed that modified low-density lipoprotein (ox-LDL) and urinary 8-isoprostane were significantly reduced, superoxide dismutase (SOD) activity increased, and **4 of the 6 subjects with impaired glucose tolerance returned to normal on the oral glucose tolerance test (OGTT)**. Subsequent human studies by Qin Shucun’s team at the Taishan Institute of Hydrogen Biomedical Research in China also confirmed that hydrogen-rich water can significantly reduce serum malondialdehyde (MDA) levels in patients with glucolipid metabolic syndrome and help stabilize glycated hemoglobin (HbA1c).
- **Product formats and usage habits**: Household whole-house/countertop high-flow hydrogen-rich water machines (for the whole family’s daily drinking), portable solid-state hydrogen drinking tumblers (for daytime on-the-go drinking to maintain a continuous dissolved hydrogen partial pressure in the body), and hydrogen-rich meal-replacement solid drink mixes.
- **Consulting-level correction and compliance red lines**: **Patients must not be told that “drinking hydrogen water allows them to stop glucose-lowering medication or cures diabetes.”** The legal and scientific positioning of molecular hydrogen in diabetes is as “an adjunctive lifestyle intervention that improves the pancreatic islet microenvironment and alleviates systemic oxidative stress damage,” and it must be used in coordination with regular medication and lifestyle control.

3.3.2 Patients Requiring Repair of Refractory Chronic Wounds and Care of Skin Ulcers (Diabetic Foot Ulcers [DFU], Pressure Sores/Bedsores, and Postoperative Wounds)

- **Population size and pain points**: Among bedridden disabled older adults and elderly patients with chronic diseases, the incidence of severe pressure sores (bedsores) is extremely high, with more than **4 million** bedridden patients with pressure sores nationwide; diabetic foot ulcers (DFU) are the leading cause of non-traumatic amputation in diabetes in China, affecting **8 million** patients nationwide, with an annual amputation rate of more than 20% and a 5-year mortality rate even higher than that of some common cancers. In addition, postoperative fat-liquefaction incisions and late-stage wounds from extensive burns and scalds have prolonged healing cycles, and dressing changes are extremely painful; antibiotic resistance and sterile deep microcirculatory failure of the wound bed are the core clinical dilemmas.
- **Molecular biological mechanism**: The core reason refractory wounds “never heal” is that the wound microenvironment remains chronically arrested in a vicious inflammatory phase of “high reactive oxygen species accumulation, excessive neutrophil infiltration, and microvascular occlusion,” with macrophages locked firmly in the pro-inflammatory M1 phenotype. Topical application of molecular hydrogen can penetrate edematous granulation tissue at nanoscale permeability, specifically scavenge hydroxyl radicals, and **drive a phenotypic polarization of wound macrophages from the pro-inflammatory M1 type to the tissue-repair- and angiogenesis-promoting M2 type**; it significantly upregulates the expression of vascular endothelial growth factor (VEGF), CD31, and fibroblast growth factor (bFGF), inducing the crawling of newly formed microcapillary networks; and it simultaneously inhibits the excessive degradation of newly formed collagen extracellular matrix by matrix metalloproteinases (MMP-2/MMP-9), accelerating flat closure of epithelial granulation.
- **Authoritative clinical evidence**: The Wound Repair Center of Ruijin Hospital Affiliated to Shanghai Jiao Tong University School of Medicine, Xijing Hospital of the Air Force Medical University, and other institutions have conducted systematic exploration. The internationally leading journal **Nature Communications** (Chen S et al., 2022, 13:5684), in a study on photothermal/photocatalytic hydrogen release to promote diabetic wound healing, systematically cited and noted: “Clinically, wound immersion and wet compresses with hydrogen-rich water have been proven to significantly promote granulation tissue regeneration and accelerate healing of diabetic foot ulcers (Hydrogen-rich water bath can promote the healing of DFU in clinic)”; multiple preclinical trials published in the journal **Burns** confirmed that irrigation with hydrogen-rich saline can shorten the healing time of severe burn and radiation ulcer wounds by 25%–35%.
- **Product formats and usage habits**: Medical-grade hydrogen-rich water foot-soak basins (for diabetic foot and lower-limb venous ulcers), hydrogen-rich micro/nano bubble cleansing solutions, and Class II medical device **hydrogen-rich medical dressings/gel patches** represented by the medical device industrial belts in Changzhou and Suzhou, Jiangsu.
- **Consulting-level compliance definition**: Wound repair falls within the high-barrier domain of serious medicine and professional nursing and must strictly follow aseptic operating procedures. Topical hydrogen-rich dressings are the product landing point with the greatest certainty for the hydrogen health sector to enter hospital dressing rooms and professional elderly care institutions.



Figure 3-7 Hydrogen-rich chip and supporting materials: on the left is a roll of medical double-sided foam structural adhesive, and on the right is an unfolded sanitary napkin sample, where the green functional core layer is visible. Such dry-state chips can be laminated into sanitary napkin, diaper, and nursing pad production lines, slowly releasing hydrogen molecules upon contact with body fluids.

Image Source: Muqi Technology official website imuqi.cn

3.3.3 Patients with Chronic Inflammatory Skin Diseases and Impaired Skin Barrier (Psoriasis, Acne, and Sensitive Skin Repair)

- **Population size and pain points**: China has more than **6.5 million** patients with psoriasis; more than **70 million** patients with atopic dermatitis (AD, eczema); the incidence of facial acne vulgaris among young people exceeds **80%**; and more than **36%** of adult women suffer from sensitive skin issues such as facial flushing, burning, and a thin stratum corneum. Although traditional topical glucocorticoid ointments can rapidly suppress rashes, long-term use may induce skin atrophy, telangiectasia, pigmentation, and severe steroid-dependent dermatitis.
- **Molecular biological mechanism**: Under stimulation by environmental physical and chemical factors or autoimmune dysregulation, epidermal keratinocytes and dermal fibroblasts excessively release inflammatory factors such as TNF-**α**, IL-1**β**, IL-6, and IL-17A. Molecular hydrogen can specifically penetrate the intercellular matrix of the epidermal stratum corneum, inhibit local mast cell degranulation, and block IgE-mediated hypersensitivity reactions; by quenching ROS, it inhibits activation of the inflammatory transcription factor NF-**κ**B and downregulates the cascade release of pro-inflammatory cytokines; it maintains the physiological weakly acidic barrier and microecological balance of epidermal cells, and **offers a substantial safety advantage of absolutely zero hormones, zero drug resistance, and no skin atrophy side effects with long-term topical use**.
- **Authoritative clinical evidence and verification of honest boundaries**:
  - **Psoriasis (evidence)**: Fudan University Affiliated Huashan Hospital, together with Tongji University Affiliated Tenth People's Hospital and other centers, published a **high-level human parallel-controlled clinical trial** in **Scientific Reports** (Zhu Q et al., 2018, 8:8051, PMID: 29795283): 75 patients with plaque psoriasis and parapsoriasis received whole-body hydrogen-rich water baths (twice weekly for 8 weeks). The results showed that the **PASI 75 response rate in the hydrogen water bath group reached as high as 24.4% (10/41 cases), significantly better than 2.9%**

(1/34 cases) in the conventional water control group, with an extremely significant statistical difference after adjustment (P_c = 0.022); moreover, the intractable pruritus score showed a precipitous improvement;

- **Atopic dermatitis (honest boundary statement)**: **The industry's common misattribution must be seriously corrected—at present, there is still no rigorous large-scale human double-blind RCT for atopic dermatitis (eczema), mainly only animal models and case observations**;
- **The iron rule that the route of administration is decisive**: The hard evidence for psoriasis comes from **"whole-body water baths (soaking)" and "local wet compresses"**. Companies must absolutely not substitute one concept for another by using literature on cutaneous hydrotherapy to endorse "drinking hydrogen water to treat skin diseases," otherwise they will be refuted on the spot in front of professional dermatologists.



Figure 3-8 Baseline/week 8 comparison photographs of skin lesions and histopathological sections from psoriasis patients, with the paper DOI

Image Source: Fudan University Affiliated Huashan Hospital × Tongji University Affiliated Tenth People's Hospital; paper: Zhu Q et al., Scientific Reports 2018, 8:8051 (open access, CC BY 4.0, attribution citation permitted)

- **Product formats and usage habits**: High-dissolved-hydrogen anhydrous solid-state dry hydrogen masks (ready to use by soaking in cold water, 1,200–1,500 ppb penetration), hydrogen-rich hot spring bath tablets, mild weakly acidic hydrogen-rich cleansing foam, and micro/nano hydrogen-rich sprays.

3.3.4 Patients with Neurodegenerative Diseases and the Silver-Haired Brain Health Population (Parkinson's Disease [PD], Alzheimer's Disease [AD], and Mild Cognitive Impairment [MCI])

- **Population Size and Pain Points**: Amid China's irreversible trend of severe population aging, the number of patients with Parkinson's disease (PD) has exceeded **3.6 million** (more than one-third of the global total, and projected to reach half of the global total by 2030); patients with Alzheimer's disease (AD) and vascular dementia exceed **10 million**, and the population with mild cognitive impairment (MCI) is as high as **38 million**. Neurodegenerative diseases progress irreversibly; existing first-line drugs (such as levodopa and donepezil) only provide short-term symptomatic improvement and cannot halt neuronal degeneration and death, and they are associated with severe dyskinesia and gastrointestinal adverse reactions.

- **Molecular Biology Mechanism**: The brain accounts for only 2% of body weight yet consumes more than 20% of the body's oxygen; it is highly enriched in polyunsaturated fatty acids and iron ions and has relatively limited endogenous antioxidant enzyme reserves, making it an extremely vulnerable, highly oxidative metabolic organ. Conventional macromolecular antioxidants (such as vitamin E and coenzyme Q10) achieve little effect because they cannot cross the extremely tight **blood–brain barrier (BBB)**. **Molecular hydrogen is the smallest molecule in the universe (molecular weight only 2 Da) and combines high lipid solubility with an extremely high diffusion coefficient; after inhalation or oral administration, it can instantly penetrate the blood–brain barrier without obstruction**, reaching deep into the mitochondrial matrix of substantia nigra dopaminergic neurons and hippocampal pyramidal cells; it selectively scavenges hydroxyl radicals, inhibits the abnormal cross-linking and aggregation of **α**-synuclein and **β**-amyloid (A**β**), and suppresses pathological overactivation of central microglia, thereby blocking neuroinflammatory degeneration.
- **Authoritative Clinical Evidence**: Yoritaka and colleagues from the School of Medicine of Juntendo University, Japan, together with the Department of Neurology at Nagoya University, published a landmark randomized, double-blind, placebo-controlled RCT in the internationally authoritative neurology journal **Movement Disorders** (2013, 28(6):836-839, PMID: 23400965): 18 patients with Parkinson's disease receiving levodopa drank 1,000 mL of hydrogen-rich water daily (dissolved hydrogen concentration ~1,600 ppb) for 48 consecutive weeks; results showed that the hydrogen water group improved by an average of -5.7 points on the total Unified Parkinson's Disease Rating Scale (UPDRS) score, whereas the placebo control group worsened by an average of +4.1 points, with a highly statistically significant between-group difference (**P** < 0.05); multicenter long-term follow-up confirmed that molecular hydrogen has unique neuroprotective potential for delaying degeneration of substantia nigra dopaminergic neurons.
- **Product Forms and Usage Habits**: Medical-grade/high-specification home high-flow hydrogen-oxygen machines (300–600 mL/min, 1–2 hours of home hydrogen inhalation per day), micro-high-pressure hydrogen-rich oxygen health chambers (1.3 ATA micro-pressure oxygen supply synergistically supporting neural antioxidation), and daily high-dissolved-hydrogen drinking water.
- **Consulting-Grade Compliance Boundaries**: Positioned as long-term chronic disease neuroprotection and quality-of-life maintenance for neurodegenerative diseases, in conjunction with clinical neurology pharmacotherapy management; it must not unilaterally claim to "completely cure stroke hemiplegia and senile dementia."

3.3.5 Mental Health and Modern Urban Neuromodulation Population (Sleep Disorders, Chronic Fatigue Syndrome, Depressive and Anxiety Tendencies)

- **Population Size and Pain Points**: According to the **2024 White Paper on Sleep Health of Chinese Residents** by the Chinese Sleep Research Society, the incidence of sleep disorders among Chinese adults is as high as **38.2% (more than 300 million people)**; the number of people with depressive disorders is estimated at more than **95 million**, and those with anxiety disorders at more than **40 million**. Among fast-paced, high-pressure white-collar workers, corporate executives, venture capital professionals, and menopausal groups, "difficulty falling asleep, early awakening and dream-disturbed sleep, chronic fatigue syndrome (CFS), low mood, and brain fog" have become highly prevalent conditions that severely erode quality of life.

- **Molecular Biology Mechanism**: Long-term psychological stress leads to persistent hyperactivity of the hypothalamic–pituitary–adrenal (HPA) axis, with serum cortisol persistently at pathologically high levels, inducing atrophy and loss of hippocampal neuronal dendritic spines and neuroinflammation; synthesis of brain-derived neurotrophic factor (BDNF) is impaired, and central monoamine neurotransmitter (serotonin 5-HT, dopamine) metabolism is dysregulated. After penetrating the central nervous system, molecular hydrogen inhibits microglial release of pro-inflammatory cytokines (IL-6, TNF-**α**) and upregulates BDNF gene expression in the hippocampus; it regulates autonomic nervous function, improving vagal activity by increasing parasympathetic tone, and promotes a shift in the cerebral cortex from tense high-frequency **β** EEG waves to relaxed **α** waves, significantly prolonging the N3 slow-wave deep sleep cycle.
- **Authoritative Clinical Evidence and Honest Correction (Rigorous Fact-Checking for Users)**:
  - **Human Clinical Facts**: A team from the Second Medical Center of the Chinese PLA General Hospital, together with the Affiliated Hospital of Chengde Medical University, published a **human single-blind randomized controlled trial** in **Medical Gas Research** (Gao YH et al., 2026, 16(2):98-102, PMID: 40826930): 66 subjects with chronic sleep disorders inhaled hydrogen-oxygen gas nasally (67% H_2 + 33% O_2, 1 hour daily for 7 consecutive days); objective sleep monitoring with Actiwatch wrist devices showed that total sleep time (TST) and sleep efficiency (SE) were significantly prolonged, and wake time (WT) was significantly reduced; **for secondary mood endpoints, the hydrogen-oxygen group's Self-Rating Depression Scale (SDS) score was significantly lower than that of the control group, but the between-group difference on the anxiety scale (SAS) did not reach statistical significance**;
  - **Boundaries That Must Be Clarified**: **To date, no rigorous human RCT has used "patients with diagnosed major depressive disorder (MDD)" as the primary endpoint.** Most research on depression comes from mouse chronic unpredictable mild stress models (CUMS, Zhang Y et al., 2016, **Sci Rep** 6:23742; Gao Q et al., 2017, **Sci Rep** 7(1):9625), and much of it involves prophylactic administration. Therefore, **companies must not claim in commercial promotion that "hydrogen can treat depression."** Compliant and persuasive messaging should focus on "improving sleep microarchitecture, deep anti-fatigue effects, and alleviating autonomic nervous system dysregulation caused by chronic psychological stress."
- **Product Forms and Usage Habits**: Bedside quiet sleep hydrogen inhalation machines (low noise, 150–300 mL/min), micro-high-pressure hydrogen-rich oxygen sleep chambers, heat-moxibustion Shenque acupoint (navel) patches, and pre-sleep high-concentration hydrogen-rich foot bath tablets.



Figure 3-9 Huimei hydrogen-oxygen machine (AMH series, Class III medical device, National Medical Device Registration No. 20203080066). The clinical indication for this model is acute exacerbation of chronic obstructive pulmonary disease; the company also references sleep and fatigue recovery scenarios in its external communications for home-use settings—this is recorded here according to the "company's stated position" and does not constitute an efficacy judgment in this report.

Image Source: Huimei Medical official website

3.3.6 Obesity, Physique Management, and Metabolic Fatty Liver Population (Overweight Fat Loss and Visceral Fat Metabolism)

- **Population Size and Pain Points**: The **Report on the Nutrition and Chronic Disease Status of Chinese Residents** shows that among Chinese residents aged 18 and above, the overweight rate is 34.3% and the obesity rate is 16.4%, **with the combined overweight and obese population exceeding 600 million**; the prevalence of non-alcoholic fatty liver disease (NAFLD/MASLD) has exceeded 29%, making it the chronic liver disease with the highest prevalence in China (more than **200 million patients**), accompanied by metabolic disturbances such as high triglycerides and insulin resistance, forming a vicious cycle.
- **Molecular Biology Mechanism**: Pioneering research by Professor Shigeo Ohta's team at Nippon Medical School revealed molecular hydrogen's unique metabolic signaling regulatory pathway: **molecular hydrogen can stimulate the liver to secrete a key endocrine hormone of energy metabolism—fibroblast growth factor 21 (FGF21)**. After release into the blood, FGF21 targets and activates peroxisome proliferator-activated receptor **γ** coactivator 1**α** (PGC-1**α**) and PPAR-**α**, **inducing a phenotypic conversion of subcutaneous white adipose tissue into energy-consuming brown/beige fat (white adipose tissue browning, WAT Browning)**; it significantly upregulates mitochondrial uncoupling protein 1 (UCP1) expression, dissipating energy as heat and increasing basal metabolic rate; at the same time, it accelerates hepatocellular fatty acid **β**-oxidation, substantially reducing hepatic triglyceride accumulation and lipid peroxide deposition, effectively reversing steatohepatitis.
- **Authoritative Clinical Evidence**: Shigeo Ohta's team published research in the internationally authoritative obesity journal **Obesity** (Kamimura N et al., 2011, 19(7):1396-1403, PMID: 21293445) confirming that in db/db severely genetically obese mouse models, long-term free access to hydrogen-rich water **significantly reduced body fat content and body weight and markedly decreased fasting blood glucose and visceral fat, even without restricting dietary caloric intake or food intake**; subsequent clinical trials by scholars in Serbia and China further confirmed that in

human subjects with metabolic syndrome, continuous consumption of hydrogen-rich water for 8–12 weeks produced statistically significant improvements in serum total cholesterol, triglycerides, small dense LDL, and the liver controlled attenuation parameter (CAP, indicating degree of fatty liver).

- **Product Forms and Usage Habits**: Portable solid-state hydrogen effervescent tablets (dissolved in water for white-collar meal replacement or before/after exercise), hydrogen-rich cold brew black coffee/green tea (metabolic synergy), and micro-porous ceramic portable hydrogen-filtering water bottles.

3.3.7 Traditional "Three Highs" and Cardiocerebrovascular Chronic Disease Population (Hypertension, Hyperlipidemia, Hyperuricemia/Gout)

- **Population Size and Pain Points**: According to the **China Cardiovascular Health and Disease Report** by the National Center for Cardiovascular Diseases, the number of hypertension patients in China reaches **245 million**; the population with dyslipidemia exceeds **400 million**; and patients with hyperuricemia reach **180 million** (more than 15 million diagnosed with gout, with a marked trend toward younger ages among men aged 20–40). Traditional chronic disease management faces pain points including poor medication adherence, dry cough/edema caused by long-term antihypertensive drugs, myalgia and elevated liver enzymes caused by statin lipid-lowering drugs, and allergic reactions induced by urate-lowering drugs.
- **Molecular Biology Mechanism**:
  - **Hypertension**: Shear stress injury and endothelial oxidative stress cause superoxide anions to react rapidly with endogenous nitric oxide (NO), generating highly cytotoxic peroxynitrite anion (**$ONOO^-$**), leading to uncoupling of endothelial nitric oxide synthase (eNOS) and loss of endothelium-dependent vasodilation. Molecular hydrogen selectively scavenges **$ONOO^-$**, protects bioactive NO concentration, significantly improves flow-mediated vasodilation (FMD), and helps stabilize peripheral resistance vessel pressure;
  - **Hyperlipidemia**: Inhibits oxidative modification of low-density lipoprotein (LDL) in the subendothelial layer to form ox-LDL, prevents unrestricted macrophage phagocytosis of ox-LDL and conversion into foam cells, and blocks the formation of vulnerable atherosclerotic plaques from the earliest cellular stage;
  - **Hyperuricemia and Gout**: Uric acid microcrystals (MSU) deposit in the joint synovial cavity, inducing an explosive burst of reactive oxygen species in macrophages, activating the NLRP3 inflammasome, and releasing large amounts of interleukin-1**β** (IL-1**β**), causing severe pain in acute gouty arthritis. Molecular hydrogen not only mildly inhibits hepatic xanthine oxidase (XOD) activity to reduce endogenous uric acid production, but also **directly blocks the NLRP3 inflammasome activation pathway and the maturation and release of IL-1β**, providing anti-inflammatory and uric acid–lowering support without gastrointestinal or renal toxic side effects during acute attacks and intercritical periods.
- **Authoritative Clinical Evidence**: Song Guohua, Qin Shucun, and colleagues at Taishan Medical University published a clinical trial in the **Journal of Lipid Research** (2013, 54(7):1884-1893, PMID: 23610159): 20 patients with metabolic syndrome drank hydrogen-rich water for 10 weeks, serum total cholesterol decreased, and **the anti-atherosclerotic protective function of high-density lipoprotein (HDL) was significantly restored**; Professor Li Changgui, a leading gout authority at the Medical

College of Qingdao University, has also published multiple hydrogen-rich water intervention studies in the international hyperuricemia and gout field, confirming that hydrogen-rich water can promote uric acid excretion and reduce the frequency of gout attacks.

- **Product Forms and Usage Habits**: High-flow household hydrogen-rich water machines (all-day drinking water replacement), hydrogen-rich herbal uric acid–lowering foot bath tablets, and hydrogen-rich joint warming transdermal patches (local synovial anti-inflammatory and swelling reduction).

3.3.8 Urban Young and Middle-Class Women Seeking "Early Anti-Aging, Self-Pleasure, and Photoaging Defense" (Core Consumers in Beauty and Personal Care FMCG)

- **Population Profile and Consumption Characteristics**: Middle-class women and workplace elites aged 25–45 in Tier 1 and Tier 2 cities are the absolute mainstay of beauty, personal care, and anti-aging consumption. They advocate scientific skincare and strongly identify with the physiological mechanisms of "antioxidation, anti-glycation, free radical scavenging, and collagen protection"; they generally reject traditional metaphysical concept marketing and have a high ability to discern ingredient lists and test reports ("ingredient-savvy consumers"). Their consumption decisions focus on post-minimally invasive aesthetic procedure repair and daily premium skincare products that offer "rigorous mechanisms, immediately perceptible results, and safety without side effects."
- **Molecular Biology Mechanism**: Ultraviolet (UVA/UVB) radiation is the absolute primary culprit in exogenous skin aging (photoaging). UV irradiation of dermal fibroblasts induces massive production of singlet oxygen and hydroxyl radicals, promotes expression of transcription factor AP-1, and thereby upregulates matrix metalloproteinase-1 (MMP-1, collagenase) and MMP-3, extensively hydrolyzing and cleaving type I and type III collagen and elastin in the dermal reticular layer, leading to skin tearing and collapse, wrinkle formation, and laxity. Molecular hydrogen, with its extremely small molecular weight of 2 Da, penetrates dermal cells and selectively scavenges hydroxyl radicals, **strongly inhibiting UV-induced MMP-1 expression while upregulating TGF-β signaling and promoting procollagen synthesis**; in addition, molecular hydrogen inhibits abnormal activation of tyrosinase in melanocytes and reduces the deposition of lipid peroxides that cause dullness in the stratum corneum, achieving translucent brightening from within.
- **Product Forms and Usage Habits**: Anhydrous solid-state dry hydrogen facial masks (Tencel/ultrafine fiber dry mask fabric combined with solid-state microcrystals, activated with water to release hydrogen, 1,200–1,500 ppb for strong penetration), hydrogen-rich antioxidant eye patches/heat-compress eye masks, hydrogen-rich micro-bubble cleansing cold-process soap, and hydrogen-rich firming essence spray.



Figure 3-10 Usage and product form of hydrogen eye patches: applied around the eyes in use (background), individual aluminum foil sachets (single patch) and ten-pack boxes (foreground)—"open and use, one patch at a time," a typical form that turns hydrogen into a repurchase consumable

Image Source: Product image from Muqi Technology's solid-state hydrogen product line (Meimeng Chengzhen H2-EYESCAPE)



Figure 3-11 Physical composition of hydrogen eye patches: the eye-shaped patch itself (pressed on the box surface), individual aluminum foil sachets, and ten-pack boxes. To judge whether a hydrogen product is a "consumable," look at three things—whether it has individual single-patch packaging, whether the per-patch price can be reduced to a self-pay acceptable range, and whether it must be repurchased after use

Image Source: Product image from Muqi Technology's solid-state hydrogen product line (Meimeng Chengzhen H2-EYESCAPE)

3.3.9 High-Intensity Fitness and Physical Recovery Segment (Marathon Running, Fitness Anti-Fatigue, and Muscle Supercompensation)

- **Segment Profile and Consumption Characteristics**: According to data from the General Administration of Sport of China, the number of people nationwide who regularly participate in physical exercise has exceeded **400 million**, of whom more than **70 million** are heavy fitness users engaged in marathon running, road cycling, triathlon, CrossFit, and high-frequency strength training. The sharp accumulation of skeletal-muscle lactic acid after exercise—causing soreness and weakness—delayed-onset muscle soreness (DOMS) after exercise, and acute sterile micro-damage to muscle fibers and systemic oxidative stress induced by high-volume training constitute the core pain points constraining athletic performance and recovery cycles.
- **Molecular Biological Mechanism**: During strenuous exercise, oxygen consumption by skeletal-muscle mitochondria surges 100–200-fold relative to the resting state; electron leakage from mitochondria triggers an avalanche-like overproduction of superoxide anions and hydroxyl radicals, severely oxidizing and damaging sarcoplasmic reticulum myosin and troponin and resulting in intracellular calcium dysregulation and massive leakage of creatine kinase (CK). Supplementing with molecular hydrogen before exercise or immediately afterward can selectively neutralize exercise-induced malignant ROS, protect the structural integrity of muscle cell membranes; promote the activity of skeletal-muscle monocarboxylate transporters (MCT), **markedly accelerating the catabolic clearance of blood lactate and its hepatic gluconeogenic elimination**; and inhibit the release of inflammatory mediators, significantly attenuating the peak of DOMS pain 24–48 hours after exercise. Combined with a mild hyperbaric oxygen environment (1.3–1.5 ATA), it can further enable supercompensation of muscle tissue and rapid rebound of physical capacity.
- **Authoritative Clinical Evidence**: The Japanese scholar Aoki et al. conducted a rigorous randomized, double-blind, placebo-controlled crossover trial in **Medical Gas Research** (2012, 2:12, PMID: 22784860) involving 10 male elite soccer players: subjects consumed hydrogen-rich water 30 minutes before strenuous incremental-load cycle ergometer exercise, and the results showed that **the post-exercise blood lactate accumulation level in the hydrogen-rich water group was significantly lower than in the placebo group, and the peak of skeletal-muscle fatigue under maximal exercise load was significantly delayed**; multiple human exercise RCTs by Mikami et al. (2019, **Can J Physiol Pharmacol**, 97(1):57-62) likewise confirmed the definitive efficacy of oral molecular hydrogen in enhancing the aerobic exercise capacity of endurance athletes and shortening the recovery period.
- **Product Formats and Usage Habits**: Portable electrolytic hydrogen-rich water bottles for exercise; solid-state micro-porous portable effervescent energy tablets (added to sports drinks for mixing); mild hyperbaric hydrogen-oxygen chambers at sports rehabilitation centers (1.3–1.5 ATA for post-competition deep recovery); hydrogen-rich deep-muscle cold-compress/heat-compress gel patches.



Figure 3-12 Visitors operating the touchscreen of the "AI Intelligent Iced/Hot Fresh-Ground Hydrogen Coffee" machine; the machine body bears the branding of peer company Kavoro

Image Source: On-site at the 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo (May 2026; photographed by the research team of this report)

3.4 Comprehensive Benchmarking of the Paradigm Shift: An Eight-Dimensional Restructuring Matrix from "Gray-Market Seminar Marketing" to "Full-Lifecycle Precision Intervention"

Through the above full-dimensional review of clinical and pathological mechanisms, the Chinese hydrogen health industry is undergoing a historic structural benchmarking transition:

Table 3-1

Assessment Dimension	Traditional Gray-Market Seminar Marketing Phase (2014–2020)	Modern Precision Lifestyle Intervention Phase (2024–2026+)	Underlying Drivers of the Transition
1. Target Segment Profile	Vaguely generalized as "the elderly, weak, sick, and disabled," with undifferentiated harvesting of middle-aged and elderly retirees	Nine precise vertical segments (diabetes, ulcerative wounds, skin inflammation, Parkinson's disease, insomnia, obesity, the "three highs" and gout, anti-aging for women, and fitness/exercise)	Clearer pathological mechanisms, surging chronic-disease prevalence, and awakening of full-lifecycle proactive health awareness
2. Core Messaging	"Cures all diseases, miracle water and miracle gas, reverses cancer, root-cause cure after stopping medication"	"Selective antioxidant stress response, adjunctive cellular anti-inflammation, microcirculation improvement, and daily cellular health management as a lifestyle"	Rejection of pseudoscience and deified concepts, with strict adherence to the legal and academic red lines of lifestyle and adjunctive medicine

Assessment Dimension	Traditional Gray-Market Seminar Marketing Phase (2014–2020)	Modern Precision Lifestyle Intervention Phase (2024–2026+)	Underlying Drivers of the Transition
3. Dominant Product Formats	Single, heavy, mains-powered electrolytic hydrogen-generation equipment costing tens of thousands of RMB (hydrogen inhalers, water generators)	A matrix of "lightweight, portable, battery-free, solid-state hydrogen storage/release micro-porous materials, and high-frequency FMCG" (bottle cores, lozenges, dry film masks, traditional Chinese medicine thermal moxibustion patches, foot-soak tablets, mild hyperbaric chambers)	Breakthroughs in new materials on the supply side (solid-state materials for hydrogen generation via hydrolysis), with product formats shifting from counter-intuitive to intuitive
4. Customer Unit Price and Decision Threshold	¥15,000–¥26,000 per unit (extremely high decision friction; one-off transaction)	Tens to hundreds of RMB per box (FMCG, low-friction decision) plus several thousand RMB (high-end household mild hyperbaric chambers)	Elimination of purchase-decision barriers, aligned with the mass psychology of high-frequency daily consumption
5. Channel Formats and Customer Acquisition Cost	Closed-door underground experience stores, acquaintance-recruitment gatherings, high-pressure private-domain seminar marketing; customer acquisition cost (CAC) extremely high and unsustainable	Branded Tmall/JD public-domain flagship stores, pan-beauty industry salons, chain pharmacy daily-chemical shelves, compliant social-commerce channels; CAC steadily declining	Departure from underground gray-market networks and full integration into mainstream modern health-industry commercial distribution channels
6. Commercial Repurchase and Customer Lifetime Value (LTV)	**Reorder rate of 0%**; once the equipment is sold outright, the enterprise loses subsequent cash flow, forcing it to keep cultivating new targets	**Monthly/quarterly high-frequency organic repurchase (>40%)**; the razor-and-blade model increases corporate LTV by 5–8× versus traditional approaches	Consumable FMCG products are inherently depletable by nature, building a self-sustaining commercial cash flow flywheel
7. Regulatory Compliance and Reputational Risk	Falls squarely within the priority scope of market regulation anti-counterfeiting campaigns, media exposés, and economic crime investigations; suspected of illegal medical practice and pyramid scheme operations	Strictly compliant with food-contact materials (GB 4806), food additives (GB 2760), cosmetic safety standards, or rigorous Class III medical device registration; zero reputational risk	Clear legal title and ownership; proactively severing the original sin of 'disease treatment' claims, embracing compliant and transparent growth
8. Public Perception and Psychological Foundation	Built on information asymmetry, pseudoscientific fearmongering, and elderly consumers' superstitious compliance	Built on 1,100+ rigorous PubMed-indexed publications, authentic human RCT evidence, and consumers' rational perception of their own health	Consumer mindset is maturing — shifting from 'being duped' to 'proactive, science-driven choice'

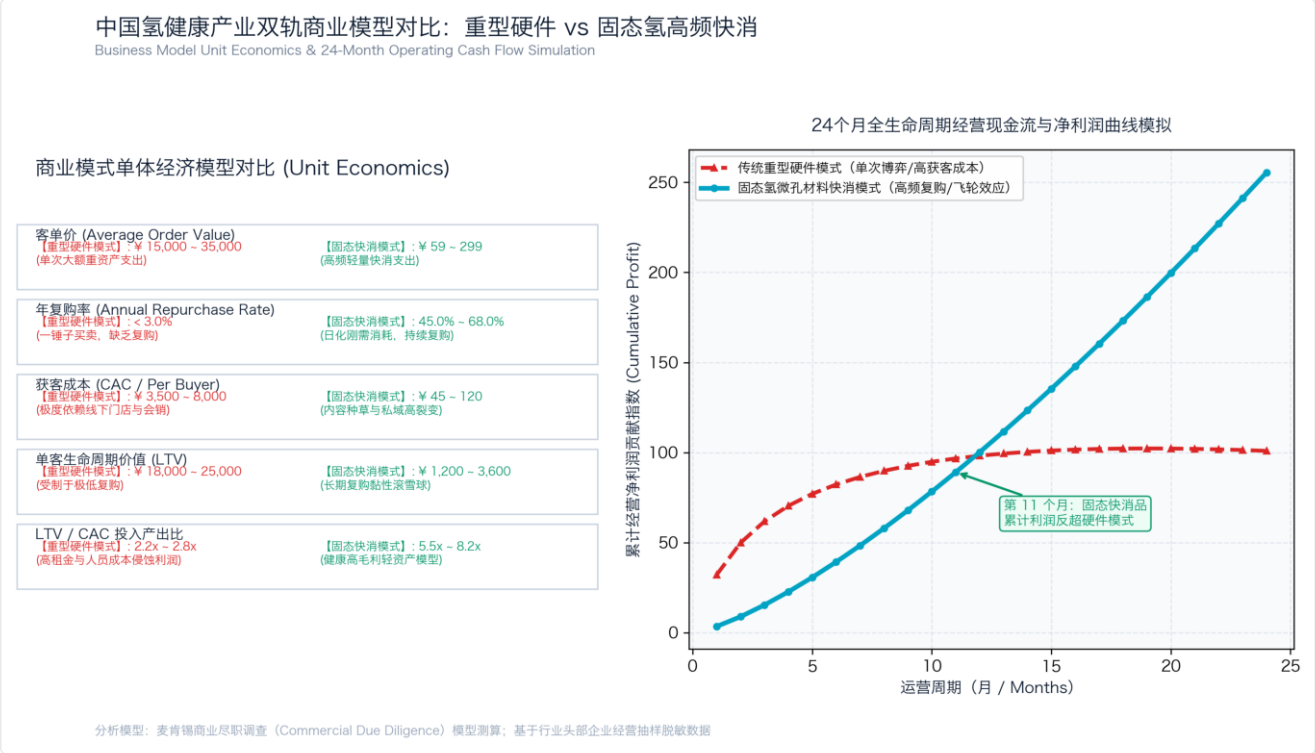


Figure 3-13 Comparison of Dual-Track Business Models in China's Hydrogen Health Industry: Heavy Hardware Single-Transaction Game vs. Solid-State Hydrogen High-Frequency FMCG (McKinsey due diligence unit economics model).

A comprehensive comparison of average order value (AOV), annual reorder rate, customer acquisition cost (CAC), customer lifetime value (LTV), and a 24-month cumulative operating cash flow simulation curve, intuitively revealing the decisive advantage of the asset-light, high-reorder FMCG model in avoiding seminar marketing risks and achieving flywheel growth.

Source: Estimates by this report (unit economics framework referenced to McKinsey due diligence methodology; AOV / reorder rate / CAC definitions see main text)

How to Read This Chart

- **What to look at:** The three lines represent AOV (average order value), CAC (customer acquisition cost), and LTV (customer lifetime value), comparing the two models side by side.
- **Core ratio:** An LTV/CAC ratio above 3 is required for scalability; the hardware model persistently falls below 1.5.
- **Definition note:** CAC is estimated on a per-customer amortized basis across offline experience stores, inclusive of rent and lecturer commissions, exclusive of brand advertising.

Key Insights

- **Finding 1:** The hardware sell-out model concentrates cash flow in the initial transaction with zero repurchase; any increase in acquisition cost directly breaches the single-store unit economics.
- **Finding 2:** The consumable repurchase model's LTV is driven by **repurchase frequency**; 8–12 repurchases per year are sufficient to cover a CAC higher than the hardware model.
- **Actionable implication:** This is not a choice between 'selling expensive or selling cheap,' but a choice between two fundamentally different businesses: 'one-time gross margin' versus 'lifetime cash flow.'

3.5 The Evolution of Public Perception: From 'Passive Victims of Superstition' to 'Rational, Science-Driven Daily Health Living'

This fundamental shift on the demand side and in target customer segments ultimately converges into Chinese consumers' **paradigm awakening in their understanding of the hydrogen molecule**:

1. **De-mystification and the Democratization of Science**: Consumers are gradually coming to understand that the hydrogen molecule is not a 'Supreme Elder Lord's panacea' capable of curing all diseases; it is, in essence, **'the smallest gas molecule — extremely safe, highly permeable, and endowed with unique selective antioxidant capacity.'** It cannot resurrect the dead, but it can, at a minimal physiological cost and through cumulative daily use, help the body neutralize the most toxic metabolic waste (**·OH**), repair damaged mitochondria, and suppress aseptic chronic inflammation. This de-mystified scientific rationality is the true establishment of the industry's healthy foundation;
2. **From 'Medical Treatment Dependency' to 'Lifestyle Medicine'**: The general public no longer views hydrogen as a therapeutic drug reserved for 'life-saving hospital visits when critically ill,' but rather as a modern lifestyle health intervention factor standing alongside 'regular sleep patterns, quality sleep, Mediterranean diet, and moderate exercise.' Whether it is a glass of high-concentration hydrogen-rich water in the morning, a solid-state effervescent tablet in the afternoon, or a traditional Chinese medicinal heat patch and hydrogen-rich foot soak before bed, hydrogen health is quietly integrating into the daily lives of hundreds of millions of Chinese middle-class and silver-haired households, constructing the first line of defense against chronic disease and aging.

CHAPTER 03 RECAP · Chapter Summary

Behind all nine population segments, there is only one dividing line: route of administration determines the boundary of permissible claims

1. **The root cause of seminar marketing is the price-point structure.** Products with factory costs of RMB 2,000–5,000 and retail prices of RMB 15,000–26,000 cannot sell organically through supermarkets or e-commerce; offline experience salons are among the few channel formats capable of absorbing such price points. Exaggerated sales rhetoric is a product of this structure, not its cause.
2. **Each of the nine population segments has its own independent evidence boundary.** The strongest evidence supports plaque psoriasis hydrogen water bathing and COPD inhalation; atopic dermatitis lacks large-scale human double-blind RCTs; diabetes, Parkinson's disease, and others can only be positioned as adjunctive interventions — claim boundaries must be strictly bound to evidence tiers.
3. **The most common form of overreach is route-of-administration mismatch.** Citing dermatological bathing literature to endorse 'drinking hydrogen water to cure skin diseases' will be instantly refuted on the spot before a professional physician; if the route is wrong, no amount of evidence hardness suffices.

Five Representative Population Segments: Evidence Status and Permissible Claim Boundaries

Table 3-2

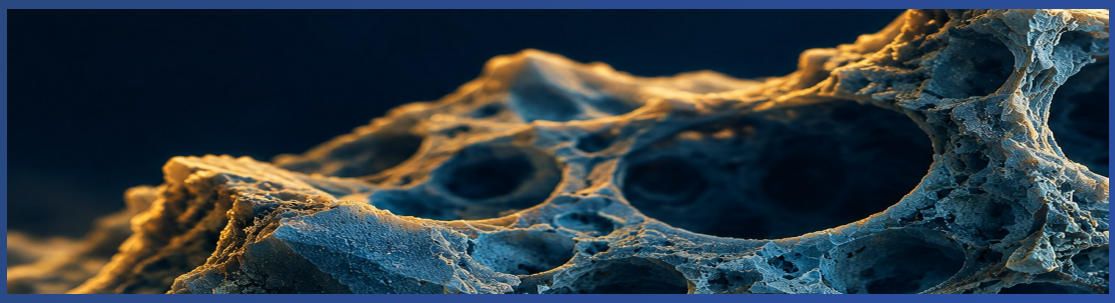
Population Segment	Primary Route of Administration	Evidence Status	Permissible Claims Boundaries
Chronic Obstructive Pulmonary Disease (COPD)	Gas inhalation	Multicenter parallel controlled trial; device already registered	Restricted to acute exacerbations of COPD; may not be extrapolated to other respiratory diseases
Psoriasis and other chronic inflammatory skin diseases	Water bath (topical)	RCT: PASI 75 response rate 24.4% vs 2.9%	Restricted to localized skin improvement; may not be extrapolated to systemic efficacy
Atopic dermatitis	Topical	No large-scale double-blind human RCTs to date	May be framed only as adjunctive care; therapeutic claims prohibited
Type 2 diabetes and metabolic syndrome	Oral ingestion via drinking water	Improvement in surrogate markers (ox-LDL, urinary 8-isoprostane)	Positioned as adjunctive intervention; glucose-lowering efficacy claims prohibited
Parkinson's disease	Oral ingestion via drinking water	Single-center 48-week UPDRS change	Positioned as adjunctive intervention; may not substitute for pharmacotherapy

Follow-up question: Is seminar marketing the industry's original sin?

The issue is first and foremost one of price-point structure. Products in this price band do not turn over organically in supermarkets or e-commerce, and offline experience is one of the few formats capable of absorbing them. Treating a structural problem as a moral one yields the ineffective solution of "sell through a different channel"—the genuinely effective solutions lie in the payment gateways examined in Chapter 7 and the consumables-based model in Chapter 8.

Follow-up question: Can the literature on hydrogen water baths support claims that "drinking hydrogen water improves skin diseases"?

No. This is a route-of-administration mismatch, and the evidence chain breaks at the level of administration route. It is also the most common form of overreach in the industry—and the one most readily refuted on the spot by specialist physicians.



CHAPTER 04

Chapter 4: The Deep Dive on Benchmark Cases

MUQI Technology deliberately left the finished-equipment business behind, focusing on materials and consumables and turning competitors into customers.

Chapter Takeaways · Benchmark Case: MQ TECH's Solid-State Hydrogen Innovation in Practice

1. **Forgoing finished equipment was a deliberate choice.** "Focusing on materials and consumables" appears on the surface to be a retreat; in substance it is a way to avoid head-on competition with every finished-equipment customer and to turn industry peers into customers—one of the most scalable positions available to an upstream supplier.
2. **The moat of the ICR technology platform.** The sintering process for hydrogen storage and release in the crystalline micro-porous lattice, the control of dissolution rates, and moisture-proof passivation constitute process barriers that are difficult to replicate in the short term; 37 patents (15 invention patents) are the formalized evidence of this moat.
3. **The enabling logic of MUQI Inside.** Four-tier enablement (raw materials—formulation—product—brand) upgrades "selling raw materials" to "selling market-ready product solutions," simultaneously lowering compliance and R&D barriers on the customer side.
4. **Structural difference in LTV.** One-off equipment sales generate zero reorders; the consumables model generates 8–12 reorders per year. This is not a difference in pricing strategy; it is the difference between two kinds of business.

4.1 Strategic Breakthrough: Why the Firm Firmly Chose to "Forgo Finished Equipment and Focus on Materials and Fast-Moving Consumables"



Figure 4-1 Eight-panel plant montage: aerial view, bagging, stainless-steel equipment, ISO, cleanroom, blue canister line, granulation, loading

Image Source: Muqi Technology official website emuqi.com; company-provided materials

While traditional hydrogen health companies have overwhelmingly clustered into the red-ocean competition of assembling household hydrogen inhalation machines, hydrogen-rich water machines, and other hardware devices,Muqi Technology (MQ TECH, Shandong Muqi Health Technology Co., Ltd.) has pursued a markedly different path of industrial innovation.

Confronted with the industry-wide structural problems of heavy-duty equipment—high unit selling prices, slow customer acquisition decisions, no consumable reorder revenue, and channel models highly dependent on seminar marketing—Muqi Technology's management established a clear industrial positioning principle in the early strategic phase:

> **"Transform hydrogen health from an equipment-type product into an embeddable, customizable, repeat-purchase, scenario-ready materials and consumables solution."**

The deeper commercial logic behind this strategic positioning is as follows:

1. **Circumvent homogeneous, hyper-competitive rivalry in asset-heavy hardware**: the assembly barrier for conventional electrolyzer hardware has gradually flattened, and focusing solely on complete units easily degenerates into price wars and a quagmire of payment terms; by contrast, underlying materials R&D carries extremely high technical barriers, formulation patents, and manufacturing know-how, capable of building long-term pricing power.

2. **Tap into a high-frequency, full-lifecycle repeat-purchase ecosystem**: hardware equipment is a one-time outright purchase with an extremely low commercial ceiling; by contrast, turning solid-state hydrogen materials into “portable water-tumbler filter cartridges, daily oral lozenges, skincare eye patches, and bath/foot patches” directly connects to the daily health consumption of hundreds of millions of consumers, forming an uninterrupted cash-flow flywheel.
3. **Build a platform-based enablement network (the “Intel Inside” model)**: rather than competing with end brands for channels, the company acts as an upstream core-technology provider, empowering global small-home-appliance, beauty and personal-care, water-purification, traditional Chinese medicine wellness chain, and cross-border overseas brands, thereby maximizing win-win value across the industrial ecosystem.



Figure 4-2 A live view of Muqi Technology’s advanced materials R&D laboratory. Leveraging an industry-academia-research innovation platform, the company has deeply cultivated micro-porous inorganic minerals and nano solid-state hydrogen-release material synthesis processes to fortify its underlying technology moat.

Image Source: Muqi Technology Industry Data Repository

4.2 Technology Foundation: The ICR Intelligent Controlled-Release Dissolved Solid-State Hydrogen Technology Platform



Figure 4-3 Left: four laboratory operation photos; right: a silver-white metal plaque inscribed with “Solid-State Hydrogen Storage New Materials Laboratory”

Image Source: Muqi Technology official website emuqi.com; company self-reported materials

Muqi Technology’s core technology engine is its self-developed **ICR (Intelligent Controlled Release) intelligent controlled-release dissolved solid-state hydrogen technology**. This technology breaks through the engineering bottlenecks of the violent reaction and uncontrollable hydrogen evolution of conventional elemental metals, and—through a multi-phase micro-porous composite ceramic lattice carrier—achieves safe storage, controlled release, and long-lasting dissolution of hydrogen gas at ambient temperature and pressure.

4.2.1 Core Engineering Parameters and Physicochemical Indicators

- **Gas-liquid equilibrium concentration**: In open water bodies at ambient temperature and pressure, dissolved hydrogen concentration is stably maintained at **1,200–1,500 ppb (1.2–1.5 ppm)**, reaching the physical saturation limit range at ambient pressure.
- **Broad water-quality adaptability with zero mechanical pressure bearing**: Unlike conventional magnesium-based metal materials, which rely solely on reverse-osmosis purified water and pose high-pressure explosion risks from hydrogen evolution in closed containers (some overseas competing products, for instance, require special pressure-relief valves), ICR micro-porous ceramics exhibit excellent broad water-quality adaptability (stable reaction in tap water, mineral water, and purified water alike), releasing gently at ambient pressure without mechanical pressure-relief components such as pressure-relief valves.
- **Negative oxidation-reduction potential (ORP)**: Effluent ORP is stably maintained in the excellent antioxidant reduction activity range of **-300 mV to -500 mV**, effectively neutralizing strongly oxidizing free radicals.
- **pH adaptive buffering**: Effluent pH is stably maintained in the weakly alkaline healthy range of **7.4–8.5**, and never produces the strongly alkaline (pH > 10) water-quality degradation commonly seen with conventional inferior strong hydrogen-release media.

- **Ultra-long dissolution half-life**: Benefiting from the micro-cluster restructuring of water molecule clusters by the micro-porous ceramic structure (NMR half-peak width notably narrowed to 50–65 Hz), the physical release half-life of hydrogen gas in closed containers reaches as high as **18–24 hours**, thoroughly resolving the consumer pain point of electrolytic hydrogen water “rapidly volatilizing to zero within tens of minutes.”

4.2.2 Intellectual Property and Industry-Academia-Research Moat

- **Patent portfolio**: Muqi Technology has cumulatively established **37** core patents, of which **15 are invention patents** with exceptionally high commercial and legal barriers, comprehensively covering material formulation, high-temperature micro-porous pore-forming processes, solid-state hydrogen-storage microsphere structures, and various downstream fast-moving consumable application forms.
- **Industry-academia-research ecosystem**: The company has long maintained joint research project mechanisms with relevant institutes of the **Chinese Academy of Sciences**, Shandong University, and well-known State Key Laboratories of Materials, and has established laboratories for microscopic physicochemical characterization, heavy-metal migration and leaching testing (GB 4806), and free-radical scavenging fluorescence testing; it is also jointly exploring, with the **Shanghai Jiao Tong University Hydrogen Science Center (Academician Ding Wenjiang’s team)**, the industrial development of solid-state hydrogen-storage materials in green agricultural inputs and modern agriculture.
- **Testing and enterprise standards**: The company has cumulatively obtained **more than 50** third-party test reports, filed **29** enterprise standards, and holds National High-Tech Enterprise qualification; test items cover food-contact material migration (GB 4806 series), heavy-metal leaching, and routine physicochemical indicators (per company statements; this report has not obtained the original reports item by item).

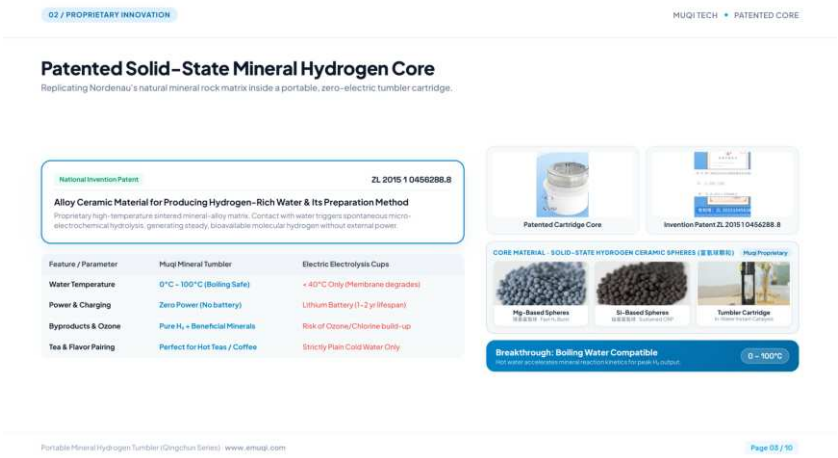


Figure 4-4 Product brochure: physical photos of magnesium-based/silicon-based ceramic balls and filter cartridges, marked with invention patent number ZL 2015 1 0456288.8

Image Source: Muqi Technology Industry Data Repository



Figure 4-5 Products and patent certificate on the inspection bench: on the left, boxed and individually bagged hydrogen eye patches; on the right, a standing invention patent certificate—Certificate No. 5890626, Authorization Announcement No. **CN 115744816B**, invention title "Solid-Supported Hydrogen Material and Its Preparation Method and Application," patentee Zibo Muqi New Materials Technology Co., Ltd., authorized and announced on April 18, 2023.

Image Source: Muqi Technology *Hydrogen Eye Patch Promotion Brochure* product materials

4.3 Full-Scenario Consumer Product Matrix: "Eat, Drink, Wash, Care, and Soak"

Enabled by the underlying ICR solid-state hydrogen technology, Muqi Technology has built a five-dimensional consumer product matrix covering all scenarios of daily life:

Table 4-1

Scenario Code	Scenario Positioning	Core Representative Products	Mechanism of Action and Consumer Value	Core Technical Parameters and Delivery Format
Eat	Oral endogenous absorption	**Hydrogen-Enriched Effervescent Tablets / Chewable Tablets**	Rapid disintegration upon contact with water yields highly saturated hydrogen water; alternatively, direct oral administration enables gradual intestinal absorption to modulate gastrointestinal microecology and provide visceral antioxidant support	Solid pressed-tablet format, dissolved hydrogen concentration of 1,200–1,500 ppb, food-grade excipient standards
Drink	Daily portable drinking water	**Yuanqi Hongxin Hydrogen Spring Cup / Filter Cartridge**	Plug-free, instant brew-and-drink; long-acting generation of 1,200 ppb weakly alkaline mineral active hydrogen water for fatigue resistance and metabolic support	Micro-porous ceramic filter cartridge module, zero-power long-acting sustained release, compatible with portable tumblers and water purification systems

Scenario Code	Scenario Positioning	Core Representative Products	Mechanism of Action and Consumer Value	Core Technical Parameters and Delivery Format
Wash	Facial anti-aging cleansing	**Hydrogen-Enriched Cold-Process Handmade Essential Oil Soap**	Micro-fine hydrogen bubbles deeply penetrate pores, gently removing excess sebum and aging free radicals while repairing redness-prone and sensitive skin	Mineral-catalyzed cold-process technique, high-density micro-bubble penetration, no soap-base chemical residue
Care	Localized microcirculation repair	**Meimeng Chengzhen Hydrogen-Enriched Eye Patches / Facial Masks**	Localized release of highly active hydrogen molecules penetrates the periocular and facial dermis, relieving eye fatigue and reducing dry lines and pigment deposition	Nano micro-porous dry-film/chip structure, in-situ catalyzed hydrogen release, high transdermal absorption rate
Soak	Whole-body hydrotherapy and foot therapy	**Nuanqingbao Thermal Moxibustion Patches / Foot Bath Tablets**	Combining thermal warming with solid-state hydrogen release, dilates plantar microvasculature, deeply dispels cold and dampness, and improves insomnia and severe fatigue	Constant-temperature 40–45°C self-heating, continuous hydrogen release at the micro-interface, compounded with authentic herbal essences



Figure 4-6 A solid-state hydrogen consumer product matrix spanning five daily scenarios—Eat, Drink, Wash, Care, and Soak: oral effervescent/pressed tablets, hydrogen water tumblers and ceramic plates, cleansing and personal care, eye patches and foot patches, and bath soaks and hydrotherapy. The extension of a single material system across five scenarios is the productization outcome of the "material supplier" positioning.

Image Source: Muqi Technology official website emuqi.com (English site)

4.3.1 Core Innovation Sub-Segments in External Applications: Hydrogen Facial Masks, Cross-Boundary Herbal Extraction, and Multi-Format Eye Care

1. **Cross-Boundary Fusion of Natural Plant Extracts and Solid-State Hydrogen (Sea Buckthorn Extract + Solid-State Hydrogen Bath Bombs / Cleansing Soap)**: In the personal care and bath product categories, the mere addition of inorganic minerals often faces limitations of monotone scent

and skin feel. Muqi Technology innovatively combines **high-activity extracts of wild sea buckthorn from the "Wild Slopes" of Lüliang, Shanxi** (rich in high concentrations of natural vitamin C, superoxide dismutase (SOD), flavonoids, and unsaturated fatty acids) with a solid-state hydrogen-releasing micro-porous matrix to develop "Hydrogen-Enriched Sea Buckthorn Nourishing Bath Bombs" and "Cold-Process Sea Buckthorn Hydrogen Soap." Upon immersion in water, micron-scale hydrogen-enriched bubbles are released while golden sea buckthorn antioxidant essence dissolves out, forming a dual-barrier repair efficacy of "plant-based antioxidant + selective antioxidant neutralization by molecular hydrogen."

2. **Materials Science Breakthrough in Hydrogen Facial Masks (From Aqueous Volatilization to In-Situ Hydrogen Release on Dry Mask Fabric)**: Addressing the pain point of conventional wet masks—"difficulty retaining hydrogen in the aqueous phase, with volatilization occurring upon factory dispatch"—the industry has explored a novel format: anhydrous dry mask fabric that stably stores hydrogen-release media at room temperature over extended shelf life, with in-situ activation and release of active hydrogen upon combination with essence before use, effectively resolving the issue of effective concentration dropping to zero during shelf life.
3. **Hydrogen Eye Masks and External Ocular Products (Device-Based vs. Solid-State Power-Free)**:
   - **Device-Based External Hydrogen Inhalation Eye Masks / Hydrogen Inhalation Goggles**: Employing medical-grade skin-friendly silicone sealing masks, connected via micro-conduits to dedicated household/commercial hydrogen generators or hydrogen-oxygen nebulizers, continuously delivering high-purity low-pressure hydrogen gas to the periocular region (e.g., 66% H_2 + 33% O_2), targeting improvement of severe dry eye syndrome, adjunctive intervention for fundus macular degeneration, and nourishment of optic nerve microcirculation;
   - **Smart Thermostatic Hydrogen Inhalation Eye Mask**: Combining graphene micro-electric heating elements with an integrated micro hydrogen storage/release chip, enabling multi-level thermostatic hot compress at 38–42°C in synergy with gentle hydrogen release;
   - **Power-Free Solid-State Hydrogen Hot/Cold Eye Patches (e.g., Muqi's "Meimeng Chengzhen")**: Utilizing body temperature to activate hydrogen release from solid-state micro-porous ceramic chips, completely free of cables and batteries, enabling instant application during travel, at the office, and for overnight sleep.
4. **Cross-Boundary Fusion of Muqi Technology's Solid-State Hydrogen-Releasing Materials (Product Name "Miqing") with Authentic Intangible Cultural Heritage Yao Medicine (Muqi Technology × Guangxi Hongyao Biological Technology Co., Ltd.)**: In the traditional bath soak and foot therapy health sector, Muqi Technology has entered a deep strategic partnership with **Guangxi Hongyao Biological Technology Co., Ltd. (Hongyao Co., Ltd.)**, the industry leader in Jinxiu Yao Autonomous County, Guangxi—known as the "Hometown of Chinese Yao Medicine." By deeply compounding solid-state hydrogen-releasing micro-porous materials developed specifically for bath soaks with Jinxiu's national-level intangible cultural heritage authentic Yao medicine (millennia-old Yao bath formulations), they have jointly developed "Hydrogen-Enriched Yao Medicine Foot Bath Packs" and "HGI Hydrogen Yao Bath Effervescent Tablets." Upon immersion in water, these instantly form -500 mV strongly negative-potential nano-microbubble hydrogen water, promoting a 3–6× increase in transdermal absorption rate of active substances such as Yao medicine flavonoids and saponins—a benchmark exemplar of deep empowerment through "modern micro-porous solid-state hydrogen + traditional ethnic minority authentic herbal medicine."



Figure 4-7 Deep blue gradient layout juxtaposing actual product shots of white and black mineral hydrogen water tumblers, with dissolved hydrogen parameters annotated on the right (parameters are company self-reported).

Image Source: Muqi Technology, **The "Hydrogen Plus" Strategic Initiative** (2026-01); company self-reported materials

4.4 Business Model Innovation: The "MUQI Inside" Four-Tier Enablement Flywheel

Muqi Technology has systematically built a **platform-based "MUQI Inside" four-tier enablement flywheel** spanning the entire industry value chain:

- **Tier 1 — Base Material Enablement (Core Hydrogen-Releasing Micro-Porous Ceramic Spheres/ Micropowder)**: Supplying standardized food-grade micro-porous ceramic microsphere materials to water treatment, functional kettles, and sanitary showerhead manufacturers worldwide;
- **Tier 2 — Core Component Enablement (Hydro-Ceramic Element Core / Composite Filter Cartridge)**: Providing modular post-treatment micro-porous hydrogen-releasing filter cartridges to small appliance and commercial water purifier brands on a plug-and-play basis;
- **Tier 3 — Consumer Product ODM/OEM Enablement (Full-Scenario FMCG Consumables)**: Delivering customized finished goods—including solid-state hydrogen effervescent tablets, handcrafted hydrogen soap, hot and cold eye patches, and thermal moxibustion patches—to beauty and personal care and health chain retailers;
- **Tier 4 — Cross-Sector Ecosystem Co-Enablement (Hydrogen TCM and Modern Agriculture)**: Providing integrated solutions—including hydrogen Sanfu patch chips and silicon-based hydrogen-enriched fertilizers—to traditional Chinese medicine clinics and leading modern agricultural input enterprises.

The defining feature of this enablement model is that **as an upstream materials and technology provider, it does not directly compete for consumer retail channels at the C-end, but instead empowers a diverse portfolio of downstream brand customers**.



Figure 4-8 A central circular MUQI Inside logo surrounded by concentric ripples and four application icons for beauty, health, fitness, and home.

Image Source: Muqi Technology, **The "Hydrogen Plus" Strategic Initiative** (January 2026); company self-reported materials

4.5 Business Economics Comparison: LTV Reconstruction — Equipment Outright-Sale Model vs. Consumable Reorder Model

A comparison of unit economics and customer lifetime value (LTV) between the traditional electrolytic hydrogen inhalation device makers' "one-time hardware outright-sale model" and the solid-state hydrogen materials-based "FMCG consumable reorder model":

Table 4-2

Business Dimension	Traditional Electrolytic Hydrogen Inhalation Device Makers (Equipment Outright Sale)	Solid-State Hydrogen FMCG Consumable Matrix (Reorder Model)	Consulting Strategic Assessment
Initial Purchase Threshold per Customer	**¥15,000–¥26,000** (highly deliberative decision)	**¥99–¥299** (low-consideration decision)	Consumable model's initial customer acquisition friction is only 1% of that for equipment, materially raising conversion rates
Customer Reorder Cycle	**Once every 3–5 years (or zero reorders)**	**Once every 30–45 days (8–12 times annually)**	Consumables generate high-stickiness, recurring repurchase cash flow, breaking free of the "one-off transaction" paradigm
Channel Customer Acquisition Cost (CAC)	Extremely high (requires long-term free experience salons and lecturer commissions)	Extremely low (public-domain e-commerce viral growth, private-domain community group buying)	Equipment model's CAC consumes over 50% of gross margin; consumable model has light fulfillment
Policy Compliance and Risk Resilience	Fragile (highly susceptible to being classified as false advertising and unlawful seminar marketing)	Robust (food-contact and personal care standards; clear compliance boundaries)	Under regulatory crackdowns, equipment seminar marketing faces seizure risk; FMCG operates in lawful compliance

Business Dimension	Traditional Electrolytic Hydrogen Inhalation Device Makers (Equipment Outright Sale)	Solid-State Hydrogen FMCG Consumable Matrix (Reorder Model)	Consulting Strategic Assessment
Cumulative 3-Year LTV per Customer	Approximately ¥18,000 (fully extracted in one transaction; limited follow-on potential)	**¥2,400–¥4,800** (continuously compounding)	Consumable model's per-customer lifetime value is structurally healthier, with strong long-term compounding effects

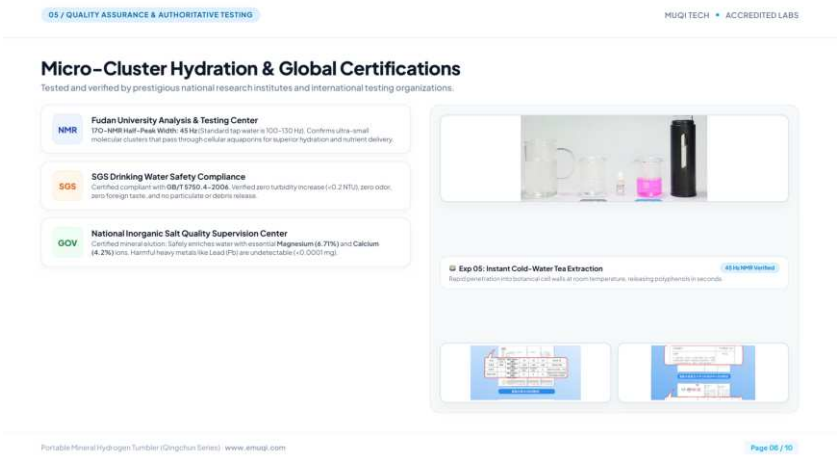


Figure 4-9 Brochure page showing thumbnails of three test reports: NMR, SGS (GB/T 5750.4-2006), and the Inorganic Salt Quality Inspection Center

Image Source: Third-party testing laboratory reports and food-contact material compliance documentation



Figure 4-10 Two explanatory boxes at top for the brand side and the supply chain, with four tiers of cooperation modules (raw materials, finished products, SOP, ecosystem) listed top to bottom below.

Image Source: Muqi Technology, **The "Hydrogen Plus" Strategic Initiative** (January 2026); company self-reported materials

4.6 Cross-Sectional Benchmarking of Consumer Hydrogen Products: An Objective Comparison of Single-Point Application Breakthroughs and Full-Industry-Chain Ecosystems

As the consumer hydrogen health sector has gathered momentum, a number of representative players and product formats have emerged in the market. A cross-sectional review of the broader industry ecosystem shows that the leading participants have leveraged differing resource endowments and technology pathways to establish differentiated competitive positions. An objective, neutral assessment of each major player's strategic positioning, core technologies, and commercial performance provides a panoramic view of the true competitive landscape of China's hydrogen health industry.

4.6.1 Model Positioning and Characteristics of Major Consumer Hydrogen Product Participants

1. **Qilin Zhengwei (Zhejiang Qilin Zhengwei Medical Technology / led by L'Oréal BOLD and Tiantu / hydrogen-enriched dry mask sheet and lead drafter of the group standard)**



Figure 4-11 Three photos of Qilin Zhengwei's laboratory, cleanroom, and automated production line; with group standard T/ZJRHXH 0017-2025

Image Source: Company public product materials and live listings on e-commerce platforms

- **Model positioning**: Focused on hydrogen-enriched dry mask sheets and microcapsule hydrogen-generating materials for beauty and personal care. Completed a Series A round of several tens of millions of RMB led by Tiantu Capital's "Beauty Pilot Fund" (in which L'Oréal BOLD holds a stake); led the drafting of China's first group standard, **Cosmetic Accessories — Hydrogen-Enriched Dry Mask Sheet** (T/ZJRHXH 0017—2025); is building a production base in Huzhou, Zhejiang, with planned annual capacity of 1 billion dry mask sheets, primarily promoting its first-generation solid-state hydrogen storage dry mask sheet ("mask companion," with cumulative shipments of nearly 50 million sheets) and its second-generation "HybridH_2Gen™" microcapsule liquid in-situ hydrogen generation technology, serving leading domestic and international beauty brands such as Shiseido and Proya.

- **Objective characteristics**: Holds significant first-mover advantages and breakout potential in the single-point beauty FMCG segment, penetration of major beauty brand supply chains, and endorsement by leading international beauty capital; its product line is highly concentrated on facial skincare and mask sheet contract manufacturing, with no involvement in high-throughput water treatment, traditional Chinese medicine patches, or agriculture.

2. **Huaqing Biotech (Huaqing Era Beijing Biotechnology / background of Professor Ma Xuemei's team at Beijing University of Technology)**
   - **Model positioning**: Founded under the national reform for enabling commercialization of scientific and technological achievements, drawing on the College of Life Science and Bioengineering at Beijing University of Technology and the Beijing Hydrogen Molecule Research Center, and led by Professor Ma Xuemei, an authority in hydrogen biology; jointly established the "BJUT–Huaqing Biotech Future Health Research Institute," focusing on hydrogen-specific molecular sensor mechanisms, cellular energy reprogramming, regenerative medicine, and wound repair, and developing hydrogen medical dressings, hydrogen masks, micro/nano hydrogen water, and cell-level health products.
   - **Objective characteristics**: Strong scientific research foundation, with distinctive strengths in "hydrogen regenerative medicine" and frontier molecular mechanisms (e.g., TRPC4 complex receptor regulation); its commercial positioning emphasizes industry–academia–research translation of university frontier technologies into high-end serious medical aesthetics, clinical wound repair, and foods for special medical purposes, while industrial-scale rollout of mass-market FMCG products and cross-sector ecosystem expansion remain in an exploratory growth phase.
3. **Qingyuanqi (Shanghai Qingmei Health Technology / background of Academician Ding Wenjiang's team at Shanghai Jiao Tong University)**
   - **Model positioning**: Drawing on Shanghai Jiao Tong University's background in light alloy materials science and HydroMg magnesium-based hydrogen storage material patents, focused on mid-to-high-end hydrogen health personal care, feminine care, and functional cosmetics (hydrogen care gels, skincare sprays).
   - **Objective characteristics**: High research focus, with deep cultivation in topical gel skincare and professional medical aesthetics experience channels, forming a distinctive label of university research commercialization; category expansion is currently centered on specialty topical gels, while hardware and multi-scenario consumable matrices are in a gradual extension phase.
4. **Qingde Hydrogen Energy (Suzhou Qingde Hydrogen Energy Technology / industry–academia–research background of the Peking University Institute of Molecular Engineering in Sunan)**
   - **Model positioning**: Leveraging the hydrogen storage and production research team at Peking University's College of Chemistry and Molecular Engineering and the Peking University Institute of Molecular Engineering in Sunan (an industry–academia–research base in Suzhou/Changshu, Jiangsu), it has implemented the commercialization of nano-hydrolysis hydrogen storage and production technology in the Yangtze River Delta. Its product line spans high-purity hydrogen storage and transport, health and personal care (nano hydrogen-generating raw materials for cosmetics, hydrogen essence, in-situ hydrogen-generating packs), and frontier modern hydrogen agriculture (its independently developed **"hydrogen molecular fertilizer synergist"**, enabling water-flush application and slow release in solid fertilizer blends, improving soil microecology and promoting nutrient uptake);

- **Objective characteristics**: Backed by the top-tier research credentials of Peking University as a national team institution and the hard-tech support of a Yangtze River Delta local industrial innovation institute, it holds a highly differentiated technology position in solid-state nano-hydrolysis hydrogen production mechanisms and agriculture-related new-quality productive forces (hydrogen fertilizer synergists); its current commercialization focus leans toward industrial energy storage and the output of specialty high-value-added agricultural and skincare raw materials, while it continues to build momentum in all-channel mass-market FMCG rollout of personal care products and full-scenario ecosystem expansion in traditional Chinese medicine patches.

5. **Shanghai Quanren Biotech (Asia-Pacific general agent for Japan's "Mainichi Suiso" / negative hydrogen ion capsules)**
   - **Model positioning**: One of the earlier representative companies in China's hydrogen health field; as the exclusive Asia-Pacific general agent for Japan's "Mainichi Suiso," it focuses on high-end solid-state negative hydrogen ion dietary supplements and a high-end exhibition model.
   - **Objective characteristics**: Has accumulated long-standing brand equity in high-end imported nutrition channels and among high-net-worth health-conscious customer groups; its business is essentially agency distribution of overseas original-brand products, with supply chain dependent on external licensing and limited in-house materials R&D and manufacturing.
6. **Rizhao Life Valley (Rizhao Life Valley Biotechnology / plasma negative hydrogen ion solidification technology)**
   - **Model positioning**: Focused on plasma negative hydrogen ion preparation technology, using nanoscale oyster shells/minerals as carriers to solidify negative hydrogen ions and developing negative hydrogen ion powders and solid pressed tablets; has previously collaborated deeply with large direct-selling health marketing systems.
   - **Objective characteristics**: Strong market promotion capabilities in solid powder hydrogen storage and health channel networks; product formats lean toward oral powders and pressed tablets, with relatively limited expansion into engineered embedding in fluid water purification and personal care FMCG scenarios.
7. **Emerging device and topical participants (external hydrogen-inhalation eye masks, graphene heating eye masks, micro-high-pressure hydrogen-oxygen health chambers)**
   - **Model positioning**: Integrating hydrogen technology with localized physiotherapy or micro-high-pressure environments, covering silicone eye masks connected to hydrogen inhalation machines, portable graphene heating eye masks, and 1.3–1.5 ATA micro-high-pressure hydrogen-enriched oxygen health chambers (hydrogen chambers), exploring periorbital microcirculation and systemic anti-aging rehabilitation.
   - **Objective characteristics**: Enriches the formats of professional hydrogen health equipment; however, hardware carries high unit prices and long decision chains, depends on external powered devices, and needs to form synergies with portable carry-on consumables.
8. **Muqi Technology (MQ TECH, Shandong Muqi Health Technology / upstream inorganic micro-porous solid-state hydrogen materials and B2B enabler)**
   - **Model positioning**: Positioned as a supply chain platform for R&D of solid-state hydrogen-releasing inorganic materials and upstream core components, promoting its proprietary "MUQI Inside" enablement model (company terminology). Its core technology is micro-porous composite ceramic hydrogen release technology (internal code ICR), maintaining a near-saturation concentration of 1,200–1,500 ppb in open water at ambient temperature and pressure, with a dissolved hydrogen

retention half-life of 18–24 hours; it has deployed 37 patents cumulatively (including 15 invention patents). Products cover inorganic hydrogen-releasing ceramic microspheres, filter element cores, oral effervescent tablets, hydrogen-enriched handmade soap, electricity-free hot/cold eye patches, hydrogen sanfu patch chips, silicon-based hydrogen-enriched fertilizers, and feed additives.

- **Objective characteristics**: Positioned as an upstream materials and core-component enabler (B2B), it does not directly operate downstream retail brands, covers a relatively broad range of scenarios (personal care, water purification, traditional Chinese medicine external therapy, modern agriculture), and has strong resilience against policy and cyclical volatility in any single category; business progress is highly dependent on the channel sell-through and market education capabilities of downstream brand customers, while overseas authoritative certifications remain in a gradual improvement phase in its internationalization process.

4.6.2 Benchmark Matrix

The following provides a cross-sectional, comprehensive comparison of the major camps above across core commercial and engineering dimensions:

Table 4-3

Assessment Dimension	Muqi Technology (MQ TECH)	Qilin Zhengwei (Beauty Dry Film)	Huaqing Biology / Qingyuanqi (University Research Commercialization)	Qingde Hydrogen Energy (Peking University Sunan Institute)	Channel Agents and Powder Peers (Quanren / Life Valley)
Value Chain Positioning	Upstream Core Materials and Components B2B Platform (Inside Model)	Vertical B2B Raw Materials/OEM Contract Manufacturing + Brand Incubation	Serious Medical Aesthetics and Regenerative Medicine Industry-Academia-Research Direct Sales/Hospital Channel	University National Team Hydrogen Storage and Production Technology Commercialization + Core Raw Material Supplier for Agriculture/Skincare	Brand Agency Distribution, or Contract Manufacturing for Specific Major Health Industry Clients
Underlying Technology and Patent Foundation	37 patents (15 invention patents), industry-academia-research joint development	Over 20 patents, led drafting of dry film group standard (T/ZJRHXH 0017)	University mechanism and hydrogen storage patents (Beijing University of Technology / Shanghai Jiao Tong University background)	Peking University hydrogen storage and production team patents, core mechanism of solid-state nano-hydrolysis hydrogen production	Relies on Japanese original manufacturer patent licensing, or plasma powder technology transfer

Assessment Dimension	Muqi Technology (MQ TECH)	Qilin Zhengwei (Beauty Dry Film)	Huaqing Biology / Qingyuanqi (University Research Commercialization)	Qingde Hydrogen Energy (Peking University Sunan Institute)	Channel Agents and Powder Peers (Quanren / Life Valley)
Hydrogen Release Mechanism and Medium Characteristics	Inorganic microporous ceramic lattice catalysis, sustained release at ambient temperature and pressure across wide water quality range (18–24h)	Solid-state hydrogen storage dry film (in-situ hydrogen release upon water contact) + microcapsule in-situ hydrogen generation	Medical dressings, wound repair solution, nano hydrogen water, skincare gel	Nano-hydrolysis hydrogen release materials, solid-state hydrogen storage packs, hydrogen molecule hydrolysis reactions	Oyster shell/mineral carrier immobilized negative hydrogen ion powder and pressed tablets
Covered Application Scenarios	Daily FMCG, water purification fluids, hydrogen TCM patches, silicon-based agriculture, ecological aquaculture	Deep focus on facial beauty and skincare (masks, microcapsule raw materials)	Medical aesthetics wound repair, cell regeneration, special medical health conversion	Modern hydrogen agriculture (hydrogen molecule fertilizer synergist), health and skincare raw materials (serum/hydrogen-generating tablets), portable hydrogen power	Dietary supplement oral capsules, health and wellness powder/pressed tablets
Primary Advantages	Strong cross-scenario versatility, resilient to single-category cyclical fluctuations, does not compete with customers	Rapid penetration into major beauty brand supply chains, strong capital backing, strong category breakout potential	High academic credibility, in-depth research on frontier molecular mechanisms and wound repair	Peking University top-tier academic backing, agricultural fertilizer synergist products first to land, high degree of technological originality	Deep brand recognition among the existing customer base; mature direct-sales/private-domain channel networks
Challenges	Dependent on sell-through by downstream brand clients; overseas authoritative certifications pending further development	Business highly concentrated in the single point of facial beauty care; cross-category expansion is difficult	Industrialized low-cost scale-up and multi-scenario commercialization entail a long cycle	Shallow penetration into mass-market daily consumer brands; multi-scenario traditional Chinese medicine and water treatment channels remain to be developed	Supply chain constrained by overseas licensing, or exposed to fluctuation among specific direct-sales customers

4.6.3 Comprehensive Industry Landscape Assessment: Divergent Models of Vertical Single-Product Breakthrough, Terminal White-Label OEM, and Upstream General-Purpose Enablement

A horizontal review of the major participants above shows that China's consumer hydrogen health industry has already produced three distinct, individually differentiated commercial evolution paths:

1. **Model 1: Vertical Segment Deep Cultivation (represented by Zhejiang KylinWay Medical Technology, Qingyuanqi, and others)**
   - **Core logic**: Enter through a specific high-growth consumer segment (e.g., beauty dry-mask fabric, sensitive-skin repair gel), deeply bind with tier-one beauty groups or professional medical-aesthetic institutions, and penetrate vertical application scenarios thoroughly.
   - **Commercial performance**: High strategic focus, clear brand recognition and industry positioning, and the ability to rapidly capture growth dividends from high-premium host industries such as beauty and personal care; the potential challenge is that business resilience is substantially constrained by the prosperity of a single category, and the threshold for extending upstream into basic mineral material sintering or laterally into cross-sector domains such as water purification and agriculture is relatively high.
2. **Model 2: Cross-Sector Translation of Frontier Technology by University "National Teams" (represented by Huaqing Biology/Beijing University of Technology, Qingyuanqi/Shanghai Jiao Tong University, Suzhou Qingde Hydrogen Energy/Peking University Sunan Institute, and others)**
   - **Core logic**: Leveraging the original-innovation patents and national major scientific research achievement translation and empowerment mechanisms of top national universities and research institutes (the Ma Xuemei team at Beijing University of Technology, the Ding Wenjiang/He Qianjun team at Shanghai Jiao Tong University, the Peking University Molecular Engineering Sunan Institute, etc.), to translate frontier molecular sensing, micro/nano hydrogen storage, and hydrolysis hydrogen production technologies into high-barrier products in a targeted manner (e.g., frontier wound dressings, functional gels, hydrogen molecular fertilizer synergists, etc.).
   - **Commercial performance**: Outstanding scientific reputation, with precise positioning in premium medical-aesthetic clinics, serious wound repair, and the specialized agriculture new-quality productive forces track; the core test lies in how to transition smoothly from laboratory results to large-scale, low-cost mass production, and how to build fast-moving consumer goods sell-through and a multi-dimensional ecosystem network suited to the mass consumer market.
3. **Model 3: General-Purpose Enablement via Upstream Materials and Core Components (represented by Muqi Technology, MQ TECH)**
   - **Core logic**: Positioned as a "core materials and technology component enablement platform" in the upstream-midstream of the value chain (a B2B "Inside" model), focused on the micro-sintering process of inorganic micro-porous ceramic materials and solid-state hydrogen storage/release formulations; it does not build its own terminal C-end brand, but instead supplies raw material microspheres, modular element cores, and semi-finished consumables to downstream brand clients across all scenarios—small household appliances, water purifiers, beauty care, traditional Chinese medicine topical applications, and modern agricultural inputs.
   - **Commercial performance**: Distinctive cross-category enablement advantage, able to simultaneously share in the growth increments of multiple tracks—home appliances, daily chemicals, traditional Chinese medicine health and wellness, and even green agriculture—with strong cross-cycle

resilience; because it does not engage in terminal retail itself, it largely avoids the policy and public-opinion risks of terminal seminar marketing; its core challenge is that business growth is highly dependent on the market education and channel sell-through efficiency of downstream brand clients, while the company is required to sustain high-intensity investment in basic materials R&D, product consistency control, and multi-scenario standard-setting.

4.7 Going Global and Three Unresolved Issues: The Corporate Roadmap, and the Shortcomings It Wrote Down Itself

The preceding six sections discussed "how this company operates in China." The three external-facing materials contain another thread that is written in greater detail—selling materials overseas, and upgrading from "selling materials" to "delivering a replicable implementation process." This thread merits separate treatment, and a separate question mark.

4.7.1 A Three-Phase Roadmap: Secure Channels First, Then Build Standard Products, and Finally Compete on Standards

The company's roadmap comprises three phases (per company planning; forward-looking judgment, not established fact):

- **Years 1–2: Enter only premium channels; offer only 1–2 hero products.** Target markets are North America, Japan, and Southeast Asia; entry points are premium SPAs, medical-aesthetic clinics, sports recovery centers, and biohacking studios—not supermarket shelves. What is sold in this phase is "effect scenarios that can be verified on the spot," not category awareness—for a category that still lacks a unified classification, this is the pragmatic path to bypass consumer education.
- **Years 3–5: Standardize the SKUs; scale via social media and e-commerce.** Shift from project-based supply to standard products with fixed formulations, fixed packaging, and fixed claim boundaries. This is the hurdle that upstream material suppliers going global must clear: cross-border channel partners cannot absorb "case-by-case negotiation" customization, and without standard products there is no repeat purchase.
- **Years 5–10: Participate in standard-setting and extend into sensor-equipped smart devices.** This is a long-term vision and is not assessed in this report.

Complementing the roadmap are three SOPs—**H_2 + red-light photobiomodulation**, **H_2 + traditional Chinese medicine external therapy**, and **H_2 + post-procedure medical-aesthetic repair**. The significance of this step is often underestimated: for clinic and medical-aesthetic customers, "a pack of material" has no value; "a set of processes that can be written into the service list, priced, and used to train technicians" does. What is truly handed off between upstream and downstream is not the product—it is the process.

On the client side, the company discloses that it has established profiles of approximately **20** named potential customers, and the original text explicitly writes "potential target customer profile"—**these are target profiles, not signed clients**; the international beauty and personal care brands cited in the materials are likewise illustrative targets. This report has obtained no public evidence of any signing, shipment, or channel listing; only the company's stated position is recorded here.

4.7.2 Three Unresolved Issues

It is worth noting that these three are not external criticisms leveled at the company, but were written down by the company itself in the final chapter of its English-language white paper.

- **Regulatory classification is the principal obstacle at present.** Solid-state hydrogen consumer products simultaneously touch three sets of regulations—food, cosmetics, and medical devices—yet no set establishes a separate category for "solid-state materials that release hydrogen upon contact with water"; the company's own assessment states that regulatory classification is "currently the biggest challenge." The implication is concrete: for each market entered, the classification argument must be redone from scratch—and classification determines claim boundaries, while claim boundaries determine channel format.
- **Clinical evidence is relatively scarce.** The company's own assessment of the evidence is "relatively scarce." This is consistent with the judgment in Chapter 1 of this report: the existing evidence base is concentrated in the two routes of inhalation and drinking, while transdermal absorption and local effects of topical solid-state materials lack human-study support. The evidence grows on "inhalation," not on "topical application."
- **Inconsistent characterization conventions and an absent standard.** Safety, efficacy, and stability must ultimately be reduced to comparable units—mg (content), mL/h (hydrogen production rate), mg/day (intake or exposure)—and at present each player follows its own conventions. The company therefore publicly calls for the formulation of a "Safety and Technical Specification for Raw Materials of Solid-State Hydrogen Consumer Products." This point is a precondition both for the four gates in Chapter 7 of this report and for the consumables trend in Chapter 8: **without unified characterization conventions, consumarization merely transfers uncertainty from the device to the product**.

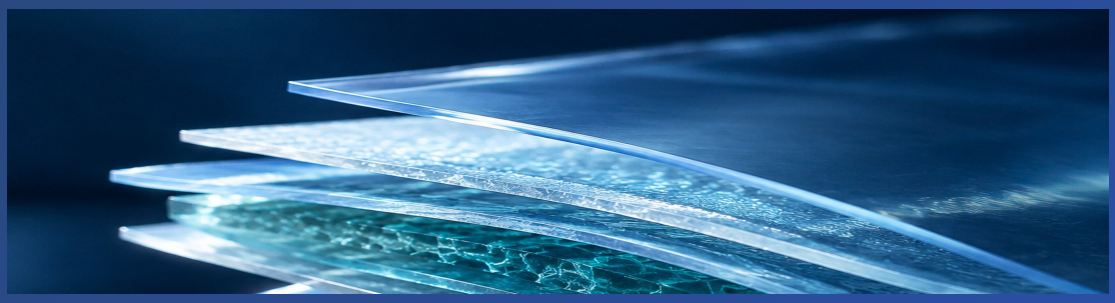
Viewed together, the true barrier to going global lies neither in channels nor in production capacity, but in "proving, market by market, what it is within a category that has not yet been classified." This also explains why this is placed at the end of the case chapter rather than in the trends chapter—it is one company's roadmap, and it is also the precondition confronting the entire solid-state hydrogen consumer products track.

CHAPTER 04 RECAP · Chapter Summary

Turning Peers into Customers: The Business Structure of the Materials Position

1. **The company’s development trajectory (the only consolidated narrative in this report).**Founded in Jinan in 2014; relocated to the Advanced Ceramics Industry Innovation Park in Zibo High-Tech Zone in 2017, the same year it launched hydrogen water ceramics and multi-element alloy antibacterial materials, marking the first appearance of the solid-state hydrogen route as a sellable product; in 2019, it co-established a solid-state hydrogen storage and generation materials laboratory with a team from the Technical Institute of Physics and Chemistry, Chinese Academy of Sciences, shifting the technology into an industry-academia-research co-development model; in 2022, it completed the full chain from raw materials to end products, transforming its industry role from “component supplier to finished-equipment manufacturers” to “materials supplier.”

2. **“No finished equipment” is a deliberate forgoing of head-on competition.**Focusing on materials and consumables effectively avoids competing in the same arena as all finished-equipment customers, turning peers into clients—one of the few scalable positions available to an upstream supplier.



CHAPTER 05

Chapter 5 Full Industry Chain Anatomy and Cross-Sector Spillover Ecosystem

Value pools are not found in midstream assembly but at the two poles: upstream materials and downstream usage scenarios.

Chapter Highlights · Full Industry Chain Anatomy and Cross-Sector Spillover Ecosystem

1. Each of the three segments has its own bottleneck.Upstream pricing is fragmented (components priced as electronics, materials priced as chemicals); midstream assembly barriers are extremely low (small-appliance assembly); downstream eight scenarios are dispersed.Value lies not in the midstream but at the two ends.
2. The institutional deficit of customs codes.Six-digit HS codes are globally consistent (8543.30 / 2201.90 / 2804.10); codes beyond eight digits are set by individual countries."Hydrogen has a code; hydrogen products do not"—directly creating a statistical black hole in cross-border trade.
3. Hydrogen agriculture is the most policy-friendly extension.The Ministry of Agriculture and Rural Affairs' "green, low-carbon, new-quality productive forces" policy explicitly favors hydrogen ecological cultivation and farming with no chemical residues, and it is not subject to medical device market access constraints—making it the direction of least resistance for industry spillover.
4. The common precondition of the eight scenarios.All extension scenarios depend on the same precondition: products must be inexpensive, easy to use, and repurchasable. Heavy equipment cannot enter any of these new scenarios.

5.1 Upstream Industry Chain: Core Raw Materials, Technical Components, and Customs Classification Characteristics

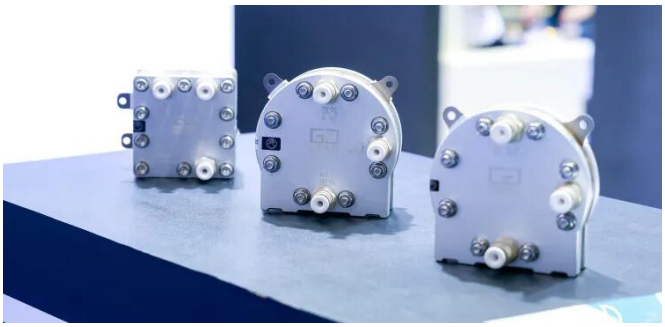


Figure 5-1 Three small metal and white electrolyzer components laid out flat, representing upstream core component forms.

Image Source: On-site at the 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo (2026-05, photographed by the report research team)



Figure 5-2 Three transparent filter cartridges displayed side by side, containing brown granular filter media with quick-connect fittings at the ends; no composition or hydrogen concentration labeling visible on site.

Image Source: On-site at the 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo (2026-05, photographed by the report research team)

5.1.1 Upstream Components and Pricing Fragmentation Across Electrolysis Equipment Technology Routes

- **Proton Exchange Membrane(PEM) and Membrane Electrode Assembly(MEA)**: Perfluorosulfonic acid proton exchange membranes are the core heart of the electrolyzer. For a long time, high-end membrane materials were monopolized by foreign giants such as Chemours (Nafion membranes) of the United States, with procurement costs reaching several thousand yuan per square meter; in recent years, domestic leaders such as Shandong Dongyue Group have achieved breakthroughs, advancing the import substitution process.
- **The measurement fragmentation of supply chain quotations (evidence from Alibaba International Station)**: On-site sampling of supply chain pricing on mainstream cross-border B2B platforms shows that the electrolysis technology route exhibits a pronounced “discrete pricing units and insufficient standardization” characteristic:
  - **Electrolyte membrane sheets**: priced by area, with quotations concentrated at **$1.10–3.00 / cm²** (MOQ 1 cm²);
  - **Catalytic membrane electrode assemblies(MEA)**: priced per piece, with quotations ranging from **$62.50 to $208.30 / piece**;
  - **PEM electrolyzer stacks**: priced per unit, with quotations ranging from **$100 to $600 / unit**;
  - **Finished-equipment assembly (hydrogen water tumblers / hydrogen inhalation machines)**: 3,000 mL-class household hydrogen inhalation machines are quoted at **$460 to $1,350 / unit**, while the lowest ex-factory price for portable hydrogen water tumblers is only **$7.20 to $8.64 / unit**, with premium branded models reaching **$38.00 to $55.00 / unit** (a 7.6-fold difference), and **minimum order quantities(MOQ) have generally been relaxed to 1 unit/piece**.

  - **Industry chain insight**: The fact that upstream quotations span multiple orders of magnitude—from area and piece to unit and finished equipment—essentially reflects that electrolytic hydrogen production products have yet to establish a unified, tiered industry technical language and an industrial standardized pricing benchmark.
- **Precious metal electrode coatings**: Electrolyzer bipolar plates and micro-porous hydrogen evolution electrodes typically use titanium substrates with nanoscale platinum (Pt), iridium (Ir), and other rare precious metals deposited on the surface as catalysts. Owing to volatile precious metal prices, the electrolyzer stack accounts for more than 40% of the total equipment cost.

5.1.2 Upstream Resources and Customs Tariff Classification Under the Solid-State Hydrolysis Materials Route

- **High-purity metal hydrogen storage carriers**: Primarily high-purity primary magnesium (purity 99.9%–99.99%), silicon-based materials, and natural inorganic non-metallic functional minerals (tourmaline, maifan stone, highly active porous diatomite, etc.). As the world's largest primary magnesium producer (accounting for more than 80% of global primary magnesium output, mainly concentrated in Yulin, Shaanxi and Yuncheng, Shanxi), China provides a low-cost, strategically secure resource base for solid-state hydrogen release materials.
- **Micro-porous crystalline ceramic matrix**: Led by materials R&D companies, rigorous industrial processes—including fine chemical grinding, micro/nano pore-forming agent compounding, and vacuum high-temperature atmosphere sintering—convert raw ore into three-dimensional crystalline frameworks with specific micro-pore diameters and high specific surface areas.
- **Practical constraints of import/export customs HS codes ("hydrogen has a code; hydrogen products do not")**: An empirical review of the Customs Import and Export Tariff (HS Code) reveals the institutional gap for Chinese hydrogen health products in international trade:
  - **High-purity hydrogen (compressed/liquefied)**: Has a dedicated statutory tariff code **2804.10.00.00** (regulatory conditions A/B, requiring a customs clearance form);
  - **Metal hydrogen storage alloy materials**: Classified under **2850.00.90** (other hydrides, nitrides, silicides, and borides);
  - **Pre-packaged hydrogen-rich water**: Can only be declared under **2201.90.90.00** (other waters, ice, and snow—the same code as ordinary purified water, with no mention of "hydrogen" in the full text);
  - **Hydrogen-rich water machines / electrolytic tumbler equipment**: Typically declared as "electrolysis equipment" under **8543.30.00.90**, or as "water filtration and purification equipment" under **8421**, or as "other small household appliances" under **8509**.
  - **Trade strategy implications**: Owing to the absence of dedicated customs codes for hydrogen health end products, imports and exports face compliance friction from discretionary classification by intended use—further evidence that the industry remains in an early growth stage of "parasitizing traditional parent industries" within the national macroeconomic statistics and tariff system.



Figure 5-3 Dozens of metal-cased electronic modules displayed in a ring on a circular exhibition stand, with heat dissipation grilles and circuit boards visible

Image Source: On-site at the 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo (2026-05, photographed by the report research team)

5.2 Midstream Industry Chain: Manufacturing, Assembly, and OEM Ecosystem

5.2.1 Hardware Equipment OEM: A Low-Barrier Small-Appliance Assembly Model

Supported by the comprehensive small household appliance supply chain in Shunde and Nanhai Districts of Foshan, Guangdong Province, and Bao'an District of Shenzhen, the barriers to complete-unit hardware manufacturing for electrolytic hydrogen water tumblers and hydrogen inhalation machines have been substantially lowered.

- Research reveals that on mainstream industrial-goods and foreign-trade supply-chain platforms, the **minimum order quantity (MOQ) for small electrolytic hydrogen water tumblers has fallen to as low as 1 unit** (e.g., factory quotes for generic white-label products are only **$7.20–$8.64 per unit**, equivalent to roughly RMB 50–60), with support for "single-unit wholesale, single-unit dropshipping, and rapid silk-screen OEM labeling (OEM)."
- This extremely low barrier to entry has enabled a large number of trading teams lacking core R&D capabilities to rapidly flood the market, resulting in highly homogenized hardware designs and inconsistent product quality.

5.2.2 Materials and FMCG Smart Manufacturing: High-Barrier Process Control and Compliance Requirements

Compared with the assembly of small household appliances, the production of solid-state hydrogen FMCG products involves sophisticated high-temperature sintering processes for inorganic materials and stringent cleanroom manufacturing standards:

- **Micro-porous ceramic microsphere sintering**: The high-temperature reducing-atmosphere sintering curve at 1,000°C–1,200°C must be precisely controlled to ensure that the micro-pore aperture maintains a nano/micro-scale distribution, while also ensuring a robust crystalline structure that will never fracture, pulverize, or leach harmful heavy metals under prolonged water-flow erosion.

- **Clean filling of fast-moving consumables**: Hydrogen eye patches and facial masks require non-woven composite lamination and vacuum packaging in a Class 100,000 GMP cleanroom; hydrogen effervescent tablets impose extremely strict requirements on workshop relative humidity (RH) (typically controlled below 20%–25%) to prevent moisture-induced spontaneous reactions of materials prior to tablet compression and packaging.



Figure 5-4 Three-step illustration of the foot-bath scenario: dropping a hydrogen tablet into water, upgrading from a $35 package to $55, and adding an eye mask at extra cost (prices are from the company's self-reported overseas program).

Image Source: Muqi Technology, "The 'Hydrogen Plus' Strategic Initiative" (2026-01); company self-reported materials



Figure 5-5 More than ten silver switching power supplies (with cooling fans) arranged in a row on a red tablecloth, with no electrolysis markings visible.

Image Source: 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo site (2026-05, photographed by the research team of this report)



Figure 5-6 Five "Yuanqi Hongxin" water-treatment filter cartridges displayed side by side, with stainless-steel mesh outer housings and inner-core structures; no hydrogen concentration markings were visible on site, so they cannot be identified as hydrogen-rich filter cartridges.

Image Source: 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo site (2026-05, photographed by the research team of this report)

5.3 Downstream Industry Chain and Eight Multi-Dimensional Extension Scenarios

As solid-state hydrogen material technologies mature and hydrogen molecular biology research advances in depth, the application ecosystem of the hydrogen health industry is breaking away from the narrow reliance on "household small appliances and bulk drinking water," extending across eight high-value scenarios spanning the national economy, modern agriculture, modernization of traditional Chinese medicine, and global commercial health:

5.3.1 Scenario 1: Chronic Disease Management and Out-of-Hospital Lifestyle Medicine Collaboration

Targeting China's vast population with chronic diseases (hypertension, type 2 diabetes, hyperuricemia, metabolic syndrome), continuous daily consumption of hydrogen-rich water and solid-state hydrogen tablets dissolved in beverages can assist in scavenging excess hydroxyl radicals (·OH), improving vascular endothelial function and insulin resistance, and forming a "lifestyle medicine collaboration" with conventional chronic disease medications.

5.3.2 Scenario 2: Silver Economy and Institutional Elderly Care

Statistics from the Ministry of Civil Affairs' annual report show that by the end of 2024, China had **40,000** registered elderly care institutions, with **5.077 million** beds, of which nursing-care beds accounted for **65.7%**. In pressure ulcer care for long-term bedridden elderly, anti-inflammatory and antioxidant support for disabled seniors, and cognitive protection for Alzheimer's disease, electricity-free solid-state hydrogen hydrotherapy and hydrogen thermal moxibustion foot patches demonstrate high embedding value.

5.3.3 Scenario 3: Health Consumption and Pan-Beauty FMCG (Hydrogen-Rich Dry Mask Fabrics, Multi-Form Eye Care, Concept Verification and Jiangsu Novel Medical Dressings)

Another player in the same track is **Huaqing Shidai (Beijing) Biotechnology Co., Ltd.** (hereinafter "Huaqing Bio"): established in September 2023 by Professor Ma Xuemei's team at Beijing University of Technology through **technology equity contribution**, with core businesses in medical dressings based on novel hydrogen storage materials and a "hydrogen medical aesthetics" product series; Ma Xuemei concurrently serves as Dean of the "BJUT–Huaqing Bio Future Health Research Institute," and the team has conducted basic hydrogen biomedical research since 2011 and claims to have deployed approximately forty international patents. Its difference from the aforementioned company lies in its origin: one grew out of university laboratory technology equity contribution, while the other entered from the beauty ingredient track in reverse; what they share is making "hydrogen + dressing/mask fabric" into intermediate goods deliverable to brand owners, rather than pursuing their own end-market blockbuster products.



Figure 5-7 Huaqing Bio's product display booth at the exhibition site: hydrogen-related facial masks, dressings, and beverage packaging on display.

Image Source: China.com report image (media image, 2025-06)

The skincare line is not being pursued solely by materials companies. Zhejiang KylinWay Medical Technology Co., Ltd. (brand KylinWay, established September 2022) launched its first product as a "hydrogen-rich dry mask fabric," positioned as a "mask companion"—applied over a conventional facial mask to trigger hydrogen release; it does not directly build an end-consumer brand but supplies underlying raw materials to beauty brands. In September 2026, it completed a Series A round of tens of millions of RMB, led by the Meili Leading Fund under Tiantu Capital, and co-established a "Hydrogen Medicine, Medical Aesthetics and Cosmetics Research Center" with Professor Li Jinhua's team at Jiangnan University. In the same year, its second-generation product shifted to "H_2 + CO_2" dual-gas solid-state controlled release; the company's disclosed third-party human trials report: at 15 minutes, hydrogen transdermal penetration increased by 50.53% versus the first generation, and the transdermal absorption efficiency of active ingredients increased by up to 2.8× (**both are company-reported figures, not independently verified by this report**).

This path merits comparison: materials companies follow "solid-state hydrogen-releasing materials → full-scenario FMCG supply chain," while skincare companies follow "skincare track → raw materials and solutions behind brands." Both choose to operate upstream and neither builds end-consumer brands; the difference lies only in track and customer structure—the former serves manufacturing segments such as daily chemicals, water purification, and non-wovens, while the latter serves beauty brand owners. This also corroborates a judgment in Chapter 6 of this report: value capture is concentrated at the two ends of "materials" and "evidence," not on the end-consumer shelf.



Figure 5-8 KylinWay (KylinWay) booth poster: golden hydrogen-rich dry mask fabric covering the face; its first product is the hydrogen-rich dry mask fabric positioned as a “mask companion.”

Image Source: KylinWay official website kylinway.com

China’s annual retail sales of cosmetics above the designated size reached **RMB 465.3 billion** (total omnichannel transaction value exceeded RMB 1.1 trillion). As consumers become more aware of anti-photoaging and sensitive-skin barrier repair, hydrogen molecules in the pan-beauty, daily-chemical FMCG, and medical dressing tracks are undergoing a deep evolution from “conceptual gimmick” to “hardcore technology”:

1. **Hydrogen-rich dry mask fabrics and anhydrous solid-state masks (breaking the aqueous-phase volatilization paradox, restructuring the tens-of-billions functional skincare track)**:
    - **Physical pain points of conventional wet masks**: Conventional aqueous hydrogen-rich masks face an insurmountable physicochemical paradox—hydrogen molecules have an extremely small molecular weight and low solubility at room temperature, and readily permeate through packaging and escape in the wet liquid of ordinary aluminum foil pouches; within one week of factory shipment, active hydrogen in the pouch is nearly zero, and such products have long been questioned as “ineffective concept water”;
    - **Breakthroughs in anhydrous solid-state dry mask fabrics and lyophilized microcrystals**: Industry pioneers (such as KylinWay, co-led by Tiantu Capital and L’Oréal BOLD, as well as Huaqing Bio and others) have innovatively developed “anhydrous solid-state hydrogen-storage dry mask fabrics.” Solid-state microcrystalline hydrogen-storage materials are compounded with skincare ingredients such as active peptides and hyaluronic acid, locked into dry plant-fiber mask fabrics, and can be stably stored for 24 months at room temperature in sealed packaging. When consumers add purified water or essence, instant in-situ hydration and activation occur, continuously releasing high-concentration nano-scale active hydrogen microbubbles of up to **1,200–1,500 ppb** within 30 seconds, reaching the dermis to neutralize harmful hydroxyl radicals (**·OH**) induced by UV and external stress, effectively inhibiting matrix metalloproteinase-1 (MMP-1)-mediated collagen degradation;
    - **Shipment scale and industry standardization**: Cumulative shipments of KylinWay hydrogen-rich dry mask fabrics have exceeded **50 million pieces**, and the company has driven the formal implementation of China’s first group standard **“Cosmetic Utensils—Hydrogen-Rich Dry Mask Fabric” (T/ZJRHXH 0017—2025)**, which statutorily establishes measurement protocols for in-situ

dissolved hydrogen concentration and micro-porous sustained release, advancing the entire functional skincare track toward a high-value-added stage of “verifiable certification and measurable data.”

2. **In-depth panoramic analysis of multi-form topical eye care (gas-phase goggles vs. graphene heat-compress eye masks vs. solid-state electricity-free hot/cold eye patches)**: Modern people staring at electronic screens for prolonged periods have led to an explosive incidence of visual fatigue and dry eye disease (especially meibomian gland dysfunction [MGD]-type dry eye). Elevated reactive oxygen species levels and accumulation of pro-inflammatory cytokines (IL-1β, TNF-α) in the ocular surface microenvironment are key pathological mechanisms. The market has evolved three distinctly different product pathways around eye care:
    - **Form 1: External gas-phase hydrogen inhalation goggles for clinical and experience-salon use (device-dependent)**: Medical-grade silicone sealed eye masks connected to a dedicated hydrogen generator or hydrogen-oxygen machine deliver high-purity hydrogen directly into a micro-enclosed space around the eyes, keeping the ocular surface cornea and conjunctiva continuously immersed in high-partial-pressure gaseous hydrogen. Its advantage lies in strong local antioxidant penetration, but it relies heavily on electrical connection and tubing, is bulky and not portable, and is mainly used in ophthalmic clinics, optometric rehabilitation centers, and offline experience salons;
    - **Form 2: Smart graphene heating hydrogen-inhalation eye masks (light-luxury electronic small appliances)**: Integrating graphene heating films with micro hydrogen-release chips or gas-permeable micro-pores, achieving **40°C–45°C constant-temperature heat compression** (physically softening abnormal lipid plugs solidified in meibomian glands) and continuous hydrogen release via USB or built-in lithium battery. The advantage is an excellent heat-compression sensory experience and reusability, but the unit retail price is relatively high (¥299–¥699 per unit), following a durable small-appliance logic;
    - **Format 3: Battery-Free Micro-Porous Solid-State Hot/Cold Hydrogen Eye Patches (FMCG, e.g., Muqi’s “Dreams Come True”)**: These patches use the periocular epidermis’s micro-sweat and a hydrophilic gel matrix to spontaneously activate a solid-state micro-porous crystalline lattice hydrogen-release chip. Each patch is individually foil-wrapped and applied immediately upon opening; at body temperature and under micro-sweat, it spontaneously releases gentle active hydrogen, providing sustained trace infiltration for 18–24 hours. This balances “zero-electrical safety, travel portability, and high-frequency spontaneous repurchase under RMB 100,” making it the FMCG format most readily scalable for penetration in eye care.
3. **Separating Concept from Reality and a Two-Sided Dialectical Review: Reflections on the Pseudoscientific Marketing of “Hydrogen Sanitary Pads” vs. the Medical-Engineering Crossover of Genuine Solid-State Micro-Porous In-Situ Hydrogen-Release Chips (Functional Sanitary Pads, Adult Incontinence Diapers, and Functional Dressings for Pressure Ulcer Wounds)**: As the hydrogen health concept penetrates lower-tier markets, the market exhibits a stark polarization: on one hand, there are low-quality abuses involving the false packaging of cutting-edge concepts; on the

other, genuine hard-core innovation is emerging, leveraging micro-porous hydrogen storage/release materials for deep penetration into feminine care, care for the disabled elderly, and wound dressings. A dialectical perspective is essential for in-depth analysis:

- **Perspective 1: Resolute Elimination of Pseudoscientific Concept Hype and Illicit Marketing Abuses (False)**: Some opportunistic merchants add only an ordinary non-woven color strip to ordinary sanitary pads and hype it as a so-called “solid-state negative-ion hydrogen chip,” falsely claiming it can “combat cervical aging, balance flora, eliminate gynecological free radicals, and even treat gynecological inflammation,” driving prices to 3–5 times those of ordinary products. From the standpoint of physical chemistry and medical device regulatory common sense, menstrual blood discharge is intermittent and sanitary pads sit in a semi-open, breathable environment, lacking a genuine hydrolysis activation mechanism and a stable hydrogen-dissolving micro-aqueous phase; trace gimmick additives simply cannot achieve effective transdermal absorption in menstrual blood. Such claims are entirely an abuse of the name of cutting-edge hydrogen medicine research to perpetrate the same false packaging as the “nano-silver/negative-ion sanitary pads” of a decade ago, seriously violating the ironclad rules of the Regulations on the Supervision and Administration of Medical Devices and the Advertising Law prohibiting non-medical devices from claiming disease prevention and treatment efficacy; they are currently being severely investigated and cleaned up by the NMPA and market regulation authorities;
- **Perspective 2: The Hard-Core Crossover of Genuine Solid-State Micro-Porous In-Situ Hydrogen-Release Chips with Functional Care/Wound Dressings (True)**: Entirely distinct from pure conceptual gimmicks, genuine solid-state micro-porous crystalline lattice materials and hydrogen-storing functional membrane fabrics have achieved substantive breakthroughs at the materials engineering level (e.g., the non-woven substrate micro-porous hydrogen-release chip developed by Muqi Technology, with a width of 2 cm–37 cm, in-situ hydrogen production per chip of > 200,000 ppb, and spontaneous mild response across a broad pH 4.0–9.0 range). When the micro-porous chip contacts trace moisture in human body fluids (menstrual blood, urine, wound exudate), it can continuously and long-lastingly release physiological concentrations of active hydrogen molecules (**H_2**) in situ, leveraging the nanoscale penetrability and selective antioxidant properties of hydrogen molecules to deliver highly defined physiological repair value:
  1. **Functional Sanitary Pads for Women During Menstruation**: Breaking the passive positioning of traditional sanitary pads as “merely physical liquid-absorbing media,” the sustained in-situ release of active hydrogen specifically neutralizes highly toxic reactive oxygen species (ROS/**·OH**) in the local damp, hot, and stuffy microenvironment, inhibits the expression of pro-inflammatory cytokines, and alleviates local mucosal redness, swelling, itching, and oxidative stress during menstruation—upgrading from “passive liquid absorption” to “active microenvironment antioxidant and anti-inflammatory care”;
  2. **Adult Incontinence Diapers for the Disabled Elderly**: Long-term bedridden and disabled elderly populations are year-round subjected to prolonged immersion in urine and feces and stimulation by hydrolytic enzymes, highly prone to inducing severe **Incontinence-Associated Dermatitis (IAD)** and breakdown of the perineal skin barrier. By incorporating hydrogen-rich functional chips into the acquisition layer of adult diapers, the chip immediately releases active hydrogen slowly upon contact with urine, effectively blocking the local skin lipid peroxidation cascade and building a robust antioxidant protective barrier;

3. **Pressure Ulcer/Bedsore Patches and Functional Dressings/Wound Dressings for Chronic Hard-to-Heal Wounds**: Patients with severe pressure ulcers (bedsores) and diabetic foot ulcers (DFU) experience localized compression-induced ischemia and hypoxia, leaving the wound in a prolonged vicious inflammatory phase of "excessive ROS accumulation and persistent M1 pro-inflammatory macrophage infiltration." By cross-linking hydrogen-rich micro-porous chips with hydrocolloid/medical foam dressings to create **functional bedsore dressings**, active hydrogen continuously penetrates in situ after covering the exudate, reaching deep damaged tissue to scavenge malignant free radicals, downregulating TNF-α and IL-1β, and **targetedly inducing phenotypic polarization of wound macrophages from the M1 pro-inflammatory type to the M2 anti-inflammatory tissue-repair type**, promoting VEGF expression and rapid capillary network migration, and multiplying the acceleration of wound granulation and smooth wound closure. This complete technology spectrum—"sanitary pad chip → diaper chip → functional bedsore dressing"—demonstrates the broad prospects of solid-state hydrogen-release micro-porous materials in the integrated medical-care and high-value consumables sectors;

- **The Chemical Paradox of "Hydrogen Shampoo and Hydrogen Body Wash"**: During shampooing and bathing, the human body is in an environment flushed by large volumes of warm-to-hot water, and surfactant foam remains on the scalp or skin surface for only seconds to minutes. Even if a trace amount of hydrogen gas is barely infused at the factory filling stage, at the moment of opening and pouring out and rubbing with hot water, due to the extremely high diffusion coefficient and gas-liquid equilibrium constant of hydrogen molecules, the trace hydrogen will 100% escape into the air within seconds, with the measured active hydrogen concentration of the residual wash liquid being an absolute **0 ppb**. Such products have neither a long-acting sustained-release lattice nor physical targeted adhesion, and are a typical "bait-and-switch" IQ-tax harvest.

4. **The Yangtze River Delta (Jiangsu Changzhou West Taihu Medical Device Industrial Park, Taizhou China Medical City, etc.) High-End Medical Dressings and the R&D Frontier and Regulatory Boundaries of Novel "Hydrogen Wound Dressings"**:

- **Jiangsu Industrial Cluster and Medical-Engineering Interdisciplinary Advantages**: Jiangsu Province (Changzhou West Taihu Medical Device Industrial Park, Suzhou BioBAY, Taizhou China Medical City, etc.) is the nation's largest and most technologically endowed highland for R&D and manufacturing of novel medical dressings, medical hydrogels, and polymers;
- **Strict Medical Device Compliance Filing Pathway**: The NMPA and Jiangsu Provincial Medical Products Administration's Class I/Class II device regulatory definitions explicitly stipulate that Class I medical devices (e.g., "Su Xie Bei" medical cold compress patches and cold compress gels) are strictly prohibited from adding ingredients with pharmacological, immunological, or metabolic effects, and are further prohibited from directly marking the character "hydrogen" in the product name for filing. Therefore, the proper medical-engineering translation pathway is to use solid-state hydrogen-release micro-porous materials or hydrogel dressings as physical microenvironment-regulating excipients and to conduct compliant filing in the form of Class II medical devices "medical sterile dressings/hydrogel dressings (Xie Zhu Zhun)," verifying their genuine efficacy in physical barrier and wound healing through rigorous preclinical and clinical trials.

5.3.4 Scenario 4: Commercial High-Throughput Hydrogen-Rich Water Machines and Scenario-Based Direct Drinking (The Commercial Water Bar Dividend Spawned by Experiential Marketing)

In recent years, **commercial high-throughput hydrogen-rich water machines** have surged in popularity in corporate office pantries, wellness experience clubs, community direct-drinking water stations, high-end fitness tea rooms, and postpartum care centers, with shipment volumes and commercial attention far exceeding the past. Behind this phenomenon lie two deep-seated industrial drivers:

1. **The "Market Education Paving Stone" Contribution of Offline Experiential Marketing (Seminar Marketing)**: In the early stage of industry development, offline health experience salons and experiential marketing brands across the country—although their sales pitches have long faced regulatory standardization challenges—objectively speaking, it is precisely these systems that over the past several years shouldered the industry's most arduous and costly consumer enlightenment and market education work, popularizing concepts such as "hydrogen-rich water, negative ORP, antioxidant, and free radical scavenging" into the public mind, laying a deep cognitive foundation for the current full-scale explosion of commercial hydrogen-rich water machines.
2. **Technological and Consumable Evolution of Commercial Water Machines**: Traditional large commercial machines mostly use high-power electrolytic cells, facing maintenance challenges such as high energy consumption, severe scaling, and the hassle of periodic acid cleaning; in recent years, the mainstream solution has evolved into **"commercial reverse osmosis/nanofiltration main unit + post-stage composite solid-state hydrogen-rich micro-porous ceramic filter element (solid-state hydrogen-release consumable)"**. Raw water flowing through the micro-porous ceramic instantly dissolves into stable hydrogen-rich small-molecule cluster water of 1,200–1,500 ppb, with a sweet, mildly alkaline taste and no electrolysis by-product odor. This not only reduces the water machine hardware tooling and O&M costs but also forms a high-stickiness cash flow model of "commercial machine leasing and deployment + periodic high-frequency filter element replacement every 3–6 months."

5.3.5 Scenario 5: The Deep Extension of Hydrogen Biology into Modern Ecological Agriculture (Hydrogen Agriculture, Silicon-Based Fertilizers, Photovoltaic Green Hydrogen Cultivation and Breeding, and the Green Ammonia/Green Fertilizer Closed Loop)

Hydrogen molecules not only act on human cells; as the fourth major gaseous signaling molecule in plants, they are unleashing new application space in plant physiological regulation, modern green ecological agriculture, and zero-carbon new energy cycles, rapidly forming a new industrial form interwoven with photovoltaic green electricity and green chemical inputs:



Figure 5-9 Three-panel composite of Qingde Hydrogen Energy promotional image, night rendering, and hydrogen molecule fertilizer cotton field poster

Image Source: Public materials from the demonstration project of Professor Zhou Pei's team at the Center for Hydrogen Science, Shanghai Jiao Tong University

1. **National-Level Research Echelon and Hydrogen Agriculture Regulation Mechanisms: The Peking University Sunan Institute, Nanjing Agricultural University, and Shanghai Jiao Tong University Industry-Academia-Research Cluster**:
    - **Academic Pioneering by Nanjing Agricultural University (Nanjing, Jiangsu; Professor Shen Wenbiao's Team)**: Professor Shen Wenbiao's team is the leading force that first systematically proposed and conducted "hydrogen agriculture" scientific research in China. As early as 2011, they were the first to reveal in international plant science journals the regulatory mechanism of molecular hydrogen as the fourth major gaseous signaling molecule in plants, confirming that hydrogen gas, by regulating the plant's endogenous auxin, salicylic acid (SA), and jasmonic acid (JA) signaling pathways, activates the plant protective enzyme system (SOD, CAT, POD), substantially improving crop drought resistance, saline-alkali tolerance, and heavy metal toxicity tolerance, and has established demonstration bases for hydrogen-rich rice and field vegetables and fruits in multiple locations in Jiangsu Province;
    - **The Advent of the "Hydrogen Molecule Fertilizer Synergist" from the Peking University Institute of Molecular Engineering Sunan (Suzhou/Changshu, Jiangsu) and Qingde Hydrogen Energy**: Leveraging the hydrogen storage and production research strengths of the Peking University College of Chemistry and Molecular Engineering, the Peking University Institute of Molecular Engineering Sunan was jointly established in Changshu, Jiangsu, and successfully incubated Suzhou Qingde Hydrogen Energy Technology, which developed the highly industry-forward-looking **"Hydrogen Molecule Fertilizer Synergist"** (hydrogen agronomy and solid-state hydrolysis hydrogen-release synergistic fertilizer). This product breaks the engineering bottleneck of traditional reliance solely on large-scale centralized electrolytic hydrogen-rich water irrigation, adopting a safe and efficient solid-state micro-nano hydrolysis hydrogen supply medium that can be applied with water flushing, drip irrigation, or directly compounded with solid mixed fertilizers. It slowly and long-lastingly releases molecular hydrogen in the soil rhizosphere microzone, not only significantly improving the soil rhizosphere microecology and beneficial microbial community structure but also effectively activating root microcirculatory absorption capacity, substantially raising the utilization

rate of nitrogen, phosphorus, and potassium macronutrients and medium/trace element fertilizers, becoming a transformation benchmark for new quality productive forces in Yangtze River Delta agriculture;

- **Macro-Theoretical Foundation by the Center for Hydrogen Science, Shanghai Jiao Tong University (Professor Zhou Pei's Team)**: The team of Professor Zhou Pei, Deputy Director of the SJTU Center for Hydrogen Science and head of agricultural hydrogen biology, published an authoritative long-form review in the top international environmental ecology journal **Critical Reviews in Environmental Science and Technology** (**A critical review for hydrogen application in agriculture: Recent advances and perspectives**), systematically laying the scientific foundation for the application of molecular hydrogen across the entire agricultural life cycle and leading the standardization and industrialization demonstration of China's agricultural hydrolytic hydrogen production equipment.

2. **Muqi Technology's Silicon-Based Fertilizer (Silicon-based Hydrogen Fertilizer) and "Hydrogen-Silicon Synergy" Novel Inputs**: Silicon (Si) is the fourth major key nutrient element for plants in building cell wall mechanical strength, strengthening stems against lodging, and defending against fungal infection. Muqi Technology, combining its core technologies in inorganic micro-porous materials and mineral materials, has innovatively developed a **silicon-based hydrogen-rich material and silicon-based fertilizer series**. After application to soil or water, the product not only slowly and long-lastingly releases molecular hydrogen in the rhizosphere microzone but also continuously dissolves plant-accessible water-soluble effective monosilicic acid (**H_4SiO_4**) and active magnesium, forming a powerful "hydrogen-silicon synergistic enhancement": it not only activates the soil beneficial microecology and nitrogen-fixing microbial community but also multiplies the crop's absorption and conversion efficiency of nitrogen, phosphorus, and potassium macronutrient fertilizers, achieving stable and increased yields while reducing chemical fertilizer and pesticide application by 15%–20%, becoming an iconic new quality productive force for "fertilizer reduction and efficiency enhancement" and green sustainable transformation in modern agriculture.

3. **Empirical Benchmarks for High-Premium Specialty Agricultural Products: Demonstration and Implementation of Shanghai "Hydrogen Rice," "Hydrogen Fruit," and Specialty Edible Fungi ("Hydrogen Mushrooms")**: Hydrogen biology has crossed from basic mechanisms to large-scale field validation and commercial sales of high-quality agricultural products. In Chongming, Jinshan, and multiple national-level modern agriculture demonstration parks in the Yangtze River Delta, a batch of benchmark practices with strong commercial recognizability has formed:

   - **"Hydrogen Rice" Demonstration Validation**: During the rice tillering and grain-filling stages, precise water-saving irrigation with high-dissolved-hydrogen micro-nano bubble water promotes well-developed deep rooting and activation of the soil nitrogen-fixing microecology, significantly enhancing rice lodging resistance and disease resistance; grain plumpness is substantially improved, the amylose/amylopectin ratio is optimized, the rice tastes soft, glutinous, and sweet, the absorption rate of beneficial trace elements such as selenium and zinc increases, and comprehensive yield per mu rises by 10%–18%, making it an iconic vehicle for customized ecological rice by local governments and high-end brands;
   - **"Hydrogen Fruit" (Strawberry, Melon, Grape, Citrus) Demonstration Validation**: Root irrigation with hydrogen-rich water combined with foliar micro-spraying significantly increases fruit chlorophyll photosynthetic rate and soluble solids (sugar content measurements generally increase by

1.5–2.5 degrees), with richer fruit aroma and more uniform fruit shape; because hydrogen molecules effectively inhibit post-harvest ethylene release and pericarp peroxidation, the shelf life of berries such as strawberries is substantially extended by 3–5 days, comprehensive field harvest loss is reduced by more than 30%, and high-premium sales of 30%–50% or more are achieved;

- **“Hydrogen Mushroom / Hydrogen-Rich Edible Fungi” (Shiitake, Oyster Mushroom, Enoki, etc.) Cultivation Validation**: Edible fungus production is extremely sensitive to environmental humidity, miscellaneous bacteria infection, and oxidative stress. By introducing hydrogen-rich water micro-spraying and solid-state hydrogen-release micro-porous substrate cultivation during substrate mixing, spawn running, and fruiting, hydrogen molecules can activate the endogenous antioxidant defense enzyme system within the mycelium, promoting thick and dense mycelial growth and vigorous development, and effectively resisting competitive contamination by green mold such as Trichoderma; during the fruiting stage, the hydrogen-rich microenvironment advances primordium formation by 2–3 days, with more uniform and dense primordium differentiation, thicker and fleshier caps and sturdy, thick stipes, significantly increasing the deposition of active nutrients such as shiitake polysaccharides, raising the first-grade commercial mushroom rate by 15%–20%, and reducing post-harvest cap opening and browning, demonstrating broad prospects for high-value-added application in industrialized edible fungus production.

4. **Empowering Modern Ecological Breeding and the Innovative “Hydrogen Feed Additive” (Substantially Reducing Egg Breakage Rate by 30%–50%)**: In intensive laying hen and meat poultry farming, chronic heat stress in summer high temperatures is a fatal pain point across the industry: chickens dissipate heat by accelerating superficial respiration, causing excessive carbon dioxide exhalation from the lungs and inducing respiratory alkalosis; the transport mechanisms of free carbonate ions (**CO_3^{2-}**) and calcium ions (**Ca^{2+}**) in the blood are severely impaired, directly inhibiting the activity of carbonic anhydrase (CA), a key enzyme in the shell gland of the oviduct, causing disordered arrangement of calcite crystals in the eggshell matrix and thin, brittle shells; the broken egg rate in large-scale laying hen farms is persistently as high as 3%–8% (annual economic loss per farm reaching hundreds of thousands to millions of RMB). Addressing this industry chronic ailment, research teams from Jiangxi Agricultural University, Nanjing Agricultural University, and pioneering enterprises represented by Muqi Technology have innovatively developed a **solid-state micro-porous mineral “hydrogen feed additive”**:

   - **Improving Eggshell Quality in Laying Hens, with Broken Egg Rate Substantially Reduced by 30%–50%**: Solid-state micro-porous hydrogen-release mineral micropowder with long-acting controlled-release properties is added at a specific ratio to laying poultry diets or drinking water systems. The micro-mineral powder stably releases active hydrogen in the weakly acidic intestinal environment, penetrates the intestinal mucosal barrier into the bloodstream, specifically neutralizes excess reactive oxygen species in the oviduct glandular epithelial cells, and significantly enhances the body’s total antioxidant capacity (T-AOC), SOD, and glutathione peroxidase (GSH-Px) activity; it significantly increases jejunal villus height and the V/C ratio, protecting the intestinal mucosal barrier and mineral absorption; it effectively repairs the oviduct gland structure, restores carbonic anhydrase (CA) and calcium-binding protein activity, and promotes tight and orderly deposition of calcite crystals in the eggshell matrix. Continuous controlled monitoring at farms in multiple locations empirically demonstrates that **eggshell thickness and eggshell compressive strength are significantly improved, and the shell breakage rate throughout the breeding cycle is**

substantially reduced by 30%–50%, the yolk color is rich and reddish, and the economic laying peak period of laying hens can be effectively extended by 1–2 months, bringing extremely significant loss-reduction and income-increase benefits to farms;

- **Heat Stress Resistance and Growth Promotion in Livestock and Poultry Meat Animals**: Addressing the severe heat stress response of broilers and finishing pigs during summer high temperatures and long-distance transport between groups, the hydrogen feed additive can effectively downregulate serum cortisol and inflammatory cytokine (IL-6, TNF-α) levels, repair damaged small intestinal mucosal villus morphology, enhance nutrient absorption and utilization efficiency, significantly reduce poultry and livestock mortality and culling rates, and markedly improve the feed conversion ratio.

5. **Innovative Breakthrough in Hydrogen-Rich Water Ecological Aquaculture: Professor Zhou Pei's Team at the Center for Hydrogen Science, Shanghai Jiao Tong University, Leads "Hydrogen Water Fish Farming and Shrimp Farming" and Green Antibiotic-Free Aquaculture Demonstration**: Addressing major industry bottlenecks that have long persisted in China's intensive, high-density modern aquaculture—such as "water bottom substrate deterioration, ammonia nitrogen and nitrite accumulation, stress from sudden weather changes and long-distance transport, frequent Vibrio and parasite outbreaks, and antibiotic dependence"—**Professor Zhou Pei's team** (Professor at the School of Agriculture and Biology, Shanghai Jiao Tong University; Director of the Key Laboratory of Urban Agriculture, Ministry of Agriculture and Rural Affairs; and Deputy Director of the Center for Hydrogen Science and head of agricultural hydrogen biology) has conducted systematic, pioneering mechanistic research and demonstration projects in the field of molecular hydrogen biology empowering modern fisheries, establishing the scientific and industrial paradigm of "hydrogen-rich water ecological aquaculture (hydrogen water fish farming and shrimp farming)":

   - **Dual regulatory mechanism of micro/nano hydrogen-rich water (aquatic ecosystem microcirculation + host non-specific immunity)**: Professor Zhou Pei's team has elucidated in depth that, by dissolving molecular hydrogen into aquaculture water via high-dissolved-hydrogen micro/nano bubble generation technology, it is possible not only to improve the oxidation-reduction potential (ORP) of bottom-layer water and activate beneficial microbial communities in sediment, but also—in recirculating aquaculture systems (RAS)—to use molecular hydrogen as a high-efficiency electron donor for autotrophic denitrifying bacteria through **hydrogenotrophic denitrification technology (HD system)**, completely reducing highly toxic nitrate (**NO_3^-**), nitrite (**NO_2^-**), and free ammonia nitrogen (**NH_3 – N**) to harmless nitrogen gas (**N_2**) under the action of autotrophic bacteria, without the addition of external carbon sources such as methanol, thereby avoiding organic secondary pollution at the root; more critically, nanoscale hydrogen microbubbles can penetrate the epidermal mucosa and gill microvasculature of aquatic animals, specifically scavenging large amounts of harmful reactive oxygen species (ROS/**·OH**) induced by abrupt water-temperature changes, pond transfers and netting, or hypoxia-induced pond turnover, significantly upregulating serum superoxide dismutase (SOD), catalase (CAT), and lysozyme (LZM) activity and downregulating malondialdehyde (MDA) accumulation in fish and shrimp, thereby comprehensively activating the non-specific immune response of aquatic organisms;
   - **Empirical evidence for "hydrogen water shrimp farming" (healthy ecological shrimp aquaculture and antibiotic-free disease prevention)**: In industrialized recirculating aquaculture (RAS) and high-elevation pond demonstrations for Pacific white shrimp (**Litopenaeus vannamei**), the introduction of a hydrogen-rich water microbubble aeration and water-conditioning system sig-

nificantly increased the metamorphosis survival rate of shrimp larvae during the zoea and mysis stages by 15%–25%; during the grow-out stage, it effectively mitigated severe physiological stress induced by extreme rainstorms and typhoons, reduced the Vibrio infection rate by more than 35%, and significantly curbed "sudden death disease" and early mortality syndrome (EMS) in shrimp. The entire farming cycle requires no reliance on chemical antibiotics or strong oxidizing disinfectants, enabling fully green and healthy "antibiotic-free shrimp" to reach the market at a high premium;

- **Empirical evidence for "hydrogen water fish farming" (quality improvement and off-flavor removal in high-value freshwater and marine fish)**: In high-density carnivorous aquaculture of California bass, large yellow croaker, grouper, and snakehead, hydrogen-rich water treatment significantly promoted colonization by beneficial intestinal bacteria (lactic acid bacteria, Bifidobacterium, etc.), improved intestinal mucosal villus morphology, and increased feed protein conversion efficiency. **Feed conversion ratio (FCR) improved significantly, the feed-to-meat ratio decreased by 8%–12%, the growth cycle was shortened by 10–15 days, and the comprehensive survival rate increased by 15%–20%**; at the same time, the antioxidant and microecological regulatory effects of molecular hydrogen significantly inhibited the synthesis and accumulation of geosmin (Geosmin) and 2-methylisoborneol (2-MIB), which cause earthy off-flavors in freshwater fish. Harvested fish exhibited dense, elastic muscle fibers, significantly higher free umami amino acid content, and good scale gloss, fully meeting the stringent standards for high-end Japanese sashimi and green organic aquatic products;
- **Long-distance cold-chain live holding and "dormancy-based loss reduction" transport for live aquatic products**: In long-distance interprovincial cold-chain distribution of live fish and shrimp, the application of hydrogen-rich low-temperature microbubble water for pre-transport holding and hydrogen-charged packaged transport effectively suppressed drastic respiratory jumps, tissue acidosis, and excessive blood lactate accumulation in aquatic animals under confined and turbulent conditions, raising the survival rate of live fish in long-distance transport (>24 hours) from the conventional 80%–85% to over 95%, opening a new technology frontier for loss reduction in the tens-of-billions-scale cold-chain live aquatic product circulation market.

6. **National-level top-tier industry-academia-research collaboration: Muqi Technology joins forces with the Center for Hydrogen Science at Shanghai Jiao Tong University (Academician Ding Wenjiang and Professor Zhou Pei's team) to tackle "novel hydrogen fertilizers" and modern agricultural applications, and participates deeply in national hydrogen agriculture symposiums**:
   - **Muqi Technology deeply participates in national hydrogen agriculture symposiums**: As a leading domestic representative in solid-state microporous hydrogen storage and release materials, Muqi Technology has repeatedly been invited to participate in national hydrogen agriculture academic seminars and industrial innovation conferences, systematically presenting engineering pathways for hydrogen production and soil improvement to national agricultural and hydrogen science experts from the perspective of inorganic mineral porous functional materials;
   - **Joint research with the Center for Hydrogen Science at Shanghai Jiao Tong University (Academician Ding Wenjiang and Professor Zhou Pei's team) on novel hydrogen fertilizers and ecological applications**: Leveraging its deep know-how in microporous ceramic pore engineering, micro-scale sintering of inorganic hydrogen storage and release materials, and industrial-scale mass production, Muqi Technology has formally launched joint research and industrialization development of **"hydrogen-releasing functional fertilizers"** and **"porous hydrogen-releasing**

water-conditioning media for green ecological aquaculture” in deep collaboration with the top-tier research foundations of the Center for Hydrogen Science at Shanghai Jiao Tong University in light-alloy solid-state hydrogen storage (Academician Ding Wenjiang’s team) and modern agricultural hydrogen biology/aquatic ecological applications (Professor Zhou Pei’s team). Both parties focus on overcoming major materials science challenges, including long-acting, controllable solid-state hydrogen release under high-humidity, alternating acid-base field soil microenvironments and the stability of micro/nano hydrogen-releasing media in water bodies. They deeply cross-link inorganic hydrogen-releasing crystalline structures with water-soluble available silicon and active organic matter matrices to develop third-generation novel green solid functional fertilizers integrating “soil remediation–microzone hydrogen release–silicon enhancement and nitrogen fixation,” establishing the highest R&D barrier from national-level frontier academic sources to industrial implementation.

7. **Integrated new-energy solution of “photovoltaic green electricity for hydrogen production + green planting and breeding” (microgrid in-situ consumption loop)**: In recent years, as distributed clean energy has expanded into agriculture and rural areas, integrated new-energy solutions such as “agrivoltaics,” “livestock-voltaics,” and “fishery-voltaics” have evolved rapidly. By installing high-conversion-efficiency photovoltaic modules on modern greenhouse roofs, livestock and poultry barn roofs, or agricultural and pastoral slopes, the green electricity generated during the day directly drives low-power distributed hydrogen production equipment (PEM/ALK/material hydrolysis reactions) to produce clean, high-purity green hydrogen:
    - **In-situ consumption in greenhouse cultivation**: Green hydrogen is directly dissolved into modern integrated water-fertilizer drip irrigation and micro-sprinkler networks, enabling scheduled, targeted, and precise irrigation with high-dissolved-hydrogen micro/nano bubble water and enhancing crop stress resistance and photosynthetic efficiency around the clock;
    - **In-situ consumption in ecological aquaculture**: In large-scale livestock, poultry, and aquaculture operations, high summer temperatures readily induce systemic heat stress in livestock and poultry, causing sharp declines in feed intake and damage to the intestinal barrier. Green hydrogen produced from photovoltaics is directly injected into intensive farming drinking-water networks and aquaculture aeration circulation systems, substantially reducing serum cortisol and inflammatory cytokines in broilers and pigs, improving feed conversion and survival rates, and simultaneously accelerating the degradation of harmful ammonia nitrogen, thereby eliminating dependence on antibiotics. This model thoroughly resolves the bottlenecks of green electricity consumption and power transmission and transformation in remote agricultural greenhouse areas, building a zero-carbon agricultural microgrid loop of “photovoltaic green electricity → in-situ green hydrogen → high-value-added output from green planting and breeding.”
8. **Cross-sector intersection of the “photovoltaic hydrogen production to green ammonia/ammonia water and green low-carbon fertilizer” value chain**: The traditional fertilizer industry (especially Haber-Bosch ammonia synthesis) is a major global source of high energy consumption and

high carbon emissions. With the development of cost-competitive photovoltaic green hydrogen, the technological route of “photovoltaic green hydrogen production → green ammonia/ammonia water synthesis → green compound fertilizer preparation” is accelerating breakthroughs in agriculture:

- **Green ammonia water and green ammonia synthesis**: Distributed photovoltaic electrolysis of water is used to produce green hydrogen, which is then directly synthesized with clean nitrogen obtained from air separation in distributed mild catalytic units to produce **zero-carbon green ammonia (Green Ammonia, $N_2 + 3H_2 \rightarrow 2NH_3$)** and agricultural high-purity green ammonia water, completely severing the traditional fertilizer industry’s high-carbon dependence on fossil feedstocks (coal, natural gas);
- **Deep cross-linking with silicon-based solid fertilizers**: The resulting zero-carbon green ammonia water is further subjected to deep chemical cross-linking and physical chelation with Muqi Technology’s highly active water-soluble silicon-based porous mineral materials and organic carbon matrices, innovatively converting and synthesizing **“zero-carbon green silicon-hydrogen-ammonia compound fertilizers.”** This new ecological input combines three functions—fast-acting nitrogen supplementation, long-acting slow-release silicon nutrition, and microzone hydrogen release for biological regulation—achieving a deep industrial intersection among **clean new energy (photovoltaics), green modern chemicals (green hydrogen/green ammonia conversion), and high-quality agricultural inputs (green silicon-hydrogen fertilizers)**, and providing an integrated solution for rural revitalization and the implementation of the national agricultural “dual carbon” goals.

5.3.6 Scenario Six: Hydrogen TCM and Hydrogen Chinese Materia Medica—Molecular Hydrogen Empowering the Modernization of Traditional Chinese Medicine External Therapies (Hydrogen Sanfu Patches, Shenque Patches, and Transdermal Delivery of Heat-Moxibustion Chinese Herbal Medicine)



Figure 5-10 Hongyao Co., Ltd. promotional page: Jinxiu Yao bath product display, ODM service card, and Yao bath extract (“Hydrogen + Chinese Materia Medica” industry-academia-research collaboration site: Jinxiu authentic Yao medicinal herb cultivation base, Hongyao Co., Ltd. deep-processing production line, and Yao bath extract)

Image Source: Muqi Technology “Hydrogen + Chinese Materia Medica” industry-academia-research project database (original photography provided by Guangxi Hongyao Biological Technology Co., Ltd.)

Traditional Chinese medicine external therapies (patches, hot compresses, mud moxibustion, foot baths, and fumigation) have faced a fundamental bottleneck for centuries: the transdermal absorption rate of macromolecular active ingredients from Chinese herbal medicines through the stratum corneum is generally below 5%–10%. The cross-sector intervention of molecular hydrogen technology has opened a breakthrough for empowering the modernization of traditional Chinese medicine:

1. **Mechanism of hydrogen-drug synergy (molecular hydrogen as a "transdermal absorption enhancer for Chinese herbal medicine")**: Hydrogen molecules are the smallest molecules in nature (2 Da), possessing an extremely high diffusion coefficient and dual lipophilic-hydrophilic penetration capacity. They can rapidly penetrate the intercellular spaces of the epidermal stratum corneum, open microchannels, and form synergistic complexation and targeted co-delivery with active ingredients of Chinese herbal medicines (such as volatile oils, flavonoids, and saponins), multiplying the transdermal penetration depth and bioavailability of active herbal ingredients.
2. **Efficacy-enhancing application of solid-state hydrogen-releasing materials in Chinese medicine external therapies (taking Muqi Technology as an example)**:
   - **A benchmark for deep industry-academia-research collaboration combining "solid-state hydrogen-releasing materials + Yao medicine": partnering with Guangxi Hongyao Biological Technology Co., Ltd. (the leading enterprise in Jinxiu Chinese Yao medicine) to jointly create a new generation of hydrogen-rich Yao bath/foot bath products**: In response to the long-standing industry pain points in traditional Chinese herbal medicine and Yao bath external therapies—"slow leaching of active ingredients during water decoction and a transdermal absorption rate through the stratum corneum generally below 5%–10%"—Muqi Technology has established a deep industry-academia-research strategic collaboration with **Guangxi Hongyao Biological Technology Co., Ltd. (Hongyao Group / Hongyao Co., Ltd., a national high-tech enterprise, Guangxi specialized, refined, distinctive and innovative enterprise, and autonomous-region-level IPO reserve enterprise)**, the leading enterprise rooted in Jinxiu Yao Autonomous County, Laibin City, Guangxi—the "World Capital of Yao Medicine · Hometown of Chinese Yao Medicine." The two parties have deeply integrated Muqi Technology's self-developed **solid-state hydrogen-releasing materials (solid-state hydrogen storage microporous ceramic mineral composite materials)**, customized for foot baths and soaking baths, with Hongyao Biological's national-level intangible cultural heritage Jinxiu authentic Yao medicine (millennium-old Yao bath formulations, molecular-level cell-wall-breaking extraction process), innovatively developing and launching new modern Chinese medicine external therapy categories such as **"hydrogen-rich Yao medicine foot bath packs" and "HGI hydrogen-element Yao bath effervescent preparations"**:
     - **Microporous hydrogen release and strong negative ORP activation**: Upon entering warm water, the solid-state hydrogen-releasing material instantly and continuously releases high-concentration micro/nano gaseous hydrogen in situ, causing the water's oxidation-reduction potential to plummet to an excellent antioxidant reduction range of **-500 mV to -531 mV**, and significantly narrowing water molecule clusters into highly active micro-cluster water (NMR half-peak width only 45 Hz);
     - **Transdermal absorption rate increased by 3–6 times**: Leveraging the extremely small size (only 2 Da) and extremely high diffusion coefficient of hydrogen molecules—the smallest in nature—it rapidly penetrates the Yongquan acupoint on the sole and the intercellular spaces of

the stratum corneum to open absorption channels, **increasing the transdermal bioavailability of core active ingredients in Jinxiu Yao medicine—such as flavonoids, triterpenoid saponins, polysaccharides, and alkaloids—by 3–6 times**;

- **Authoritative qualifications and significant clinical user-perceived effects**: This collaborative system has secured 2 national invention patents, obtained a disinfection product hygiene license (Xiao Zi Hao), 3 authoritative physicochemical testing reports, and complete enterprise standards; large-sample field testing and long-term user monitoring show that the **user-perceived effective rate exceeds 85%** for improving refractory insomnia and enhancing deep sleep quality, and the **effective rate exceeds 80%** for assisting in stabilizing postprandial blood glucose and improving diabetic peripheral neuropathy and lower-limb microcirculation disorders, establishing a benchmark model of “modern frontier hydrogen technology × ethnic minority intangible cultural heritage authentic herbal medicine” empowering rural revitalization and health FMCG;

- **Hydrogen Sanfu patches and hydrogen acupoint patches (modern upgrade of winter disease treated in summer)**: The classic traditional Chinese medicine “winter disease treated in summer” Sanfu patch formulation (white mustard seed, asarum, dried ginger, corydalis, etc.) is integrated with solid-state hydrogen-releasing microcrystalline chips. By leveraging the dilated sweat gland pores and elevated body temperature during the dog days of summer to gently activate the chip for hydrogen release (constant 40–42°C heating), the patches both warm and tonify yang qi at acupoints such as Dazhui, Feishu, and Danzhong, and strongly promote deep absorption of active herbal ingredients while specifically scavenging deep inflammatory free radicals, effectively eliminating the blistering and burn risks of traditional Sanfu patches;
- **Hydrogen-rich herbal hot compress patches / joint patches**: Solid-state hydrogen-releasing chips are compounded with authentic Chinese medicinal ingredients such as mugwort, angelica, and ginger, maintaining the most comfortable constant heating temperature for the human body at 40–42°C, so that meridian-warming and selective elimination of sterile deep inflammation in muscles and joints reinforce each other;
- **Shenque acupoint patch (navel patch)**: Building on the classical umbilical therapy of Daoist and traditional Chinese medicine, this patch utilizes the rich superficial peritoneal microvascular network at the Shenque acupoint and guides herbal ingredient absorption through solid-state hydrogen-releasing chips to regulate uterine cold and subhealthy cold-deficiency constitutions;
- **Hydrogen Chinese medicine foot bath tablets and herbal soaking baths**: This breaks through the cumbersome pain point of traditional Chinese herbal medicine requiring prolonged open-flame decoction and slow leaching of active ingredients. When placed in warm water, the tablets dissolve to produce high-concentration hydrogen-rich fine-bubble micro-cluster water, strongly enhancing the absorption of herbal essences through the Yongquan acupoint on the sole and the meridians of the lower limbs.

5.3.7 Scenario Seven: High-End Medical Rehabilitation and Micro-Hyperbaric Hydrogen-Rich Oxygen Health Chambers (Hydrogen Chambers / Hydrogen-Oxygen Micro-Hyperbaric Chambers)

In high-end medical rehabilitation centers, sports rehabilitation bases, postpartum care centers, and high-net-worth private health clubs, **micro-hyperbaric hydrogen-rich oxygen health chambers (hydrogen chambers / hydrogen-oxygen micro-hyperbaric chambers)** have become flagship health equipment integrating modern hyperbaric oxygen medicine and molecular hydrogen antioxidant medicine:

1. **Differentiation of pressure levels and physiological adaptability (1.3 ATA vs. 1.5 ATA)**: The operating pressure of civil and commercial mild-pressure chambers is generally defined between 1.1 and 1.5 ATA, and the market has evolved into two core ranges around actual user experience and indications:
    - **1.3 ATA (the golden mild health-preservation range, equivalent to a micro-pressure environment approximately 3 meters underwater)**: Ear pressure changes are very slight, and the vast majority of middle-aged and elderly people and subhealthy populations can easily adapt without frequently performing eustachian tube pressure-equalization swallowing maneuvers. While safely increasing physically dissolved oxygen in plasma, it avoids the hidden oxidative stress risk induced by high pressure, and is mainly used for private home health preservation, chronic fatigue syndrome conditioning, improving deep sleep in middle-aged and elderly people, and alleviating cerebral hypoxia;
    - **1.5 ATA (deep rehabilitation and commercial enhancement range)**: The air pressure inside the chamber is significantly higher, and the physical solubility of blood oxygen and the effective tissue diffusion distance increase exponentially. This pressure imposes extremely high engineering requirements on the chamber's pressure-bearing steel structure and airtight valves, and is more suitable for rapid repair of soft-tissue microdamage after high-intensity exercise in professional athletes, postoperative rehabilitation, neurological functional reconstruction after stroke hemiplegia, and customer acquisition for medical aesthetics and anti-aging clubs.
2. **Dual synergy of "micro-hyperbaric oxygen enrichment + controlled molecular hydrogen" and the explosion-proof safety red line**:
    - **Complementary closed-loop mechanism**: A micro-hyperbaric oxygen environment can substantially increase blood oxygen partial pressure and mitochondrial adenosine triphosphate (ATP) synthesis, but cellular hyperoxic metabolism is often accompanied by excessive superoxide anion ($O_2^{-\cdot}$) and highly toxic hydroxyl radicals (·OH) (i.e., hyperoxic reperfusion peroxidative injury). At this point, synchronized injection of trace amounts of molecular hydrogen can leverage the nanoscale penetration and selective antioxidant properties of hydrogen molecules to target and quench the malignant free radicals induced by hyperoxic metabolism, achieving a perfect synergy of "deep oxygen supply under high pressure" and "targeted antioxidant detoxification by hydrogen";
    - **Explosion-proof engineering safety red line**: Injecting flammable hydrogen gas into an oxygen-enriched enclosed space poses stringent industrial-grade safety control challenges. Mainstream compliant equipment uses precision digital flow valves and electrochemical hydrogen sensors to strictly lock the hydrogen concentration inside the chamber within a **golden safety window of**

1.5%–2.5% (far below the 4.0% lower flammability and explosion limit of hydrogen in air), and is equipped with dual independent overpressure safety valves, automatic emergency pressure relief upon power failure, and forced explosion-proof exhaust systems, eliminating any safety hazards.

3. **Product Forms, Commercial Price Tiers, and Industry Standardization (QB/T 8049-2024)**:
    - **Entry-level portable soft-shell folding chamber (1.3 ATA, high-strength TPU material)**: retail price approximately **¥9,000–¥25,000**; compact footprint and foldable, primarily serving ordinary household self-use and basic oxygen therapy for chronic disease;
    - **Hard-shell single-person intelligent chamber (carbon steel / aviation aluminum alloy / acrylic transparent viewport, 1.3–1.5 ATA)**: retail price approximately **¥30,000–¥70,000**; equipped with an intelligent touchscreen, negative-ion fresh-air system, and audio-visual interaction, it is the flagship model for high-end private households and community wellness experience salons;
    - **Luxury multi-person room-type hydrogen-oxygen composite chamber (integrated hydrogen-oxygen nebulization, medical-grade purification, and micro-bubble humidification system)**: retail price approximately **¥80,000–¥200,000+** (commercial luxury custom-grade units can reach several hundred thousand to over RMB 1 million), predominantly deployed in high-end postpartum care centers, sports rehabilitation centers, and corporate executive wellness rooms;
    - **Industry Normative Guidance**: the formal implementation of the national light industry standard **“Micro-Pressure Oxygen-Enriched Chambers for Household and Similar Applications” (QB/T 8049-2024)** ended the prior disorder in which micro-pressure chambers lacked a unified production safety standard. Upstream materials firms (such as Muqi Technology and others) have developed high-pressure-resistant dedicated solid-state micro-porous hydrogen-releasing filter elements and micro/nano hydrogen-enriched humidification components for hydrogen chambers, establishing a virtuous profit loop of “large-scale hardware equipment sales + periodic high-frequency consumable replacement.”

5.3.8 Scenario Eight: Global Cross-Border Trade and Supply Chain Export

Leveraging the world’s most complete contract manufacturing system for primary magnesium/silicon material smelting, ceramic sintering, and fine chemicals, China is becoming the most important “world factory” for global hydrogen health products. Customs bills of lading and Tendata foreign trade big data confirm that China-made hydrogen-rich water tumblers, hydrogen inhalation equipment, commercial water machines, and solid-state hydrogen raw materials are exported in large volumes to North America, Europe, ASEAN, and the Middle East, occupying a significant supply share in overseas cross-border e-commerce and regional direct-sales networks.

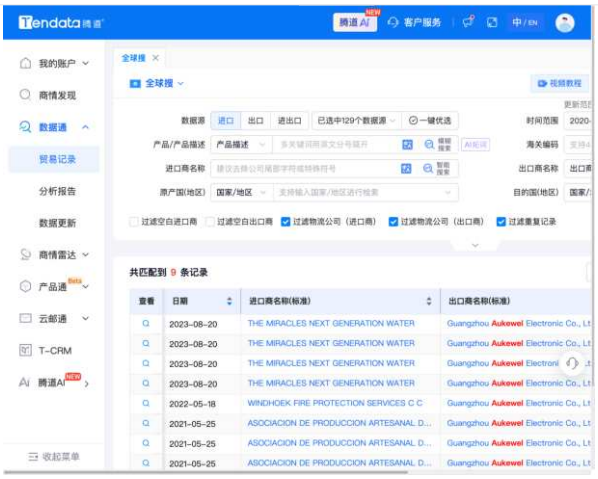


Figure 5-11 Tendata trade record search page: 9 matches in total (2021–2023), exporter Guangzhou Aukewel

Image Source: Tendata customs data (2023-10 to 2026-10 scope)

CHAPTER 05 RECAP · Chapter Summary

Bottlenecks in the three-stage structure, and an institutional deficit

1. **Value does not lie in the midstream.** Upstream pricing is fragmented (components priced as electronics, materials as chemicals), midstream assembly barriers are extremely low (small-appliance assembly), and the downstream eight scenarios are dispersed—profit is distributed at both ends: materials and formulations at the front, scenarios and repeat purchases at the back.
2. **"Hydrogen has a code; hydrogen products do not."** High-purity hydrogen has a dedicated tariff code, yet pre-packaged hydrogen-rich water shares the same code as ordinary purified water, with no occurrence of the word "hydrogen" in the full text; end products lack a dedicated code, and cross-border trade can only be classified at discretion by end use.

Current customs classification of hydrogen-related products (six digits harmonized globally; eight digits and beyond set by each country)

Table 5-1

Product	Current Classification	Trade Consequence
High-purity hydrogen (compressed/liquefied)	2804.10.00.00	Dedicated tariff code; regulatory conditions A/B; customs clearance form required
Metal hydrogen storage alloy materials	2850.00.90	Classified under other hydrides and nitrides, unrelated to function
Prepackaged hydrogen-rich water	2201.90.90.00	Same code as ordinary purified water; attributes not visible
Hydrogen-rich water machines / electrolysis tumblers and other end products	8543.30.00.90, or declared as water filtration equipment 8421 or as household appliances 8509	Classification random, high compliance friction and statistical black hole



CHAPTER
06

Chapter 6 Competitive Landscape and Corporate Ecosystem Map

About 180 firms form three main camps, and value capture concentrates where the Class III registration certificate and the materials sit.

Chapter Takeaways · Competitive Landscape and Corporate Ecosystem Map

1. The true stratification of 180 firms 99% hold no medical device certificate, with the vast majority being ordinary small appliances or daily consumer goods. There are approximately 180 verifiable active firms, concentrated in Guangdong, Shandong, Zhejiang, and Shanghai.
2. A tripod rather than a melee the device layer (Huimei, holding dual certificates), the materials layer (solid-state hydrogen supply), and the channel layer (complete units and seminar marketing). Value capture concentrates at the two ends: the “certificate” and the “materials.”
3. International comparisons cannot be made directly China’s 180 firms make no disclosures, whereas listed Korean companies do—a direct comparison compares two disclosure regimes, not two industries. The China-Korea comparison in this report stops at “methodological comparability.”
4. The migration of exhibition discourse from “hydrogen as a single energy vector” toward the plural coexistence of “hydrogen health and hydrogen agriculture,” which reflects a shift in industry export pressure rather than a mere upgrading of slogans.

6.1 Map of 180+ Incumbent Firms and Industrial Cluster Distribution

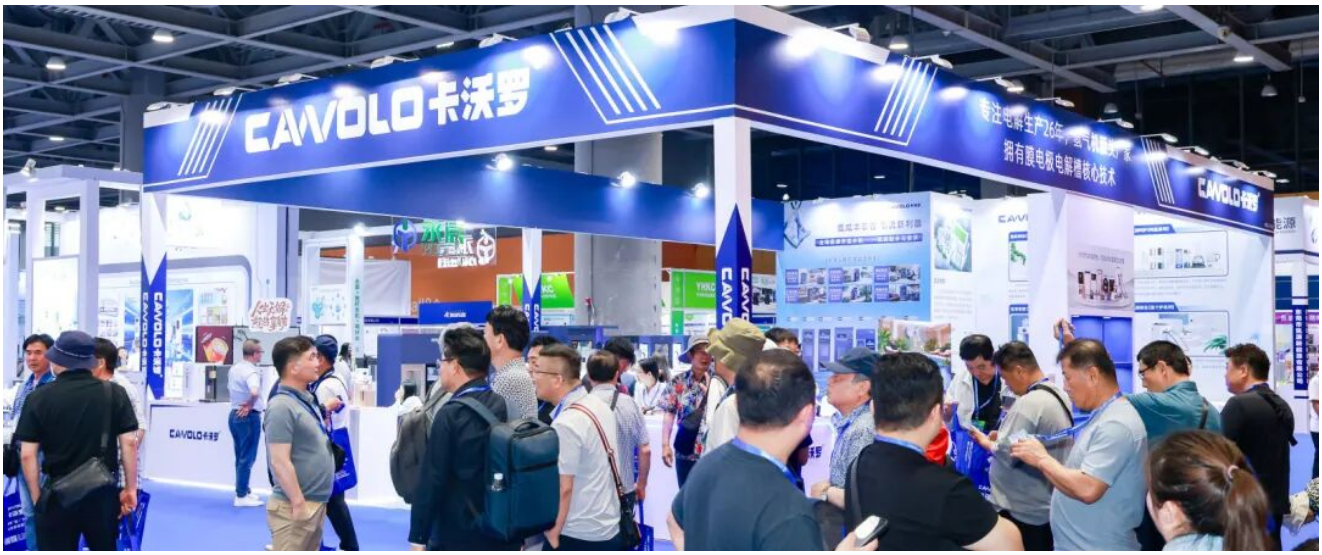


Figure 6-1 Panoramic view of a blue custom-built exhibition booth: tall header, ceiling truss, and crowd below in one frame (booth belongs to peer company CAVOLO)

Image Source: 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo site (2026-05, photographed by this report's research team)

Industry monitoring data indicates that China currently has approximately **180+** hydrogen health-related enterprises with verifiable physical operations and owned brands or proprietary trademarks. Geographically, the industry exhibits a highly distinct three-cluster effect:

1. **Pearl River Delta Cluster (Guangzhou, Foshan, and Shenzhen, Guangdong)**: Leveraging a globally leading small-home-appliance manufacturing and cross-border trade base, this cluster concentrates over 50% of the nation's OEM/ODM production of electrolytic hydrogen water tumblers and household hydrogen inhalation machines. Representative enterprises include Guangzhou Cawolo, Shenzhen Wsealdon, Aukewel, and Rikang, which are distinguished by rapid tooling and mold development, high production capacity flexibility, and agile e-commerce operations.
2. **Shandong Peninsula Cluster (Zibo, Jinan, and Qingdao, Shandong)**: Leveraging Shandong's deep heritage in new materials and advanced ceramics, together with its marine biopharmaceutical industrial belt, this cluster concentrates the nation's most core production capacity for inorganic solid-state hydrogen storage and release materials and healthy water treatment media. The representative benchmark enterprise is **MQ TECH**, which, driven by micro-porous ceramic solid-state hydrogen storage and release materials, supplies supply chains nationwide and globally.
3. **Yangtze River Delta Cluster (Shanghai, Nanjing, and Hangzhou)**: Proximate to top-tier medical universities and research institutions, this cluster focuses on high-barrier medical device registration, rigorous clinical trial advancement, and premium brand building. Typical representatives include Shanghai Huimei Medical, which obtained the nation's first Class III certificate, and research-oriented enterprises specializing in micro/nano-bubble technology instrumentation.



Figure 6-2 Crowds streaming through the entrance of “Hall 4,” with wayfinding signage and a brand wall positioned side by side.

Image Source: On-site at the 2026 HST 10th Guangzhou International Hydrogen Technology Industry Expo (May 2026; photographed by the report research team)

6.2 Competitive Camp Segmentation: A Tripartite Structure

The supply side of China's hydrogen health market can be segmented into three core camps with distinct characteristics:

Table 6-1

Competitive Camp	Representative Entities	Business Model and Product Characteristics	Core Barriers and Advantages	Strategic Risks and Weaknesses
Serious Medical Device Camp	**Shanghai Huimei Medical**	Targets hospital respiratory departments and critical care rehabilitation; holds the only two Class III certificates in the country; primarily markets medical-grade hydrogen-oxygen nebulizers (AMS series)	**Legitimate status as a nationally registered medical device**, providing an exclusive channel into public hospitals and expert-led clinical collaboration	Extremely high registration and maintenance costs; narrowly limited indications (restricted to acute exacerbations of COPD); unable to rapidly penetrate mass-market FMCG channels
Household Small Appliance and Seminar Marketing Camp	Guangzhou Cawolo, Wsealdon, Xinxiang Yu'an, and more than 100 small and medium-sized OEM/ODM factories	Assembles electrolytic water tumblers, portable hydrogen inhalation machines, and hydrogen-rich water generators; primarily ships to e-commerce white-label brands, overseas buyers, or offline franchise experience stores and seminar marketing channels	Mature supply chain, extreme factory-cost control, and rapid new-product tooling and mold development	Severe hardware homogenization, lack of core materials technology, no consumable-driven reorder stickiness, and highly vulnerable to local market regulation enforcement
New Materials Enablement and FMCG Camp	**MQ TECH**	Focuses on upstream solid-state hydrogen storage and release materials and full-scenario FMCG consumables; serves downstream brands and supply chains through a platform-based enablement model	**Underpinned by 37 patented technologies**; electricity-free and convenient; FMCG consumables drive multi-dimensional, high-frequency repurchases; extremely high full-lifecycle customer value (LTV)	Requires sustained investment in consumer education and industry standardization; market and brand collaboration network requires continued expansion



Figure 6-3 Forum area audience seating: a full-capacity audience facing a large screen displaying a personal profile page

Image Source: On-site at the 2026 HST 10th Guangzhou International Hydrogen Technology Industry Expo (May 2026; photographed by the report research team)

6.3 International Peer Benchmarking: Comparative Industry Characteristics of China, South Korea, Japan, and Europe

From a global perspective, China's hydrogen health industry possesses irreplaceable and distinctive advantages in supply chain depth and commercial vitality:

Table 6-2

Country / Region	Dominant Industrial Technologies and Formats	Market Access and Regulatory Environment	Commercial Channels and Pricing Logic	Interaction with the Chinese Market
China	**Dual-track approach (electrolysis equipment + solid-state material FMCG)**, with full-scenario coverage across “eat, drink, wash, care, and soak”	A single Class III medical device certificate; ordinary consumer products are regulated primarily under food-contact and daily-chemical standards; regulators crack down hard on false advertising	Shows diversified positioning around raw-material anchors, product anchors, and efficacy anchors; online e-commerce and offline specialty stores operate in parallel	**Global manufacturing and materials innovation hub**, with overwhelming advantages in large-scale mass production and low-cost delivery

Country / Region	Dominant Industrial Technologies and Formats	Market Access and Regulatory Environment	Commercial Channels and Pricing Logic	Interaction with the Chinese Market
Korea	Predominantly traditional functional ceramic balls and alkaline reduction filter cartridges + portable water bottles	Strict NSF/ANSI certification thresholds; KFDA classifies certain alkaline reduction water generators as Class II devices	Deeply embedded in the OEM filter supply chains of rental water purifiers from Coway, ChungHo, and others; strong emphasis on overseas B2B exports	Korea's domestic functional ceramic capacity is relatively constrained, and its product mix skews toward traditional water purification; there is a pressing need for deep industrial collaboration with leading Chinese enterprises that possess scaled capacity and an emerging FMCG matrix
Japan	Packaged hydrogen-rich water in aluminum foil pouches; high-end electrolyzed water generators	In earlier years, certain products held Foods for Specified Health Uses (FOSHU) designation; efficacy claims have since been tightened, with emphasis on objective dissolved-hydrogen concentration testing	High-frequency retail through convenience stores and drugstores; high-end generators sold through large home-appliance chains	Japan is the academic birthplace of hydrogen medicine and commands high brand premiums, but manufacturing is gradually shifting toward contract manufacturing in Chinese supply chains
Europe	Hydrogen water immersion baths at spa sanatoriums; hydrogen inhalation experiences at high-end clinics	**No CE certification for any hydrogen medical device**; strict enforcement of MDR medical device and EFSA food claim restrictions	Bundled service billing(€14–30 per session); **entirely devoid of the seminar-marketing "efficacy anchor"**, with a focus on physical and mental relaxation experiences	Europe has rigorous standards and high willingness to pay, but lacks domestic materials and complete-equipment manufacturing —making it a high-value potential export destination

6.3.1 Representative Products from Class III Origins: Equipment Exports, University Spin-offs, and FMCG Brands

Zooming in from the corporate directory to individual products reveals three distinct origin pathways: **a Taiwanese equipment exporter**, **a Beijing-based university spin-off**, and **a Shanghai solid-state hydrogen FMCG brand**. What they share is that they have turned hydrogen into something that can sit on a shelf or counter; what distinguishes them is who controls the core components, who controls the brand, and who controls the channel.

CHYBIOTECH (New Taipei, Taiwan). It follows a PEM + MEA pure-water electrolysis route, publicly claims hydrogen purity > 99.995%, and states that it has obtained SGS purity certification and complies with relevant U.S. FDA standards (**company claims**); its product line spans five models, from a 20 mL/min portable unit to a 1,000 mL/min flagship with dual hydrogen outlets, focused primarily on ODM/OEM

exports, and it describes itself as Taiwan's largest hydrogen equipment manufacturer by export volume to Japan. **This segment represents the model of "deepening core components and complete units, and delivering through foreign trade."**

Huaqing Bio (Huaqing Times (Beijing) Biotechnology Co., Ltd.). Founded in September 2023 by Professor Ma Xuemei's team at Beijing University of Technology through technology equity contribution, it follows an "adhesion/sustained-release" hydrogen-ingredient route—neither electrolytic hydrogen production nor solid-state hydrogen storage—with products positioned as hydrogen-rich packaged drinking water, hydrogen masks and hydrogen dressings, and hydrogen-rich instant-brew tea machines. **This segment represents the pathway of "directly converting university laboratory results into consumer products"; its weakness and its strength are one and the same: the technology has a credible provenance, but scale and channels must be built separately.**

Qingyuanqi (Shanghai Qingmei Health Technology Co., Ltd.). Founded in 2019 with the brand launched in 2020, founder Ding Zhiguang holds a PhD in materials science from Shanghai Jiao Tong University; the technology relies on magnesium-based solid-state hydrogen materials(HydroMg), and the company has jointly established a "Solid-State Hydrogen Joint R&D Center" with the Shanghai Jiao Tong University Hydrogen Science Center. Product formats are FMCG items such as effervescent drink mixes and essences; the company completed a Pre-A round in October 2022 (led by Shengqu Capital) and states that sales have exceeded RMB 10 million (**company claims**). **This segment represents the combination of "materials route + FMCG brand + capital acceleration."**



Figure 6-4 CHYBIOTECH flagship hydrogen inhalation machine, the "Hydrogen King CHY1000HC": dual hydrogen outlets, rated 1,000 ± 10% mL/min, purity > 99.995%

Image Source: Source: CHYBIOTECH official website, chybiotech.com



Figure 6-5 CHYBIOTECH "futura" hydrogen-rich water generator: features a blue water-level viewing window, positioned for household and gift scenarios

Image Source: Source: CHYBIOTECH official website, chybiotech.com



Figure 6-6 Huaqing Bio "Rejuvenating Firming Repair Mask": hydrogen formulated into a dry-state sheet-mask carrier, part of the "hydrogen medical aesthetics" product line

Image Source: Source: Huaqing Bio product materials (published via the partner group's official website)



Figure 6-7 Huaqing "Packaged Drinking Water": hydrogen-rich water in a bottled FMCG format

Image Source: Source: Huaqing Bio product materials (published via the partner group's official website)



Figure 6-8 "Hydrogen-Enriched Smart Instant-Brew Tea Machine": Integrating hydrogen generation and tea brewing into a single desktop device

Image Source: Huaqing Bio product materials (published via the partner group's official website)



Figure 6-9 Qingyuanqi booth: display of sparkling-beverage and skincare solid-state hydrogen products

Image Source: Qingyuanqi franchise recruitment / public exhibition images

It should be noted that "Qingyuanqi" and Taiwan's "Hydrogen Element" are two enterprises with no equity relationship whatsoever; they are frequently conflated merely because their product categories are similar. This report records them separately by entity and does not consolidate them. The purity, gas output, and sales figures cited above all reflect the companies' own public disclosures and have not been independently re-tested by this report.

6.3.2 Huaqing Bio vs. CAVOLO: A Direct Comparison of the Equipment End and the Consumables End

These two companies are frequently discussed together (see Table 6-3), yet they in fact stand at opposite ends of the same value chain: **CAVOLO (CAVOLO) defends the equipment end, while Huaqing Bio attacks the consumables end**. Only by laying out the differences does it become clear where they genuinely compete and where they are in fact unrelated.

Table 6-3

Dimension	Huaqing Bio (Huaqing Times (Beijing) Biotechnology Co., Ltd.)	CAVOLO (Guangdong CAVOLO Hydrogen Technology / CAVOLO)
Origin	Founded in September 2023 with technology equity contributed by Professor Ma Xuemei's team at Beijing University of Technology; a university research commercialization pathway	More than 20 years of experience starting from water treatment and water electrolysis; founded as an equipment manufacturer, with its plant in Nanhai, Foshan
Core capability	Material formulations for adherent / sustained-release hydrogen components—keeping hydrogen resident in facial sheet mask cloth, dressings, and beverages	PEM proton exchange membrane water electrolysis for hydrogen production, with self-developed membrane electrode assemblies; publicly claims cumulative patents exceeding one hundred (sources vary)
Product focus	Dry-state consumables: hydrogen masks, hydrogen dressings, hydrogen-enriched packaged drinking water, hydrogen-enriched instant-brew tea machine	Powered equipment: full series of 0.5–500 Nm³/h industrial PEM electrolyzers; household hydrogen-enriched water machines, hydrogen inhalation machines, hydrogen water tumblers, purified drinking machines
Requires electricity	No. Hydrogen is released upon contact with water or body fluids; usage scenarios are not constrained by power outlets	Yes. Electrolytic hydrogen production depends on power and water sources; form factor is limited to "machine + outlet"

Dimension	Huaqing Bio (Huaqing Times (Beijing) Biotechnology Co., Ltd.)	CAVOLO (Guangdong CAVOLO Hydrogen Technology / CAVOLO)
Customer structure	Domestic brand owners, medical aesthetics and skincare channels	Overseas OEM / channels (products sold to Europe, the Americas, and Australia), in parallel with domestic distribution and gift channels
True barrier	Material formulations + university endorsement + medical aesthetics compliance	Core electrolyzer components + certification and production line scale (250 Nm^3/h electrolyzers already rolled off the line in 2023)
Point of direct confrontation	Strictly speaking, the two do not compete head-on in the same market segment: one sells electrochemical hardware, the other sells material formulations. Their true confrontation occurs along the "**equipment → consumables**" migration path—in scenarios such as masks, dressings, and portable water where "hydrogen previously required buying a machine," once consumables can deliver hydrogen independently, the equipment end's incremental volume is intercepted.	

Judging competition between these two should therefore not hinge on whose product specifications are higher, but on who first becomes the other's customers' default option. For CAVOLO, the risk is not that Huaqing Bio takes its overseas OEM orders, but that its consumer equipment customers start asking "can we do without a machine"; for Huaqing Bio, the risk is not that CAVOLO enters masks, but that its brand-owner customers discover that "building an electrolysis unit + on-demand production" costs less than pressing its own mask cloth. **This is also why this report treats "consumablization" as the core variable throughout: it is not a category choice but a structural question that determines who gets bypassed.**

6.4 The Paradigm Shift in Exhibition and Organizational Ecosystems: From Singular "Hydrogen Energy" to the Diversified Coexistence of "Hydrogen Health and Hydrogen Agriculture"

In recent years, within China's hydrogen energy industry top-level strategic planning, major professional exhibitions, and industry organizational ecosystems, a profoundly significant paradigm migration is underway: **the traditional "hydrogen energy" macro landscape, previously highly focused on fuel cells, heavy-duty transportation, and chemical storage and transport, has seen a proliferation of high-value-added cross-sector projects and dedicated exhibition zones for "hydrogen health, hydrogen medicine, and hydrogen agriculture."**

6.4.1 A New Exhibition Landscape: From “Energy Hydrogen” Toward “Life and Ecological Hydrogen”

At various high-level hydrogen energy industry expos and industry summits hosted by national ministries, local governments, or authoritative associations, the industry’s boundaries are being rapidly reconfigured:

1. **Expansion of exhibition space at national-level hydrogen energy expos**: Leading events such as the **China (Foshan) International Hydrogen Energy and Fuel Cell Technology and Products Exhibition (CHFE)** and the **World Hydrogen Energy Industry Expo (WHE)** have broadly evolved from their early lineup of “nothing but stacks, hydrogen dispensers, and pipe fittings and valves” to establishing dedicated “Hydrogen Lifestyle and Life Health Zone” and “Hydrogen Agriculture and Green Application Ecosystem Exhibition Area”;
2. **Vertical deepening of specialized hydrogen health exhibitions**: The **Guangzhou International Hydrogen Technology Industry Expo (Hydrogen Expo)** has been held for ten consecutive editions and has become the world’s most central supply-demand matching hub for hydrogen health equipment; the **World Expo Way · China International Health Industry Expo (Health Expo Hydrogen Health Exhibition)** focuses on the cross-sector integration of hydrogen health with senior care and elderly services and with traditional Chinese medicine rehabilitation;
3. **Rise of local hydrogen energy chambers of commerce and cross-sector alliances**: Local organizations such as the Zibo Hydrogen Energy Chamber of Commerce (with Muqi Technology serving as vice-chairman unit) and the Hydrogen Kinetic Energy Team of the Shandong Green and Low-Carbon Development Center actively break down the barriers between energy and big health, and strive to advance “Hydrogen into Every Home” from single-purpose energy heating toward healthful drinking water, daily care, and green modern farmland for millions of households.



Figure 6-10 A speaker at the forum, with a hydrogen medicine development timeline on the background screen

Image Source: On-site photograph by the report research team (Guangzhou International Hydrogen Technology Expo / National Hydrogen Biomedicine Conference)

6.4.2 The Underlying Business Logic and Macro Drivers of This Cross-Sector Integration

Why do hydrogen health and hydrogen agriculture projects exhibit explosive growth across major hydrogen energy industry plans and professional exhibitions?

- **First, driven by the demand for high-value, asset-light downstream absorption**: Investment in hydrogen fuel cell transportation and industrial pipeline networks routinely runs into tens of billions, and infrastructure construction (hydrogen refueling stations, hydrogen transmission pipelines) involves lengthy cycles; the industry broadly faces anxiety over stranded heavy assets and delayed commercialization and profitability. By contrast, "hydrogen health, hydrogen medicine, and hydrogen agriculture" directly target people, plants, and a consumer market of hundreds of millions of end users, and possess an excellent commercial closed-loop profile of **short investment cycles, high value-added products, high-frequency repeat purchases, and no dependence on long-distance transmission pipelines**, making them the most important "cash-flow engine" for revitalizing regional hydrogen energy industry chains;
- **Second, deep alignment with new quality productive forces and the "dual carbon" green circular economy**: In formulating medium- and long-term hydrogen energy plans, governments at all levels are progressively recognizing that hydrogen is not only the "ultimate clean energy" but also a cross-sector "biological antioxidant medium" and the "fourth major gas signaling molecule in plants." Empowering big health and wellness (addressing population aging) and modern ecological agriculture with hydrogen science—deeply integrating full-chain solutions such as "photovoltaic green electricity hydrogen production + green planting and breeding" integrated microgrids, "photovoltaic green hydrogen to green ammonia/ammonia water and green silicon-hydrogen fertilizer," and reduced chemical fertilizer and pesticide use—both aligns with "Healthy China 2030" and deeply empowers rural revitalization and the national "dual carbon" circular economy, and thus enjoys strong favor from industrial plans and large hydrogen energy exhibitions at all levels.
- **Third, empowerment by national standardization organizations**: Institutions such as the National Technical Committee for Microbubble Technology Standardization (TC584) and the National Technical Committee for Antimicrobial Surface Performance Standardization continue to advance measurement protocols and general standards, serving as a mainstay in driving the industry toward regularization.

CHAPTER 06 RECAP · Chapter Summary

The True Stratification of 180 Companies: Value Lies at Both Ends—"Certificates" and "Materials"

1. **This is not a red-ocean melee but three-tier differentiated competition.** There are approximately 180 verifiable active companies; 99% hold no medical device certificate, and the vast majority are ordinary small household appliances or daily-use products; the device tier, materials tier, and channel tier each have their own moats and monetization models.
2. **Value capture is concentrated at both ends.** "Certificates" determine whether one can enter hospitals; "materials" determine whether others can bypass you; the midstream assembly squeezed in between is a fully competitive zone and the layer most easily substituted.

3. **International comparison can only stop at "methodological comparability."** China's 180 companies have no mandatory disclosure, whereas Korean listed companies do; directly comparing the numbers compares two disclosure regimes, not two industries.

Moats and Monetization Models of the Three Camps

Table 6-4

Camp	Representatives	Moat	Monetization Model
Device Tier	Huimei (two Class III certificates, limited to acute exacerbation of COPD)	Market access qualifications and clinical evidence	In-hospital programs, consumables, and ancillary support
Materials Tier	Solid-state hydrogen suppliers (MQ TECH, etc.)	Process control and patent portfolio	Raw materials, formulation licensing, and white-label OEM
Channel Tier	Whole-device and seminar-marketing companies (the vast majority of the 180)	End-user reach and local trust	Whole-device margins, services, and packages



CHAPTER

Chapter 07 Institutional Environment, Regulatory Compliance, and Development Bottlenecks

Of the four institutional gates, entry and promotion are open, pricing is half open, and payment has not yet been opened.

Chapter Key Points · Institutional Environment, Regulatory Compliance, and Development Bottlenecks

1. **Four gates, two and a half open** Entry is open (only Huimei holds two Class III certificates, limited to acute exacerbation of COPD), promotion is open (Shandong appropriate-technology direct promotion to village clinics), pricing is half open (Code 120300003, independent pricing), and payment is not open (the word “hydrogen” appears nowhere in the payment catalog).
2. **A certificate is not a pass** — a certificate opens the question of "whether one can enter hospitals," not "whether one can claim to treat disease." Treating market access as a pass was the common starting point for a cohort of companies penalized in 2024.
3. **Standards set a ruler, not a threshold** — GB/T 46918.2-2025 specifies only "how to measure," not "how much qualifies as compliant"; the June 2026 group standard provides application specifications, but it remains a group standard rather than a mandatory threshold.
4. **Absence of reimbursement → out-of-pocket transactions → consumable-ization** — This causal chain is the institutional backbone of the entire report: without access to reimbursement, a product generally must be cheap enough to be accepted in out-of-pocket decisions; the form that can currently push unit prices into the out-of-pocket-acceptable range is primarily the consumable; this does not preclude other pathways, but its preconditions are the fewest.

7.1 The Four-Gate Series Model: A Testable Framework for Institutional Anatomy

Regarding China's hydrogen health industry, two questions are most frequently discussed in the industry: "When will the industry take off?" and "Does policy actually support it?"

From a consulting evidence-based perspective, these two questions fundamentally misread how institutions operate: **they mistake policy for a binary on-off switch**. The switch model cannot explain a verifiable industry fact — why this sector has both the highest-level Class III certificate issued by the National Medical Products Administration and severe administrative penalties lawfully imposed by the State Administration for Market Regulation classifying products as "ordinary household appliances, by no means medical devices"; both inclusion by a provincial health commission in its appropriate health technology promotion catalog, reaching village-level clinics, and a jointly issued ministerial policy plan on silver-economy eldercare in which the word "hydrogen" appears nowhere in the entire text.

These four categories of administrative fact occur in the same period, the same country, and the same administrative system. The correct institutional analysis is not to ask "does it support," but to dissect: **how many administrative gates must a hydrogen health product cross to travel from the technology laboratory to the patient bedside and then to the payer? What is the current state of each gate?**

Based on the series logic of China's health administration, healthcare security, and market supervision, the pathway for hydrogen health products to mainstream medical care and compliant commerce is strictly locked by **four administrative gates, each a necessary condition for the next**, and **one horizontal national ruler**:

The current actual openness of the four gates can be precisely summarized as: **"Access open, grassroots promotion open, pricing half-open, reimbursement unopened; standards have set a ruler, but a qualification threshold has not yet been established."**

Table 7-1

Gate tier	Competent ministry	Core policy basis and statutory facts	Current status	Consequences and real-world impact of the industry fracture
First gate: Access (whether one can do it)	**National Medical Products Administration (NMPA)**	Shanghai Huimei obtained the only two Class III certificates nationwide (National Medical Device Registration Certificate 20203080066 / 20233081929)	**Open (narrow aperture)**	Only one indication approved — acute exacerbation of COPD; the remaining 99% of products without certificates may circulate only as ordinary commodities and are strictly prohibited from claiming any therapeutic efficacy
Second gate: Promotion (whether it can be done at the grassroots level)	**National/ Provincial Health Commission**	Shandong Provincial Health Commission 2023 Appropriate Health Technology Promotion Project List (No. 27, Tai'an City Central Hospital, promoted to village clinics/ community stations)	**Fully open**	The health administrative department recognizes the safety of its technical operation and permits lawful deployment and popularized experience at the most grassroots village-level diagnostic and treatment sites

Gate tier	Competent ministry	Core policy basis and statutory facts	Current status	Consequences and real-world impact of the industry fracture
Third gate: Pricing (whether one can charge)	**National/ Provincial Healthcare Security Bureau**	Shandong Provincial Healthcare Security Bureau, Lu Yi Bao Fa [2025] No. 15: merged into Medical Service Fee Code 120300003 (nitric oxide inhalation), with independent pricing across the province	**Half-open (independent pricing)**	Hospitals have obtained a lawful entry point for project establishment and billing, but "independent pricing" means public hospitals lack a government price endorsement and exercise extreme caution in charging
Fourth gate: Reimbursement (who pays)	**National Healthcare Security Administration / Ministry of Civil Affairs**	Ministry of Civil Affairs and 13 other departments, Three-Year Action Plan for Expanding Capacity and Improving Quality in the Rehabilitation Assistive Devices Industry (2026–2028) (Min Han [2026] No. 48)	**Unopened (no mention of hydrogen in the full text)**	Neither the medical insurance fund, long-term care insurance, nor civil affairs subsidies include any hydrogen sub-item; patients cannot obtain third-party reimbursement, and consumption is borne entirely out of pocket
Horizontal ruler: Standards (how to measure)	**Standardization Administration of China (SAC)**	National Standard GB/T 46918.2-2025, Microbubble Technology — Measurement Methods for Gas Content in Microbubble Dispersion Systems in Water — Part 2: Hydrogen Content	**A Ruler Without a Threshold**	It specifies titration and gas chromatography measurement protocols, but does not stipulate the concentration threshold that must be met for a product to be legally designated “hydrogen-rich water.”

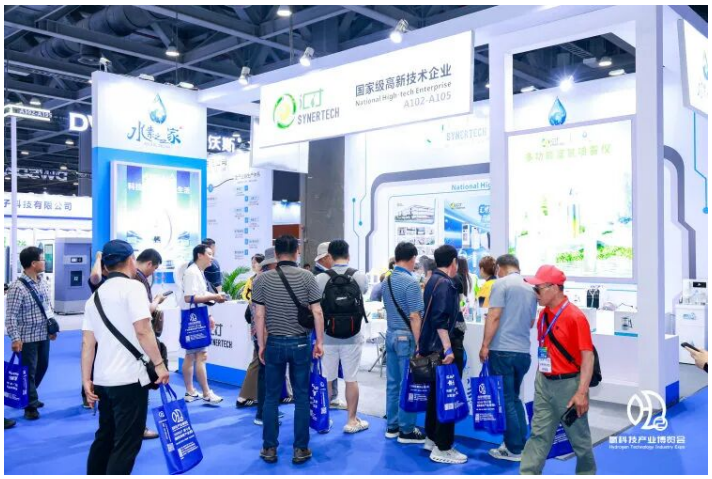


Figure 7-1 The booth fascia of one exhibitor displays “National High-Tech Enterprise” and booth numbers A102/A105. This is a single-company sample and does not represent industry-wide conditions.

Image Source: On-site at the 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo (May 2026; photographed by the report research team)

7.2 Factual Reconstruction of the Market-Access Gate: From Line-by-Line Verification of Class III Certificates to the “Voluntary Cancellation” of Class II Certificates

7.2.1 Line-by-Line Verification of Shanghai Ascleway’s Two Class III Certificates



中华人民共和国医疗器械注册证

注册证编号：国械注准20233081929

注册人名称	上海澔美医疗科技有限公司
注册人住所	上海市嘉定区嘉新公路758号3幢
生产地址	上海市嘉定区嘉新公路758号
代理人名称	/
代理人住所	/
产品名称	氢氧气机
型号、规格	AMS-TA-01/15B、AMS-TA-01/15C、AMS-H-03/30B、AMS-H-03/30C
结构及组成	由主机（水电解模块、湿化过滤模块、电脑控制模块）、氢气浓度探测器（型号：AMS-HD2）和鼻罩(型号：AMS-NM-15M）组成。
适用范围	该产品可辅助用于慢性阻塞性肺疾病急性加重期的成人患者的症状（气喘呼吸困难、咳嗽、咳痰）改善。其作用并规应符合《慢性阻塞性肺疾病诊治指南（2021年修订版）》要求。该产品需配合Pharma Systems AB公司生产的6310型呼吸过滤器使用。
附　件	产品技术要求
其他内容	
备　注	

审批部门：国家药品监督管理局

批准日期：二〇二三年十二月八日
生效日期：二〇二三年十二月八日
有效期至：二〇二八年十二月七日

国家药品监督管理局电子证照 https://zwfw.nmpa.gov.cn 2025-12-12 11:11:54:054

仅供商务使用
For Business Purpose Only

Figure 7-2 People’s Republic of China Medical Device Registration Certificate: Registration Certificate No. **NMPA Reg. No. 20233081929**; registrant name **Shanghai Ascleway Medical Technology Co., Ltd.**; product name **Hydrogen-Oxygen Generator**; models and specifications include AMS-TA-01/15B, AMS-TA-01/15C, AMS-H-03/30B, and AMS-H-03/30C; the scope of application is the improvement of symptoms (dyspnea, cough, and sputum production) in adult patients with acute exacerbation of chronic obstructive pulmonary disease. This is the second Class III certificate in the field; the first was NMPA Reg. No. 20203080066 (February 2020).

Image Source: Public materials from the Ascleway official website

The two Class III certificates held by Shanghai Ascleway Medical Technology Co., Ltd. (NMPA Reg. No. 20203080066 and 20233081929) have **the same entity as registrant**. The only statutory sample in the entire industry that has crossed the “market-access gate” resides with this single company: as of the finalization of this report, these are the only two publicly verifiable Class III registration certificates for hydrogen-oxygen inhalation devices, and **no second certificate-holding enterprise has been identified**. A rigorous line-by-line version verification of the approved fields on the face of these certificates reveals a highly cautious regulatory trajectory:

- **NMPA Reg. No. 20203080066** (issued in 2020; model AMS-H-03): the scope of application was expressly limited to — “this product **is to be used in medical institutions**, as an adjunct for symptom improvement in adult patients with acute exacerbation of chronic obstructive pulmonary disease (AECOPD) **requiring inpatient treatment**.”

- **NMPA Reg. No. 20233081929** (issued in 2023; models include AMS-H-03/30B, AMS-TA-01/15B, etc.): the 2023 certificate renewal and scope expansion introduced two substantive deletions and revisions — **"in medical institutions" was deleted, and "requiring inpatient treatment" was deleted** — and the scope was changed to "as an adjunct for symptom improvement in adult patients with acute exacerbation of chronic obstructive pulmonary disease; the specific use environment shall comply with the requirements of the Guidelines for the Diagnosis and Treatment of COPD; must be used in conjunction with the Model 6310 respiratory filter."

Regulatory Reality and Strategic Boundary: This major adjustment indicates that the regulator recognizes the safety of this class of medical device in extending from "inpatient treatment within hospitals" to "home medical care environments for patients." It must nonetheless be kept in the sharpest focus that **what the NMPA relaxed was solely the "physical place of use," and by no means the "disease indication" itself**. The registration certificate remains strictly confined to the narrow respiratory indication of "symptom improvement in adult patients with acute exacerbation of AECOPD." Any marketing claim on the market asserting that "the NMPA has certified that hydrogen can prevent cancer, lower blood pressure, combat aging, or treat diabetes" constitutes malicious, out-of-scope false application of this Class III registration certificate and amounts to a serious violation of law.

7.2.2 Empirical Evidence of Voluntary Cancellation of Class II Medical Device Registration Certificates: Class II Certificates Have Shifted from "Moats" to "Net Cost Items"

A popular argument in industry discourse holds that "as long as one obtains a provincial Class II medical device registration certificate, one can build an impregnable commercial barrier." Official notices from the drug regulatory authorities of two provinces, however, puncture this myth:

Table 7-2

Province	Announcement Date and Document Number	Registration Certificate Number(s) Involved	Name of Certificate-Holding Enterprise	Product Name	Legal Basis and Disposition Verb
Shanxi Province	2025-11-25, Announcement [2025] No. 102	**Shanxi NMPA Reg. No. 20232090129**	Qinxing Medical Technology (Shanxi) Co., Ltd.	Electrolytic Water Generator	In accordance with the provisions of the Regulations on the Supervision and Administration of Medical Devices, **upon application by the enterprise, the certificate is hereby cancelled**
Jiangxi Province	2025-11-06, Drug Regulatory Announcement	**Jiangxi NMPA Reg. No. 20242090021**	Jiangxi Qing'ai De Medical Technology Co., Ltd.	Electrolytic Water Generator	In accordance with the provisions of the Regulations on the Supervision and Administration of Medical Devices, **upon application by the enterprise, the certificate is hereby cancelled**

In-Depth Analysis of the Legal Action and Business Economics:

1. **The Jurisprudential Distinction Between "Cancellation" and "Revocation"**: "Revocation" refers to the regulatory authority's compulsory withdrawal of a certificate in accordance with the law on grounds of enterprise violations or fraud, and carries a punitive and condemnatory character. By contrast, both of the foregoing cases constitute **voluntary cancellation "at the enterprise's own application"**—an entirely autonomous commercial exit by the enterprise.
2. **Economic Exhaustion and Compliance Backlash**: Holding a Class II medical device certificate entails bearing, each year, the high operating costs of a quality management system (dynamic GMP assessment), periodic product sampling inspections, adverse event monitoring, system re-audits, and the substantial expense of renewal registration upon five-year expiry (the annualized maintenance cost of a single certificate typically reaches several hundred thousand RMB). In the end market, Class II electrolytic water machines can neither be included in public hospital Basic Medical Insurance reimbursement nor freely promoted in the public domain of e-commerce, owing to "extremely stringent review of medical device advertising." When "the compliance maintenance cost of holding a certificate far exceeds the commercial premium it confers," the Class II certificate ceases to be a moat and instead becomes a financial liability for the enterprise. The two enterprises applied for voluntary cancellation within merely one to two years of obtaining their certificates—a warning to the asset-heavy equipment model that blindly places faith in a "Class II certificate moat."

7.2.3 Shandong Haojing's "Medical Device Certificate": In Whose Name It Is Held, and Until What Date

The market claim that Shandong Haojing "holds a medical device certificate" means that the product is registered by the certificate-holding entity, which is responsible for complete-unit manufacturing. Registration held by the registrant and production by the complete-unit manufacturer is a common division of labor in the water appliance industry.

An example of a comparable product: the "electrolytic water machine" of Jiangxi Qing'ai Medical Technology Co., Ltd. holds **Gan Xie Zhu Zhun 20242090021**, a certificate the enterprise **voluntarily applied to cancel on 2025-11-06**; the Jiangxi Provincial Medical Products Administration subsequently issued a "Certification Letter" confirming that qualified products manufactured during the original certificate's validity period remain lawful medical devices and may continue to be sold and used.

Shandong Haojing Energy-Saving Equipment Co., Ltd. is principally engaged in air-conditioning heat pumps and conventional water purification equipment (2025 operating revenue of approximately RMB 8.97 million), and holds no registered medical device registration certificate or production license in its own name.

The more pervasive problem in the industry lies not with any single enterprise, but in **lumping three types of qualification together as "state certification"**:

- **Water-Related Product Approval (Wei Shui Zi)**: Issued by **health administrative departments** pursuant to the Measures for the Hygienic Supervision and Administration of Drinking Water, it certifies only that water-contact materials and effluent water quality meet drinking water hygiene and safety standards, and **confers no disease-prevention or anti-aging function whatsoever**;

- **Food-Contact Material Testing (GB 4806 series)**: Issued by third-party testing institutions, certifying that heavy metal migration from plastic or metal inner liners under specified immersion conditions does not exceed limits;
- **Medical Device Registration Certificate (Xie Zhu Zhun)**: Issued by **the National or provincial Medical Products Administration**, requiring clinical trials or rigorous clinical evaluation to demonstrate preventive or therapeutic efficacy against a specific disease.

> **Consultative Verification Criterion**: When confronting any electrolytic water or hydrogen-rich water machine enterprise claiming "medical certification," one need only apply a single, simple check—**"Please produce the medical device registration certificate bearing the words 'Xie Zhu Zhun,' not the 'Wei Shui Zi' water-related product approval."** This one question suffices to distinguish the three types of qualification—breaking "state certification" down into "which certification, in whose name, valid until what date"—and most vague claims will clarify themselves on the spot.

7.3 The Promotion Gate: Downward Deployment Pathways for Appropriate Technologies and Prefecture-Level Policy Breakthroughs

Coexisting with the NMPA's prudent market access is the health administrative system's active downward deployment along the "appropriate technology" dimension.

7.3.1 Provincial Appropriate Health Technology Promotion: Primary-Care Deployment Exemplars from Tai'an and Provincial Tertiary A Hospitals

In the "2023 Appropriate Health Technology Promotion Project List" issued by the Shandong Provincial Health Commission, hydrogen-related technologies account for 2 of the 80 appropriate technologies in the full list:

1. **No. 27**: "Standardized Application of Hydrogen-Oxygen Inhalation Therapy in Primary-Care COPD Prevention and Treatment," submitted by Tai'an Central Hospital, with target institutions explicitly deployed down to **village clinics and community health service stations**;
2. **No. 57**: A project submitted by the Second Affiliated Hospital of Shandong First Medical University, targeting county- and district-level medical institutions.

Why can the promotion gate open all the way down while the payment gate remains locked shut? This reveals the particular demands of China's primary-care health system: village clinics and primary-care communities face a vast population with COPD and age-related chronic cough and wheezing, yet lack expensive intensive-care equipment. Hydrogen-oxygen inhalation is simple to operate and free of serious side effects, and has been recognized by health authorities as a "physical intervention appropriate technology" suited to mastery by primary-care general practitioners. Yet "appropriate technology promotion" represents only administrative technical recognition and operational authorization; it is not

tied to medical insurance charging or public reimbursement. Village doctors may administer hydrogen-oxygen inhalation to villagers, but cannot settle payment via medical insurance cards—and this institutional separation leads directly to out-of-pocket payment by the public.

7.3.2 Prefecture-Level Policy Breakthrough: Zaozhuang Municipal Health Commission Incorporates Hydrogen-Oxygen Medicine into the "15th Five-Year Plan" and Jurisdictional Medical Institution Promotion Pilots

Under the demonstrative leadership of provincial appropriate health technology policy, certain prefecture-level health authorities in Shandong Province with keen forward-looking vision have begun exploring the direct incorporation of hydrogen medicine into local medium- and long-term development plans and public healthcare system pilots.

The most typical landmark event is that—**the Health Commission of Zaozhuang Municipality, Shandong Province, in the course of drafting its "15th Five-Year Plan" health development plan, formally incorporated frontier health intervention technologies such as Lumei Medical's hydrogen-oxygen medicine into the local "15th Five-Year Plan" health development planning layout and key big-health cultivation projects**; an authoritative industry media outlet devoted a dedicated report to this, entitled "Firing the Starting Gun—Luomei Hydrogen-Oxygen Medicine Incorporated by the Zaozhuang Municipal Health Commission into the '15th Five-Year Plan.'"

This prefecture-level administrative policy breakthrough exhibits three core strategic orientations: 1. **Multi-scenario pilots across jurisdictional medical institutions**: For comprehensive tertiary A hospitals within Zaozhuang Municipality (such as Zaozhuang Municipal Hospital and Shandong Health Group Zaozhuang Central Hospital), specialized medical institutions, and tightly integrated county-level medical communities, it promotes non-invasive green physical interventions such as hydrogen-oxygen mixed-gas inhalation and hydrogen-oxygen nebulization, conducting standardized appropriate-technology clinical exploration and physician-patient education in clinical departments including chronic obstructive pulmonary disease (COPD), post-stroke/ischemic cerebrovascular disease sequelae rehabilitation, sleep apnea, and chronic degenerative pain; 2. **Closing the trinity implementation loop of "planning + appropriate technology + independent medical insurance pricing"**: The Zaozhuang Municipal Health Commission's planning incorporation, together with the Shandong Provincial Health Commission's appropriate health technology promotion policy (the 14th batch and 2023 annual projects) and the Shandong Provincial Healthcare Security Bureau (Lu Yi Bao Fa [2025] No. 15, concerning the independent pricing code 120300003 for hydrogen-oxygen inhalation), forms an efficient vertical administrative loop that completely removes the prior institutional concerns of public hospitals—"no status, dare not enter; no planning, dare not promote; no code, dare not charge"; 3. **A demonstration of transition from "disorderly private experience sessions" to "standardized in-hospital and post-hospital intervention"**: For a long time, hydrogen health devices, lacking public medical endorsement, have relied heavily on private seminar-marketing experience salons, breeding exaggerated claims and regulatory friction; the Zaozhuang health system's introduction of hydrogen medicine into the formal public hospital system for appropriate technology promotion and clinical research monitoring sets an important institutional innovation exemplar for how prefecture-level health authorities nationwide may "co-opt, standardize, and guide hydrogen health as a new quality productive force through the regular army of institutions."

7.4 The Charging and Payment Gate: “Parasitic Project Establishment” and the Independent Pricing Trade-off



Figure 7-3 A text page re-typeset in official-document format: key points of Lu Yi Bao Fa [2025] No. 15 and Project 120300003

Image Source: Shandong Provincial Healthcare Security Bureau, Lu Yi Bao Fa [2025] No. 15 document

At the level of medical service price administration, the Notice on Revising Certain Medical Service Price Items Including the High-Sensitivity C-Reactive Protein Assay (Lu Yi Bao Fa [2025] No. 15), issued by the Shandong Provincial Healthcare Security Bureau, constitutes the industry's most representative charging breakthrough exemplar.

The document cleverly adopts a “parasitic revision” strategy: without establishing an entirely new charging item, it directly supplements the scope of an existing mature item—**“Nitric Oxide Inhalation (Item Code 120300003)”**—to add “including hydrogen-oxygen mixed-gas inhalation therapy,” with the pricing unit calculated by “hour,” and tertiary, secondary, and primary public medical institutions all practicing **“independent pricing.”**

Why does “independent pricing” equal “the gate only half open”?

In China's medical service pricing system, “independent pricing” is a double-edged sword: it means hospitals are not constrained by excessively low government price caps, but it also means **the absence of catalog reimbursement endorsement by the pooled medical insurance fund**. For public hospital management, launching diagnostic and treatment items with no medical insurance backstop and requiring full out-of-pocket payment by patients entails enormous physician-patient communication resistance and allegations of unlawful charging; the hospital's rational choice is therefore often to “passively refrain from launching” or “recommend only to a minority of high-willingness self-paying patients.” “Having a code does not equal having a price; having a price does not equal having someone pay”—this assertion precisely captures the current reality of the half-locked price gate on the public medical side.

7.5 Local Think Tanks and Frontier Policy Exploration: An In-Depth Anatomy of the Shandong Provincial Government Development Research Center's “Research on the R&D and Industrialization Development of Hydrogen Medicine and Hydrogen Agriculture”

While policy in most provinces nationwide remains confined to the traditional energy mindset of “subsidizing hydrogen fuel cell vehicles and refueling stations,” Shandong Province—a core carrier province of the “China Hydrogen Energy Demonstration Project (Hydrogen into Ten Thousand Homes)” and a strong province in agriculture and medicine—has already taken the key step, at the policy and think-tank decision-making level, **“from energy hydrogen toward life and health (hydrogen medicine) and green ecology (hydrogen agriculture).”**

The dedicated research output publicly released in Shandong Economic Strategic Research, a journal administered by the Shandong Provincial People's Government Development Research Center—**“Research on the R&D and Industrialization Development of Hydrogen Medicine and Hydrogen Agriculture”**—constitutes the industry's highest-level local government think-tank dedicated decision-consulting exemplar. Taking leading local enterprises deeply engaged in solid-state hydrogen materials and green agriculture, such as Muqi Technology, as its core samples, the research directly reflects local decision-makers' frontier understanding and strategic assessment of the hydrogen health industry:

7.5.1 Core Strategic Assessment: Cultivating New Quality Productive Forces and Breaking the Single Dependence on “Energy Hydrogen”

1. **Breaking traditional industrial boundaries**: The report explicitly proposes, for the first time at the level of a provincial government think tank, that hydrogen energy is not only a clean energy carrier under the “dual carbon” goals, but also a cross-sectoral life and health intervention medium and a modern bio-agricultural input;
2. **Absorption and self-sustaining demands**: Traditional asset-heavy hydrogen refueling stations and transportation demonstration investments are large and slow to yield returns; by contrast, “hydrogen medicine and hydrogen agriculture,” as asset-light, high-value-added, long-industrial-chain physical applications, can provide local absorption and a self-sustaining cycle for regional hydrogen energy infrastructure, and constitute a strategic new track for cultivating green, low-carbon new quality productive forces.

7.5.2 Policy Endorsement and Commercial Loop Along the Hydrogen Agriculture Dimension

The research report provides a focused analysis of the practical efficacy of hydrogen molecules in the field of modern ecological agriculture:

- **Reduced chemical inputs and improved quality and yield**: Through irrigation with solid-state hydrogen hydrolysis materials and nano-bubble water, soil aggregate structure and root-zone microecology are improved. Empirical evidence shows that the germination rate and root vitality of leafy

vegetables such as spinach and bok choy, as well as crops such as rice, are substantially enhanced, achieving **yield increases of 15%–30% and reductions in chemical fertilizer and pesticide application of 15%–20%**;

- **Green preservation of fruits and vegetables**: Post-harvest hydrogen fumigation or hydrogen-rich water treatment can significantly inhibit ethylene release and chlorophyll degradation, extending shelf life by 3–5 days;
- **Full-chain closed-loop model**: The report strongly endorses the full-chain closed-loop business model exemplified by companies such as Muqi Technology—comprising "core hydrogen-generating new materials / silicon-based fertilizers + standardized agricultural planting protocols + brand premium for green, high-quality agricultural products (30%–50% premium rate)"—and prospectively identifies the strategic direction of leveraging "distributed photovoltaic green hydrogen production + in-situ cultivation and absorption in protected agriculture + green hydrogen-derived green ammonia / green silicon-hydrogen compound fertilizer" to deeply empower modern green circular and zero-carbon ecological agriculture.

7.5.3 Institutional Synergy Insights: The Complete Trinity of the "Shandong Experience"

By comparing this research report with the series of health administrative measures previously issued by Shandong Province, the nationally unique "Shandong Experience in Breaking Institutional Ice for the Hydrogen Health Sector" can be clearly assembled:

1. **Top-level strategic guidance by a think tank**: The special research conducted by the Provincial Government Development Research Center legitimizes and defines "hydrogen medicine and hydrogen agriculture," elevating them to the status of regional new quality productive forces and a modern agricultural health initiative;
2. **Grassroots appropriate-technology foundation**: The Provincial Health Commission has incorporated hydrogen-oxygen inhalation therapy at Tai'an Central Hospital into the provincial catalog for the promotion of appropriate grassroots health technologies (extending directly to village clinics);
3. **Public medical service pricing and item establishment**: The Provincial Healthcare Security Bureau, via Document Lu Yi Bao Fa [2025] No. 15, grants medical institutions across the province an autonomous pricing and charging code (120300003); this trinity of "think-tank research setting the tone + health commission technology promotion + healthcare security item establishment and charging" establishes a highly instructive provincial model for other provinces nationwide to explore compliant governance and industrial cultivation of the hydrogen health sector.

7.6 Regulatory Storm and Industry Reflection: Governance of False Advertising in Seminar Marketing



Figure 7-4 Exterior views of two “hydrogen experience centers” and promotional text of hydrogen-related experience centers

Image Source: CCTV Finance “Financial Investigation” special report and SAMR enforcement disclosures

The typical commercial distortion arising from two and a half of the four gates being opened is that **the absence of a payer-side mechanism forces products entirely into the private out-of-pocket consumer market**; in this out-of-pocket market, the high ex-factory costs and zero-repurchase characteristics of heavy equipment in turn force channels to rely on closed-door “free experience centers and efficacy-exaggerating seminar marketing.” This high-risk distortion prompted a forceful nationwide regulatory crackdown between 2024 and 2026.

7.6.1 The Tip of the Iceberg Exposed by CCTV's “Financial Investigation”

On August 25, 2024, the CCTV Finance Channel's “Financial Investigation” program broadcast an investigative report titled “Uncovering the Secret of 'Enjoying Hydrogen Bliss' in Hydrogen Therapy Centers,” using the Wiselton Hydrogen-Oxygen Experience Center in Taigu District, Jinzhong, Shanxi, as a typical sample to deeply expose the profit pipeline of traditional seminar-marketing experience stores:

- **Empirical evidence of distorted excess margins**: An ordinary hydrogen-oxygen machine with an ex-factory cost of only RMB 2,000–3,000 was packaged in the experience center as a “miracle machine” with “anti-cancer, blood vessel-clearing, and blood sugar-lowering” effects, with a terminal retail price per unit as high as **RMB 17,999**;
- **Profit-sharing chain**: For each unit sold, the franchise store received a commission of **RMB 5,000**, while the upstream equipment manufacturer captured **RMB 10,000** in high gross margin; a single county-level store of just a few dozen square meters sold over 300 units annually, generating annual net profit exceeding RMB 1.5 million;
- **Administrative enforcement**: The day after the report aired, the Taigu District Market Supervision Administration sealed the premises involved and opened a case for investigation in accordance with the law, seizing all equipment.

7.6.2 SAMR Typical Enforcement Actions and Official Determinations on Anti-Unfair Competition Targeting the Elderly

The market regulatory authorities' crackdown on non-compliant hydrogen health advertising has escalated from local administrative penalties to nationwide typical cases publicized by the State Administration for Market Regulation (SAMR). Multiple authoritative case files reveal the legal characterization of ordinary hydrogen equipment by enforcement agencies:

Table 7-3

Enforcement cause / Document number	Enforcement authority and parties involved	Products involved and alleged claims	Applicable legal basis and version	Official authoritative legal characterization	Penalty outcome
Tong Shi Jian Chu Fa [2024] No. 150 (2024-10-21)	Tongling Municipal Market Supervision Administration / Tonggu District Hydrogen-Oxygen Electronic Products Business Department	Claimed that the "hydrogen-oxygen health machine" had auxiliary therapeutic effects on diseases	**Article 8, Paragraph 1** of the Anti-Unfair Competition Law (2019 version)	**Ordinary electronic instrument product**	Ordered to cease unlawful conduct; fined **RMB 5,000**
SAMR Typical Case No. 5 on Anti-Unfair Competition Targeting the Elderly, 2026-09-02	Yangquan Municipal Market Supervision Administration High-Tech Zone Branch / Yangquan Xinfu Health Consulting Center	Free trials coupled with claims that the "Dehydrogen multi-function hydrogen-oxygen machine provides auxiliary treatment and prevents cancer"	Anti-Unfair Competition Law (2025 Revision) **Article 9, Paragraph 1**	**Ordinary household appliances; not medical devices**	Order to cease unlawful conduct; fine of **RMB 50,000**

Two deep legal and economic perspectives:

1. **Officially stripping away the "medical mask"**: enforcement notices expressly state in black and white that **"the equipment sold by the party is an ordinary household appliance / ordinary electronic instrument and is not a medical device."** This determination in the enforcement case files completely shatters market claims that ordinary hydrogen inhalers are "medical-grade miracle machines."
2. **The equal irony of unlawful gains and single-unit profit**: the Tongling case carried a fine of RMB 5,000, and the Yangquan case RMB 50,000. In the Taigu store exposed by CCTV, the store gross margin on a single device priced at RMB 17,999 was exactly RMB 5,000 per unit. This means local fines are merely equivalent to the profit from selling one to several devices in-store. Driven by seminar-marketing windfalls of hundreds of units sold annually and profits of millions of RMB, traditional administrative penalties are insufficient to restrain the profit motive; the closed loop must be broken at the source through payment structure and product-category form.

7.6.3 Institutional Root-Cause Analysis: The Six-Step Self-Locking Institutional Loop Induced by “Payment Not Yet Open”

Why has the hydrogen health industry repeatedly become a hotspot for “elderly-targeted fraud and exaggerated claims”? Reducing it merely to “moral decay among practitioners” would forfeit the analytical depth of institutional economics. At the bottom of the value chain, the industry’s various disorderly practices are essentially a six-step self-locking institutional loop induced by the fourth payment gate remaining closed (the absence of medical insurance and public funds):

[Institutional-Economics Deduction] The Six-Step Self-Locking Institutional Loop Induced by “Payment Not Yet Open”

- ① **Payment gate closed**: public medical care and the medical insurance / long-term care insurance catalogs contain no “hydrogen” entry anywhere; the prescription-reimbursement channel is fully closed
  ↓ **(leads to)**
- ② **Terminal 100% dependence on out-of-pocket payment**: the entire industry’s commercial capacity must be paid for entirely out of pocket by mass consumers
  ↓ **(forces)**
- ③ **Mandatory reliance on heavy “free experience salons” for customer acquisition**: non-essential durable equipment priced at tens of thousands of RMB must be sold through prolonged hospitality and emotional accompaniment to achieve deep persuasion
  ↓ **(drives in turn)**
- ④ **Dependence on seminar marketing and high terminal unit prices (RMB 15,000–RMB 26,000 per unit)**: rent and seminar-lecturer commissions inflate the cost structure of complete hardware units
  ↓ **(evolves into)**
- ⑤ **Elderly-targeted violations and high incidence of false advertising “deifying hydrogen as a cure-all / cancer preventive”**: to dispel elderly consumers’ doubts and support unit prices in the tens of thousands of RMB, frontline sales irreversibly slide into unlawful rhetoric
  ↓ **(invites)**
- ⑥ **Heavy regulatory crackdowns, CCTV undercover exposure, and damage to category credibility**: customer acquisition cost (CAC) in legitimate channels surges, forcing companies in reverse **to retreat even further into seminar marketing steps ③ and ④**

The internal logic of the six-step causal chain:

- **Step one: payment not yet open**: the national medical insurance catalog, long-term care insurance, and the Ministry of Civil Affairs’ Three-Year Action Plan for Rehabilitation Assistive Devices (Min Han [2026] No. 48) contain no “hydrogen” entry anywhere; hospitals cannot conduct scaled treatment through prescription reimbursement;
- **Step two: out-of-pocket payment**: with public channels blocked, 100% of industry capacity must be paid for entirely out of pocket by mass consumers;

- **Step three: experience-based persuasion**: non-essential health equipment priced at tens of thousands of RMB generates no natural purchase impulse among ordinary consumers in e-commerce or supermarkets; merchants are forced to open numerous offline “free experience salons,” relying on prolonged hospitality, emotional accompaniment, and lecture-based persuasion to achieve cognitive penetration;
- **Step four: dependence on seminar marketing and high unit prices**: heavy rent, utilities, gifts, and lecturer commissions at offline experience stores push the retail price of complete hardware units to RMB 15,000–RMB 26,000 per unit to sustain the channel profit-sharing system;
- **Step five: high incidence of false advertising**: facing elderly consumers lacking medical knowledge, when the experience does not produce dramatic therapeutic effects immediately, sales staff under performance pressure irreversibly move toward deifying hydrogen, even claiming it “cures all diseases and reverses cancer”;
- **Step six: regulatory crackdown and credibility backlash**: non-compliant seminar marketing draws CCTV exposure and strict case filing by enforcement agencies, with sites sealed and equipment classified as ordinary small appliances. This causes the public to develop widespread distrust of “hydrogen,” a molecule that originally carried rigorous academic value; customer acquisition cost (CAC) in legitimate channels surges more than tenfold. Legitimate enterprises unable to acquire customers in public e-commerce domains are, under survival pressure, forced in reverse into more concealed private-domain underground seminar marketing, plunging the entire system into a self-reinforcing closed state.

> **The most direct breakthrough inference**:
> This closed loop proves that as long as enterprises continue to sell high-priced heavy hardware through private out-of-pocket channels, the cycle will be difficult to break on its own. **The primary reason upstream materials companies (such as Muqi Technology, etc.) firmly choose “not to make complete machines, only embeddable solid-state micro-porous materials and high-frequency consumables” is not technological preference, but separating the business from high-risk seminar-marketing channels**—transforming hydrogen health into low-ticket (tens to hundreds of RMB), high-frequency, spontaneously repurchased daily FMCG relying on food-grade and daily-chemical compliance standards; this is one realistic path for China’s hydrogen health industry to escape gray-market path dependence and move toward a virtuous self-sustaining cycle.

7.7 Standardization System and Testing Safety Baseline

For the industry to leave behind wild growth, it must establish rigorous technical metrology. China is accelerating the completion of standards and safety baselines in the hydrogen health field:

7.7.1 National Recommended Standard GB/T 46918.2-2025

Supervised by the Chinese Academy of Sciences and administered by the National Technical Committee for Standardization of Microfine Bubble Technology (TC584), the recommended national standard **GB/T 46918.2-2025, Microfine Bubble Technology—Measurement Method for Gas Content in Microfine Bubble Dispersions in Water—Part 2: Hydrogen Content**, modified by adopting international standard ISO 7383-2:2024, was officially released at the end of 2025 and will take effect on July 1, 2026.

- **Substantive value of the standard**: it changes the previous situation of inconsistent dissolved-hydrogen concentration calibers and dispersed measurement methods for hydrogen-rich water, and clarifies the benchmark of two measurement methods: “redox titration” and “gas chromatography headspace analysis (GC).”
- **Current limitations**: the standard is a “measuring ruler,” not an “entry threshold.” It specifies how to measure, but does not specify how many ppb are required to be legally called “hydrogen-rich water”; mandatory industry product standards still await further advancement.

7.7.2 Food-Industry Processing Aids and Water-Contact Safety Red Lines (GB 2760 and GB 4806 Series)

- **Statutory positioning as a food-industry processing aid (GB 2760-2024)**: in the National Health Commission’s National Food Safety Standard—Standard for Use of Food Additives (GB 2760-2024, officially implemented on February 8, 2025), hydrogen is expressly included in the list of **Appendix C “Food-Industry Processing Aids.”** Its legal meaning is very clear: in the food industry, hydrogen is only a process processing aid (analogous substitute in nitrogen-flushing deoxygenation processes), not a direct functional food nutrient fortifier; pre-packaged drinking-water enterprises are strictly prohibited from claiming any “disease prevention or treatment” efficacy on bottle labels or outer packaging.
- **Mandatory version-upgrade safety red line for food-contact materials (GB 4806 series)**: when producing hydrogen-rich cups, hydrogen-rich water machines, and other water-contact products, inner-tank plastic components must comply with **GB 4806.7-2023** (which has replaced the old 2016 edition), and metal water-contact components must strictly comply with **GB 4806.9-2023** (which sets relatively strict limits on migration and leaching of heavy metals and harmful impurities such as lead, cadmium, arsenic, mercury, antimony, beryllium, and lithium). Solid-state hydrogen materials must pass food-contact toxicological testing to avoid secondary heavy-metal leaching caused by insufficient process control.

7.8 Breakthrough Rules for Enterprises Under Institutional Constraints: Why Consumabilization Is Closer to the Reality of Most Enterprises

The structural constraints of the four gates actually point to a clear breakthrough dividing line for China’s entire hydrogen health industry:

Table 7-4

Strategic decision dimension	Traditional Standalone Medical Equipment Route (Asset-Heavy Hardware Model)	Solid-State Hydrogen Material FMCG Consumables Route (Asset-Light Consumer Goods Model)	Advantage and Disadvantage Assessment Under the Institutional Environment
1. Regulatory Market-Access Threshold	**Extremely high**: Class III medical devices must pass large-scale, multi-center, double-blind RCT clinical trials, with an approval cycle of 3–5 years and expenditures in the tens of millions of RMB; moreover, approved indications are confined to specific acute and critical respiratory conditions and cannot be generalized to ordinary consumer products	**Compliant and transparent**: Adherence to national food-contact material standards (GB 4806 series), food processing aids (GB 2760-2024), and cosmetics safety regulations; no medical device market-access filing is required, and time-to-market is extremely short	The consumables model circumvents the medical approval ceiling and enters broad public-domain distribution through standardized daily-use product compliance
2. Unit Price and Decision Friction	**Relatively high**: Standalone unit retail prices of RMB 15,000 to RMB 26,000, an extremely long consumer purchase decision chain, and heavy reliance on closed-door offline experience sessions and prolonged emotional persuasion	**Accessible**: Consumables priced in the tens to low hundreds of RMB per box, with individual units as low as a few RMB; consumers face virtually no decision burden, readily triggering spontaneous trial purchases	The consumables model lowers the decision threshold by two orders of magnitude, naturally aligning with modern mass-market consumption habits
3. Customer Acquisition and Channel Costs (CAC)	**Relatively high**: Requires bearing experience-store rent, utilities, gifts, and lecturer commissions, with customer acquisition cost (CAC) consuming more than 50% of retail revenue	**Asset-light and agile**: Seamless integration with existing public-domain e-commerce platforms, boutique supermarkets, CS beauty and personal-care counters, pharmacy shelves, and compliant private-domain communities, with CAC significantly controllable	The consumables model benefits from the enabling infrastructure of existing mature channels, with extremely low marginal expansion costs
4. Reorder Stickiness and Customer LTV	**One-time buyout, zero reorders**: Absent consumable stickiness, firms must continually burn capital to find the next new customer, easily falling into an acquisition death spiral	**Cyclical high-frequency reorders (>40%)**: Monthly tumbler filter replacement, daily lozenge consumption, weekly mask application, and regular foot-bath tablet stockpiling form a sustained and stable cash-flow flywheel	The consumables model reconstructs the “one-off transaction” into a health subscription business with “high lifetime value (LTV)”
5. Policy and Compliance Risk	**Relatively high risk**: Sales teams, seeking to recoup high costs, readily exaggerate therapeutic efficacy, making them a priority target of anti-unfair-competition enforcement and media scrutiny	**Safe and controllable**: Objective claims regarding basic antioxidant stress relief, skin microbiome improvement, and daily health maintenance are completely decoupled from medical treatment, providing a robust legal firewall	Decoupled from medical claims, with clear compliance boundaries

Strategic decision dimension	Traditional Standalone Medical Equipment Route (Asset-Heavy Hardware Model)	Solid-State Hydrogen Material FMCG Consumables Route (Asset-Light Consumer Goods Model)	Advantage and Disadvantage Assessment Under the Institutional Environment
6. Asset Structure and Supply Chain	**Asset-heavy and inventory-heavy**: Shell tooling, electrolyzer stack procurement, and tube-and-valve assembly tie up substantial sunk capital; technological iteration can readily trigger inventory write-downs and impairment	**Asset-light and platform-based**: Focus on upstream R&D and standards output for micro-porous functional hydrogen storage and release materials, serving downstream brands through a platform-enabled model	Highly flexible with cyclical resilience, delivering return on invested capital (ROIC) far exceeding hardware assembly

Under this structure, and given stringent national market-access controls and the absence of Basic Medical Insurance reimbursement, the more viable landing point for most enterprises is **electricity-free, portable, compliant and transparent, high-frequency-reorder solid-state hydrogen FMCG consumables**, rather than continued bets on standalone medical equipment.

7.9 Five Medium- and Long-Term Strategic Trends in the Institutional and Policy Evolution of China's Hydrogen Health Industry (2026–2035)

01

Top-Level Planning Spills Over from Energy-Only Hydrogen to Livelihood Scenarios

The "1+N+X" Framework: Energy Security and Supply as 1, Industrial Decarbonization and Power Storage as N, and Livelihood Health, Ecological Agriculture, and Zero-Carbon Microgrids as X

02

Device Market Access and Public Healthcare Tighten at Both Ends, Breaking Ice in Stages

Any therapeutic claim is uniformly anchored to a Class III certificate; clinical applications expand from respiratory medicine to MDT multidisciplinary settings

03

Normalized Enforcement Forces an Industry "Great Divergence"

The serious medical device track and the compliant FMCG consumables track proceed in parallel, with the sandwiched gray-zone seminar-marketing segment cleared out

04

Hydrogen agriculture gains preferential policy treatment under green and low-carbon frameworks

Chemical-residue-free inputs enter demonstration parks and green agricultural input subsidy selections, with hydrogen irrigation and hydrogen aquaculture emerging as new growth poles

05

Customs tariff classification gaps compel standards and coding to go global

Push for dedicated tariff lines for hydrogen-rich water, solid-state hydrogen-releasing materials, and hydrogen inhalation devices with the General Administration of Customs and the WCO

At the juncture between the conclusion of the 14th Five-Year Plan and the launch of the 15th Five-Year Plan, China's macroeconomic growth driver transition, green and low-carbon transformation, and aging population structure are reshaping the institutional environment. By tracing the policy trajectories and local pilots of ministries and commissions including the National Development and Reform Commission, the National Energy Administration, the National Medical Products Administration, the National Health-

care Security Administration, the Ministry of Agriculture and Rural Affairs, and the General Administration of Customs, this report identifies **five medium- and long-term strategic trends** in the institutional and policy evolution of China's hydrogen health industry over the next decade (2026–2035):

7.9.1 Trend One: The national "dual carbon" top-level plan spills over from "single-purpose energy hydrogen" to a diversified "1+N+X" livelihood scenario framework

- **Policy background and macro shift**: The Medium- and Long-Term Plan for the Development of the Hydrogen Energy Industry (2021–2035), issued by the National Development and Reform Commission and the National Energy Administration, established hydrogen energy's strategic positioning as "an important component of the future national energy system" and "an important carrier for achieving green and low-carbon transformation at the end-use level"; the State Council's 14th Five-Year Plan for a Modern Energy System and the Third Plenary Session of the 20th Central Committee further designated hydrogen energy as a strategic emerging industry and a key direction for new quality productive forces. Over the past five years, however, conventional hydrogen energy has been highly concentrated on "hydrogen heavy-duty trucks, fuel cell passenger buses, and hydrogen refueling station networks," facing high hydrogen costs, infrastructure gaps, and intense competition from the battery electric vehicle (BEV) route; the pace of progress in the conventional transportation track has slowed, and fiscal subsidies have simultaneously stepped down.
- **Diversified offtake and livelihood applications under the 15th Five-Year Plan**: Meanwhile, green hydrogen projects via water electrolysis — matched to multi-gigawatt-scale wind and solar renewable energy bases in Northwest and North China — are being commissioned successively at volumes of several million tons per year, increasing pressure for local offtake and commercial monetization across the value chain. At the policy level, the national hydrogen strategy is being extended from its previous emphasis on transportation applications toward a **"1+N+X" framework (with energy security and supply as the "1," industrial decarbonization and power storage as the "N," and livelihood health, ecological agriculture, and zero-carbon microgrids as the "X")**.
- **Local policy leadership**: The Ministry of Science and Technology's National Key R&D Program "Hydrogen Technology" special project and the "Hydrogen into Ten Thousand Homes" science and technology demonstration projects in representative provinces are expanding from purely industrial by-product hydrogen heating to health drinking water for households and modern protected agriculture; Guangdong Province (Medium- and Long-Term Plan for the Hydrogen Energy Industry in Nanhai District, Foshan), Zhejiang Province (Jiaxing Hydrogen Life Demonstration Zone), and Shandong Province (Jinan and Zibo life health and hydrogen kinetic energy demonstration belt) have already included "hydrogen molecular biomedicine equipment, hydrogen-rich wellness household appliances, and hydrogen agricultural technology" in their local industrial support catalogs as part of dedicated support lists for new quality productive forces, providing a landing point for hundred-billion-scale green hydrogen capacity that features higher per-unit added value, asset-light operations, and direct orientation toward end consumers.

7.9.2 Trend Two: Tightening medical device market access with phased expansion of clinical applications

- **Access side: Narrowing gray space and clear Class III thresholds**: The National Medical Products Administration (NMPA) will define and enforce regulation of hydrogen-related medical devices more clearly and strictly. Under Subdirectory 09 (Physical Therapy and Rehabilitation Equipment) and 08 (Active In Vivo/In Vitro Therapeutic Equipment) of the Medical Device Classification Catalog, any active hydrogen inhalation device claimed in product promotion to have clear clinical efficacy against specific diseases (such as chronic obstructive pulmonary disease, adjunctive radiotherapy and chemotherapy for tumors, or cerebral ischemia-reperfusion injury) will be regulated as a "Class III medical device" under the high-threshold pathway, requiring completion of multicenter, large-sample randomized double-blind controlled (RCT) clinical trials before market access; the previous practice by some companies of attempting to obtain Class II certificates for non-specific disease indications through local drug regulators is being phased out as unannounced inspections become routine and national review guidelines are unified (as evidenced by Luomei's voluntary cancellation of its Class II certificate).
- **Clinical side: Expansion from a single respiratory department to multidisciplinary team (MDT) care**: Driven by relevant clinical research and experts and scholars, the clinical application of molecular hydrogen in top-tier public tertiary hospitals is gradually expanding in a phased manner from a single focus on acute exacerbations of chronic obstructive pulmonary disease (COPD) to multiple disciplines, including perioperative lung protection in thoracic surgery, sepsis and hypoxic microcirculatory dysfunction in the intensive care unit (ICU), radiotherapy and chemotherapy toxicity reduction and efficacy enhancement, repair of refractory wounds, and adjunctive rehabilitation of neurodegenerative diseases.
- **Payment side: Local pilots and spread of commercial insurance**: Public medical institution medical service pricing items will gradually extend from Shandong Province's pilot of "incorporating nitric oxide inhalation therapy (120300003) into independent pricing" to the Yangtze River Delta (Shanghai, Jiangsu, Zhejiang) and the Greater Bay Area and other provinces and municipalities with stronger payment capacity; as multicenter evidence-based data mature, some economically developed regions are exploring the gradual inclusion of molecular hydrogen rehabilitation therapy with relatively robust evidence-based support into city-customized commercial medical insurance (such as "Huimin Bao" or commercial health insurance supplemental payment catalogs for specialty drugs and devices); and in the primary healthcare system, the health authorities' promotion of appropriate technologies will continue to leverage the advantages of "low cost and broad coverage," becoming a relevant lever for primary-level rollout.

7.9.3 Trend Three: Routine market regulation enforcement drives industry stratification (The Great Bifurcation)

- **Routine, full-chain crackdown on seminar marketing targeting the elderly and false advertising**: The State Administration for Market Regulation, together with the Ministry of Public Security, the Ministry of Civil Affairs, and the National Health Commission, has designated the crackdown on illegal and non-compliant gathering-based marketing (seminar marketing) targeting middle-aged and elderly groups and involving elderly care, medical claims, and false advertising as a routine regulatory priority. Relying on the national 12315 digital platform and big-data-driven dynamic monitoring of online

public opinion, the gray operational space of “free experience as a traffic draw, brainwashing and deifying therapeutic effects, and opportunistic high-price sales of unlicensed hardware” has been significantly narrowed.

- **Industry stratification**: Stricter regulation will not eliminate the industry; rather, it will drive market stratification, gradually separating compliant operators from gray-market operators:

  1. **Left track: Serious Medical Device Track**: Fully adhering to evidence-based medicine principles, with the Class III certificate as the core threshold, focusing on in-hospital public hospital scenarios, expert academic committees, and multicenter clinical trials, and capturing serious medical premiums through in-hospital prescriptions and compliant self-pay pricing;
  2. **Right track: Compliant FMCG & Solid-State Consumable Track**: Making no claims of “treatment, curing disease, or medical device” efficacy, and complying with current requirements such as the national food contact materials standards (GB 4806 series), food industry processing aids (GB 2760-2024), and the Safety and Technical Standards for Cosmetics. Leveraging inorganic micro-porous solid-state hydrogen materials and electricity-free portable technology, it enters fast-moving consumer goods categories such as packaged drinking water, functional drink mixes, portable hydrogen-generating tumbler cores, hydrogen-rich facial masks, and acupoint transdermal patches, targeting younger and middle-class consumer groups with lifestyle language such as “cellular-level antioxidant, daily anti-fatigue, mild anti-inflammatory, and skin microbiome maintenance”;
  3. **Sandwich layer: Contraction of gray hardware seminar marketing**: Gray seminar marketers and white-label assemblers that sit between the two tracks — holding neither a formal medical device registration certificate nor a legitimate business model, while maintaining heavy standalone hardware priced in the tens of thousands of RMB — are expected to contract markedly during 2026–2028.

7.9.4 Trend Four: Policy support for chemical-residue-free hydrogen ecological cultivation and breeding under agriculture and rural areas’ “green, low-carbon new quality productive forces”

- **National strategic orientation toward green and low-carbon agriculture**: In implementing the Ministry of Agriculture and Rural Affairs’ Action Plan for Fertilizer Reduction by 2025, Action Plan for Chemical Pesticide Reduction by 2025, and the national rural revitalization and ecological circular agriculture strategies, the state’s support orientation toward chemical-residue-free, environmentally friendly agricultural inputs and green biotechnology is becoming increasingly clear. As a “natural endogenous stress-resistance signaling molecule,” molecular hydrogen has demonstrated biological effects — without adding any exogenous chemical pesticide or antibiotic load — in promoting crop root growth, blocking the uptake of heavy metals such as cadmium and arsenic, improving the sugar-acid ratio of fruit, and reducing mortality rates in aquaculture and livestock and poultry.
- **Standard-setting and demonstration-promotion support**: Precision hydrogen water irrigation systems, hydrogen-controlled-atmosphere fruit and vegetable preservation warehouses, antibiotic-free recirculating aquaculture systems (RAS) based on hydrogenotrophic denitrification (HD), and hydrogen-releasing feed additives for poultry heat stress resistance are being incorporated into modern agricultural demonstration parks, green and low-carbon new quality productive forces pilot projects,

and agricultural machinery/green agricultural input promotion subsidy selection sequences in multiple regions. Led by national-level research institutions such as the School of Agriculture and Biology at Shanghai Jiao Tong University and the College of Life Sciences at Nanjing Agricultural University, local agricultural societies and industry associations are accelerating the formulation and issuance of a series of association standards — including "Code of Practice for Hydrogen Agriculture Rice Cultivation," "Quality Evaluation Specification for Hydrogen-Rich Water-Irrigated Fruits and Vegetables," and "Technical Specification for Hydrogen Water Ecological Aquaculture" — to drive hydrogen agriculture from university research pilots toward broader demonstration applications.

- **Closed-loop new energy microgrids and the green fertilizer value chain**: Policy will further guide the coordination of the entire value chain between "agricultural and rural new energy microgrids (photovoltaic green electricity — on-site green hydrogen — in-situ integrated water, fertilizer, and gas offtake)" and "green hydrogen-derived green ammonia — silicon-hydrogen composite micro-porous fertilizer," making them an important pillar for national agricultural carbon sink accounting and high-premium certification of green organic agricultural products.

7.9.5 Trend Five: Demand for classification standards and independent tariff lines arising from gaps in customs HS codes

- **Current tariff classification gaps**: China is the world's largest manufacturer and exporter of hydrogen health products (accounting for more than 85% of global capacity for electrolytic hydrogen water tumblers and complete hydrogen inhalation units, and more than 90% of inorganic solid-state hydrogen-releasing micro-porous materials). However, in customs statistics and international trade regulation, clear classification gaps exist:
  - Hydrogen-rich packaged drinking water is mostly declared as ordinary "other packaged drinking water" (HS 22019010/22019090), which cannot reflect its technical characteristics or cargo value;
  - Solid-state porous hydrogen-releasing inorganic ceramics and functional granules are often mixed into "other chemical products/mineral materials not elsewhere specified" (HS 38249999 / HS 69091900); because the materials contain trace active metal components, they frequently encounter product-name challenges and customs clearance resistance in European, American, and ASEAN customs;
  - Household and commercial hydrogen inhalation devices can generally only be classified under "other physiotherapy and rehabilitation machinery" (HS 90191010) or ordinary small household appliance categories, facing mismatches in VAT export refund rates and frictions in cross-border technical compliance certification.
- **Medium- and long-term classification improvements and standards export (2026–2035)**: Some enterprises, together with the China Chamber of Commerce of Metals, Minerals & Chemicals Importers & Exporters and the China National Institute of Standardization, are pushing to submit proposals for additional tariff lines to the Tariff Department of the General Administration of Customs and the World Customs Organization (WCO), hoping to add dedicated sub-codes for "hydrogen-rich packaged drinking water," "solid-state hydrogen-releasing composite materials for biomedical health use," and "micro-bubble hydrogen dissolution devices and hydrogen inhalation equipment" under the framework of the Harmonized Commodity Description and Coding System (HS Code) or within China Customs' 10-digit declaration codes. At the same time, building on the ISO 7383 series of international standards for fine bubble technology — which China has deeply led in revising and adopting — and

GB/T 46918.2-2025, China is actively taking the lead in promoting the construction of internationally mutually recognized testing criteria for hydrogen health products, reducing trade frictions through the dual pathways of standards export and dedicated tariff lines, and serving the compliant global expansion of China's hydrogen health supply chain.

CHAPTER 07 RECAP · Chapter Summary

Only two and a half of the four gates are open; if one remains closed, the entire chain locks itself

1. **Access is open, but extremely narrow.** There are only two Class III certificates, both held by Luomei, and both limited to acute exacerbations of COPD — the certificate opens "whether one can enter hospitals," not "whether one can claim to treat disease."
2. **Promotion is open, pricing is half-open, and payment is not open.** Shandong has incorporated hydrogen-oxygen inhalation into provincial appropriate health technologies and extended it down to village clinics; pricing relies on independent pricing under code 120300003; but the word "hydrogen" appears nowhere in the full text of the medical insurance payment catalog.
3. **Standards have set a ruler, not a threshold.** GB/T 46918.2-2025 only specifies "how to measure," not "how much qualifies as compliant"; association standards provide application specifications but remain voluntary.

The four gates: status, institutional basis, and corporate responses

Table 7-5

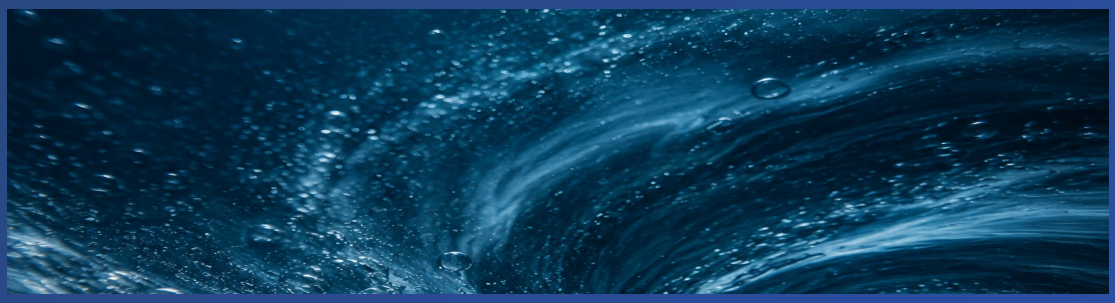
Gate	Status	Factual Basis	Corporate Countermeasures
Market Access	Open (Extremely Narrow)	Only Lumi holds two Class III certificates, limited to COPD acute exacerbation	Not pursuing own certification; entering via consumables and supporting products
Promotion	Open	Included in Shandong Provincial Suitable Health Technologies, extended to village clinics and community health service stations	Pursuing intra-hospital project and local think-tank pathways
Fee / Charging	Partially Open	Code 120300003, public hospitals autonomous pricing	Striving for project implementation, price fluctuates with local policies
Payment / Reimbursement	Not Open	The full text of the medical insurance payment directory contains no 'hydrogen' term	Can only be sold as self-pay consumables; unit price must drop to level acceptable for self-pay decisions

Six Inflection Points in Institutional Evolution: Which Year Changed the Corporate Feasible Set

Table 7-6

Time Point	Institutional Action	Direct Consequences for Enterprises
2020	Lumi obtains Class III certificate (limited to COPD acute exacerbation)	Device layer sees sole compliant entry point; other enterprises lose 'certificate' narrative
2024	SAMR special enforcement on elderly-related unfair competition; CCTV 'Economic Investigation' exposure	Seminar-sales script-driven revenue physically compressed; efficacy-anchored pricing collapses

Time Point	Institutional Action	Direct Consequences for Enterprises
2025	GB/T 46918.2-2025 Recommended National Standard Released	Have a ruler for 'how to test,' but still no threshold for 'what counts as qualified'
2025	Shandong includes hydrogen-oxygen inhalation in provincial suitable health technologies and extends to grassroots level	Promotion gate opens, but charging and payment remain mismatched
2026	Group standard provides application specifications (voluntary adoption)	Compliant claims have a basis, but are not mandatory and do not constitute market access
2026	Code 120300003 supports public hospital autonomous pricing	Half-Open Fee Structure: Eligible for Project Approval and Reimbursement, Yet Excluded from Basic Medical Insurance Payment



CHAPTER 08

Chapter 8 Market Sizing, Strategic Opportunities, and Future Outlook

Two sizing bases are presented side by side and cannot be divided by each other, and consumables remain the only sustainable model.

Chapter Highlights · Market Sizing and Future Outlook

1. **Two Parallel Bases, Not Interconvertible** The segment-level empirical basis (hydrogen-rich water dispensers at RMB 4.23 billion / +18.7%) and the host-industry penetration projection basis (home appliances, with a denominator of RMB 1,169.5 billion) each serve distinct purposes, and cannot be added together or divided by each other.
2. **Five Major Trends** Lightweight product form factors, consumables-based business models, rigorous claims, ecosystem-oriented scenarios, and globalized supply-chain expansion.
3. **Three Action Principles** ① Restructure cash flow around consumables; ② Replace rhetoric-based endorsement with compliance evidence; ③ Embed into others' channels from an upstream materials position rather than building terminals independently.
4. **The Most Certain Conclusion** Until the payment side opens up, any model reliant on high unit prices and therapeutic claims is not sustainable. This is the conclusion history has delivered, and one validated by 2024 regulatory enforcement.

8.1 Market Sizing via the Host-Industry Penetration Model

In professional industry-consulting methodology, since hydrogen health does not constitute an independent statistical category in the national economy, the only viable path to scientifically sizing its market is to adopt the **"Host Industry Penetration Model."**

By treating hydrogen health technologies and products as an "incremental enabling factor" embedded within large, mature host industries in the broader health sector, layered sizing is conducted:

Table 8-1

Core Host Parent Industries	Host Industry Aggregate Size (Official Authoritative Data Sources)	Hydrogen Health Technology Entry Format	2026E Penetration Rate and Reachable Market Size (TAM)	2030E Projected Penetration Headroom (SAM)
Home Appliances and Household Water Purification Equipment	**RMB 1,169.5 billion** (National Bureau of Statistics, 2025 retail sales of home appliances above designated size)	Hydrogen-rich water purifiers, post-stage hydrogen-rich filter cartridges, smart portable hydrogen water bottles, mineralized water cups	**Penetration rate 1.2% ≈ RMB 14 billion**	Penetration rate 3.5% ≈ **RMB 40 billion**
Commercial Direct Drinking and Scenario-Based Water Bars	**Several-hundred-billion-level commercial office direct drinking and tea-brewing water market**	Commercial high-throughput hydrogen-rich water machines, tea-room brewing machines, community water stations, composite micro-porous ceramic filter cartridges	**Penetration rate 0.8% ≈ RMB 2.5 billion**	Penetration rate 2.5% ≈ **RMB 8 billion**
Cosmetics and Daily-Chemical Beauty Industry	**RMB 465.3 billion** (National Bureau of Statistics, retail sales above designated size; over RMB 1.1 trillion across all channels)	Hydrogen-rich eye patches, anti-aging hydrogen masks, cold-processed hydrogen soap, hydrogen-rich sprays	**Penetration rate 1.5% ≈ RMB 7 billion**	Penetration rate 4.0% ≈ **RMB 20 billion**
Modern Traditional Chinese Medicine and Physical Therapy Patches	**Approximately RMB 250 billion** (TCM external patches and physical therapy consumables market)	Hydrogen-rich herbal hot-compress patches, Shenque acupoint patches, hydrogen mud moxibustion, hydrogen-rich TCM foot bath tablets (solid-state hydrogen release for enhanced efficacy)	**Penetration rate 1.0% ≈ RMB 2.5 billion**	Penetration rate 3.0% ≈ **RMB 7.5 billion**
Institutional Elderly Care and Senior Living	**40,000 registered elderly care institutions / 7.99 million beds** (Ministry of Civil Affairs Statistical Bulletin)	Rehabilitation hydrogen-rich water immersion bath systems, hydrogen-rich thermal moxibustion patches, and localized antioxidant care for pressure ulcers	**Coverage rate 5.0% ≈ RMB 2.5 billion**	Coverage rate 20.0% ≈ **RMB 10.0 billion**

Core Host Parent Industries	Host Industry Aggregate Size (Official Authoritative Data Sources)	Hydrogen Health Technology Entry Format	2026E Penetration Rate and Reachable Market Size (TAM)	2030E Projected Penetration Headroom (SAM)
Specialty Modern Agriculture and Ecological Farming	Large-scale agriculture, forestry, animal husbandry, and fishery base (trillion-level irrigation and seed industry denominator)	Silicon-based hydrogen-rich micro-porous fertilizers, hydrogen-rich fine-bubble seed soaking and germination, fruit and vegetable preservation, and aquatic and livestock activation	**Exploratory early stage ≈ RMB 1.5 billion**	Industrialization and widespread adoption ≈ **RMB 8.0 billion**
Cross-Border Trade and Overseas Exports	China's aggregate annual export base of several billion USD in healthy water appliances and personal care products	OEM/ODM solid-state hydrogen FMCG consumables, portable water tumblers, and micro-porous ceramic ball raw materials for overseas markets	**Export volume ≈ RMB 3.0 billion**	Export volume ≈ **RMB 12.0 billion**
Total Potential Addressable Market	—	—	**Currently approximately RMB 33.0 billion**	**Projected to reach RMB 105.5 billion by 2030**



Figure 8-1 Control panel, silver machine column, and Japanese-language 'Nano-bubble Hydrogen Generator (ナノバブル水素生成器)' housing displayed on a white cabinet

Image Source: On-site at the 2026HST 10th Guangzhou International Hydrogen Technology Industry Expo (May 2026, photographed by the report research team)

8.2 Five Key Trends in China's Hydrogen Health Industry, 2026–2030

Building on current technological breakthroughs and the regulatory pivot, the consulting team presents five strategic assessments of the evolution of China's hydrogen health industry over the next five years:

Trend 1: Lightweight Formats and FMCG Transition

Products will accelerate their departure from the “bulky instrument” paradigm and shift comprehensively toward “anytime, anywhere, battery-free, portable” daily FMCG formats. Within the next five years, FMCG categories represented by solid-state hydrogen effervescent tablets, pressed functional tablets, portable mineralized hydrogen water tumblers, and antioxidant eye patches will comprehensively surpass traditional large-scale electrolysis equipment in sales volume, becoming the industry’s most mainstream product carrier.

Trend 2: Recurring-Purchase and Consumable-Based Business Models

The era of “one-time hardware buyout” is formally ending. “Low-threshold hardware customer acquisition + periodic high-frequency consumable reorders” will become the industry’s most profitable commercial flywheel. Similar to the capsule coffee machine and razor-and-blade models, solid-state filter cartridges and disposable patches will contribute more than 70% of enterprises’ long-term gross profit, fundamentally resolving the operational crisis of customer acquisition costs exceeding LTV.

Trend 3: Seriousness and Decoupling of Promotional Messaging

The industry will resolutely distance itself from itinerant-medicine-style pseudoscience claiming “miracle cures for all diseases” and firmly pivot toward a serious scientific positioning of “baseline antioxidant stress response, adjunct anti-fatigue, daily gentle anti-inflammatory support, and skin health micro-ecological maintenance.” Enterprises will proactively and completely decouple “disease treatment (a medical act)” from “daily sub-health conditioning (a lifestyle behavior)” in their marketing, building a robust compliance firewall.

Trend 4: Cross-Sector Integration and Scenario Ecosystem Development

The “hydrogen molecule” will no longer operate in isolation; rather, it will deeply integrate into major traditional high-growth tracks as an efficacy-enhancing catalyst:

- **“Hydrogen + Traditional Chinese Medicine”**: Solid-state hydrogen compounded with herbal extracts, leveraging hydrogen’s high permeability to multiply botanical absorption rates;
- **“Hydrogen + Light Therapy”**: Combined anti-aging therapies of “red light irradiation + localized hydrogen release” in medical aesthetics and skin repair centers;
- **“Hydrogen + Water Purification”**: Traditional household water purifiers comprehensively upgraded from simply “drinking purified water” to “drinking hydrogen-rich mineralized living water.”

Trend 5: Globalization of Chinese Technology Solutions and Supply Chain Exports

China’s comprehensive cost advantages in metal hydride synthesis, high-quality micro-porous ceramic sintering processes, and FMCG supply chains will propel China from a “product OEM” to a “standards and core materials enabler” for the global hydrogen health industry. Overseas markets such as Europe, North America, Japan, and South Korea—which possess high payment capacity but lack domestic large-scale manufacturing capabilities—will become the golden blue ocean for the next round of expansion by Chinese hydrogen health enterprises.

8.3 Corporate Strategic Action Guide: Three Rules for Survival and Breakthrough

Faced with the profound restructuring of the industry landscape, practitioners and new entrants in China's hydrogen health sector should adhere to three fundamental rules for survival and breakthrough:

1. **Baseline Rule: Respect the Compliance Red Line and Resolutely Sever the Legacy of Seminar Marketing**
   No ordinary consumer product that has not received National Medical Products Administration (NMPA) approval shall feature any wording related to disease prevention or treatment on product packaging, online content, or offline retail outlets. Resolutely abandon the gray-zone marketing model that relies on closed-door gatherings and emotional manipulation, and fully embrace public-domain e-commerce, mainstream retail daily-chemical shelves, and compliant private-domain community operations.
2. **Core Rule: Cultivate the Materials Foundation and Secure Proprietary Core IP**
   Move beyond low-level hardware assembly and internal competition. Direct R&D resources toward core solid-state hydrogen storage and release material formulations, micro-porous sustained-release crystallization processes, and food-contact-grade safety metrics. Only by constructing a high-barrier portfolio of invention patents can a company secure an unassailable ecological position in the forthcoming industry standardization shakeout.
3. **Growth Rule: Embrace Platform Empowerment and Expand Through an Asset-Light Model**
   For the vast majority of end-brand companies that lack deep materials R&D foundations, there is no need to invest enormous R&D capital in reinventing the wheel. Proactively integrate mature empowerment modules offered by upstream material suppliers—direct raw-material supply, white-label OEM production, and scenario SOP deployment—to concentrate core energy on brand building and channel activation, achieving agile growth through an asset-light posture.

CHAPTER 08 RECAP · Chapter Summary

Before Payment Gates Open, the Only Certainty Is Consumabilization

1. **Two sizing calibers presented in parallel and not cross-convertible.** The segment-evidence approach yields hydrogen-rich water generators at approximately RMB 4.23 billion in 2025, +18.7% year-over-year; the host-penetration extrapolation approach uses household appliances and audio-visual equipment at RMB 1,169.5 billion as the denominator. The two serve different purposes and must not be added together or divided against each other.
2. **Five trends point to the same direction: lightweight, fast-cycle, compliant, cross-sector, and global.** Form-factor miniaturization, consumable-based business models, scientifically rigorous messaging, scenario-based ecosystem integration, and supply-chain globalization—all five collectively reduce reliance on single-unit hardware margins and elevate the weight of reorder revenue.
3. **Three action rules.** ① Rebuild cash flow around consumables; ② Replace verbal assurances with compliant clinical evidence; ③ Embed into others' channels through an upstream materials position rather than building proprietary terminals.

STRATEGIC OUTLOOK · 2026

The future of China's hydrogen health industry lies not in the frothy bubbles of deified concepts, but in a solid materials foundation, rigorous scientific evidence, and a consumer reorder ecosystem that genuinely integrates into everyday life.

With breakthroughs in solid-state hydrogen material technology and the comprehensive rollout of high-frequency lifestyle scenarios—Eat, Drink, Wash, Care, and Soak—China's hydrogen health industry is accelerating its leap from the early equipment era of asset-heavy infrastructure and weak reorder rates into a new epoch of trillion-RMB-scale mass-health consumer FMCG.

EPILOGUE · Conclusion

The industry's fifty-one-year history has proven only one thing:
Every genuine leap has come from an external condition being unlocked—not from being better at selling.

1975
A paper
A mechanism proposed

2007
A mechanism
Enters the international spotlight

2020
A certificate
Market access unlocked

2025
A ruler and a code
Standards and price items

2026
A group standard
The industry gains a common language

1975 was a paper, 2007 was a mechanism, 2020 was a certificate, 2025 was a ruler and a code, 2026 was a group standard. None of these milestones was self-declared by the industry; rather, the external world finally granted it a "position that can be recognized."

Conversely, every devastating setback has originated from the same direction—claims that overstep the boundary of evidence. The reason the August 2024 CCTV coverage became a watershed moment was not because regulation tightened, but because it dismantled, in one stroke, the information asymmetry upon which the "efficacy anchor" depended.

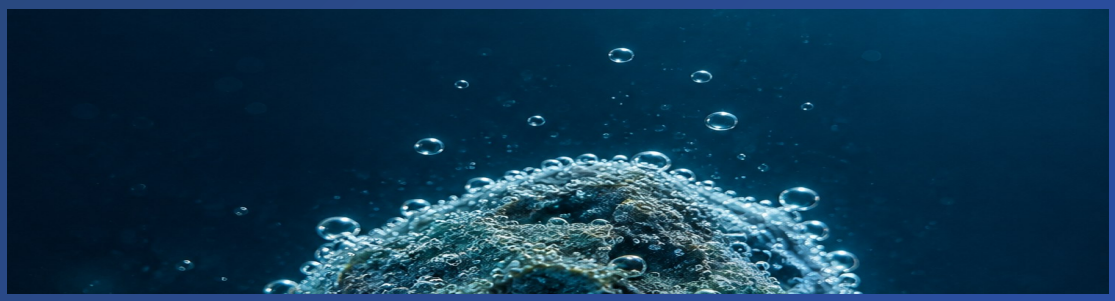
Placing these milestones together, the central thread this report discerns is: **Under conditions where the payment end has not yet opened, product forms whose unit price is willingly accepted by out-of-pocket consumers without crossing the red line of therapeutic claims are more likely to fall on the consumables and daily-chemical side; and competition on that side ultimately returns to two verifiable assets—material controllability and evidence presentability.** This is a conditional judgment: once the payment end opens, or if regulators adjust the claim framework, this central thread must be

recalculated. It does not name who will survive, nor does it predict where the industry is heading. It describes only one thing under existing constraints—the barrier on the consumables side is not set at equipment or channels, but at materials and evidence.

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Publishing Institutions: Muqi Solid-State Hydrogen New Materials R&D Center · Hydrogen Health Industry Strategic Research Center



Appendix A Quick-Reference Data Tables

If the reader remembers only seven numbers, these are the seven that carry the argument.

The table below summarizes the core figures and strategic implications cited throughout this report. Each figure's source type is annotated item by item in Appendix B and remains classified into three categories: **Primary official documents** (statistical bulletins, national standard texts, reproducible regulatory database sources), **Corporate claims and industry disclosures** (company materials, institutional reports, industry republications), and **This report's estimates** (extrapolations and models, which must carry stated assumptions and denominators).

Table 9-1 Quick-Reference Table of Core Operating Data for China's Hydrogen Health Industry

Dimension	Core Metric	Measured Value / Official Fact	Strategic Implication
Academic Foundation	Total Global Hydrogen Medicine Publications	**5,120 papers** (2007–2026)	28% increase over nineteen years; slow-growth field, not an explosion
	Chinese scholars' contribution volume and share	**1,143 publications (22.3%)** cumulative	Phase IV share 14.0%→32.9%, with share shifting eastward
	WHO ICTRP registered active clinical trials in China	**39 trials** (inhalation 24 / drinking water 5 / hydrogen-containing liquid 3 / unspecified 7)	Evidence is densely concentrated in the inhalation route
	Keyword contamination rate	Of 53 hits, 14 were non-hydrogen (**26.4%**)	Without stated screening and exclusion rules, the denominator is contaminated
Regulatory access	Class III Certificate	**2 certificates, both held by Luomei** (20203080066 / 20233081929)	Limited to acute exacerbation of COPD, not general practice
	Device innovation channel	Entered the national Class III innovation green channel in March 2017	A precondition for obtaining certification in 2020
	Medical service price code	Lu Yi Bao Fa [2025] No. 15 (**120300003**)	Code exists with independent pricing; no national pricing
	National recommended standard	**GB/T 46918.2-2025** (modified adoption of ISO 7383-2:2024)	Establishes a yardstick, not a threshold
Standards and promotion	Association standard	“General Specification for Clinical Application of Hydrogen-Oxygen Mixed Gas Inhalation Therapy” (issued June 13, 2026)	Led by the National Center for Respiratory Medicine, Peking Union Medical College Hospital, and Luomei; co-authored by more than 20 tertiary hospitals
	Provincial-level appropriate health technology	Shandong: hydrogen-oxygen inhalation included in the promotion catalog, extended down to village clinics	The promotion gate has opened
	Reimbursement catalog	The civil affairs and BMI reimbursement catalogs **contain no mention of “hydrogen”**	The reimbursement gate remains closed; products must be purchased out of pocket

Dimension	Core Metric	Measured Value / Official Fact	Strategic Implication
Market and pricing	Hydrogen-rich water dispenser market (segment-level empirical data)	**RMB 4.23 billion** (2025, +18.7%); 2026E to exceed RMB 5 billion	Single-category hardware scope, not total industry size
	Global Household Hydrogen-Rich Water Dispensers	Approximately **USD 598 million** in 2025; USD 838 million by 2032E	China accounts for roughly 30% (alternative institutional estimate)
	Three Price Anchors	¥0.67 per tablet · ¥548 per unit · ¥17,999 per machine	A price spread of nearly 30,000x = three parallel markets
	CCTV verification of retail prices	Hydrogen-rich water dispenser at **RMB 17,999**	Exposed in August 2024; the inflection point at which the therapeutic-efficacy anchor collapsed
Corporate Landscape	Verifiable active enterprises	**Approximately 180** (concentrated in Guangdong, Shandong, Zhejiang, and Shanghai)	99% hold no medical device certificate
	Enterprises holding a Class III certificate	**1** (Huimei)	De facto monopoly at the market-access layer
	Chambers of commerce / academic organizations	The National Hydrogen Biomedicine Conference has been held **12 times**	The venue where academic credibility is generated and converted
Host Sectors	Home appliances and audio-visual equipment above designated size	**RMB 1,169.5 billion** (2025)	The home-appliance parent market for hydrogen-rich water dispensers and filter cartridges
	Cosmetics and personal care above designated size	**RMB 465.3 billion** (over RMB 1.1 trillion across all channels)	The high-premium host market for hydrogen eye patches and hydrogen facial masks
	Elderly care institutions and service facilities	**406,000** (40,000 registered, 7.99 million beds)	The parent market for health-and-wellness and silver-care scenarios
Clinical Evidence	RCT of hydrogen-rich water baths for psoriasis	PASI 75 response **24.4% vs 2.9%** (Pc=0.022)	Huashan Hospital; Scientific Reports, 2018
	RCT of hydrogen-rich water for Parkinson's disease	UPDRS **-5.7 vs +4.1** (P<0.05)	48 weeks; Movement Disorders, 2013



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Appendix B Information Sources and Methodological Notes

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Every retrieval is reproducible, but the two sizing bases used throughout are not meant to be divided against each other.

This report cites a source for every key figure it references. The table below summarizes the principal information sources by category; wherever a figure is an inference rather than a direct data point, it is set out separately in the "Nature" column, so that estimation is never presented as measurement.

B.1 Official and Regulatory Sources

Table 10-1

Information Source	Content Cited in This Report	Date	Nature
National Medical Products Administration (NMPA) registration database	Guo Xie Zhu Zhun 20203080066 / 20233081929; both registrants are Shanghai Huimei Medical Technology Co., Ltd. (the same entity holding two independent certificates)	2020-02-02 / 2023-12-08	Public research: NMPA approval delivery notices + corporate website + multiple media reports (the NMPA registration database is a dynamic page; this report did not access the database pages directly, and "only these two certificates exist" is a judgment)
National Standards Full-Text Public Disclosure System	GB/T 46918.2-2025 *Microbubble technology — Measurement method for hydrogen content* (modified adoption of ISO 7383-2:2024)	2025	Standard text
Shandong Provincial Healthcare Security Bureau	Lu Yi Bao Fa [2025] No. 15: hydrogen-oxygen inhalation is merged into the nitric oxide inhalation item, Code 120300003, with public hospitals setting prices autonomously	2025	Original policy text
Shandong Provincial Health Commission	Hydrogen-oxygen inhalation is included in the provincial Appropriate Health Technology Promotion Catalogue and extended down to village clinics and community health service stations	2025	Original policy text
National Bureau of Statistics	2025 retail sales of household appliances and audio-visual equipment above designated size: RMB 1,169.5 billion; cosmetics: RMB 465.3 billion	Early 2026	Statistical communiqué
Ministry of Civil Affairs, *National Bulletin on the Development of Aging Undertakings*	40.6 million elderly care institutions and facilities nationwide, 40,000 registered institutions, and 7.99 million beds	2025	Statistical communiqué
WHO ICTRP (trialsearch.who.int)	Title=hydrogen + Country=China returned 53 hits; after manual screening, 39 valid records	Retrieved 2026-10-18	Reproducible search

B.2 Academic Literature Sources

Table 10-2

Literature	Conclusion Cited in This Report	Marker
Ohsawa et al., *Nature Medicine*	2% hydrogen inhalation ameliorates cerebral ischemia in animals, establishing the "selective antioxidant" mechanism and regarded as the origin of modern hydrogen medicine	2007
Sun Xuejun et al. (Second Military Medical University)	Neuroprotective Effects of Hydrogen-Rich Saline on Cerebral Ischemia-Reperfusion Injury — China's First Hydrogen Medicine Study	2008
Kajiyama et al., *Nutrition Research*	Eight weeks of hydrogen-rich water intake in patients with type 2 diabetes and IGT significantly reduced ox-LDL and urinary 8-isoprostane levels	PMID 19083400 (2008)
Yoritaka et al., *Movement Disorders*	Forty-eight weeks of hydrogen water intake in Parkinson's disease patients: UPDRS -5.7 vs. control +4.1 (P<0.05)	PMID 23400965 (2013)
Zhu Q et al., *Scientific Reports*	Hydrogen-rich water bath for psoriasis: PASI 75 response rate 24.4% vs. 2.9% (Pc=0.022)	PMID 29795283 (2018)
He Qianjun research team, *Nature Communications*	Nano-photocatalytic in situ hydrogen generation promotes diabetic wound healing	2022, 13:5611
PubMed E-utilities re-run	Global cumulative total of 5,120 papers; China 1,143 (22.3%); four periods 997/1,013/1,155/1,278 and 140/250/342/420	Retrieved 2026-10-18

B.3 Corporate and Industry Public Sources

Table 10-3

Information Source	Content Cited in This Report	Time Point
Ascleway Medical official website (ascleway.org /.com)	Project initiated 2011; founded 2013-08; entered national innovation green channel and obtained CE Class IIb in 2017-03; first certificate 2020-02; second certificate 2023	2025—2026
China Daily	Ascleway founding date (August 2013) and 2020 Class III certificate approval	2025-12-26
China.com(digi.china.com)	*General Specifications for Clinical Application of Hydrogen-Oxygen Mixed Gas Inhalation Therapy* co-authored by more than 20 tertiary Grade A hospitals; led by the National Center for Respiratory Medicine, jointly drafted under the leadership of Peking Union Medical College Hospital and Ascleway	2026-06-16/17

Information Source	Content Cited in This Report	Time Point
Phoenix Net Hainan	The hydrogen-oxygen medicine group standard was officially announced, delineating the industry boundary between hydrogen-oxygen machines and hydrogen generators	2026-06
Chinese Research Hospital Association	The group standard was proposed by the Respiratory Medicine Professional Committee	2026
Chinese Association of Geriatric Research(caogr.org)	The 12th Conference on Hydrogen Biomedicine was held 2026-07-03–04 in Harbin; branch committee re-election	2026-07
Hydrogen Expo official website (qkjcy.com / qbhexpo.com)	7th Conference (2021-11, online); 10th Conference (2024-11, Tai'an)	2021 / 2024
ScienceNet	Sun Xuejun interview: first chairman of the Chinese Society for Hydrogen Molecular Biomedicine; by 2014 had already published dozens of papers with collaborating institutions	2014-08-29
Video China	Sun Xuejun: the team began research in September 2007, among the earliest in China and globally	2023-04-30
Sohu / Zhihu	*Hydrogen in Cancer Control: Theory and Practice* released 2019-06-01, endorsed by Academician Zhong Nanshan and multiple academicians; Xu Kecheng himself positioned it as "rehabilitation, not treatment"	2019-06
Baidu Baike (corporate entry)	Shandong Muqi Health Technology Co., Ltd. was founded on 2014-11-24 and registered in the Advanced Ceramics Industry Innovation Park, Zibo High-tech Zone	—
China.com Shandong / Phoenix News Shandong / China Hydrogen Industry Network	Muqi: 2017 hydrogen water ceramics and multi-element alloy antimicrobial materials; 2019 recruitment of Huang Yong's team from the Technical Institute of Physics and Chemistry, Chinese Academy of Sciences; 2022-02 HGI Hydrogen Element establishes a full solid-state hydrogen industry chain	2022—2026
Jiemian News / Booyan Consulting	2025 China hydrogen-rich water dispenser market size RMB 4.23 billion, up +18.7% year on year; projected to exceed RMB 5 billion in 2026	2025—2026
QYResearch	2025 global household hydrogen-rich water dispenser sales USD 598 million, 2032E USD 838 million	2025
Tendata customs data	2023-10 to 2026-10: 155 shipments / 21 deduplicated buyers / 12 markets / $1.34M / 27.1 tonnes	2026-10
Chinese Sleep Research Society, *2024 White Paper on Sleep Health of Chinese Residents*	Sleep disorder prevalence among adults 38.2%	2024

B.4 Regulatory Event Sources

Table 10-4

Event	Media and Content	Date
Financial Investigation feature	CCTV: Hydrogen-oxygen experience salons claim that "a single breath of hydrogen can fight tumors and aging"; hydrogen-rich water dispensers priced at RMB 17,999	2024-08-26
Economic Information Broadcast feature	CCTV: Beware of "hydrogen inhalation" health scams—hype far outweighs actual efficacy, as upstream hydrogen-oxygen machine manufacturers reap excessive profits	2024-08-25
Local enforcement cases	Zhejiang Lishui Municipal Administration for Market Regulation penalized Jiankangfang for exaggerated and fabricated therapeutic claims regarding hydrogen inhalation and hydrogen-rich water consumption, which misled elderly consumers into purchasing	2022-03-31
Science communication and myth-busting	Science China: analysis of whether drinking hydrogen water, inhaling hydrogen, and hydrogen bathing can "cure all diseases"; current state of industry group standards	2024-10-08

B.5 Methodological Discipline (Required Reading)

FOUR INVIOLABLE METHODOLOGICAL RED LINES

1. **Publication counts cannot be divided by one another or used as mutual denominators.** Between PubMed publication counts and ICTRP registration counts lie three attrition gaps—"conducted but not published," "published but not registered," and "registered but not conducted"—so any "conversion rate" calculation is fabricated.
   This report's approach: present in parallel only; never divide.
2. **RMB 4.23 billion ≠ total industry size.** It is the single-category hardware sales figure for "hydrogen-rich water dispensers." A separate claim circulating in the market states that "hydrogen-rich water dispensers exceeded RMB 8 billion in 2025"; this originates from manufacturer-recommendation advertorials on commercial websites, with no institutional attribution or statistical methodology, and is **neither adopted nor presented in parallel by this report**.
3. **Hydrogen energy ≠ hydrogen health.** The "over 36.50 million tonnes produced and consumed in 2024" cited in the National Energy Administration's *China Hydrogen Energy Development Report* reflects an energy-sector methodology and has **no convertible relationship whatsoever** with the health consumer market discussed in this report; it is cited solely as macro context and must never be conflated.
4. **The comparison between China's 180 companies and listed Korean companies is confined to "methodological comparability."** The former disclose no data; the latter do. A direct numerical comparison compares two disclosure regimes, not two industries.

ON THE NATURE OF THIS REPORT

This report was prepared by an independent researcher to inform industry research and cross-border cooperation discussions and **does not constitute any medical advice, diagnostic basis, or investment recommendation**. All clinical data cited herein are drawn from publicly available original literature; specific indications and methods of use must follow the judgment of licensed physicians and applicable regulatory requirements. Where data are marked with or, readers should retain the level designation when citing.

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REPRODUCIBILITY · Reproducibility and Version Record

How the data in this report were obtained, and how to verify them

This document is the 2026-10 final version; internal discussion drafts are not for external citation. Upstream data updates are logged as revision points in this appendix only.

1. **Online project space.** The search strings, figure-source ledger, and revision history for this report are synchronized on the official E-Muqi Intelligence portal online reading site **https://www.emuqi.com/h2report/** (multi-language interactive reading and version tracking); the PDF is a point-in-time snapshot of this report, while the online version is continuously updated.
2. **Search reproducibility.** PubMed E-utilities and WHO ICTRP (Title=hydrogen + Country=China) were both searched on 2026-10-18; search strings, hit counts, and screening procedures are set out and reproducible.
3. **Price collection and policy texts are time-stamped.** Price sampling was conducted in early October 2026; policy and standards texts are marked with their publication dates. Prices are volatile and should be re-verified if older than three months.
4. **Projection models are flagged separately.** The assumptions and denominators for TAM/SAM/SOM and host-penetration projections are explicitly disclosed in Chapter 8 and are always labeled — never summed together.