

Key Factors Required for a Renewable Hydrogen Economy

- Achieving Scale and a Roadmap to Value Chain Profitability
- A Level Playing Field relative to other forms of Alternative Energy
- Global Collaboration between Public and Private Sectors
- A Predictable and Sustained Commitment from Governments

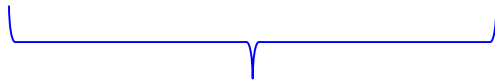
2050 Hydrogen Vision



Source: Hydrogen Council

Japan's Responsibility for Energy Transition

- **Energy trilemma:**
 - ✓ **E**nergy Security
 - ✓ **E**nvironment (Sustainability)
 - ✓ **E**conomic Affordability (Cost)



3 “E” + Safety



METI Headquarters	1-3-1 Kasumigaseki, Chiyoda-ku, Tokyo 100-8901, Japan
Minister Responsible	• Hiroshige Sekō, Minister of Economy, Trade and Industry

- Established May 5, 1930
- Consolidated Net Sales: ¥ 670.7B / \$6.7B (FY 2017)
- Employees: 9,453 (3/2018)
- CEO: Akiji Makino



ENERGY
47%



INDUSTRIAL GASES
& MACHINERY
27%



MATERIALS
20%



AGRI-BIO FOODS
& OTHER
6%

Iwatani's Commitment to Hydrogen in Japan

- Leading Market Position
- Vertically Integrated Supply Chain
- Significant Focus on Safety
- Extensive Investment in R&D



Manufacturing Plants



Distribution Equipment



27 Fueling Stations

Iwatani

Entering the Light Duty Hydrogen Fueling Station Market in California



Future Opportunities



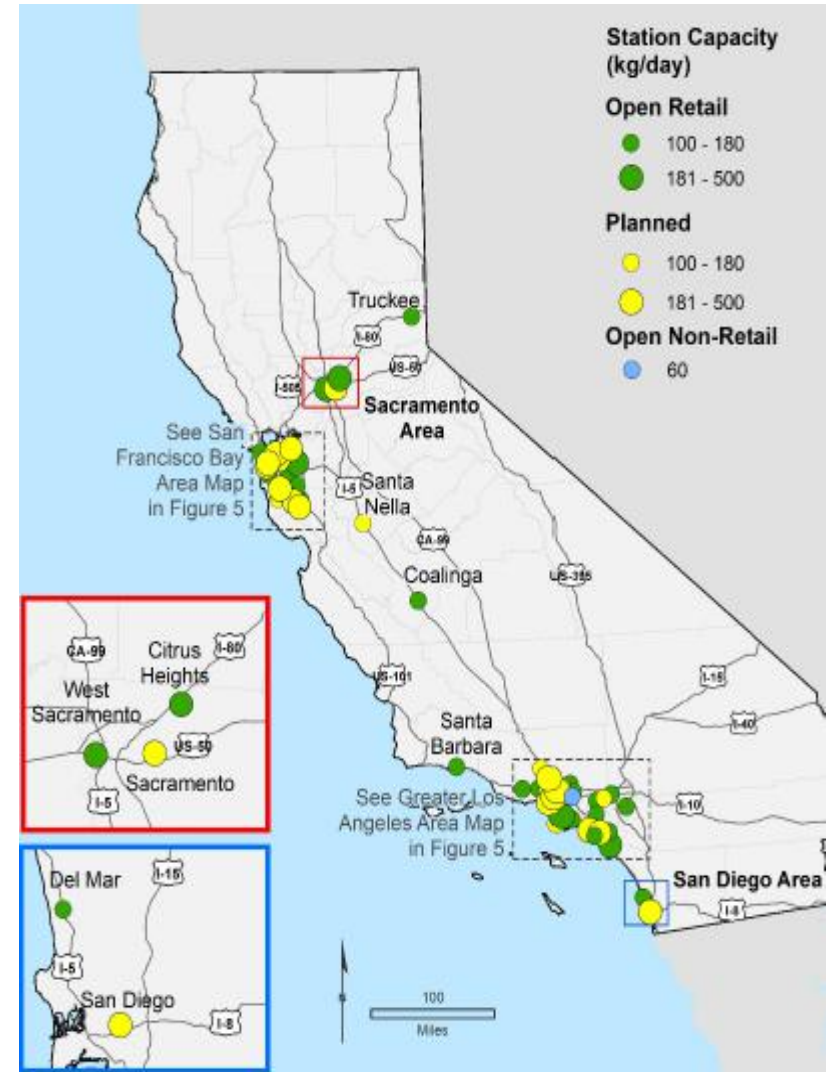
Renewable Energy Production



Renewable Hydrogen Production

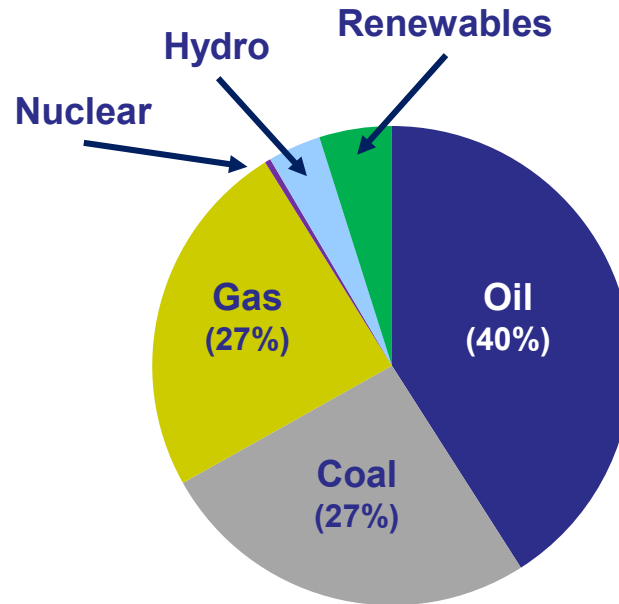


Medium & Heavy Duty ZEV Fueling



Source : California Energy Commission

Japan's Sources of Energy: 2016



- ✓ **E**nergy Security → Mitigates dependence on specific countries
- ✓ **E**nvironment (Sustainability) → De-carbonized energy source
- ✓ **E**conomic Affordability (Cost) → High priority: Access to low-cost feedstock

Japan's "Basic Hydrogen Strategy"



Prime Minister Abe's H2 Initiatives

- Establish World's 1st National H2 Strategy
- 2050 Vision: Position H2 as a new energy option
- Affordable H2
 - \$3/kg by 2020
 - \$2/kg by 2050

Essential Enablers

- Achieve Scale across the entire Supply Chain
- Leverage untapped resources
- Encourage / Incentivize Mass Adoption
 - Mobility
 - Power Generation

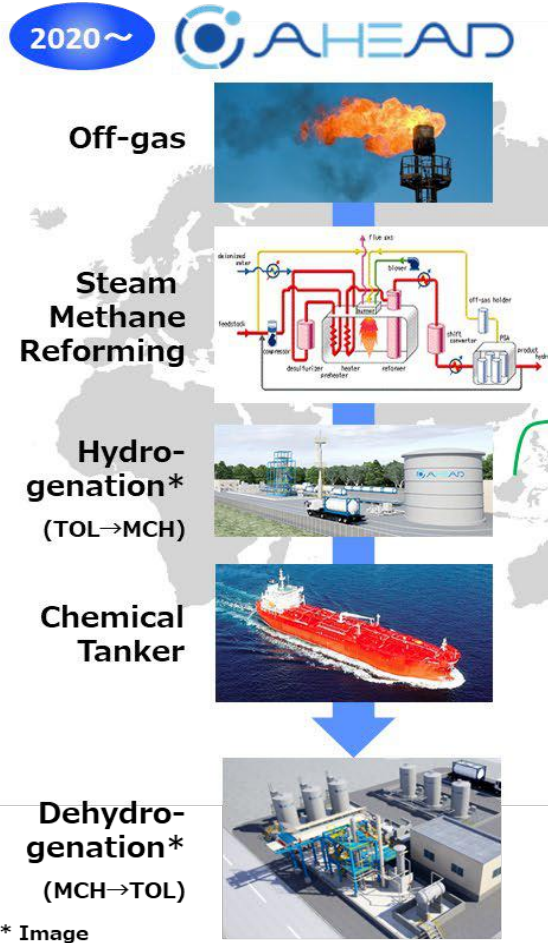
Tokyo Statement Agenda Outcomes

- Harmonization of Regulation, Codes and Standards
- International Joint R&D emphasizing Safety
- Study and evaluate Hydrogen's Potential
- Communication, Education and Outreach

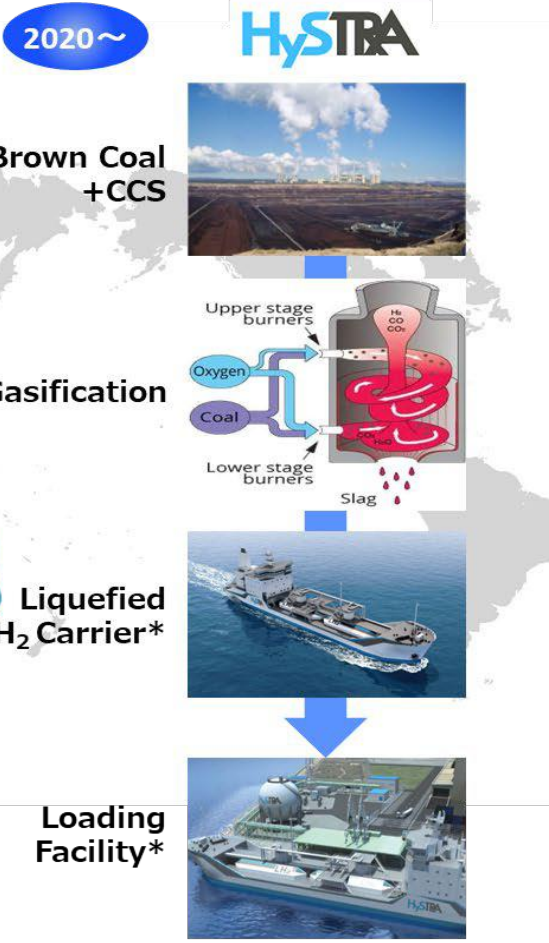
Examples of Some of the Global De-carbonized Hydrogen Projects

International H₂ Supply Chain

Japan-Brunai Pilot Project



Japan-Australia Pilot Project

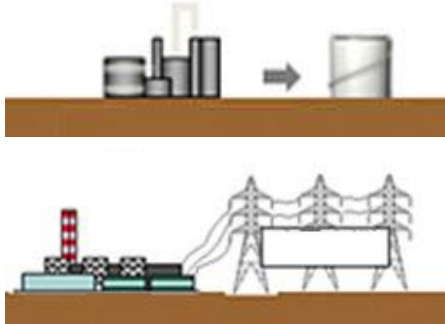


Power-to-gas

Fukushima Renewable H₂ Project



Today's High-level Hydrogen Supply Chain for Fueling Stations



H2 Production Processes

- Reforming (SMR)
- Gasification
- Electrolysis

Feedstock Options

- Natural Gas
- Chemical
- Biomass
- Coal (w/ sequestration)
- Water
- Nuclear
- Residuals
- Others



H2 Conversion/Handling

- Liquefaction
- Compression



H2 Distribution

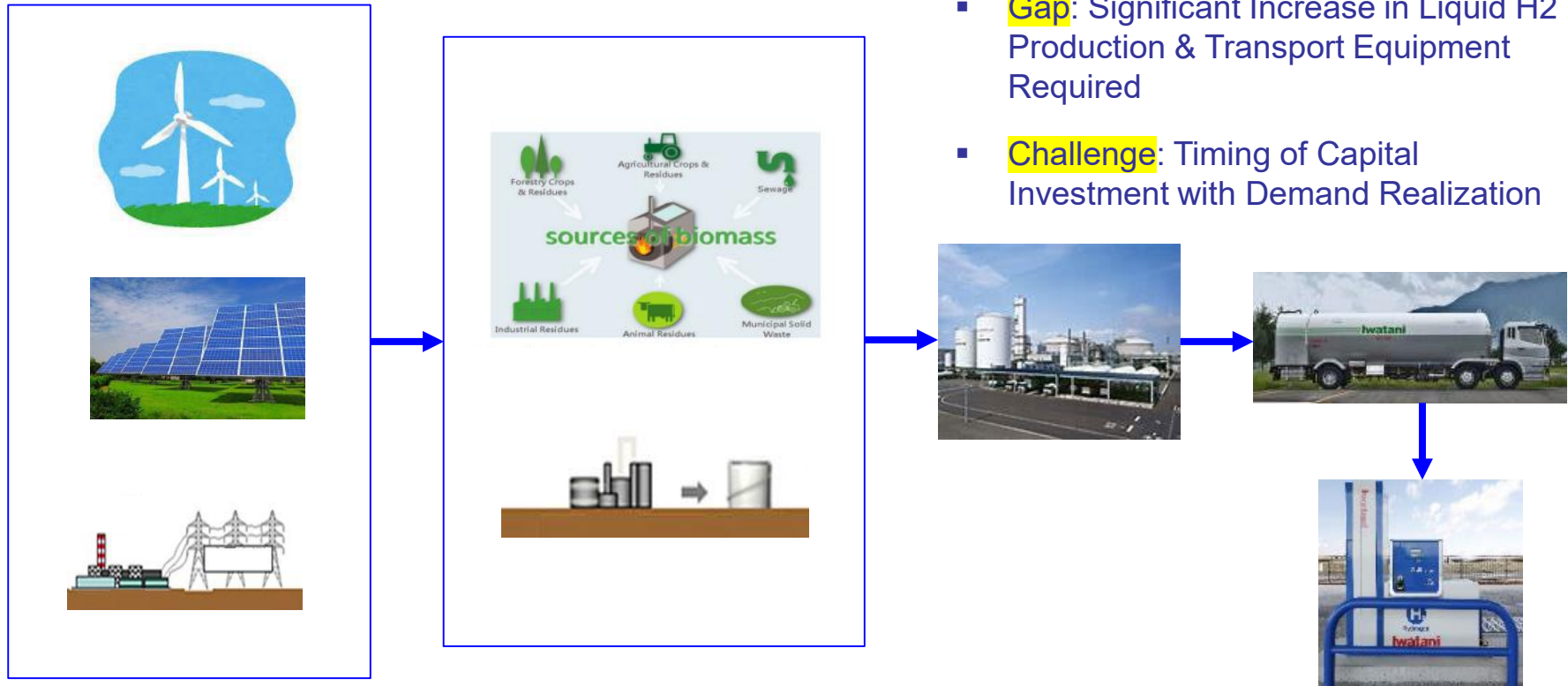
- Liquid Trailer
- Tube Trailer (Gas)



H2 Dispensing

- Vaporized Liquid
- Compressed Gas

Anticipated Future State Hydrogen Supply Chain: Gaps / Challenges



- **Gap:** Increased Reliance on Renewable Power Generation
- **Challenge:** Price of Power / Timing of Investments

- **Gap:** Significant % H2 Feedstock Required to be Derived from Renewable Sources / Low Carbon Intensity Pathways
- **Challenge:** Significant Cost Reduction Required; Definitions / Incentive Programs & Capital

- **Gap:** Significant Increase in Liquid H2 Production & Transport Equipment Required
- **Challenge:** Timing of Capital Investment with Demand Realization

- **Gap:** Cost Parity of H2 at Dispenser with Gasoline
- **Challenge:** Upstream H2 Capital Investment will likely require ROI / T&C's to compensate for Downstream Risks

Iwatani's Vision: To Create a Global Scale CO₂-Free H₂ Supply Chain

Renewable Energy & H₂ Production



Ocean Transport



Import & Distribute H₂ Throughout Japan



Solar, Wind, Hydro, Bio-Waste Recovery & Others

Electrolyzer & Other Renewable Hydrogen Sources

- Hydrogen FC Vehicles
- Turbines for Power Generation
- Back-up Power Generation
- Fuel Cell Powered Equipment



CA H2 Supply Chain Challenge: Scale Alone Might not be Enough

Renewable Power Generation & Grid kWh Cost

- \$/kWh Grid Price puts Electrolyzers at a disadvantage in many markets
- ❖ Scale projects have likelihood of proceeding where new Utility Islands can be created utilizing Hydro, Solar and Wind Power Generation (i.e.. Canada)

Shift to Renewable H2 Sources

- Visibility into timing of capacity additions, potential for grid integration, reliability enhancements, proximity and Gov't policy/commitment are key factors
- ❖ Regulatory Agency Commitment to Definitions of Renewable Pathways are essential to De-Risk Project Investments

Expanding Liquid H2 Supply

- World Class Plant: 30 TPD / \$125 MM+
- ❖ To achieve Long Term CA LD Goals could require 20+ New LH2 Plants, massive increases in storage capacity and Significant investment in new Distribution Equipment
- ❖ Building Standalone Merchant LH2 Plants are Speculative Investments and present Supply Agreements reflect this reality
- ❖ Unlike gasoline, there are no LH2 Racks today and H2 Costs are relatively less transparent

Achieving Cost Parity at the Pump for Drivers

- \$3.50/gasoline gallon / 27 MPG = \$0.13/Mile*
- Today \$14/Kg H2 / 66 MKg = \$0.21/Mile*
- Cost Parity would require roughly \$8/Kg H2*
- ❖ How long will Automobile OEM's subsidize fuel purchases?
- ❖ Positive NPV at LT Target H2 Cost at Dispenser requires subsidies
- ❖ Vertically Integrated Competitors will likely have a significant advantage

*Source: CEC & CARB Staff Report on AB8

Innovation is Driving Demand for H₂...But it is a Long Term Play

H₂ Mobility

H₂ Station Network

2013~

*113 Stations
by November 2018



H₂ Applications

2016~



FC Bus

X 100 in 2020



FC Truck Demo

H₂ Power Generation

H₂ Co-generation Demonstration Project



Hydrogen Gas
Turbine (1MW class)

2018~



Joint Venture for H₂ Infrastructure Development

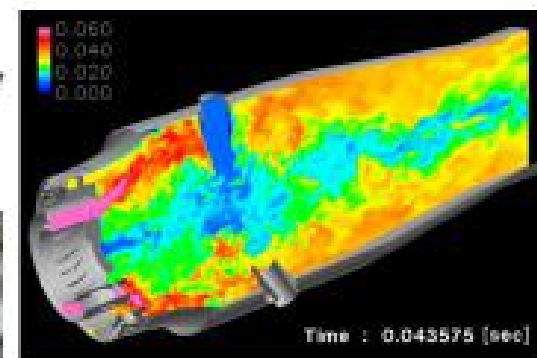
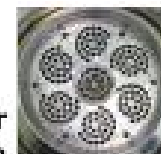
2018~



R&D of H₂ Burner Systems



For Power
Generation
<500MW



Burning Simulation
(H₂ + CH₄)

Iwatani

- Achieving Scale leads to a *Sustainable* Industry
 - Harmonization of Codes & Standards enables economies of scale via equipment procurement savings, station design and inter-operability across national boundaries
 - Promote Development of Light AND Heavy-Duty ZEV Infrastructure
 - Support Transportation Initiatives: Maritime, Bridges & Tunnel Crossings
 - Encourage All Forms of Renewable Hydrogen Production
- Create a Level Playing Field Across All Alternative Fuel Modes
- Support Programs that Encourage Collaboration between Public and Private Sectors (e.g. Japan & California Model)
- Predictable and Sustained Commitment Allows for Long-Term Investment, Planning and De-Risks Projects

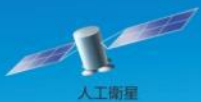
Many Challenges...but Japan and California are Two Bright Spots

- Significant Government Agency Support & Constructive Engagement and Financial Commitment
 - CEC, CARB, BAAQMD, SCAQMD, GO-Biz, DOT, DOE, NREL, SANDIA, Local Municipalities & Others
 - METI, New Energy and Industrial Technology Development Organization (NEDO) and Japan External Trade Organization (JETRO)
- High Private Industry Commitment and Investment
 - Automobile OEM's, Industrial Gas & Energy Company's, Capital Equipment Suppliers and Entrepreneurs
- Trade Organizations creating platforms for constructive collaboration and overcoming the chicken and egg dilemma
 - Hydrogen Council, JHyM, California Fuel Cell Partnership, CHBC & Others
- University Support and Talent Pipeline

Energy Transitions & Global Environment for Sustainable Growth

- June 15 & 16, 2019
- Karuizawa, Japan
- Anticipated Outcome:
 - Communique
 - Action Plan





人工衛星

Thank you



燃料電池船

太陽電池イカダ

液化水素航空機

LH₂ロケット

液化水素プラント

液化水素タンカー

風力発電

高温熱分解
水素製造

集合住宅向き
燃料電池コージェネレーション

水素トレーラー

燃料電池
コージェネレーション

水素エンジン
ヒートポンプ

燃料電池
フォークリフト

水素発電

水素自動車

工業用
コージェネレーション
発電システム

大型燃料電池

燃料電池バス

家庭用燃料電池
コージェネレーション

H₂-STATION

水素パイプライン

液化水素ローリー

燃料電池自動車

燃料電池
アシスト自転車

燃料電池搭載
移動式電源車

水素ステーション

燃料電池バイク

燃料電池自動車

燃料電池列車

水素ハイブリッド自動車

Iwatani

Copyright © Iwatani Corporation. All rights reserved.