Asia-Pacific Economic Cooperation

APEC Clean and Low-Carbon Hydrogen Policy Convention

Hydrogen Energy Technology Development in Chinese Taipei

Low Carbon Energy & Energy Storage Technology Division,
Green Energy and Environment Research Laboratories (GEL),
Industrial Technology Research Institute (ITRI),
Chinese Taipei

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Business Director

May 20, 2026

Outline

- Introduction to GEL, ITRI
- Strategic Energy Policy Context
- Roadmap & Market Demand
- Technical Progress & Pilot Case Studies
- Strategic Synthesis
- Conclusion Remarks

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Key Research Pillars in GEL

Renewable & Zero-Carbon Energy

- Solar PV
- Geothermal
- Wind Power
- Marine Energy
- **H_2/NH_3 Energy**
- Bioenergy
- e-fuels

Optimal Energy Efficiency

- EMS
- HVAC & Cooling
- Thermal & Heat Dissipation
- Building / Industrial Energy Efficiency

Energy & Environmental Policy

- Environmental Adaptation
- Energy Auditing
- Policy Think Tank
- Net-Zero Strategies
- Policy Promotion

Smart Grid & Power Electronics

- Smart Grid/Micro Grid
- Power Electronics
- Energy Storage
- VPP
- Explosion-proof Certification & Power Safety

Sustainable Environment

- CCUS
- Pollution Prevention & Remediation
- Resource Recycling
- Chemical Disaster Response
- Nuclear Waste Treatment

VPP: Virtual Power Plant; CCUS: Carbon Capture, Utilization & Storage; EMS: Energy Management System; HVAC: Heating, Ventilation, and Air Conditioning

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GEL's R&D Infrastructure & Site Presence

Hsinchu

- Headquarters
- Planning & business development

Taipei

- Energy policy support
- RE project offices

Shalun, Tainan

- Hydrogen energy demonstrations
- Mass production, testing, verification

Nantou

- Integrated technologies for agriculture and industry

Total Employees

832

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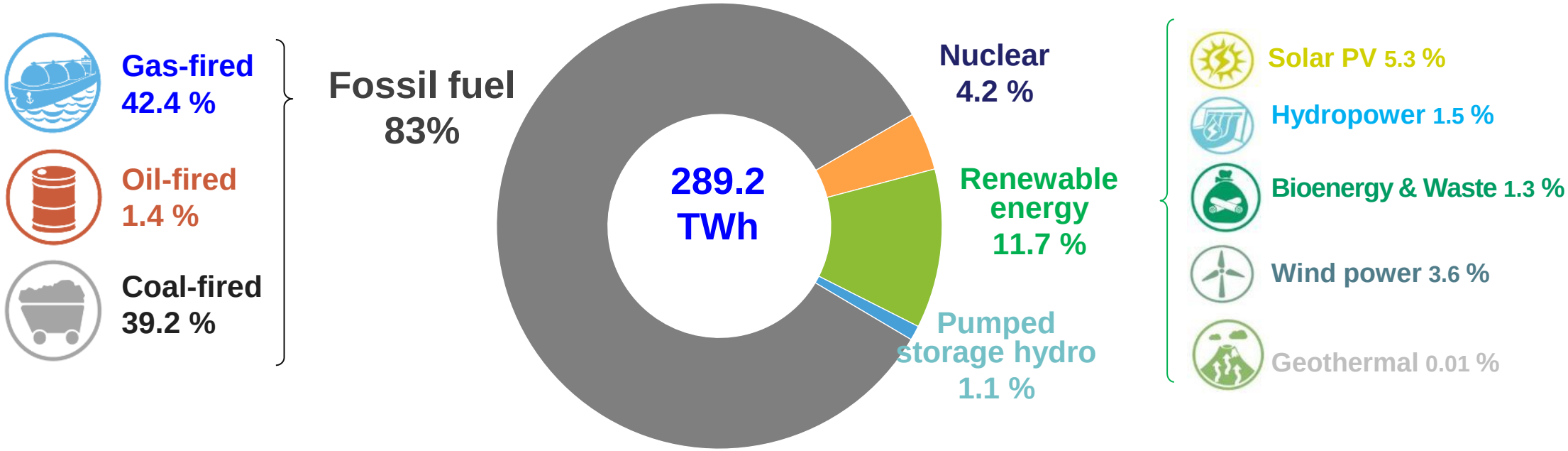
Current Energy Structure & Challenges

- **83%** of electricity comes from imported fossil fuels
- Renewable energy accounted for **11.7 %** of total **power generation**
- The development of **carbon-free** and **low-carbon energy** must be accelerated

Heavy Reliance on Fossil Fuel Imports



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Pathway to 2050 Net-Zero Emissions (NZE)

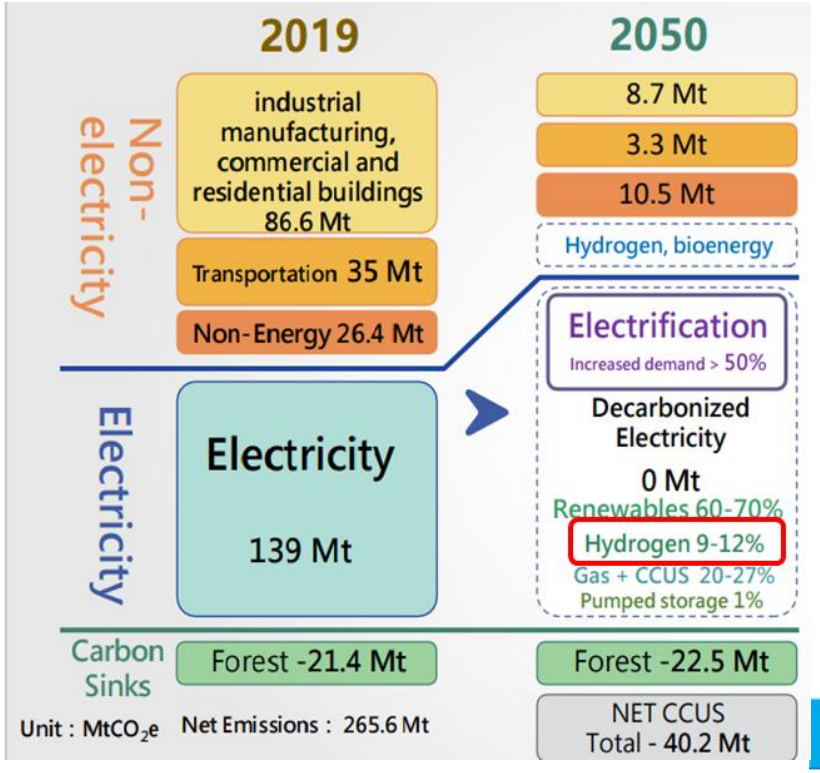
- In 2022, announced **NZE pathway** and **12 key strategic action plans** to achieve 2050 NZE.
  - Electricity from hydrogen accounts **9 -12%** in 2050
  - Hydrogen applications focus on **power generation**, **industry** and **transportation**
- In 2024, aims to promote the **Second Energy Transition**, including **diversifying green energy**, **deep energy saving** ,**and technical power storage and resilient power grid**

4 Major Transition Strategies:
Energy, Industry, Lifestyle, Social

2 Governance Foundations:
Technology R&D , Climate Legislation

12 Key Strategies:

1. Wind/Solar PV
2. **Hydrogen**
3. Innovative Energy
4. Power Systems & Energy Storage
5. Energy Saving & Efficiency
6. CCUS
7. Carbon-free EVs
8. Recycling & Zero Waste
9. Carbon Sinks
10. Green Lifestyle
11. Green Finance
12. Just Transition



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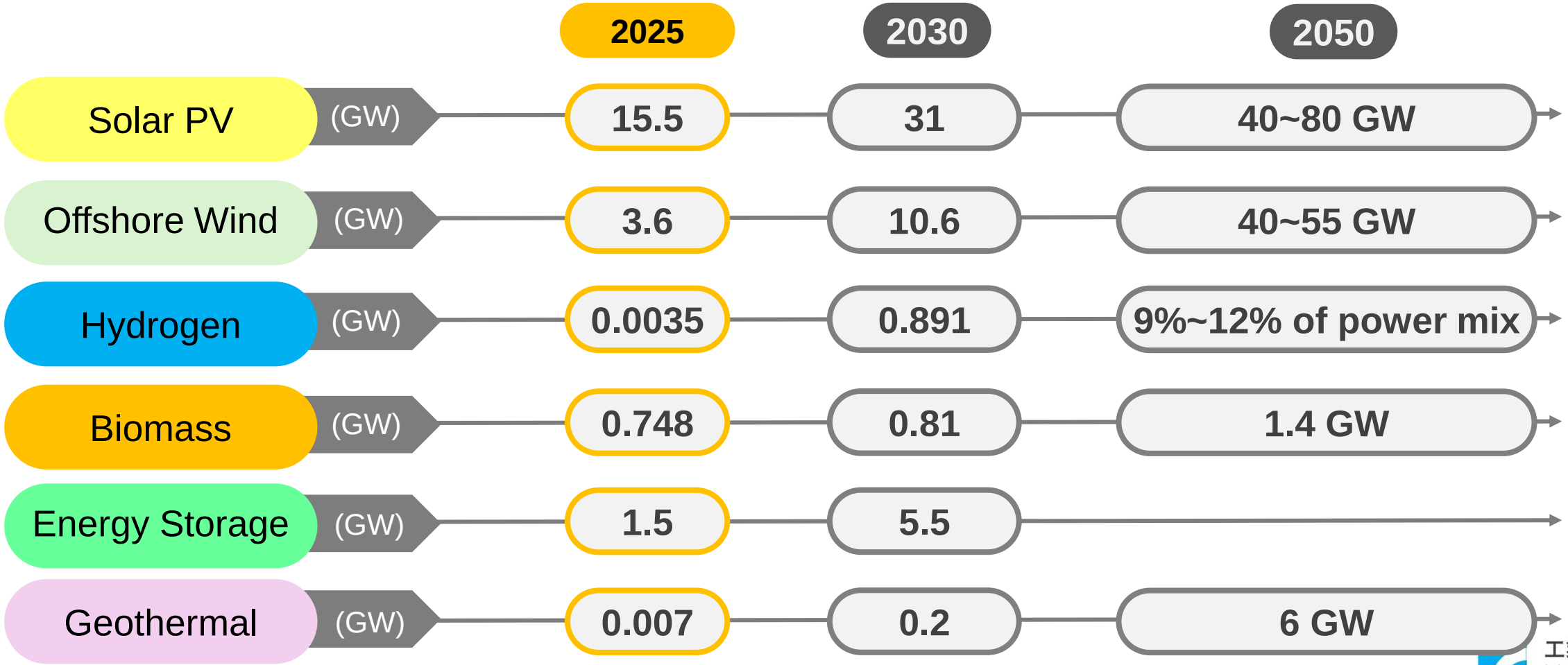
Net-Zero Energy Sector: Status & Goals

- Renewable energy continues to expand, with the development of new energy technologies, energy storage, and grid upgrades



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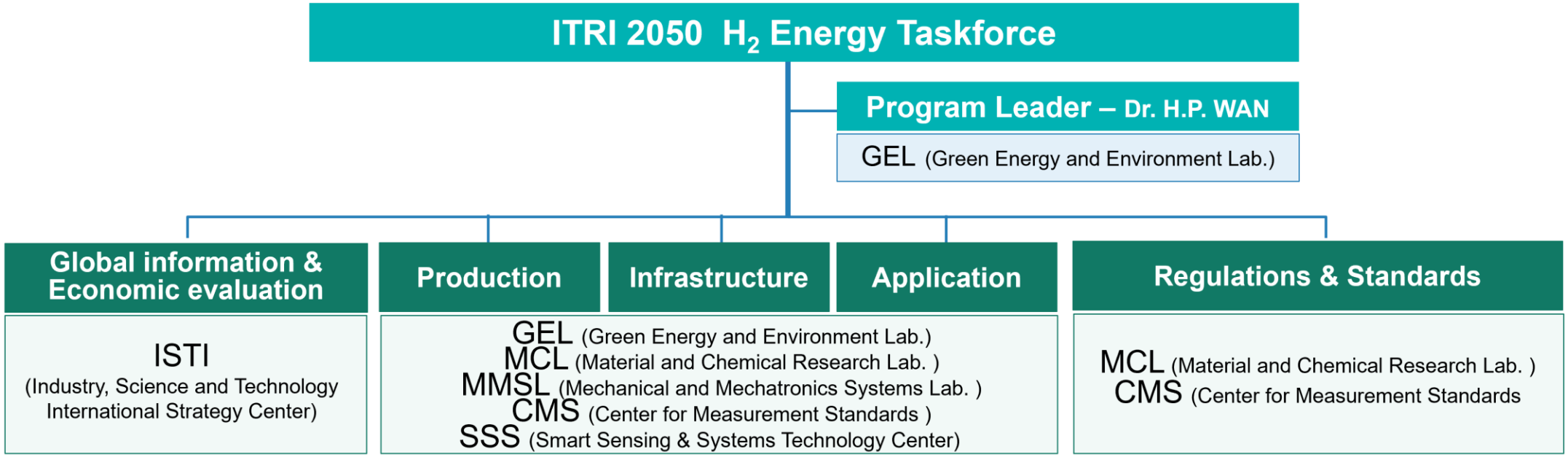
ITRI's Hydrogen Energy Taskforce

- ITRI serves as a key think tank for the economy and assists the authorities with policy, R&D, and international collaboration.
- ITRI established a task force in 2021 and published the first "2050 Hydrogen Application Technology Roadmap" in 2022.
  - Near term (~2035): Hydrogen carriers (mainly liquid ammonia)
  - Mid-term (~2045): Start importing liquefied hydrogen
  - Long term (2045–2050): Dual imports — liquid hydrogen & ammonia



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Strategic Hydrogen Development Scenario by 2050

Roadmap & Market Demand

Applications for Decarbonization

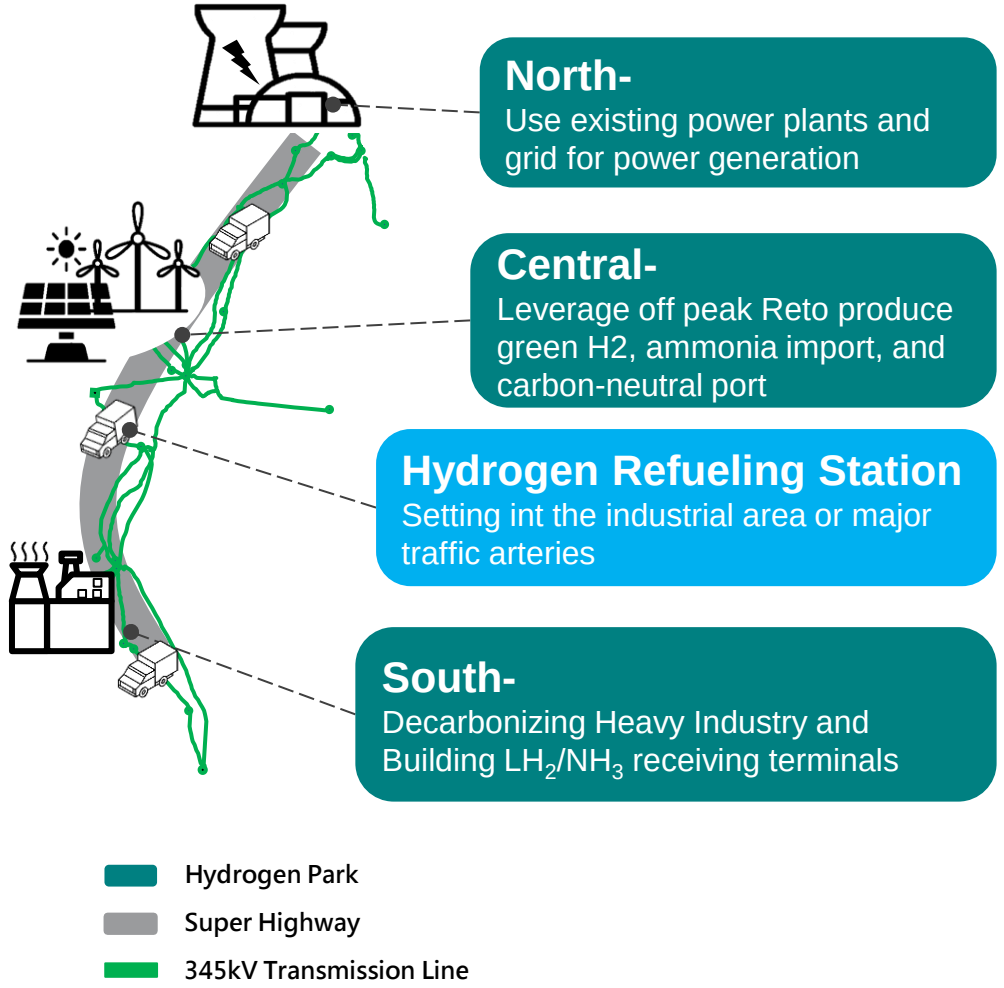
Power generation: Low/Zero Carbon Electricity

Industry: Steel industry, petrochemical industry, and semiconductors industry.

Transport: Heavy-duty and long-haul vehicles

H_2 Application Featured Parks

- Northern Area: Set up a hydrogen/ammonia mono-combustion power generation park on the existed power plant site.
- Central Area： Develop a green hydrogen and energy storage park alongside offshore wind power, support industry and grid stability, expand ammonia storage with ammonia-to-hydrogen conversion and promote carbon-neutral port .
- Southern Area：Construct LH_2 receiving terminal and leveraging CCU technology to produce hydrogen-based green chemicals, and low-carbon power applications.



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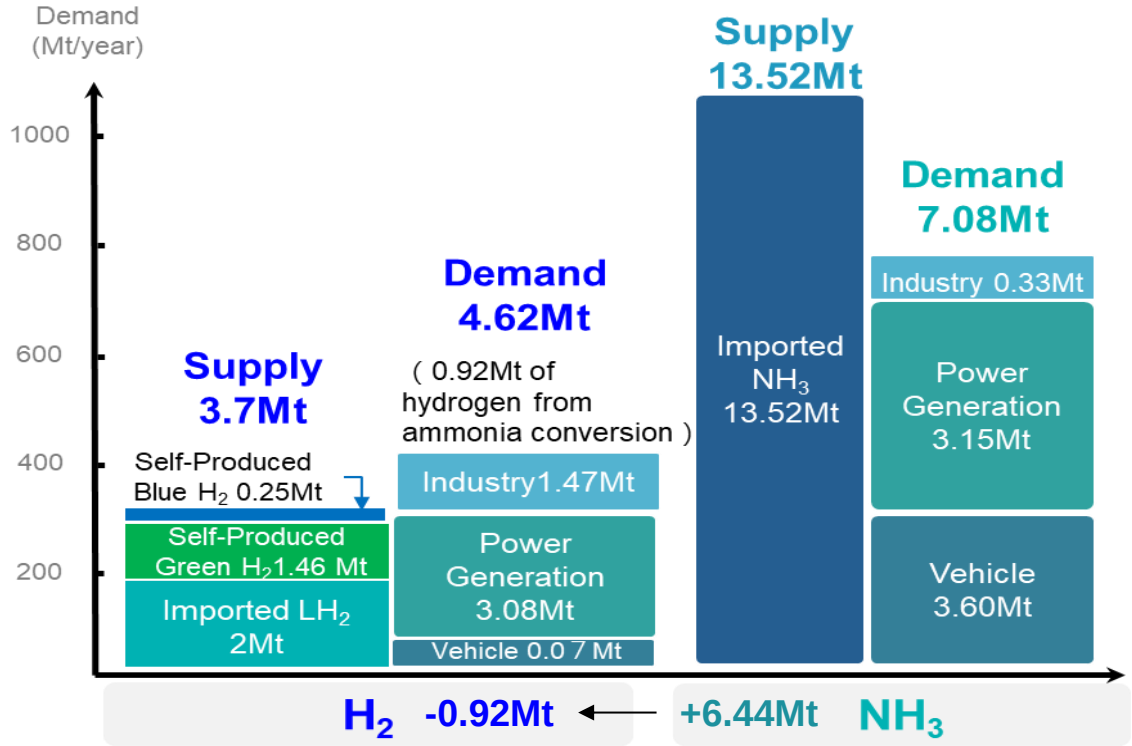
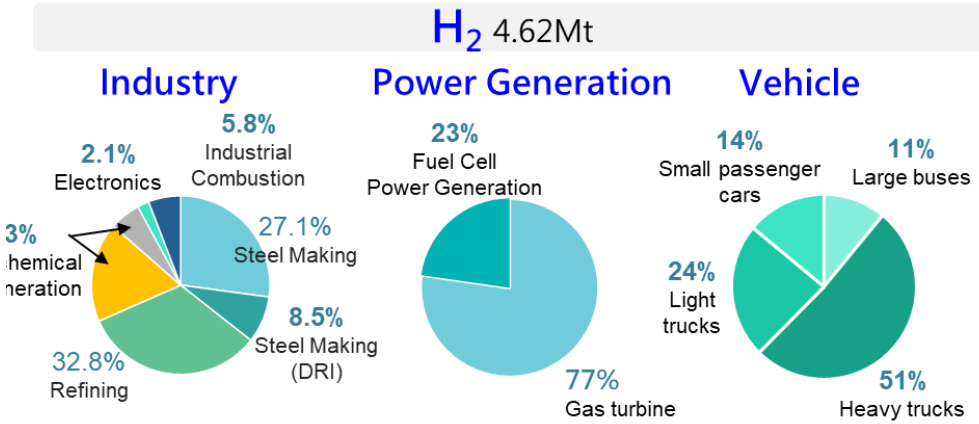
Reference：ITRI's Hydrogen Energy Taskforce, 2021-2025 (updated 2025/10)

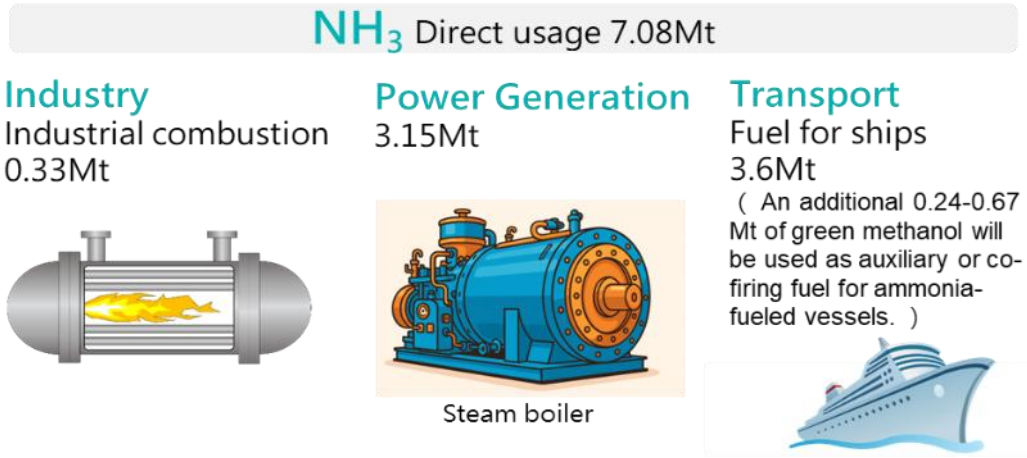
Projected Hydrogen Demand and Supply in 2050: ITRI Estimates

Roadmap & Market Demand

- Demand Side: Hydrogen is around 4.62 Mt; ammonia is about 7.08 Mt
- Supply Side: Total hydrogen supply is approximately 3.70 Mt (domestic blue/green hydrogen production accounts for about 36%, imported liquid hydrogen accounts for about 43%), and imported ammonia is about 13.52 Mt







* 0.92Mt of hydrogen require approximately 6.44 Mt of ammonia.

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Near-term Key Technology Development Strategy

Roadmap & Market Demand

ITRI's Recommended technology developments for short term (up to ~2035) are as follows:

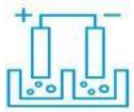
1 Hydrogen and Ammonia Application

- **Distributed Power:** High-power PEM / reversible SOFC modules; ammonia-fed SOFC power generation technology
- **Industrial Applications:** Carbon recycling processes; hydrogen blending in blast furnaces / hydrogen direct reduction of iron; mixed ammonia or hydrogen combustion in industrial furnaces and burners
- **Mobility Applications:** Demonstration of hydrogen–ammonia mobile energy systems (multi-fuel sources / 100 kW high-power / high-efficiency fuel cell stacks)

2 Infrastructure

- **H_2/NH_3 Flow & Quality:** Mobile refueling metering verification, gas quality testing, reference material supply, and field sampling technologies
- **Hydrogen Cylinders:** Localized manufacturing for large and small vehicle hydrogen tanks
- **H_2/NH_3 Safety Monitoring:** Leak detection (sensors, color films, drones) and AIoT-based sensing & early warning systems

3 Hydrogen and Ammonia Supply



- **Hydrogen Production Technologies:** R&D, demonstration, and validation of high-efficiency electrolysis (e.g., electrode materials, stacks, systems, renewable-based hydrogen); mid/low-temperature ammonia cracking; by-product hydrogen utilization; blue hydrogen with CCUS demonstration
- **e-Fuel Production Technologies:** Development of methanol synthesis catalysts and acidic catalysts for methanol-to-oil conversion
- **International Supply Chain Cooperation:** Secure H_2/NH_3 supply through economic modeling and feasibility studies

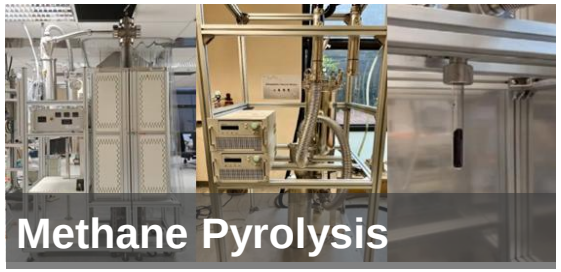
Implementation Status: Demonstration Projects

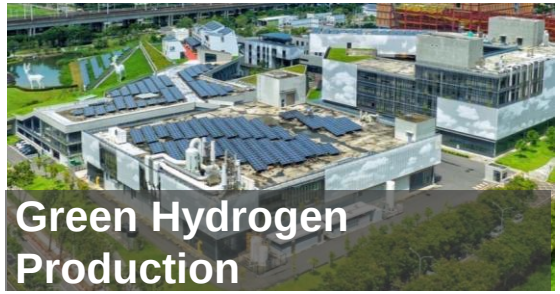
Progress & Pilot Case

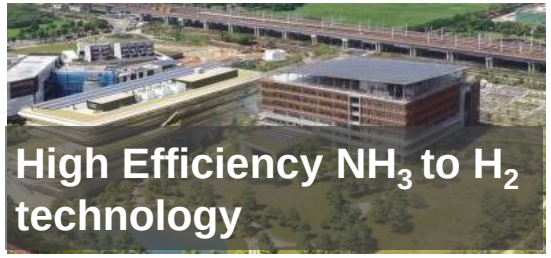
- Promote hydrogen demonstration and verification projects：Application, Supply, Infrastructure, Rule and Subsidy
- Conduct world-leading partner on co-firing and liquefied hydrogen receiving terminal
- Focus on technologies: methane pyrolysis, water electrolysis, and ammonia cracking

Application

Supply







Infrastructure

Rule and Subsidy

Hydrogen Energy Technology Development in ITRI

Progress & Pilot Case

Key Components | **System** | **Demo. & Verification**

Stack & BOP

Electrolyzer Stack

SOFC-fuel Reformer

Fuel Cell Stacks

Fuel Cell & H_2 Production:

- **SOFC** system
- **PEM** CHP system
- **AEM** electrolyzer
- **Ammonia** cracking

Industry Cooperation:

- H_2 forklift/drone
- Fuel cell power generation
- Backup power
- Hydrogen solution assessment

Shalun H_2 Energy Tech. Demo. Site

- Electrolysis H_2 production
- Distributed power generation system (SOFC & PEMFC)
- H_2 compression and storage

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Case Study: ITRI-Shalun Hydrogen Demonstration Platform

Progress & Pilot Case

First Hydrogen Energy Demonstration Site for Production, Transportation, Storage, and Utilization

Welcome Technology Validation with Domestic and International Partners

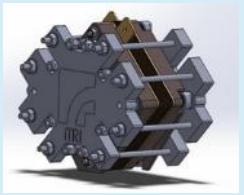
Over 20 Companies and Institutes Join the Platform , Including Startup 'Blade Hydrogen', a company, in 2023

Provide a platform for Testing and Validation on Electrolyzers, Fuel Cells, and Systems Integration

AEM Electrolyzer – Catalyst and Stake Design

Progress & Pilot Case

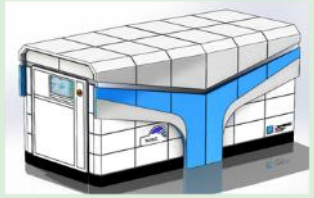
ITRI's AEM stack 2023



Stack spec.:

- Power: 1 kW
- Stack Efficiency:
  $\eta_{LHV} \geq 65\%$; $\eta_{HHV} \geq 80\%$

AEM Electrolyzer System 2027

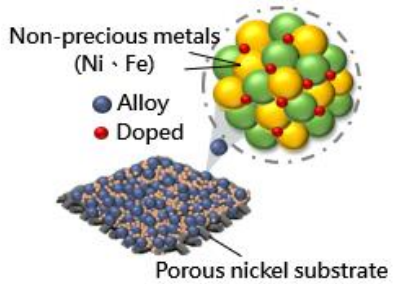


AEM Electrolysis system Spec.:

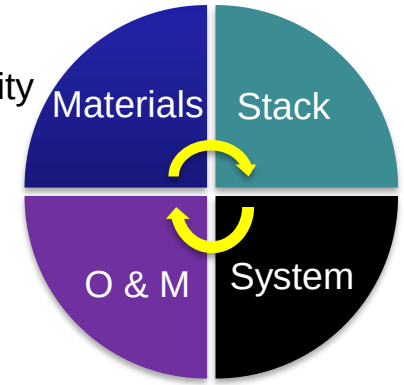
Power : 100 kW

System Efficiency : ≥ 70% (LHV)

I. Advanced in Catalyst and electrodes to improve performance



- Nickel-based alloy catalyst
- Scalable synthesis of non-precious metal (Ni, Fe) OER catalysts.
- Improves conductivity & activity

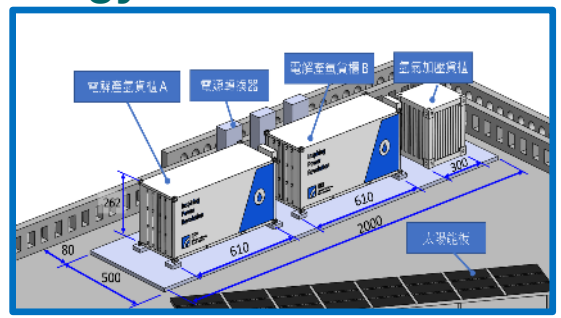


II. High-pressure electrolyzer development

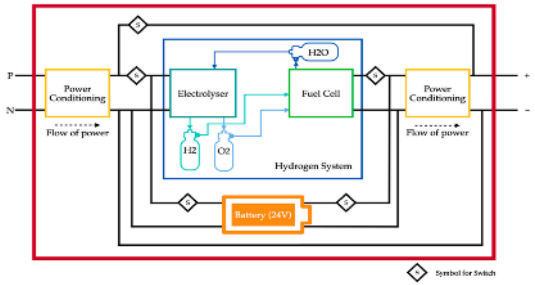
- Low-Impedance & Uniform Temperature Design
- Optimized symmetric flow field reduces KOH pressure drop by 40% & temp diff by 50%.
- 30% smaller stack volume than comparable products.

III. Electrolysis system integration technology

- Integration of 150/350 bar hydrogen storage system
- BOP optimization of multi-module electrolysis system



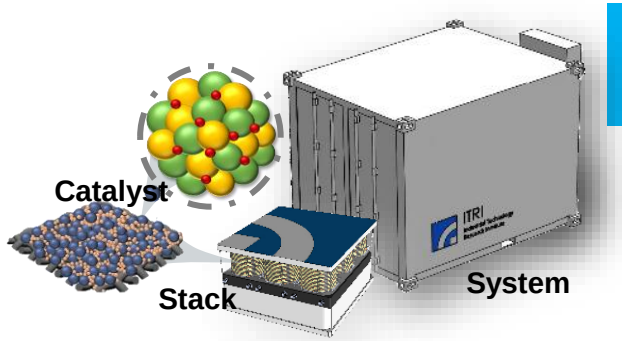
IV. Optimal Control of Hydrogen Production from Renewable Energy

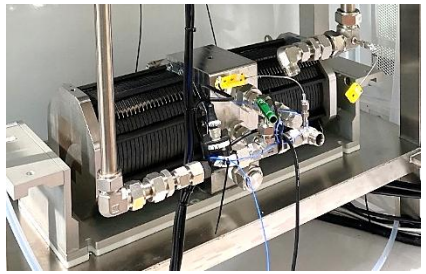


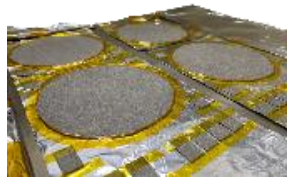
- Scenario analysis of renewable energy
- Variable loading control of hydrogen production
- System security verification

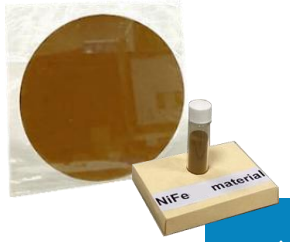
AEM Electrolyzer – Development Roadmap

Progress & Pilot Case









Target : Integration 100kW AEM system
AEM Stack Module ≥50 kW；Efficiency ≥70%
2027

AEM Multi-core System Power ≥**20 kW**
Electrolysis Stack Efficiency ≥65% (**10kW**)
2025

Electrolysis Stack Efficiency ≥65% (**1kW**)
AEM System Power Efficiency ≥60%
2023

Hydrogen testing platform
2022

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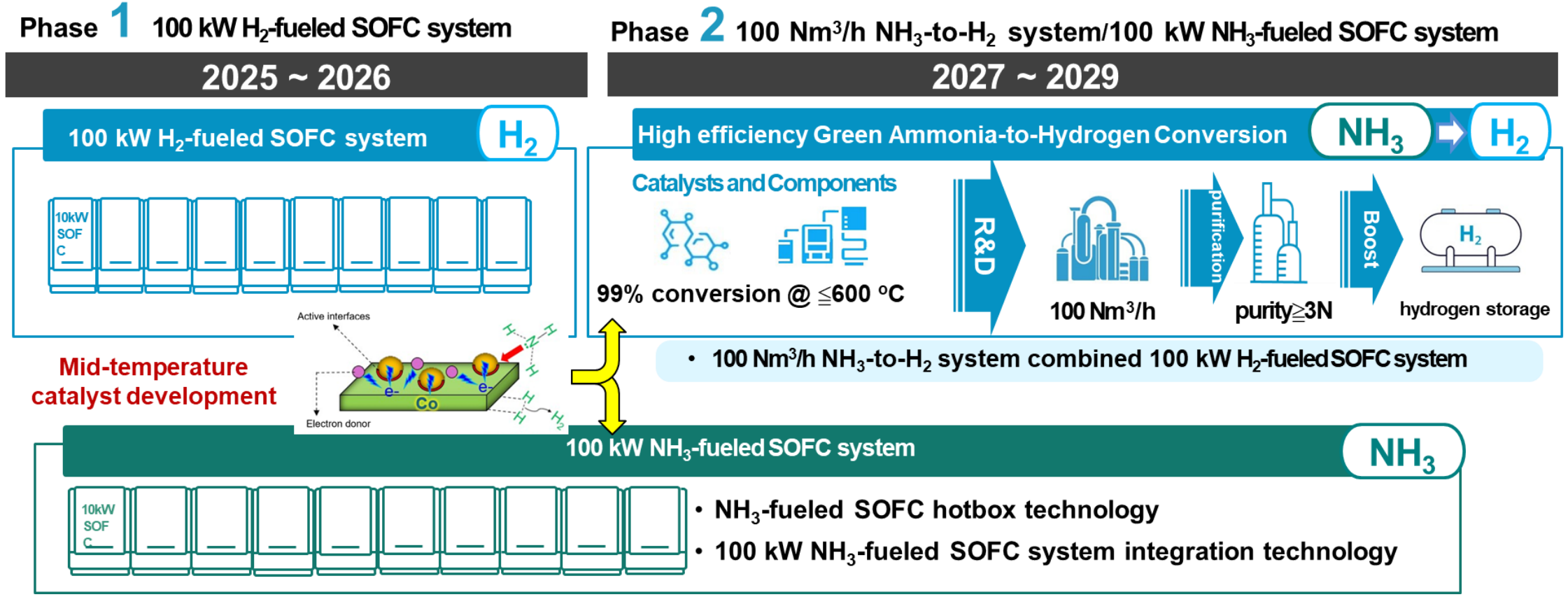
Ammonia-to-Hydrogen Cracking and SOFC Application

Progress & Pilot Case

- Objective: Development of commercialize NH_3-to-H_2 and power generation technology
- Project Duration: 2025–2029



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Stationary Fuel Cell Deployment Status

Progress & Pilot Case

- **Industrial Maturity**: The domestic fuel cell power system industry has reached commercial scale (100 kW level).
- **Global Supply Chain**: Local components manufacturers have integrated into the global supply chains of leading SOFC (Solid Oxide Fuel Cell) providers.
- **Market Drivers**: **AI & Semiconductor Growth**

  By 2030, booming AI and advanced semiconductor sectors will drive up electricity demand by another **700 MW**.

Total Projects: 51 (including those under construction)
Total installed capacity: 7,115 kW(including 2,035 kW under construction)
(as of May 2026)

Northern Region
Projects：27
Capacity：4,214 kW

Central Region
Projects：5
Capacity：1,276kW

Southern Region
Projects：16
Capacity：1,574 kW

East Region
Projects： 3
Capacity： 51 kW

Unimicron 600W

Porite 650W

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Strategic Synthesis: The Bridging to 2050

By integrating High-Efficiency Production & Storage with Safety Verification, GEL transforms renewable surplus into a resilient and socially accepted energy asset for 2050.

2050 Wind Scenario

- **Wind Surplus:** Target of **40-55 GW** offshore wind creates a massive seasonal power surplus.
- **Strategic Need:** Hydrogen is the only viable medium for Cross-seasonal Energy Storage.

Strategic Bottlenecks

- **Economic(Green Premium):** High production costs and inefficient storage carriers hinder commercial scaling.
- **Social (Safety Trust):** Public concern regarding site safety and infrastructure deployment.

Integrated Solution

- **High Efficiency:** Advancing AEM Electrolyzers to slash production costs.
- **Advanced Storage**: Develop high density carriers for high-density seasonal balancing.
- **Safety Trust:** Proving standards via field sites to secure social license.

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Conclusion remarks

- **9–12% Hydrogen Power by 2050:**

  Driving a strategic, policy-backed commitment to secure low-carbon energy supply and long-term grid resilience.

- **ITRI R&D & Shalun Validation:**

  Leveraging key capabilities in electrolysis, cracking, and system integration to build long-term operational experience in a living laboratory.

- **Open Collaboration for APEC Economies:**

  Welcoming regional partners to utilize the Shalun platform for joint technological testing, validation, and industrial scaling.

THANK YOU.

Innovating a Better Future

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