

# The Introduction of Hydrogen and Fuel Cell Industrial Development in Taiwan



Taiwan Hydrogen and Fuel Cell Partnership

Taiwan Institute of Economic Research

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2022.10

# Global emission policy and International indicators—Policy



(2021/10/30-10/31)

- Reiterated the goal of Paris Agreement: **limit global warming to 1.5 °C** (Compare to pre-industrial levels)
- **End financing for international coal power plants**; Contribute 100 billion USD for Developing Countries to tackle climate change



(2021/10/31-11/13)

- **Glasgow Climate Pact**: **limit global warming to 1.5 °C**; New emission goal shall be proposed by 2022
- **Cut 45% of emission by 2030** (Compare to 2010) ; **Net Zero emission by 2050**
- Energy Transition as one of the goals ; Review “NDCs” on yearly bases



## ● European Green Deal & CBAM

(Carbon Border Adjustment Mechanism)

- Net zero emission by 2050 ; Sustainable development
- European Climate Act



US

- **Rejoin the Paris Agreement**, aim to **cut 50% of emission by 2030**
- Investing 119 billion USD in **low-carbon tech & Energy transition**
- Renewable energy & Emission Trading



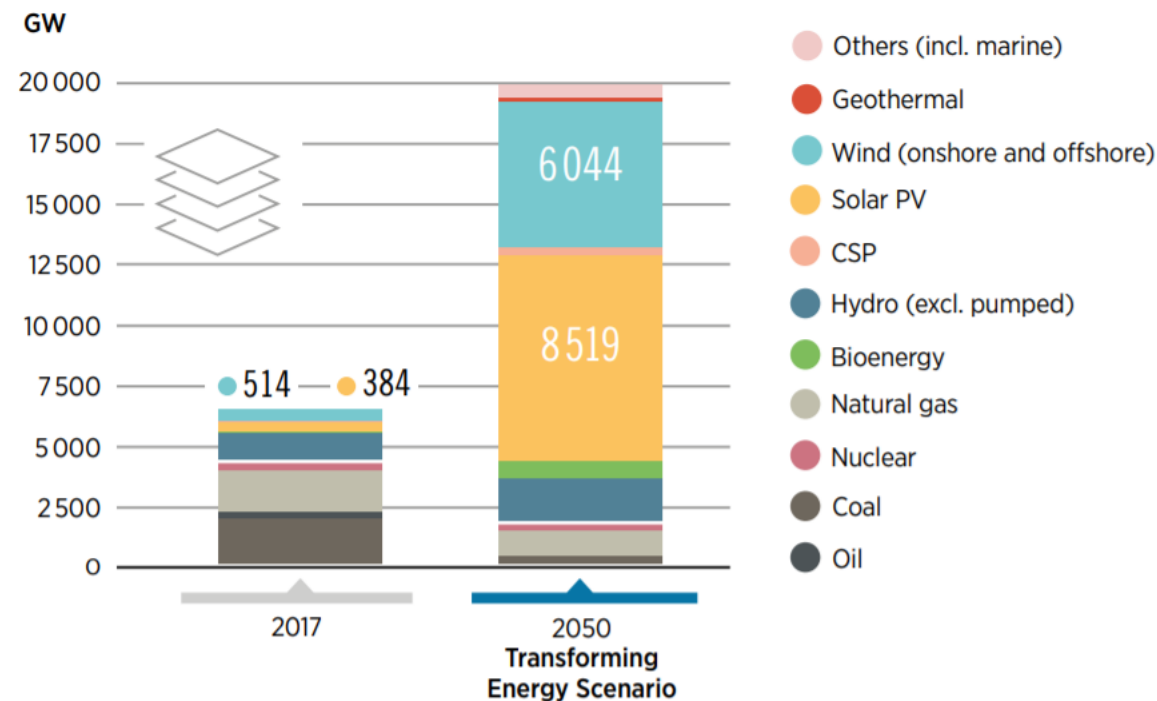
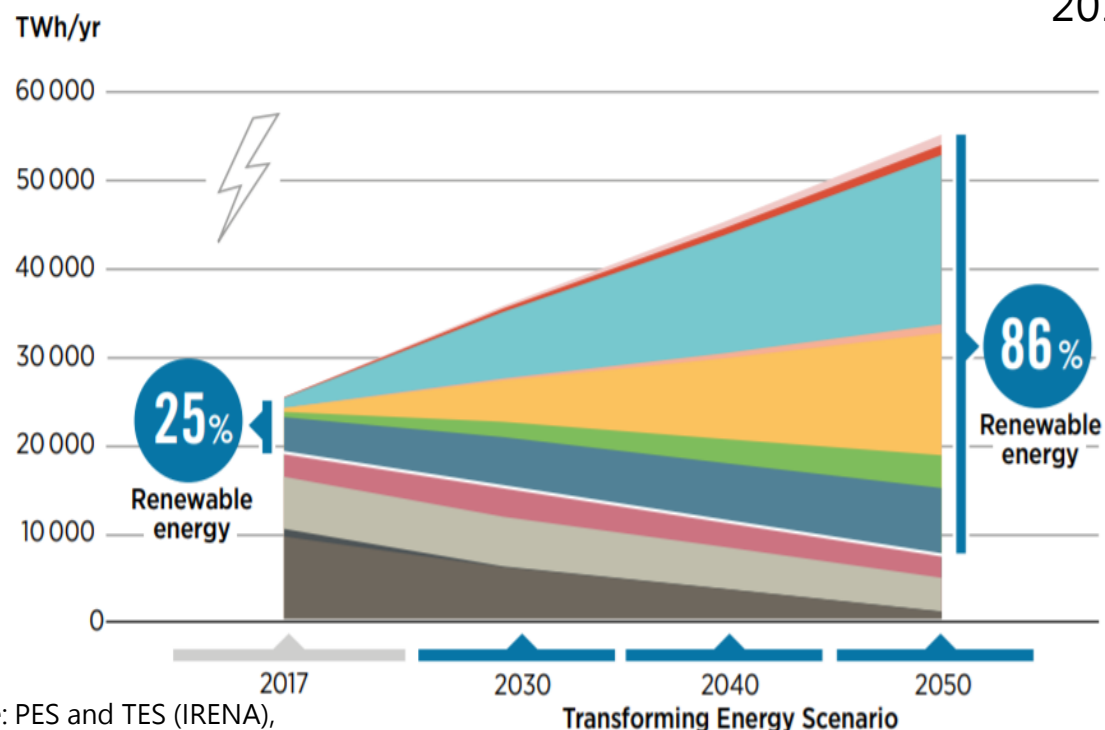
South Korea

- **The Green New Deal**, 42.7 trillion Won will be invested
- Green transition of infrastructure, low-carbon and decentralized energy, Innovation in green industries

# Hydrogen Energy as a solution

- Emission caused by Energy generation should be reduced by 70% by 2050, and 90% of these emission cut can only be achieved by Renewable energy and energy efficiency.
- According to IEA's Net-Zero roadmap, Hydrogen energy and energy efficiency, Energy saving, Electrification, Renewable energy and CCUS will play a vital role among emission reduction actions.

Solar, wind and other renewable power generation until 2050  
Breakdown of electricity generation and total installed capacity by source, 2017-2050



Note: PES and TES (IRENA),  
2017 values based on IEA (2019b)  
Notes: CSP = concentrating solar power;  
TWh = terawatt-hour.  
CCUS: Carbon Capture, Utilization and Storage

# Global emission policy and International indicators



**UNIDO**  
Eco-Industrial Parks



**OECD**  
Green Growth Indicator



**GGGI**  
Green Growth Index

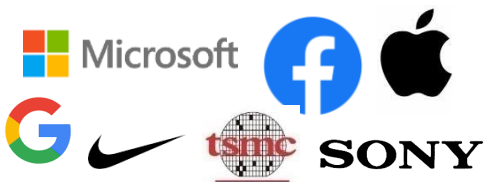


<b>Introduction</b>	Specialized agency of UN, with over 170 member states	Main research institute of WTO, with 27 member states	Founded by South Korea in 2010, with 28 member states
<b>Mission of the organization</b>	To promote industrial development for poverty reduction, inclusive globalization and <b>environmental sustainability</b> .	To promote global economic cooperation and development.	Support and <b>promote sustainable economic growth</b> in developing countries and economies
<b>Year of establishment</b>	Jointly proposed with GIZ(Deu) and WB in 2017	Proposed in 2011(revised every 5 yr.)	Proposed in 2019
<b>Purpose of the indicator</b>	A Developing framework for E.I.P.	Fostering economic growth while ensuring sustainable natural asset	Measuring a country' s performance in achieving SDGs, Paris Agreement, Aichi Biodiversity Targets

**RE 100**

## Renewable Energy 100

Bring businesses committ to 100% Renewable Electricity by 2050, joined by more than 300 MNCs.



**EP 100**

## Energy Productivity 100

Bring businesses committ to optimize their energy efficiency, joined by more than 120 MNCs.



**CLIMATE GROUP**  
**EV100**

## Electric Vehicle100

Bring businesses committ to switch their fleets to EVs, joined by more than 120 MNCs.



## Science Based Targets Initiative

Drives ambitious climate action among businesses, enable them to set science-based emissions cut targets, joined by more than 2000 MNCs

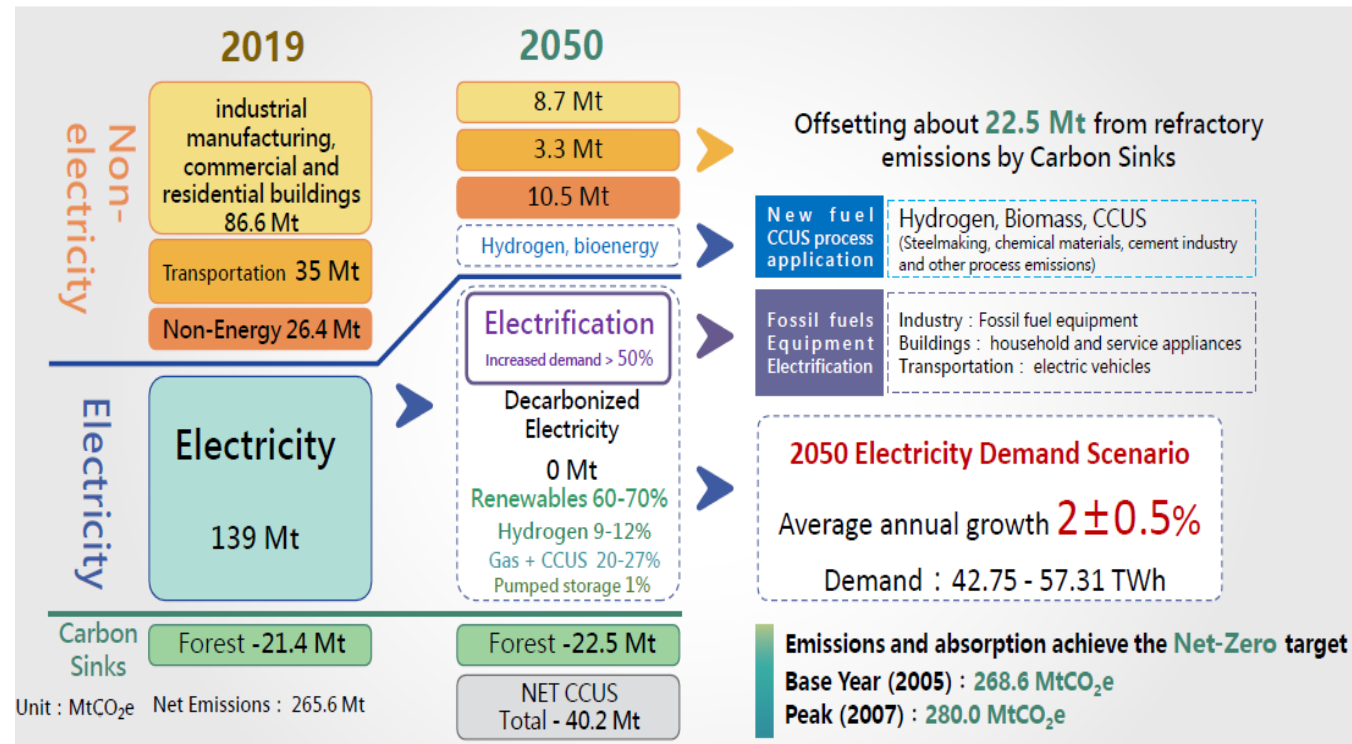


# Carbon emission goals and hydrogen policies in TW

## Carbon emission goals

- The amendment of the “**Climate Change adoption Law**” was passed in April 2022 by Legislative Yuan, **setting a goal for greenhouse gas to achieve net zero emissions by 2050** ;
- “**Net Zero Carbon Emission Route Map by 2050**” was published in March 2022 by NDC, it indicates that **TW will legalize the hydrogen energy bill**, and TW’ s power supply has to be 60 to 70% renewable energy, **including 9 to 12% hydrogen energy**.

## 2050 Net-Zero Emissions Plan



## Energy policies

- Nuclear-free homeland in 2016;
- Green energy **up to 20%**, and installation capacity up to 27GW (**fuel cell 60MW**) in 2025;
- To develop energy saving, green energy industry, and technological innovation, such as **fuel cells**, etc.





# Taiwan's action on Net Zero emission –Action taken by Enterprises



## RE100<sub>(2020)</sub> ; 2050 Net Zero

- 100% Renewable energy consumption in TSMC offices.
- Low-Carbon product design and purchase Clean Energy.
- Renewable Energy and energy-efficient device.



## RE100<sub>(2021)</sub> ; 100% Renewable energy by 2030 ; Reducing carbon intensity by 56.6% by 2025

- Participate SBTi and RE100.
- Purchase 190 GWh Renewable Energy Certificates.
- Invest Renewable Energy device.



## Reduce carbon emissions by 50% by 2025 ; 100% renewable energy by 2035

- Ensure that key suppliers achieve a 30% reduction in carbon intensity rates by 2025
- Increase energy efficiency of major products by 50% by 2025
- Using software and hardware to improve the energy efficiency of products.



## TANZE(Taiwan Alliance for Net Zero Emission)

- Ultimate goal : Net Zero Emission by 2050
- Taiwan alliance of companies, policymakers and organizations to realize Net Zero Emission, including TSMC ,TAISE ,AUO ,CSR...etc, total 27.

# Supply Chain in Taiwan's Hydrogen and Fuel Cell Industry

Raw materials	Stack	System applications				Peripheral products		
Bipolar plate	Stack components	Stationary		Transportation	Hydrogen alloy tank	System peripheral components	Hydrogen Production	Hydrogen storage and transportation
APFCT	ITRI	ITRI	KAORI	APFCT	HBank	KAORI	YF	LLIG
SDI	NCSIST	TPC	YATEC	KYMCO	BPS	AcBel	TCI	APSF
LT	INER	GOC	e-Formula	BPS	APFCT	porite	LLIG	ALFE
homytech	GOC	APFCT	ARTC	YC	HYTEC	APFCT	APSF	APFCT
TTTW	BPS	BPS	Fucell.us	Aeon	TTTW	PMT	ALFE	HBank
Carbon cloth, carbon paper	TEC	INER	hiPower	EET	Methanol supply	HANBELL	FPG	BPS
CeTech	CHEM	M-FIELD	GHT	NOVELTEK	MEC	homytech	CPC	TISPACE
homytech	APFCT	TEC	AHE	AHE	LCY GROUP	UCC	CPDC	YUARN NIRING
TTTW	EET	CHEM	YC	GHT	Purification recycle and reuse	micelin	CCPC	Semisils
Catalyst	SDI	EET	TTTW	TT	TEC	HEPHAS	GPPC	TTTW
GHT	HEPHAS	HBank		AVIX	IPI	TTTW	TPCC	Ammonia supply
SOLAR	LFC			TYCE	KAORI	on-site hydrogen production	TSMC	Taiwan Fertilizer
TTTW	micelin			TTTW	hiPower	GHT	LCY GROUP	Inspection and Verification 、 Testing Equipment
Reformer	Fucell.us			Portable	GHT	KAORI	GHT	TÜV
ITRI	TTTW			ITRI		CHEM	U Hydrogen	HEPHAS
GHT	MEA			TTTW			HEPHAS	UL
KAORI	Yangtze						GOC	ARTC
CHEM	GOC						KAORI	
IPI	Fucell.us						TTTW	
HEPHAS	ITRI							
TTTW	microcosm							
	TTTW							

# 2021

## The Fuel Cell Demonstration in Taiwan

經濟部能源局(MOEA)

行政院環境保護署(EPA)

台灣經濟研究院(TIER)

工業技術研究院綠能與環境研究所(ITRI/GEL)

THCP 台灣氫能與燃料電池夥伴聯盟(THFCP)



38

Application: Telecommunications base stations  
Capacity: 20kW  
Company: Toplus  
Date of installation: 2015



1

Application: Forest Park  
Capacity: 2kW  
Company: Toplus  
Date of installation: 2013



5

Application: Government units  
Capacity: 6kW  
Company: M-field  
Date of installation: 2012



39

Application: Telecommunications base stations  
Capacity: 25kW  
Company: Toplus  
Date of installation: 2016



3

Application: Stadium  
Capacity: 20kW  
Company: Toplus  
Date of installation: 2014



20

Application: Telecommunications base stations  
Capacity: 10kW  
Company: M-field  
Date of installation: 2010



40

Application: Telecommunications base stations  
Capacity: 26kW  
Company: Toplus  
Date of installation: 2016



14

Application: Factory  
Capacity: 40kW  
Company: Toplus  
Date of installation: 2011



2

Application: Telecommunications base stations  
Capacity: 1kW  
Company: Toplus  
Date of installation: 2012



41

Application: Telecommunications base stations  
Capacity: 20kW  
Company: Toplus  
Date of installation: 2017



6

Application: Exhibition  
Capacity: 30kW  
Company: M-field  
Date of installation: 2010



4

Application: Telecommunications base stations  
Capacity: 5kW  
Company: Toplus  
Date of installation: 2014



42

Application: Telecommunications base stations  
Capacity: 20kW  
Company: EET (CHEM)  
Date of installation: 2017



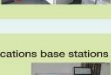
19

Application: Institute of Nuclear Energy Research  
Capacity: 15kW  
Company: CHEM  
Date of installation: 2014



7

Application: Telecommunications base stations  
Capacity: 10kW  
Company: Toplus  
Date of installation: 2011



43

Application: Telecommunications base stations  
Capacity: 20kW  
Company: EET (CHEM)  
Date of installation: 2017



18

Application: Factory  
Capacity: 5kW  
Company: CHEM  
Date of installation: 2010



8

Application: Telecommunications base stations  
Capacity: 1kW  
Company: Toplus  
Date of installation: 2012



44

Application: Telecommunications base stations  
Capacity: 20kW  
Company: Toplus  
Date of installation: 2017



35

Application: Motorcycle  
Capacity: 36kW  
Company: APFCT  
Date of installation: 2012



24

Application: Factory  
Capacity: 10kW  
Company: Toplus  
Date of installation: 2012



45

Application: Telecommunications base stations  
Capacity: 22kW  
Company: EAP (Toplus)  
Date of installation: 2017



36

Application: Motorcycle  
Capacity: 160kW  
Company: APFCT  
Date of installation: 2012



25

Application: Telecommunications base stations  
Capacity: 5kW  
Company: Toplus  
Date of installation: 2012



46

Application: Telecommunications base stations  
Capacity: 26kW  
Company: Toplus  
Date of installation: 2017



30

Application: Telecommunications base stations  
Capacity: 5kW  
Company: CHEM  
Date of installation: 2012



32

Application: Fire Station  
Capacity: 15kW  
Company: CHEM  
Date of installation: 2012



47

Application: Telecommunications base stations  
Capacity: 15kW  
Company: Toplus  
Date of installation: 2018



37

Application: Motorcycle  
Capacity: 96kW  
Company: APFCT  
Date of installation: 2012



9

Application: Telecommunications base station  
Capacity: 5kW  
Company: Toplus  
Date of installation: 2012



22

Application: Fire Station  
Capacity: 5kW  
Company: Toplus  
Date of installation: 2009



10

Application: Telecommunications base stations  
Capacity: 5kW  
Company: Toplus  
Date of installation: 2009



23

Application: Telecommunications base stations  
Capacity: 5kW  
Company: Toplus  
Date of installation: 2009



11

Application: Telecommunications base stations  
Capacity: 5kW  
Company: Toplus  
Date of installation: 2010



26

Application: Telecommunications base stations  
Capacity: 5kW  
Company: Toplus  
Date of installation: 2010



12

Application: TV station  
Capacity: 11kW  
Company: CHEM  
Date of installation: 2010



27

Application: Telecommunications base stations  
Capacity: 5kW  
Company: Toplus  
Date of installation: 2010



13

Application: Telecommunications base stations  
Capacity: 5kW  
Company: Toplus  
Date of installation: 2014



28

Application: Telecommunications base stations  
Capacity: 5kW  
Company: Toplus  
Date of installation: 2014



15

Application: Telecommunications base stations  
Capacity: 5kW  
Company: Toplus  
Date of installation: 2013



29

Application: Telecommunications base stations  
Capacity: 5kW  
Company: Toplus  
Date of installation: 2013



16

Application: School  
Capacity: 1kW  
Company: Toplus  
Date of installation: 2012



31

Application: Hospital  
Capacity: 40kW  
Company: Toplus  
Date of installation: 2010



17

Application: School  
Capacity: 10kW  
Company: Toplus  
Date of installation: 2012



33

Application: Telecommunications base stations  
Capacity: 5kW  
Company: Toplus  
Date of installation: 2014



21

Application: Train station  
Capacity: 1kW  
Company: Toplus  
Date of installation: 2011



34

Application: Telecommunications base stations  
Capacity: 5kW  
Company: Toplus  
Date of installation: 2014



49

Application: Backup-power  
Capacity: 5kW  
Company: Chung-Hsin Electric & Machinery  
Date of installation: 2019



48

Application: Telecommunications base stations  
Capacity: 15kW  
Company: Toplus  
Date of installation: 2018





# Hydrogen and Fuel Cell Project for Backup Power

- Actual setting case : As of May 2022, TIER has assisted the whole station to complete 12 cases.

## NCC' s Project of Subsidies :

fuel cell for disaster-resistant information communication platform for backup power.



Department of Sports, Taipei City Government  
2015 ; 20kW



National United University  
2016 ; 26kW



National Chung Cheng University  
2016 ; 25kW



Community center in Shuangxi Dist.  
2017 ; 20kW



Community center in Wuliao, National Taitung University  
2017 ; 20kW



National Dong Hwa University  
2017 ; 25kW



National Taiwan Ocean University  
2018 ; 20kW



National Sun Yat-sen University  
2018 ; 22kW



Lala Mountain Taoyuan County  
2018 ; 15kW



Huafan University, New Taipei  
2019 ; 15kW

## Taiwan Railway Bureau :

backup power for the railroad signal lights



Fangye Signal Station Taiwan Railway,  
Pingtung County  
2019 ; 15kW

# Hydrogen and Fuel Cell for Remote and Offshore Areas

- Hydrogen and fuel cell is suitable for maintaining stable regional power supply.



Green Energy Demonstration Charging Station, Penghu County  
2021 ; 5kW



Tai Tam Power Plant,  
Taiwan Power Research Institute  
2020 ; 5kW



Sanwa Community and Kiln Cultural and  
Creative Park , Taoyuan City  
2020 ; 5kW



Kuei-Hui Li Office , Taoyuan City  
2020 ; 5kW



- Since 2018, the research team has assisted local governments in planning fuel cell backup power installation projects.
- As of 2020, five fuel cell backup power installation sites have been completed.



Taipei Spinel Community ,  
New Taipei City  
2018 ; 5kW



**Crestview Crest Community,  
New Taipei City  
2018 ; 5kW**



Xiehe Daxin Community, Taichung, Taiwan  
2021 ; 5kW



# Green Hydrogen Applications in Taiwan



**low-carbon hydrogen production**  
facility in Tainan Technology  
Industrial Park, Tainan County  
2021 ; 25MW



**Green Energy Demonstration**  
Charging Station, Penghu County  
2021 ; 5kW



**235 Environmental Education Green**  
Energy Living Hall, Chiayi County  
2018 ; 5kW



**Industrial Technology  
Research Institute**



**Asia Hydrogen  
Energy Co., Ltd.**



**Marketch  
International Corp.**



Under the MOU,  
the three parties will  
develop a team of  
**hydrogen power**  
**generation**



# Hydrogen Transport Applications in Taiwan

- Taiwan is planning hydrogen transport applications for **land, sea and air transportation**

## Go-Cart



Eco-Energy Tech Co.

- Fuel Cell : 1 kW
- Battery : 48V 20Ah
- Maximum Speed : 60 km/h
- Drive Distance : 50 km



## Drone



AVIX  
Technology Inc.



Thunder Tiger Co.



## Boat



YC Synergy  
Co., Ltd.

- Type : PEM
- Endurance : 8 hours
- Seating Capacity : 90



## Scooter



APFCT



KYMCO



BPS



Aeon



## Backlot Tram



A hydrogen-based bus will be introduced to replace the existing fuel-based medium-sized buses on the Central Cross Highway.

## Bus



Hydrogen fuel cell electric bus is in the planning stage

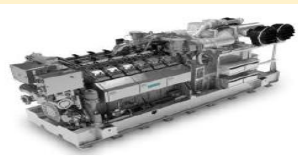


# Hydrogen Power and Gas Reuse Applications in Taiwan



## Hydrogen power

**AHE Asia Hydrogen Energy Corp.**



- Hydrogen generator set
- Fuel: Syngas, low-concentration hydrogen.
- Low pollution, low water consumption, high energy efficiency

## Industrial hydrogen applications

**Air Liquide Far Eastern LTD.**

- Electrolyzer
- 1,000 NM<sub>3</sub>/H
- Ultra-high purity (99.9995%)



## Industrial hydrogen applications

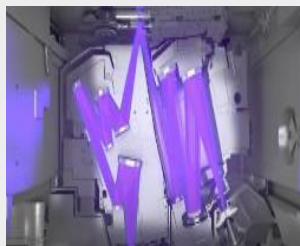
**AIR PRODUCTS SAN FU CO., LTD.**

- LB Production Plants
- LB Tank Station
- On-site gas generator



## Industrial hydrogen applications

**TSMC Taiwan Semiconductor Manufacturing Co., Ltd.**



- Semiconductor industry
- Extreme Ultraviolet (EUV) Process

## Industrial hydrogen applications

**KAORI Kaori Heat Treatment Co., Ltd.**

- Waste hydrogen treatment system
- Purification efficiency 70~80%
- PSA, PEM



## Industrial hydrogen applications

**Green Hydrotec, inc**

- Methanol on-site H<sub>2</sub> generator
- Heating catalyst
- simple and safe in operation



Taiwan has a mature and complete fuel cell industry chain, providing international manufacturers with excellent quality and affordable fuel cell products and related key components.



Bloom Energy's 100 kW SOFC Generator - **Kaori** is the main **Hotbox** supplier for 100 kW SOFC system.



Taiwan's **AcBel** is the only business offering an **electrical management system** to the US's Bloom Energy.



**Porite** manufactures SOFC **interconnect plate**. It supplies Bloom Energy.



**Plus Metal Tech** is an **interconnect coating** manufacturer. 5 years ago, it invested in FC manufacture. It is currently Bloom Energy's main supplier.



# International Hydrogen Industry Cooperation



**Canada-Taiwan Low Carbon Emission – HFC Forum**  
加台低碳排放-氫能與燃料電池論壇  
( 2022/01/18 )



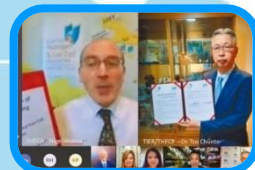
**The 25th Taiwan-Dutch Economic Cooperation Conference**  
第25屆台荷經濟合作會議  
( 2019/06/14 )



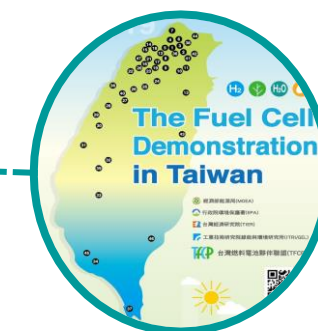
**Germany and Taiwan– Energy Transition Forum**  
德台能源轉型論壇  
( 2021/08/11 )



**U.K.-Taiwan Hydrogen Forum**  
台英氫能論壇  
( 2021/10/21 )



**Taiwan-France Hydrogen Fuel Cell Business Forum and Matchmaking Meeting**  
台法氫燃料電池商務論壇  
( 2019/06/17 )



**Taiwan-India Smart Asia 2017**  
台印綠色能源物聯網產業推動合作  
( 2017/11/23 )



**Taiwan-Thailand ASEAN Sustainable Week**  
台泰亞洲國際再生能源展  
( 2018/6/6~6/9 )



**Taiwan-Malaysia Renewable Energy Conference**  
台馬再生能源會議  
( 2018/11/27 )



**Taiwan-Australia Hydrogen Trade and Investment Dialogue**  
台澳氫能貿易投資對話  
( 2021/07/29 )





# Conclusions and Discussion

- Taiwan's product quality and reliability, a comprehensive supply chain and cross-sector industry integration are some of Taiwan's biggest advantages.
- Through vertical and horizontal integration, **the green industry in Taiwan is capable of providing a set of total solutions**, such as solar energy, wind energy, hydrogen and fuel cell, energy storage, and power management systems customized to demand.
- **Geographically Taiwan is the heart of Asia** and has positively legislated for the high-tech industries, propelling the countries to prosperity from a relatively recent agrarian base.
- In recent years, Taiwan conducted hydrogen forum or signed MoU with U.K., Germany, Australia and Canada. It shows the determination of Taiwan to cooperate with other countries in hydrogen energy development.



U.K.-Taiwan  
Hydrogen Forum  
( 2021/10/21 )



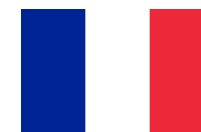
Germany and Taiwan  
– Energy Transition  
Forum ( 2021/08/11 )



Taiwan-Australia  
Hydrogen Trade and  
Investment Dialogue  
( 2021/07/29 )



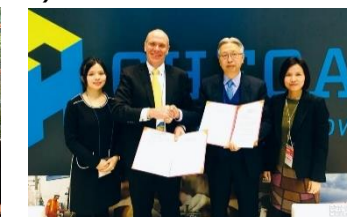
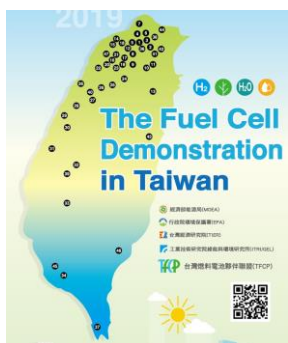
The 25th Taiwan-  
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Conference  
( 2021/07/29 )



Taiwan-France  
Hydrogen Fuel Cell  
Business Forum  
and Matchmaking  
Meeting ( 2019/06/17 )

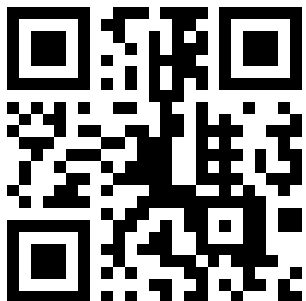


Taiwan, Canada  
signed MoU  
( 2018/03/02 )





# Thank you



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