Monitor Deloitte.

Final Report

Hydrogen market research in Thailand -Focus on the EEC area-

Deloitte Consulting Ltd.

March 2025

This study explores the feasibility of hydrogen supply chain development in Thailand's EEC area through desktop research, demand estimation and stakeholder interviews

Table of Contents

**EEC area includes Chachoengsao, Chonburi, and Rayong Prefecture in this study.*

0. Background and Purpose of the Study

This study explores the feasibility of hydrogen supply chain development in Thailand's EEC area through market sizing and cost analysis

Overview of the Study

1 Demand

Future Hydrogen Demand in the EEC area

- ❑ Investigation of potential large-scale hydrogen consumers
- ❑ Hydrogen demand estimation at multiple timeline
- ❑ Cost Parity analysis

2 Supply

Future Hydrogen Supply in the EEC area

- ❑ Investigation of major hydrogen supply Sources in/near EEC area
- ❑ Hydrogen supply volume at multiple by supply sources
- ❑ Hydrogen production cost analysis

3 Transportation

Comparison of Transport Capacity and Prices for Each Transportation Method

- ❑ Study of suitable transportation methods in the EEC area
- ❑ Investigation of transportation costs and total supply costs (production cost + transportation cost)
- ❑ Investigation of transportable quantities

Investigation of Hydrogen Station Installation

- ❑ Investigation of hydrogen station installation locations

4 Regulation

Legal Restrictions related to Hydrogen Transport and Supply

- ❑ Organization of hydrogen related regulations in Thailand (including actual operational conditions)

5 Policy

Consideration of Necessary Policy Support

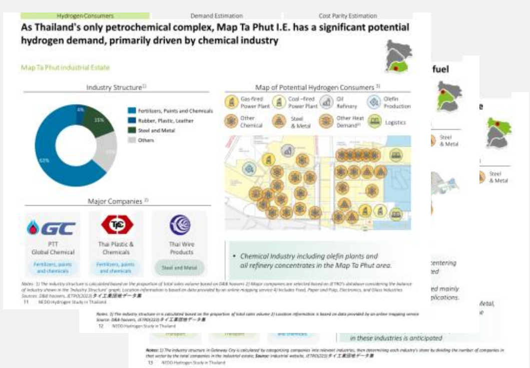
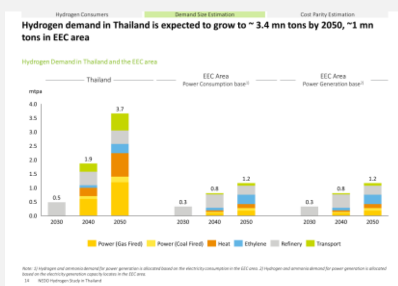
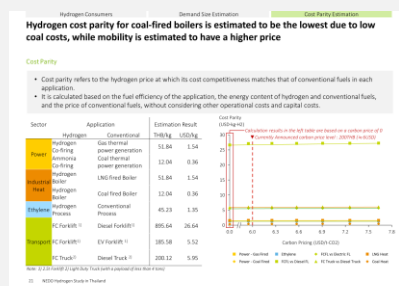
- ❑ Consideration of policy support from both the supply and demand sides, with a primary focus on how to mitigate the cost gap

1. Hydrogen Utilization in the EEC area

- Study on potential hydrogen consumers
- Hydrogen Demand Estimation
- Cost Parity Estimation

We identified major hydrogen consumers and estimated demand in the EEC area, as well as assessed cost parity for major hydrogen applications

1 Demand Summary of the Research Result

	① Study on Potential hydrogen consumers	② Hydrogen Demand Estimation	③ Cost Parity Estimation
Study item	❑ Major hydrogen consumers in the EEC areas	❑ Hydrogen demand in each timeline (2030, 2040, 2050)	❑ Hydrogen Cost Parity and Willingness to Pay (Research + Interview)
Approach	❑ Desk Research – Identify industry categories consuming hydrogen and map potential hydrogen consumers within targeted industrial estates ❑ Interview – Conduct interview with potential hydrogen consumers in the EEC areas (Contents are not disclosed)	❑ Demand Estimation in Thailand – Corrected some errors from the estimation conducted in the previous phase ❑ Demand Estimation in the EEC area – Based on the above estimation, demand in the EEC area is calculated by proportional allocation	❑ Conduct interviews with identified large-scale customers to gather information on KBFs, such as the necessity for additional investment and the maturity/stability of the supply chain.
Results			

Target industrial estates and potential off-takers are selected based on their business size and the potential usage of hydrogen, considering their industry segments

Selection Approach

All industrial estates
in the EEC area
p.8,9

Target industrial estates
in the EEC area
p.11-13

Industry Sectors
with hydrogen demand
p.10-13

Companies
with hydrogen demand
p.11-13

Select target industrial estates based on two criteria

1. *Availability of information*
2. *Scale of an industrial park*

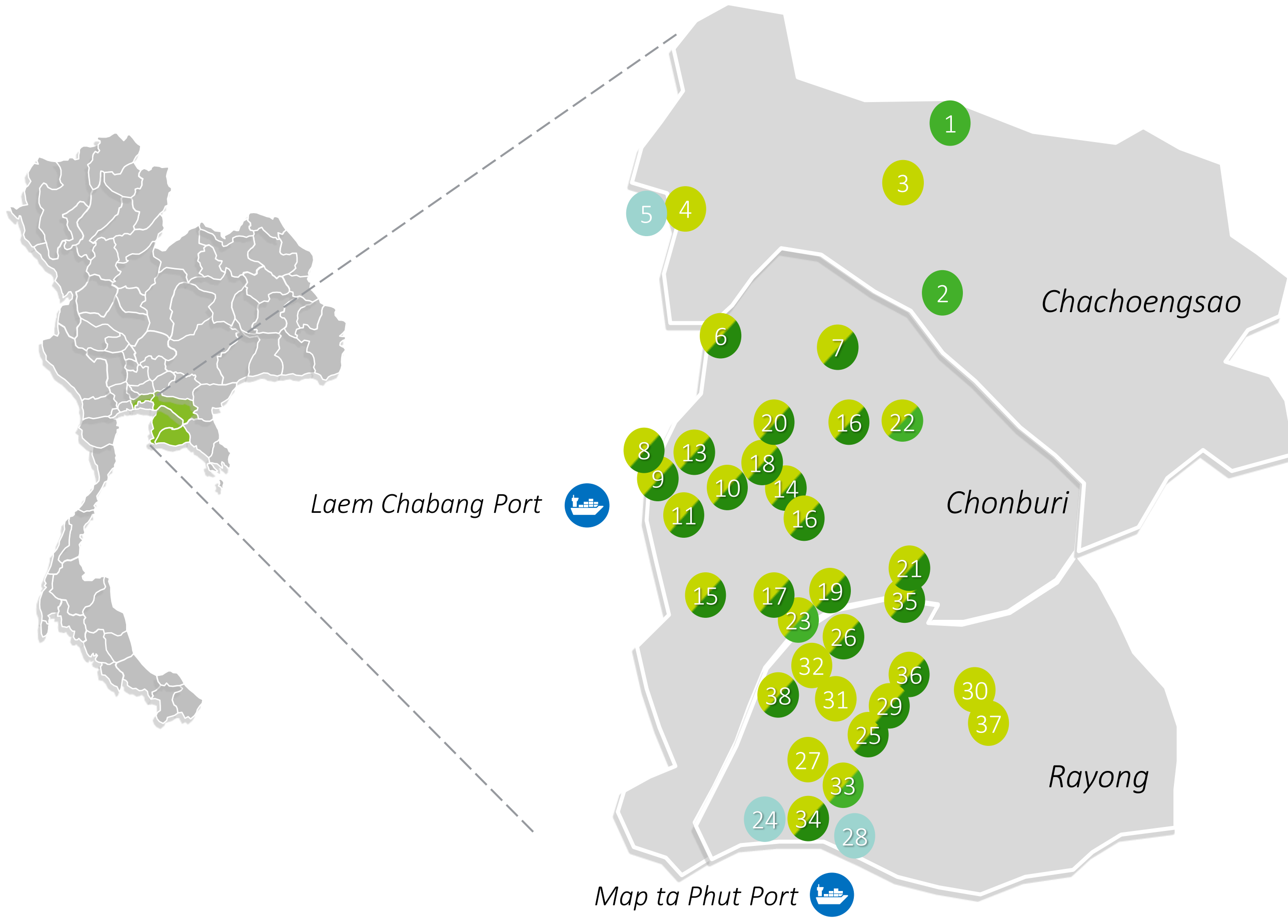
Select target industries based on potential needs of hydrogen

1. *Power Industry*
2. *Hard to Abate industries (especially Steel and Chemical)*
3. *Industry with Heat demand (other than 2)*

Select potential hydrogen consumers and conduct interviews with these companies(contents are not disclosed)

Focused industrial estate was selected from all industrial estates in EEC regions, as listed on the Industrial Estate Authority of Thailand (IEAT) website

Industrial Estates in the EEC Area[1)]



The color of the circular markers indicates the main industries of each industrial park. The main industries reflect up to two key industries mentioned in the industrial park survey published by JETRO.

- Automotive
- Machinery
- Electronics

Automotive industry and its related industries, such as the machinery and electronics industries, are concentrated in the EEC area

- Chemicals

Petrochemical industry is concentrated in the Map Ta Phut area in addition to the above mentioned industries.

Notes: 1) The above list of industrial parks is based on the list published by the EEC, and has been compiled by referencing the IEAT website and past surveys from JETRO

Sources: EEC (2019). EEC-Promotional Zones; EEC-EEC Capital City, WISE (2025). Thailand Industrial Park MAP - Check out the tenants! - Wise Digital [Information site for people living in Thailand], IEAT (n.d.). Industrial Estate Authority of Thailand (IEAT) , JETRO(2023)タイ工業団地データ集

Focused industrial estate area was selected from all industrial estates in EEC regions, as listed on the Industrial Estate Authority of Thailand (IEAT) website

Industrial Estates in the EEC Area

Chachoengsao region

1	304 Industrial Park
2	Apex Green Industrial Estate
3	Gateway City Industrial Estate
4	TFD I.E. (2nd Project)
5	Wellgrow I.E. 1)

Rayong region

6	Amata City Chonburi I.E. 1)
7	Asia Clean
8	Laem Chabang Industrial Estate
9	Pinthong Industrial Estate
10	Pinthong Industrial Estate (3rd Project)
11	Pinthong Industrial Estate (4th Project)
12	Pinthong Industrial Estate (5th Project)
13	Pinthong Industrial Estate (Laem Chabang)
14	Rojana Chonburi
15	Rojana Laem Chabang
16	Rojana Nongyai
17	WHA Chonburi I.E.1 1)
18	WHA Chonburi I.E.2 1)
19	WHA Eastern Seaboard I.E.1 1)
20	WHA Eastern Seaboard I.E.2 1)
21	WHA Eastern Seaboard I.E.3 1)
22	Yamamoto Industries I.E. 1)

Chonburi region

23	Amata City Rayong I.E. 1)
24	Asia Industrial Estate
25	CPGC I.E. (Rayong)
26	Eastern Seaboard I.E. (Rayong) 1)
27	EGCO Rayong Industrial Estate
28	Map Ta Phut Industrial Estate
29	Pinthong Industrial Estate (6th Project)
30	Rojana (Rayong 1)
31	Rojana (Rayong 2)
32	Siam Eastern Industrial Park 1
33	Smart Park I.E. 1)
34	WHA Eastern Industrial Estate
35	WHA Eastern Seaboard I.E. 1 1)
36	WHA Eastern Seaboard I.E. 4 1)
37	WHA Industrial Estate (Rayong)
38	WHA Rayong Industrial Estate 36

Notes: 1) I.E. stands for Industrial Estate. The name of each Industrial Estate mostly follows the English name shown on the EEC website. Minor corrections/alignments have been made for those with clear translation errors.
Sources: EEC (2019). EEC-Promotional Zones; EEC-EEC Capital City, WISE (2025). Thailand Industrial Park MAP - Check out the tenants! - Wise Digital [Information site for people living in Thailand], IEAT (n.d.). Industrial Estate Authority of Thailand (IEAT) , JETRO(2023)タイ工業団地データ集

Based on the understanding of industrial processes and interviews with stakeholders, the following industrial sectors have been selected as potential hydrogen consumers

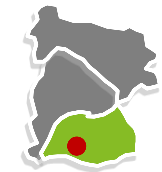
Major Hydrogen Demand in each Industry Sector

These icons and color codes are used in the following slides.

Industry Sector		Demand Category	Demand Volume	Detail Use of Hydrogen
Power	Gas Thermal	Hydrogen co-firing	Large	Used in co-firing in gas-fired power plants (blending hydrogen with natural gas)
	Coal Thermal	Ammonia co-firing	Large	Used in co-firing in coal-fired power plants (blending ammonia with coal)
Oil Refinery, Chemical	Oil Refinery	Hydrotreating, Desulfurization	Medium	Petroleum refining processes
	Olefin Production	Material Usage	Large	Hydrogen-based olefin production process as an alternative to naphtha cracking process
		Heat	Medium	High-temperature processes
	Others [1]	Heat	Medium	High-temperature processes
Steel		DRI[2]	Large	low-carbon steel production as an alternative to blast furnaces.
		Heat	Medium	High-temperature processes
Metal		Heat	Medium	High-temperature heating
Paper and Pulp		Heat	Medium	High-temperature heating
Food		Heat, Hydrogenation	Medium	High-temperature heating
Electronics		Heat	Medium	High-temperature heating
Glass		Heat	Medium	High-temperature heating
Logistics		Mobility Fuel	Medium	Fuel cell vehicles and forklifts in logistics

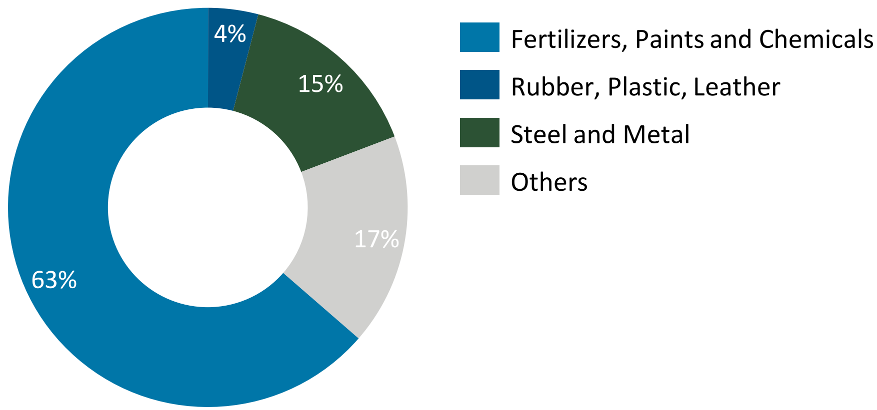
Notes 1) Others include all chemical industry aside from Oil Refinery and Olefin Plants. 2) Since there are no blast furnaces in Thailand, hydrogen demand for DRI is not considered in this study.

As Thailand's only petrochemical complex, Map Ta Phut I.E. has a significant potential hydrogen demand, primarily driven by chemical industry

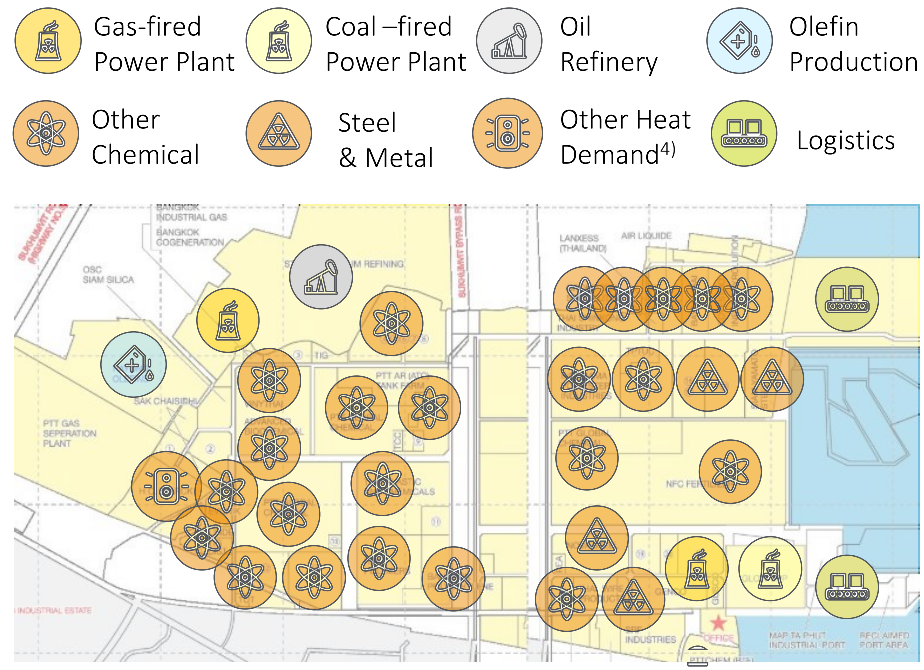


Map Ta Phut industrial Estate

Industry Structure[1)]



Map of Potential Hydrogen Consumers [3)]



Major Companies [2)]

PTT Global Chemical	Thai Plastic & Chemicals	Thai Wire Products
Fertilizers, paints and chemicals	Fertilizers, paints and chemicals	Steel and Metal

- *Chemical Industry including olefin plants and oil refinery concentrates in the Map Ta Phut area.*

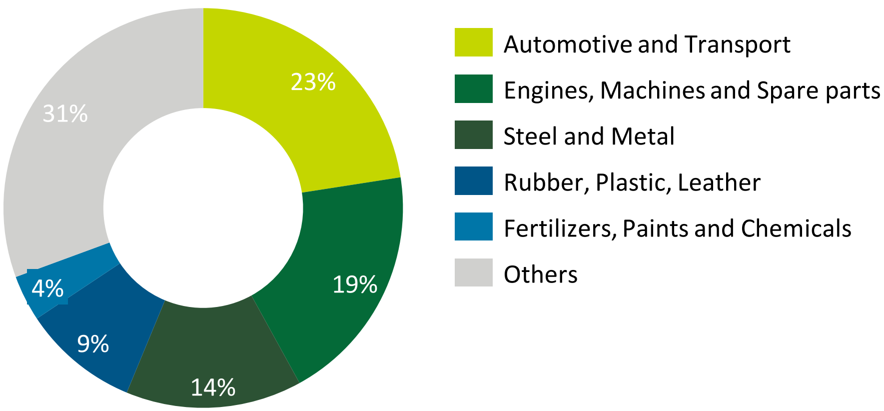
Notes: 1) The industry structure is calculated based on the proportion of total sales volume based on D&B hoovers 2) Major companies are selected based on JETRO's database considering the balance of industry shown in the 'Industry Structure' graph, Location information is based on data provided by an online mapping service 4) Includes Food, Paper and Pulp, Electronics, and Glass Industries

Sources: D&B hoovers, JETRO(2023) タイ工業団地データ集

Amata Chonburi hosts a wide range of industries, and the aggregated heat and fuel demand is expected to generate a significant hydrogen demand

Amata City Chonburi Industrial Estate

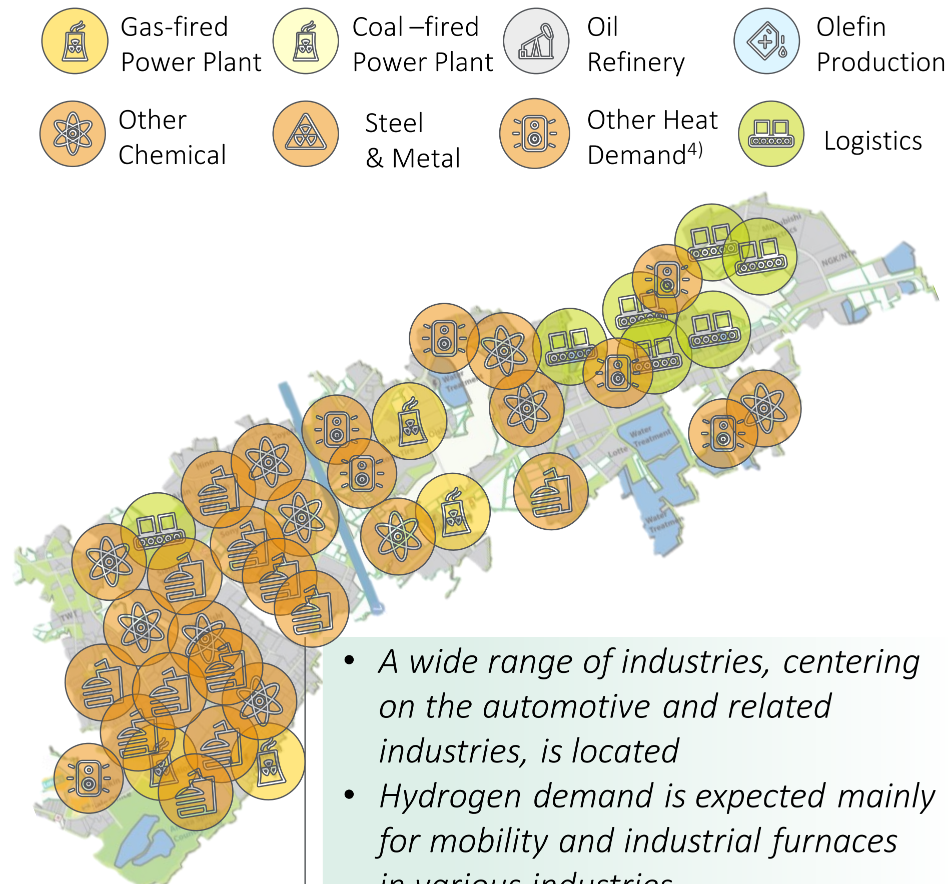
Industry Structure[1)]



Major Companies[2)]

Hino Motors	Siam Kubota Corporation	Daikin Industries
Automotive and Transport	Engines, Machines, and Spare parts	Engines, Machines, and Spare parts

Map of Potential Hydrogen Consumers[3)]



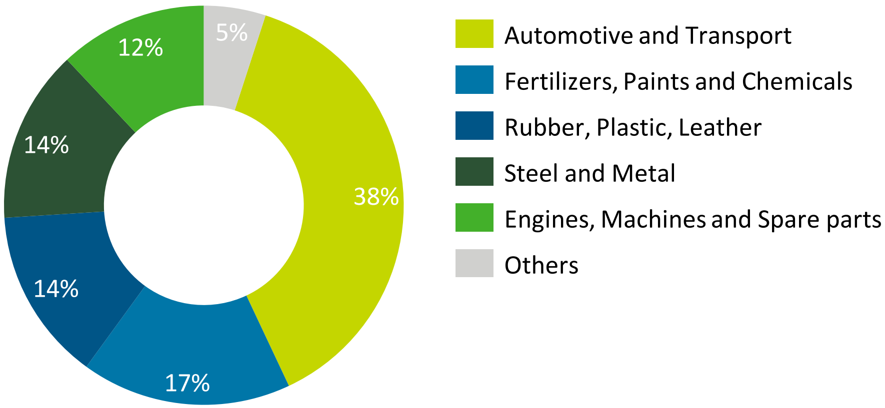
- *A wide range of industries, centering on the automotive and related industries, is located*
- *Hydrogen demand is expected mainly for mobility and industrial furnaces in various industries*

Notes: 1) The industry structure is calculated based on the proportion of total sales volume based on D&B hoovers 2) Major companies are selected based on JETRO's database considering the balance of industry shown in the 'Industry Structure' graph, Location information is based on data provided by an online mapping service 4) Includes Food, Paper and Pulp, Electronics, and Glass Industries,
Sources: D&B hoovers, JETRO(2023) タイ工業団地データ集

The automotive and related industries are concentrated in Gateway City, where hydrogen demand for logistics purposes in these industries is anticipated

Gateway City Industrial Estate

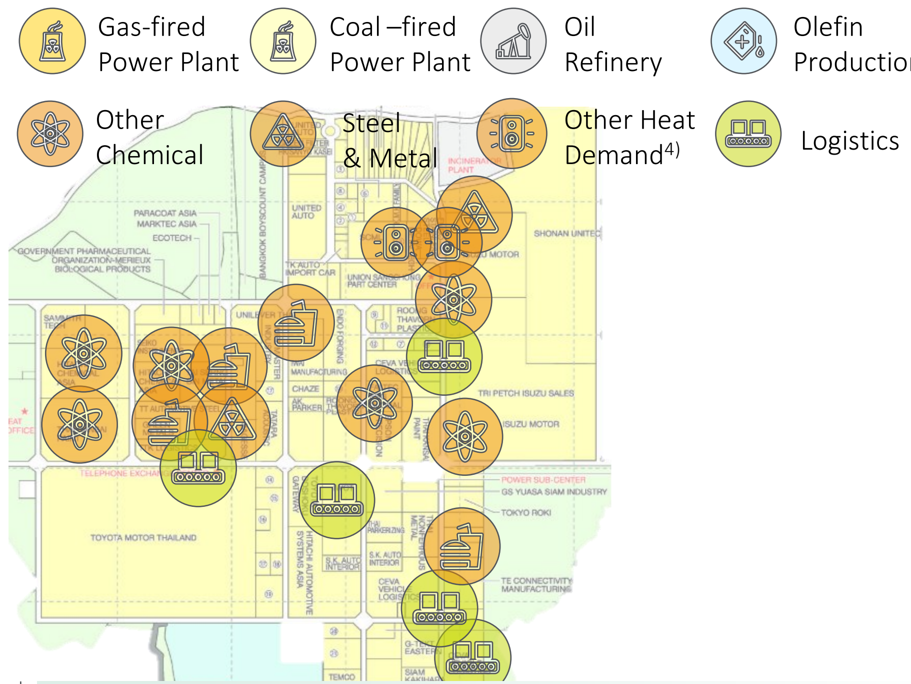
Industry Structure[1]



Major Companies[2]

Toyota Motor	Isuzu Motor	Kansai Paint
Automotive and Transport	Automotive and Transport	Fertilizers, paints and chemicals

Map of Potential Hydrogen Consumers[3]



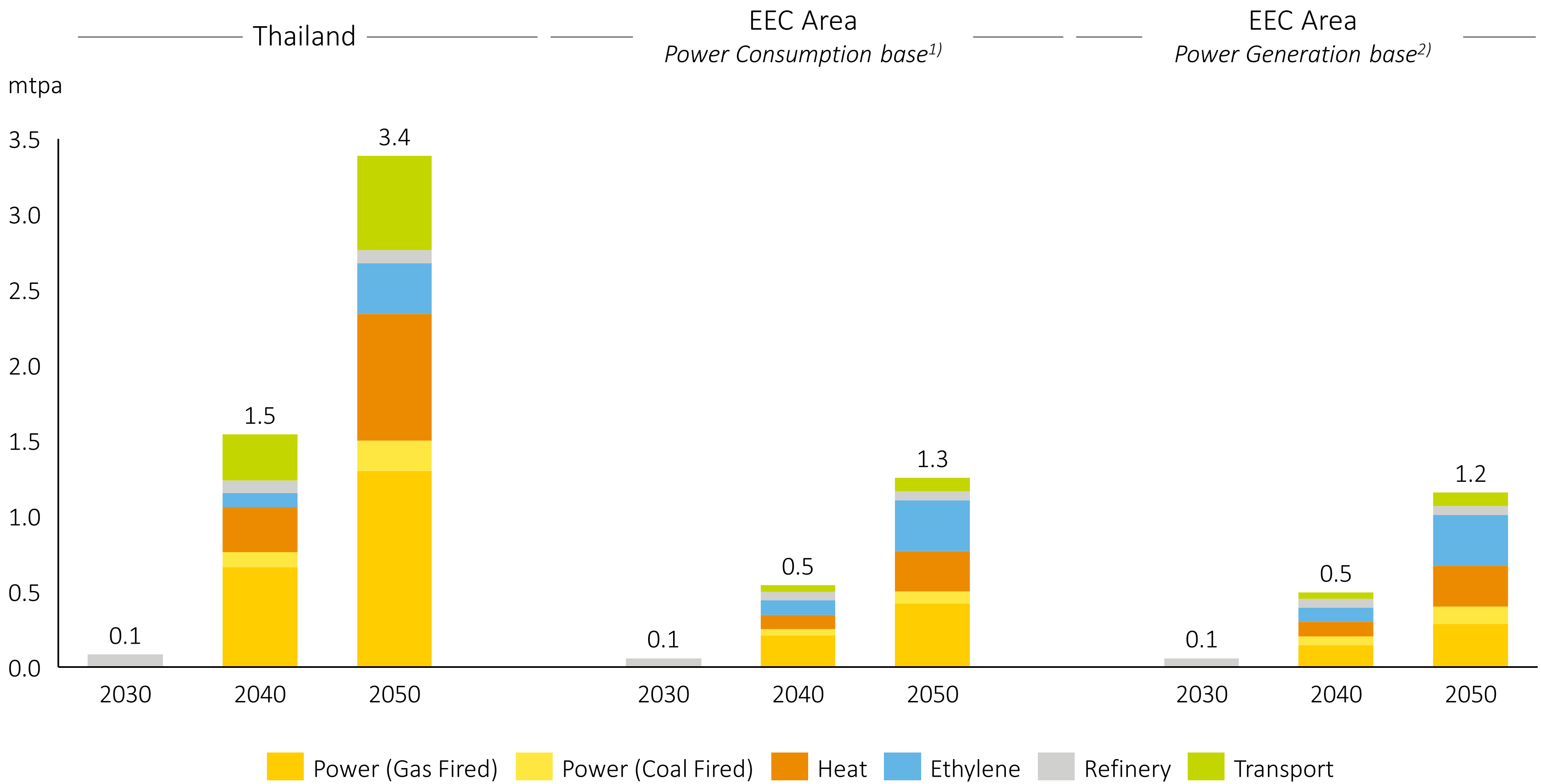
- *Automotive industry and related industries (Metal, Machine, Paint, and so on) concentrates in the area.*
- *Hydrogen demand for logistics purposes in these industries is anticipated*

Notes: 1) The industry structure in Gateway City is calculated by categorizing companies into relevant industries, then determining each industry's share by dividing the number of companies in that sector by the total companies in the industrial estate 2) Major companies are selected based on JETRO's database considering the balance of industry shown in the 'Industry Structure' graph, Location information is based on data provided by an online mapping service 4) Includes Food, Paper and Pulp, Electronics, and Glass Industries

Sources: Industrial website, JETRO(2023)タイ工業団地データ集

Hydrogen demand in Thailand is expected to grow to ~ 3.4 mtpa by 2050, ~1.3 mtpa in the EEC area

Hydrogen Demand in Thailand and the EEC area



Notes: 1) Hydrogen and ammonia demand for power generation is allocated based on the GDP proportion of the secondary industry in the EEC area. 2) Hydrogen and ammonia demand for power generation is allocated based on the electricity generation capacity locates in the EEC area.

Hydrogen and ammonia demand for co-firing in gas-fired and coal-fired power plants are considered

Approach | Power Generation

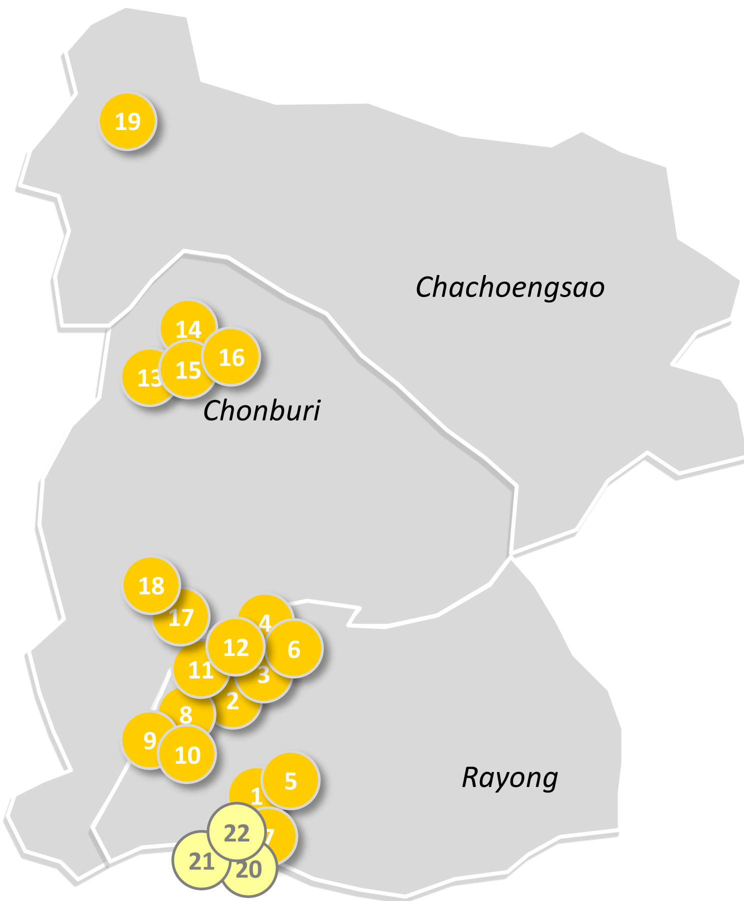
Calculation approach		• Estimation for both gas-fired and coal-fired power generation is based on the following approach: hydrogen co-firing is assumed for gas-fired plants and ammonia co-firing for coal plants. Ammonia demand is converted to Hydrogen Equivalent Value based on calorific value.
		  • Hydrogen demand [t] = Hydrogen quantity per MJ [t/MJ] x Heating value [MJ]
		  • Heating value [MJ] = Heating value per kWh [MJ/kWh] x Total power generation [kWh]
		  • Total Power Generation [kWh] = Σ Total Power Generation Capacity [kW] x Operating hours [h]

Scenario	*Power Genration Capacity*	• Power Generation Capacity of gas-fired and coal fired power plants [GW] is assumed to remain unchanged over 2050 (based on previous year's estimates)
	Hydrogen adoption rate	• Set at 0% in 2030, 15% in 2040, and 30% in 2050 (based on previous year's estimates)
	Proportion Of the EEC area	1. Power Consumption Base: Allocated based on the GDP proportion of the Secondary Industry (incl. Manufacturing, Mining and Construction Industries) : 32% [1)] 2. Power Generation Base: Allocated based on the electricity generation capacity in the EEC area: 22% for Gas-fired power plants, 50% for coal-fired power plants [2)]

Sources and Notes: 1) 日タイ経済協力セミナー/泰日工業大学J-Seminar 講演資料 2023/05/16 2) Power plants considered in this study is shown in the next slide.

Listed gas-fired and coal-fired power plants in the EEC area are considered in the study

Approach | Power Generation, Map of Power Plants in the EEC area



Gas-fired | Coal-fired

1	GNLL	10	Amata (Rayong) 4
2	GVTP	11	Amata (Rayong) 5
3	GTS1 & GTS2	12	GSPP1
4	GTS3 & GTS4	13	Amata 1 & 2
5	GNLL2	14	Amata 3
6	GSRC	15	Amata 4
7	Rayong Co-Gen	16	Amata 5
8	Amata (Rayong) 1 & 2	17	B Grimm (WHA) 1
9	Amata (Rayong) 3	18	Glow IPP
19	GNNK		
20	BLCP	21	Gheco One
22	Glow Energy		

Hydrogen demand for ethylene production is estimated in the case where the naphtha cracking process is converted to a process that utilizes hydrogen

Approach | Ethylene Production

Calculation approach		• Calculate the required hydrogen demand based on the following chemical reaction equation. $5CO_2 + 15H_2 \rightarrow C_2H_4$ (Ethylene) + C_3H_6 (Propylene) + $10H_2O$ • According to the equation, 15 mol of hydrogen and 5 mol of CO_2 recovery are required to produce 1 mol of ethylene and propylene. • Hydrogen demand [t] = Ethylene sales volume in Thailand [mol] × Hydrogen required per mol of production [mol/mol] × Unit conversion [t/mol]
Scenario	*Ethylene sales volume*	• Ethylene production is assumed to remain unchanged until 2050 (based on previous year's estimates)
	Hydrogen adoption rate	• Set at 0% in 2030, 2% in 2040, and 7% in 2050. (10 years later than the IEA's introduction forecast, based on previous years' estimates.)
	Proportion Of the EEC area	• Set at 100%, considering the concentration of ethylene plants in the EEC area.

Hydrogen demand in transportation sector considers the powertrain transition to fuel cell vehicles

Approach | Transportation

Calculation approach		• Energy Consumption in Transport Sector [Mtoe] x Heating Value of Oil [MJ/t] / Heating Value of Hydrogen [MJ/t]
Scenario	*Energy (Fuel) Consumption*	• Energy (Fuel) Consumption is assumed to grow at the same pace projected in the ERIA's energy outlook. (18% by 2030 and 84% by 2050, with 2020 as the reference year)
	Hydrogen adoption rate	• Set at 0% in 2030, 1.5% in 2040, 2.5% in 2050 (Set based on ERIA's hydrogen studies and the proportion of passenger/commercial vehicles)
	Proportion Of the EEC area	• Set as 14.6% based on the GDP proportion of the EEC area [1].

Sources and Notes : 1) 日タイ経済協力セミナー/泰日工業大学J-Seminar 講演資料 2023/05/16

Hydrogen demand in oil refinery is estimated based on the existing hydrogen consumption in oil refinery

Approach | Oil Refinery

Calculation approach		• Hydrogen Demand [t] = Annual Hydrogen Consumption in oil refinery [t/bd] x Capacity of the Oil Refinery in Thailand [bd]
Scenario	*Refinery Generation*	• Oil Refinery Capacity is assumed to remain unchanged until 2050 (based on the previous year's estimates)
	Hydrogen adoption rate	• Given that hydrogen is already being utilized in existing processes, the adoption rate is set at 100% (based on the previous year's estimates).
	Proportion Of the EEC area	• Set at 70%, allocated based on the proportion of oil refinery capacity in the EEC area

Hydrogen demand for heat is estimated considering the introduction of hydrogen as a heat Sources in industrial sectors

Approach | Industrial Heat

Calculation approach		• Hydrogen Demand [t] = Heat consumption [MJ] x Hydrogen quantity per MJ [t/MJ]
Scenario	*Heat Consumption*	• Heat Consumption is assumed to grow at the same pace projected in the ERIA's energy outlook. (18% by 2030 and 84% by 2050, with 2020 as the reference year)
	Hydrogen adoption rate	• Set at 0% in 2030, 3% in 2040, and 7% in 2050 (based on the previous year's estimates)
	Proportion Of EEC area	• Set as 32% based on the GDP proportion of the Secondary Industry (incl. Manufacturing, Mining and Construction Industries) [1]

Sources and Notes : 1) 日タイ経済協力セミナー/泰日工業大学J-Seminar 講演資料 2023/05/16

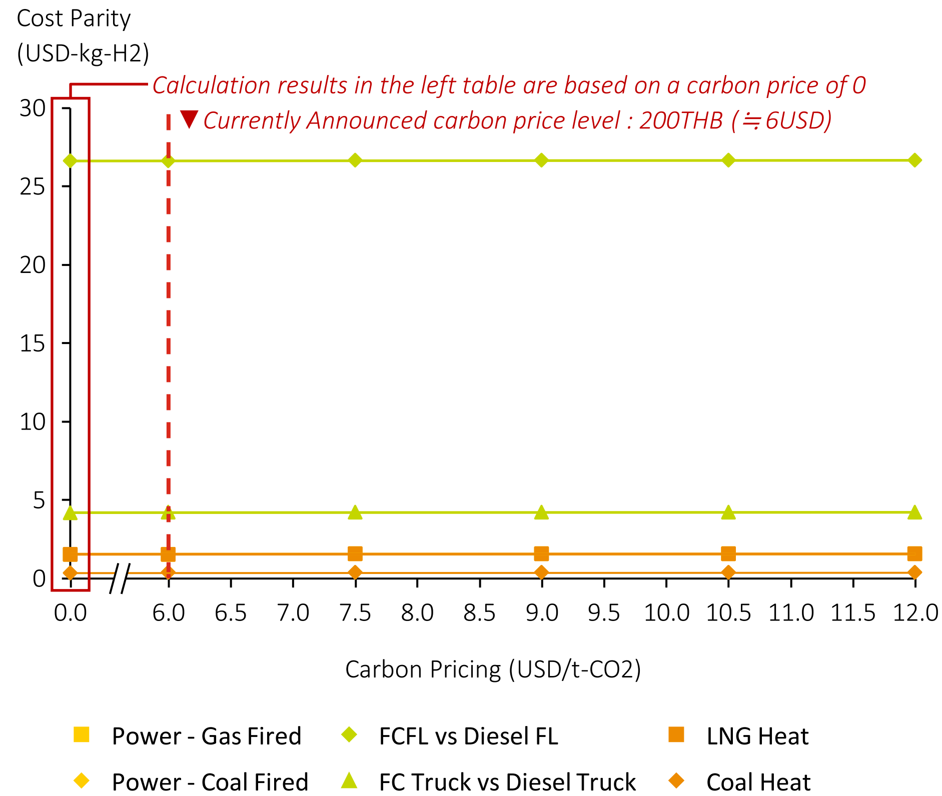
Hydrogen cost parity for coal-fired boilers is estimated to be the lowest due to low coal costs, while mobility is estimated to have a higher price

Cost Parity

- Cost parity refers to the hydrogen price at which its cost competitiveness matches that of conventional fuels in each application.
- It is calculated based on the fuel efficiency of the application, the energy content of hydrogen and conventional fuels, and the price of conventional fuels, without considering other operational costs and capital costs.

Sector	Application		Estimation Result	
	Hydrogen	Conventional	THB/kg[3]	USD/kg
Power	Hydrogen Co-firing	Gas thermal power generation	46.26	1.54
Power	Ammonia Co-firing	Coal thermal power generation	10.75	0.36
Industrial Heat	Hydrogen Boiler	LNG fired Boiler	46.26	1.54
Industrial Heat	Hydrogen Boiler	Coal fired Boiler	10.75	0.36
Ethylene	Hydrogen Process	Conventional Process	62.83	2.10
Transport	FC Forklift [1]	Diesel Forklift[1]	799.20	26.64
Transport	FC Forklift[1]	EV Forklift [1]	165.60	5.52
Transport	FC Truck[2]	Diesel Truck [2]	126.00	4.20

Notes: 1) 2.5t Forklift 2) Light Duty Truck (with a payload of less than 4 tons) 3)1USD=30THB



Cost Parity is calculated based on the fuel efficiency of the application, the energy content of hydrogen and conventional fuels, and the price of conventional fuels

Approach [1]

Power	Gas Thermal	• Cost Parity [USD/kg] = LNG Price [USD/kg] × Conversion value of Hydrogen/LNG
	Coal - Thernal	• Cost Parity (Coal) [USD/kg] = Coal Price [USD/kg] × Conversion value of Ammonia/Coal x Conversion value of Hydrogen/Ammonia
Heat	Gas Thermal	• Cost Parity (LNG) [USD/kg] = LNG Price [USD/kg] × Conversion value of Hydrogen/LNG
	Coal - Thernal	• Cost Parity (Coal) [USD/kg] = Coal Price [USD/kg] × Conversion value of Ammonia/Coal x Conversion value of Hydrogen/Ammonia
Ethylene		• Cost Parity [USD/kg] = (Ethylene/Propylene Production Cost [USD] – Carbon Capture Cost [USD]) / Hydrogen Production Amount [Kg] • Carbon Capture Cost [USD] = Amount of CO2 Capture Required [t] x Cost per ton [USD/t]
Transport	Diesel FL	• Cost parity [USD/kg] = Diesel Price [USD/L] * Fuel Economy of Diesel FL [L/km] x Fuel Economy of FC FL [km/kg]
	EV FL	• Cost Parity [USD/kg] = Electricity Price [USD/kWh] * Fuel Economy of Diesel FL [kWh/km] x Fuel Economy of FC FL [km/kg]
	Diesel Truck	• Cost parity [USD/kg] = Diesel Price [USD/L] * Fuel Economy of Diesel FL [L/km] x Fuel Economy of FC FL [km/kg]

Sources: 1) The calculation approach follows the cost parity estimation method used by the Hydrogen Policy Committee of Japan's METI
https://www.meti.go.jp/shingikai/enecho/shoene_shinene/suiso_seisaku/pdf/002_01_00.pdf

Cost Parity is calculated based on the fuel efficiency of the application, the energy content of hydrogen and conventional fuels, and the price of conventional fuels

Assumptions

Currency		
USD to Baht	0.03	USD/THB
USD to JPY	0.01	USD/JPY
Price		
Hydrogen [1]	45.00	USD/kg
LNG [2]	13.50	USD/MMBTu
Coal [3]	65.80	USD/t
Ethylene [4]	910.00	USD/t
Propylene [4]	930.00	USD/t
Diesel [1]	0.90	USD/l
Electricity [1]	0.15	USD/kWh
CO2 Capture Cost [5]	8.33	USD/t
Fuel Economy		
FC Forklift [1]	0.13	kg/h
Diesel Forklift [1]	3.70	l/h
EV Forklift [1]	4.60	kWh/h
FC Truck [5]	6	km/L
EV Truck [5]	28	km/kg

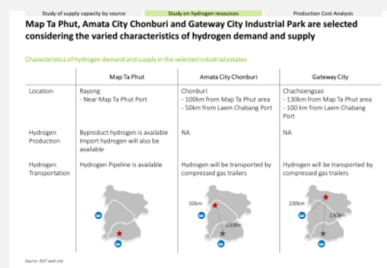
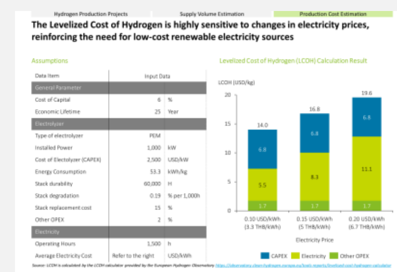
Note: Numbers are rounded off to be nearest whole number. Sources: 1) Approximate value od cost and fuel economy data are obtained from FL company. 2) Thaiger News 3) Medium .com 4)ECHEMI.COM As of December, 2024 5) Hydrogen Policy Committee of Japan's METI

2. Hydrogen Production in the EEC area

- Study on Hydrogen Supply Capacity by Sources
- Study on Hydrogen Resources available in the EEC area
- Production Cost Analysis

We examined the available hydrogen sources for each target year and conducted a production cost analysis

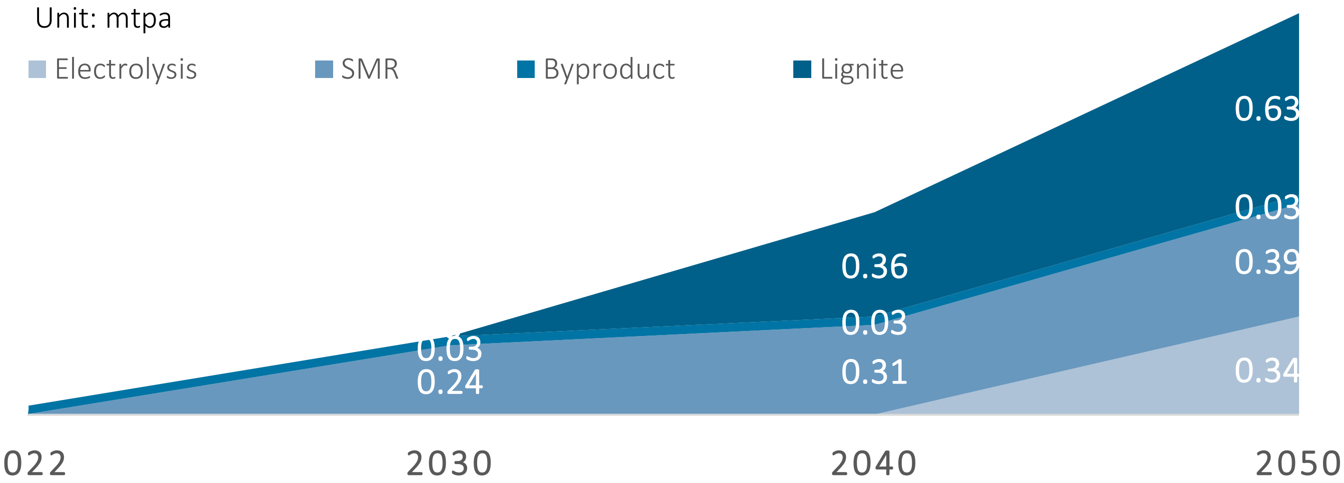
2 Supply Future Hydrogen Supply Network in the Thailand EEC Area

	① Study on Hydrogen Supply Capacity by Sources	② Study on Hydrogen Resources available in the EEC area	③ Production Cost Analysis
Study item	❑ Supply capacity in Thailand and EEC area at each timeline	❑ Major hydrogen resources available in/near EEC area	❑ Production Cost of Hydrogen
Approach	❑ Identify available hydrogen sources for each target year: 2030, 2040, and 2050	❑ Desk Research – Investigate key hydrogen sources and their production locations. ❑ Interview – Conduct interviews with stakeholders to discuss available hydrogen sources based on actual circumstances.	❑ Desk Research – Calculate production cost for RE electrolysis and biogas SMR ❑ Interview – Conduct interviews with stakeholders to confirm the validity of the calculation results
Results			

Domestic hydrogen supply potential is projected as 1.39 mtpa in 2050 in consideration to Electrolysis, SMR-Biogas, Byproduct and Lignite

Domestic Hydrogen Production in Thailand

**Please Notes that this calculation is conducted in 2023, prior to the announcement of the new draft of PDP*



Domestic Hydrogen Production	0.03	0.27	0.70	1.39
Byproduct (external sales)	0.03	0.03	0.03	0.03
Lignite	0	0	0.36	0.63
Steam Methane Reforming- Biogas (SMR)	0 (0.18: potential)	0.24 (+0.8: crop residue0.8)	0.31 (+0.8: crop residue0.8)	0.39 (+0.8: crop residue0.8)
Electrolysis	0	0	0	0.34

In the short term, building a hydrogen supply chain utilizing by-product hydrogen from the Map Ta Phut area is the most feasible approach

Available hydrogen sources in the EEC area by time frame

Current ~ 2030 | ~2040 | ~2050

Scenario

- *Carbon price has not been introduced. Renewable electricity and biogas costs are still high.*
- *Applications utilizing hydrogen have not been widely adopted, and hydrogen demand is limited.*

Implication

- ***Utilizing by-product hydrogen*** *in the Rayong area, where both supply volume and supply infrastructure are well-established, is likely to be more feasible. In area where onsite renewable electricity is largely installed, hydrogen from renewable electricity can be cost competitive*

	Byproduct	Lignite + CCS	Renewable Electricity	Biogas	Import (Blue)
Production Cost	*1-6 USD/kg[1)]*	*2 USD/kg[2)]* • *Lignite SMR: Low* • *CCS; Uncertain*	*3-8 USD/kg[2)]* • *RE: High* • *Electrolysis: High*	*2- USD/kg[2)]* • *Biogas: High* • *SMR: High*	*2 USD/kg[2)]* • *Depends on the Sources, but should be low*
Production Potential	*0.03* • *Significant amount is already being supplied*	*0 -* • *Abundant lignite is available in Thailand, but not in EEC area*	*0 -* • *In areas where onsite RE is largely installed*	*0 - 0.24* • *Abundant biogas are available in Thailand, but not in EEC area*	*--* • *Utilized to supplement domestic demand*
Availability in the EEC area	• *Available in the Map Ta Phut area*	• *Lignite is not suitable for long-distance transportation*	• *In areas where onsite RE is largely installed*	• *Requires long distance transportation*	• *Hydrogen carrier technology is still under development*
Carbon Intensity	• *Considered as 'Gray' hydrogen*	• *Depends on the volume of CCS*			• *Depends on the volume of CCS*

Notes: 1) Average of various information Sources 2) IEA's estimation. Biogas SMR cost data is unavailable, so natural gas SMR data is used for the Biogas part. Cost of import hydrogen is based on fossil fuel SMR + CCS case. Sources: IEA(2020) CCUS in Clean Energy Transition

In the medium term, effectively utilize imported hydrogen while continuing to utilize by-product hydrogen

Available hydrogen sources in the EEC area by time frame

Current ~ 2030 | ~2040 | ~2050

Scenario

- *Carbon price has been introduced. Renewable electricity and biogas costs are still high.*
- *Although hydrogen demand will gradually begin to emerge, willingness to pay for hydrogen price still remains low.*

Implication

- *Besides continuing to use by-product/renewable hydrogen (depends on the location), **effectively utilize imported hydrogen, which is relatively low-cost and in sufficient supply**, to supplement the hydrogen supply.*

	Byproduct	Lignite + CCS	Renewable Electricity	Biogas	Import (Blue)
Production Cost	*1-6 USD/kg[1)]*	*2 USD/kg[2)]* • *Lignite SMR: Low* • *CCS: Uncertain*	*1-6 USD/kg[2)]* • *RE: High* • *Electrolysis: High*	*2- USD/kg[2)]* • *Biogas: High* • *SMR: High*	*2 USD/kg[2)]* • *Depends on the Sources, but should be low*
Production Potential	*0.03* • *Significant amount is already being supplied*	*0 - 0.36* • *Abundant lignite is available in Thailand, but not in EEC area*	*0* • *In areas where onsite RE is largely installed*	*0.24 – 0.31* • *Abundant biogas are available in Thailand, but not in EEC area*	*--* • *Utilized to supplement domestic demand*
Availability in the EEC area	• *Available in the Map Ta Phut area*	• *Lignite is not suitable for long-distance transportation*	• *In areas where onsite RE is largely installed*	• *Requires long distance transportation*	• *Import terminal will be developed*
Carbon Intensity	• *Considered as 'Gray' hydrogen*	• *Depends on the volume of CCS*			• *Depends on the volume of CCS*

Notes: 1) Average of various information Sources 2) IEA's estimation. Biogas SMR cost data is unavailable, so natural gas SMR data is used for the Biogas part. Cost of import hydrogen is based on fossil fuel SMR + CCS case. Mid-term cost outlook is not provided in database, so the average of the short-term and long-term cost outlooks is used. Sources: IEA(2020) CCUS in Clean Energy Transition

In the long term, maximize the effective use of domestic resources such as biogas and renewable electricity, while also effectively utilizing imported hydrogen

Available hydrogen sources in the EEC area by time frame

Current ~ 2030 | ~2040 | **~2050**

Scenario

- *Carbon price has been increased. Renewable electricity and biogas costs become low.*
- *Applications utilizing hydrogen have been widely adopted, and large demand for hydrogen exist.*

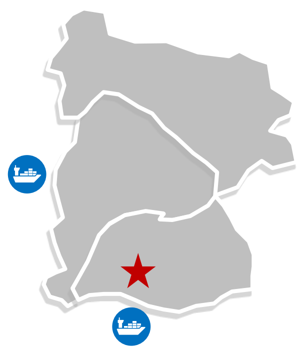
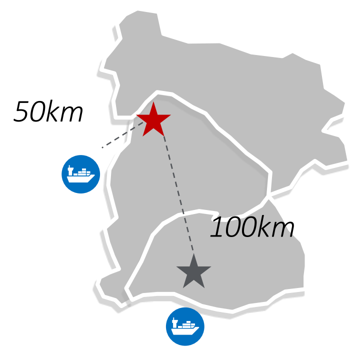
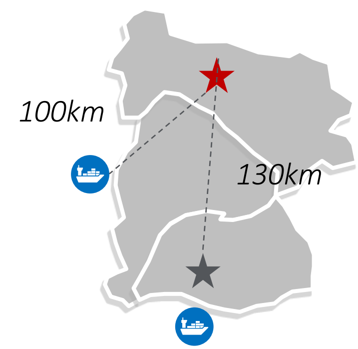
  *→ **Maximize the effective use of domestic resources such as biogas and renewable electricity**, while also effectively utilizing imported hydrogen.*

	Byproduct	Lignite + CCS	Renewable Electricity	Biogas	Import (Blue)
Production Cost	*1-2 USD/kg[1)]*	*2 USD/kg[2)]* • *Lignite SMR: Low* • *CCS: Uncertain*	*1-3 USD/kg[2)]* • *RE: Low* • *Electrolysis: Low*	*2- USD/kg[2)]* • *Biogas: Low* • *SMR: Low*	*2 USD/kg[2)]* • *Depends on the Sources, but should be low*
Production Potential	*0.03* • *Significant amount is already being supplied*	*0.36 - 0.63* • *Abundant lignite is available in Thailand*	*0 - 0.34* • *Sufficient RE installed capacity*	*0.31 – 0.39* • *Abundant biogas are transported to EEC area cost effectively*	*--* • *Utilized to supplement domestic demand*
Availability in the EEC area	• *Available in the Map Ta Phut area*	• *Lignite is not suitable for long-distance transportation*	• *In areas where onsite RE is largely installed*	• *Transportation scheme or infrastructure will be established*	• *Import terminal will be developed*
Carbon Intensity	• *Considered as 'Gray' hydrogen*	• *Depends on the volume of CCS*			• *Depends on the volume of CCS*

Notes: 1) Average of various information Sources 2) IEA's estimation. Biogas SMR cost data is unavailable, so natural gas SMR data is used for the Biogas part. Cost of import hydrogen is based on fossil fuel SMR + CCS case, Sources: IEA(2020) CCUS in Clean Energy Transition

A different hydrogen supply strategy is needed, considering the differing characteristics of hydrogen demand and supply

Characteristics of hydrogen demand and supply in the selected industrial estates

	Map Ta Phut	Amata City Chonburi	Gateway City
Location	Rayong - Near Map Ta Phut Port	Chonburi - 100km from Map Ta Phut area - 50km from Laem Chabang Port	Chachoengsao - 130km from Map Ta Phut area - 100 km from Laem Chabang Port
Hydrogen Production	Byproduct hydrogen is available Import hydrogen will also be available	NA	NA
Hydrogen Transportation	Hydrogen Pipeline is available	Hydrogen needs to be transported by trailers, or produced onsite from RE	Hydrogen needs to be transported by trailers, or produced onsite from RE
		 	

Sources: IEAT web site

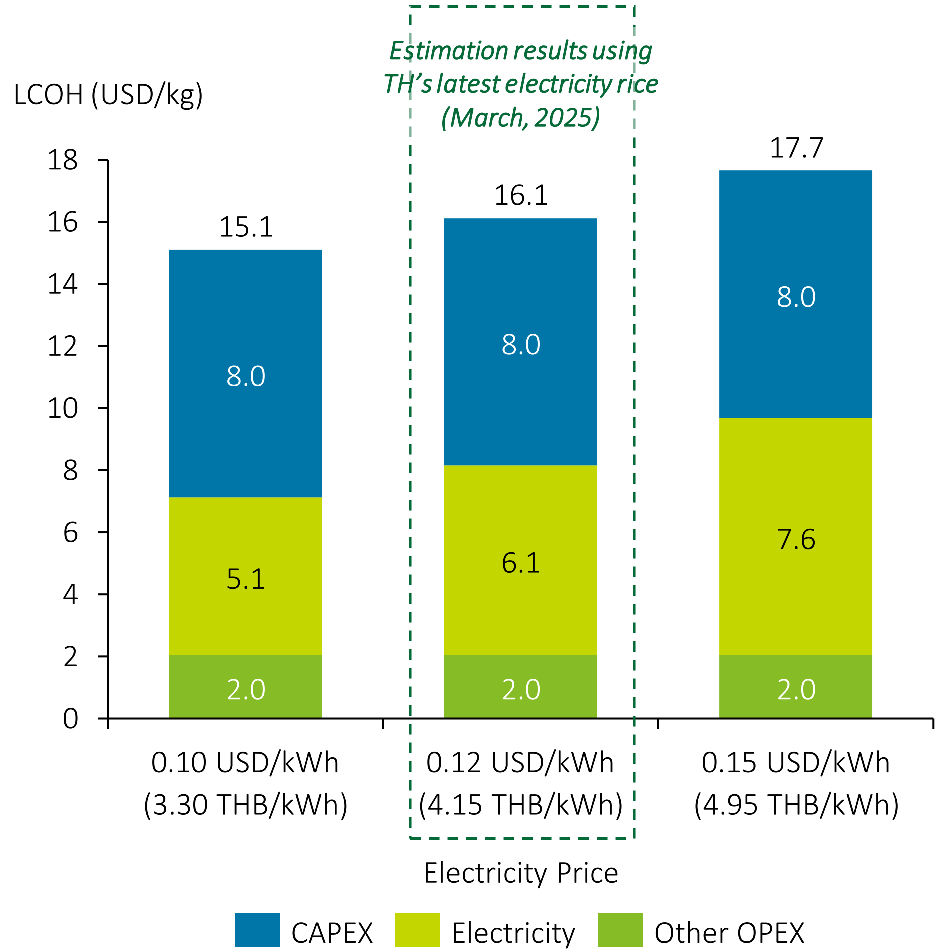
The Levelized Cost of Hydrogen is highly sensitive to changes in electricity prices, reinforcing the need for low-cost renewable electricity Sources

Assumptions

Annual Hydrogen Production : 37.5 t-H2/year *

Data Item	Input Data	
General Parameter		
Cost of Capital	6	%
Economic Lifetime	25	Year
PEM Electrolyzer		
Type of Electrolyzer	PEM	
Installed Power	1,500	kW
Cost of Electrolyzer (CAPEX)	2,500	USD/kW
Energy Consumption	50	kWh/kg
Stack durability	60,000	H
Stack degradation	0.2	% per 1,000h
Stack replacement cost	15	%
Other OPEX	2	%
Electricity		
Operating Hours	1,250	h
Average Electricity Cost	Refer to the right	USD/kWh

Levelized Cost of Hydrogen (LCOH) Calculation Result



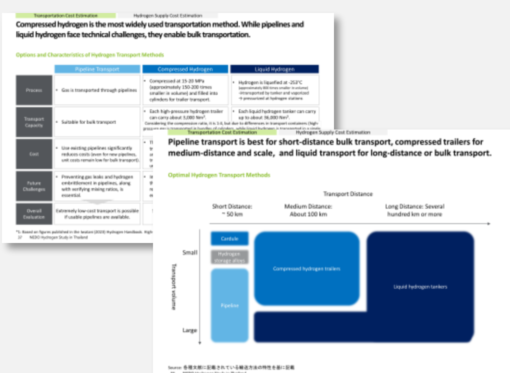
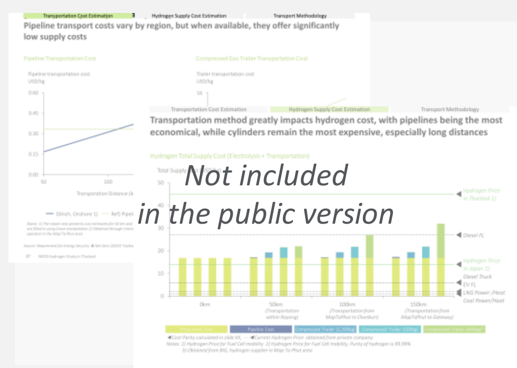
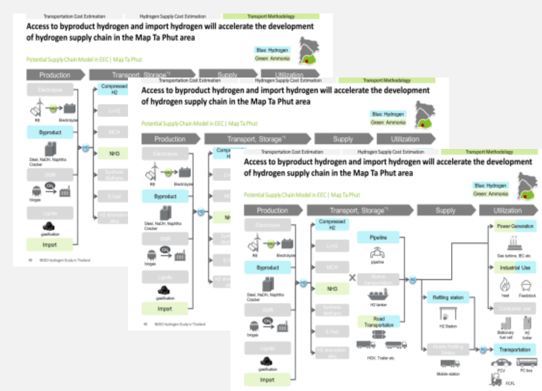
Sources: Annual Hydrogen Production volume is calculated based on the installed capacity, operating hours, and Energy Efficiency of the Electrolyzer. Installed Power and Operating Hours are set to align closely with the approximate production scale of the hydrogen station installed in Pattaya (150kg-H2 production at maximum). LCOH is calculated by the LCOH calculator provided by the European Hydrogen Observatory (Accessed Date" March 12, 2025) https://observatory.clean-hydrogen.europa.eu/tools-reports/levelised-cost-hydrogen-calculator

3. Hydrogen Transportation in the EEC area

- Study on Hydrogen transportation options
- Transportation Cost Analysis
- Total Hydrogen Supply Cost Analysis

We reviewed the characteristics of hydrogen transport options and estimated transport costs in the EEC area

3 Transport Comparison of Transport Capacity and Costs for Each Method

	① Study on Hydrogen transportation options	② Transportation Cost Analysis	③ Study on Hydrogen transportation Options in the EEC area
Study item	❑ Available/Suitable hydrogen transportation options	❑ Transport costs ❑ Total Supply Cost(Production + Transportation)	❑ Total Supply Cost(Production + Transportation)
Approach	❑ Desktop Research. ❑ Interviews with hydrogen supplier in the EEC area	❑ Desktop Research ❑ Interviews with hydrogen supplier in the EEC area	❑ Desktop Research ❑ Interviews with hydrogen supplier in the EEC area
Deliverables image			

Compressed hydrogen remains the most commonly used transport method; however, pipelines and liquid hydrogen offer advantages for large-scale transport

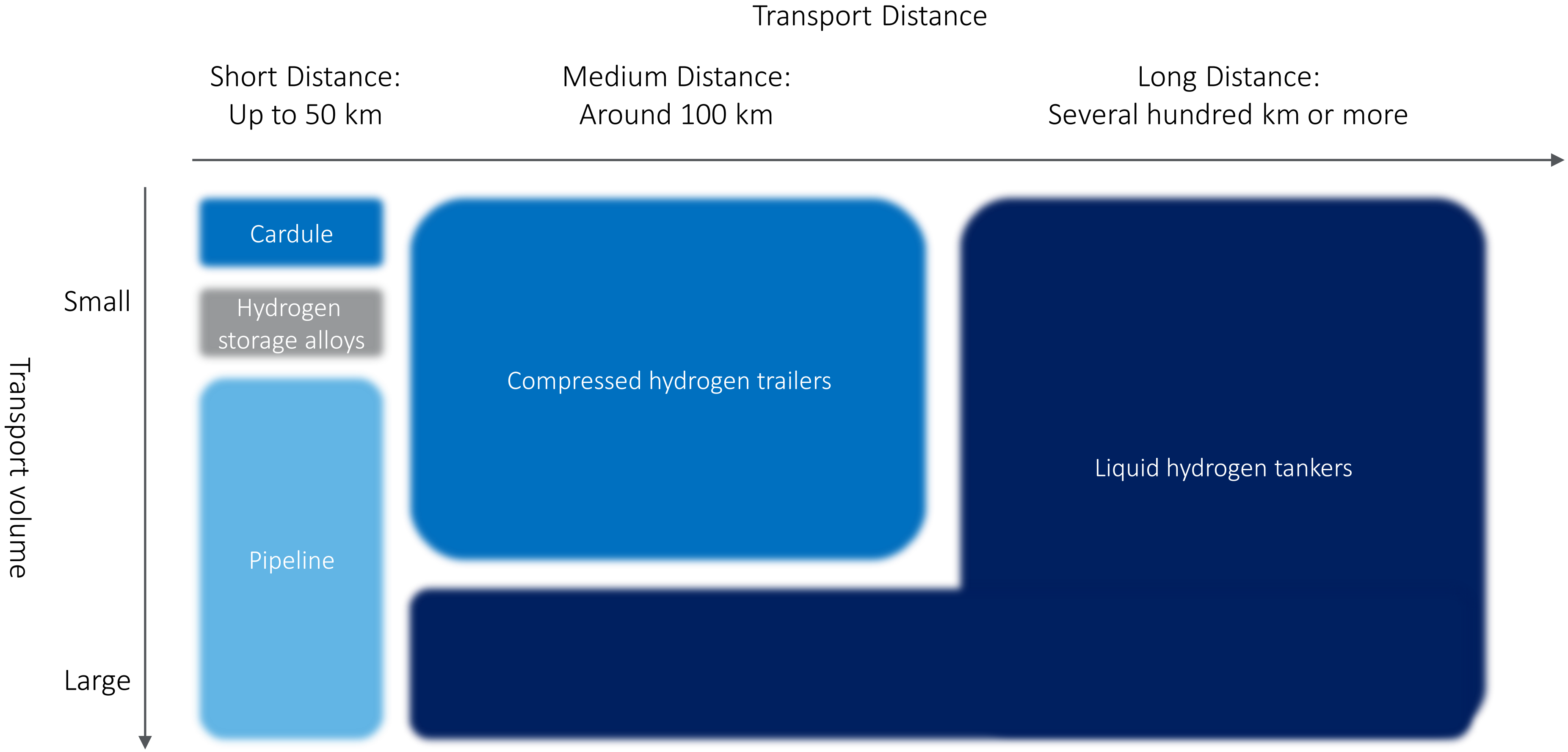
Options and Characteristics of Hydrogen Transport Methods

	Pipeline	Compressed Hydrogen	Liquid Hydrogen
Process	• Transported through pipelines	• Compressed at 15-20 MPa[1)] (approximately 150-200 times smaller in volume) and filled into cylinders for trailer transport.	• Hydrogen is liquefied at -253°C (approximately 800 times smaller in volume) →transported by tanker and vaporized → pressurized at hydrogen stations
Volume	• Suitable for large volume transportation	• Each high-pressure hydrogen trailer can carry about 3,000 Nm^3 [1)]. The compression ratio is 1:4, but due to differences in transport containers—bundles of cylinders for high-pressure gas and single tanks for liquid hydrogen—the difference can reach up to 1:12	• Each liquid hydrogen tanker can carry up to about 36,000 Nm^3 [1)].
Cost	• Use existing pipelines significantly reduces costs (even for new pipelines, unit costs remain low for large volume transportation).	• The most standard hydrogen transport method; (however, pipeline and liquid hydrogen have higher transport efficiencies, leading to higher unit costs.)	• Liquid hydrogen transport incurs high liquefaction costs, • But bulk transport reduces unit costs.
Future Challenges	• Preventing gas leaks and hydrogen embrittlement in pipelines, along with verifying mixing ratios, is essential.	• Improvements in transport efficiency through higher pressure and cost reductions in equipment are expected.	• Reduce liquefaction costs • Minimize losses from hydrogen volatility are key.
Overall Evaluation	Enables low-cost transportation if existing pipelines can be utilized.	Suitable for supplying dispersed demand in small quantities	This method is suitable for large demand when pipelines are not available.

Notes: 1) Based on figures published in the Iwatani (2023) Hydrogen Handbook. High-pressure hydrogen trailers with a pressure of 45 MPa have also been developed.

Pipeline transport is best for short-distance bulk transport, compressed trailers for medium-distance and scale, and liquid transport for long-distance or bulk transport

Optimal Hydrogen Transport Methods



Sources: Described based on the characteristics of transportation methods documented in various literature

(Ref.) Cost by transport distance and method from the Hydrogen Council

While pipelines are generally a low-cost option, their availability and transport costs depend significantly on the condition of existing infrastructure

X Priority from Estimation Results

<0.1 USD/kg | 0.1–1 USD/kg | 1–2 USD/kg | >2 USD/kg

Costs		Distribution		Transmission		
		0–50 km	51–100 km	101–500 km	>1,000 km	>5,000 km
Pipelines[1]	Retrofitted	City grid	Regional distribution pipelines	Onshore transmission pipelines		
	New	1	Regio 1 ribution es	Onshor 1 mission p s	tr	
Shipping	LH_2	N/A	N/A	N/A		
	NH_3[2]	N/A	N/A	N/A	NH_3 ship	NH_3 ship
Trucking	LOHC[2]	N/A	N/A	N/A		
	LH_2 trucking	Distribu 3 ck LH_2	Distrib 3 uck LH_2	Distrib 2* ick LH_2		
	Gaseous trucking	Distribu 2 ck CH_2[3]	Distrib 2 ick CH_2[3]	Distribu 3* ck CH_2[3]		

(Excerpt from the report)

- Pipelines can achieve significantly lower costs compared to liquid and high-pressure gas transport, even over long distances.
- However, costs are heavily dependent on the condition of existing pipelines.

(Excerpt from the report)

- For small-scale or variable demand, the use of liquid or high-pressure gas is expected as a bridge until pipelines are established.
- The choice between liquid or high-pressure gas is determined by demand volume and transport distance.

Sources: Hydrogen Council (2021) "Hydrogen Insights, A Perspective on hydrogen investment, market development and cost competitiveness"

Fuel cell applications offer the advantage of short refueling times and eliminate the need for storage spare for spare battery storage and swaps

Advantages of fuel cell applications beyond cost factors

- Although most applications don't yet achieve cost parity with current hydrogen supply costs as shown in the previous page, **FC mobility, with relatively higher cost parity, is already widely adopted**.
- **These advantages, beyond fuel costs, should be considered to promote hydrogen mobility** and the proper distinction between electric and FC mobility.

Example of the Advantages of FC mobility

Rapid Refueling	• EVFLs take about 8 hours to charge, while FCFLs refuel in 3 minutes • This **saves labor costs and storage space for spare batteries**.
Continuous Operation	• Due to the longer driving time per refuel, it is capable of **handling high operational demand.**
Resistant to temperature changes	• FCFLs can operate in environments where electric forklifts are unsuitable.

Adoption Cases

amazon

- *Over 17,000 fuel cell forklifts have been introduced across more than 80 fulfillment centers*
- *Large scale adoption enhances cost efficiency and enables onsite hydrogen production*

- *Adopted for 24-hour logistics warehouses*
- *As a grocery chain, they need forklifts that can operate in cold storages*

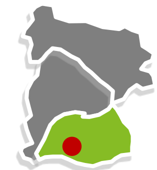
Walmart

Sources: WIRED.jp, NewsPicks

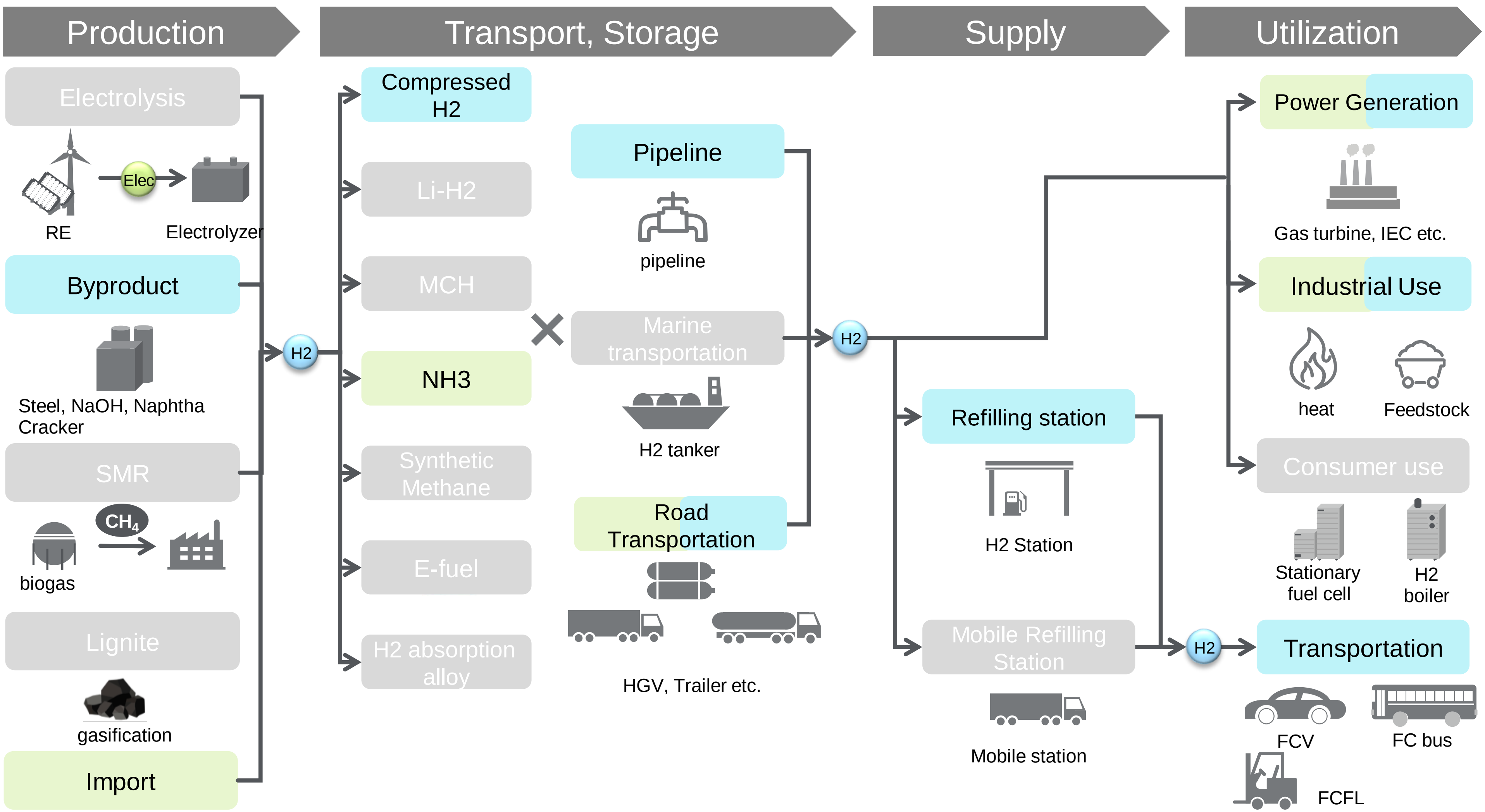
Access to byproduct hydrogen and import hydrogen will accelerate the development of hydrogen supply chain in the Map Ta Phut area

Blue: Hydrogen

Green: Ammonia



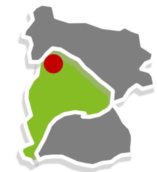
Potential Supply Chain Model in EEC | Map Ta Phut

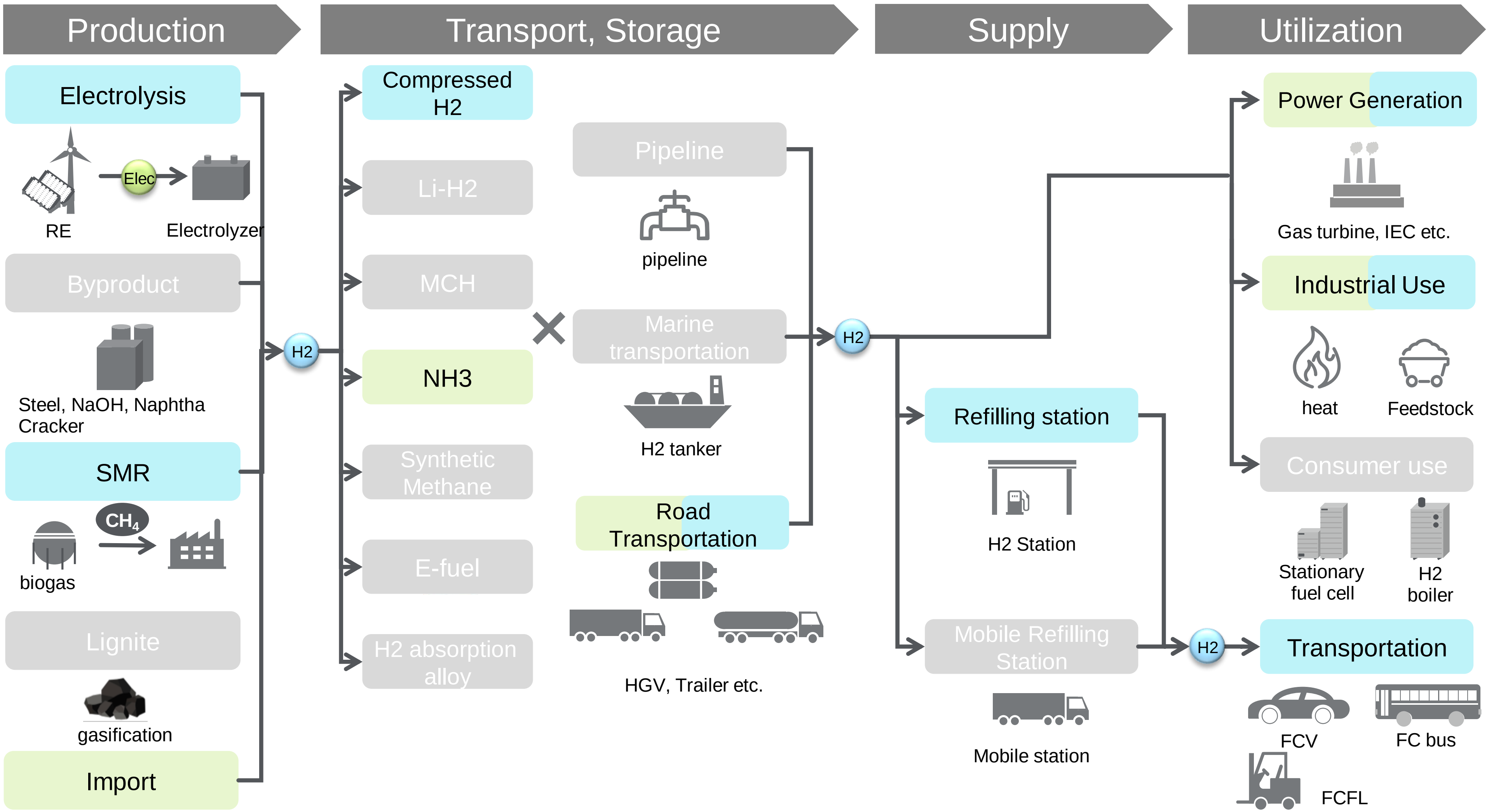


In the Chonburi area, aggregating hydrogen demand through collaborations among consumers will enhance the cost-effectiveness of hydrogen supply

Potential Supply Chain Model in EEC | Amata City Chonburi

Blue: Hydrogen
Green: Ammonia

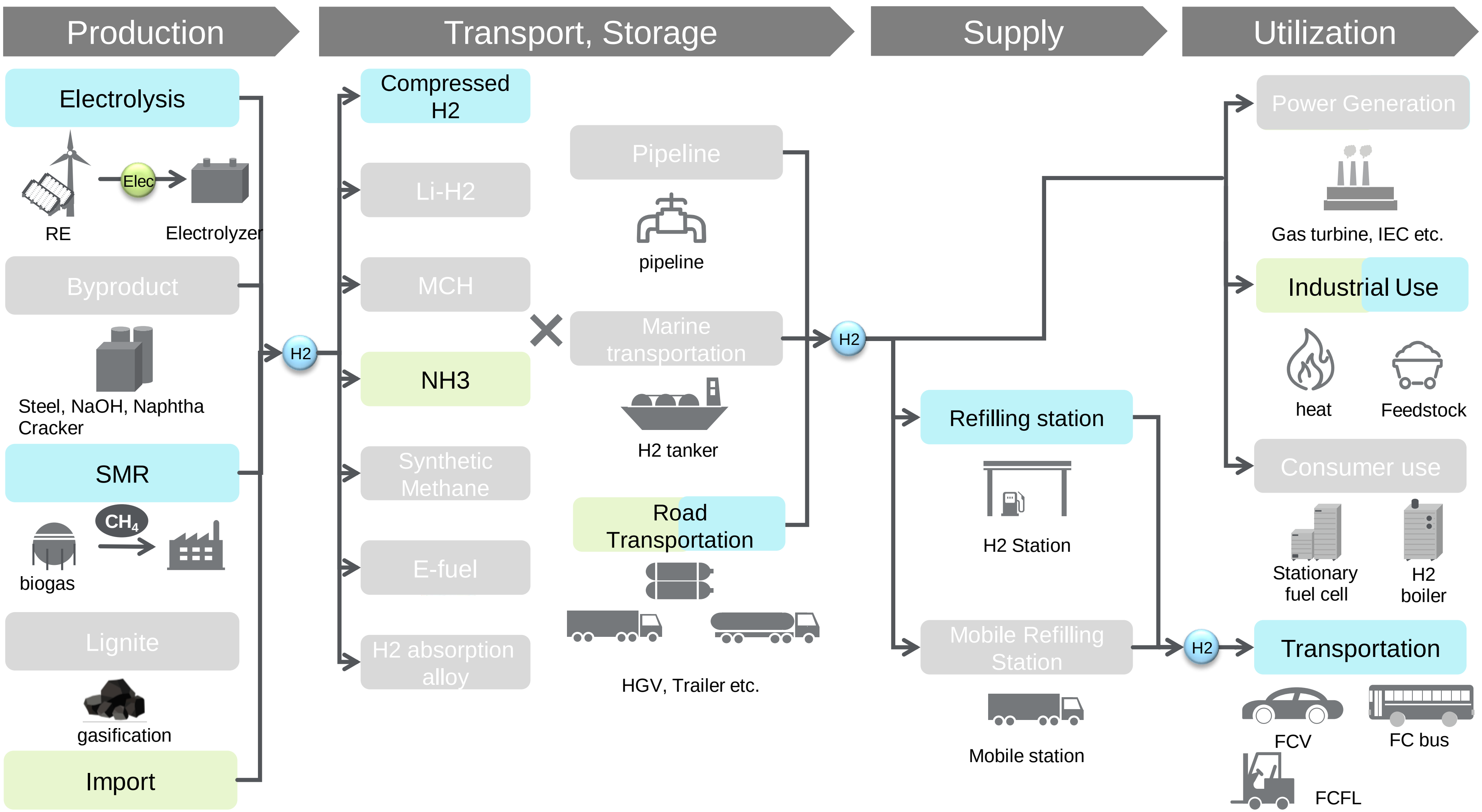




In the Chachoengsao area, which are far from hydrogen supply Sources, it is necessary to continue exploring hydrogen procurement options

Blue: Hydrogen
Green: Ammonia

Potential Supply Chain Model in EEC | Gateway City



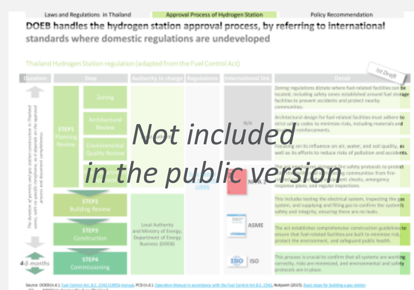
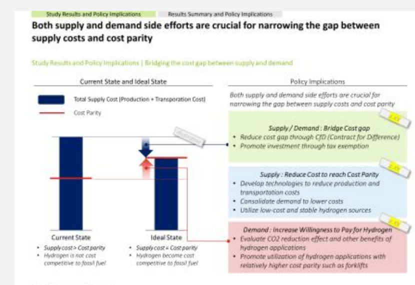
4. Hydrogen related Laws and Regulations

- Study on Laws and Regulation development status in Thailand
- Study on the approval process of Hydrogen Stations

The development status of hydrogen-related laws, regulations, and the approval process for hydrogen stations has been studied

4 Regulation

5 Policy

	Study on Laws and Regulation development status in Thailand	Study on the approval process of Hydrogen Stations	Policy Recommendation
Study item	❑ Hydrogen related Laws and Regulation development status in Thailand	❑ Approval process of Hydrogen Stations	❑ Policy Recommendation
Approach	❑ Desk Research ❑ Interview with the TH Government	❑ Desk Research ❑ Interview with hydrogen suppliers	❑ Derive policy recommendation based on all research results
Results			

Laws and regulations to be complied with for hydrogen production, transportation, Storage, and utilization have been complied

Hydrogen Law and Regulations in Japan, Thailand, Korea and Europe

Supply Chain				Japan	Thailand	South Korea	EU
Produce	Transport	Store	Utilize				
●	●	●	●	• High Pressure Gas Safety Act (Act No. 204 of 1951)	• Energy Industry Act B.E.2550 (Ministry of Energy, Energy Regulatory Commission)	• High-pressure Gas Safety Control Act (Ministry of Trade, Industry and Energy)	• Directive - 2014/68 - EN - EUR-Lex
●	•	•	•	• Gas Business Act (Act No. 51 of 1954)		• Gas Corporation Act (Ministry of Trade, Industry and Energy)	• Regulation - 2017/1938 - EN - EUR-Lex
●	●		●	• Electricity Business Act (Act No. 170 of 1964)		• Electric Utility Act (Ministry of Trade, Industry and Energy)	• Directive - EU - 2024/1711 - EN - EUR-Lex • Regulation - EU - 2024/1747 - EN - EUR-Lex
	●			• Fire Service Act No. 186 of 1948	• Ministerial Regulation on the Standard for Administration and Management of Occupational Safety, Health and Environment in relation to Fire Prevention and Control, B.E. 2555 (2012) (Ministry of Labor, Department of Labor Protection and Welfare)	• Framework Act on Firefighting Services (Ministry of Public Safety and Security)	• Delegated regulation - 2016/364 - EN - EUR-Lex • F-gases – update of minimum requirements for fire protection systems
	●		●	• Road Transport Vehicles Act (Act No. 109 of 1964)	• Land Transport Act, B.E. 2522 (1979) (Ministry of Transport, Department of Land Transport) • Ministerial Regulations on Safety in the Transport of Dangerous Goods by Road, B.E. 2558 (2015) (Ministry of Transport, Department of Land Transport)	• Traffic Safety Act • (Ministry of Land, Infrastructure and Transport)	• EUR-Lex - 02004L0054-20090807 - EN - EUR-Lex • EUR-Lex - 02008L0096-20191216 - EN - EUR-Lex
	●	●	●	• Waste Management Act (Act No. 137 of 1970)	• Notification of Ministry of Industry on Management of Waste or Unused Materials, B.E. 2566 (2023) (Ministry of Industry, Department of Industrial Works)	• Wastes Control Act (Ministry of Environment)	• Directive - 2008/98 - EN - Waste framework directive - EUR-Lex
		●		• Building Standards Act No. 201 of 1950	• Building Control Act, B.E. 252 (1979) (Ministry of Interior, Department of Public Works and Town & Country Planning) • The Factory Act B.E. 2535 (1992) (Ministry of Industry, Department of industrial works)	• Building Act (Ministry of Land, Infrastructure and Transport)	• Directive - EU - 2024/1275 - EN - EUR-Lex
		•			• Fuel Control Act, B.E. 2542 (1999) (Ministry of Energy, Department of Energy Business)		

Regulatory development related to hydrogen is ongoing across various responsible ministries

Implementation Plan (2022 – 2030)

These improvements **aim to address safety standards**, **production methods**, **transportation**, **storage**, **and utilization of hydrogen** for energy, transportation, and industries sectors. The regulatory updates are **expected to align with global best practices**, promote investment in hydrogen technologies, and support the country's transition toward cleaner and more sustainable energy systems.

The organization of enhancing hydrogen regulation in Thailand:

- **DOEB:** Department of Energy Business
- **DLT:** Department of Land Transport
- **TISI:** Thai Industrial Standards Institute
- **DIW:** Department of Industrial Works
- **DLPW:** Department of Labor Protection and Welfare
- **PTT:** PTT Public Company

Topic	Standards and Regulations Plan	Organization
1. Safety operations	1.1 Safety of **operation plants**	DIW
	1.2 Safety of **occupational health and working environment**	DLPW
	1.3 **Fuel cell** safety standards and regulations	TISI
	1.4 Safety in hydrogen **use sites**	DOEB
	1.5 Safety of **hydrogen stations**	DOEB
2. Production	2.1 Quality of **natural gas mixed with hydrogen**	PTT
	2.2 Industrial product standards of **hydrogen under pressure**	TISI
	2.3 The characteristics and **quality of hydrogen for vehicles**	DOEB
3. Storage	3.1 **Storage tanks**	DLPW
	3.2 **Storage facilities**	DOEB
	3.3 **Storage business**	DOEB

Topic	Standards and Regulations Plan	Organization
4. Transport by road and pipeline	4.1 Transportation of dangerous goods by road	DLT/ DIW
	4.2 Transport tank	DOEB
	4.3 Transportation via pipeline systems	DOEB
5. Commercial use of hydrogen	5.1 **Fuel cell** standards and regulations	TISI
	5.2 **Accessories and equipment of vehicles** hydrogen used as fuel	DLT
	5.3 **Industrial product standards for vehicles** that use hydrogen as fuel	TISI
	5.4 Hydrogen **traders**	DOEB
	5.5. Hydrogen **service stations**	DOEB

Sources: EPPO (2022). Study policy recommendations to promote commercial hydrogen use in Thailand

Current regulatory development status of hydrogen pipelines regarding odorization and hydrogen blending

Current Regulations | Hydrogen Pipeline

	Japan	Thailand
Odorization	Gas users and suppliers must add odorants, except in these cases: • Supplying gas at **medium pressure or higher** for large consumers. • Reliable **leak detection systems** are installed. • Gas is **detectable by odor at a 1/1,000 air-gas ratio**. • Gas is for **a specific use and not part of a power plant**.	**Hydrogen pipeline** is still in the **early stage**, so regulations and standards around **odorization** specifically **might not yet exist.**
Utilization of existing pipeline and blending of hydrogen	Currently, there are **no clear regulations for hydrogen blending into existing pipelines** in Japan. However, ongoing demonstrations and studies may contribute to future regulations. Examples of demonstration projects: **•Daigas Energy and Yanmar Energy Systems:** They confirmed that **up to 30% hydrogen can be blended** without changing hardware or control software, maintaining the same power output and efficiency as pure city gas. **•Kawasaki Heavy Industries:** Hydrogen **can be mixed with city gas in amounts between 5% and 30%**, and they can switch to a 30% hydrogen mix in just a few minutes. **•NEDO:** They studied hydrogen-methane mixtures and found that **a 25% hydrogen blend can be used** without burner changes, but higher concentrations require modifications.	The utilization of **existing natural gas (NG) pipelines and the blending of hydrogen** are **being explored and studied by PTT** as part of the country's transition to a low-carbon hydrogen economy. • The **draft PDP 2024** outlines a plan to **blend 5% hydrogen with NG for power generation**. **Hydrogen Blending Initiatives** • **Pilot Project:** PTT has launched pilot projects to assess blending hydrogen with NG, aiming to test the compatibility of industrial burners and **explore blending up to 20% H_2 by volume**. • **Collaboration:** PTT is collaborating with international partners to **develop pilot projects for hydrogen blending in industrial applications.**

Sources: EPPO (2022). Study policy recommendations to promote commercial hydrogen use in Thailand, RINA (2023). Thai company PTT strengthens partnership in hydrogen technologies, The Nation (2024). Hydrogen and nuclear power to drive transition to clean energy, Nishimura & Asahi(2023)パイプライン等を含めた水素供給体制に係る法制度と課題, NEDO(2023)「水素利用等先導研究開発事業」終了時評価報告書

Current regulatory development status of hydrogen stations regarding location and qualified personnel

Current Regulations | Hydrogen Station

	Japan	Thailand
Location of Hydrogen Station	Regulations for hydrogen station installation in Japan are as follows: ■ Safety Distance (High-Pressure Gas Safety Act) • **From Property Boundaries:** Hydrogen equipment must be **at least 8 meters from the property boundary**, but this can be reduced with safety measures. • **From Public Roads:** The dispenser must be **at least 8 meters from the road boundary**. • **From Fire-Handling Facilities: A minimum 8-meter distance is required from facilities using fire.** ■ Land Use Rules (Building Standards Act) • **Zoning Restrictions:** Hydrogen stations are **allowed in industrial areas**, while commercial and residential areas require special approval.	Thailand is in the **process of developing specific regulations and guidelines for hydrogen station.** The regulations **may align with hazardous substance safety** guidelines e.g., • A **minimum distance** from other structures, property lines, and high-traffic areas. • Hydrogen systems must be **separated from hazardous zones** i.e., electrical installations and ignition Sources. • The area must **maintain fire-resistant barriers** or setback distances from facilities handling flammable materials.
Qualified Personnel	In Japan, hydrogen stations must have a **Safety Supervisor** on-site per the **High-Pressure Gas Safety Act**. At least **one** must be present during operation. ■ **Requirements** **Certification:** A **High-Pressure Gas Safety Manager License** (Type A/B Chemical, Type A/B Mechanical, or Type C Chemical). **Experience:** One of the following: •**6+ months** in **hydrogen production** (compressed or liquefied). •**6+ months** in **CNG/LNG production** + a hydrogen safety course. •**6+ months** in **flammable gas production** + a hydrogen safety course.	Thailand is in the **early stage of hydrogen infrastructure development**, and the availability of fully qualified personnel for **hydrogen station operation and maintenance is currently limited**. • The department of Energy Business (DOEB) is formulating policies for hydrogen use related safety standards.

Sources: Thailand Business News (2023). Green Hydrogen: A New Frontier for Thailand and Saudi Arabia, Thai German Cooperation (2024). GIZ Thailand Green H_2 Railways Study H2Uppp, DIW (n.d.) Notification of the Department of Industrial Works regarding the Manual for Chemical, B.E.2550 (2007), MLIT(2021)参考資料2 関係法令等, Jhym 事業を始めるには

Ref) The California Public Utilities Commission promotes RNG through incentives the role of hydrogen to support the state's decarbonization goals

RNG Procurement Scheme

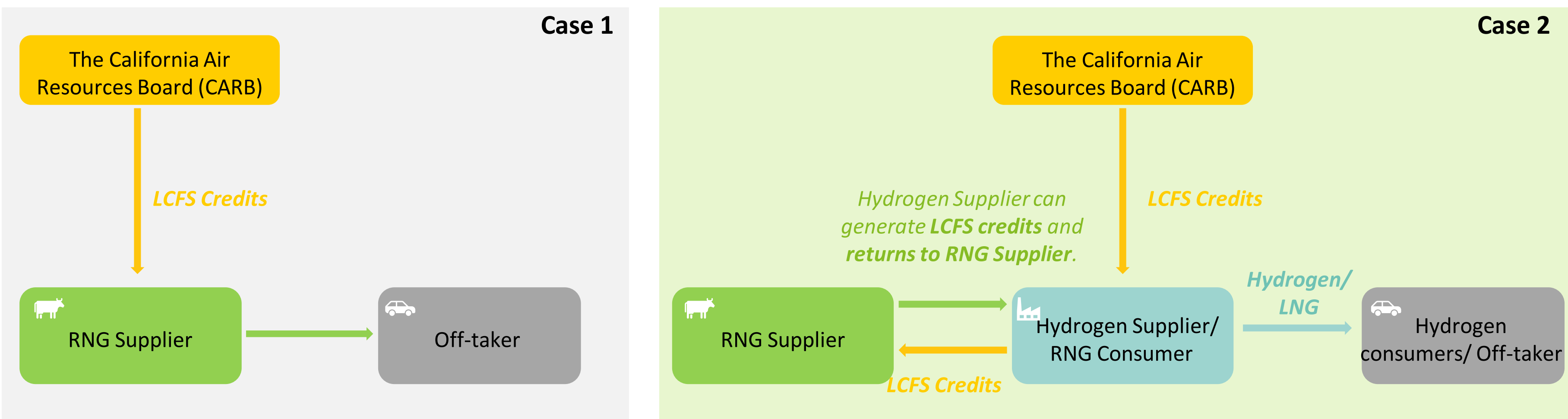
CALIFORNIA
Public Utilities Commission

What is RNG?

- **Biomethane, also known as Renewable Natural Gas (RNG)**, is a purified form of biogas produced through the anaerobic decomposition of organic materials.
- It serves as **a sustainable alternative to fossil natural gas**, capturing methane emissions from the waste sector and reducing greenhouse gas (GHG) emissions.
- RNG can **replace fossil natural gas** for uses such as **powering appliances**, **industrial operations**, **electricity generation**, and **vehicle fuel**.

RNG Procurement Scheme

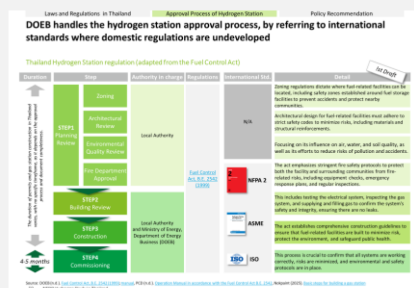
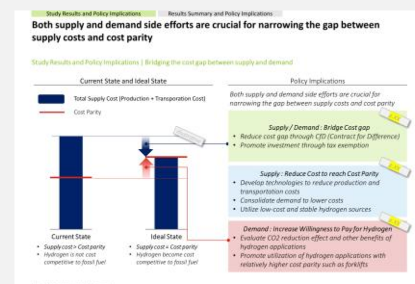
- In California, **hydrogen producers** can receive credits under the state's **Low Carbon Fuel Standard (LCFS)** when they use **RNG as the feedstock for hydrogen production**.
- **The California Air Resources Board (CARB) issues LCFS credits** based on how much carbon is reduced compared to conventional fuels, with prices ranging from **$47.50 to $100.00 per MT.**



Sources: CPUC (2025). Renewable Gas, California Air Resources Board (2025). Low Carbon Fuel Standard, Guidehouse (2022). Economic Analysis of Renewable Natural Gas

5. Policy Recommendations

Policy recommendations from both supply and demand perspectives have been developed based on all research findings

	4 Regulation		5 Policy
	Study on Laws and Regulation development status in Thailand	Study on the approval process of Hydrogen Stations	Policy Recommendation
Study item	❑ Hydrogen related Laws and Regulation development status in Thailand	❑ Approval process of Hydrogen Stations	❑ Policy Recommendation
Approach	❑ Desk Research ❑ Interview with the TH Government	❑ Desk Research ❑ Interview with hydrogen suppliers	❑ Derive policy recommendation based on all research results
Results			

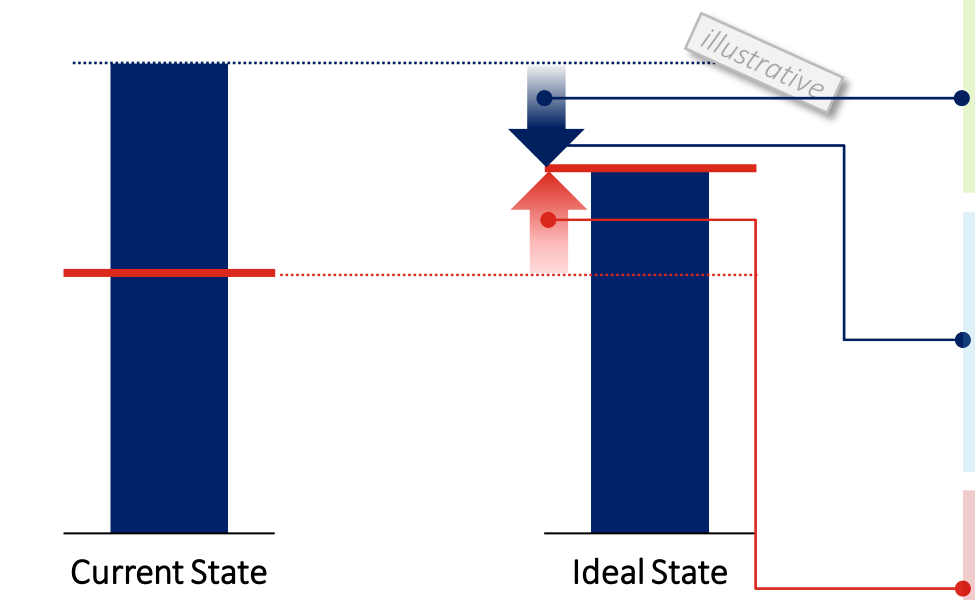
Both supply and demand side efforts are crucial for narrowing the gap between supply costs and cost parity

Study Results and Policy Implications | Bridging the cost gap between supply and demand

Current State and Ideal State

Total Supply Cost (Production + Transportation Cost)

Cost Parity



Current State

- ***Supply cost > Cost parity***
- *Hydrogen is not cost competitive to fossil fuel*

Ideal State

- ***Supply cost = Cost parity***
- *Hydrogen become cost competitive to fossil fuel*

Policy Implications

Both supply and demand side efforts are crucial for narrowing the gap between supply costs and cost parity

Supply / Demand : Bridge Cost gap

- *Reduce cost gap through CfD (Contract for Difference)*
- *Promote investment through tax exemption*

p.51

Supply : Reduce Cost to reach Cost Parity

- *Develop technologies to reduce production and transportation costs*
- *Consolidate demand to lower costs*
- *Utilize low-cost and stable hydrogen sources*

p.52

Demand : Increase Willingness to Pay for Hydrogen

- *Evaluate CO2 reduction effect and other benefits of hydrogen applications*
- *Promote utilization of hydrogen applications with relatively higher cost parity such as forklifts*

From a supply perspective, utilizing by-product hydrogen short-term and both clean domestic and imported hydrogen long-term could be an effective strategy

Results Summary and Policy Implications | Supply (Production and Transportation)

Supply Side Summary

Supply Volume

- Currently, sufficient quantities of by-product hydrogen are being produced and supplied in the Map Ta Phut area. However, the availability of clean hydrogen sources, such as large-scale renewable energy and biogas, remains limited in areas surrounding the Eastern Economic Corridor (EEC).

Supply Cost

- By-product hydrogen in the Map Ta Phut area is supplied through a well-developed hydrogen pipeline network, enabling relatively low and stable procurement costs.
- Until hydrogen demand reaches a certain scale, transportation costs are expected to remain high, making long-distance transport (approximately 100 km) economically challenging.

Policy Implications

- In the short term, the **most feasible supply chain model is likely to be the utilization of low-cost by-product hydrogen near its production sites**.
- Given the currently high transportation costs, in areas **distant from by-product hydrogen sources, onsite hydrogen production using onsite renewable energy plants would likely represent the most cost-effective option.**
- As the supply volume of by-product hydrogen is not expected to increase in the future, it will be necessary over the medium to long term to secure additional cost-competitive hydrogen supply sources. This will require further development of hydrogen production from renewable energy and biomass.
- In addition to these efforts, from the perspective of cost and supply volume, the **strategic use of imported hydrogen** could also be an effective option.

From a demand perspective, fuel cell mobility with high-cost parity and added benefits can drive hydrogen demand

Study Results and Policy Implications | Demand

Demand Side Summary

Power, Heat, Process Conversion

- In Thailand, particularly within the EEC area, future hydrogen demand is expected to be primarily driven by the power generation and industrial heat sectors.
- However, both estimation results and interviews with potential consumers indicate that hydrogen adoption in these sectors has made limited progress, largely due to challenges in achieving cost parity. Simulation results suggest that the introduction of mild carbon pricing, cost parity would remain largely unchanged.
- Given current hydrogen costs, launching significant hydrogen demand in these sectors is expected to remain challenging without the introduction of very strong policy incentives.

Mobility

- In contrast, **fuel cell mobility demonstrates a higher cost parity**, making it a more accessible entry point for hydrogen adoption.
- Interviews with potential consumers further support that fuel cell mobility is perceived as a more feasible and near-term application compared to hydrogen utilization for industrial processes or as a heat source.

Policy Implications

- To bridge the cost gap, strong policy mechanisms—such as the introduction of carbon taxes to internalize the societal benefits of CO_2 reduction and other currently unaccounted values—are essential.
- While robust financial policy support is critical to address cost-related challenges, additional non-financial measures are equally important.
- For example, **promoting broader awareness and understanding of the unique advantages of fuel cell applications**—particularly in the mobility sector, such as **short refueling times and extended driving ranges**, which may not be fully captured through direct cost comparisons—is necessary. Such efforts would help facilitate the optimal differentiation and strategic deployment of battery electric and fuel cell technologies, aligning their applications with their respective strengths.

To attract investment from private companies, especially global firms with a strong motivation for decarbonization, efforts to ensure policy predictability are essential

Results Summary and Policy Implications | Laws and Regulations

Demand Side Summary	• Hydrogen-related regulations in Thailand are currently under active discussion, and detailed information regarding the approval process—including the **relevant ministries or departments to contact, as well as comprehensive lists of applicable regulations—is not yet fully available to the public**. • While ongoing efforts are addressing gaps in existing regulatory frameworks by referencing international standards, **the approval process may still involve a degree of flexibility and evolving requirements**. • Consequently, businesses considering entry into the Thai hydrogen market may face **challenges in accurately assessing market risks and opportunities, which could potentially influence investment decisions**. • To facilitate smoother market entry and encourage investment, organizations such as the EEC office, which promote collaboration between the private sector and government bodies, are playing an important role in bridging communication and supporting the development of a transparent and predictable regulatory environment.
Policy Implications	• To accelerate the development of the hydrogen supply chain in Thailand, it is essential to attract investment from both highly motivated hydrogen suppliers and potential off-takers. • In support of this objective, **enhancing information accessibility and strengthening policy predictability are critical to ensuring a stable and transparent business environment.** • One potential initiative to achieve this could be the development of a comprehensive **guidebook that consolidates information on relevant laws and regulations**, made available in both the local language and English. • Such a resource would facilitate greater understanding among domestic and international stakeholders, contributing to increased confidence and active participation in Thailand's hydrogen sector.

Important notice

This document has been prepared by Deloitte Consulting Pte Ltd (“Deloitte Consulting”) for the sole purpose of providing a proposal to the parties to whom it is addressed in order that they may evaluate the capabilities of Deloitte Consulting to supply the proposed services.

The information contained in this document has been compiled by Deloitte Consulting and includes material which may have been obtained from information provided by various sources and discussions with management but has not been verified or audited. This document also contains confidential material proprietary to Deloitte Consulting. Except in the general context of evaluating our capabilities, no reliance may be placed for any purposes whatsoever on the contents of this document or on its completeness. No representation or warranty, express or implied, is given and no responsibility or liability is or will be accepted by or on behalf of Deloitte Consulting or by any of its partners, members, employees, agents or any other person as to the accuracy, completeness or correctness of the information contained in this document or any other oral information made available and any such liability is expressly disclaimed.

This document and its contents are confidential and may not be reproduced, redistributed or passed on, directly or indirectly, to any other person in whole or in part without our prior written consent.

This document is not an offer and is not intended to be contractually binding. Should this proposal be acceptable to you, and following the conclusion of our internal acceptance procedures, we would be pleased to discuss terms and conditions with you prior to our appointment .

In this document, references to Deloitte are references to Deloitte Consulting which is an affiliate of Deloitte Southeast Asia Ltd, a member firm of Deloitte Touche Tohmatsu Limited.

About Deloitte

Deloitte refers to one or more of Deloitte Touche Tohmatsu Limited (“DTTL”), its global network of member firms, and their related entities (collectively, the “Deloitte organization”). DTTL (also referred to as “Deloitte Global”) and each of its member firms and related entities are legally separate and independent entities, which cannot obligate or bind each other in respect of third parties. DTTL and each DTTL member firm and related entity is liable only for its own acts and omissions, and not those of each other. DTTL does not provide services to clients. Please see www.deloitte.com/about to learn more.

Deloitte Asia Pacific Limited is a company limited by guarantee and a member firm of DTTL. Members of Deloitte Asia Pacific Limited and their related entities, each of which are separate and independent legal entities, provide services from more than 100 cities across the region, including Auckland, Bangkok, Beijing, Hanoi, Hong Kong, Jakarta, Kuala Lumpur, Manila, Melbourne, Osaka, Seoul, Shanghai, Singapore, Sydney, Taipei and Tokyo.

Disclaimer

This communication contains general information only, and none of Deloitte Touche Tohmatsu Limited (“DTTL”), its global network of member firms or their related entities (collectively, the “Deloitte organization”) is, by means of this communication, rendering professional advice or services. Before making any decision or taking any action that may affect your finances or your business, you should consult a qualified professional adviser.

No representations, warranties or undertakings (express or implied) are given as to the accuracy or completeness of the information in this communication, and none of DTTL, its member firms, related entities, employees or agents shall be liable or responsible for any loss or damage whatsoever arising directly or indirectly in connection with any person relying on this communication. DTTL and each of its member firms, and their related entities, are legally separate and independent entities.