Knowledge Sharing:

PTT DECARBONIZATION JOURNEY

Analyst Meeting Q3/2025

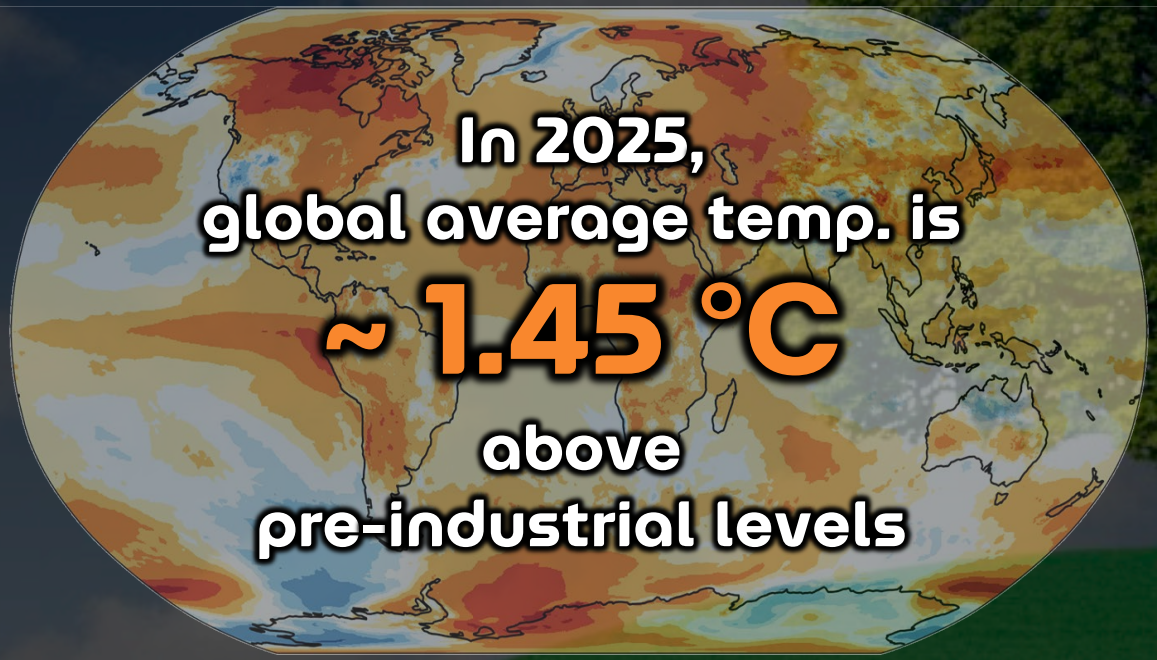
PTT Public Company Limited

19 November 2025

Mr.Rathakorn Kampanathsanyakorn
Senior Executive Vice President, Corporate Sustainability

Climate risks are impacting Thailand and countries worldwide

The global average temperature



Source: Our World in Data (2025)

The results of climate changes

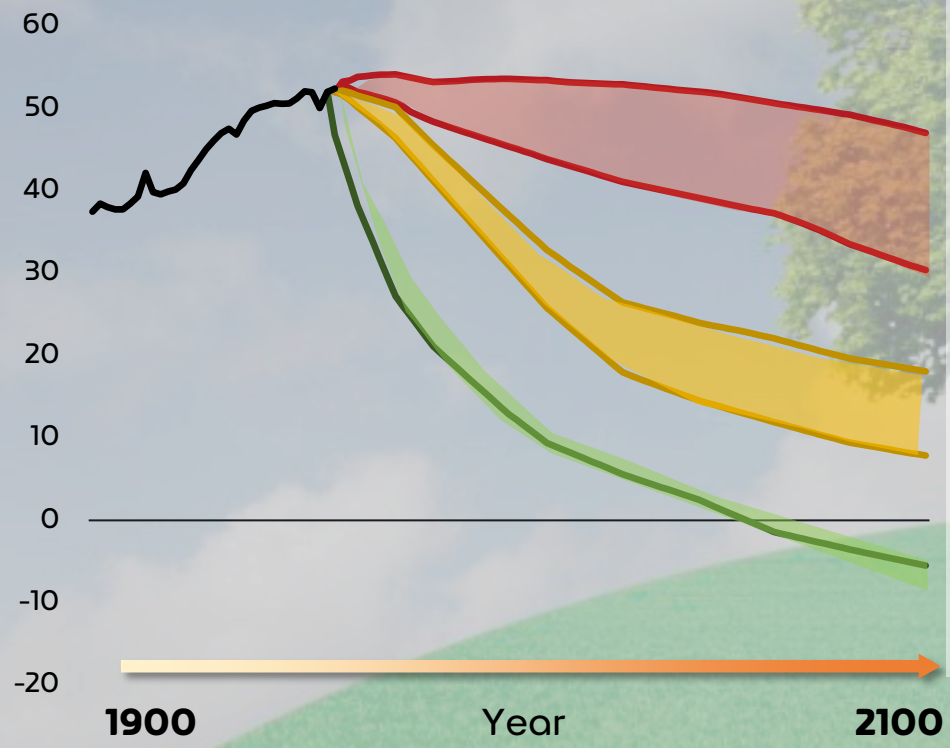
Rising Temperature will affect on sea level, food and plant/animal extinction

IMPACT on temperature increases from pre-industrial levels	1.5°	2°	3°	4°
Sea Level Raise	55 cm	62 cm	7+ Meter	> 10 Meter
Food	Wheat, rice, corn, and soybeans – declining yield	Agricultural yields have declined significantly.	Local fish species have declined significantly in many areas.	Food security is declining.
Plant / Animal extinction	9%	10 - 20%	20 - 30%	40%

Source: Climate change synthesis report (2023)

With current policies, global temperatures could rise by nearly 3 °C by 2100, Investing to achieve 1.5 °C will save multiple times more than in GDP losses

Net Global emission[1]
(Unit: $GtCO_2e$/year)
included sinks from LULUCF and negative emissions technologies



■ **2.5-2.9°C**
Policies & Action

■ **1.9-2.1°C**
Pledges & targets

■ **1.5°C**
Compatible

New NDC to be aligned with 1.5 °C pathway

Need to invest for reducing temperature and climate risks

To reduce global temp. to 1.5 °C

Up to
$175 Trillion
required

in investment to achieve 1.5°C target[2]

Note: $175 Trillion is an investment from 2025 to 2060

5X Saving

from GDP loss for adaptation and mitigation

Source:
1. https://climateactiontracker.org/global/emissions-pathways/
2. Woodmac energy transition outlook/

Decarbonization has become an important global agenda, with most of countries and companies announcing targets for 2050

Net Zero Emission Commitment

Countries (Example)

2040	2050	> 2050
SWEDEN	US, EU, UK	CHINA
ICELAND	JAPAN, CANADA, 100+ Countries	INDIA

Net Zero Emission Target 2050

Energy Companies

Scope 1 & 2: ptt, Chevron, ExxonMobil, Saudi Aramco, PETRONAS

Scope 1+2+3: eni, REPSOL, TOTAL, Shell, equinor, bp

Thailand accelerates Net Zero target to be achieved 15 years earlier

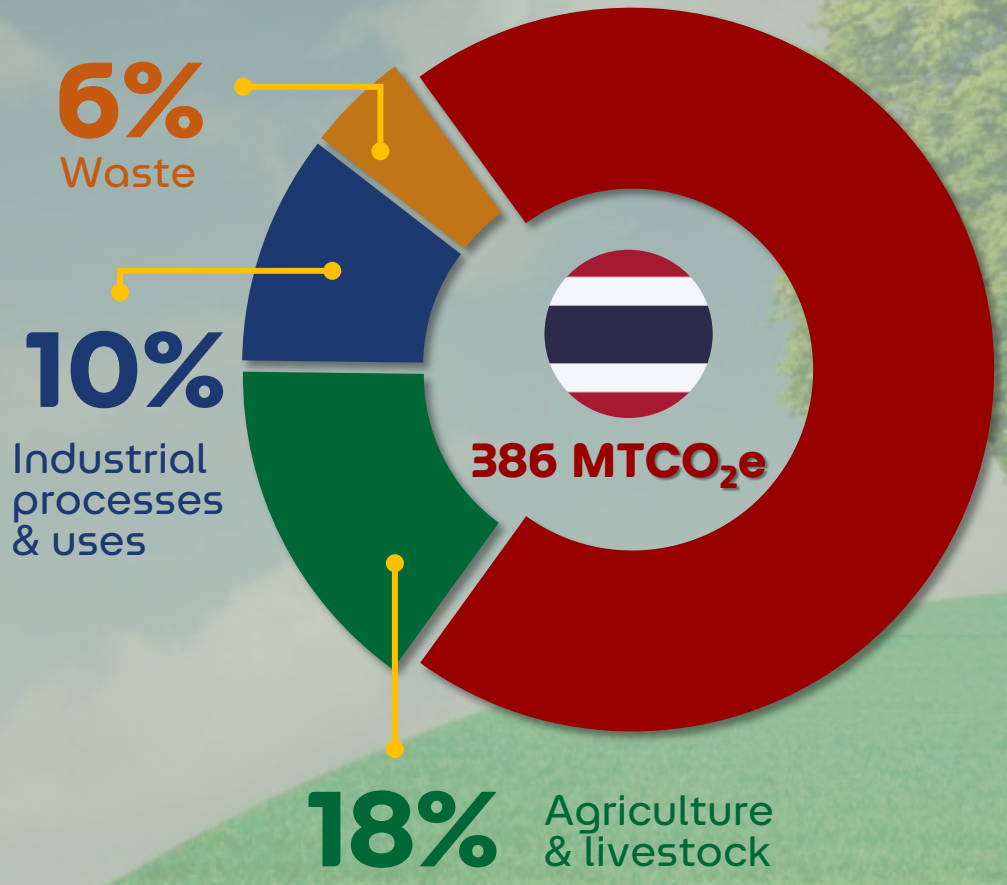
2026	2030	2035	2050	Accelerate	2065
Thailand Climate Change Act	**NDC 2.0** ลด GHG 16% (ปีฐาน 2019)	**NDC 3.0** ลด GHG 47% (ปีฐาน 2019) เป้าหมาย CCS >6 MTPA	**NET ZERO Emission**		

*NDC = Nationally Determined Contribution

Source: LT-LEDs: Long-Term Low Greenhouse Gas Emission Development Strategies and Department of Climate Change and Environment, Thailand

66% of CO_2 emission in Thailand is in energy and transport sectors, while PTT Group emits CO_2 ~ 12% of Thailand emission

Thailand 2022 CO_2 emission, by source[1]



PTT Group emitted[2]

46 $MTCO_2e$

(~ 12%)

of Thailand CO_2 emission

Source :
1. Thailand's First Biennial Transparency Report : BTR1
2. PTT Sustainability Performance Data 2021 - 2024

Vision

TOGETHER FOR SUSTAINABLE THAILAND WORLD

ปตท.
“แข็งแรงร่วมกับสังคมไทย” และ “เติบโตในระดับโลก” อย่างยั่งยืน

Mission

ดำเนินธุรกิจด้านพลังงานและธุรกิจที่เกี่ยวข้องอย่างครบวงจร
ในฐานะเป็นบริษัทพลังงานแห่งชาติ
โดยดูแลผู้มีส่วนได้ส่วนเสียอย่างสมดุลและยั่งยืน

Governance + Economic

มีธรรมาภิบาล โปร่งใส
ตรวจสอบได้
และคำนึงถึงเศรษฐศาสตร์

Social

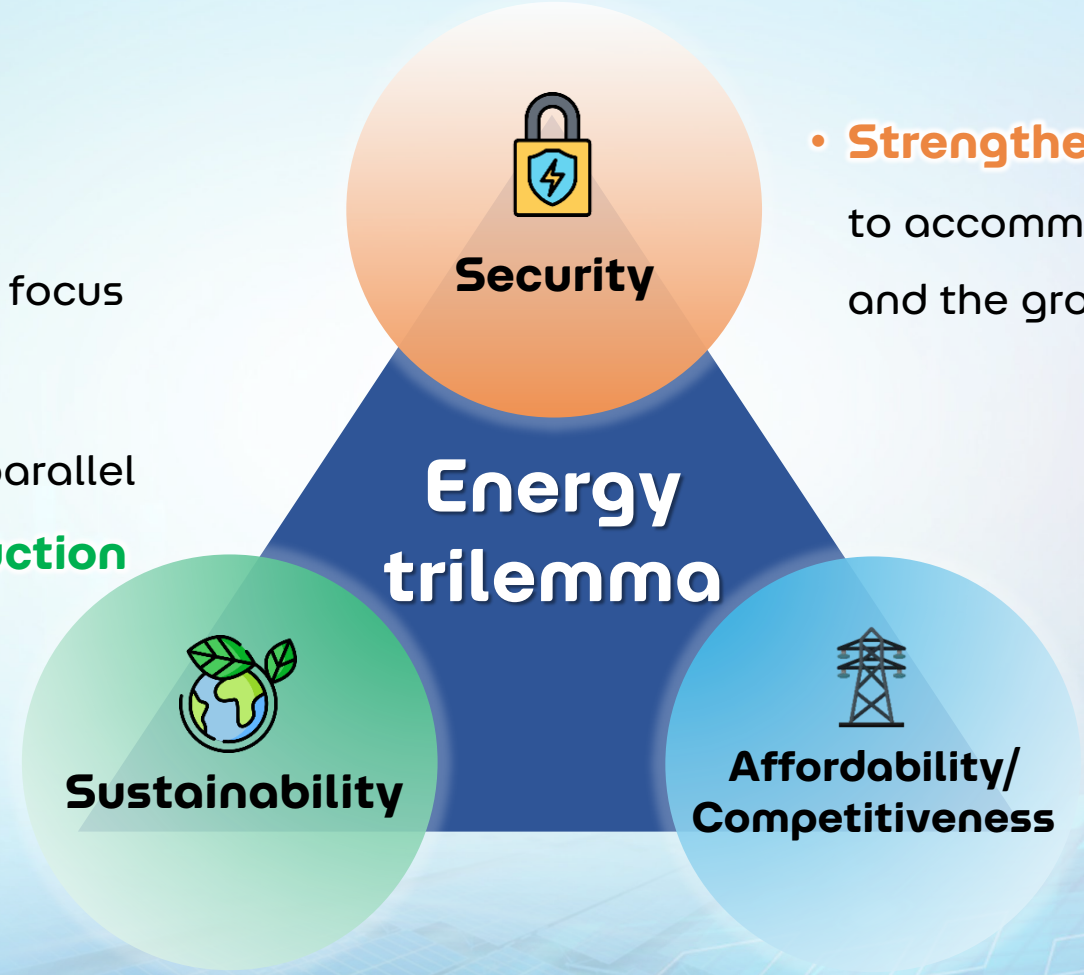
ดูแลผู้มีส่วนได้ส่วนเสีย/
สังคมอย่างสมดุล

Environment

จัดการสิ่งแวดล้อม
อย่างยั่งยืน

Driving for balanced & Equitable energy transition

- Drive business growth with a focus on **holistic Sustainability**
- Pursue economic growth in parallel with **greenhouse gas reduction**



- **Strengthen energy security** to accommodate economic expansion and the growing energy demand
- Provide accessible energy at **affordable prices**

PTT Group Strategy 2025

Ensuring energy security and promoting growth while achieving the goal of reducing GHG emissions in a balanced manner

LT Adj. EBITDA & Net Profit ⟷ **BALANCE** ⟷ **Sustainability : Net Zero by 2050**

1 Competitiveness Enhancement & Growth : Existing Business

1.1 Hydrocarbon & Power Business

Cost Competitiveness Enhancement

Upstream: E&P, Gas

Power: Power

Downstream: Petchem & Refinery, Trading, Retail

LNG, LNG Value Chain

1.2 Non-Hydrocarbon Business

EV Chargers focused: Electric Vehicle

Self-funding growth: Life Science

Sustainability & AI Tech

New Ventures

2 Necessity & Opportunity

Hydrogen & Carbon Business Integration

- **H_2 & CCS** as **decarbonize** tools for PTT Group and country towards Net Zero target
- **Opportunistic** play **to transform** PTT business
- **Feasible, Flexible & Sign-post driven** Investment

Hydrogen

CCS

3 Sustainability : Unleash Business Values through Sustainability

- Balancing ESG outcomes toward resilience and sustainable businesses
- Strive for Net Zero, Integrate Sustainability into Business Strategy & Portfolio Planning

4 Enablers for Transformation

Triple Transformation
Operational Excellence, AI & Digital Transformation and People & Organization

Asset Monetization
Synergize, Optimize & Monetize assets to increase utilization and uplift performance

5 Foundation

Convergence of GRC and Sustainability

Value Driven Financial Excellence

Stakeholder Management

Sustainability and decarbonization strategy

Influencing Role in Global Sustainability

Adaptation

Mitigation

C^3

ESG Leadership

Lead the Industry in Sustainability Actions

Sustainability Growth

Existing businesses
Climate-resilience Biz
- LNG value chain
- Downstream transformation
- Low carbon power + REC
- OR ecosystem diversification

New businesses
Climate-resilience Biz
- CCUS
- Hydrogen
- Carbon credit

Decarbonization

Group decarbonization: mitigation & adaptation
- Climate-resilience Biz (Portfolio Transformation)
- Carbon-conscious Asset
- Coalition, Co-creation, and Collective Efforts for All

Contribute to SDGs

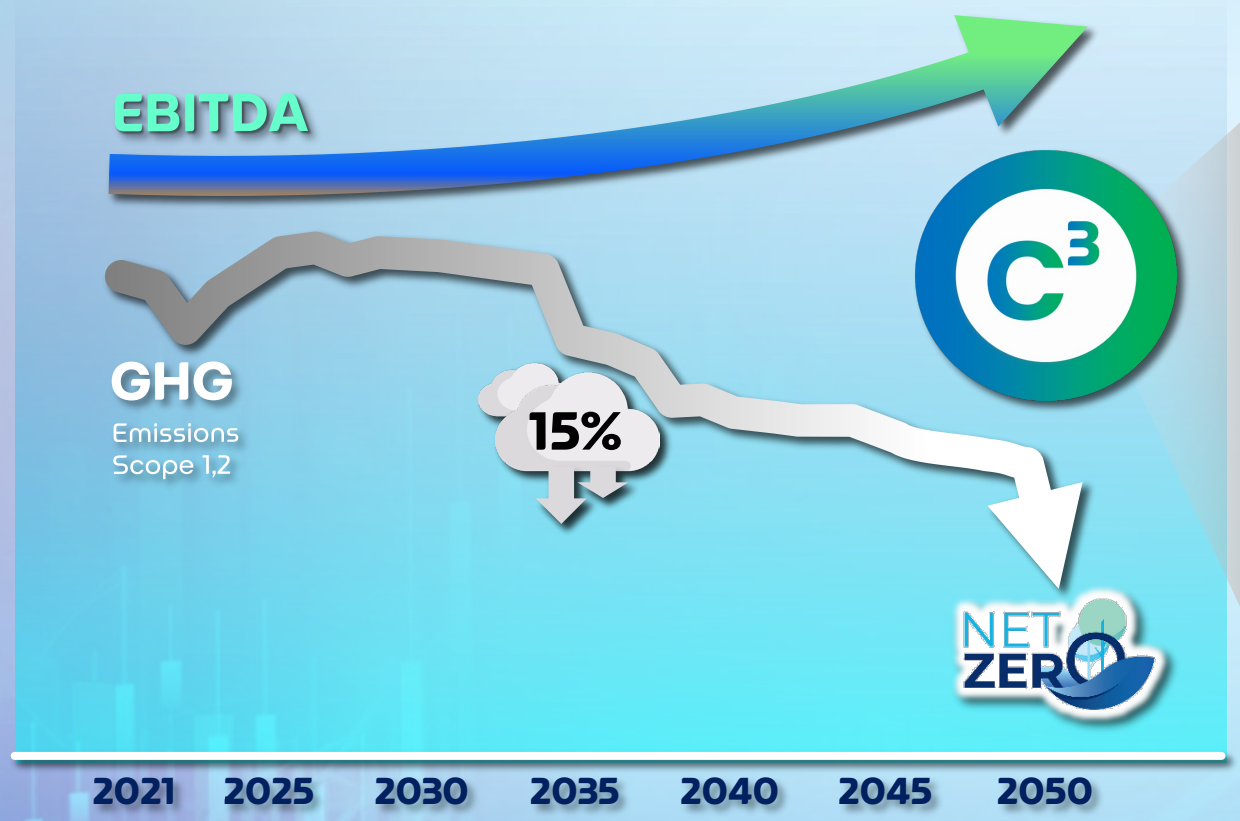
Top Rank
in leading ESG rating

%Revenue Contribution in 2035

%GHG Reduction
15% in 2035*
Net Zero in 2050*

*vs. 2021 base year / scope 1, 2

Sustainability and business growth integration & ESG balancing with business portfolio



Proactively managing risks

Capturing full upside

Driving climate adaptation

C1 Climate-resilience business

- LNG
- RE Biz.
- Bioproducts (PLA, biojet, etc.)
- EV station

C2 Carbon-conscious asset

- MissionX: Efficiency improvement
- Clean energy adaptation
- Adv. tech (CCU, SMR, etc.)
- Digitalization (AXIS)

C3 Coalition, co-creation, and collective efforts for all

- CCS
- Hydrogen
- Carbon credit project & mgmt.
- Forestation
- Water Mgmt.

*Also support offsetting

Execution with clarity and the flexibility to respond to signposts

C3 Climate-Resilience Business

Carbon Conscious Asset

Coalition, Co-Creation, and Collective Efforts for All

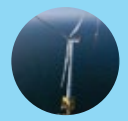
Gas as a Destination Fuel

- New growth along LNG value chain
- Exit coal business


Portfolio Shift to Low Carbon Business

- Global RE investment (India/Taiwan)


Solar



Onshore / offshore wind

- Global RE Investment in Cleaner Form of Energy)

H_2


RE (Scotland)

- Expand EV Charging Station

1,285 Charging stations (as of 30 June 2025)

Covering all **77** provinces

- Sustainable Aviation Fuel (SAF)

1ST PRODUCER IN THAILAND

Physical Platform

Digital Platform

- Expanding and diversifying portfolio beyond the oil business to facilitate the transition to a low-carbon society

Diversified Business

PetChem diversify towards Bio-based circular, high value business, with end-to-end waste management platform

- allnex
- Envicco
- NatureWorks

GHG **~760+** $ktCO_2e$

GHG avoidance per year

- Green Product


SAF (Co-processing / Alcohol to Jet)


Green Hydrogen

Green Product Certification

- Circularity-Driven Growth

Conversion into High-Value Products

Closed-loop recycling

Upcycling

C3

Climate-Resilience Business

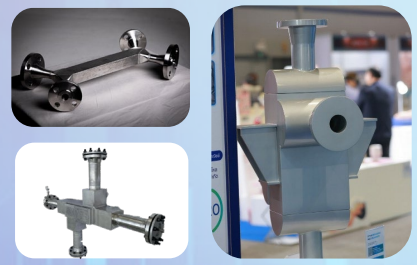
Carbon Conscious Asset

Coalition, Co-Creation, and Collective Efforts for All

Efficiency Improvement

- Process improvement & optimization
- Operational excellence
- Digitalization

Microchannel Heat Exchanger



Up to 30% Higher thermal efficiency

Flare & Leak Reduction

- Optimization
- Recovery system
- Others

Methane Emission Detection and Quantification Tool

- Advances drone- and robot-mounted technologies
- Detect and quantify methane emission

2030 Target

Near-zero	Zero
Upstream methane emission	Routine flaring

Clean Energy

- Solar
- Wind
- SMR (nuclear energy)
- Renewable energy certificates (RECs)

Small Modular Reactor (SMR)

Renewable Energy Certificates (RECs)

- Selling volume > 600,000 RECs/yr

One Stop Service

- Device registration
- Issuing
- Demand supply matching

Advanced Technologies

- Membrane separation
- Others

Advance membrane technology

- Separate and purify products with the lower energy consumption

Potential GHG reduction

~ 20 $ktCO_2e/y$

Potential cost saving

~ 100 MB/y

C3

Climate-Resilience Business

Carbon Conscious Asset

Coalition, Co-Creation, and Collective Efforts for All

Carbon Capture & Storage (CCS)

Upstream

ptt GPSC Thaioil GC IRPC

- Carbon Capture Technology for Specific Need of each Operation
- PTT Group invested in Carbon Capture Technology

Midstream

ptt

- Develop Infrastructure
- Work with Government: Regulatory Unlock

Downstream

PTTEP

- Carbon Storage & Offshore Facilities

ptt **PMO** – As an Orchestrator & Drive Success Across PTT Group

Upstream

ptt PTTEP

- Sourcing / JV for low-carbon H_2 / NH_3
- Global Investment (Out-Out)
- Importing to Thailand when the project is feasible

Midstream

ptt

- Develop Infrastructure
- Engage Government & Stakeholders
- Law & Regulatory Unlock
- Incentive

Downstream

GPSC Thaioil GC IRPC — Industry Use

OR Opportunity — Mobility

- Utilize H_2 / NH_3
- Develop Biz Model

Hydrogen (H_2)

Collaboration with Government Agencies:

THAILAND BOARD OF INVESTMENT

NH_3 = Ammonia

Decarbonization principle

Investments must be feasible and yield appropriate returns. Key signposts are monitored, and investments are strategically flexible based on the situation

Decarbonization targets

15 % GHG Reduction

2035

Net Zero

2050

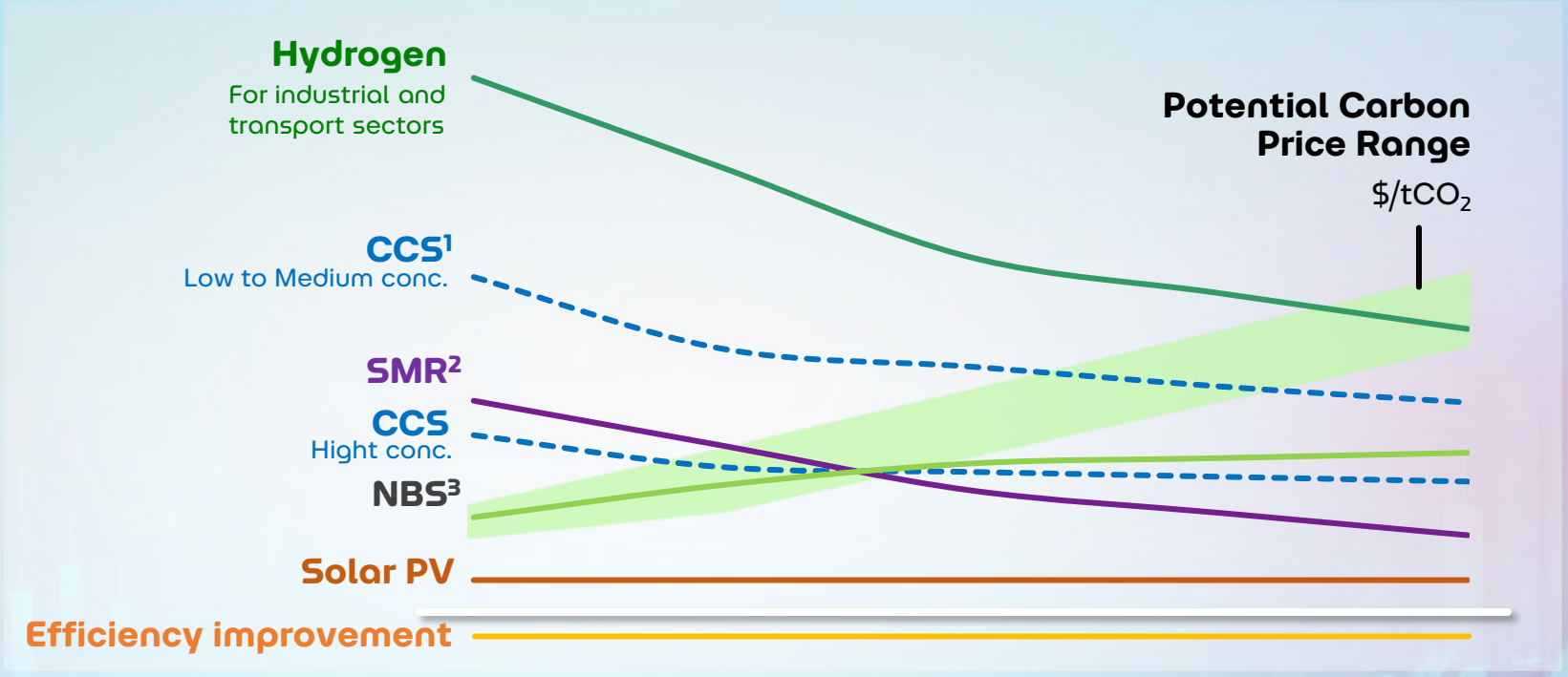
- **Feasible**
- **Signpost-driven**
- **Strategically flexible**

PTT Group monitors technologies development alongside carbon pricing mechanism

Cost of Action < Cost of Inaction

Marginal Abatement Costs

$/tCO$_2$e abated



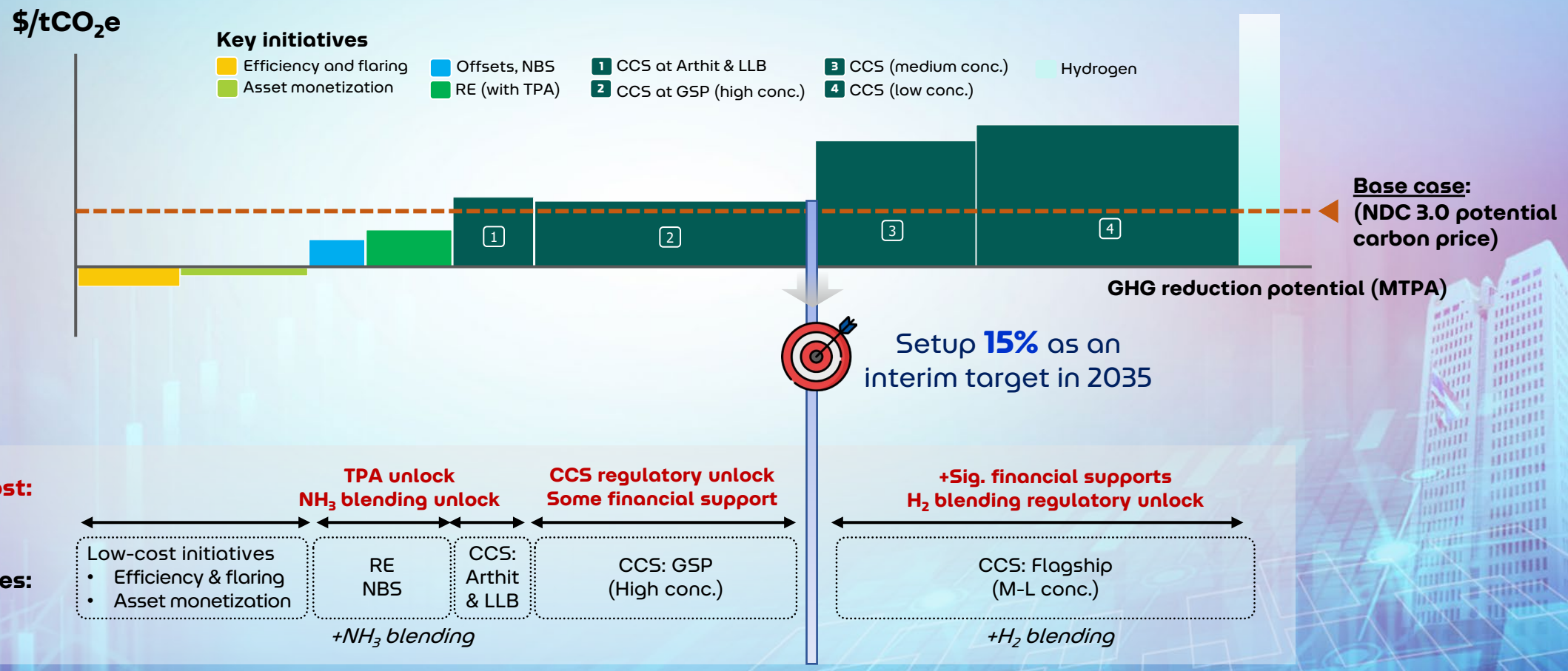
PTT Group Potential Technology Pathway:
(when abatement cost < carbon price)

2030	2035	2040	2045	2050
Solar	CCS (High-Conc.)	SMR	CCS (Low to Medium Conc.)	Hydrogen[4]
NBS				
Efficiency Improvement				

Remark: 1 Carbon Capture & Storage; 2 Small Modular Reactor (nuclear energy); 3 Nature-base Solutions; 4 For chemical sector
Source: PTT Group database, Thailand NDC 3.0, BCG, IEA, IMF, World Bank, peer analysis

PTT Group decarb. pathways aligning technology and market signals:
a better-off, cost-effective option that enhances resilience and long-term value

2035 Group Marginal Abatement Cost Curve (MACC)

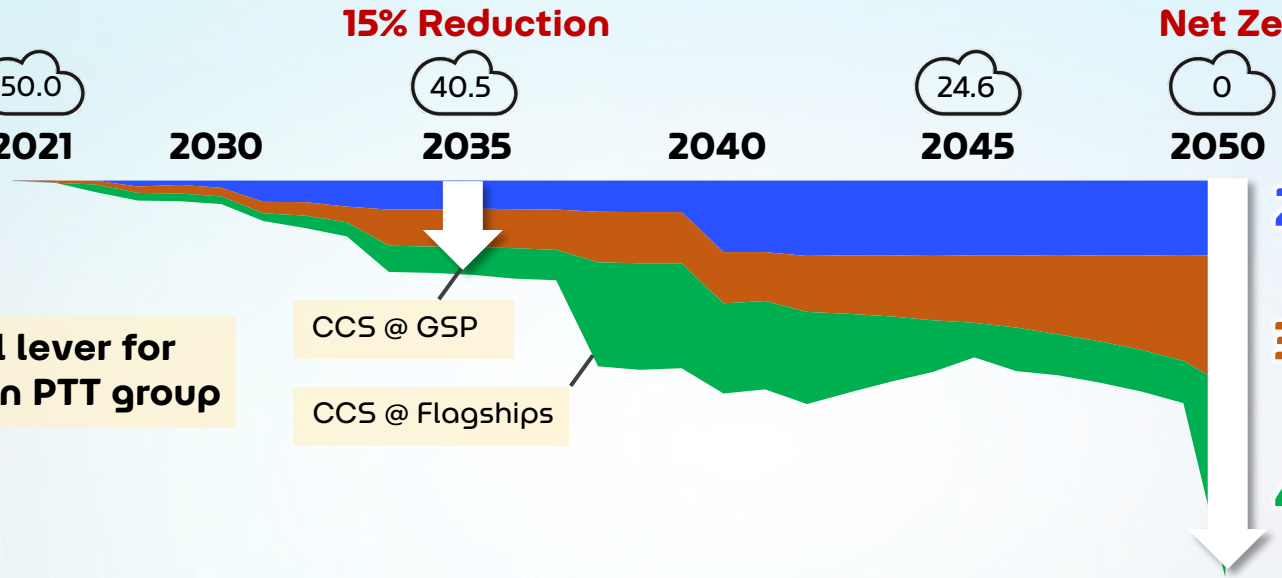


Signposts and key conditions are continuously monitored to ensure that GHG reduction efforts are cost-effective

GHG Emission:
(Scope 1,2 – $MtCO_2e$)

GHG Reduction:
(Scope 1,2)
(vs. 2021 base year)

CCS is a critical lever for decarbonization in PTT group



20% Climate-resilience biz

35% Carbon-conscious asset

45% Coalition, co-creation, and collective efforts for all

Key Signposts & Conditions precedent

Carbon price: ETS allowance:	☑ ≥ $65/tCO2e ☑ ≤ 65%	☑ ≥ $120/tCO2e ☑ 0%	NDC 3.0 / LT-LEDS, Climate change act, etc.
Regulatory: Biz / partnership model:	☑ TPA / dPPA / CCS permitting ☑ Incentive to meet PTT hurdle rate ☑ Lock-in demand / ETS trading / Article 6	☑ CCS / SMR / H2 permitting ☑ Incentive to meet PTT hurdle rate ☑ Lock-in demand / ETS trading / Article 6	Progress & actions of relevance government agencies & committees
Technology:	☑ CCS cost ≤ carbon cost	☑ CCS / SMR / H2 cost ≤ carbon cost	Technology development & deployment


Carbon
Capture and
Storage (CCS)

Carbon Capture & Storage (CCS) is a technology for capturing CO_2 from emitter and transport to storage area

Capture

Capture CO_2 from point-source or from the air

Point - Source

Refinery

Powerplant

NG Processing

Petchem plant

Direct Air Capture (DAC)

CO_2 removal directly from atmosphere

Transport

Transportation of CO_2 from source by pipeline, ship or truck

Transport Mode

Pipeline

Usually supercritical phase ideal for large scale fixed capacity

LCO_2 Vessel

Requires liquefaction, suits long-distance

Other transportation mode: Truck for small scale, multiple sources and injection sites—but very high cost

Storage or Utilization

Storing CO_2 onshore or offshore in saline aquifer, depleted field, or enhanced oil recovery (EOR)

Storage

Depleted oil and gas field

Saline Aquifer

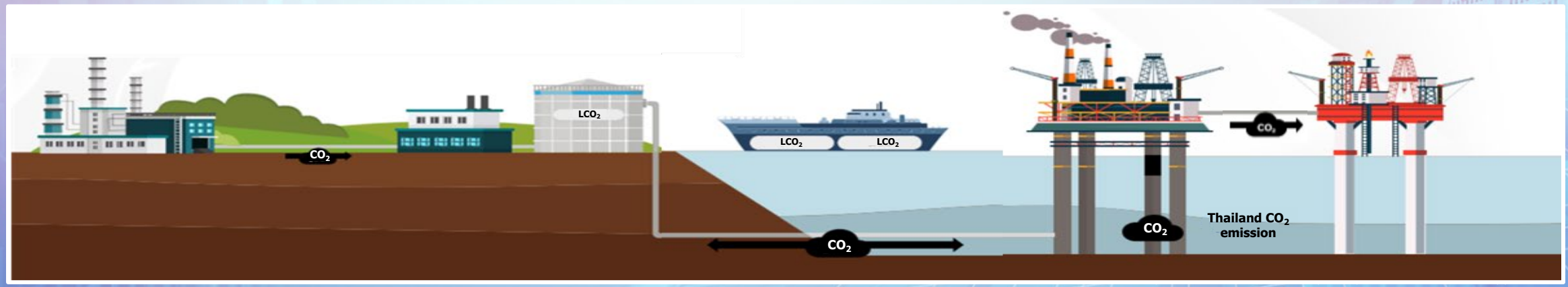
Enhanced Oil Recovery (EOR)

Utilization

- Food and beverage
- Chemicals
- Medical/pharmaceutical
- e-SAF (Sustainable aviation fuel)

Cost

Capture	Transport	Storage
60 – 70%	10%	20 - 30%



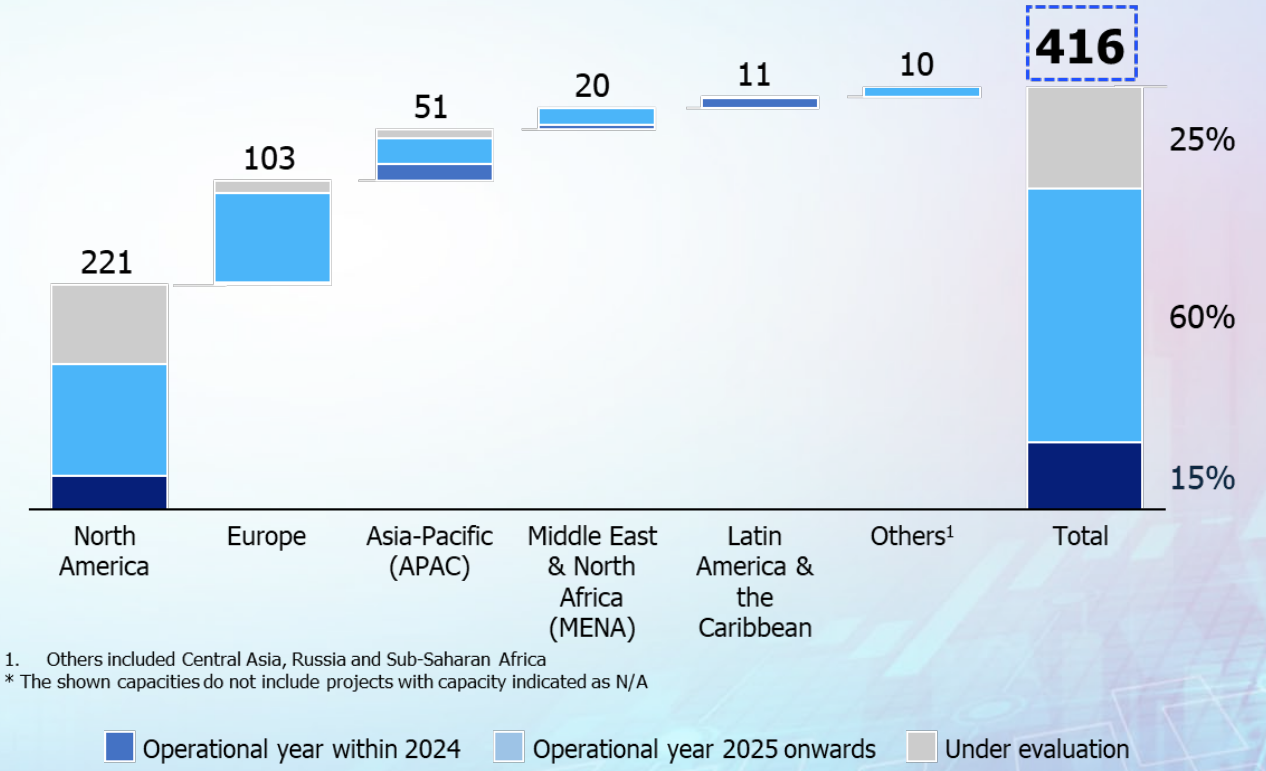
Global capture capacity is 416 MTPA, addressing only ~10% of the projected CO_2 emissions by 2050

Global demand is expected to reach

4,500 MTPA

In 2050

Global capture capacity, by region (MTPA)



1. Others included Central Asia, Russia and Sub-Saharan Africa
* The shown capacities do not include projects with capacity indicated as N/A

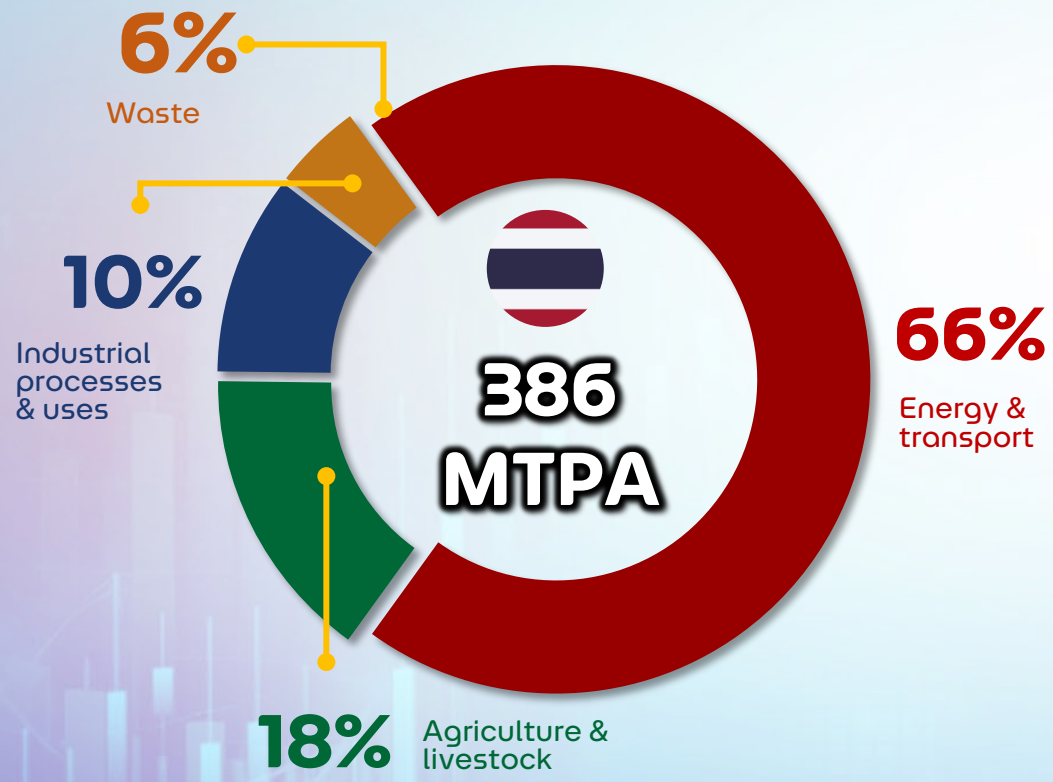
~10%

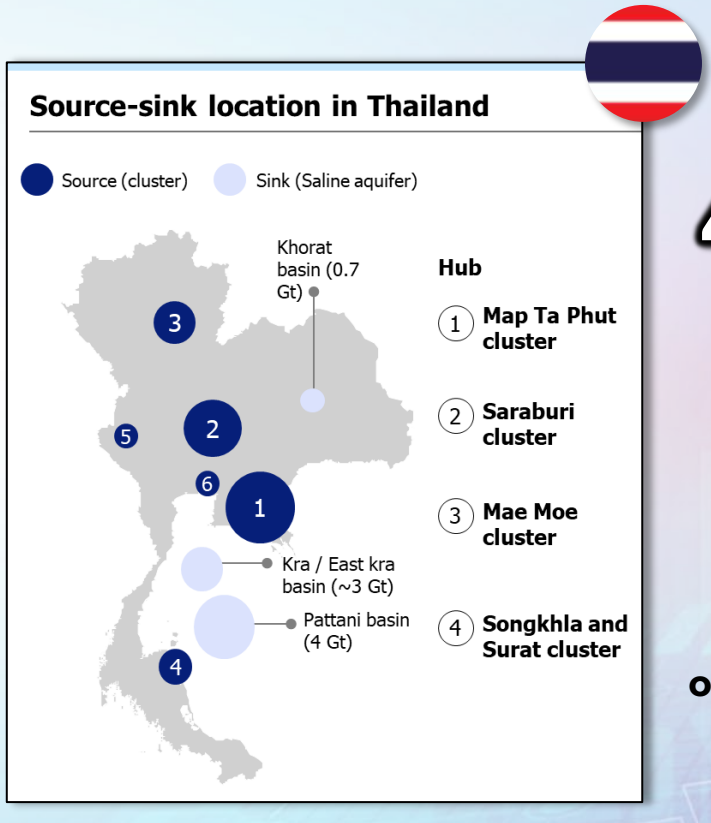
capacity from demand in 2050

Source :
1. Global CCS Institute
2. McKinsey Analysis

Potential CCS Capacity in Thailand is ~60 MTPA, ~16% of Thailand CO_2 emission in 2022

Thailand 2022 CO_2 emission, by source[1]





40 - 60 MTPA

Potential CCS capacity in 2050

~16%

of CO_2 emission in 2022

Source :
1. Thailand's First Biennial Transparency Report : BTR1
2. McKinsey Analysis

Key success factors of CCS in Thailand

Technology

- Need **novel technology** for breakthrough CCS and cost optimization

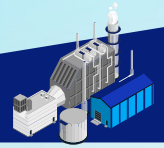
Business model

- Need **suitable business model** to optimize investment cost

Regulatory/ Incentives

- **Regulatory unlock** to advance the project
- **Proper incentives** for economic viability
- **Appropriate structure model** for execution

Carbon Capture and Storage / Utilization (CCUS) strategy



Decarbonize own emissions
and provide sequestration solutions for Thailand &
Asia Pacific in a cost competitive way

1 Set up Thailand CCUS backbone by being hub operator

- Full chain solution to decarbonize owned emissions starting with ≥ 5 MTPA
- T&S solution for Thailand emitters
- Pilot CCS project (Pilot Arthit project)
- Become alternate sink for Singapore and Japanese

2 International project investment

- **Project investment** in EU/US with minority stake e.g., Farming in, developers
- Gain knowledge, government support, and operations

3 Technology investment

- **Technology investment –** to improve cost competitiveness and licenses to operate in Thailand

4 Governance structure, operating model and investment model	• Set up SPV and Asset co. to enable risk allocation enhance synergy across different projects • Reach out to potential partners/investors • Define clear role & responsibilities between relevant partners
5 Low-cost financing	• Secure right blend of financiers
6 Regulatory support and commitment from the government	• Drive the adoption of CCS implementation under a single, government-led framework • Secure incentives support from government on carbon pricing, direct funding, tax incentives • Establish cross-border mechanism • Policy support on storage
7 Key capabilities and knowledge	• Acquire/Upskill required capabilities

1 Eastern Thailand CCS Hub

≥ 5 MTPA, FID 2031 / COD in 2034

Convey CO_2 to the central collection station

Potential Demand

EEC area:
- Chonburi
- Rayong

Capture CO_2 from emission sources

Emitters

Onshore terminal

Jetty for unloading and conversion

CO_2 transportation via ship or subsea pipeline
determined by the scale and geographical location of emission sources

LCO_2 ship

Offshore pipeline

Kra Basin

Offshore storage in the Gulf of Thailand

≤10 MTPA
during the initial phase

Shipping for Cross-border

Potential to support CO_2 transportation & storage
Provides an opportunity for the country to position itself as a regional hub

Arthit

FID 2025 / COD 2028

1 Arthit Project

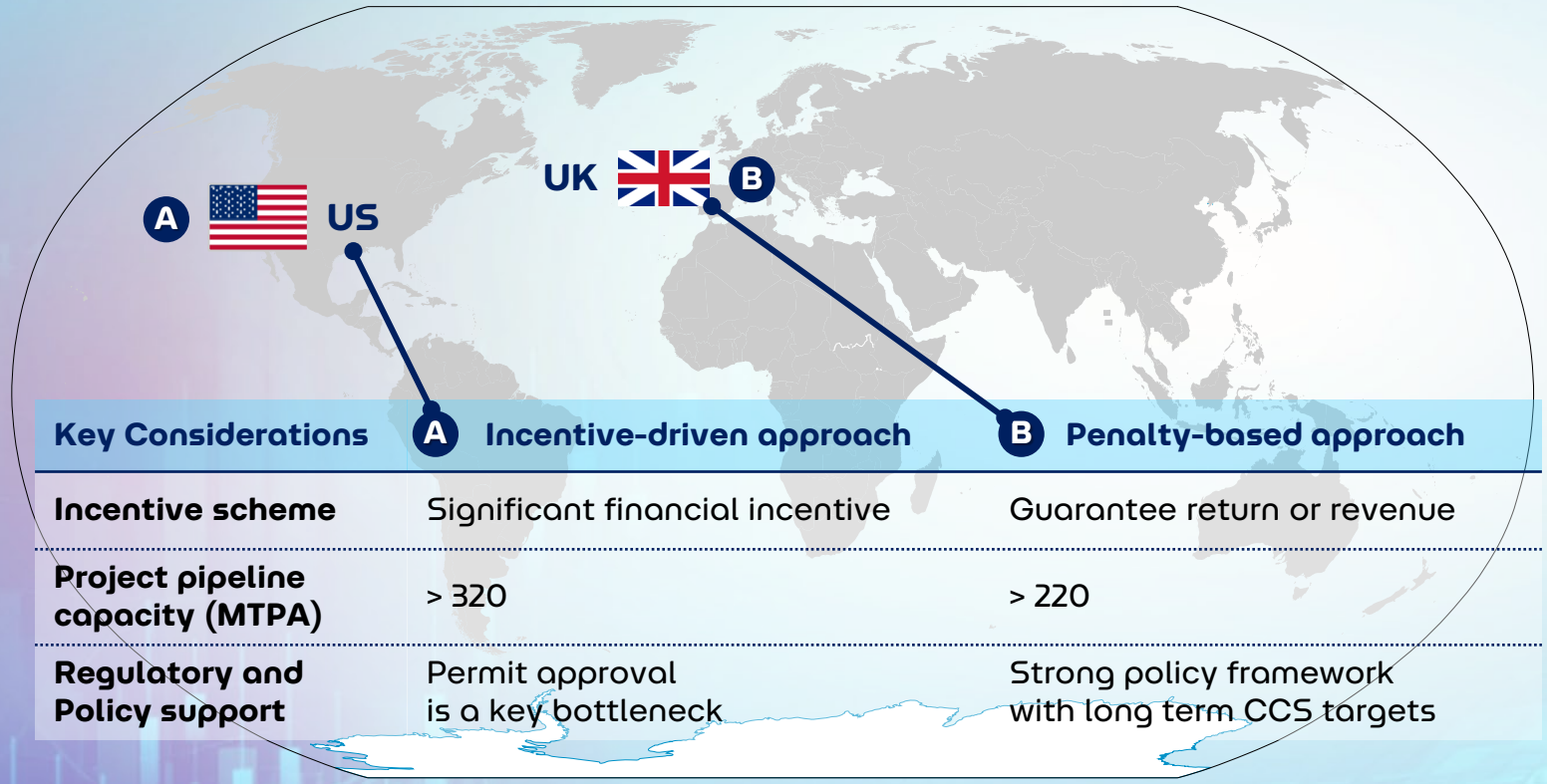
1st pilot CCS project in Thailand
(1 MTPA)

For Visualisation Purposes

Onshore Pipe (km) — Offshore Pipe (km) — Shipping (km)

2 Invest in international CCUS projects to gain experiences and know-how to further develop project in Thailand

PTT is currently exploring on US and UK project investment



Key Considerations	A Incentive-driven approach	B Penalty-based approach
Incentive scheme	Significant financial incentive	Guarantee return or revenue
Project pipeline capacity (MTPA)	> 320	> 220
Regulatory and Policy support	Permit approval is a key bottleneck	Strong policy framework with long term CCS targets

Advantages of investment in international projects

- **Gain experience to drive the project** (e.g. regulatory/ incentives)
- **Gain operational experiences**
- **Gain acceptable return & Partnership for future**

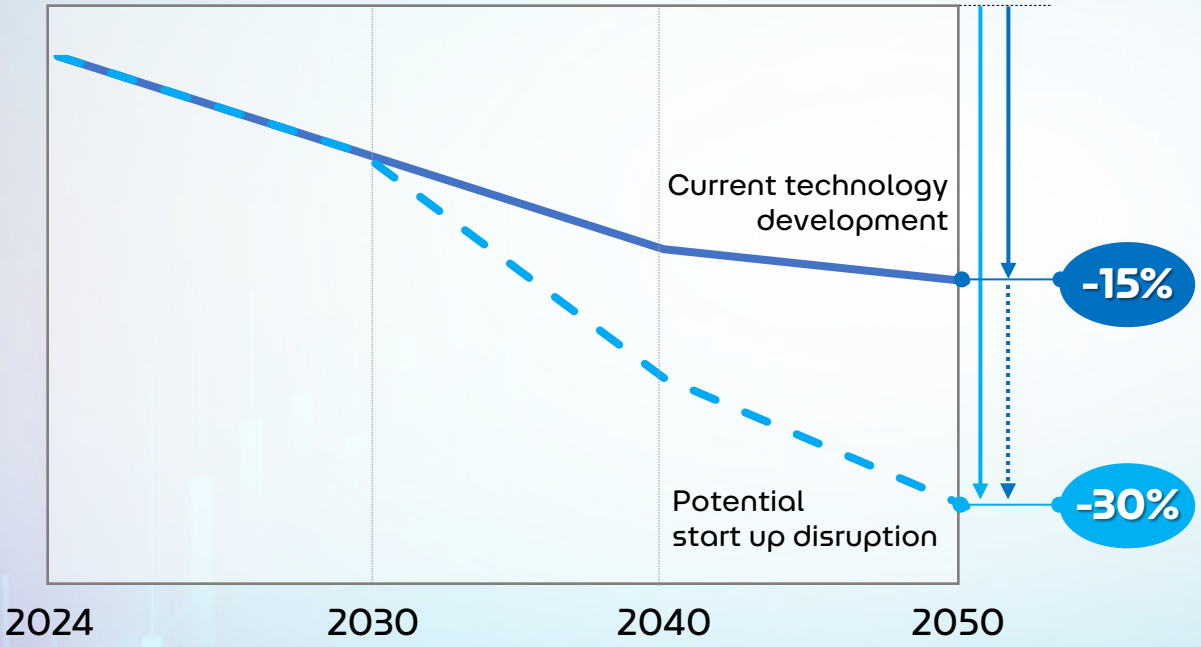
RAB: Regulated asset base

Source: World bank (2024)

Access innovations for possible cost reduction pathway

Exploring both technology leaders and pioneers

Carbon Capture cost, USD/t



Source: McKinsey analysis

To evaluate technology / feasibility study for implementation in short to mid term

Conventional technology

Balance

Emerging Technology

ExpresSo

To deep-dive in novel technology for significant cost reduction

CCUS development is on track with achievement along the way

NET ZERO 2050

EASTERN TH CCS HUB FID 2031 / COD 2034

MOU Signing within PTT Group

- ✓ Clear business model
- ✓ Pre-feasibility study (high to low conc.)

Collaborating with government

- ✓ Incorporating the CCS Hub into NDC 3.0
- ✓ Seismic survey under approval

Exploring int. investment

- ✓ Deep-dive study in US and UK projects

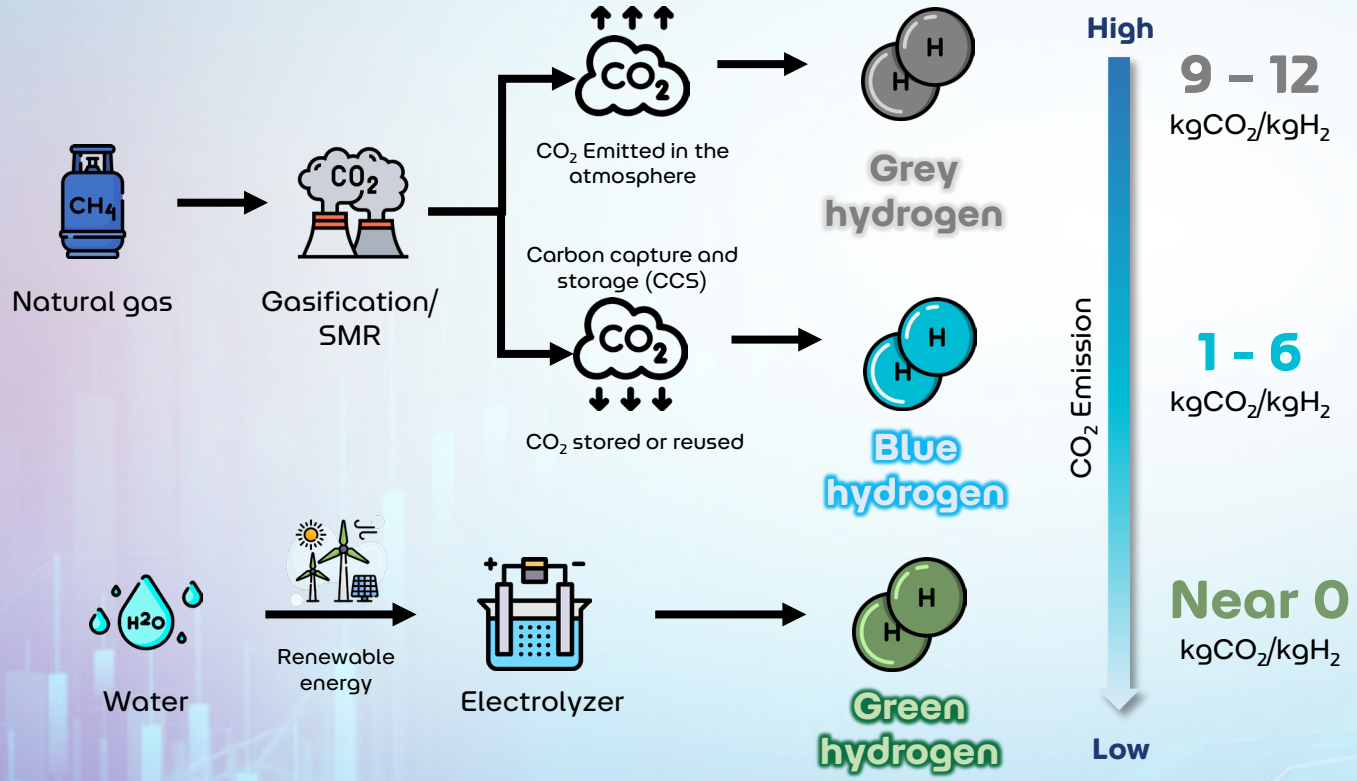
Partnering with tech. owners

- ✓ MOU signing to explore investment opportunities and conduct feasibility study

Hydrogen

Hydrogen serves as a clean energy solution driving decarbonization in industry, power, and mobility

What is hydrogen and how to use?



Industry use

- Chemical feedstock
- Heat
- Alternative fuel

Power

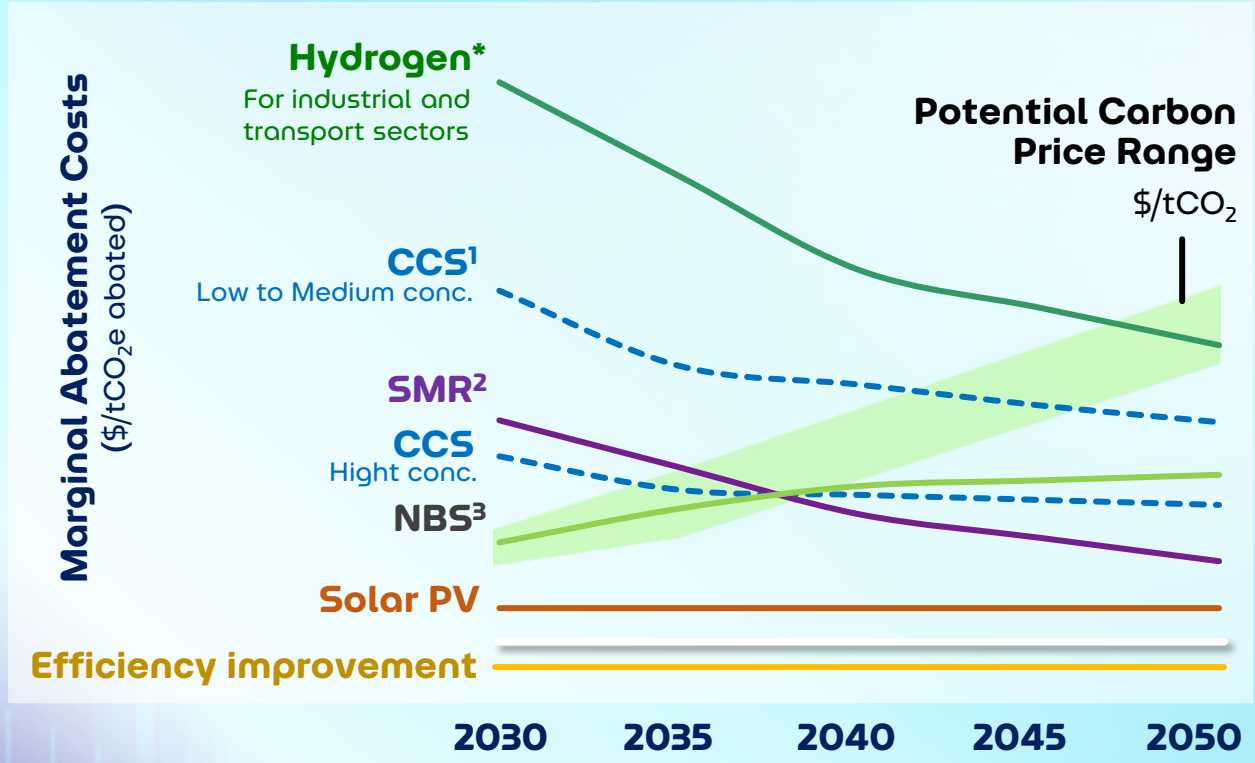
- H_2 blending in natural gas/pure H_2 for power gen.
- Energy storage

Mobility

- Truck
- Aviation
- Maritime

Technology development and policy support are key success factors to drive hydrogen as an alternative fuel

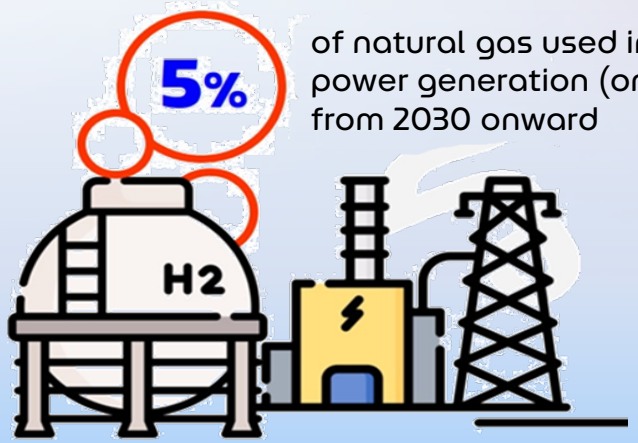
Hydrogen is a long-term abatement lever for decarbonization



*Domestic green hydrogen production cost

Drafted Power Development Plan (PDP) 2024

Government has announced in drafted PDP 2024 that **Hydrogen 5% blending in natural gas pipeline** is an abatement lever to decarbonization



of natural gas used in power generation (on-grid) from 2030 onward

=

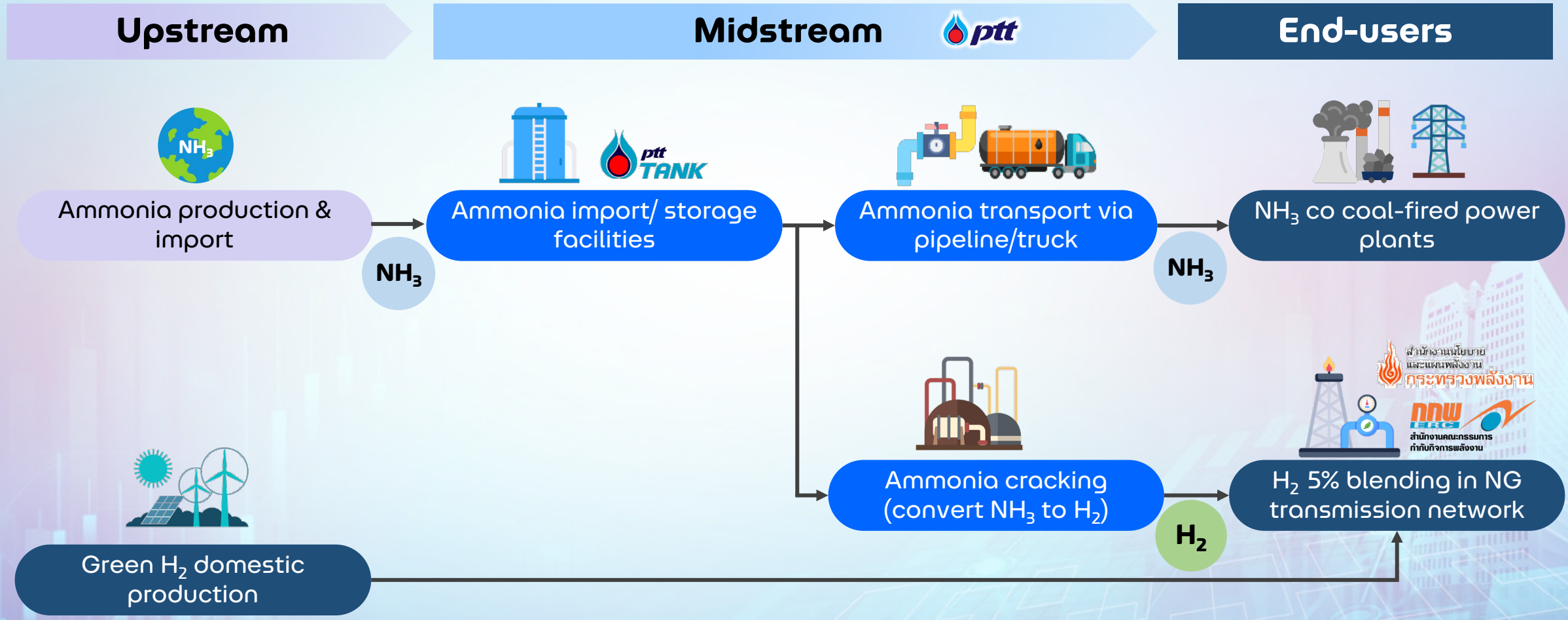
Hydrogen

120,000

ton per annum in 2030 Is required following the plan

Remark: 1 Carbon Capture & Storage; 2 Small Modular Reactor (nuclear energy); 3 Nature-base Solutions; 4 For chemical sector
Source: PTT Group database, Thailand NDC 3.0, BCG, IEA, IMF, World Bank, peer analysis

Thailand leverages hydrogen and ammonia to decarbonize power and enable energy transition through an integrated value chain



However, investment cost of 5% H_2 blending is 105x higher than 5-10% ammonia co-firing in coal power plant

Domestic infrastructure requirement

	Total infra. investment for PTT Group utilizing current assets	PTT Group					Power Producer
		Ammonia import terminal	Ammonia tank	Reconversion (Ammonia cracking)	H_2 pipeline (To blending point ≈10 km)	NG network* (Retrofit ≈3,000 km)	
1 **5% H_2 blending** in gas fired power plant's infrastructure	105x	*Utilize existing asset*				**Need further physical study*	CCGT *Retrofit for power plant*
2 **5-10% NH_3 co-firing** in coal power plant's infrastructure	x	*Utilize existing asset*	Ammonia import terminal	Existing Ammonia tank modification[1]	Ammonia pipeline (To coal power plant ≈10 km)		CFPP *Retrofit for power plant*

Remarks:
[1]Tank Modification includes: replace with bigger pump, install export pump, and upgrade heating and related units NH_3 pipeline (10"or 12") new build $1.0M/km CAPEX, H_2 pipeline new build $1.5m/km CAPEX, 3,000 km of on-shore retrofitted H_2 pipelines at $0.6m/km CAPEX, Coal fired power plant retrofit assumed ~$50m/GW for 5-10%$NH_3$ co-coal fired, 2.1 GW coal fired power plant capacity, CCGT retrofit assumed $5m/GW, New build of 36,000 tons NH_3 Tank assumes $50-100 MUSD

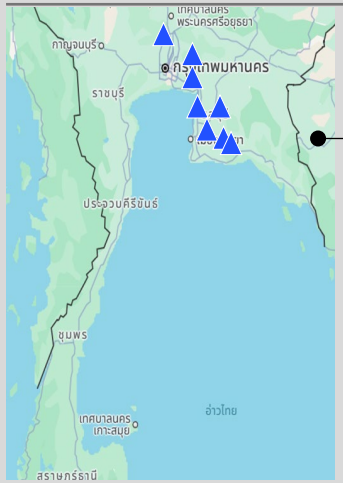
5–10% NH_3 co-firing in coal-fired power plants is a cost-effective interim solution

Government initiative & Comparative option

H_2 blending options for gas fired power plants

- High infrastructure investment cost
- Wide-reaching effects on end-users across industries, beyond energy sector
- Limited flexibility for fuel switching after the transition phase

Option 1A: Blending across the east grid



5% H_2 blending in gas-fired power plant by blending H_2 directly in the NG pipelines

Total capacity	~22 GW
Estimated Total CO_2 emissions	~59 MTPA
H_2 blending	5%
H_2 required *(Volume basis)*	~120 KTPA
Estimated CO_2 emission savings	**~1.1 MTPA**
Estimated CAPEX (incl. infrastructure)	**105X**

Option 1B: Off-pool blending in east TH

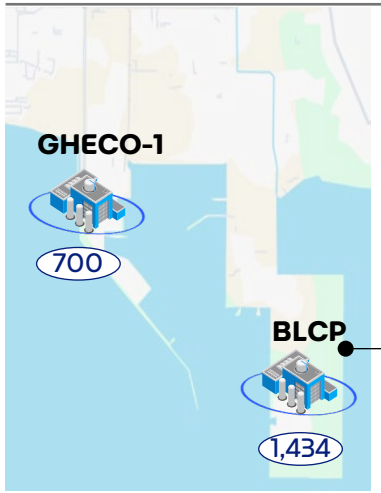
11% H_2 blending in gas fired power plants in East TH where direct H_2 pipelines can be considered

Total capacity	~10 GW
Estimated Total CO_2 emissions	~27 MTPA
H_2 blending	11%
H_2 required *(Volume basis)*	~120 KTPA
Estimated CO_2 emission savings	**~1.1 MTPA**
	90X

Propose alternative solution

NH_3 co-firing at coal-fired power plants

Option 2: Targeted CFPP (BLCP, GHECO-1)



- Minimal investment cost
- Rapid deployment readiness
- Focused on energy sector with similar CO_2 abatement potential
- Strong adaptability for fuel transition during interim period

10% NH_3 blending in coal-fired power plant

Total capacity	~2.1 GW
Estimated CO_2 emissions	~15 MTPA
NH_3 blending	10%
NH_3 required *(Energy basis)*	700 KTPA
Estimated CO_2 emission savings	**~ 1.5 MTPA**
	X

Assumption 1. Onshore retrofitted H2 pipelines needed at $0.6m/km CAPEX, CCGT retrofit assumed $5m/GW, rest of CAPEX from terminals, tanks & cracker; 2. Assumes 1,000km of onshore new-build H2 pipelines needed at $1.5m/km CAPEX, rest of assumptions same as option 1A because H2 required is the same; 3. ~$50-100m/GW needed for coal fired power plant retrofit, rest of CAPEX from terminals, tanks and NH3 pipeline of 10km at $1.0m/km, no need for reconversion facility hence saving CAPEX

Ammonia co-firing and SMRs drive the energy transition to Net Zero

2030 Energy Transition → 2040 Energy Transition → 2050 Net Zero

2030 — Carbon Price = $0/tCO2e

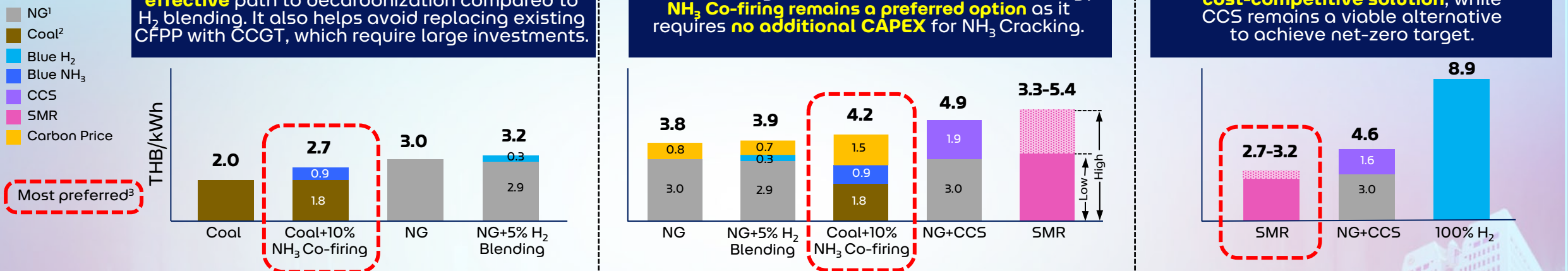
NH_3 Co-firing offers a **quicker and more cost-effective** path to decarbonization compared to H_2 blending. It also helps avoid replacing existing CFPP with CCGT, which require large investments.

2040 — Carbon Price: Domestic $100/tCO2e with 45% allowance

While awaiting cost reductions in SMR technology, **NH_3 Co-firing remains a preferred option** as it requires **no additional CAPEX** for NH_3 Cracking.

2050 — Carbon Price: Domestic $160/tCO2e

SMR is expected **to be the most cost-competitive solution**, while CCS remains a viable alternative to achieve net-zero target.



% CO_2 Savings	0%	10%	0%	~2%	0	~2%	10%	>90%	100%	100%	>90%	100%
CO_2 Savings ($kgCO_2/kWh$)	0	0.09	0	0.01	0	0.01	0.09	0.36	0.40 or 0.85 Compared with NG or Coal	0.40 or 0.85 Compared with NG or Coal	0.36	0.40 Compared with NG
CAPEX (B.USD)[4]		0.125		2.210		2.210	0.125					

Decarbon. Pathway

- **Coal for CFPP:** Only existing CFPP → Coal+NH_3: PPA Extend for NH_3 Co-firing → NH_3 Co-firing cost < SMR
- **SMR:** SMR cost < NH_3 Co-firing → If SMR is preferred over CCS
- **NG for CCGT:** High CAPEX investment for CCGT as long-term project could cost the opportunity loss for other technology for energy transition; Only existing CCGT → NG+CCS: If CCS is preferred over SMR

Signpost

1 NG (Natural gas) คือเชื้อเพลิงสำหรับโรงไฟฟ้าพลังความร้อนร่วม (Combined Cycle Gas Turbines: CCGT)
2 Coal คือเชื้อเพลิงสำหรับโรงไฟฟ้าพลังความร้อนจากถ่านหิน (Coal-Fired Power Plant: CFPP)
3 Subject to signpost
4 CAPEX on H_2 Blending/NH_3 Co-firing incl. infrastructure and pipeline retrofit/new build (depend on each case)

Hydrogen & Ammonia strategy

National H_2/NH_3 supply and infrastructure value chain leader to support PTT New growth aspiration and Net Zero ambition

1 Integrated value chain:
connecting potential supply & demand, while capturing value-added opportunities

H_2/NH_3 infrastructure readiness
- Optimize existing NH_3 infrastructure
- Ensure infrastructure expansion for domestic NH_3 usage

Invest in H_2/NH_3 production consortia to

Out-in: to export in Thailand for domestic use

Out-out: to supply to countries that need clean energy

2 Domestic
H_2/NH_3 production and infra. development

Domestic clean H_2 production
- Prepare infrastructure for domestic clean hydrogen/ammonia production in Thailand

3 Technology
To access cutting-edge tech. through investment/ project development

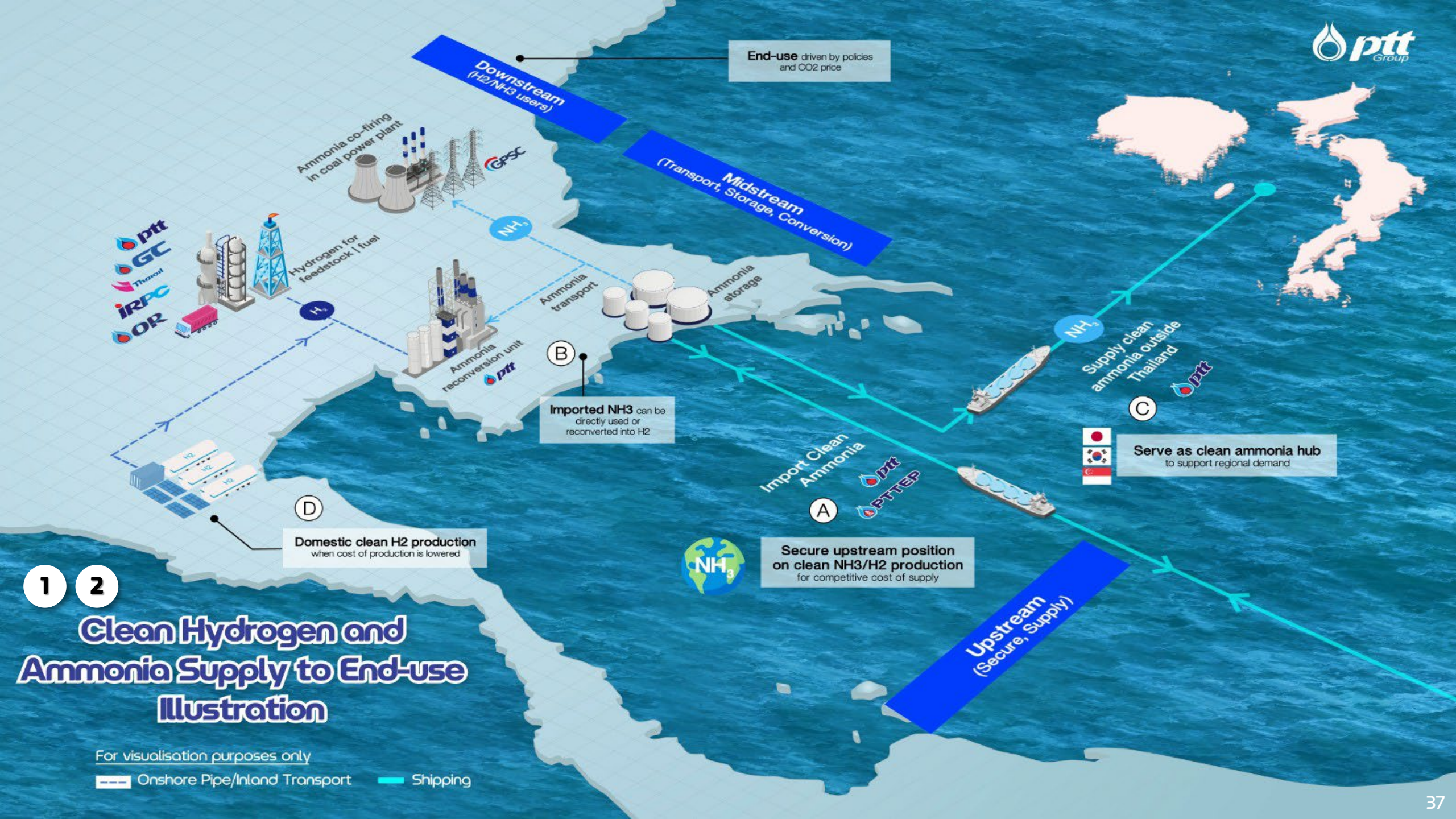
Technology investment
- Explore potential tech. that could lower production cost of H_2/NH_3 to be competitive against cost of other potential clean energy

Project development
- Demonstrate tech. locally and acquire license to operate in Thailand

4 Organization and capability
- Center development / commercial capabilities and projects in unit, but leverage broader organization

5 Investment and financing mechanisms
- Leverage balance sheet finance of projects while actively seeking equity partners to distribute risk / capital needs

6 Government policies
- Actively create transparency on H_2/NH_3's role in Thailand (incl. pot. drive national H_2/NH_3 strategy), considering the economics of H_2/NH_3 across sectors, infrastructure needs, and success factors for implementing PDP H_2/NH_3 mandate, as well as facilitate partnerships within Thai ecosystem

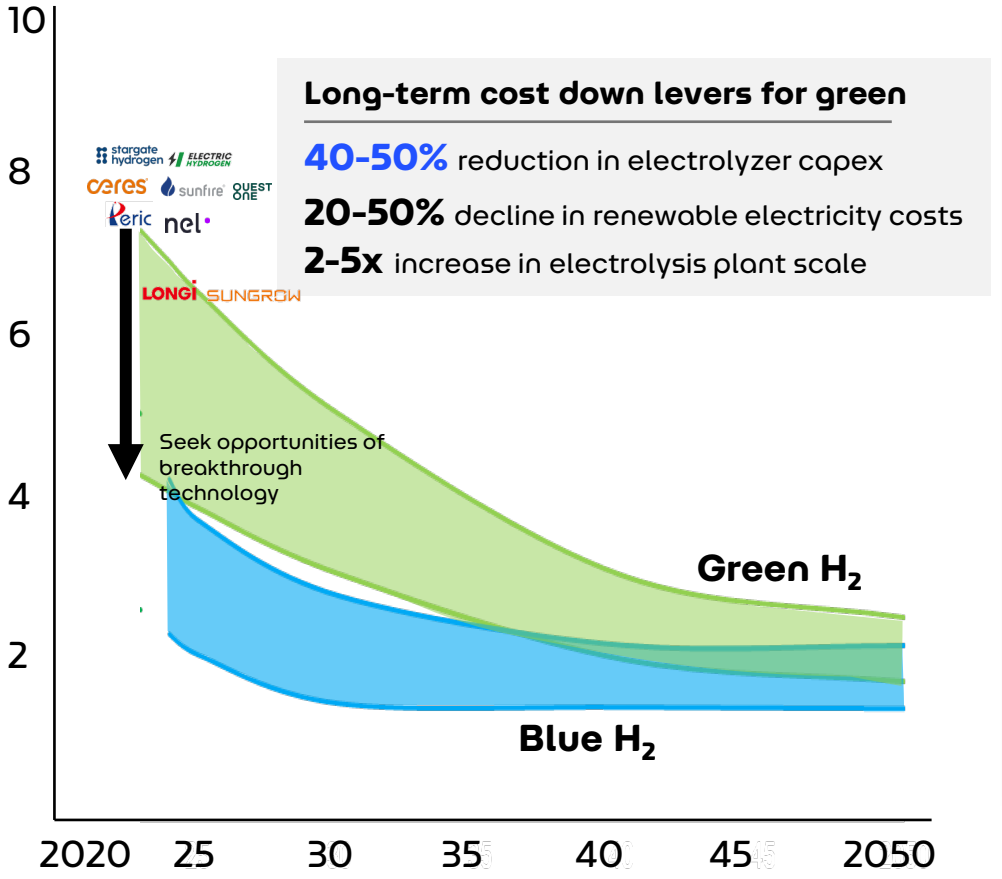

Downstream
(H2/NH3 users)
End-use driven by policies and CO2 price
Midstream
(Transport, Storage, Conversion)
Upstream
(Secure, Supply)
Ammonia co-firing in coal power plant
GPSC
Hydrogen for feedstock | fuel
ptt
GC
Thaioil
IRPC
OR
Ammonia transport
Ammonia storage
Ammonia reconversion unit
B
Imported NH3 can be directly used or reconverted into H2
Supply clean ammonia outside Thailand
C
Serve as clean ammonia hub
to support regional demand
Import Clean Ammonia
PTTEP
A
Secure upstream position on clean NH3/H2 production
for competitive cost of supply
D
Domestic clean H2 production
when cost of production is lowered
1
2
Clean Hydrogen and Ammonia Supply to End-use Illustration
For visualisation purposes only
Onshore Pipe/Inland Transport
Shipping

3

Explore and invest in hydrogen breakthrough technologies that drive hydrogen cost competitiveness

Levelized cost of H_2

USD/kg



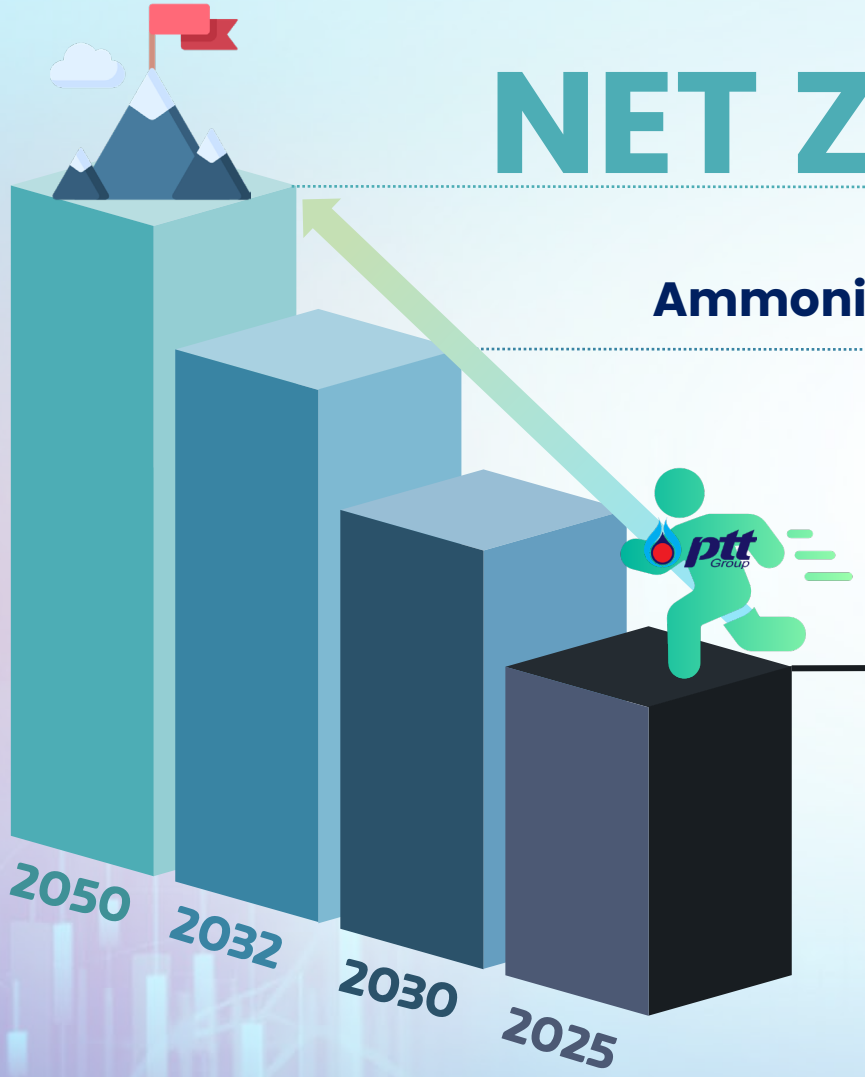
Source: McKinsey Global Hydrogen Tradeflow Model

Production Technology Focus in Pipeline

Technology	Color of H_2	LCOH (USD/kg H_2)
Green —  (TRL* 9) — **Electrolyzer**: Alkaline Water Electrolysis; Proton Exchange Membrane; Solid Oxide electrolysis; **Membranless electrolysis (New)**	Green	2.4 - 12.0
Status: Tech. assessment and finding key partners for business collaboration		
Blue —  (TRL* 9) — **Steam Methane Reforming**: Widely used and cost-effective, but carbon-intensive unless paired with CCS	Blue (with CCS)	1.8 - 4.7
Status: Tech. improvement to enhance H2 yield from its existing operations in PTT Group		
Other Low Carbon —  (TRL* 3-8) — **Emerging Tech.**: Natural & stimulated hydrogen such as **olivine, microbial**; Turquoise; H_2 from biocatalyst; H_2 from biomass/biogas	White (Naturally occurred); Blue (with CCS)	**Cost** expect to lower than Blue from conventional process
Status: Seeking for Emerging tech. / breakthrough technology for cost reduction		

*TRL = Technology Readiness Level (TRL 1-3 : Proof of concept, TRL 4-6 : Deployment Pilot, TRL 7-9 : Demonstration / Commercial)

Hydrogen development is on track with achievement along the way



Ammonia co-firing FID 2030 / COD 2032

MOU signing with PTT Group

- ✓ Hydrogen value chain with PTT as an orchestrator

Collaborate with government

- ✓ H_2/NH_3 in drafted PDP
- ✓ H_2/NH_3 as fuels in Fuel Oils Control Act

Build project partnerships

- ✓ Partnering with H_2/NH_3 suppliers in KSA, India
- ✓ MOU with coal power plants in Thailand

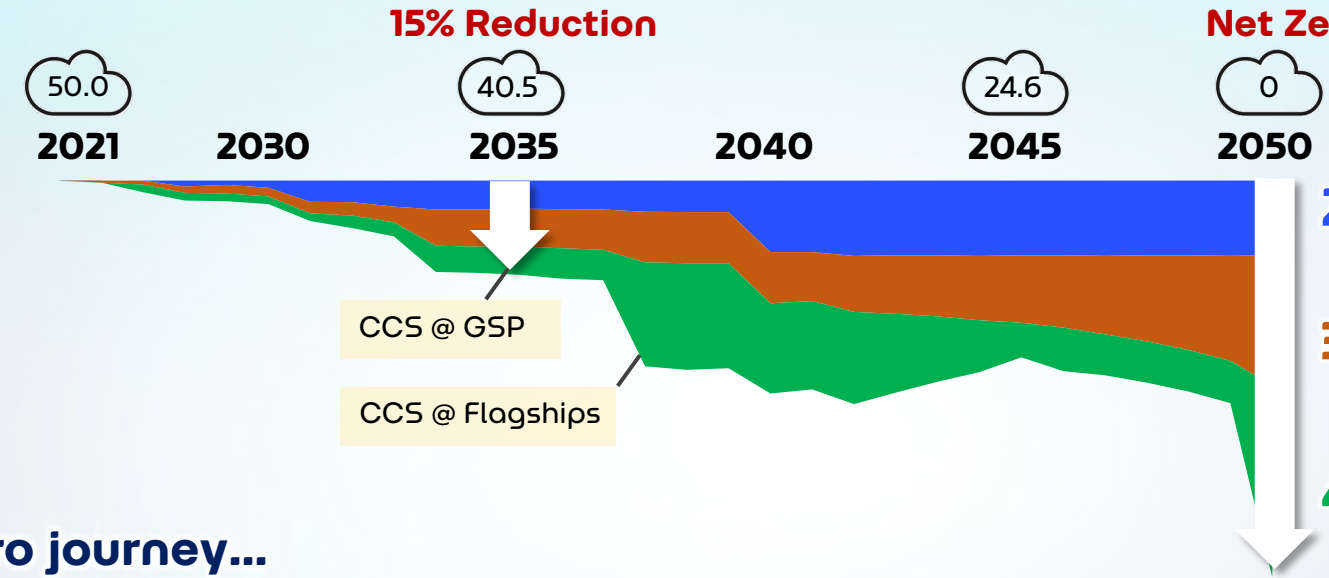
Partnering with tech. owners

- ✓ NDA/MOU with tech. owners (green H_2, white H_2, bio H_2)

Signposts and key conditions are continuously monitored to ensure that GHG reduction efforts are cost-effective

GHG Emission:
(Scope 1,2 – $MtCO_2e$)

GHG Reduction:
(Scope 1,2)
(vs. 2021 base year)



20% Climate-resilience biz

35% Carbon-conscious asset

45% Coalition, co-creation, and collective efforts for all

Towards net-zero journey...

"No Regrets" Initiatives

- Asset Efficiency Improv.
- Asset monetization

"Build Foundations" for Scalable Impact

- Renewable Energy (Solar, Wind, SMR)
- CCS & CCU
- Hydrogen
- Reforestation

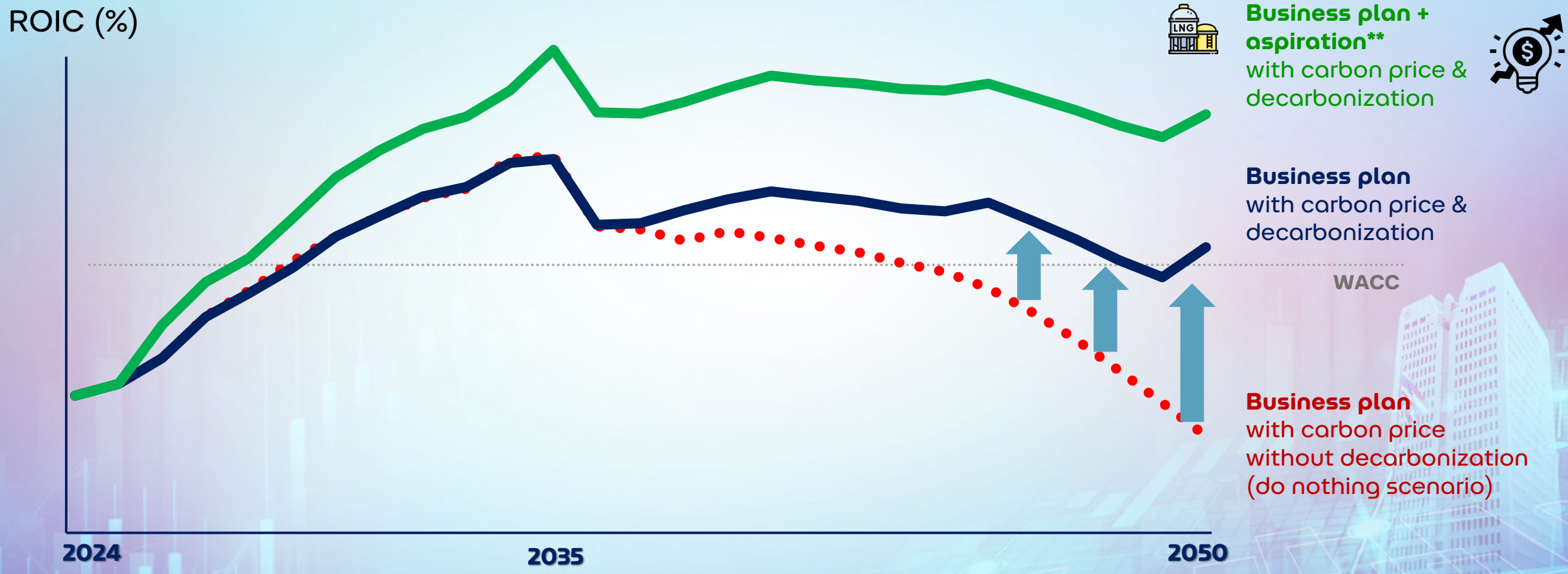
"Technology Exploring" for Competitiveness

Breakthrough tech. for no regrets initiatives and scalable impact

Key Signposts & Conditions precedent

- Carbon price
  ETS allowance
- Regulatory
  Biz / partnership model
- Technology

Pursuing the decarbonization pathway retains competitive ROIC



*Including impact from Genesis;
**Including (1) additional asset monetization initiatives (infrastructure co.) (2) additional LNG equity to meet target
Note: Carbon price assumption = 65$ by 2035 and 160$/t by 2050


FROM VISION ...
... TO ACTION
PTT Group advances Thailand's transition towards
a sustainable future with effective and realistic actions