Future Energy

Accelerating Transition, Balancing Tomorrow

Future Energy:
Accelerating Transition, Balancing Tomorrow

Global Energy Outlooks

Case Studies of Fast & Slow Movers

Balancing Thailand's Energy

Future Energy:
Accelerating Transition, Balancing Tomorrow

Global Energy Outlooks

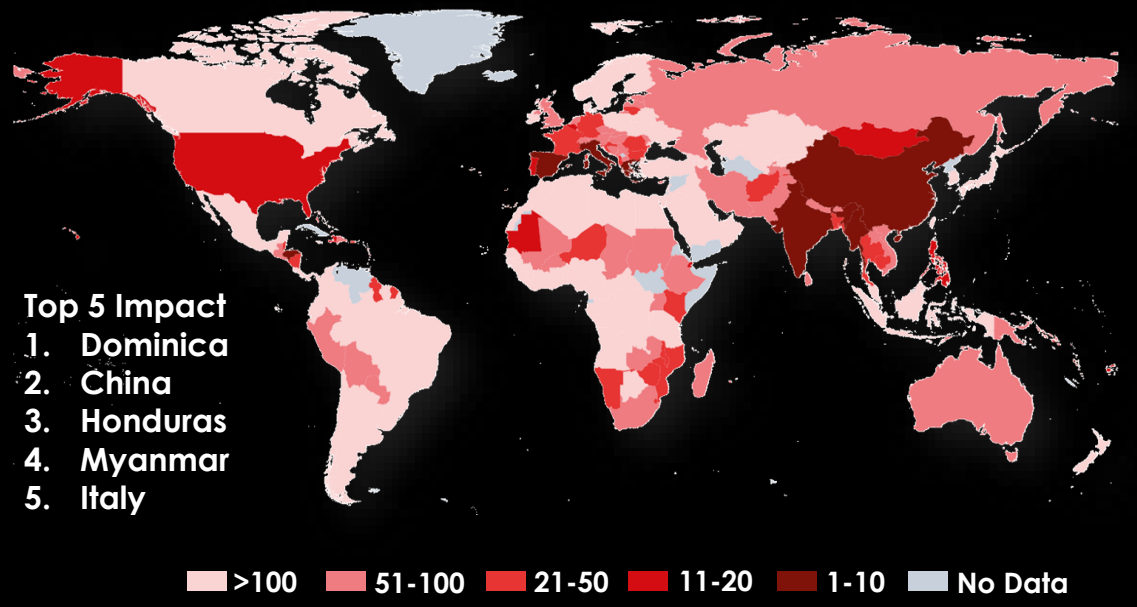
Case Studies of Fast & Slow Movers

Balancing Thailand's Energy

CLIMATE CRISIS

CLIMATE CHANGE IS IMPACTING COUNTRIES WORLDWIDE

Climate Risk Index: Overall Ranking 1993 - 2022



Climate change will intensify environmental risks unless carbon emissions are reduced.

Source GermanWatch Climate Risk Index 2025

THAILAND FLOODING 2025

RESULTING IN SUBSTANTIAL DAMAGES

CARBON EMISSIONS

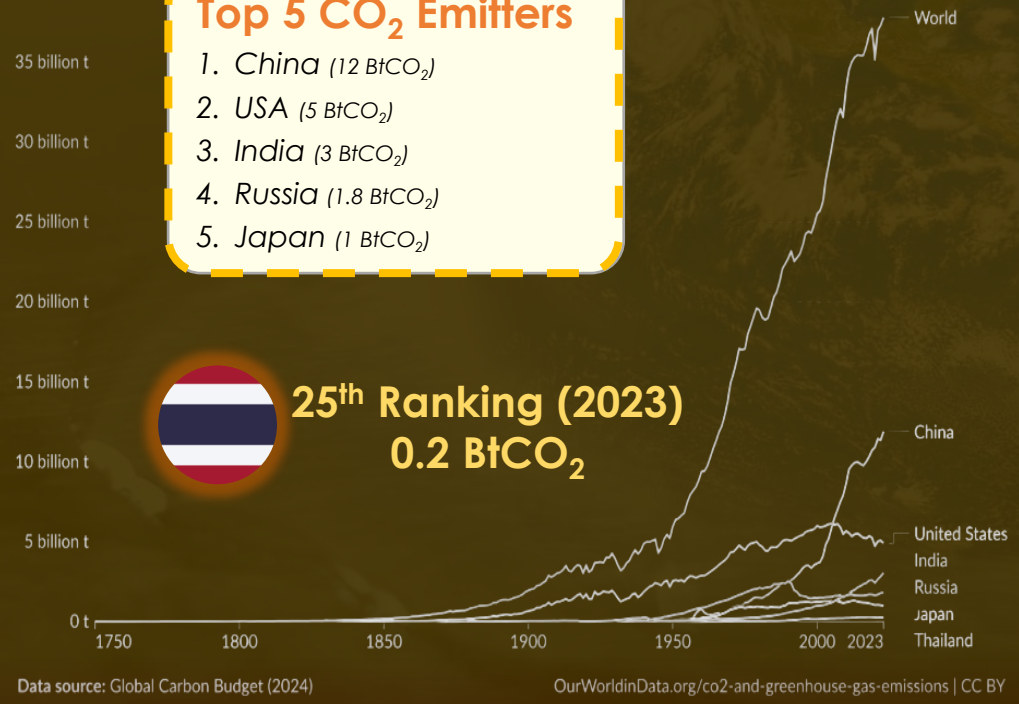
THE MORE CARBON EMISSIONS THE WORLD RELEASES, THE HIGHER GLOBAL TEMPERATURE WILL RISE

The World emitted approximately 37.8 Billion (Gt) tons of CO_2 ($GtCo_2eq$)

Top 5 CO_2 Emitters

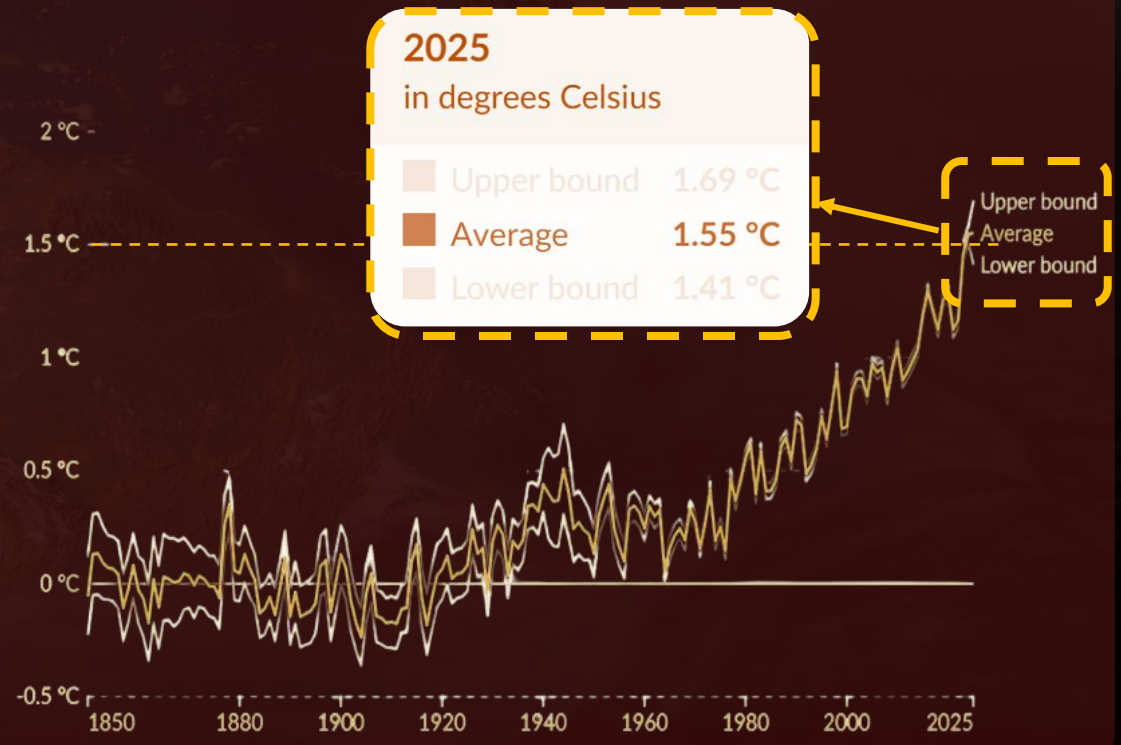
1. *China (12 $BtCO_2$)*
2. *USA (5 $BtCO_2$)*
3. *India (3 $BtCO_2$)*
4. *Russia (1.8 $BtCO_2$)*
5. *Japan (1 $BtCO_2$)*

25th Ranking (2023)
0.2 $BtCO_2$



Carbon dioxide (CO_2) emissions from fossil fuels and industry. Land-use change is not included

The Global Average Temperature exceeded 1.5 °C above pre-industrial levels.



Source: ourworldindata.org, Global Carbon Budget 2024, GermanWatch Climate Risk Index 2025

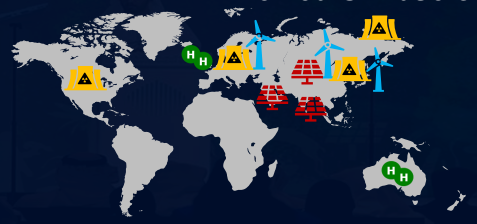
GLOBAL ENERGY TRANSITION MOMENTUM

SCALING UP CLEAN ENERGY AND PHASING DOWN FOSSIL FUELS

COP26

- Large-Scale Harvesting

8-450 GW Scale



COP27

- Green H_2 Agreement

1st NDC Submission

COP28

- Boosting Clean Energies

Tripling
RE Capacity Globally by 2030

Standardize
Certification Scheme of H_2/ Derivatives

Tripling
Nuclear Energy Capacity Globally by 2050

Transitioning Away
From Fossil Fuels in Energy System

COP29

- Limited Progress

6X Increase
Energy Storage and Grid Expansion by 2030

Establish
Infrastructure Development for RE

Scaling Up
H_2 Production and Decarbonization

Pushed Back without Consensus
Defer to be discussed further

COP30

- No New Major Pledges but Increase Financial Commitment

Clean Energy Investment Keeps Scaling Up

4X Increase
Sustainable Fuels (Belém 4x)

Mobilizing Climate Finance
Support in Developing Countries

2nd NDC Submission

Average Temperature Rise at Pledges & Long-Term Targets (°C in 2100)

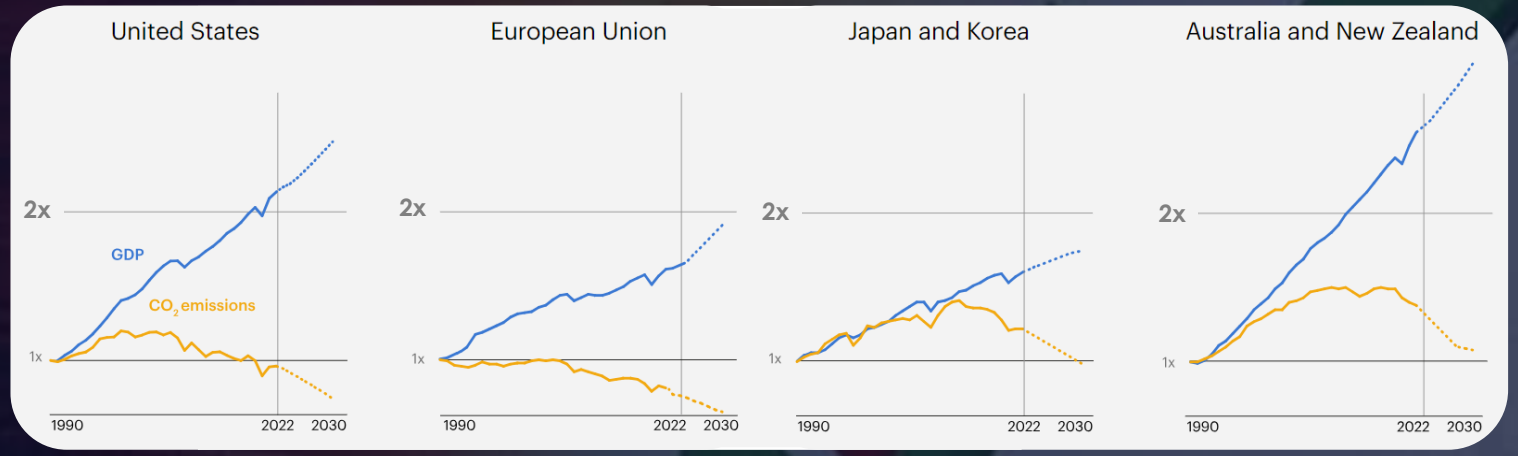
>3 (Pre-COP21) ---------- ~2.1 ---------- ~1.5 - 2 ?

UNFCCC: United Nations Framework Convention on Climate Change, COP: Conference of the Parties , NDC: Nationally Determined Contribution

GLOBAL ENERGY TRANSITIONS

CHALLENGES IN REDUCING EMISSIONS WHILE SUSTAINING GDP GROWTH

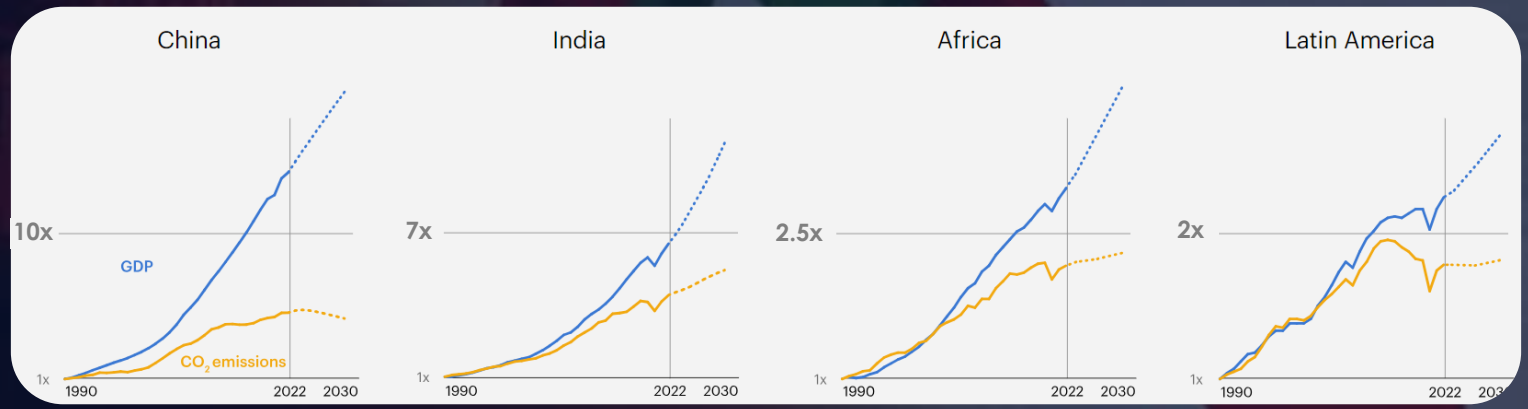
Advanced Economies Regions Where Emissions Are Falling While GDP Continues to Grow



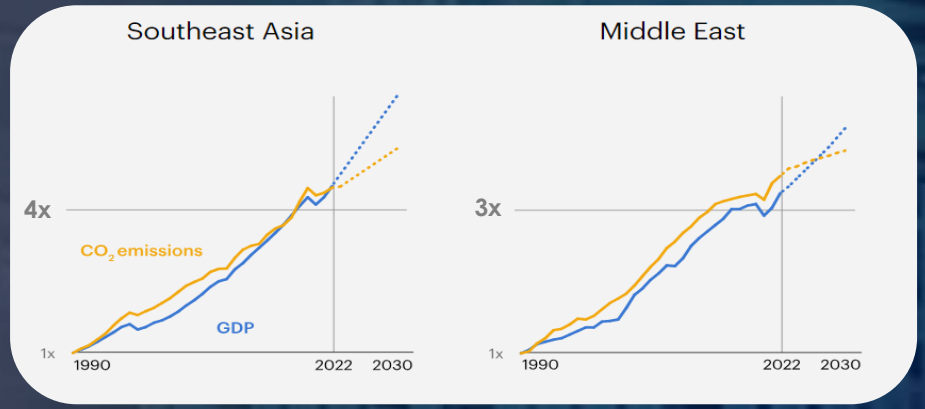
Pathways to Reduce CO_2 Emissions While Sustaining GDP Growth

- *Clean Energy Investment*
- *Energy Efficiency Improvements*
- *Transitions Away from Coal*

Emerging Economies Regions Where Emissions and GDP Growth Are Positively Correlated



Southeast Asia Emissions Have Grown Alongside GDP



GDP CO_2

Source: The relationship between growth in GDP and CO2 (IEA Analysis)

GLOBAL ENERGY TRANSITIONS

NAVIGATING SHORT-TERM VOLATILITY
WHILE ADVANCING CLEAN ENERGY AND CARBON-REDUCTION TECHNOLOGIES TOWARD NET ZERO

Short Term

Policy Shifts

- Support **Oil Production**
- Scaled **back environment policies**

- Enhance **Climate Actions** e.g., **CBAM**

- Focus on **Renewable Energy Investment**

Geopolitics Uncertainty

- **Iran-Israel Conflict:** Risk to Oil and LNG Transportation through the Strait of Hormuz
- **Russia-Ukraine War:** Cut in Gas Supply to Europe
- **U.S. Tariffs:** Risk of Losing Competitiveness
- **Others**

Long Term

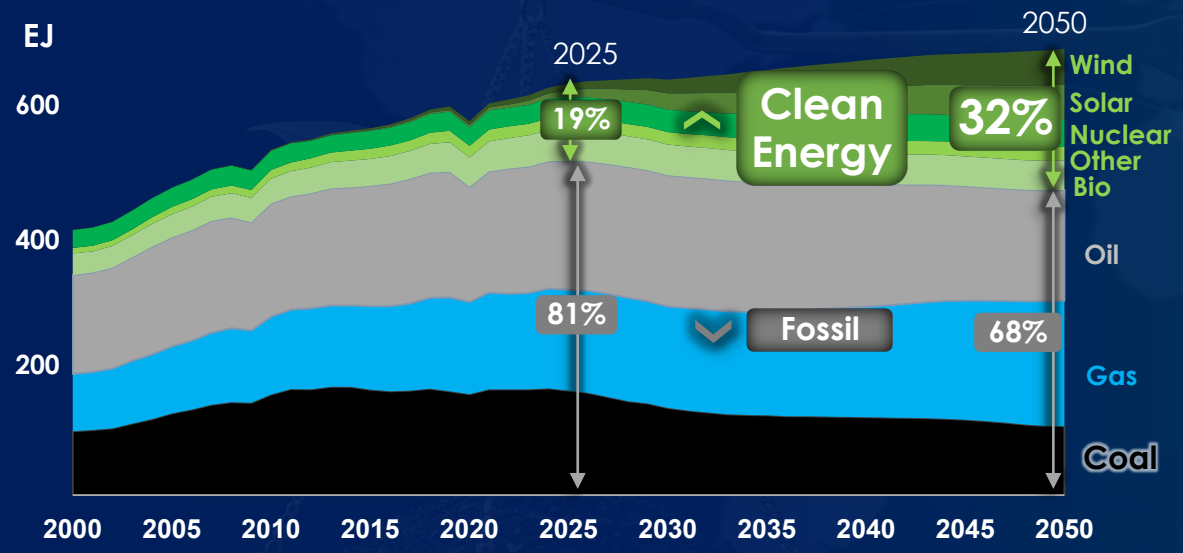
Clean Energy & Decarbonization

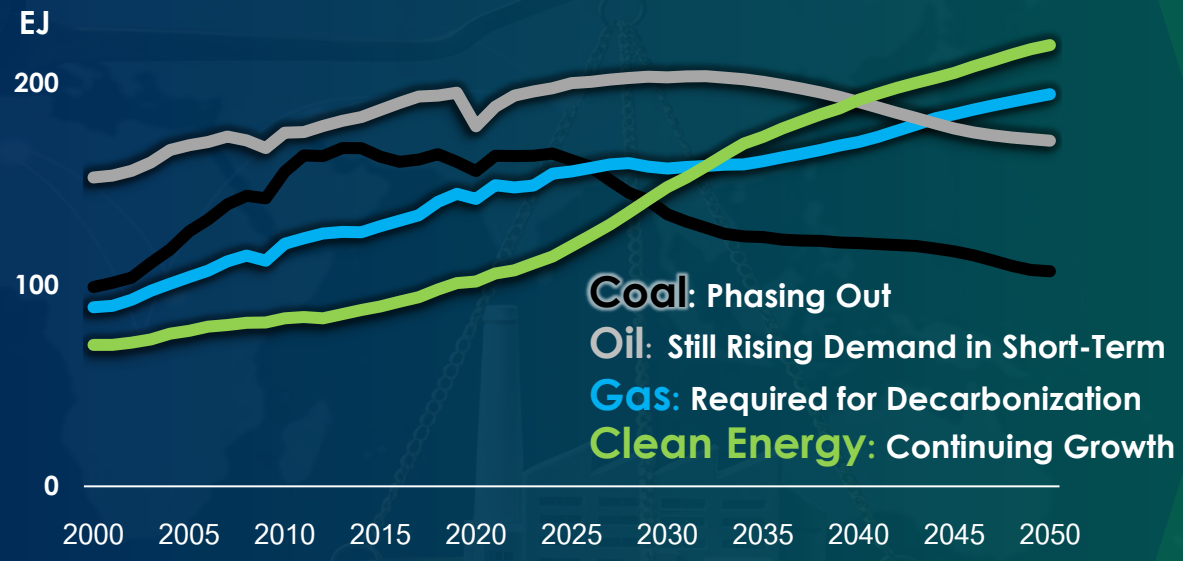
- **Net Zero Target**
- **Balancing Energy**
  - Security
  - **Sustainability**
  - Equity & Economic Development
- **Policy & Investment Alignment**
  - Activate/Improve Some Enablers
  - More **Clean Fuels**
  - **Carbon Removal Technologies**

THE FUTURE OF ENERGY

Clean Energy Rising, Yet Fossil Fuels Still Essential

Primary Energy Consumption Rising





Oil Peaks around 2032, Key is Efficiency Improvement

Natural Gas is a Destination Fuel, CCS Required

Clean Energy continues to grow, especially Solar and Wind

*EJ = Exajoule

Source: BloombergNEF New Energy Outlook 2025 (Economic Transition Scenario)

Future Energy:
Accelerating Transition, Balancing Tomorrow

Global Energy Outlooks

Case Studies of Fast & Slow Movers

Balancing Thailand's Energy

ENERGY TRANSITION PROGRESS

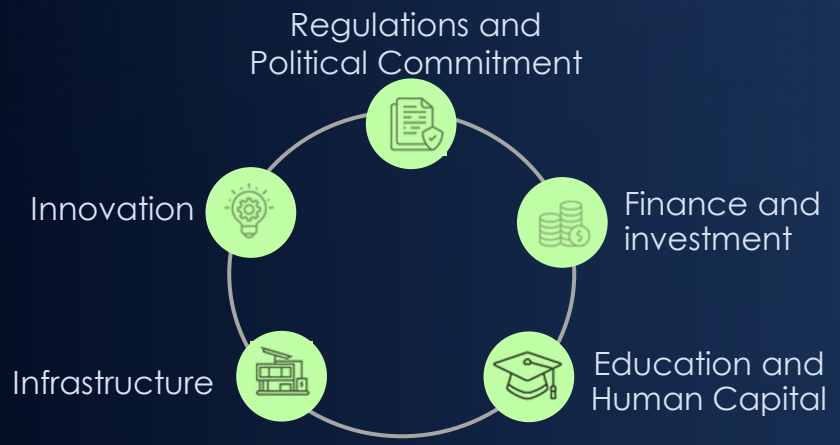
WORLD ECONOMIC FORUM

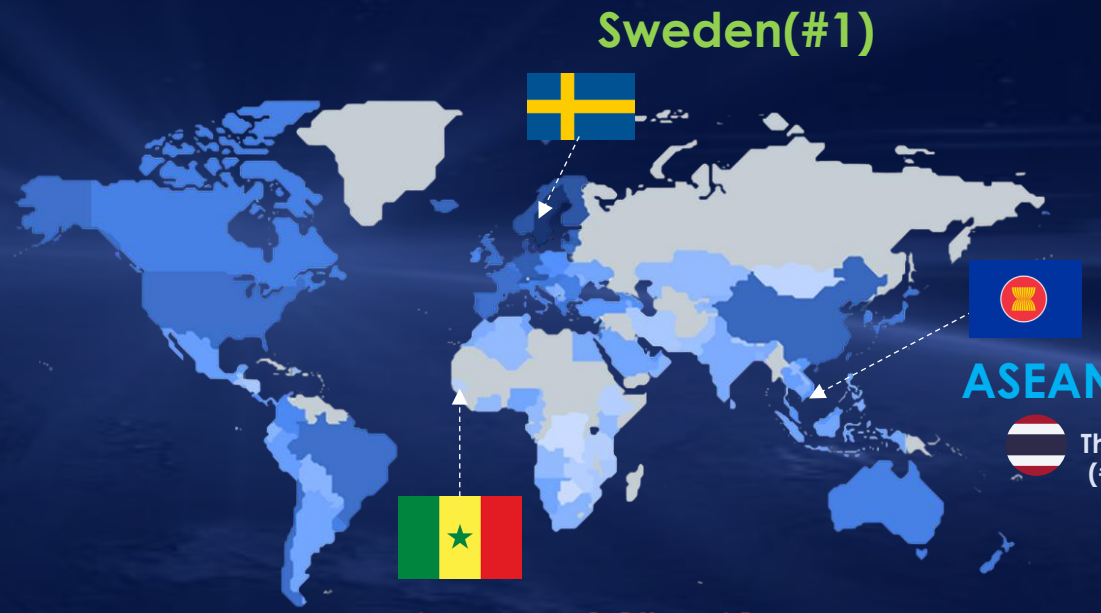
PTT PRISM

ADVANCED NATIONS SURGE AHEAD, EMERGING FACE LIMITS, ASEAN STRIVE TO ACCELERATE

1. System Performance: Overall Performance of the Current National Energy System

2. Transition Readiness: The Ability to Establish a Strong Enabling Environment for the Energy Transition



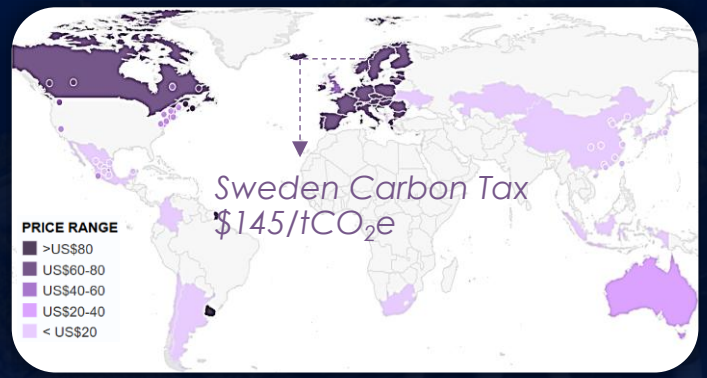


Source: World Economic Forum, Fostering Effective Energy Transition 2025

SWEDEN
ADVANCED NATIONS SURGE AHEAD

1. Robust Climate Policy Framework

- **Net Zero** Target by **2045**
- First introduced **Carbon Tax by 1991**

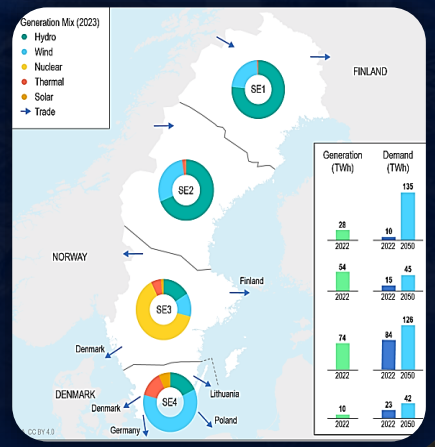


2. Highly Diversified Clean Energy Mix

- **Fossil-Free** Electricity Supply by **2040**

fossil → Hydro, Solar, Wind, Bioenergy

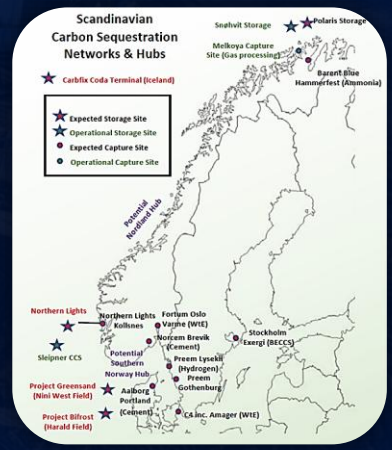
Electricity Generation *and Demand in Sweden*



3. Green Industrial & Decarbonization Shift

- **Green steel** and Clean Industry Driven by **Hydrogen**
- **Transport** Sector through **EV** and **Advanced Biofuels**
- Collaboration Scandinavian for **CCS Networks & Hubs**

Scandinavian *Carbon Networks & Hubs*



Source: World Economic Forum, Fostering Effective Energy Transition 2025, Sweden information

SWEDEN
ADVANCED NATIONS SURGE AHEAD

4. Global Innovation Leadership

- **2nd rank** in the Global Innovation in 2024
- **500 Climate Tech** Companies, Valued at Over $28 billion

SWEDISH CLIMATE STARTUP MAP

Cestore

Ocean Carbon Removal *Tech Solution*

5. Equitable and Sustainable Energy Access

- **Social Welfare Support** by Providing Compensation during Energy Crisis
- **Community Participation** Promotes Energy Communities

The Swedish Village of Simris:
100% Renewable*, Locally Produced*

6. Supporting Infrastructure Investment

- Nordic Investment Bank lends **$120M** to develop **BECCS**
- **$300M Grid Upgrade** Invested to Enhance Clean Energy Transfer

Hitachi Energy's Project:
*to **Boost Up** Transmission **Capacity by 50%***

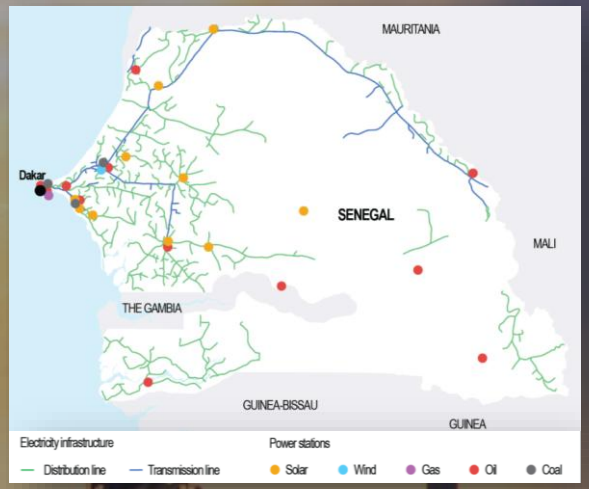
Source: World Economic Forum, Fostering Effective Energy Transition 2025, Sweden information

SENEGAL

EMERGING COUNTRIES FACE LIMITS AND NEED MORE SUBSTANTIAL SUPPORT

Limitation

- Electricity Access: **32%** of the Population still **Lacks Electricity**
- **Renewables 14.3%** Share of Power Generation
- *High* **Imported Fossil Fuels, 70%** *of Energy Supply*
- Research and Innovation are still at **Early Stage**



Electricity **Infrastructure** and Power Plants in Senegal

International Supported by JETP

- ***Increasing Electricity Access*** *for Senegal's Population*
- ***Boosting Renewable Energy*** *Share to 40% by 2030*
- ***Promoting Economic Development*** *by Lower Energy Prices*

*JETP (Just Energy Transition Partnership)

JETP Coordinated by **France & Germany**

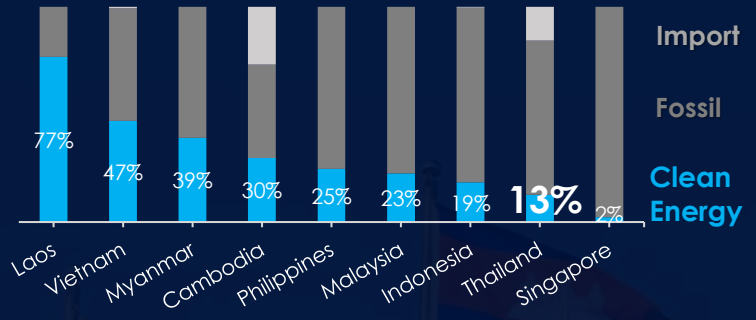
Source: World Economic Forum, Fostering Effective Energy Transition 2025. , IEA 2022, Senegal Information

ASEAN
STRIVE TO ACCELERATE

1. Clean Energy Investment

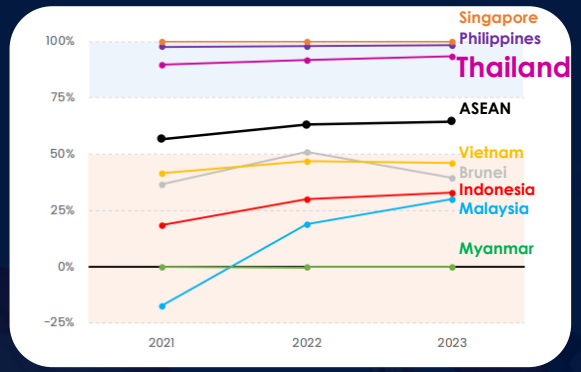
Expansion of Clean Energy

Domestic Electricity Generation used in 2024 in ASEAN[1]



2. Energy Security Risks from High Imported Fuels

~60% Crude Oil Import[2]



3. Climate Change Actions

CO_2 Reduction Target

Carbon Mechanism Development

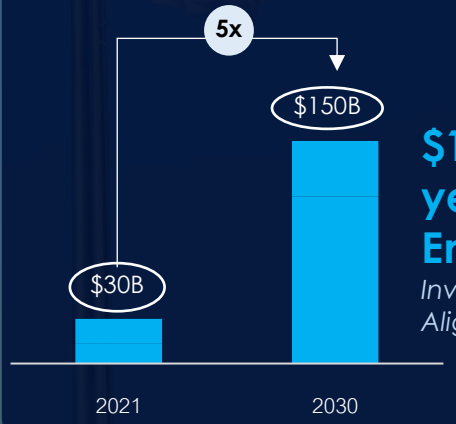
(Carbon Tax, Carbon Credit, ETS*, etc.)

Technology Deployment

4. Smart Grids Unlock

$4 - 10.7 billion *Needed in Smart Grids Investment to Fully Unlock Clean Power Potential*[3]

5. Green Financing Support



$150 billion per year in Clean Energy *Required Investments by 2030 to Align with Net Zero Targets*[4]

Source: 1: lowcarbonpower, 2: aseanenergy 3: Ember analysis, 4: BCG analysis & WEF& IEA, *ETS: Emissions Trading System

GLOBAL KEY DRIVERS OF ENERGY TRANSITION

STRATEGIC PRIORITIES AND ACTIONS SHAPING THE PATH TO NET ZERO

1. Adapt Policy

Ensure Effective Implementation of National Objectives

Finland

2035 Carbon Neutrality Target

2. Boost Innovation

Execution Capacity through Upskilling Talent

Switzerland

1st Rank World Talent & Global Innovation

3. Modernize Energy Infrastructure

Grids, Storage, and Interconnectors

USA

1st Rank Investment in Smart Grid & Digitalization

4. Accelerate Clean Technology Adoption

In Hard-to-Abate Sectors

China

1st Rank Clean Technology Investment

5. Enhance Capital Investment

In Developing Countries

Norway

*1st Rank ODA/GNI**

*ODA/GNI: (Official Development Assistance per Gross National Income)

Future Energy:
Accelerating Transition, Balancing Tomorrow

Global Energy Outlooks

Case Studies of Fast & Slow Movers

Balancing Thailand's Energy

BALANCING THAILAND'S ENERGY TRANSITION

ENHANCING THAILAND'S ENERGY SECURITY WHILE ADVANCING DECARBONIZATION TO MEET NET ZERO GOALS

Thailand Net Zero From 2065 to 2050

- E&P
- Industry
- Power Plant

Natural Gas plays a crucial role with Decarbonization

- CCS
- Hydrogen
- SMR

Renewable Energy is Essential, but Further Development is Required to Overcome Existing Limitations

	2030		2050
RE	26%	→	53%
Gas	30%	→	23%
Oil	32%	→	11%
Coal	10%	→	3%
H_2&SMR	0%	→	8%

Thailand's Energy Mix*

Sources:* (Draft) National Energy Plan, (draft) 5 sub-energy plans 2024, EPPO DOEB DEDE, Energy Demand and supply Projection Calculated by LEAP Model, Economics and Industry Research and Intelligence Department (Polarized Green, NZ 2065)

CCS IS THE KEY TECHNOLOGY TO ACHIEVING NET ZERO

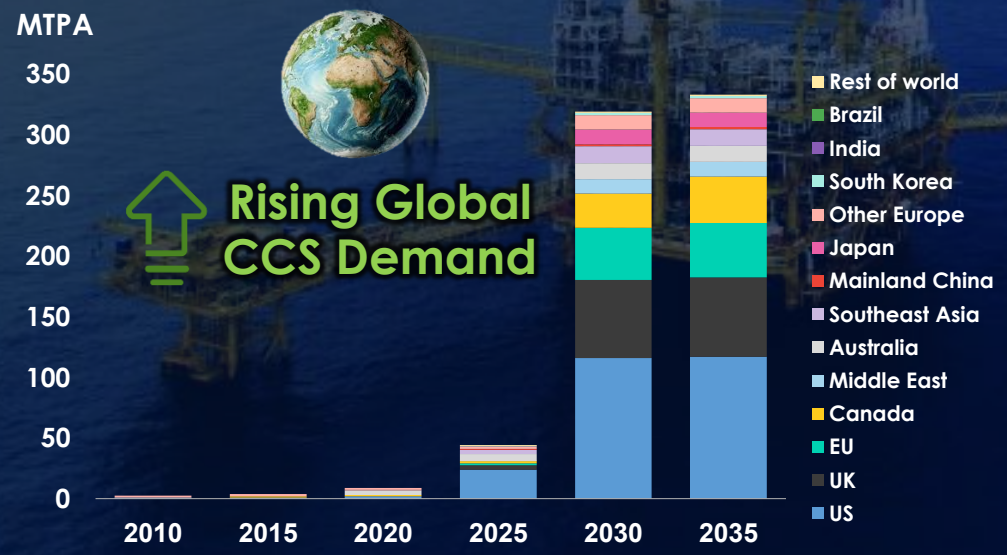
CCS PROJECTS ARE GROWING GLOBALLY, WITH ASEAN EMERGING AS A REGIONAL HUB

Global

77 Operational Projects[1]

657 Under Development Projects[1]

Historical and Proposed Capture Capacity for Storage[2]



ASEAN

20 Under Development Projects[1]

Arthit CCS, Pilot Project

- Thailand's First CCS Project to Support National CO_2 Reduction Target
- Start in 2028, 1 Million Tons CO_2 per Year
- Pilot Project Establishing Thailand's CCS

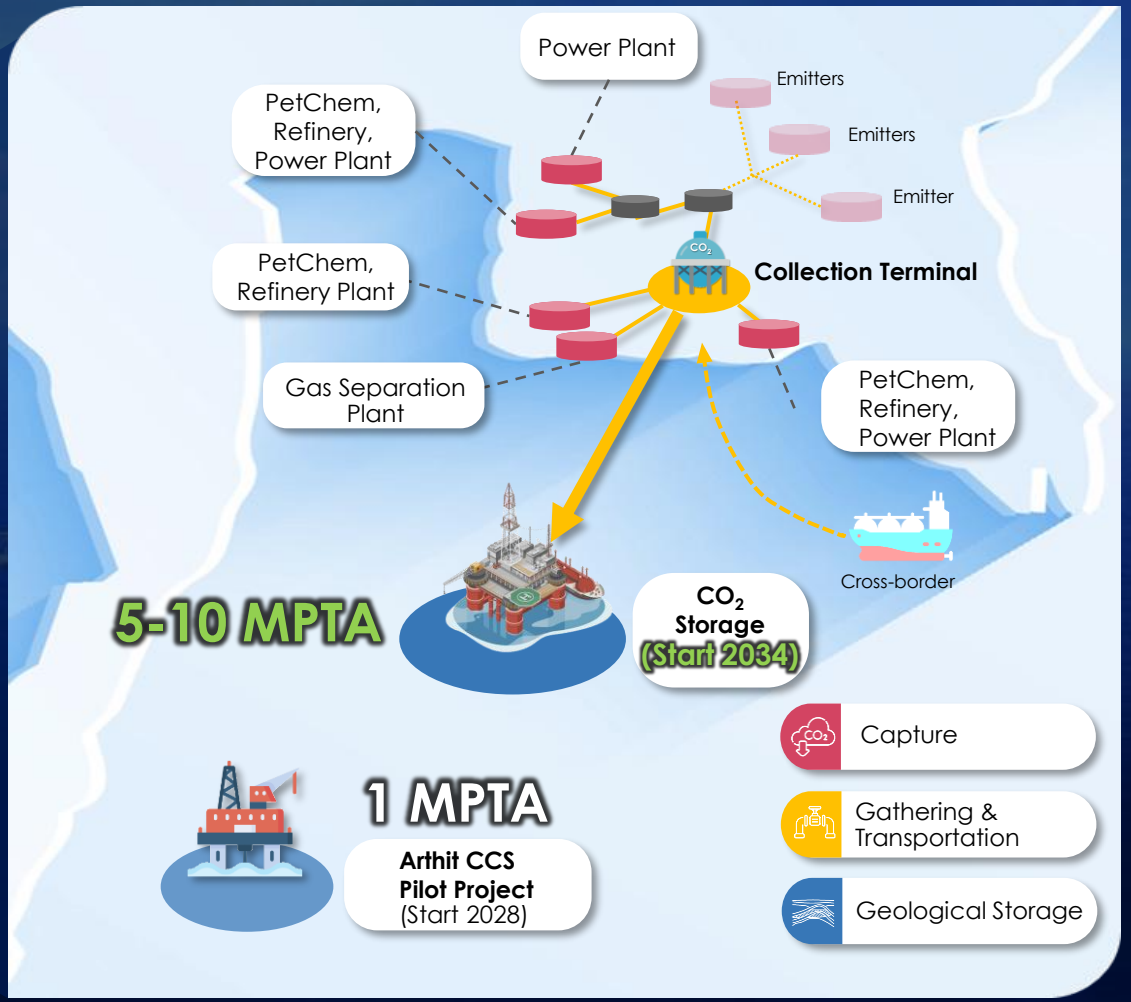
Petronas Kasawari,

- First Large-Scale Offshore CCS Development in Malaysia
- Start in 2029 and Store Up to 3.3 Million Tons CO_2 per Year

Source : 1 Global CCS Institute 2025, 2 BloombergNEF

THAILAND'S CCS POTENTIAL

EASTERN THAILAND CCS HUB: REDUCING EMISSIONS IN MOST CARBON-INTENSIVE AREAS



Source: McKinsey

CCS POWERING THAILAND'S ECONOMIC FUTURE

ACCELERATING CCS TO GENERATE A SIGNIFICANT VALUE FOR THAILAND

>6 MTPA

CO_2 Emissions Reduction

11,000 Jobs

Increased Employment

18,000 Million THB per Year

Economic Boost through Investment

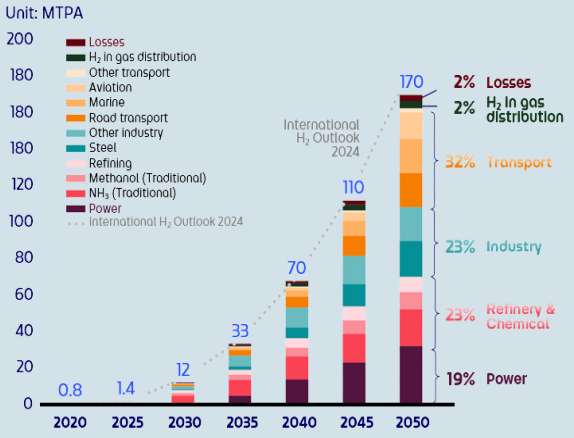
Source: PTT Group

Hydrogen & SMR

DELIVERING RELIABLE POWER AND DRIVING THAILAND'S SUSTAINABLE FUTURE

Hydrogen Projects Capacity 150 MTPA Announced

Global Clean hydrogen Demand Increasing

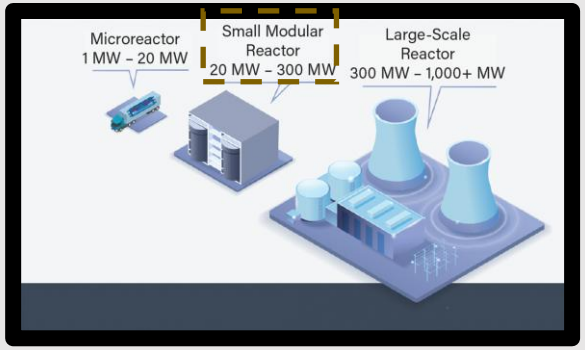


Industry and **Transport** are the main sectors for long-term H_2 consumption

Further Technological Advancements could lead to **Cost Reductions, Similar to the Solar** Industry a decade ago

Nuclear Energy's Competitiveness

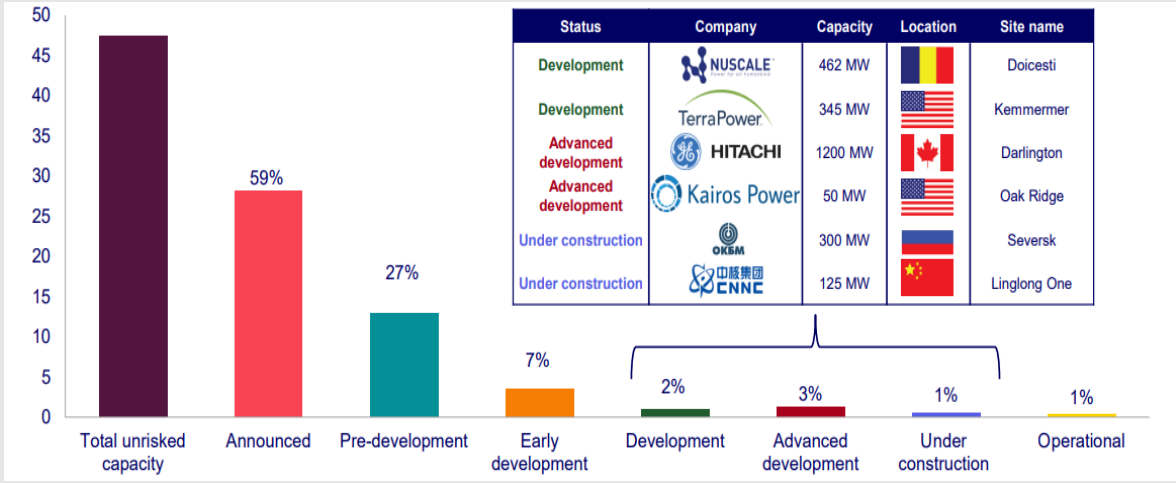
Small Modular Reactor



Low Carbon Footprint
Not Emit Greenhouse Gas

Grid Stability
Predictable & Continuous Baseload Power

The Unrisked SMR Project Pipeline is at 47 GW Globally



Source: WoodMackenzie Q1 2025

THAILAND'S URGENT PRIORITIES TO ACCELERATE ENERGY TRANSITION

1. Modernization of Regulations

Updating Policies to
Support National Target

2. Technology Advancement & Investment

Driving Innovation & Financial Support
In Green Technology & Carbon Reduction Project

3. Energy Efficiency Improvement

Applying New Standards and
Initiatives to Reduce Energy Cost

4. Enhanced Public-Private-People Collaboration

Strengthening Partnerships to Promote
Sustainability toward Future Energy Together


Energy Transition
is not an Option,
but a NECESSITY