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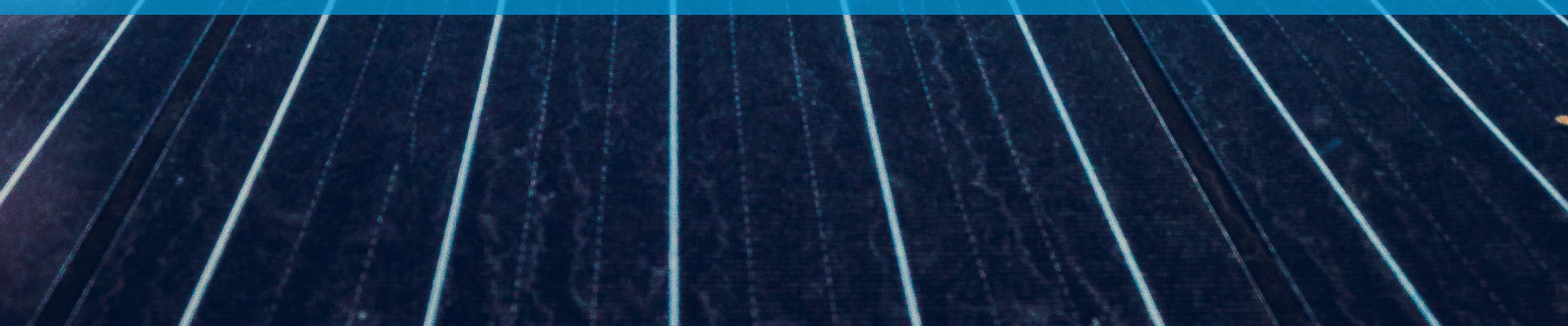
한국에너지공단
KOREA ENERGY AGENCY

Department of Alternative
Energy Development and Efficiency
MINISTRY OF ENERGY

In partnership with
the Republic of Korea

Policy Guidelines to Strengthen Renewable Energy and Energy Efficiency in Thailand's Industrial Sector for Decarbonization Pathways

Policy White Paper



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Policy White Paper

Acknowledgments

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Executive Summary

In pursuit of its climate goals of achieving carbon neutrality by 2050 and net zero greenhouse gas (GHG) emissions by 2065, Thailand has intensified efforts to strengthen its renewable energy capacity and enhance energy efficiency. Strengthening the adoption of renewable energy and energy efficiency within Thailand's industrial sector will be crucial to achieving carbon neutrality.

The industrial sector is Thailand's largest energy consumer, accounting for approximately 45 per cent of the country's electricity use. The share of renewable energy in electricity generation is expected to reach 51 per cent by 2037, up from currently 20 per cent. Clean electricity will play an increasingly important role in the industrial sector in the face of geopolitical and trade tensions, and the need to meet international climate goals.

Thailand is finalizing the draft of its Alternative Energy Development Plan (AEDP) and Energy Efficiency Plan (EEP), which is expected to be implemented from 2025 to 2037. The AEDP focuses on promoting the use of domestic renewable energy sources and maximizing their potential through appropriate technologies and cost-effective measures. The EEP aims to reduce energy intensity by 36 per cent by 2037 compared to the 2010 baseline. Together, these plans will be instrumental in shaping policies, incentives and regulations that drive the adoption of renewable energy and energy efficiency, thereby decarbonizing Thailand's industrial sector and helping the country achieve its climate goals.

This Policy White Paper is a collaboration between the United Nations Industrial Development Organization (UNIDO), the Korea Energy Agency (KEA), and Thailand's Department of Alternative Energy Development and Energy Efficiency (DEDE). It proposes policy measures to promote the adoption of renewable energy and energy efficiency in Thailand's industrial sector. These decarbonization policies will contribute significantly to Thailand's goals of achieving carbon neutrality by 2050 and net zero emissions by 2065. Rather than providing final and prescriptive conclusions, this White Paper highlights key stakeholders' perspectives, illustrating how these inputs influenced the decision-making process. DEDE officials played a leading role in its preparation.

The White Paper outlines six policy objectives aimed at reducing Thailand's carbon footprint, ensuring energy security, and strengthening the sustainability of the country's industrial growth by 2037. These objectives align with the goals set by the AEDP 2024 and EEP 2024, and include (i) promoting the integration of renewable energy sources; (ii) enhancing energy efficiency in industrial applications; (iii) decarbonizing energy-intensive industrial processes; (iv) encouraging investments in green technologies; (v) strengthening institutional capacity and raising awareness, and finally, (vi) contributing to Thailand's sustainable development and climate goals.

To achieve these policy objectives, the White Paper recommends a set of targeted policy measures to support AEDP and EEP and strengthen renewable energy and energy efficiency in the industrial sector to support Thailand's path to carbon neutrality.

Under the AEDP (renewable energy measures), the proposed actions include enhancing financial incentives for renewable energy adoption; streamlining the regulatory framework and permitting process; supporting the development of industrial clusters and microgrids; incentivizing distributed renewable energy generation; establishing a National Renewable Energy Marketplace; introducing Renewable Energy Purchase Agreements (REPAs); encouraging the integration of smart grids and energy storage solutions, and developing a National Waste-to-Energy (WTE) Programme.

Cross-cutting measures aim to build an enabling environment through capacity development and technical support; research and development (R&D) in green technologies; the creation of green financing mechanisms; establishing monitoring and reporting systems; conducting public awareness and engagement campaigns; introducing a carbon pricing mechanism; and implementing a "Green Industry" labelling system to encourage sustainable practices.

Under the EEP (energy efficiency measures), the recommendations include mandating energy efficiency targets for industries; promoting Energy Performance Contracting (EPC); supporting industrial symbiosis and circular energy models; introducing Energy Efficiency Certification for industrial products and establishing an Industrial Energy Efficiency Fund to finance efficiency improvements.

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List of abbreviations

ADB	Asian Development Bank
AEDP	Alternative Energy Development Plan
AI	Artificial intelligence
ASEAN	The Association of Southeast Asian Nations
BCG	Bio-circular-green
BOI	Board of Investment
CBAM	Carbon Border Adjustment Mechanism
CCUS	Carbon capture, utilization, and storage
CO_2	Carbon dioxide
COD	Commercial operation date
DEDE	Department of Alternative Energy Development and Energy Efficiency
DPPA	Direct power purchase agreement
DSM	Demand Side Management
EE	Energy efficiency
EED	Energy Efficiency Directive
EEE	Energy efficiency in electricity
EEP	Energy Efficiency Plan
EERF	Energy Efficiency Revolving Fund
EERS	Energy Efficiency Resource Standards
EGAT	Electric Generating Authority of Thailand
ENCON Fund	Energy Conservation Fund
EnMS	Energy management systems
EPC	Energy Performance Contracting
ERC	Energy Regulatory Commission
ESCO	Energy service company
ESG	Environment, social and governance
ESS	Energy storage system
ETS	Emissions Trading System
EU	European Union
EV	Electric vehicle
FiT	Feed-in-tariff
GCF	Green Climate Fund
GDP	Gross domestic product
GEAP	Green Energy Auction Program
GHG	Greenhouse gas
GW	Gigawatt
GWh	Gigawatt hour
HRD	Human resource development
IEA	International Energy Agency
IEEF	Industrial Energy Efficiency Fund
IoT	Internet of Things
IPP	Independent power producer
IPS	Independent power supplier

IRA	Inflation Reduction Act
IREC	International Renewable Energy Certificate
KEA	Korea Energy Agency
KPX	Korea Power Exchange
ktoe	Kilotonne of oil equivalent
kWh	Kilowatt-hour
LPG	Liquefied petroleum gas
LT-LEDS	Long-term low-carbon development strategies
MEA	Metropolitan Electricity Authority
MMBtu	Million British thermal units
MOTIE	Ministry of Trade, Industry, and Energy
mtCO2	Metric tonnes of carbon dioxide
M&V	Measurement and verification
MW	Megawatt
NDC	Nationally determined contribution
NEP	National Energy Plan
nZEB	Nearly zero-energy building
PDP8	Power Development Plan 8
PEA	Provincial Electricity Authority
PEP	Philippine Energy Plan
PPA	Power purchase agreement
PR	Public relations
PV	Photovoltaic
R&D	Research and development
RDF	Refuse-derived fuel
RE	Renewable energy
REC	Renewable Energy Certificate
RED	Renewable Energy Directive
REMIT	Regulation on Wholesale Energy Market Integrity and Transparency
REPA	Renewable Energy Purchase Agreement
ROK	The Republic of Korea
RPS	Renewable Portfolio Standard
RRF	Recovery and Resilience Facility
SAF	Sustainable aviation fuel
SDGs	Sustainable Development Goals
SME	Small and medium-sized enterprise
SPP	Small power producer
TISI	Thai Industrial Standards Institute
T-VER	Thailand Voluntary Emission Reduction
UGT	Utility green tariff
UNIDO	United Nations Industrial Development Organization
U.S.	United States
VAT	Value-added tax
VSPP	Very small power producer
WtE	Waste-to-Energy
ZEB	Zero-energy building

1 Introduction and background

As developing countries in Southeast Asia modernize and industrialize, rising average incomes and rural-to-urban migration are fuelling increased energy demand. Over the past two decades, energy demand in the region has expanded rapidly, driven by the industrial sector's strong growth. This sector is projected to grow at an average of 3.5 per cent annually through 2050 (IEA, 2024).

This presents a serious challenge to both the region's energy security and its ability to achieve national and regional climate change commitments. Despite its vast renewable resource potential and plans to establish an integrated Association of Southeast Asian Nations (ASEAN) power grid with multilateral power trade, Southeast Asia is currently not on track to meet its regional target of generating 23 per cent of its total primary energy supply from renewable sources by 2025.

Thailand's gross domestic product (GDP) is expected to reach USD 545.3 billion in 2025 (IMF, 2025). The country's economy heavily relies on exports, accounting for 65 per cent of GDP. In 2024, Thailand's energy demand is dominated by fossil fuels, with natural gas and liquefied natural gas (42 per cent), oil (40 per cent), and coal (11 per cent) comprising the bulk of consumption (EPPO, 2025). The country has intensified efforts to strengthen its renewable energy capacity in line with its climate goals of achieving carbon neutrality by 2050 and net-zero greenhouse gas (GHG) emissions by 2065.[1]

Thailand's National Energy Plan (NEP), expected to be finalized in 2025, will outline a strategic roadmap for the country's energy landscape through the 2040s. Serving as a guiding framework for both government agencies and private enterprises operating within the energy sector, NEP aims to increase the share of renewable energy to over 51 per cent by 2037 and promote more efficient energy use. The goal is to reduce energy consumption by 30 per cent by 2030 and 40 per cent by 2050.

Achieving carbon neutrality will require Thailand's industrial sector to increase the use of renewable energy (RE) and improve energy efficiency (EE). This sector accounts for the largest share of final energy consumption in Thailand, accounting for around 45 per cent of the country's electricity use. The share RE in electricity generation is expected to increase to 51 per cent by 2037, up from approximately 20 per cent today. Thailand also aims to reduce the industrial sector's energy consumption for electricity and heat by 12,432 kilotons of oil equivalent (ktoe) from 2025 to 2037 (DEDE, 2024). Clean electricity will become increasingly important for the industrial sector against the backdrop of geopolitical tensions, trade frictions, and international climate goals.

1 Thailand's Long-Term Low Green House Gas Emission Development Strategy, Ministry of Natural Resources and Environment, Nov 2022.

The United Nations Industrial Development Organization (UNIDO) launched a new project titled "Supporting Southeast Asian Countries to Cope with Climate Change Through Policy Consultation and Capacity-Building in Renewable Energy and Energy Efficiency." The project aimed to strengthen the capacity of governments and the private sector across Southeast Asia to reduce GHG emissions and advance sustainable development. To this end, UNIDO partnered with the Korea Energy Agency (KEA) and Thailand's Department of Alternative Energy Development and Energy Efficiency (DEDE) to support Thailand's energy transition efforts, ensuring that the country's growing energy demands are met while reducing carbon intensity.

This Policy White Paper was prepared by a team of government officials from DEDE, in collaboration with UNIDO and KEA. The paper sets out policy measures and implementation strategies to promote RE and EE in Thailand's industrial sector. These measures will contribute significantly to achieving the targets outlined in NEP: reaching carbon neutrality by 2050 and net-zero GHG emissions by 2065.

The Paper highlights several aspects of RE and EE policies that are relevant to the industrial sector's energy transition. Rather than presenting final and prescriptive conclusions, it showcases how the input of all stakeholders influenced the decision-making process. DEDE officials played a leading role in drafting the paper, supported by a task team consisting of representatives from DEDE and other relevant institutions. What makes this Policy White Paper particularly significant is that it was prepared by young Thai policymakers who will be implementing the proposed policies.

A series of workshops was conducted to gather comprehensive analyses and recommendations on advanced energy policies in Thailand. These workshops equipped Thai policymakers with international knowledge and relevant policy instruments. In 2023, the Policy Research Center on the Green Economy, which is part of the Faculty of Economics at Thammasat University, provided a benchmark report on policies targeting electric vehicles, RE, and monitoring and evaluation tools. The report served as a valuable resource for training sessions and facilitated the sharing of policy experiences among stakeholders. Additionally, the task team obtained insights from external experts who contributed global experience and policy recommendations, as well as assistance in finalizing the White Paper.

The rest of the document is structured as follows: Section 2 reviews global and international trends in RE and EE. Section 3 summarizes Thailand's national energy plans and supporting policies, while Section 4 presents policy recommendations.

2 Global and international renewable energy and energy efficiency trends and policies

Under the Paris Agreement, which aims to limit the global temperature increase to below 1.5 degrees Celsius, countries around the world have voluntarily submitted GHG reduction targets, long-term low-carbon development strategies (LT-LEDS), and nationally determined contributions (NDCs) as part of their commitments. As of mid-2025, 180 countries have submitted NDCs, and 130 countries have announced net-zero targets.[2]

These climate commitments have driven significant growth in investments in RE and EE in recent decades, as part of a major effort to reduce carbon dioxide (CO_2) emissions in the energy sector, the largest contributor to total CO_2 emissions. According to the World Energy Outlook 2024 (IEA, 2024), global investment in RE grew significantly in 2023, reaching approximately USD 750 billion, led by a boom in investments in solar photovoltaic (PV) and wind energy. The rising share of renewables in the energy sector is expected to reduce cumulative emissions by roughly 3 to 4.5 gigatons of CO_2 to meet climate goals. In 2023, annual investment in EE exceeded USD 390 billion, supported by policy and regulatory measures implemented in various countries, such as the Inflation Reduction Act in the United States (U.S.) and the Energy Efficiency Directive in the European Union (EU).

This section summarizes key policy innovations and incentives to promote RE and EE, drawing on international experiences, including from the EU, the U.S., China, the Republic of Korea (ROK) and ASEAN countries.

The European Union (EU)

In 2019, EU Member States committed to achieving carbon neutrality by 2050 through the **European Green Deal**, a comprehensive set of policy initiatives. This was followed by the adoption of the first EU Climate Law in 2021, which legally established the EU's goal of becoming climate neutral by 2050, with a 55 per cent reduction in emissions by 2030 and a 90 per cent reduction by 2040 (a new recommendation announced in February 2024), compared to 1990 levels (European Commission, 2024). To achieve these targets, the Fit for 55 legislative package was proposed in July 2021 and has since been fully adopted, providing a fair, cost-effective and competitive pathway towards the EU's 2030 climate goals. As part of this set of laws, several initiatives and policy measures have been introduced to support progress in RE and EE in the EU, including the Renewable Energy Directive (RED), the Energy Efficiency Directive (EED), the Carbon Border Adjustment Mechanism (CBAM), the reform of the EU Emissions Trading System (ETS) and the establishment of the Social Climate Fund (European Commission, 2024a).

As the energy sector accounts for around 75 per cent of total GHG emissions in the EU, the revised RED in 2023 sets a target to increase the share of RE in the EU's energy consumption to at least 42.5 per cent by 2030 to accelerate the deployment of RE, reduce reliance on Russian fossil fuels, and increase the availability of affordable, secure and sustainable energy in the EU (European Commission, 2024). The public sector must reduce energy consumption by 1.7 per cent annually, and is supported by the Social Climate Fund, which helps improve quality of life and promote EE.

2 The UNFCCC NDC Registry lists a total of 222 NDC submissions, including updated versions and submissions by regional organizations such as the European Union.

More recently, in 2023, the EED introduced a new binding target to reduce both final and primary energy consumption by 11.7 per cent compared to 2020 levels. It also sets out guiding principles that prioritize EE, including an annual cumulative energy savings obligation of 1.49 per cent from 2024 to 2030. In addition, it establishes specific obligations for the public sector to achieve its annual energy reduction target of 1.9 per cent by converting at least 3 per cent of the total floor area of public buildings to achieve nearly zero-energy buildings (nEZB) standards every year.

In May 2022, the European Commission launched the REPowerEU plan to address supply and demand disruptions in the energy market caused by Russia's invasion of Ukraine (EC, 2025). The plan seeks to phase out Russian fossil fuel imports while increasing energy savings, clean energy production, and diversification of the EU's energy supply, with some adjustments to the targets. It aims to increase its RE target from 40 per cent to 45 per cent by 2030, equivalent to 1,236 gigawatts (GW) of installed capacity. For solar PV, it aims to increase new installations to 320 GW by 2025 and 600 GW by 2030. According to recent EU reports, renewable installations in 2025 alone are expected to reach a record 89 GW, including 70 GW of solar PV and 19 GW of wind power, further accelerating progress towards the 2030 target (European Commission, 2025). In addition, REPowerEU proposes increasing EE from the current target of 9 per cent to 13 per cent. In addition, the Energy Performance of Buildings Directive will be implemented to accelerate EE gains and encourage the purchase of efficient appliances by reducing value-added tax (VAT) rates on high-efficiency heating systems and building insulation.

To support the clean transition and enhance the competitiveness of Europe's net-zero industry, the European Commission proposed the Green Deal Industrial Plan in 2023. The plan aims to scale up the EU's manufacturing capacity for net-zero technologies and products to achieve carbon neutrality by 2050, building on the efforts of the European Green Deal. It is structured around four pillars to drive industrial innovation and clean technologies in the EU.

Table 1. The four pillars of the EU's Green Deal Industrial Plan

Pillars	Initiatives
Simplifying regulations	▶ The '**Net Zero Industry Act**' aims to increase the manufacturing of clean technologies in the EU. It simplifies the regulatory framework for producing strategic net-zero technologies such as solar, wind, sustainable biomass, batteries and storage, carbon capture and storage, heat pumps and grid technologies, with recent secondary legislation adopted in 2025 to further facilitate production and deployment. ▶ The '**Critical Raw Materials Act**' aims to strengthen the EU's critical raw materials capacities across the value chain, strengthen domestic supply chains, increase resilience by reducing dependencies, and promote supply chain sustainability and circularity. The Act also aims to simplify regulations related to green industries. ▶ The '**Electricity Market Reform**' aims to strengthen the integrated EU energy market to accelerate the transition to clean energy while improving energy security and affordability. Recent 2025 proposals include measures to enhance grid flexibility for integrating growing shares of RE, as well as updated rules to strengthen wholesale market integrity and transparency.
Funding access	▶ A new **Temporary State Aid Crisis and Transition Framework** aims to accelerate investment and financing for clean technology production in the EU, extending the schemes to accelerate the deployment of RE and energy storage, as well as the decarbonization of industrial production processes. It also simplifies conditions for granting support to small projects and less mature technologies such as renewable hydrogen and expands opportunities for supporting industrial processes that transition to hydrogen-derived fuels. ▶ The use of existing **EU funds** to finance clean technology innovation, manufacturing and deployment will be facilitated, such as the Recovery and Resilience Facility (RRF) to fund the REPowerEU plan, the InvestEU Fund and the EU Innovation Fund.
Enhancing skills	▶ The establishment of '**Net-Zero Industry Academies**' aims to support upskilling and reskilling programmes in strategic industries. ▶ Supporting measures include combining a 'skills-first approach' that recognizes actual competencies, facilitating access for EU Member State nationals to labour markets in priority sectors, and aligning public and private funding to advance skills development.
Facilitating trade	▶ The plan on global cooperation and trade for the green transition under the fair competition and open trade aims to build resilient supply chains through the EU's network of **Free Trade Agreements** and other forms of cooperation. It also explores the establishment of a '**Critical Raw Materials Club**' and a '**Clean Tech/Net-Zero Industrial Partnership**' while safeguarding the Single Market against unfair trade practices.

Source: European Commission, 2025

The United States

The U.S has set an ambitious goal of reducing GHG emissions between 50 per cent and 52 per cent by 2030, achieving net-zero emissions by 2050 and reaching 100 per cent clean electricity by 2035. Accordingly, the U.S. released a long-term strategy that highlights electricity decarbonization, clean fuels, energy conservation, non-CO_2 abatement and CO_2 removal as key innovation challenges. In 2022, President Biden announced the Cleaner Industrial Sector initiative to help manufacturing companies adopt cleaner energy, improve efficiency, and produce next-generation products in a sector that accounts for one-third of U.S. GHG emissions.

The most significant milestone was the '**Inflation Reduction Act' (IRA)** which originally allocated the largest policy budget in U.S. history for clean energy and climate investments, totalling USD 360 billion over the next 10 years. The IRA is designed to strengthen U.S. energy security, lower consumer energy costs, and reduce GHG emissions. Policies related to EE include grants, loans, and tax credits for low-carbon vehicles.

A share of the budget is dedicated to energy security and climate change investments with the aim of supporting energy reliability and clean energy production and to decarbonize the economy (Senate Democrats, 2025). Examples of programmes and tax incentives to support clean energy manufacturing and production include the following:

Figure 1. Key incentives and budgets for clean energy technologies in the U.S. (Biden administration, 2021–2025)

The U.S. has also introduced various policies and programmes at the state and local levels to promote distributed generation, which is the generation of electricity from sources close to the point of use rather than at centralized power plants, and energy efficiency initiatives.

Under the Trump administration, which took office on 20 January 2025, U.S. federal energy and environmental policy has shifted. Through executive orders and regulatory actions, the U.S. has withdrawn again from the Paris Agreement, rolled back earlier environmental regulations, and adjusted subsidies for certain energy sources.

Table 2. Key energy efficiency incentives in the U.S. (Biden administration, 2021–2025)

Incentive	Explanation
Appliance Standards	▶ Setting minimum efficiency standards for appliances to reduce energy consumption
Building Codes	▶ Mandating energy performance requirements for new construction and renovations
Commissioning Programs	▶ Ensuring building systems are installed and functioning properly
Zoning and Permitting	▶ Encourages energy-efficient construction through incentives to meet energy efficiency criteria
Energy Benchmarking and Disclosure	▶ Improving the traceability of building energy performance and driving demand for energy efficiency improvements through a market-based tool
Energy Efficiency Resource Standards (EERS)	▶ Mandating specific energy savings goals within a specified timeframe for energy providers
Utility Business Model Adjustments	▶ Introducing decoupling rate adjustment mechanisms to recover the fixed costs for utilities, ensuring fair return on investments

Table 3. Overview of U.S. Federal Renewable Energy and Energy Efficiency Policy Changes

Policy area	Biden administration. (2021-2025)	Trump administration (2025-)
Climate Target	▶ 50-52% GHG reduction by 2030; 100% clean electricity by 2035; net-zero by 2025 (reaffirmed)	▶ The target remains in place; federal emphasis on its implementation has been reduced
International Commitments	▶ Rejoined Paris Agreement; submitted enhanced NDC	▶ Renewed withdrawal from the Paris Agreement (EO 14162)
Clean Energy Incentives	▶ IRA (2022): PTC/ITC tax credits for renewables, 45x manufacturing credit, low-income bonuses	▶ Early termination/modification of wind and solar production and investment tax credits (EO 14154)
Industrial Sector	▶ Cleaner Industrial Sector Initiative – support for clean energy adoption, efficiency, next-gen products	▶ Adjustments of federal support programmes; conventional fossil fuel generation prioritized
Energy Efficiency (EE)	▶ Energy Star maintained; stronger DOE standards for buildings, appliances, lighting: IRA-funded retrofits	▶ EE programmes modified or reviewed; some funding streams have been paused or redirected

Source: Author's compilation

This includes the early termination or modification of production and investment tax credits for wind and solar, new permitting requirement for federal projects, and the cancellation or reallocation of previously awarded clean energy grants. Federal policy signals a shift in energy priorities, with an emphasis on fossil fuel production and dispatchable electricity alongside RE.

EE programmes have also been affected: federal initiatives such as Energy Star and building efficiency standards have been modified or delayed, while funding streams established under the IRA for retrofits and appliance electrification have been reallocated or temporarily paused.

China

China's green growth policy has been picking up speed since the 2006 revision of the **Renewable Energy Law** of the People's Republic of China, an important milestone in the industry's development. Since then, subsequent related laws have been enacted. Over the past decade, with support from the central government, China has become a global leader in solar and wind power. By May 2025, China's total installed RE capacity reached approximately 2,090 GW, more than double its 2020 level and accounting for over 60 per cent of the country's total power generation capacity, positioning the country as the world's largest holder of RE capacity.[3].

China's RE sector is centred on hydropower, wind and solar. In 2025, solar power capacity is projected to reach about 1,080 GW and wind power about 570 GW, while total power generation capacity is expected to exceed 3,600 GW. In 2020, President Xi Jinping pleaded that China would peak carbon emissions before 2030 and achieve carbon neutrality by 2060. Since 2021, the country has shifted its focus from "sustained momentum" to "extensive expansion" in wind and solar power, developing ultra-large-scale clean energy bases that integrate multiple power sources, while also expanding hydropower and energy storage capacities. By the end of 2024, new energy storage installations exceeded 70 GW, reflecting a rapid expansion to support grid stability.

In 2021, China released two policy frameworks in response to the Climate Change Action Plan: '**Working Guidance for Carbon Dioxide Peaking** *and Carbon Neutrality in Full and Faithful Implementation of the Development Philosophy*'[4] and the 'Action Plan for Carbon Dioxide Peaking Before 2030'. Building on the previously announced goals of peaking carbon emissions by 2025 and achieving carbon neutrality by 2060, the plans set specific targets: reducing energy consumption per unit of GDP by 13.5 per cent and cutting non-CO_2 emissions per unit of GDP by 18 per cent, increasing the share of non-fossil fuel consumption to 20 per cent, and increasing forest cover to 24.1 per cent by 2025 compared to 2020 levels. The action plan proposes policies to facilitate a gradual transition to renewable energy, enhance infrastructure efficiency, and promote a circular economy to improve resource use and recycling.

3 *The 14th Five-Year Plan period (2021–2025) has yielded landmark achievements, including solid progress in the green energy transition* (National Development and Reform Commission [NDRC], 2025).

4 Department of Resource Conservation and Environmental Protection. (2021a, October 24). 【Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy】 (NDRC) People's Republic of China. En.ndrc.gov.cn. https://en.ndrc.gov.cn/policies.

In June 2022, China published the 14th Five-Year Plan on Renewable Energy Development, outlining a comprehensive roadmap for RE. The plan aims to increase RE generation by 50 per cent (from 2.2 trillion kWh in 2020 to 3.3 trillion kWh in 2025), increase RE consumption by 33 per cent (from 28.8 per cent in 2020), and ensure that 50 per cent of China's electricity and energy consumption between 2021 and 2025 comes from renewable sources.

China's central government has implemented numerous regulatory standards to improve EE across sectors. China introduced efficiency standards for coal-fired power plants, which are now required to use ultra-supercritical technologies, while small, low-efficiency coal-fired plants are being phased out. China has also established an appliance standards and labelling system. For this purpose, the government runs an energy-saving catalogue and public education programme, as well as an Energy Efficiency Leader programme that selects highly efficient products. Additionally, with the importance of air conditioning and cooling rising, the government announced a broader implementation plan to improve efficiency in cooling systems, including in buildings.

In May 2024, China issued the "2024–25 Energy Conservation and Carbon Reduction Action Plan", targeting a 2.5 per cent improvement in national energy intensity for 2024 (and 3.5 per cent for large-scale industry), aiming to save energy equivalent to 100 million tons of coal over two years. The Plan also sets sector-specific energy-saving and CO_2 reduction targets for steel, cement, petrochemicals, non-ferrous metals, data centres and transport. It also mandates the elimination of scattered coal and small boilers, while raising non-fossil energy consumption targets to 18.9 per cent in 2024 and 20 per cent in 2025.[5]

Building standards apply to new urban residential and public buildings to ensure compliance with energy conservation design requirements. The "14th Five-Year Plan" recently introduced additional regulations to improve building EE. These regulations include the renovation of existing buildings, the use of RE, and building electrification projects.

Table 4. Key policies to support renewable energy development in China

Policy	Explanation
Large-Scale Development	▶ Construction of large wind and solar plants and expansion of distributed generation
Energy Storage & Utilization	▶ Improving energy storage capacity and promoting diverse energy consumption
Technology Capabilities	▶ Strengthening renewable energy innovation and modernizing industrial chains
Market Mechanism	▶ Simplifying administration and completing market-based supporting systems
International Cooperation	▶ Participating in global eco-friendly energy system and the establishment of international standards

5 State Council of the People's Republic of China. (2024, May 29). Action Plan for Energy Conservation and Carbon Reduction (2024–2025). Climate Cooperation China – International Climate Initiative. Retrieved from https://climatecooperation.cn/climate/china-issues-action-plan-for-energy-saving-and-carbon-reduction-2024-2025/

Additionally, benchmark standards have been introduced for energy-intensive industries. To further enhance EE in key industrial sectors, the Ministry of Energy published the "Energy Efficiency Benchmarking Levels and Benchmark Levels for Key Industrial Sectors (2023 Edition)". In line with its goal of maximizing carbon emission reductions before 2030, China expanded its EE benchmarking scheme in 2023 from 25 to 36 high-energy-consuming industrial sub-sectors. This expansion brings additional industries—such as ethylene glycol, urea and titanium dioxide—under mandatory EE standards, broadening efforts to improve efficiency across a wider range of energy-intensive industries.

The Republic of Korea

In 2024, new and RE sources accounted for around 10.6 per cent of electricity generation in the Republic of Korea (ROK), surpassing the 10 per cent mark for the first time. The government recently has finalized the "11th Basic Plan for Electricity Supply and Demand (2024-2038)", aiming to increase the share of RE generation to 21.6 per cent by 2030 and expand RE capacity to 78 GW, rising further to 121.9 GW by 2038. The plan emphasizes a balanced energy mix that reduces reliance on fossil fuels while integrating adequate levels of RE, alongside nuclear power. It also proposes expanding the power grid and energy storage to create a competitive market and minimize public costs. To achieve these goals, ROK has implemented several programmes, including:[6]

a. **Renewable Portfolio Standard (RPS)**: The current RPS requires power generators with an installed capacity exceeding 500 megawatts (MW) to increase their share of RE generation to 15 per cent by 2026. Since 2001, ROK has relied on feed-in-tariffs as the main incentive for renewables. However, the surge in solar PV installations strained the government's national electricity industry infrastructure fund, which supports the programme, and challenged the network's stability. Consequently, RPS replaced FIT in 2012. As of 2025, the obligation rate has increased to approximately 14 per cent, with 27 companies participating. The government plans to gradually increase the RPS obligation share by 2030. To meet their obligations, companies can generate new RE themselves and receive proportional Renewable Energy Certificates (RECs) from KEA, or purchase RECs traded on the electricity market operated by the Korea Power Exchange (KPX).

b. **RE 100 programmes**[7]: The programme allows the purchase of electricity generated entirely from renewable sources and green power certificates. Unlike the Global RE100 programme, participants are not limited by consumption levels or company size and can independently achieve their RE goals. Through the programme, companies can participate in the Global RE100 initiative, which aims for 100 per cent RE use by 2050. Companies can use the issued certificates to participate in various campaigns. Implementation options include the Green Premium Program, which requires companies to pay KEPCO an additional fee, as well as REC purchases, power purchase agreements (PPAs), and self-generation. However, supplementation is necessary because ROK's RE generation rate is low, carbon credit and REC double counting is not allowed, and a bias exists towards less burdensome options such as the Green Premium. In addition, under the Lee Jae-myung administration, the government announced the establishment of RE100 industrial complexes as a flagship initiative, alongside efforts to expand the electricity grid

6 The Government of the Republic of Korea. (2020, December). 2050 CARBON NEUTRAL STRATEGY OF THE REPUBLIC OF KOREA

7 KOREAN RE100. (n.d.). RE100 INFORMATION PLATFORM. Retrieved March 29, 2024, from https://www.k-re100.or.kr

to support greater RE penetration, with the aim of facilitating corporate participation and accelerating the national transition to RE.

c. **Feed-in-tariff (FiT) system**: The Ministry of Trade, Industry, and Energy (MOTIE) introduced a FiT system in 2002 to provide stable revenue for small-scale solar power generators and simplify electricity sales procedures. It allows contracts to be concluded at fixed prices without separate bidding competitions but was discontinued in 2012 as ROK transitioned to the RPS. To provide additional support for small-scale solar generation, a Korean-style FiT was introduced in 2016 and formally implemented in 2018, targeting solar power plants under 100 kw. This system was designed to ensure predictable income and simplify electricity sales. However, due to various operational challenges and limitations, the Korean-style Fit system was officially terminated in 2023. Since then, ROK has relied primarily on the RPS to drive RE deployment.

Furthermore, the government plans to upgrade the grid to reflect the growing share of RE and to promote innovation in EE, as well as behavioural changes to better manage demand. An annual budget has been allocated to support RE programmes in ROK.

MOTIE has announced a *Renewable Energy Policy Improvement Plan* to address challenges identified in the energy sector since the "**Renewable Energy Plan 3020**" of 2017. The Plan emphasized promoting RE development, optimizing project sites, strengthening the supply chain, and supporting the establishment of RE industrial complexes to accelerate transition to clean energy.

Table 5. Overview of U.S. Federal Renewable Energy and Energy Efficiency Policy Changes[8] [9]

Programme	Annual Budget (Thousand USD)		
	2022	2023	2024
Promotion and support for new renewable energy	233,092	179,115	121,457
Financial support (loans) for new renewable energy	412,705	338,869	267,788
Core technology development for new renewable energy	199,558	198,407	233,208
Support for the price difference in new renewable energy generation (FiT)	187,599	155,406	54,247
Establishment of a Wind Power Core Material and Component Engineering Center	4,248	5,564	4,204
Support for the development of large-scale offshore wind farms led by the public sector	6,522	5,797	5,797
Establishment of a wind power testbed	4,275	3,913	3,022
Support for the offshore wind power industry	5,362	11,920	6,147
Development of offshore wind power and environmental coexistence technologies	724	1,377	1,039
Demonstration projects for next-generation solar panels	-	-	724
Support for the standardization and certification enhancement of new renewable energy	2,210	2,763	611

8 Budget and fund utilization plan for the year 2024, JAN 2024, MOTIE.

9 Exchange rate (as of April 2024): KRW 1,380 / USD 1

Table 6. Strategies for renewable energy development in the Republic of Korea

1. New renewable energy supply targets	2. Cost-effectiveness and competition in power generation
▶ ROK's RE target for 2030 is set at 21.6 per cent. While the RPS ratio will decrease next year, the annual RE capacity target will increase to 5 GW. The government plans to optimize offshore wind power by reducing wind measurement areas to minimize disputes and systematically expanding capacity through government-led site exploration and permit support.	▶ The government plans to revise the REC weighting system to favour mid- to large-scale projects. The fixed-price competitive bidding programme, previously limited to solar, will now include wind power. By 2027, the RPS programme will be phased out in favour of an auction system. The Korea FiT system was terminated in July 2023.
3. Power transmission network pressure alleviation	**4. Institutional framework for local acceptance**
▶ To address grid pressure, the government will impose new obligations on RE generators, requiring participation in the electricity market. A pilot programme in Jeju-do to expand nationwide by 2025, will require generators to submit advance bids. Additionally, businesses must install inverters that provide grid information. The unlimited access programme for solar installations under 1 MW was terminated in 2023.	▶ The government will establish guidelines to improve local acceptance of RE projects. Measures include requirements for local governments and operators, the creation of public-private regional councils, and the use of underutilized sites such as reservoirs for solar power. Guidelines will also cover separation distances and safety measures for solar facilities in mountainous areas.

ROK's EE policies combine regulatory mandates with voluntary initiatives, offering a mix of requirements and incentives to enhance performance across different industries and firms of various sizes. Mandatory programmes impose penalties for noncompliance, while voluntary initiatives provide operational and financial support, particularly to small and medium-sized enterprises (SMEs). At the industrial park level, EE initiatives use shared infrastructure and services to reduce costs and risks, complemented by practices such as waste heat recycling and the shared use of RE resources.

As of 2025, ROK continues to prioritize financial assistance in its energy efficiency budget-directing significant support towards programmes such as soft loans, tax credits, investments and subsidies now expanded to include new initiatives like the 'Top-Grade Appliance Rebate' for households and enhanced SME efficiency support schemes. The largest share was allocated to the Demand Side Management (DSM) programme, followed by the soft loan programme, Energy Efficiency Resource Standards (EERS), and tax credits. Pilot programmes such as EERS, which has been in place since 2019, require public enterprises to innovate based on their previous year's energy consumption, with penalties for noncompliance.

The industrial sector manages efficiency goals through the "Excellent Workplace Certification" system. Efficiency is further regulated through the ETS and the Target Management System. Installation subsidies are provided for "factory energy management solutions", enabling real-time energy monitoring and control. Additional support has been introduced for digital energy management platforms in SMEs, integrating AI-based demand forecasting and equipment control.

In the building sector, new buildings must comply with energy-saving design standards and achieve zero-energy building (ZEB) certification. The "Green Remodeling" policy targets improved energy performance in existing buildings. Efficiency is promoted through consumption efficiency grades, high-efficiency equipment certification, and standby power reduction systems. The requirement for ZEB certification is being extended to larger public and private buildings, with higher certification levels to apply by 2030. Under the Third Green Building Master Plan (2025–2029), the ZEB certification process has been simplified and requirements strengthened: from 2025, non-residential buildings with a gross floor area (GFA) of 1,000 m² or more, as well as apartment complexes with over 30 units, must obtain ZEB certification. From 2030, all new buildings with a GFA of 500 m² or larger will be required to comply, with higher certification levels applied to public buildings.

ASEAN countries

The climate change mitigation and adaptation goals of ASEAN countries are closely aligned with their development objectives. According to the latest NDC targets, GHG emissions in the ASEAN region are projected to continue rising through 2030. To stay on track with the Paris Agreement's temperature targets, ASEAN must peak emissions no later than 2030 and aim for net-zero GHG emissions by 2050.[10]

The following summarizes relevant energy plans of ASEAN countries for 2050:

Indonesia is an energy-independent country, with coal and gas exports far exceeding its imports. In the first half of 2025, Indonesia exported approximately 66.5% of its coal production, with 29% allocated to domestic use and the remainder held as stock. The Indonesian government aims to achieve a national primary energy mix in which new and RE sources account for a minimum of 23 per cent by 2025, increasing to 31 per cent by 2050. The country aims to reach net-zero emissions by 2060 or earlier. This ambitious target underscores the country's commitment to addressing climate change and reducing its carbon footprint. To support this transition, Indonesia is developing three key roadmaps: the Energy Transition Roadmap, the Carbon Market Roadmap, and the Carbon Tax Roadmap.

Malaysia is transitioning towards a sustainable energy system to address climate change while promoting economic growth. Its energy transition policy is outlined in the 12th Malaysia Plan (2021–2025) and the National Energy Policy. The country aims to reduce its GHG intensity by 45 per cent from 2005 levels by 2030. Malaysia targets a 31 per cent share of RE in the national energy mix by 2025, increasing to 40 per cent by 2035, with a focus on solar, wind and biomass. Malaysia now targets a 45 per cent reduction in economy-wide GHG emissions intensity relative to GDP by 2030, compared to 2005 levels, reflecting its strengthened commitment to energy efficiency and decarbonisation. However, several challenges remain, including heavy reliance on fossil fuels, limited infrastructure, and high costs for transitioning to renewables. Addressing these challenges is crucial for achieving a sustainable energy future.

10 ASEAN State of Climate Change Report, 2021.

Viet Nam's National Electricity Development Plan (2021–2030), also known as Power Development Plan 8 (PDP8), has been significantly updated as of April 2025 as the country's long-term roadmap towards net-zero emissions. The Plan includes increasing electricity generation from various renewable sources and gas-based generation to balance the volatility associated with renewables, along with investments in energy storage and the electricity grid. The plan aims for renewable energy (excluding hydropower) to constitute 28–36% of the total installed electricity capacity by 2030, with hydropower included, the share rises to approximately 47%. .[11]

Cambodia has committed to reducing carbon emissions by 42 per cent by 2030 compared to current levels. The government plans to increase the share of RE in the country's electricity mix to 25 per cent by 2030 by prioritizing solar, hydropower and biomass. Its energy transition strategy includes expanding solar power through favourable tariffs and streamlined approval processes for both large-scale and rooftop projects; advancing hydropower through ongoing and completed projects; supporting biomass and waste-to-energy initiatives that utilize agricultural residues and municipal waste; and launching EE programmes to improve standards and promote energy-saving technologies in industry, buildings and transport. However, the country faces several challenges such as limited grid infrastructure, financial constraints, and reliance on imported fossil fuels.

The Philippines is actively transitioning towards a sustainable energy system under the Philippine Energy Plan (PEP) 2023–2050, which supports economic growth, reduces GHG emissions, and enhances energy security. The country's goals include reducing emissions by 75 per cent by 2030 and increasing the share of RE in the energy mix to 35 per cent by 2030 and 50 per cent by 2040, with a focus on solar, wind, geothermal and hydroelectric power. Key strategies include RPS, mandating RE sourcing; the Green Energy Auction Program (GEAP), which facilitates competitive bidding; net metering; and FIT schemes, which encourage investment. Other strategies include the Energy Efficiency and Conservation Act.

Laos is advancing its energy transition by prioritizing RE and EE. The country is leveraging its substantial hydropower potential while expanding solar energy through supportive policies. Additionally, to diversify its energy mix, Laos is exploring biomass and wind projects. To promote EE, Laos enacted the Energy Efficiency and Conservation Law, which establishes energy use standards across different sectors. The government is also implementing programmes that provide incentives for adopting energy-efficient technologies and enforcing new building codes mandating energy-efficient design. Despite these efforts, Laos faces challenges such as limited financial resources and technical expertise, which must be addressed to achieve its energy transition goals.

11 https://kpmg.com/vn/en/home/insights/2023/09/pdp-8-key-developments-in-renewable-energy-for-vietnam.html

Lessons and challenges from international energy transition experiences

Although countries are advancing RE and EE policies, they continue to face significant challenges. Policy uncertainty and delayed responses to macroeconomic shifts have disrupted investment climates, while government interventions to manage rising energy prices have exacerbated this uncertainty. Additionally, rising interest rates have increased the costs of wind and solar projects, reducing their attractiveness to investors. Inadequate grid infrastructure limits the rapid expansion of RE by making it difficult to connect new projects. Complicated and lengthy permitting processes further undermine the economic viability of these projects. As regards EE, limited awareness among consumers, businesses and policymakers, coupled with high upfront technology costs, continues to impede investment and create financing barriers.

EU countries have recently intensified efforts to strengthen RE policies in response to energy security concerns, with the aim of increasing the share of renewables in electricity, transport and heating to reduce reliance on fossil fuels. However, several limitations remain. First, these policies emphasize short-term solutions such as imports from the U.S. and Africa to address energy security rather than long-term solutions, such as integrating RE sources or smart grids. Second, insufficient and restrictive policies in some countries create uncertainty, particularly around scaling up support programmes for decentralized solar power, for example, which is negatively impacting growth. Furthermore, labour shortages and limited support for heat pump installers are holding back progress in many countries. Another limitation is the continued existence of fossil fuel subsidies and support for recovery and rehabilitation funds, which constrain the expansion of RE sources.

In the **U.S.**, the IRA reversed a multi-year decline in investment, resulting in USD 4.21 billion in growth in utility-scale clean energy in 2024. However, a faster pace of RE deployment is needed to meet the goal of 100 per cent carbon-free electricity by 2035. Key challenges include a shortage of transformers needed to connect clean energy projects to the grid. Currently, delivery times range from 50 to 150 weeks, and only 20 per cent of U.S. demand is being met by domestic supply. Rising interest rates and complex state-level approval processes are also hindering progress, resulting in project cancellations and inefficiencies. To address these barriers, the Transmission Facilitation Program will allocate USD 2.5 billion to develop additional transmission lines and USD 1.3 billion to enhance grid capacity. These investments aim to overcome supply chain bottlenecks and support the rapid deployment of RE. Ongoing legislative discussions on modifications to the IRA create uncertainty for future clean energy projects, highlighting the importance of monitoring policy developments.

In 2023, **China** achieved a 50 per cent RE generation capacity, becoming a leader in wind power, microgrids and energy storage. The country produces two-thirds of the world's solar panels and half of its wind turbines. Despite this progress, the country faces several challenges, including high reliance on crude oil and natural gas (71.2 per cent and 40.2 per cent, respectively), and while RE accounts for 50.5 per cent of generation capacity, it only contributes 33.6 per cent of actual electricity output. Volatile RE sources, such as solar and wind, cause grid stability issues. Additionally, the distance between RE sites and demand centres limits further expansion. To address these challenges, China issued the Guiding Opinions on Stabilizing the New Power System, which aim to develop a decentralized smart grid and enhance the direct current transmission network.

ROK has made progress in expanding RE, improving facilities, increasing generation, and reducing costs. However, renewables account for only 2.13 per cent of the national energy mix. Challenges include disorganized solar power expansion, complex subsidy schemes, and unfair market practices. The surge in small-scale solar projects, driven relaxed permit standards and higher RPS ratios, has led to conflicts with fishermen and higher costs due to grid concentration in specific regions, undermining the competitiveness of domestic RE businesses. In addition, low and rigid electricity tariffs limit market efficiency and discourage innovation in EE. Investment incentives heavily favour loans and R&D (89 per cent), while tax benefits and subsidies, which are more attractive to companies are neglected. The emissions trading system has led to the purchase of emission credits instead of boosting investment efficiency. Existing buildings lack proper energy management. Furthermore, over 50 per cent of appliances fall into the lowest efficiency tier, and fuel efficiency standards for large, eco-friendly vehicles remain inadequate.

Although global uncertainties in the U.S. could reduce or delay investments in some RE projects in Southeast Asia, volatile fuel prices, such as those for imported liquefied natural gas, have driven countries to increasingly turn to domestic renewable sources to replace fossil fuel imports. The new Trump Administration has cut subsidies for clean energy and electric vehicles, and the U.S.'s withdrawal from the Paris Agreement will likely reduce climate finance for Southeast Asian countries such as Indonesia (Tsu-lin, 2025). Meanwhile, Europe remains firmly committed to achieving climate neutrality by 2050. To this end, it has implemented measures under the Clean Industrial Deal and approved over EUR 85 billion in aid as of June 2025. Additionally, it has introduced tax incentives accelerate the transition to a clean and affordable European energy system (European Commission, 2025).

International experience has shown that clear and consistent policies are crucial for facilitating RE development, providing policy incentives to promote clean energy, and addressing barriers to RE integration. ROK has implemented RPS and REC programmes to support RE, such as solar power combined with energy storage systems. Integrating RE into the power sector requires modernized grid connection facilities and storage capabilities. Streamlining licensing processes could facilitate RE expansion. Additionally, ROK has developed comprehensive plans for hydrogen development and has advanced hydrogen promotion policies.

To improve EE, it is essential to prioritize public education, such as through the International Energy Agency's (IEA) Energy Efficiency Program. Rather than relying solely on subsidies through FiTs, the country should consider auction systems that reflect future market prices. Establishing neighbourhood councils and guidelines to manage conflicts with residents can help ensure smoother implementation. Additionally, incentivizing agglomeration and conducting pilot projects to improve grid capacity through planned siting should be explored.

3 Thailand's national energy plans and supporting policies

Key targets and policies for RE and EE in Thailand

Alternative Energy Development Plan 2024–2037

The draft **Alternative Energy Development Plan 2024–2037 (Draft AEDP 2024)** emphasizes the promotion of domestically available RE sources and the maximization of their potential through appropriate technologies and cost-effective measures. The Plan aims to foster sustainable growth, improve quality of life, protect the environment, and strengthen the country's competitiveness.

Aligned with the National Energy Plan (NEP), which envisions a "just, sustainable, and secure energy transition", three strategic pillars have been established to guide its implementation.

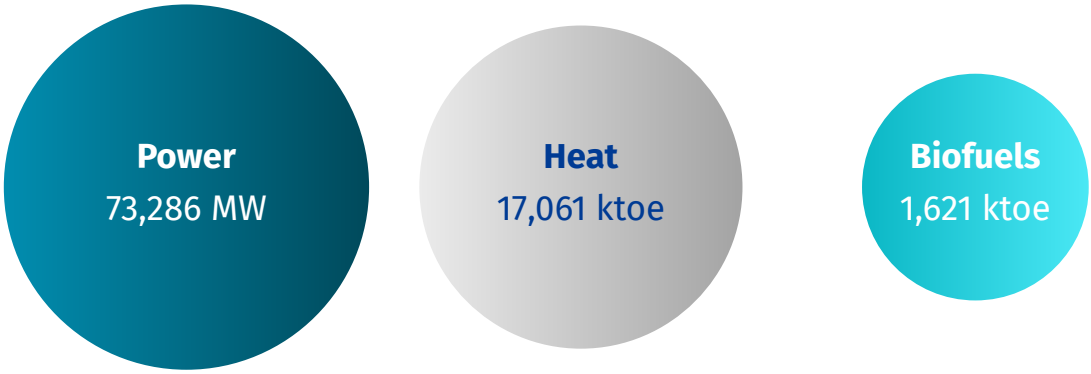
- *Pillar 1. Strengthening Energy Security*: Ensures a reliable and uninterrupted energy supply to meet the nation's growing demand.
- *Pillar 2. Promoting Energy Sustainability*: Supports the transition to a low-carbon economy by encouraging the use of RE sources and improving EE.
- *Pillar 3. Ensuring Energy Equity*: Guarantees equitable access to affordable, reliable energy services for all, especially vulnerable population groups.

Table 7. Key policy objectives of the Draft AEDP 2024

Policy objectives	1. Set renewable energy production and consumption targets to achieve carbon neutrality by 2050, in alignment with the national energy framework 2. Increase the share of renewable and alternative energy consumption to 36 per cent of total energy consumption by 2037 3. Reduce CO_2 emissions by at least 75 $mtCO_2$ by 2037 4. Promote new forms of renewable and alternative energy, such as hydrogen and sustainable aviation fuels 5. Support access to funding, such as investment incentives from the Board of Investment (BOI) and green finance.

The Draft AEDP 2024 intensifies efforts to increase RE production and consumption, targeting a 36 per cent share of final energy consumption by 2037. It sets specific targets for alternative and RE across three sectors: power, heat and biofuels.

Figure 2. Renewable and alternative energy targets from 2024–2037



1. The power sector

Thailand's electricity demand has steadily increased each year, reflecting economic growth. Both on-grid and off-grid consumers drive this demand. Off-grid consumers purchase electricity from independent power suppliers (IPS) licensed by the Energy Regulatory Commission (ERC). These IPSs are often referred to as off-grid power producers. Recently, the number of off-grid power producers generating electricity from renewable sources, particularly solar power, has grown significantly, supplying their own consumption or selling to other consumers.

Consequently, the Draft AEDP 2024 sets two primary objectives:

- *Objective 1*: Promote electricity generation from renewable and alternative energy sources for integration into the national grid.
- *Objective 2*: Support electricity generation from renewable and alternative energy sources by off-grid power producers for self-consumption or direct sale to consumers (through PPAs).

Specific targets for renewable and alternative energy in the power sector are:

Table 8. Alternative energy and renewable energy targets in the power sector by 2037

Energy type*	Existing (COD and PPA) as of Dec 2023	Additional installed capacity (MW) 2024–2037	Target in 2037 MW	Target in 2037 GWh	Target in 2037 ktoe
Biomass	3870	1046	5490	26424	2252
Biogas	404	936	1682	8186	697
Municipal waste	842	300	1142	4834	412
Industrial waste	237	12	249	1530	130
Small hydro	243	99	347	912	78
Large hydro	2918	0	2918	5919	504
Imported hydro	4462	6907	10295	45249	3856
Wind	4034	5345	9379	19522	1664
Solar PV	9104	24412	38974	60365	5144
Floating solar	108	2681	2789	4415	376
Hydrogen	-	5% blended from 2030	-	2503	213

**Based on the Draft Power Development Plan (Draft PDP 2024)*

Energy type**	As of Dec 2023	New additions from 2024 to 2037	Total MW in 2037
Biomass (IPS)	925	0	925
Biogas – waste (IPS)	161	0	161
Solar power (IPS)	2300	3139	5439
Off-grid small hydro	3	2	5
Off-grid solar power	4	15	19

***Based on estimated IPS*

Source: Draft AEDP (2024)

Solar PV is projected to be the largest contributor to installed capacity during the 2024–2037 period, followed by imported hydropower and wind. By 2037, RE is expected to account for 61 per cent of total power generation, estimated at 292,818 GWh.

The Draft AEDP 2024 outlines three main policy pillars to promote the use of renewable and alternative energy in the power sector:

Table 9. Policy pillars of Draft AEDP: The power sector

Pillar 1: Policy, Law and Regulation	Pillar 2: Stability and Security	Pillar 3: New RE sources
▶ Promote the purchase of electricity from renewable sources at appropriate rates: ▷ Procurement of biomass fuel ▷ Procurement of waste-to-energy electricity from communities ▷ Procurement of electricity from solar PV. ▶ Encourage RE production through tax incentives. ▶ Support the establishment of appropriate utility green tariffs.	▶ Promote and develop energy storage systems (ESS) ▶ Support the development of mechanisms for decentralized RE production. ▶ Encourage the establishment of off-grid RE production systems in remote areas, such as solar and hydro. ▶ Develop RE forecasting systems using digital technologies.	▶ Explore electricity generation data and the integration of hydrogen in the power sector. ▶ Support the production and use of green hydrogen.

Source: Draft AEDP (2024)

2. The thermal (heat) sector

The industrial sector dominates thermal energy consumption in the economy. A detailed review of energy statistics highlights the substantial use of thermal energy in industries such as non-metallic minerals, food processing, chemicals and paper production. Fossil fuels, particularly coal, natural gas, fuel oil, and liquefied petroleum gas (LPG), remain the primary energy sources for these industries. Among them, the cement, ceramic, and glass industries currently consume the largest amounts of heat. There are three categories of renewable heat potential:

1. *Residual RE feedstocks*, including waste, biomass and biogas;
2. *Solar thermal energy* depending on the target group's demand for solar thermal applications;
3. *Other alternative energy sources*, such as geothermal energy, hydrogen and pyrolysis oil. These sources represent emerging options that could become viable as technological advancements reduce costs.

Table 10. Alternative and RE in the heat sector from 2024-2037

Energy type*	Target by 2037 (ktoe)	Fuel replaced	Targeted industries
Biomass	15,551	Coal, fuel oil, LPG	Food, textiles, paper, non-metals, chemicals and others
Biogas	700	Fuel oil, LPG	Food and chemicals
Waste energy	600	Coal	Paper and non-metals
Solar	200	LPG	Commerce, chemicals, food and textiles
Others (e.g. hydrogen)	243	Fuel oil, LPG	Chemicals, metals, food, textiles and others

Source: Draft AEDP (2024)

Biomass is projected to be the most important source of heat, with the industrial sector expected to demand 30,280 ktoe, or 69 per cent of total heat demand by 2037. Therefore, the role of electrified heat to further decarbonize the industrial sector should be considered, particularly in the food and beverages industry. The latest Draft AEDP 2024 does not include specific targets for heat electrification.

Table 11. Policy pillars of Draft AEDP: The heat sector

Pillar 1: Price and Quantity	Pillar 2: Business Attitude	Pillar 3: Investment	Pillar 4: New RE sources
▶ Promote systematic management, storage, and collection of renewable energy fuels. ▶ Encourage the processing of alternative fuels to be used as primary or co-firing fuels, such as wood pellets, refuse-derived fuel (RDF). ▶ Promote the use of alternative fuels from production waste materials. ▶ Support business matching.	▶ Publicize the outcomes of successful projects. ▶ Promote pilot projects in industries that have not yet adopted RE or are still in the early stages of adoption.	▶ Promote investment in RE production and use through tax incentives/ low-interest loans. ▶ Support the conversion of equipment from fossil fuels to suitable alternative or renewable fuels, such as burner modifications, promoting hybrid hot water production systems. ▶ Facilitate access to funding such as the Thailand Taxonomy and other green finance initiatives.	▶ Explore information on the production and use of hydrogen in the industrial sector. ▶ Support the production and use of green hydrogen.

Source: Draft AEDP (2024)

3. The biofuel sector

Thailand's strategic transition towards RE in the transport sector is underpinned by a multifaceted approach that aligns with both domestic policy priorities and international climate commitments. The nation's roadmap encompasses the following key initiatives:

- **Electric Vehicle (EV) Adoption**: A comprehensive strategy to promote widespread adoption of EVs, including the expansion of charging infrastructure, the provision of attractive incentives for EV purchases, and the fostering of a robust domestic EV manufacturing ecosystem.
- **Biofuel Development**: The expansion of bioethanol and biodiesel production and use to reduce reliance on fossil fuels and to support rural economies.
- **Electrification of Public Transport**: A concerted effort to transition public buses, trains, and other modes of public transport systems to electric power to improve air quality and reduce GHG emissions.

The development of biofuels is aligned with the Oil Plan, aiming to promote blended biofuel (B7) to replace diesel and blended ethanol (E10) to replace gasoline. Biofuels could play a crucial role in the transport sector, but less so in the industrial sector.

Table 12. Biofuel targets for the transport sector from 2024-2037

Energy type*	Target in 2037 (ktoe)	Targeted industries
Ethanol	289	1.55 million litres per day
Biodiesel	775	2.46 million litres per day
Sustainable aviation fuel (SAF)	553	1.85 million litres per day
Hydrogen	4	1395 tons

Source: Draft AEDP (2024)

Energy Efficiency Plan 2024–2037

The draft **Energy Efficiency Plan 2024–2037 (Draft EEP 2024)** aims to strengthen Thailand's energy intensity targets in support of achieving carbon neutrality by 2050 and net-zero emissions by 2065. The plan sets a goal to reduce energy intensity by 36 per cent by 2037 (compared to the 2010 baseline), equivalent to cutting energy consumption by 35,497 ktoe and reducing CO_2 emissions by 106 million tons. The Plan emphasizes technology-driven measures and innovations for energy conservation to adapt to disruptive technological changes and shifts in energy consumption patterns. These measures will enhance EE while expanding the use of RE technologies, such as solar, wind and hydrogen. Additionally, the Plan introduces comprehensive measures across all energy users and promotes participation in energy conservation, engaging industries, transport, buildings, households and the government through inclusive policies, incentives, and public awareness campaigns. The Plan is implemented through three strategic pillars:

1. **Mandatory pillar**: Enforcing energy conservation standards and implementing energy management systems in factories and buildings.
2. **Promotion pillar**: Providing financial and investment incentives for high-performance equipment and promoting energy-efficient technologies and labelling.
3. **Support pillar**: Facilitating knowledge transfer, awareness campaigns, and technology innovation to strengthen energy conservation.

Table 13. EEP policy measures and energy conservation targets in 2037

Pillar	Measures	Conservation target (in ktoe)
Pillar 1: Mandatory measures (3 measures)	1. Enforce **energy management standards** in controlled factories/buildings	5,764
	2. Enforce **energy standard criteria** (Energy Code) for factories, buildings, residential homes and agriculture	937
	3. Energy conservation measures in the road transport sector	1,650
Pillar 2: Promotion measures (8 measures)	4. Standard criteria and equipment efficiency labelling	3,568
	5. Financial incentives such as subsidies, soft loans, ESCO fund, tax incentives, credit guarantees	4,904
	6. Promote innovation (Internet of Things (IoT), smart technology, big data, artificial intelligence (AI))	317
	7. Energy conservation in the **transport sector** (EV, land/water/air/rail transport systems)	15,341
	8. Energy conservation in the **agriculture sector** (smart farming, switch to machinery)	660
	9. Energy conservation in the **residential sector** (energy-efficient homes, smart home)	1,754
	10. Improve efficiency of RE equipment (biomass gasifiers, biomass stoves, electric generators, solar heat)	222
	11. Promote EE in electricity (EEE) production, grid systems and usage, including energy efficiency for electricity users (EERS)	280
Pillar 3: Support (3 measures)	1. R&D in energy conservation technologies and innovations 2. Develop energy conservation personnel (human resource development, HRD) Public relations (PR) and awareness campaigns for energy conservation	

Source: Draft EEP (2024)

Table 14. Energy conservation targets for the industrial sector by 2037

By energy type:	Mandatory measures	Promotion measures	Total (ktoe)
Electricity	1,136	2,897	4,033
Heat	3,995	4,404	8,399

Source: Draft AEDP (2024)

The industrial sector is targeted to reduce 12,432 ktoe of energy consumption from electricity and heat, in particular in the heat sector. About 41 per cent of the energy conservation target in the industrial sector is expected to be achieved through mandatory measures.

Emission reduction impacts and expected benefits

The Draft AEDP and EEP are expected to deliver the following economic, social and environmental benefits.

Figure 3. Impacts and expected benefits of EEP

Source: DEDE (2024)

Table 15. Impacts and expected benefits of EEP

Dimension	
Economic	▶ Energy saving of 35,497 ktoe equivalent to the value of THB 532,455 million ▶ Create jobs and enhance industry's competitiveness
Social	▶ Enhance EE awareness ▶ Establish behavioural changes in energy consumers ▶ Provide resilience against volatile energy situations
Environmental	▶ Reduce 106 $MtCO_2$ by 2027

Source: DEDE (2024)

Challenges and opportunities for renewable energy development

The energy transition towards greater use of renewable electricity and RE sources to replace fossil fuels in the industrial sector faces several challenges. However, RE development in Thailand could deliver long-term benefits, such as cheaper, less volatile energy prices and increased industry competitiveness.

Table 16. Challenges for advancing renewable energy development

Grid Integration	▶ **Integration of intermittent RE**: Integrating large amounts of RE sources, such as solar and wind, requires robust infrastructure and energy storage solutions to manage fluctuations and ensure grid stability. ▶ **Insufficient transmission capacity**: The current transmission grid may not have sufficient capacity to accommodate large-scale RE, especially from remote locations. Upgrading and expanding the grid will require significant investments.
Regulatory and Policy Uncertainties	▶ **Frequent policy changes**: Frequent changes in RE policies and regulations can create uncertainty for investors, hindering project development and long-term planning. ▶ **Complex permitting process**: The approval process for RE projects can be complex and time-consuming, delaying implementation and increasing costs.
Cost Considerations	▶ **High upfront costs**: RE technologies, particularly those with storage capabilities, require higher upfront investments compared to traditional fossil fuel-based systems. ▶ **Grid integration costs**: Without adequate planning to build flexibility into the power system, upgrading and expanding the grid to accommodate large-scale RE integration will be costly.
Public Acceptance	▶ **Community impacts**: Large-scale RE projects (e.g. biomass power plant) may face opposition from local communities due to concerns about land use and potential emissions.
Limited Domestic Manufacturing	▶ **Reliance on imports**: Thailand's heavy reliance on imported components for RE technologies could create supply chain vulnerabilities and exposure to price fluctuations.

Table 17. Opportunities for renewable and alternative energy

Solar energy	▶ Geographical advantage: Thailand's proximity to the equator provides abundant solar radiation year-round, making it ideal for solar energy production. ▶ Government incentives: The Thai government has introduced policies such as the FiT scheme, tax incentives, and soft loans to encourage investment in solar energy. ▶ Rooftop solar market: There is substantial potential for rooftop solar installations across the residential, commercial and industrial sectors.
Wind energy	▶ Wind resources: Coastal areas and highlands, particularly in southern and northeastern Thailand, have significant wind potential. ▶ Policy support: The government aims to increase wind energy capacity by offering incentives and support for wind energy projects.
Bioenergy	▶ Agricultural by-products: Thailand's strong agricultural sector provides a steady supply of biomass and biogas feedstock from crop residues, animal waste and organic waste. ▶ Existing infrastructure: A foundation of biomass power plants already exists, with government plans to expand capacity.
Waste-to-Energy (WtE)	▶ Proactive policy incentives: Thailand's national waste disposal and management policy promotes WtE as a solution for municipal solid waste management. The government also provides FiT and financial programmes to develop sustainable waste management solutions and align with national sustainability goals.

Opportunities from policies and financial programmes

- Energy target: The Ministry of Energy's master plan aims for at least 51 per cent share of RE in the total energy mix by 2037.
- NDC target: Thailand has submitted a conditional NDC target of 40 per cent GHG reduction by 2030, conditional on international support for technology transfer and financial resources.
- Public-private partnerships: Policies encourage private-sector participation in RE projects through public-private partnerships and independent power producers (IPPs).
- Foreign investment: Thailand's RE sector is open to international investment, offering opportunities for international companies to enter the market, e.g. by offering incentives such as, tax exemptions.
- Green financing: The availability of green bonds and sustainable financing options can support RE projects.
- Thailand taxonomy: This paves the way for issuing green bonds in Thailand. These bonds specifically finance projects that meet sustainability criteria, potentially lowering borrowing costs for RE developers. Furthermore, financial institutions can leverage the taxonomy to assess the environmental credentials of projects seeking loans or other forms of financial support.

The transition to greater use of RE to replace fossil fuels requires significant capital investment in new technologies, machinery and processes. However, the energy transition towards renewables will likely have a positive impact on energy prices in the long term, as renewables such as solar and wind have no fuel costs and are less exposed to fuel price fluctuations. This transition also aligns with national and global climate commitments. In addition, the declining costs of renewable technologies in the future will attract more green investment to support the low-carbon industrial sector, reducing costs across the entire supply chain.

In the industrial sector, fossil fuels are becoming less competitive than RE due to increasing national and international commitments to climate goals (such as carbon neutrality and net-zero emissions targets). Additionally, environment, social and governance (ESG)-related principles at the corporate level, carbon pricing, and trade mechanisms such as CBAM will further reduce the competitiveness of fossil fuels. Replacing fossil fuels will therefore require higher adoption of RE and other low-carbon sources.

Additionally, SMEs have limited access to financial capital and require quicker returns on investment. Consequently, the investments needed for the energy transition could severely impact some industries more than others. Furthermore, SMEs still rely heavily on coal and fuel oil for production, and switching to biomass would necessitate investments in new machinery, which could lead to higher costs and shortages in the future due to higher demand. Additionally, around 2,000 to 3,000 SMEs in the polymer industry may not be able to remain competitive in the global market due to rising energy costs and may require government support.

To maintain industrial competitiveness during the transition, particularly in the short- and medium term, manufacturers need government support to enable full adoption of RE systems, including infrastructure that supports modern energy systems, competitive utility costs (such as electricity and water), financial incentives for green investment, and fair RE access prices. Furthermore, SMEs may need additional assistance to mitigate the transition's impact. Other factors that enable the industry to remain competitive during the transition include the development of RECs and green tariffs.

Lessons learned and implications for enhancing private-sector involvement

Renewable Energy Subsidy Programmes

A. **Adder Program**: The Adder Program is one of the earliest and most significant efforts to stimulate investment in RE projects nationwide. Launched in 2007, it has played a key role in promoting the generation of electricity from RE sources, such as solar, wind, biomass and biogas, by providing financial incentives to power producers. The programme provided an additional incentive ranging from THB 0.3 to 8 per kWh on top of the regular electricity tariff, guaranteed for 7 to 10 years, depending on the technology. The programme was highly successful in attracting investment in RE, improving RE projects' financial viability and shortening payback periods for investors. However, it also came at a cost: the added expense was reflected in the electricity tariff for consumers. The programme was criticized because the cost of RE technologies, especially solar, decreased significantly over time. Consequently, the Thai government replaced the Adder Program with a FiT scheme, which offered fixed tariffs without the need for additional adders.

B. **Feed-in-tariff (FiT)**: The FiT Program replaced the Adder Program as Thailand's primary incentive mechanism for RE. It provides RE producers with long-term contracts ranging from 20 to 25 years, offering financial certainty and stability to investors in RE projects. Different rates apply to different types of RE. Unlike the Adder Program, which provided an additional incentive on top of the regular electricity tariff, the FiT rates consist of three components.

1. Fixed feed-in-tariff (FiTf) – a fixed tariff rate that is constant throughout the contract period;

2. Variable feed-in-tariff (FiTv) – a variable tariff rate that may vary over the course of the contract, mainly to account for inflation;

3. Premium feed-in-tariff – an additional tariff rate of THB 0.5 per kWh for projects in the following provinces: Yala Pattani Narathiwat and Songkhla (Chana, Thepha, Saba Yoi, Na Thawi districts only).

Tariff levels vary depending on the technology being used. The tariff for each technology type as of August 2024 is presented below, reflecting each technology's cost structure and maturity level.

In recent years, as RE costs have continued to decline, Thailand has considered transitioning from fixed FiT rates to competitive bidding processes for new projects. This approach aims to further reduce costs further and ensure that only the most efficient projects are pursued.

Table 18. Renewable electricity feed-in-tariff (FiT) rate (2022–2030)

Technology Type	FiT (THB/kWh)			Duration
	FiTF	FiTV	Total*	
1. Biogas (wastewater/waste)				
All capacity	2.0724	-	2.0724	20 years
2. Wind				
All capacity	3.1014	-	3.1014	25 years
3. Solar photovoltaic				
Ground-mounted – all capacity	2.1679	-	2.1679	25 years
Ground-mounted + energy storage Capacity 10 - 90 MW	2.8331	-	2.8331	25 years
4. Biomass				
Installed capacity < 3 MW	2.61	2.2382	4.8482	20 years
Installed capacity ≥ 3 MW	2.39	1.8736	4.2636	20 years
5. Biogas				
Waste/wastewater share < 25%	2.79	1.9369	4.7269	20 years

*Exclusive of Premium Feed-in-Tariff

Energy efficiency subsidy Programmes

The establishment of the Energy Conservation Fund (ENCON Fund) plays a critical role in advancing Thailand's EE goals, reducing reliance on imported fuels, and mitigating environmental impacts associated with energy consumption. It provides financial assistance for upgrading equipment, improving energy management practices, and implementing energy-saving technologies. The Fund also supports R&D and deployment of various EE programmes. As of 31 August 2024, the Fund had a balance of THB 14,212 million (approximately USD 420 million). Many of the energy efficiency subsidy programmes have been financed through the ENCON Fund.

a. **Direct subsidy programme:** The government may subsidize the cost of replacing old, inefficient equipment with high-efficiency alternatives. The subsidy will cover the cost of the equipment and installation, as well as the consultant fees for more complex projects. The subsidy amount varies by project type and target sector, with a maximum simple payback period and subsidized amount indicated. Examples include a 20 per cent subsidy for equipment replacement in large factories and buildings and a 30 per cent subsidy for equipment replacements in SMEs, etc.

b. **Demand-side management bidding (DSM-bidding)**: Similar to the direct subsidy programme, this scheme subsidizes project implementation costs. However, the subsidy amount varies. The DSM-bidding programme operates follows a performance-based approach, where the subsidy amount is determined by actual energy savings. Applicants requesting a subsidy must specify the amount per unit of energy saved and projects that bid the lowest amount are awarded support, provided that the total subsidy amount does not exceed the predetermined amount. In its most recent implementation, the programme primarily targeted thermal energy utilization, with a maximum bid of THB 70 per million British thermal units (MMBtu) and a total subsidy of THB 250 million (approximately USD 7.4 million).

c. **Energy Efficiency Revolving Fund (EERF)**: The EERF is a soft loan programme that provides low-interest loans for EE projects. Initially, the interest rate was capped at 4 per cent, and in later phases, at 3.5 per cent. one key characteristic of this programme was the involvement of financial institutions, which assessed applicants' financial viability, while DEDE evaluated the projects' technical feasibility. The involvement of financial institutions familiarized them with EE projects, and by the programme's later stages, many had established dedicated credit lines for EE and RE projects. The programme disbursed a total of around THB 11 billion (approximately USD 320 million), which mobilized total investments in EE projects valued at THB 19 billion across around 450 projects (approximately USD 560 million).

Enhancing RE and EE with increased private-sector involvement

Thailand has implemented many subsidy programmes. However, more can be done to ensure the continued growth of RE and EE projects.

1. Multiply the benefits of energy efficiency and renewable energy projects

While energy savings and RE generation directly reduce costs and increase revenue, there are also other benefits that may not be purely financial. These benefits may be direct, such as reducing GHG emissions, or indirect, such as creating employment opportunities in green industries. It is therefore of great importance for the government to emphasize these additional benefits through capacity development and, where possible, develop innovative mechanisms to translate these benefits into tangible economic value.

2. Leverage the global movement to reduce greenhouse gas emission

With many national and international monetary and non-monetary programmes available to support GHG reductions and climate commitments, stakeholders have a significant opportunity to benefit from these programmes. The government should facilitate access to information and, where possible, expedite the process.

3. Enhance innovative financial programmes

These programmes may include green bonds, on-bill financing, public-private financing, and the facilitation of private-sector investment in green projects through green taxonomy or financing platforms.

4. International cooperation and best practices

Collaborate with international organizations and other countries to learn from their experiences in managing energy subsidies and engaging the private sector. Seek technical assistance or funding from international donors or organizations to implement reforms and promote private-sector engagement.

As observed from ROK's experience, mandatory policies such as RPS play a key role in boosting investments in RE. The RPS requires power generators to increase the share of RE each year and supports the growth of RECs to meet RPS's obligations. Additionally, establishing a "one-stop-shop" system that incorporates social acceptability criteria and designates pre-determined areas for wind project development could lower permitting costs and encourage private-sector investment. Furthermore, improving interconnectivity with neighbouring countries could strengthen RE integration into the grid by providing more flexible power sources to accommodate RE variability and create opportunities for investments in clean energy projects.

To meet the growing demand for green electricity and align with climate neutrality goals, Thailand has made progress in developing a green taxonomy, providing guidance for financial institutions to support investments in clean energy projects. Thailand has also introduced utility green tariffs (UGTs), enabling consumers to purchase electricity from renewable sources at a premium. Additionally, Thailand has approved a 2 GW direct power purchase agreement (DPPA) quota to promote investments in Thailand's data centre industry.

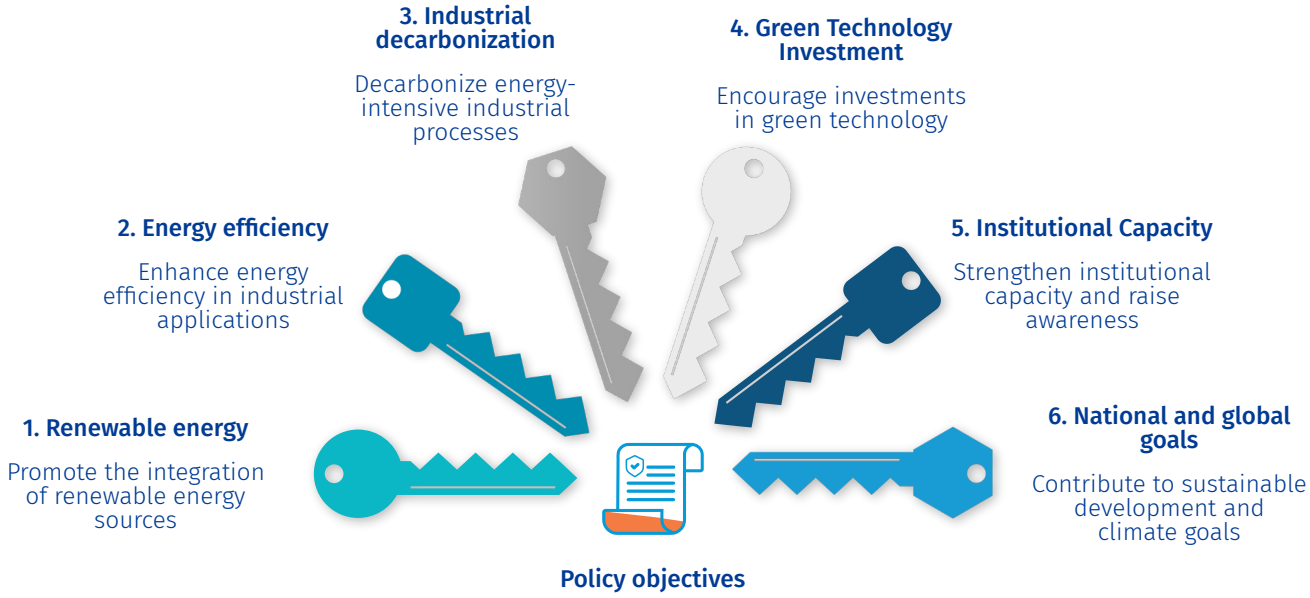
Implementing these strategies will enhance the efficiency of Thailand's energy subsidy programmes, encourage greater private-sector participation, and ultimately foster a more sustainable and effective energy policy.

4 Policy recommendations for Thailand

Set policy objectives

In line with the goals set in the Draft AEDP 2024 and the Draft EEP 2024, six policy objectives have been identified to collectively reduce Thailand's carbon footprint, enhance energy security, and promote sustainable industrial growth by 2037, supporting the country's path towards carbon neutrality and net-zero emissions.

Figure 4. Policy objectives to strengthen RE and EE in the industrial sector



1. Promote the integration of renewable energy sources

The objective is to boost the use of RE sources in the industrial sector in line with national energy action plans and to reduce both reliance on fossil fuels and GHG emissions by increasing the share of solar, wind, biomass and biogas energy in industrial energy consumption.

2. Enhance energy efficiency in industrial applications

This strategy focuses on improving EE across the industrial sector by applying cutting-edge technologies and energy-saving techniques to meet EEP targets. It aims to reduce overall energy consumption through energy-efficient manufacturing techniques, equipment upgrades, and energy management systems, all of which will reduce energy intensity.

3. Decarbonize energy-intensive industrial processes

By supporting the transition to cleaner energy sources, this policy advances the decarbonization of energy-intensive industrial processes in line with AEDP's objectives. This involves assisting sectors in shifting from RE sources and enhancing energy recovery systems, both of which result in notable decreases in CO_2 emissions.

4. Encourage investments in green technology

The programme encourages investments in energy-efficient machinery, smart grid technologies, and RE initiatives. Its goal is to promote industrial commitment to sustainable energy practices through subsidies, financial incentives or tax breaks.

5. Strengthen institutional capacity and raise awareness

The strategy aims to strengthen institutional frameworks and enhance stakeholder understanding in the industrial sector about the significance of RE and EE for long-term environmental and economic benefits. This entails legislative measures, technical assistance and capacity development initiatives.

6. Contribute to sustainable development and climate goals

The strategy aligns with Thailand's national commitments to achieve the Sustainable Development Goals (SDGs) and cut carbon emissions. By promoting EE and the use of RE in Thailand's industrial sector, it also supports international climate agreements, such the Paris Agreement.

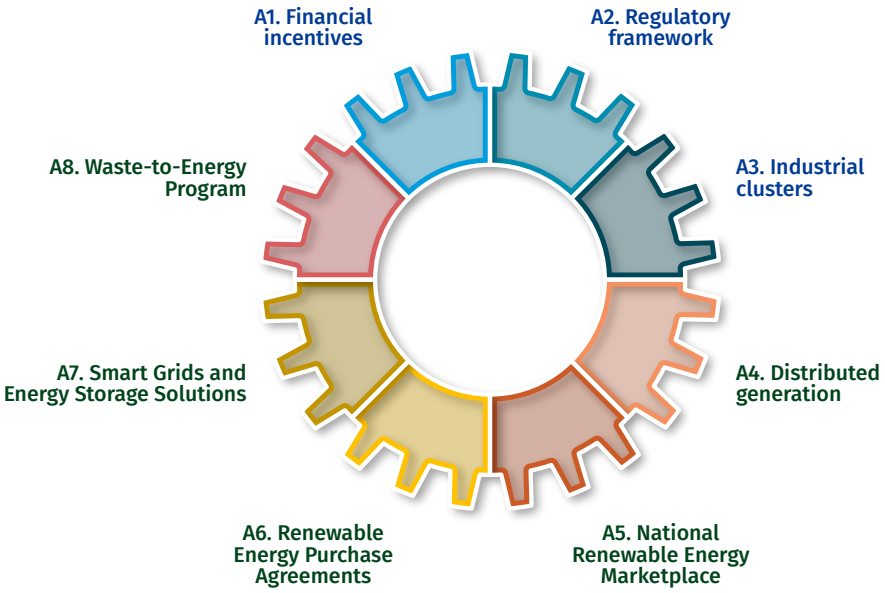
Strengthen policy measures

To achieve these policy objectives, several policy measures supporting AEDP and EEP are recommended to strengthen RE and EE in the industrial sector on its path towards carbon neutrality.

Policy measures to accelerate renewable energy deployment under AEDP

Recommended policy measures supporting AEDP include strengthening existing policy measures (A1-A3) and initiating new policy measures and programmes (A4-A8)

Figure 5. Policy measures supporting AEDP



A1. Enhanced financial incentives for renewable energy adoption

Enhance existing financial incentives to accelerate the integration of RE in the industrial sector, including tax exemptions, subsidies and low-interest loans. Industries can lower the upfront costs related to the implementation of renewable technologies, such as solar, wind, biomass and biogas systems, and improving these support systems. This measure aligns with the AEDP goals to raise the share of RE in the country's energy mix. The Thai government allocates approximately THB 4 billion annually in financial support, including through subsidies, low-interest loans, and tax incentive such as corporate tax exemptions, to promote RE adoption.[12] Despite these efforts, challenges persist, including limited budget coverage across all technologies, inconsistent support for smaller-scale projects, and barriers to broader private sector participation.

To enhance effectiveness, Thailand could increase budget allocations, diversify financial instruments such as green bonds and public-private partnerships, implement performance-based incentives linked to energy output or CO_2 reductions, and strengthen inter-agency coordination. Particular attention should be directed towards financial and fiscal support for small- and medium-scale RE facilities, which have experienced slower deployment compared to large-scale projects. These measures would improve technology uptake, encourage private investment, and accelerate progress towards Thailand's RE and decarbonization objectives.

A2. Streamlined regulatory framework and permitting process

Streamline and expedite the permitting process and regulatory framework for RE energy projects. This includes reducing red tape, accelerating approval processes, and creating a more business-friendly environment to support RE initiatives in the industrial sector. Streamlining the framework would enable industries to implement the AEDP's objectives more effectively. Thailand's RE programme requires multiple project approval stages, including project planning, feasibility studies, environmental impact assessments, construction permits, grid connection approvals, and PPA negotiations, which take 3-4 years in total.

Key challenges include overlapping responsibilities between agencies, uncontested environmental approvals, limited grid capacity, and regulatory uncertainty. For example, greater consistency and standardization are needed among the relevant agencies (Electric Generating Authority of Thailand (EGAT), PEA (Provincial Electricity Authority), MEA (Metropolitan Electricity Authority)) regarding grid connection. Additional reforms should include establishing a unified digital permitting platform, standardizing requirements across agencies, strengthening administrative capacity, and enhancing stakeholder engagement to accelerate project approvals and support broader RE adoption.

12 As of 2025, the government allocates approximately THB 2.7 billion (USD 77.5 million) annually to support RE development. Additionally, the Energy Conservation Promotion Fund (Encon Fund) committed THB 3 billion (USD 99 million) for RE and EE programmes during 2022–2024. These resources are channelled through various financial instruments, including grants, low-cost project debt, and project-level equity, to encourage both public and private investment. (Clean energy finance and investment roadmap of Thailand, OECD, 2024).

A3. Support for industrial clusters and microgrids

Promote the development of microgrids and industrial clusters powered by RE. Businesses can lower energy losses and boost efficiency by supporting localized energy production and distribution. By generating and distributing power on-site, industrial clusters can reduce reliance on centralized grids, lower transmission losses, and better manage peak demand. In Thailand, several pilot microgrid projects exist, but the challenges are cluster-specific: unclear regulatory frameworks for multi-user microgrids, limited integration with existing industrial infrastructure, and the absence of standardized technical guidelines for interconnection and energy management.

To enhance the deployment and impact of industrial microgrids, a cluster-specific approach may be more effective: instead of applying uniform regulatory or technical standards, tailoring microgrid operations and design to the unique energy demands of each industrial zone can strengthen efficiency. Additionally, regulatory and institutional reforms to support multi-user microgrid operations, such as clarifying legal and regulatory frameworks, developing standardized technical guidelines and streamlining permitting processes for industrial microgrid projects. Capacity development of staff plays a critical role as well; targeted training programmes for energy managers and operational staff within industrial clusters could strengthen operational efficiency, maintenance, and the adoption of renewable technologies.[13]

New policy measures for AEDP:

A4. Incentivize distributed renewable energy generation

Promote the deployment of distributed RE systems, such as rooftop solar panels, small-scale wind turbines and bioenergy systems at industrial facilities. The Thai government provides incentives such as tax deductions for household rooftop solar systems and corporate tax exemptions for industrial RE projects,[14] encouraging both industries and households to generate their own RE. This not only eases pressure on the national grid but also increases the share of RE in the overall energy mix, supporting AEDP objectives.

To further expand distributed RE deployment, Thailand could prioritize maintaining consistent policies beyond FiT (i.e. once FiT contracts expire or are no longer applicable) by introducing long-term PPAs to provide investment certainty, strengthening financial instruments to provide investment certainty, and developing community-based RE initiatives to boost public participation and reinforce local grid stability.

A5. Establish a national renewable energy marketplace

Establish an advanced commercial centre for RE that connects producers with industrial consumers. This platform would enable businesses to directly purchase clean energy, supporting the development of RE sources such as solar and wind power. It would also promote energy trading and incentivize investment in RE projects.

13 Meenual, T., & Usapein, P. (2021). Microgrid Policies: A Review of Technologies and Key Drivers of Thailand. Frontiers in Energy Research, 9, 591537.

14 Ministry of Energy, Thailand (2025), Tax incentives and policies for renewable energy (DEDE)

To address the monopolistic challenges posed by EGAT and current regulatory gaps, the proposed platform would enable SME aggregation, automate contract setup, and provide a digital interface for pricing, tracking and settlement. The marketplace could also integrate blockchain-based tokenization of RE certificates or energy contracts, facilitating virtual asset trading and automated settlement of RE purchases. This initiative would position Thailand as a regional RE hub within ASEAN, attract private investment, expand direct renewable procurement by industries, and enhance decarbonization, market efficiency and transparency.

A6. Introduce Renewable Energy Purchase Agreements (REPAs)

Implement REPAs that allow businesses to enter long-term contracts with RE suppliers. These contracts would enable businesses to secure a stable supply of clean energy at predictable costs, supporting the shift from fossil fuels to renewables. REPAs would also provide RE producers with guaranteed demand, thereby encouraging further investment in green energy infrastructure. In Thailand's current market, electricity sales are dominated by EGAT, PEA and MEA, with RE generation primarily channelled through IPP, SPP and VSPP projects, limiting opportunities for direct industrial procurement.

REPAs could address this by adopting portfolio-based aggregation, pooling multiple RE projects or industrial buyers to achieve economies of scale, diversify risk, and enable SME participation.[15] In addition to linking payments to "actual energy generation or verified carbon reductions", the framework could incorporate CO_2 emission reductions, the issuance and trading of RECs, and local job creation, thereby strengthening alignment with ESG objectives.

A7. Encourage the integration of smart grids and energy storage solutions

Allocate resources to the development of smart grid technologies and energy storage solutions to support the integration of RE in the industrial sector. Smart grids would enable real-time monitoring and management of energy use, improve EE and reducing waste. Energy storage solutions, including battery systems, would enhance the reliability of RE by ensuring consistent availability even during periods of low generation. Thailand has initiated pilot projects under its Smart Grid Development Master Plan (2015–2036), but progress remains limited to small-scale demonstrations, largely due to high capital costs and limited regulatory recognition of energy storage systems (ESSs).

To accelerate deployment, Thailand should prioritize ESS in strategic industrial zones, establish clearer regulatory frameworks that classify storage as a grid service, and explore the integration of storage solutions with REPAs and REC trading platforms. In addition, adopting digital innovations, such as AI-driven grid management, digital twins, and second-life EV batteries, could help lower costs and improve operational efficiency.

15 Hunton Andrews Kurth LLP, "Unlocking Opportunities in Thailand's new Third-party access and Direct PPA projects", 2023.

A8. Develop a national waste-to-energy (WtE) programme

Promote WtE projects to increase Thailand's RE portfolio. Bioenergy or electricity could be produced from municipal solid waste, agricultural residues and industrial waste, thereby reducing the amount of landfill waste and supplying the industrial sector with RE. WTE projects would support the AEDP 2018 bioenergy production targets and help address waste management challenges. As of 2025, only a few small-scale WtE plants are in operation, reflecting the slow pace of deployment. Key challenges include community resistance over environmental and health concerns, inconsistent waste quality and supply, and weak monitoring frameworks.

To improve local acceptance of WtE projects, Thailand could strengthen community engagement through consultations and implement transparent environmental monitoring. For example, the Thai government could establish community advisory boards and implement dashboards to provide real-time data on environmental and health impacts, fostering trust and accountability. To ensure a reliable waste supply, segregated collection, sorting incentives, and IoT-based tracking could be introduced.

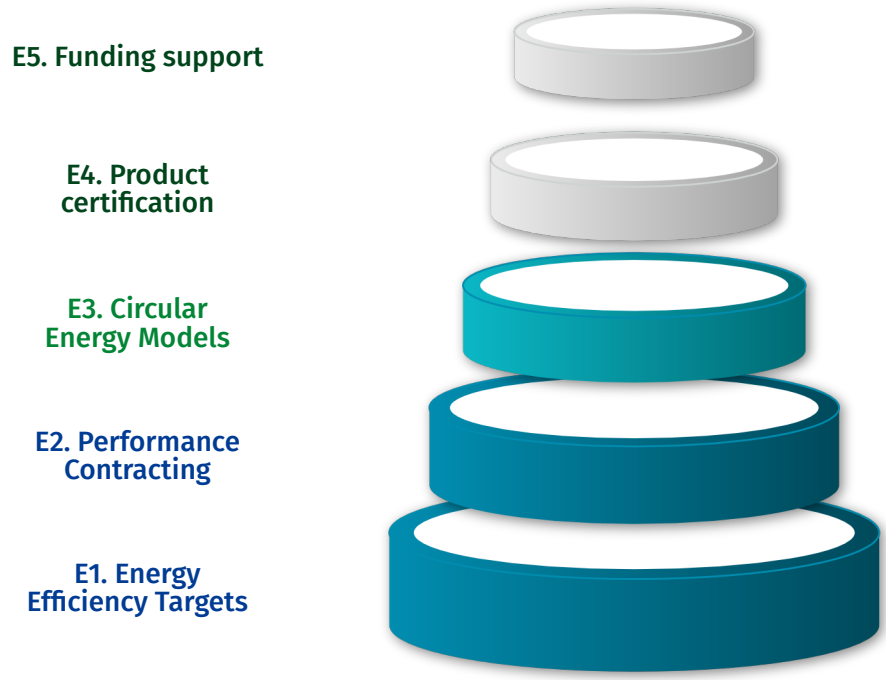
Policy measures to enhance EE under EEP

E1. Mandatory energy efficiency targets for industries

Implement stricter mandatory EE targets for energy-intensive industries under the EEP framework. These targets should gradually escalate to ensure steady progress in energy conservation. Introducing penalties for non-compliance and rewarding industries that exceed targets will drive greater EE efforts. The targets should focus on reducing energy intensity and promoting efficient production technologies.

Since the enactment of the EnCon Act in 2007, Thailand has implemented instruments to mandate compliance with energy management systems (EnMS) in industry and adherence to sector-specific energy intensity metrics. Despite these measures, challenges persist, including uneven compliance among SMEs and limited enforcement capacity. Expanding technical support, training programmes, and recognition schemes for high-performing industries could strengthen the effectiveness of these mandatory EE targets.

Figure 6. Implementation of EE measures



E2. Promotion of Energy Performance Contracting (EPC)

Increase the number of EE improvements that can be financed by through EPCs. Energy service companies (ESCOs) and industrial players can collaborate to upgrade energy systems with minimal financial risk. This approach provides industries with financing options and technical expertise to improve EE in line with EEP objectives.

EPC has been implemented in Thailand since 1999 under the EEP and through public sector projects led by agencies such as PEA and EGAT. While EPC offers the advantage of no upfront investment, adoption remains limited. Key barriers include low awareness of EPC contract structures, limited trust in ESCOs' technical capabilities and performance guarantees. Moreover, EPCs' legal framework remains incomplete, with the Energy Conservation Promotion Act and Board of Investment (BOI) incentives providing indirect support only, while standardized contracts, mandatory measurement & verification (M&V) protocols, and ESCO certification are still lacking to prevent misuse or imitation. To strengthen adoption, Thailand could expand industrial education on EPC models, implement standardized M&V protocols, and establish clear policy incentives, particularly targeting SMEs. These measures would accelerate industrial EE improvements and advance national EEP objectives.

New policy measures for EE

E3. Support industrial symbiosis and circular energy models

Promote industrial symbiosis, where waste heat and energy from one industry are used as inputs by another. This approach encourages resource-sharing among industries, enhancing overall EE. Government policies could support the development of industrial eco-parks that implement such energy exchange systems.

Ulsan Eco-Industrial Park in ROK highlights the importance of coordinated governance, tailoring financing mechanisms, and capacity development programmes for participating industries.[16] Such measures can strengthen cooperation, improve resource efficiency, and accelerate the adoption of circular economy models across industrial sectors.

E4. Strengthen the energy efficiency certification for industrial products

Strengthen and expand the certification programme for industrial products and machinery focused on EE, which currently operates through the Thai Industrial Standards Institute (TISI) certification[17] and EGAT No. 5 energy labels. Certified products meet strict EE criteria, encouraging industries to adopt energy-saving technologies.

To strengthen the role of certification in promoting industrial EE, the programme should be expanded to include high-energy-use industrial equipment with clear, measurable standards. Additionally, a performance-based tiered certification system could further incentivize higher EE levels, with higher-grade products receiving preferential treatment in public procurement, industrial park adoption programmes or fiscal incentives. When combined with technical guidance, training and alignment with supportive financial or policy measures,

16 Behera, S. K., Kim, J.-H., Lee, S.-Y., Suh, S., & Park, H.-S. (2012). Evolution of 'designed' industrial symbiosis networks in the Ulsan Eco-industrial Park: 'Research and development into business' as the enabling framework. Journal of Cleaner Production, 24, 76–85. https://doi.org/10.1016/j.jclepro.2011.12.028

17 TISI. (2025). Thailand Industrial Product Certification Overview. Retrieved from https://www.tisi.go.th

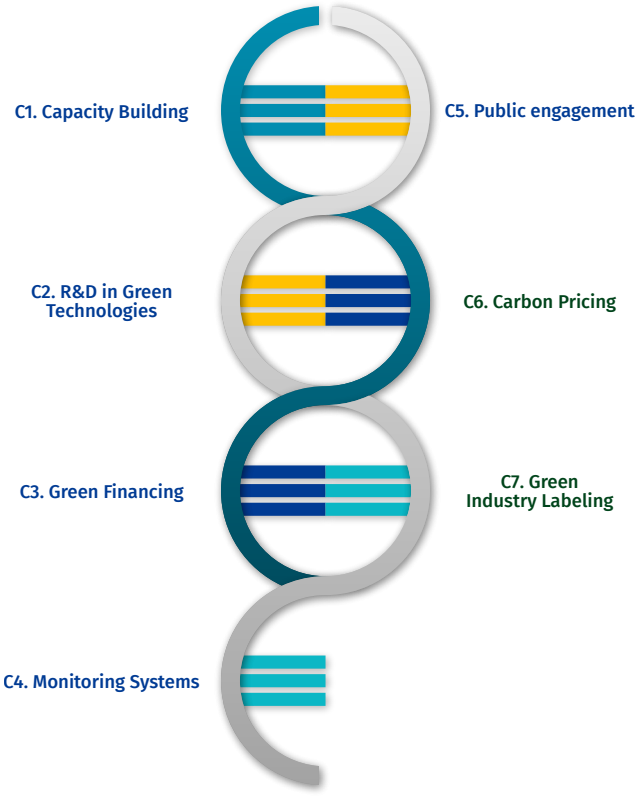
these steps would enhance adoption among SMEs and large manufacturers, maximize energy savings, and reduce energy intensity across Thailand's industrial sector.

E5. Establish an Industrial Energy Efficiency Fund

Establish an Industrial Energy Efficiency Fund (IEEF) that provides grants or low-interest loans to projects implementing EE improvements. The Fund would support projects such as upgrading energy-efficient equipment, enhancing building insulation, and implementing energy management systems. This measure aligns with the EEP objectives by making EE investments more accessible and reducing energy consumption and emissions.

Cross-cutting measures

Figure 7. Implementation of cross-measures



C1. Capacity building and technical support

Establish comprehensive capacity development programmes to enhance technical knowledge and capabilities in EE and RE. This includes training programmes for industry employees, energy managers and decision-makers. The government should collaborate with universities, research institutes and international partners to provide technical support, enabling industries to adopt advanced energy management systems and implement RE projects effectively.

Training programmes should focus on improving the technical skills, design knowledge, and installation capabilities of industry workers, RE technicians, and installers to support the medium- and long-term expansion of RE. Capacity development initiatives for EE should target ESCOs and building developers—whose industry accounts for 25 per cent of final energy consumption—aiming to strengthen their understanding of EE project implementation, develop technical competencies, and provide training on energy management and M&V practices.

C2. Research and development (R&D) in green technologies

Increase investment in R&D targeting innovative RE technologies and energy-efficient industrial processes. The government should promote public-private partnerships to develop locally sourced green technologies tailored to Thailand's industrial landscape. Strengthening R&D efforts will support the development of cost-effective solutions for decarbonization aligned with the long-term objectives of AEDP and EEP.[18]

18 The new Government of ROK, inaugurated in June 2025, plans to invest KRW 2.2 trillion (approximately USD 1.7 billion) in 2026 to develop green technologies as next-generation strategic industries. Key focus areas include ultra-high-efficiency solar cells, large-scale high-output wind systems, AI-based EnMS, next-generation local power grids for community energy self-sufficiency, and long-duration ESS.

Examples include collaborative R&D between industry and research institutions or universities, pilot evaluations of new technologies in industrial settings, and dissemination workshops to share findings and best practices. There is also potential to establish monitoring and assessment frameworks to evaluate technology impact, costs and scalability. Strengthening these R&D efforts is expected to enhance the development and implementation of cost-efficient decarbonization technologies, promote domestic technological self-reliance, and support the long-term goals of the AEDP and EEP.

C3. Green financing mechanisms

Create new green finance tools to encourage investments in EE and RE projects, such as carbon credits and green bonds. Implementation could include establishing dedicated green finance investment funds, offering credit guarantees for industrial RE and EE projects, and developing standardized methodologies for estimating emission reductions to support carbon trading.

The Thai government could also strengthen financial incentives to expand small-scale, community-led RE projects, promoting decentralized energy generation, off-grid power supply, and local economic development. Measures could include preferential interest rates, relaxed collateral requirements, and extended loan terms for SMEs and local communities. Additionally, favourable financing conditions, such as credit guarantees, could be extended to ESCOs to support EE improvements. These actions aim to provide capital for industries to transition to low-carbon technologies, reduce carbon emissions and offer low-cost investment opportunities that build market confidence and increase investment transparency.

C4. Strengthened monitoring and reporting systems

Improve reporting and monitoring mechanisms to track industry progress towards achieving EE and RE targets. Introduce digital platforms and tools for real-time performance tracking and data collection, ensuring accountability and transparency. These systems can integrate smart metres, IoT sensors, and automated reporting dashboards to provide real-time analytics. Immediate data collection allows industries to monitor energy consumption, RE generation, and carbon emissions more accurately, facilitating prompt decision-making and informed modifications to energy management plans.

Improved monitoring would strengthen compliance assessment, enhance transparency, and provide policymakers with real-time information to guide investment and initiatives. Integrating digital technologies with comprehensive performance monitoring enables industries to accelerate progress towards EE and RE goals, while also promoting a more robust and efficient energy system.

C5. Public awareness and engagement campaigns

Public participation and awareness should be enhanced through campaigns that emphasize the value of EE and RE in the industrial sector.[19] To strengthen support for decarbonization initiatives, campaigns should target the public, including students at all levels, local communities, and industry partners. An informed public can influence demand for environmentally friendly products and services, shaping sustainability and carbon-conscious decisions at both consumer and producer levels.

19 In ROK, EE awareness has a long-standing tradition, underpinned by the Framework Act on the Promotion of Energy Conservation (first enacted in 1979 and subsequently amended).

These objectives can be reached through targeted national media outreach; industry seminars and workshops; interactive exhibitions on EE and RE technologies; industry competitions focused on energy savings; and EE and RE-related capacity development for energy managers and staff. Online platforms can complement these efforts by providing practical guidelines, case studies, and tools for implementing EE and RE solutions. A comprehensive approach will enhance stakeholder engagement, foster a culture of EE, and support measurable reductions in energy consumption and carbon emissions.

C6. Introduce a carbon pricing mechanism[20]

Although Thailand has implemented a carbon tax and is developing an ETS, further measures are needed to translate these policies into effective industrial decarbonization. Policies should focus on implementation strategies, compliance mechanisms, and incentives to encourage broader industrial participation. Measures could include establishing industry-specific emissions reduction benchmarks, providing guidance and support for SMEs to participate effectively, and linking carbon pricing to RE adoption or EE improvements.

Complementary measures could include integrating carbon pricing with financial instruments, such as green bonds or subsidies for low-carbon technologies, making emission reductions financially attractive while supporting industrial competitiveness. Monitoring and evaluation systems should be established to track emission reductions, assess both quantitative and qualitative economic impacts, and adjust carbon pricing and exemptions as needed to achieve emissions-reduction goals. By focusing on effective implementation rather than simply introducing policies, these measures would accelerate Thailand's transition to a low-carbon industrial sector, in alignment with the Energy Efficiency Plan and AEDP objectives.

C7. Implement a "Green Industry" labelling system

Maintain and enhance the existing "Green Industry" labelling system to recognize industries that achieve high levels of RE adoption and EE. This certification currently allow industries to differentiate themselves in the market, providing a competitive advantage to those that meet environmental standards.[21] The programme aims to promote cleaner and more efficient industrial operations; however, opportunities have been limited, SME certifications remain low, and public awareness of the awards is minimal.

Thailand could strengthen the system by introducing tiered incentives tied to certification levels, providing technical assistance and training for SMEs, actively promoting certified companies through public and private channels, and integrating certification into supply chain requirements. These measures would boost adoption, enhance industry recognition in the marketplace, and create more opportunities for industry to realign their operations with national sustainability and clean energy goals.

20 Thailand's government has announced plans to implement a carbon tax in 2025, becoming the second ASEAN nation, after Singapore, to do so. The tax, set at THB 200 (USD 5.88) per metric ton of carbon emissions, is intended to encourage sustainable practices and address climate change challenges.

21 Department of industrial works (DIW), Thailand (2022). Green Industry Brochure.

Support for industrial decarbonization

In addition to the policy measures promoting RE and EE, the government should develop a national industrial decarbonization roadmap. This roadmap should establish targets and guidelines for decarbonization strategies aimed at reducing fossil fuel use in industry. The following pillars should be considered to support the industrial transition:

a. **EE** is a low-hanging fruit opportunity that should be prioritized in the near term. Stakeholders have widely recognized its potential, and it should be prioritized to reduce energy consumption in the industrial sector. This aligns with international examples in the U.S. and China, where EE is considered the most cost-effective decarbonization solution in the short term.

b. **Material circularity** requires government support to encourage investments in new machinery, technologies and processes. Strategies such as replacing single-use plastics with circular materials may require both technological and financial support to upgrade equipment and implement new, innovative processes. The BOI provides incentives to support the Bio-Circular-Green (BCG) model, including investments in new machinery, technologies and processes that reduce energy consumption. Currently, the BOI supports recycling operations, the production of recycled plastics, and refuse-derived fuel (RDF) facilities that convert waste into energy.

c. **Green electricity** is in high demand in the industrial sector, but faces several challenges. Corporate initiatives by parent firms towards net-zero targets and the RE100 network, as well as businesses expected to be impacted by CBAM have contributed to the considerable rise in demand for green electricity in the private sector in recent years. The Issuer of International Renewable Energy Certificates (IRECs) in Thailand has reported increased demand, particularly from industries in supply chains that must meet carbon neutrality targets or have joined the RE100 network. Examples include Toyota in Japan, as well as Microsoft, Amazon and Google. However, Thailand's carbon credit market has yet to gain international recognition. For example, a carbon offset under the Thailand Voluntary Emission Reduction (T-VER) programme is not widely recognized or accepted by international companies.

d. **Government support** is needed for SMEs to adopt bioenergy and hydrogen. While hydrogen adoption is being addressed in high energy-intensive sectors, SMEs still need to invest in new machinery and equipment to replace coal or fuel oil with bioenergy. They require government guidance and financial support to transition to low-carbon fuels such as bioenergy and hydrogen. At the national level, a carbon tax could incentivize long-term hydrogen use. Supporting financial and policy initiatives are practical to making investment projects viable.

e. **The electrification of heat** has not yet become economically viable for stakeholders. High cost of electric boilers and heat pumps, combined with stakeholders' lack of expertise and confidence in these technologies, the electrification of heat processes has not yet reached an economically viable stage in Thailand. Concerns also exist that heat pumps would require power from the grid, which still relies heavily on fossil fuels. Therefore, the grid may not be able to supply heat pumps with entirely green electricity, which could discourage the industrial sector from adopting heat electrification as an alternative to reduce Scope 2 emissions and decarbonize. While some manufacturers may have the capacity to install their own solar power systems, many limitations remain. However, switching to electronic boilers or heat pumps could reduce fossil fuel use for heat production. This is in line with international practices that highlight the economic viability of heat pumps and electronic boilers due to their technological readiness in the near term.

f. **A central carbon capture, utilization, and storage (CCUS) roadmap** is needed at the national level. In particular, hard-to-abate industries such as cement, chemicals and iron require advanced solutions such as CCUS to meet climate targets. The public and private sectors would need to collaborate, and industrial policies would need to align with global trends. A central "technology roadmap" is important at the national level and should specify how much carbon needs to be captured, as well as every industry's plan for carbon capture and storage and include monitoring and evaluation to assess these plans. Developing high technologies such as CCUS requires significant effort and investment. Accurate estimation of the amount of carbon that needs to be captured will make it possible to correctly appraise economic, technological and geographical areas for CCUS. Although this is a technology for the future, its development must start now. Currently, Thailand lacks a central CCUS roadmap at the national level; however, several companies have initiated separate CCUS development plans. SCG has concluded partnerships and has received funding from NEPO Japan to pilot a CCU plant in Maptaput. Thailand's storage infrastructure is not yet ready, and despite multiple organizations working on CCUS, effective collaboration remains limited.

g. **International funds and support** should be pooled and allocated transparently and fairly to facilitate the industrial transition and ensure execution-oriented outcomes. Priorities should focus on industries with higher readiness and competitiveness to enable quick, practical successes. Industrial sectors should develop strategies and maintain ongoing communication with the government to achieve their targets. The government should not impose excessive restrictions that could undermine the manufacturing sector's competitiveness.

While hard-to-abate industries such as cement, chemical and steel have clear incentives to develop their own industrial roadmaps to achieve net-zero targets and issue guidelines for prioritized technologies and measures in the short-, medium- and long term, other industries can also benefit from an industrial roadmap that would guide their future pathway towards higher RE adoption. Cross-cutting strategies that could be applied at an industry-wide level. For example, low-temperature heat industries such as food and beverages, paper and textiles (which together account for around 37 per cent of final energy consumption in the Thai industrial sector) could benefit from an electrification of heat strategy.

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