Thailand Energy Saving Potential Research

Executive Report

Japan Bank for International Cooperation

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Executive Summary

This research aims to quantitatively **assess the impact of energy conservation measures in Thailand's industry sector, particularly the manufacturing sector,** using primary data and interviews. Energy conservation is no longer merely a cost-reduction measure. It has become a **strategic foundation** for Thailand to maintain competitiveness in international markets, secure energy supply stability, and attract high-value FDI. The research finds that **the manufacturing sector accounts for 36.8% of national energy consumption and relies heavily on fossil fuels**. Although **energy efficiency is crucial for enhancing competitiveness** and addressing the Carbon Border Adjustment Mechanism (CBAM), key barriers remain: the regulatory framework, including the Climate Change Act, is still under development, and SMEs in Thailand exhibit a strong tendency to avoid upfront investment costs without evaluating lifecycle energy savings and cost-effectiveness, which remains a major obstacle to modernization

. The study identifies **6 priority industries** (Food Products, Rubber & Plastics, Fabricated Metals, Non-Metallic Minerals, Automotive, and Chemicals), each selected through a two-dimensional screening of **impact** and **feasibility**. The **combined carbon emission reduction potential across these 6 industries is estimated at 14.4 to 39.8 MtCO_2e from 2023 to 2037 with cost saving of THB 95 – 210 billion annually (approximately 1.6 – 3.6% of projected manufacturing GDP).**To realize this potential, **Japanese solution providers are recommended to adopt two complementary market entry strategies**:

(1) Transitioning from selling individual equipment to **offering integrated system solutions** (e.g., bundling digital EMS with high-efficiency equipment such as chillers and air compressors)

(2) Leveraging proprietary innovative solutions to **enter niche markets as an initial foothold**. Once customer trust is established, **gradually expand the offerings into related products and services**. This strategy establishes the advantage of Japanese solutions through value-added technical services and system integration proposals, overcoming both (a) high initial adoption costs and (b) price competition with local companies and manufacturers from other countries

To chart the future direction of energy conservation in Thailand, the research raises **critical challenges across 4 domains: A. Energy Generation and Storage, B. Grid Infrastructure, C. Optimizing Energy Usage, and D. Market Enablement.** To address these challenges, the report recommends:

(1) A **regulatory approach**, including enacting the Climate Change Act, enforcing building energy codes, and establishing PUE benchmarks for data centers

(2) The government should **promote private participation** through **market liberalization**, including deregulating direct PPAs by 2030 and allowing private capital participation in transmission and distribution grid development

(3) Building on Thailand's track record of effectively utilizing foreign capital and international cooperation, Thailand should further strengthen collaboration between private and public model to de-risk the adoption of innovative energy conservation technologies through effective use of Japanese policy-based and private financing, including JBIC two-step loans, Thai government equipment subsidies for energy-saving machinery upgrades, and joint R&D regulatory sandboxes that enable pilot-scale testing of innovative technologies under relaxed regulatory conditions

The Content Flow of this Research

This research consists of 6 chapters, from an overview of the landscape to policy recommendations

Chapter 1: Overview of Thailand's Energy Conservation Policies and Regulatory Framework

*Identify **key regulations and incentive mechanisms** driving demand for energy conservation solutions in Thailand*

Chapter 2: Thailand's Industrial Structure and Current Energy Consumption

*Map **Thailand's industry energy consumption patterns***

Chapter 3: Quantitative Potential for Energy Conservation

*Quantify **energy conservation potential** across industries and equipment categories to pinpoint the highest-value opportunities*

Chapter 4: Applicability of Japanese Energy-Saving Technologies and Products

*Assess **competitive dynamics** between Japanese technologies and alternatives from **China, Thai, and Europe** to develop differentiated market entry and expansion strategies*

Chapter 5: Policy Recommendations and Institutional Improvements

*Identifies **regulatory gaps**, proposes **policy recommendations**, and outlines a **strategic roadmap** for long-term sustainability*

Chapter 6: Future Vision

*Proposes **Japan-Thailand collaboration recommendations**, including strategic partnership frameworks and **public-private sector examples** to accelerate energy-saving investment*

The Policies and Regulations Framework

Thailand drives energy efficiency and environmental sustainability through three key pillars: (1) Mandatory Policies setting regulatory baselines, **(2) Financial Compliance** aligning market incentives with sustainability, and **(3) Supporting Policies** reinforcing adoption through complementary measures

Energy Efficiency & Environmental Impact

1 Mandatory Policy

Mandatory Regulation

Establishes the legal floor and minimum standards that all entities must follow

"Transparency & Legal Compliance"

Annual Disclosure Document Regulation, ENCON Act, Climate Change Act

Pricing Mechanism

Transforms environmental impact into a financial cost to discourage high-carbon activities

"Polluter Pays Principle"

Climate Change Act (Carbon Tax), Climate Change Act (Mandatory ETS), Voluntary Market (T-VER)

2 Financial Compliance

Screens and directs investment capital toward sustainable projects while limiting funding for others

"Green Taxonomy & Funding Access"

Thai ESG Fund, Thailand Taxonomy, Financing the Transition

3 Supporting Policy

Provides government incentives to lower the upfront costs and risks of adopting green technology

"Subsidies & De-risking"

BOI Investment Promotion, DEDE Soft Loans, Utility Green Tariff, Direct PPA, SME Green Productivity, EXIM Green Goal, OSMEP BS, 80:20 Support, BOI SME Transformation

External Factors

Green Trade Barriers:	Supply Chain Accountability:	Specific Regulations:
EU CBAM, U.S. CCA	EU CSDDD, EU CSRD	EUDR, CORSIA

EU CBAM = Carbon Border Adjustment Mechanism
U.S. CCA = Clean Competition Act

Strengthening Export Competitiveness through Energy Efficiency and Environmental Impact Reduction

Energy efficiency is no longer just a cost-saving measure, but a critically important strategic foundation for Thailand to secure competitiveness in international markets, enhance business resilience, and attract high-value foreign direct investment (FDI)

Benefit	Details
1 **Mitigating Global Trade Barriers**	• **CBAM Readiness:** Improving energy efficiency lowers the carbon intensity of products, helping exporters avoid high carbon cost risks in key markets such as the EU • **Compliance as a Competitive Advantage:** Securing the "License to Trade" through adherence to international standards such as ISO 50001, and establishing a position as a preferred supplier in global supply chains
2 **Cost Competitiveness**	• **Lower OPEX:** Using smart technology (sensors, high-efficiency motors) reduces the energy cost per unit, protecting margins against global energy price volatility • **Leveraging Green Finance:** Sustainable factories gain access to BOI tax incentives and low-interest green loans, reducing the financial burden of expanding production • **Addressing Energy Security Risks:** As Thailand's vulnerability from heavy dependence on imported energy becomes more apparent amid escalating Middle East tensions, securing supply chain stability and stabilizing production costs through the promotion of energy efficiency measures
3 **Strategic Positioning**	• **Attracting Foreign Direct Investment (FDI):** Modern energy management attracts high-value industries (EV, smart electronics) that require "Net Zero" supply chains to meet their international targets • **Market Diversification:** Obtaining green certifications enables access to sustainability-conscious markets, reducing exposure to protectionist trade policy risks accompanying environmental regulations

* ISO 50001: International standard for Energy Management Systems (EnMS), specifying requirements for organizations to establish systematic processes to improve energy performance, efficiency, and consumption.

Hurdles for Policy Adoptions

Unlocking Thailand's sustainability policy adoption requires addressing barriers across thefull decision chain from regulatory readiness and mindset to capability and financing

Hurdles	Details
1 **Regulatory & Market Infrastructure**	• **Pending Legislative Framework:** Thailand's Climate Change Act has yet to be enacted, creating policy uncertainty that undermines long-term investment confidence and delays enforcement mechanisms
2 **Awareness & Mindset Barriers**	• **Mindset Priority:** SMEs prioritize revenue generation over energy efficiency (viewed as a Tier 3 - 4 priority) Sustainability is often funded by a "leftover budget" rather than dedicated CAPEX • **Information Access:** Businesses still lack centralized channels for incentives, causing missed opportunities • **Mission Conflict:** Some organizations (especially public organizations) face regulatory ambiguity on whether selling energy (solar) conflicts with their core mission
3 **Capability & Talent Gaps**	• **In-House Expertise Deficit:** A significant proportion of enterprises, particularly SMEs, lack the specialized skills required to establish robust carbon accounting frameworks and develop actionable decarbonization roadmaps • **Ecosystem Talent Shortage:** The supply of qualified carbon consultants and advisory service providers in Thailand remains insufficient to meet growing demand, creating a bottleneck for companies seeking external support
4 **Financial & Budgeting Constraints**	• **Misaligned Financial Mechanisms:** Green loans exist, but project ticket sizes for SMEs are often too small to incentivize banks (high transaction cost vs. return) • **The Budget Trap:** Public sector entities and universities face bureaucratic hurdles where "saving budget means cutting future budget," discouraging investment in efficiency measures (e.g., solar rooftops) • **Carbon Credit Market Immaturity:** Current local standards (T-VER) limit international trading; ongoing efforts to upgrade to Premium T-VER (CORSIA) are critical but nascent

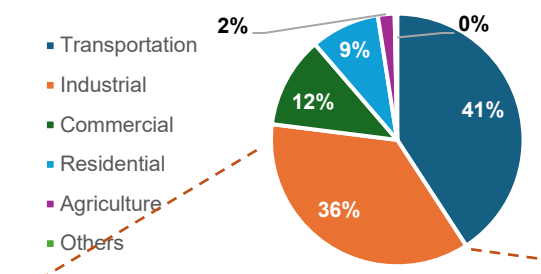
Source: ThaiBMA (Thai Bond Market Association), TGO, SET, Expert interview

Thailand Overall Energy Trend

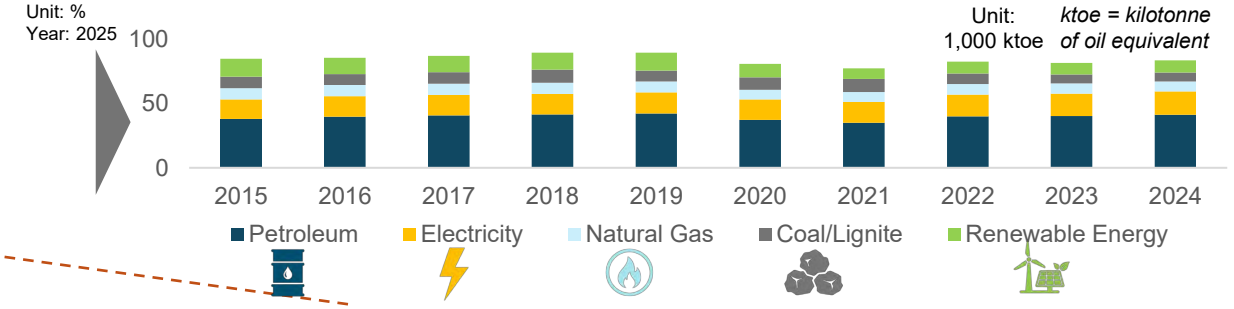
Thailand's energy consumption has been increasing despite the drop from COVID-19 period, with industrial and transportation sectors driving 77% of total consumption. While industrial renewable adoption is rising, it remains uneven: coal-dependent sectors contrast with renewables-adopting ones

THAILAND

Thailand's Energy Consumption

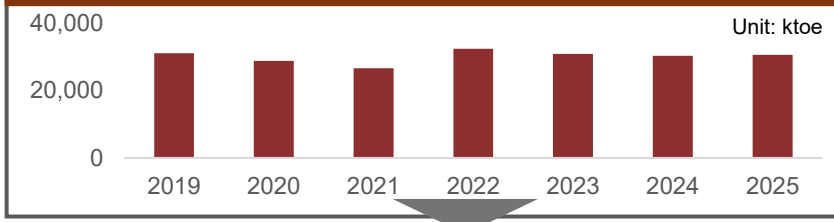


Final Energy Consumption by Fuel Type

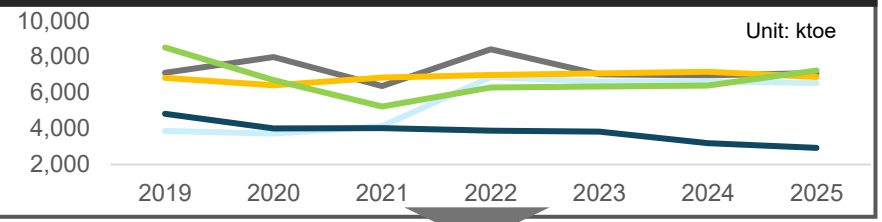


INDUSTRIAL

Industrial Energy Consumption Trend by Year



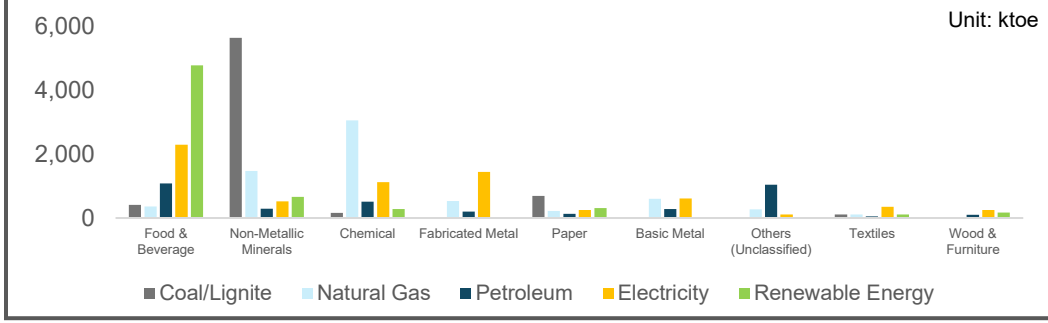
Industrial Energy Consumption Trend by Year by Fuel Type



INDUSTRIAL SECTOR & ELECTRICITY

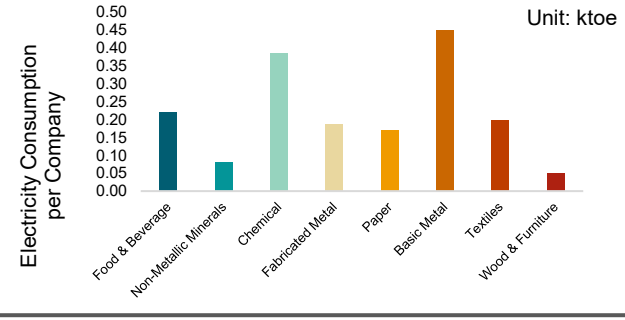
Industrial sector

Industrial Sector Energy Consumption by Sub-sector and Source (2023)



Electricity

Electricity Consumption by Company and Industrial Sector (2023)

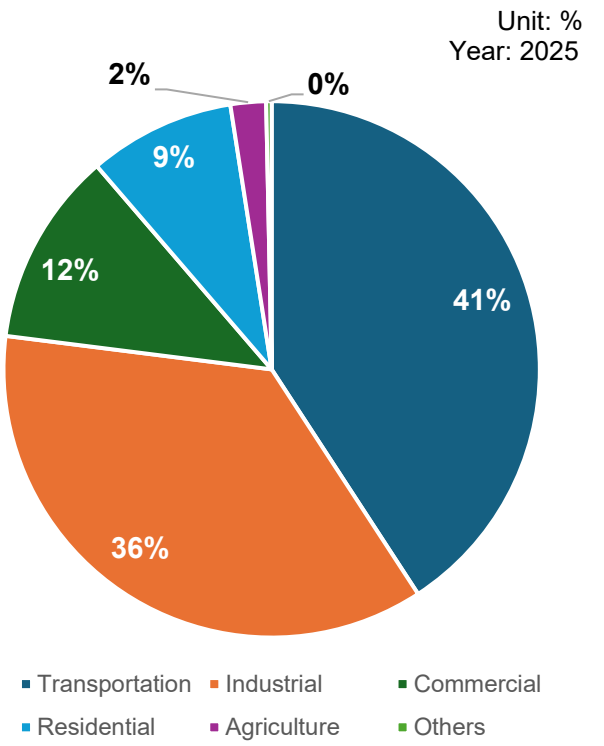


Current data as of April 2026

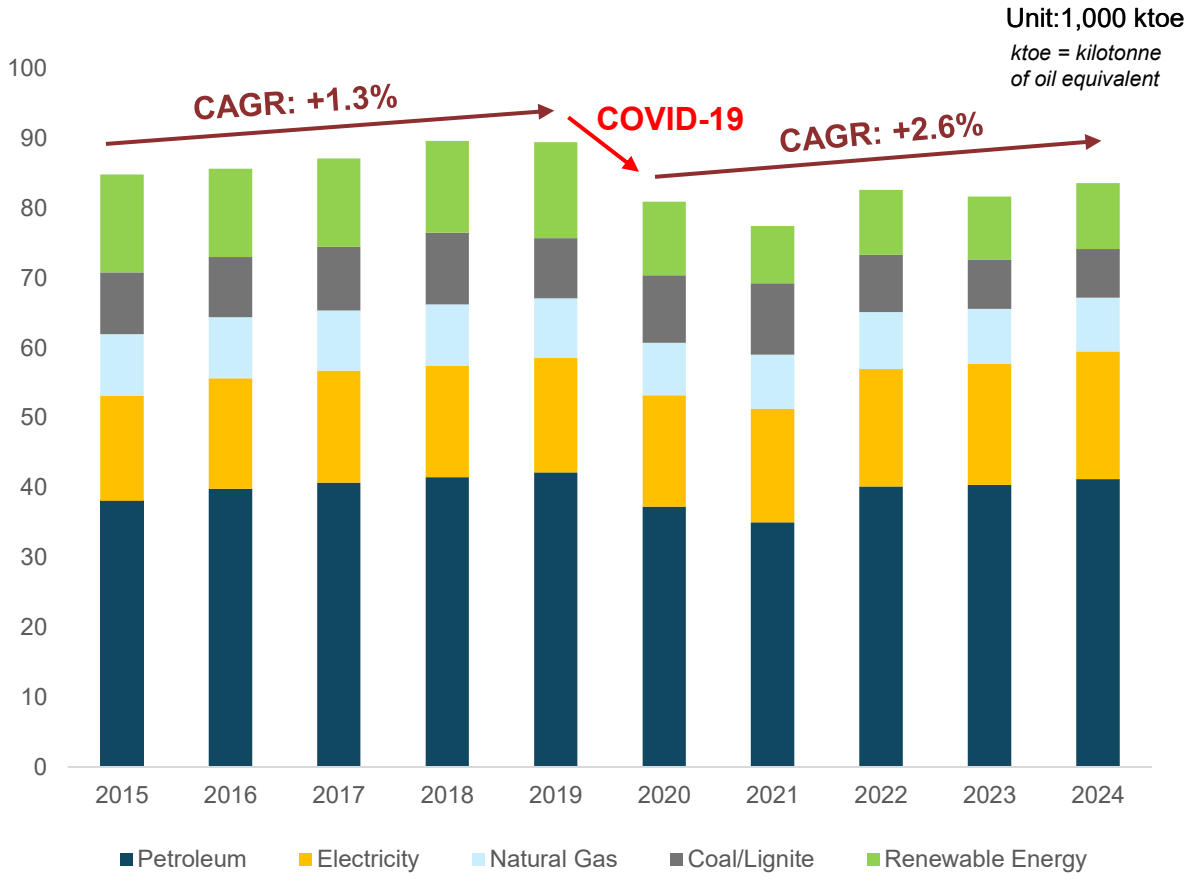
Thailand Overall Energy Trend

Thailand's final energy consumption has been increasing, with a temporary drop during the COVID-19 period. Collectively, the Industrial and Transportation sectors drive around 77% of the total consumption

Thailand's Energy Consumption



Final Energy Consumption by Fuel Type



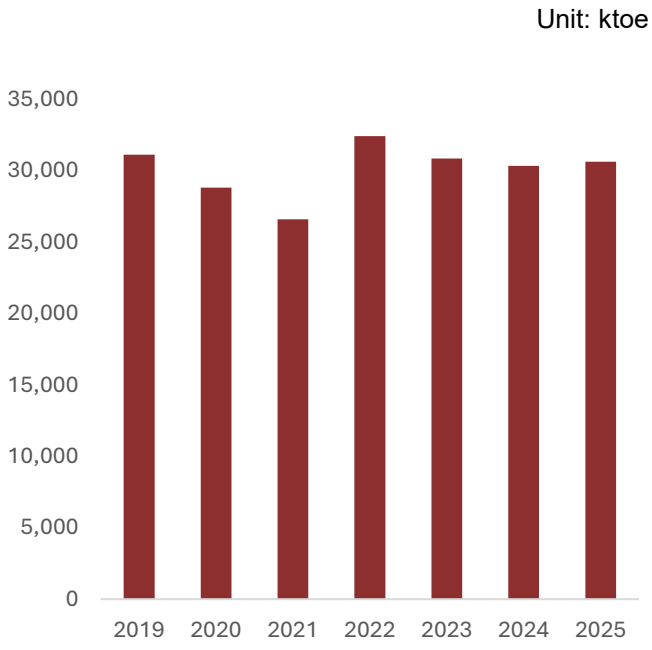
**Although Natural Gas is the primary fuel for Power Generation, Petroleum accounts for ~50% of Final Energy Consumption due to high demand in the transportation and industrial sectors*

Source: PDP2024 (Power Development Plan), Ministry of Energy

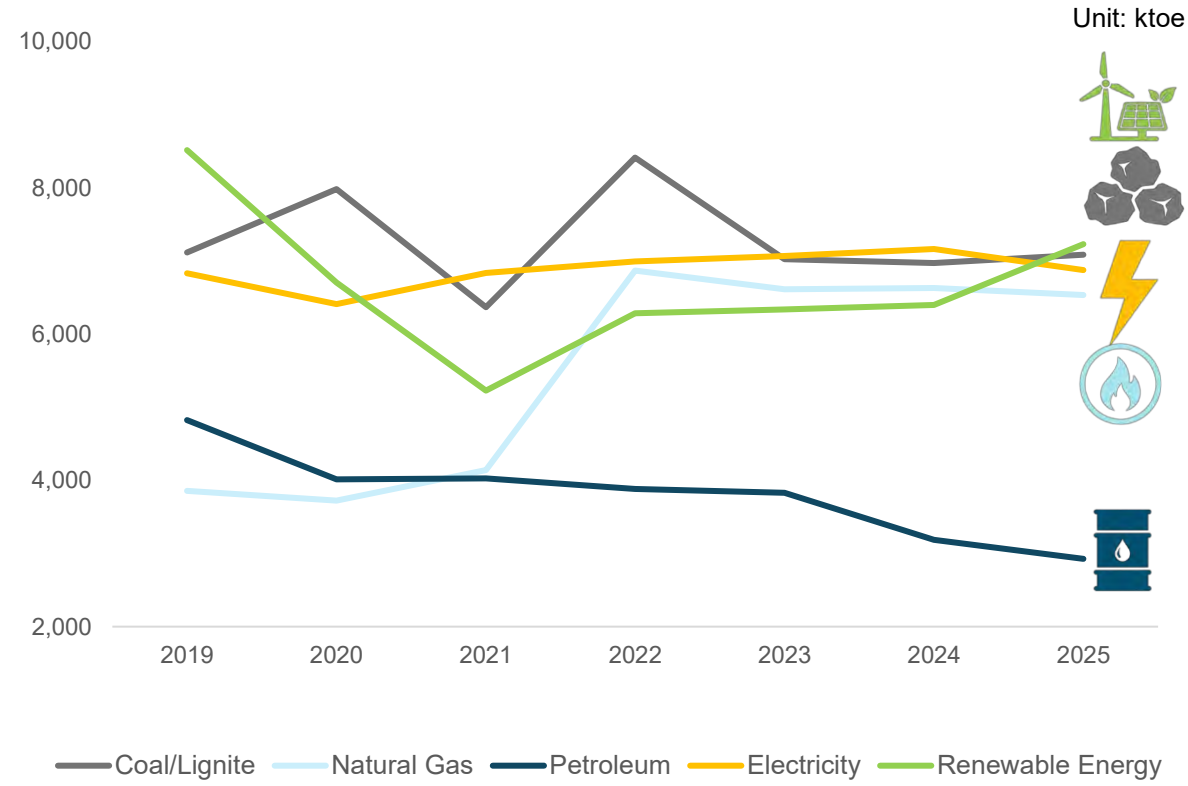
Thailand Industrial Energy Consumption

Industrial energy consumption shows a rising trend in renewable energy adoption, driven by industrial recovery and sufficient cash flow for investment, while coal & natural gas usage peaked post-COVID-19 due to their immediate availability

Industrial Energy Consumption Trend by Year



Industrial Energy Consumption Trend by Year and Fuel Type

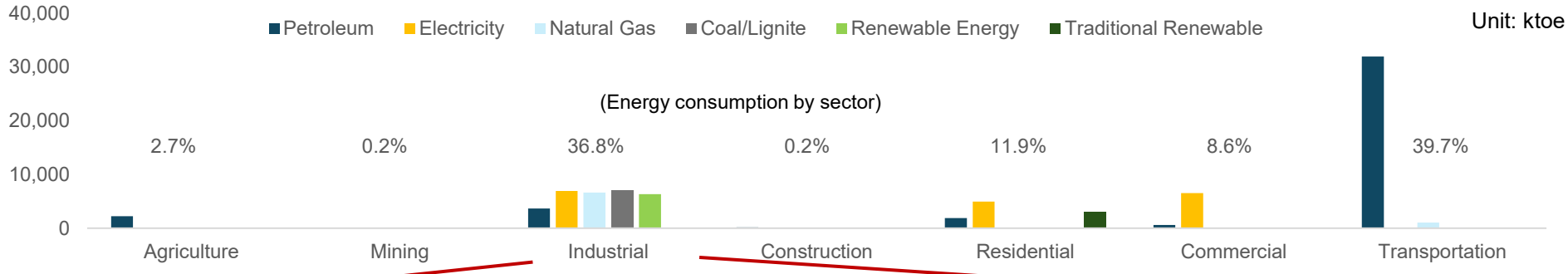


Source: DEDE

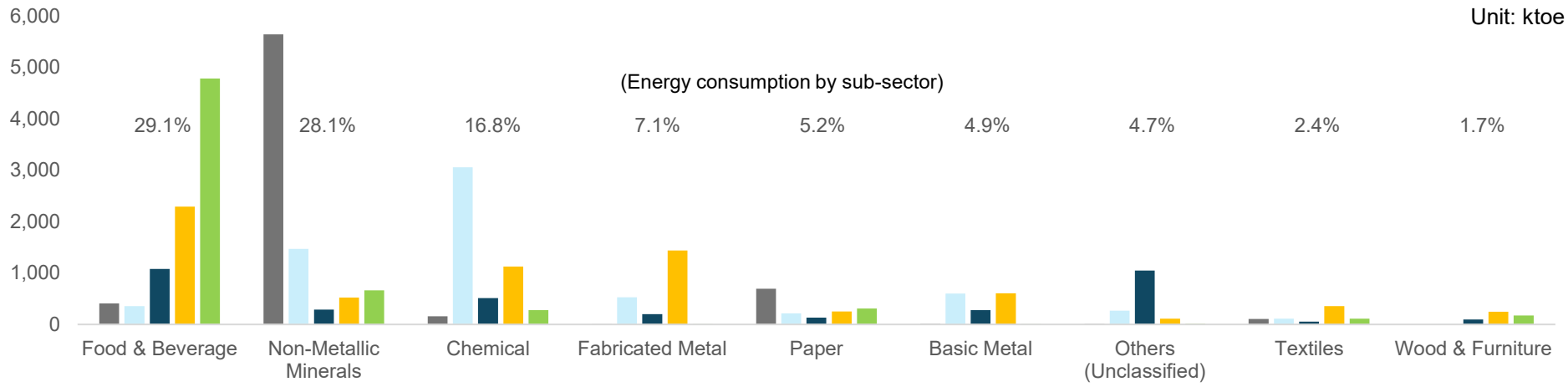
Thailand Energy Consumption by Industrial Sector

Food & Beverage and Non-metallic minerals have high manufacturing energy consumption, yet exhibit contrasting fuel profiles. Food & Beverage leverages renewables while non-metallic minerals remain coal-dependent

Thailand Energy Consumption by Sector and Source (2023)



Manufacturing Energy Consumption by Sub-sector and Source (2023)

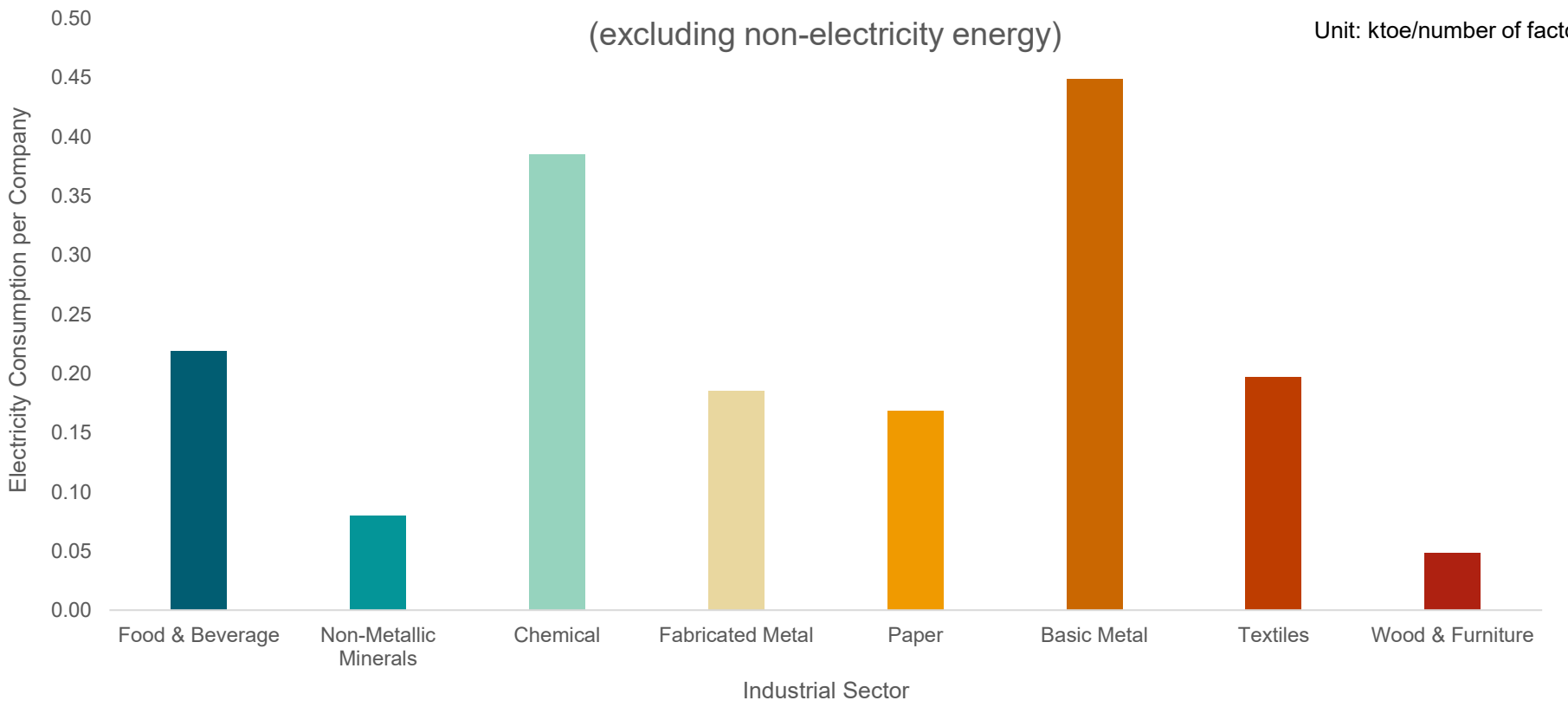


Source: DEDE; Current data as of April 2026

Electricity Efficiency by Industrial Sector

In terms of electricity, the Basic Metal and Chemical sectors exhibit the highest electricity consumption per company, significantly outpacing other industrial sectors in Thailand

Electricity Consumption by Company and Industrial Sector (2023)



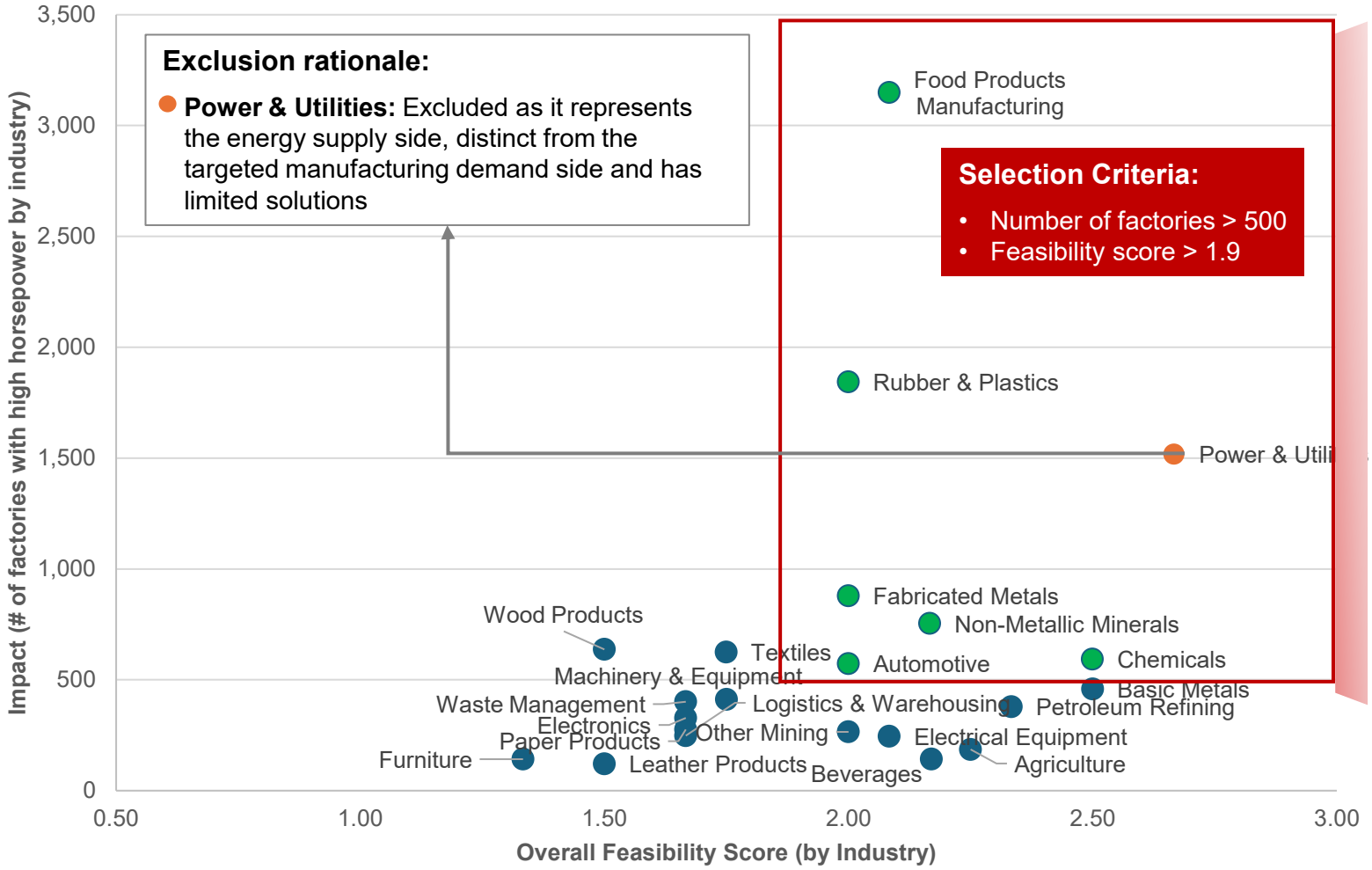
Remark: Fabricated metal consists of automotive parts, machinery and metal fabrication

Source: DEDE, DIW; Current data as of April 2026

Result of Target Industries with High Energy-saving Potential

Finalizing the Top 6 target industries by balancing high-volume impact (factory count) against strategic feasibility scores to ensure high potential for energy-saving solutions

Summary of target industry



6 industries
Food Products
Rubber & Plastics
Fabricated Metals
Non-Metallic Minerals
Automotive
Chemicals

Remark: For scoring criteria of each indicator, they will be shown in page 85 - 88. Category of each industry is referred to the definition from TSIC
Logistics & Warehousing was included in the selection as many warehousing facilities use chillers for temperature control, making them a target for energy-saving improvements.

Source: Analysis from current study

Selection and Prioritization Approach of Target Industries

Filtering Thailand's 35 industrial industries through impact and feasibility criteria to identify high-potential sectors for energy-saving solutions

All manufacturing industries in Thailand, as defined by the Ministry of Industry

- Agriculture
- Beverages
- Textiles
- Wood products
- Automotive
- Chemicals
- Basic metals
- Food products
- Electronics
- …

35 Industries

Criteria 1

Impact

- Energy consumption intensity
- Number of factories

Criteria 2

Feasibility

- Regulatory pressure
- Tech readiness
- Financial viability

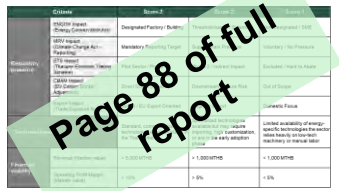
6 target Industries

1. Food Product
2. Rubber & Plastics
3. Fabricated Metals
4. Non-Metallic Minerals
5. Automotive
6. Chemicals

Filter for industries driven by regulatory pressure, high technology readiness and financial viability

Select high energy-consuming Industries with a large factory base to maximize widespread impact

**Detailed criteria*



Source: Ministry of Industry

Reference: Industry Prioritization Process

Prioritizing 35 industries down to the top 6 through impact x feasibility evaluation

Industry screening process

Impact

1 **35 industries** (First list)

Set 5 levels of horsepower ranges using a percentile distribution

Criteria:
- Cut-off by # of factories > 100

Unit: # of factories

Industry	Level 1	Level 2	Level 3	Level 4	Level 5
Percentile of horsepower of machine in factory	<20%	20 – 40%	40 – 60%	60 – 80%	>80%
Food Products	1,403	1,590	1,797	2,356	3,149
Rubber & Plastics	804	1,031	1,679	2,107	1,843
Power & Utilities	8	6	24	47	1,517
…	…	…	…	…	…

Feasibility

2 **22 industries** (Second list)

Unit: Score

22 industries (Second list)

Industry	Regulatory pressure					Tech readiness	Financial viability		Total score (AVG)
	ENCON	MRV	ETS	CBAM: Industry impact	CBAM: Export out of Thailand impact		Revenue	Operating profit margin	
Food Products	3	2	1	1	3	3	2	1	2.2
Rubber & Plastics	3	2	2	2	3	3	2	2	2.5
Power & Utilities	3	3	3	3	1	3	2	3	2.7
…	…	…	…	…	…	…	…	…	

3 **6 target industries**

Remark: The Feasibility score is a proprietary metric developed by the research team based on three core dimensions (Regulatory pressure, Tech readiness, and Financial viability) with detailed criteria and scoring definitions provided on the Full Report in page 85 - 87

Carbon Footprint Reduction Potential Calculation

By 2037, annual energy cost savings are estimated at 95 – 210 billion THB with carbon footprint reduction potential from energy saving being around 14.4 – 39.8 $MtCO_2e$

6 Target Industries
(% energy saving potential)

- Food Products: **28% - 33%**
- Rubber & Plastics: **Up to 22%**
- Fabricated Metals: **22% - 58%**
- Non-Metallic Metals: **13% - 54%**
- Chemicals: **Up to 21%**
- Automotive: **13% - 22%**

Manufacturing Sector (Scope 2)

Estimated Reduction Potential in 2037 Through Energy Efficiency Promotion (Relative to 2023 Energy Consumption)

Energy Cost Saving

95 – 210

Billion THB / year

from

Carbon Footprint Reduction Potential

from energy saving

14.4 - 39.8

$MtCO_2e$

National Target Based Estimation:
24.5 $MtCO_2e$

36%

Manufacturing

National Target (NDC 3.0)

Energy sector 2019 baseline **185.2** $MtCO_2e$

Energy sector 2019 baseline **117.1** $MtCO_2e$

The difference =

Energy sector emissions reduction

68.1 $MtCO_2e$

(36.8% reduction from 2019 baseline)

Calculation process:
[Energy Reduction]
1) Calculate energy reduction by industry and energy source (coal, natural gas, petroleum, electricity, renewables) using the formula:
   Formula: [Energy consumption by industry & source (ktoe) / 2023] × [Energy saving potential by industry (%)*]
   * For industries outside the 6 target sectors, the average potential of the 6 target sectors is applied
   * Calculated separately for minimum and maximum energy saving potential

[Energy Cost Saving]
2) Multiply the energy reduction from step 1) by [unit price per energy source (THB/ktoe) / 2025] to calculate cost savings by industry and energy source
3) Sum cost savings across all industries to estimate total manufacturing sector savings

[Carbon Footprint Reduction]
4) Multiply the energy reduction from step 1) by [GHG emission factor per energy source / 2025] to calculate carbon footprint reduction by industry and source ($MtCO_2e$)
5) Sum carbon footprint reductions across all industries to estimate total manufacturing sector reduction

Calculation process:
Assume target emission reductions are **proportional to manufacturing energy usage** (36%) of total energy consumption of all sectors

Source: UNFCC, EEP, NESDC, TGO, DEDE

Summary of Overview in Each Industry (1/2)

Industry	Energy cost per revenue	Energy intensity (MJ/USD)	Energy saving potential	Energy saving solutions examples
Food Products • GDP growth rate*: 4.7%	**SET** (avg) 2.6% Surveyed samples: 2 - 8%	**Thailand**: 7.2 **Japan**: 1.5 **US**: 4.8 **UK**: 2.5	28 - 33%	• **Heat leakage** is addressed by insulation jackets, reducing radiant heat **loss by up to 85%** • **Aging steam systems** are improved through electric drive conversion, **achieving 30 - 40%** fuel savings • **Inefficient refrigeration systems are** optimized with VFD retrofit and smart controls, **reducing electricity use by 20 - 30%**
Rubber & Plastics • GDP growth rate* : - 2%	**SET** (avg) 7.9% Surveyed samples: 7 - 30%	**Thailand**: 3.6 **Japan**: N/A **US**: 4.0 **UK**: 6.1	Up to 22%	• **Waste heat** is recovered using heat recovery systems, **saving 12.5% thermal energy** • **Fixed-speed motors** are upgraded with VFD/servo systems, **reducing** energy use **by 25%** • **Compressed air systems** are improved via piping overhaul, **cutting** energy costs **by 17.5%**
Fabricated Metals • GDP growth rate* : - 0.4%	**SET** (avg) 3.1% Surveyed samples: 1 - 11%	**Thailand**: 2.6 **Japan**: 0.7 **US**: 1.0 **UK**: 1.1	22 - 58%	• **Compressed air waste** is reduced by optimization and automation, cutting energy **loss by 50%** • **Heat generation** is improved through temperature optimization and heat recovery, **reducing fuel use by 20%** • **Emissions from high-emission gas-fired furnaces** are reduced by transitioning to Electric Arc Furnace, **reducing CO_2 by 40 - 70%**

Energy Intensity : Thailand: Electricity Consumption (EEP) / GDP (NESDC) Overseas data: IEA *Based on GDP 2015*

*GDP Growth Rate is calculated between 2021 - 2024
SET = Stock Exchange of Thailand

Summary of Overview in Each Industry (2/2)

Industry	Energy cost per revenue	Energy intensity (MJ/USD)	Energy saving potential	Energy saving solutions examples
Non-Metallic Minerals • GDP growth rate* : - 2.8%	**SET** (avg) 6.6% Surveyed samples: 17 - 23%	**Thailand**: 29.7 **Japan**: 9.3 **US**: 13.4 **UK**: 13.6	13 - 54%	• **Grinding energy consumption** is reduced through optimization by VFD installation and upgrade to IE3/IE4, **cutting** electricity use **by 30%** • **Kiln heat loss** is addressed with waste heat **recovery, generating 25 - 30%** of plant power • **Kiln efficiency** is improved using AI control, **reducing** fuel use **by 3 - 7%**
Chemicals • GDP growth rate* : - 2.4%	**SET** (avg) 4.9% Surveyed samples: 5 - 15%	**Thailand**: 2.9 **Japan**: 5.2 **US**: 6.8 **UK**: 2.9	Up to 21%	• **Exothermic heat loss** is reduced using a waste heat boiler, **capturing 45% of heat** • **Motor & pump losses** are reduced with VFD retrofit, **cutting** energy use **by 20 - 50%** • **Inefficient cooling towers** are improved with VFD upgrades, **saving 20 - 30% energy costs** (~1.3M ฿/year)
Automotive • GDP growth rate* : - 1.2%	**SET** (avg) 3.3% Surveyed samples: 2.5 - 6.5%	**Thailand**: 0.8 **Japan**: 0.8 **US**: 1.1 **UK**: 0.7	13 - 22%	• **Pneumatic pressure losses** are reduced with detection systems, **saving 7% compressor power** • **Peak-speed motor burnouts** are reduced with VFDs**, cutting** power use **by 50%** • **High daytime grid reliance** is reduced with solar PV, **offsetting 25% of peak electricity** (720,000 kWh)

Energy Intensity : Thailand: Electricity Consumption (EEP) / GDP (NESDC) Overseas data: IEA *Based on GDP 2015*

*GDP Growth Rate is calculated between 2021 - 2024

SET = Stock Exchange of Thailand

Example of Success Stories of Energy Saving Investment

Food Product	**CPF (Charoen Pokphand Foods)**	**CPF Chanthaburi, Thailand's first 100% Renewable Energy Farm, transforming waste into clean power for a Net Zero future** *2023 - 2025*
Rubber & Plastic	**Sumitomo Rubber (Thailand)**	**Sumitomo Rubber (Thailand) operates the group's largest virtually 100% renewable energy factory (zero-carbon electricity), powered by a 22 MW solar rooftop and I-RECs** *2023 - 2025*
Chemicals	**SCGC**	SCGC developed a **Phase Change Material (PCM)** solution that cuts cold storage electricity consumption by **15-20%**, with plans to scale across Thailand *2025*
Automotive	**SAT (Somboon Advance Technology)**	**SAT is driving sustainable operations through high-efficiency equipment and solar power integration** *2025*

Thailand Data Center Summary

Thailand's data center industry is expanding rapidly, driving increased investment in energy management solutions, including cooling systems, BESS, UPS, and EMS

Data Center Overview (Market Growth, Supply Chain)

Market Growth	• In 2025, 36 BOI-approved projects worth 728,000 MTHB were recorded, concentrated in Rayong, Chonburi, and Samut Prakan; for the 2026 Outlook, 7 large-scale projects with combined investment exceeding 96,000 MTHB have been approved for development • Facility support systems (cooling, UPS, BESS, EMS) account for ~12% of total data center CAPEX globally, representing a significant commercial opportunity for Japanese suppliers in Thailand • Thailand's data-center-specific cooling market is projected to grow at a CAGR of ~12% (2025 - 2031)
Supply Chain	• Upstream: Infrastructure providers (power, network, land) and hardware suppliers (servers, storage, IT equipment) • Midstream: Data center operators (facility management) and service providers (cloud, colocation) • Downstream: End users (financial institutions, government agencies)

Current Data Center Operator Players' Energy Management

Energy Security	• Thailand's grid moderately supports data center operations, but scaling requires infrastructure investment; tariff competitiveness and Direct PPA access remain key policy issues despite cost pass-through to customers
Energy Cost	• Electricity costs are contractually passed through to customers, insulating operators from electricity price volatility • Direct PPA access and tariff competitiveness remain key policy issues affecting operators' long-term cost planning
Energy Efficiency	• Thailand's data centers show some improving rooms in energy efficiency compared to Asia Pacific region • Operators prioritize maintenance quality and local support when selecting chiller or BESS providers; integrated EMS-chiller-BESS solutions represent a key differentiator for Japanese suppliers
Energy Environment	• Domestic renewable supply remains limited; operators are awaiting direct PPA legislation that would enable greater clean energy procurement • Thailand's relatively clean grid emissions profile is an advantage, but meeting hyperscalers' 100% clean energy targets requires accelerating direct PPA access

Source: BOI, IoT Analytics (2025), Mordor Intelligence (2025), Data Insights Market (2025), Krungsri Research, Datacentermap, Data center operator interview

Solution Category

Solutions are organized into 5 categories along the decarbonization value chain, covering energy savings from both cost and volume perspectives

Type	Category	Details	Solution example
Visualization	1 Digital & EMS	Visualizes energy data to track consumption and identify saving opportunities	• Energy dashboard • Carbon dashboard • EMS • IoT automation
Direct reduction of carbon footprint	2 Energy source	Replaces fossil fuels with renewable generation and energy storage systems	• Solar, Biomass, Wind • Hydrogen, BESS • EV adoption • Fuel switch (LPG → LNG)
	3 HVAC, lighting and temperature control	Optimizes thermal management to reduce energy load from heating and cooling	• Boiler, Chiller, Cooling tower • Cogeneration, Heat recovery • Efficient lighting
	4 Motor, mobility and automation	Improves operational efficiency of industrial machinery and automated lines	• Air compressor • Highly efficient motor • EV fleet
Indirect reduction of carbon footprint	5 Advanced process and circularity	Manages post-process emissions through carbon capture and waste recycling	• Wastewater treatment • CCU / CCUS / CCS

Note :Advanced process and circularity optimizes resource efficiency, significantly reducing the total energy required for production

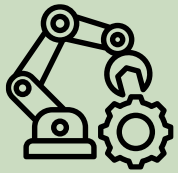
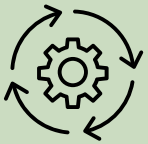
The solution framework is synthesized from IEA, IRENA, UNIDO and NEDO

Summary of Solution Category (1/2)

Category (Featured solution)	Market Overview (Featured solution)	Major players by country (Featured solution)	Solution Company Examples
1 **Digital & EMS (Carbon Dashboard)**	**CAGR** ***24.6%**** *2024 - 2033*	**Key drivers** • Mandatory reporting & ETS • Energy efficiency investment demand • CBAM	***Japan*** Strategic B2B partnerships targeting local large enterprises ***USA & EU*** Building credibility through global standards ***Thai*** Local startups specialize in Thai regulatory requirements	***ZEROBOARD (THAILAND) CO., LTD*** **Unique selling points** • End-to-end ESG platform • CFO and environmental item reporting • ERP/API integration and supplier portal **Purchasing barriers** • Availability of free tools with limited functions • Investment deferred until the relevant law is enacted • High cost of infrastructure
2 **Energy Source (BESS)**	**CAGR** ***17.3 %*** *2024 - 2032*	**Key drivers** • Peak demand reduction • Tax incentives • Data center demand	***Japan*** Technical superiority, regulatory support, integration focus ***China*** Cost leadership, Innovation driven ***Thai*** Local expertise, system integrator	***Hitachi Asia CO., LTD.*** **Unique selling points** • Japanese quality standard at competitive prices • BESS + EMS bundle, no subscription fee • Scalable product lineup **Purchasing barriers** • Long ROI payback • Cost pressure from import tariff • Lack of cost-effectiveness
3 **HVAC, lighting and temperature control (Chillers)**	**CAGR** ***6.3 %*** *2026 - 2033*	**Key drivers** • Data center growth • Updated EEP (Energy Efficiency Plan) • BEC Regulation	***Japan*** Compete on premium product quality ***China*** Cutting-edge technology at low cost ***USA & EU*** Prioritize ultra-high energy efficiency and low-GWP	***Mitsubishi Heavy Industries (Thailand) LTD.*** **Unique selling points** • Proven delivery track record • Wide range of chiller & refrigerant lineup • Improvement of system COP **Purchasing barrier** • Overall assessment • Local HFC refrigerant phase-down schedules • Japan's subsidy reporting requirement

EMS: Energy Management System | BESS: Battery Energy Storage System | EEP: Energy Efficiency Plan
CBAM Carbon Border Adjustment Mechanism | ERP: Enterprise Resource Planning
API: Application Programming Interface | JIS: Japanese Industrial Standards
*CAGR is APAC's value

Summary of Solution Category (2/2)

Category (Featured solution)	Market Overview (Featured solution)	Major players by country (Featured solution)	Solution Company Examples
4  **Motor, mobility and automation (Air compressor)**	**CAGR** ***3.7 %*** *2024 - 2030* **Key drivers** • JCM subsidy • Green Audit Requirement • MEPS for Air Compressors	***Japan*** Durability, User-friendly design, leveraging Japanese networks in Thailand ***China*** Network drives rapid market expansion through attractive dealer margins ***USA & EU*** Focus on long-term value. High initial cost offset by VSD technology	***ANEST Iwata Southeast Asia CO., LTD.*** **Unique selling points** • IE5 PM motor & larger air-end design • Oil-cooled stability in high-temperature environments • Early ROI through proven energy savings **Purchasing barriers** • Initial price over energy savings • Thai companies waiting for government support
5  **Advanced process and circularity (Water treatment chemicals)**	**CAGR** ***5.9 %*** *2025 - 2033* **Key drivers** • Water resource security • BOI Incentives • Water recycling demand	***Japan*** Provide end-to-end service, from initial design through to maintenance ***USA & EU*** Market leadership through patented technologies in specialty chemicals and more ***Thai*** Expertise in local regulations	***Aqua Nishihara CORP. LTD.*** **Unique selling points** • Biological wastewater treatment • High energy saving efficiency • Full service & local capabilities **Purchasing barriers** • Greater focus on price than quality • Lack of urgency • Challenges in sunk cost recognition

IE5: International Efficiency Class 5
PM: Permanent Magnet

Challenges in adoption and strategies: Summary

Each category faces distinct hurdles, but pricing disadvantage and ROI constraints are key challenges common across all categories

	Low urgency & Demand	Pricing disadvantage & ROI constraints	Human capacity & technicals issues	Others (E.g., unaware of solutions etc.)
1 Digital & EMS	• **Unwilling to pay** for products that don't affect production capacity • **Perceive no urgency** without regulations	• **High upfront costs** result in low ROI and longer payback periods • **Intense price** competition from other countries brands and **strong local** competition creates market entry barriers • **Commodity mindset limits** adoption of premium solutions		
2 Energy source				
3 HVAC, lighting and temperature control				• **Lack of data/awareness** regarding long-term savings, low prioritization • **Difficult** engineering required to retrofit old factories
4 Motor, mobility and automation	• **Limited preventive maintenance culture**			• **Japanese brands lack local customer networks** • **Existing factory inefficiencies** hide the potential gains (technology)
5 Advanced process and circularity	• **Wastewater treatment** is viewed merely as a **compliance cost rather than a value driver**, deprioritizing investment	• **Bio & CCUS** seen as financially unviable solutions	• **Specialized maintenance requirements and complex implementation** make scalable models (like leasing/rental) difficult	

Strategic Recommendations – National Overview

Japanese providers should enter via niche first-mover solutions, then expand to holistic offerings, leveraging quality trust and system integration to differentiate from low-cost competitors

Plan A "Niche First-Mover to Cross-Sell"

Plan B "Integrate to Add Value"

High cost

JP Players (Plan A)

Find a specific pain point, establish a **"First-Mover" specific function**, and then expand/cross-sell to offer holistic solutions

USA & EU Players

Focus on offering high-quality products with strong brand reliability and trust, reinforcing a premium and credible market positioning

Procure cost-effective CN components and **"Add Value"** through system integration

JP Players (Plan B)

Being end to end service provider in the market offering comprehensive, high-end integrated solutions (e.g., Dashboard + Chiller systems)

Individual

Holistic

Thai Local Integrators

Provide holistic system integration at a more accessible price point compared to JP by combining various affordable components

CN Products

Cost-effective, standalone components or specific hardware. Focus on price competitiveness rather than system integration

Low cost

Source: Current study analysis
Note: There are few Thai local brands e.g., Bangkok Industrial Boiler, Kulthorn Kirby, etc.

Strategic Recommendations – Overview

	Key Recommendations		
	Holistic Positioning through Bundling and Integration	**Leveraging Government Support Measures**	**Hidden cost transparency**
1 Digital & EMS	• Capture **carbon + supply chain compliance revenue** • Ensure compliance with **Thai regulations** & **standard hardware** • **Customize** offering to maximize client fit	• Catalog all **Thai** (BOI, DEDE, etc.) and **Japanese** (JBIC, NEDO, etc.) incentives, and financing programs; build a **matching function** to identify programs suited to each factory	
2 Energy source	• Scale **integrated Solar + EMS + monitoring** as a **turnkey business proposal**	• Japanese programs cover **technology demonstration and market entry**; Thai programs cover **market development and regulatory framework**. Together they establish Japanese technology in Thailand and expand the energy saving market. • Initially, solution providers incorporate subsidies into integrated proposals to **shorten payback and reduce adoption risk** for factories; as track records grow, they transition to **self-sustaining sales** driven by proven capabilities	
3 HVAC, lighting and temperature control	• Unlock efficiency by integrating **chillers and cooling towers** with EMS		• **Conduct energy audits** to uncover hidden operational costs such as excess energy consumption, heat loss, and inefficient equipment utilization • **Quantify cost-saving opportunities** from heat recovery and phased equipment upgrades to build a clear business case for tailored solutions
4 Motor, Mobility, and Automation	• **Conduct a system diagnostic** to identify issues and **propose an efficient package** (e.g., energy-saving compressor air treatment package)		
5 Advanced Process and Circularity	• Capture value through **integrated wastewater treatment** and **carbon accounting**	• **Partner with Japanese government programs** to pilot and develop **publicly-supported low-carbon technologies**	

Gap Analysis Framework

Gaps and recommendations are categorized into four key areas

Energy generation and storage

Clean energy production and BESS deployment for reliable supply

Grid and flexibility infrastructure

Energy transmission infrastructure with grid modernization & flexibility

Optimizing energy usage

Optimizing energy usage in factories and buildings with technology and regulation

Market enablement

Financing, incentives, and partnerships to drive market adoption

Gaps in Thailand: Summary

Thailand's energy efficiency gains are held back by a fossil-heavy supply mix, an inflexible grid without smart infrastructure, absent demand-side tools and weak building/equipment codes, and gaps in carbon pricing, green finance, and skilled workforce

A Energy generation and storage

- **Fossil-heavy power mix:** 72% fossil-fueled electricity, emissions must fall by 47% by 2035, yet solar/wind stands at only 4.2% despite solar cost parity since 2022
- **Climate change risks to external power sources:** The plan to double hydropower imports from neighboring countries raises concerns over increased supply chain risks stemming from droughts and other climatic factors
- **Energy storage gap:** 11.8 GW of battery storage needed by 2037, yet the current baseline of operational utility-scale is roughly 0.3 GW

B Grid infrastructure

- **State monopoly control:** Grid development strictly controlled by state entities with limited mechanism for private capital to enter
- **Lacking smart capabilities: Deficient** smart meters or node-level monitoring
- **Grid code not VRE-ready:** Code lacks harmonization among state-owned utilities, lack of flexibility pricing prevents competitive purchasing of back up power from private developers

C Optimizing energy usage

- **Limited demand-side tools and consumer incentives:** Rigid TOU structures, no dynamic pricing, and low smart meter penetration limit incentives to shift energy use. DER aggregation, VPP, demand response, and V2G frameworks lack the regulatory and commercial platforms for scale
- **Low digital/AI adoption:** Conventional operations persist with weak incentives for technology uptake and a lack of skilled digital workers
- **Slow efficiency gains:** Thailand's improvement is half of COP28's target of 4% per year, and slower than developing countries like India (>4%)
- **Weak equipment & building codes:** Low motor standards (60% of manufacturing power), insufficient enforcement of building energy codes for smaller structures amid rising AC ownership
- **Unclear data center regulation:** No concrete PUE benchmarks or energy efficiency standards for data centers

D Market enablement

- **Insufficient carbon pricing & absence of climate legislation:** Weak carbon pricing and underpriced taxes limit private capital for decarbonization while The Climate Change Act has not been enacted yet
- **Investment gap:** Over USD 65B needed, yet regulatory barriers deter capital investment and SMEs favor short-term payback
- **Workforce shortage:** Insufficient energy efficiency expertise; SMEs lack benchmark data for energy-saving decisions
- **Green finance remains inaccessible**: concentrated among large firms, while SMEs lack access. The market is shallow, costly, and highly concentrated in energy and financing service)

Thai Government Recommendations: Summary

Thailand must accelerate action across clean energy, grid infrastructure, energy efficiency, and market enablers to achieve its carbon neutrality and energy transition goals

A Energy generation and storage

- **Deploy energy storage at scale:** Target 11.8 GW battery and 20 GWh pumped hydro by 2037 to absorb variable RE output
- **Diversify the energy source:** Develop biogas, geothermal, SMR nuclear, and cross-border RE
- **Accelerate solar & wind energy:** Solar is already 40 - 60% cheaper than new gas plants. Utilize competitive bidding and faster permits to scale up quickly
- **Liberalize via direct PPA:** Expand third-party access by 2030 to enable corporate clean-energy procurement

B Grid & flexibility infrastructure

- **Upgrade to smart grid standards :** Introduce node-level monitoring and **deploy grid-enhancing technologies** to bypass the 5 - 15 years expansion bottleneck
- **Publish transparent grid capacity data:** To unlock capacity
- **Update MEA/PEA grid codes:** To include BESS/inverter standards and VRE ramp-rate requirements, to be piloted via the ERC Sandbox before national rollout

C Optimizing energy usage

- **Deploy TOU tariffs & demand response:** Introduce real-time pricing and load-shifting incentives to flatten peak demand
- **Adopt digital/AI energy management:** Enable real-time optimization across manufacturing and commercial facilities
- **Raise industrial energy efficiency standards:** Mandate IE3 motors, ISO 50001 adoption for targeted large energy consumers
- **Strengthen building codes & cooling:** Enforce AC MEPS and pilot district cooling systems
- **Set data center energy standards:** Establish PUE benchmarks

D Market enablement

- **Enforce carbon pricing & climate legislation:** Pass the Climate Change Act by 2026
- **Financial support to drive investment:** Provide soft loans, credit guarantees
- **Unlock capital flows for clean energy:** Support green finance for energy efficiency / clean energy investment
- **Business matching:** Build an online platform and organize business matchmaking events
- **Skill development:** Develop training programs to build workforce capacity

Roadmap for support energy-savings: Summary

The urgent immediate actions required are finalize direct PPA, enact Climate Change Act and partnership, as these are the critical foundations for building upon other policies

	Recommendation	Short Term (0-3 Years)	Medium Term (3-10 Years)	Long Term (10 Years +)
A. Energy generation and storage	Scale up energy storage deployment through auctions		●	
	Diversify energy resources		●	●
	Accelerate renewable energy deployment (Solar & Wind)	●	●	
	Liberalize market through Direct PPA	●	●	●
B. Grid Infrastructure	Modernizing the grid with smart technology	●		
C. Optimizing energy usage	Expand TOU tariffs and demand response programs	●	●	
	Utilize digital technology and AI for energy optimization	●	●	
	Enhance manufacturing energy efficiency standards		●	●
	Strengthen building energy codes and cooling efficiency		●	
	Set energy efficiency standards for data center	●	●	
D. Market enablement	Enforce carbon pricing and enact climate change legislation	●	●	●
	Financial support for energy efficiency investment	●	●	
	Unlock capital flows for clean energy transition		●	●
	Support business matching	●		
	Support energy efficiency skill development	●		

Roadmap for Japan-Thailand Collaboration

Japan and Thailand could collaborate on a long-term basis by combining financial support with market creation efforts, including regulation, human capability development, and technology transfer

Market creation	Short Term (0-3 Years)	Medium Term (3-10 Years)	Long Term (10 + Years)
Finance	Technology 1: Development phase; Commercial Phase	Technology 2: Development phase; Commercial Phase	Technology 3: Development phase; Commercial Phase
Regulation	**TH:** Mandate energy efficiency standards for priority industries Example • Enforce the Climate Change Act to set binding sectoral targets	**JP:** Share knowledge on some regulations design and carbon pricing mechanisms (e.g., Japan's GX-ETS, J-Credit scheme) **TH:** Develop and introduce rules & regulations carbon pricing mechanisms Example • Tighten MEPS for industrial equipment • Launch a pilot ETS (~2029)	
Human capability	**JP:** Share knowledge through training, expert visits, and case study workshops	**JP & TH:** Set up joint research labs or education hubs for technology development and knowledge transfer Example • Integrate university curriculum • Cross-border engineer exchange programs	
Technology		**JP & TH:** Co-research frontier technologies and align bilateral standards Example • Green hydrogen, SMR, and low-carbon tech	

Development phase

JP: Support market expansion for Japanese solution providers with emerging technology not yet widely adopted
TH: Provide complementary resources such as facilitating pilot testing, regulatory sandbox, and dedicated sites for demonstration projects

Commercial phase

JP: JBIC and other public finance act as catalytic capital, crowding in private investment
TH: Fund adoption of proven, market-ready technology for those who need funding support (e.g., SMEs, prioritized industries)

Recommendation for collaboration between Japan - Thai: Overview (1/2)

JBIC

Five collaboration mechanisms across Thai and Japanese stakeholders to strengthen energy conservation outcomes through coordinated action

	Role of key stakeholders					Differentiate point
	Thai government	Factory	Financial institution	Solution provider	Japan government	
Seminars & Training • To increase skills & knowledge	• **Bridge business needs** with Japanese Government support • **Fund energy conservation initiatives** • **Drive regulator changes**	• **Attend training** and apply at factory level	• **Educate on ROI** & bankability • **Provide** financial literacy on **green financing**	• **Deliver structured training programs** • Deploy technical **experts for on-site capacity** building	• **Bridge business needs** with Thai Government support • **Fund energy conservation initiatives** • **Deliver structured training programs**	• **Provide practical skills** not just theory, through a structured curriculum • **On-site training** at Thai factories using best practices
Matching event • To create new business partner	• Coordinate with DEDE and BOI **on investment incentives** • **Provide tax and non-tax instruments** to encourage participation	• **Participate in matching** events with clear technical needs and budget information • **Leverage AZEC-SAVE Platform** to discover partners efficiently	• Provide **financial advisory** services • Leverage client network • Offer pre-approved financial packages	• **Participate matching** between demand and supply stakeholders both of onsite & online • **Leverage AZEC-SAVE Platform** for seamless coordination in the future	• Coordinate with DEDE and BOI **on investment incentives** • **Provide tax and non-tax instruments** to encourage participation	• **On-site and online matching events** to maximize business matching opportunities

Recommendation for collaboration between Japan - Thai: Overview (2/2)

Five collaboration mechanisms across Thai and Japanese stakeholders to strengthen energy conservation outcomes through coordinated action

		Role of key stakeholders					Differentiate point
		Thai government	Factory	Financial institution	Solution provider	Japan government	
Project based support	To encourage investments in high-efficiency technology	• **Offer tax & non-tax incentives** for energy efficiency equipment • **Fund adoption** of proven, market-ready technology and support Thai SMEs in financing	• **Receive support** for energy efficiency equipment & services	• **Provide green loans** for high technologies with strong investment viability • **Develop sustainability-linked loans** (SLL) • **Provide** financial literacy on **green financing** • Provide **financial advisory** services	• **Expand client base** for energy efficiency service	• **Provide supports to Japanese solution providers** • **Support market expansion** for Japanese solution providers with emerging technology not yet widely adopted	• **Multiple co-funding sources** (e.g., JBIC, Thai banks) to broaden access and reduce risk
	To develop new energy-saving innovation	• **Co-invest** in technology demonstration projects for Thai industry • **Support joint labs** between Thai and Japanese universities	• **Provide resources for developing solutions** for Thai business • Share data for MRV & impact evaluation		• **Share energy-saving data** for MRV & impact evaluation • **Develop energy-saving solutions** tailored to Thai industrial contexts	• **Co-invest in new technology and demonstration projects** • **Support joint labs** between Thai and Japanese universities	• **Built-in path** from energy-saving demo to commercial-scale deployment
	To provide a sandbox for data sharing & testing	• **Establish regulatory sandboxes** • Provide resources for pilot • **Link industry data with R&D**	• **Share data for R&D** and **pilot new innovations**		• **Leverage Thai business data** for R&D and innovation	• **Establish regulatory sandboxes** for Japanese solution providers • Provide resources for technology testing • **Link industry data with R&D development**	• Dedicated **regulatory sandbox** • **Fast-track permits** & data sharing

Policies and Regulatory Framework
Current Energy Consumption
Quantitative Potential
Japanese Energy-Saving Technologies
Policy Recommenda-tions
Future Vision