

Evidence-Based Evaluation on Industrial Decarbonization in Thailand:

From Past Performance to Net Zero Target



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1

Energy Consumption and efficiency: at-a-glance

Overview of Final energy consumption and regulation

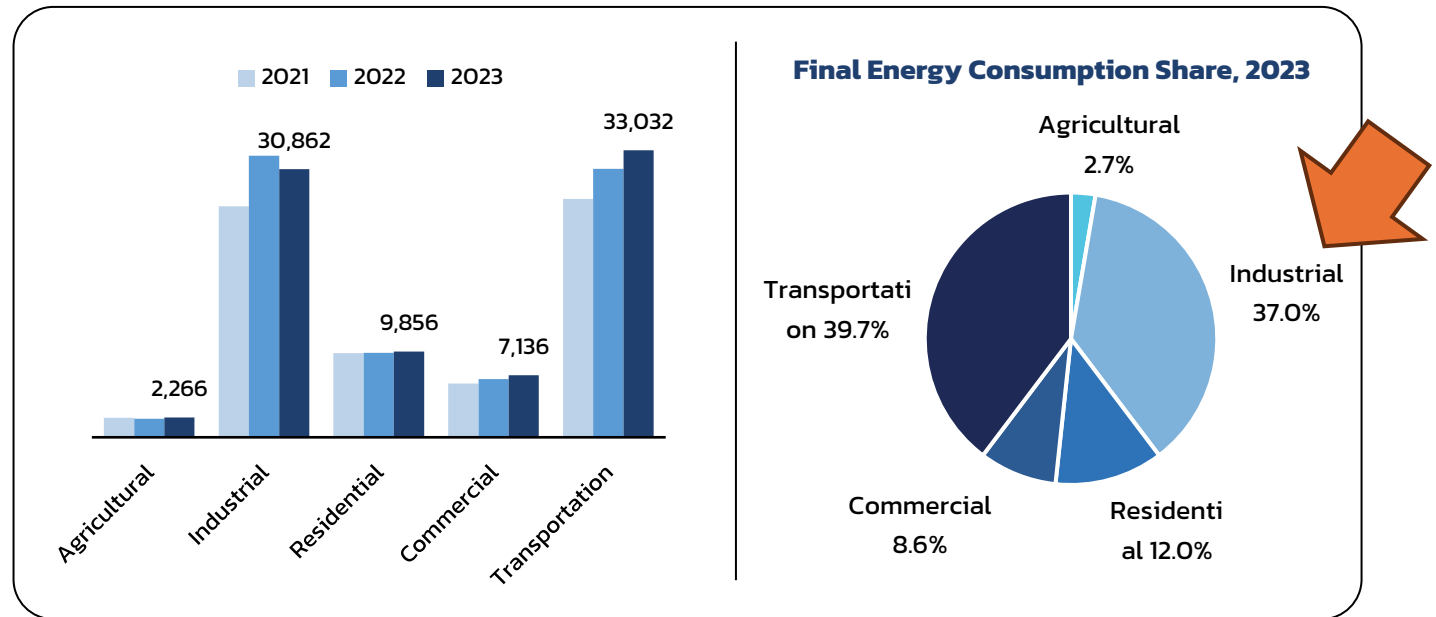
1. Energy Consumption in Thailand's Industrial Sector

Final Energy Consumption by Economic Sectors 2023

Final Energy Consumption by Economic Sector	Quantity (ktoe)			Growth (%)	
	Year	2021	2022	2023	
1. Agricultural		2,234	2,152	2,266	(3.7) 5.3
2. Industrial*		26,598	32,438	30,862	22.0 (4.9)
3. Residential		9,675	9,725	9,856	0.5 1.3
4. Commercial		6,194	6,706	7,136	8.3 6.4
5. Transportation		27,460	30,927	33,032	12.6 6.8
Total		72,161	81,948	83,152	13.6 1.5

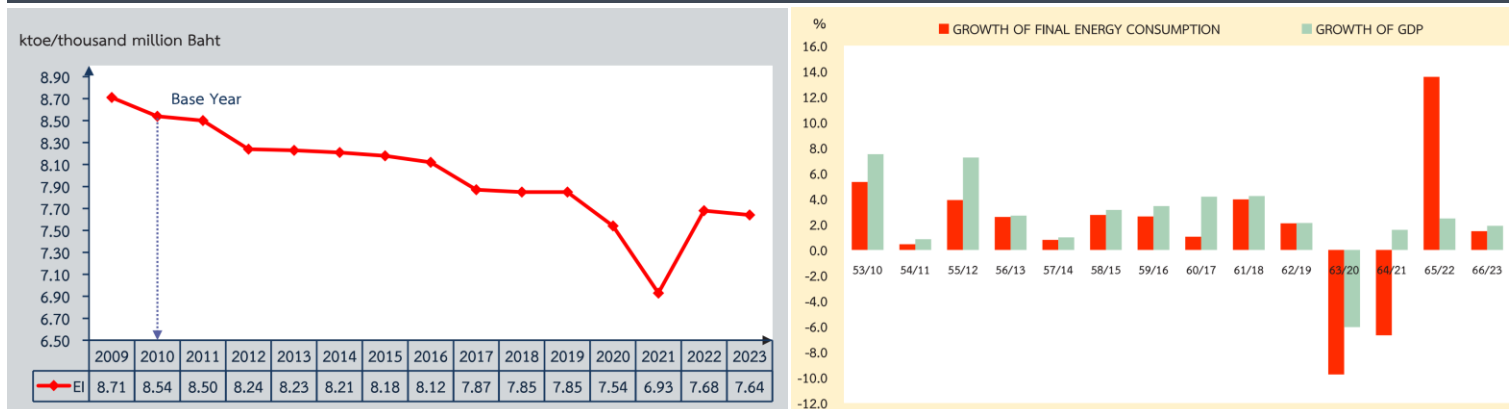
* Industrial including manufacturing (30,600 ktoe), mining (125 ktoe) and construction (137 ktoe).

Source : ENERGY BALANCE OF THAILAND 2023, The Department of Alternative Energy Development and Efficiency (DEDE)



The industrial sector consumed 30,862 ktoe of final energy, accounting for **37%** of the TFEC — the second-largest energy sector, just after the transport sector. However, it's in decline trend.

Energy Efficiency Improvement 2023



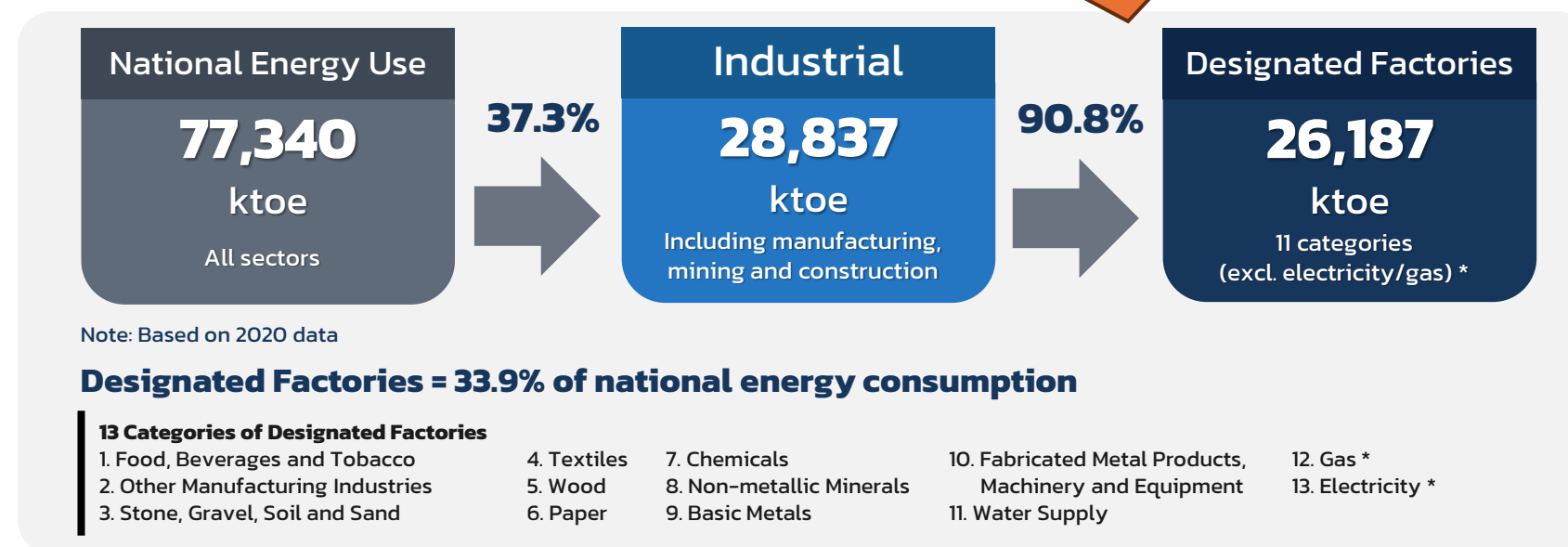
Source : ENERGY BALANCE OF THAILAND 2023, The Department of Alternative Energy Development and Efficiency (DEDE)

- Thailand's energy efficiency policy is guided by the **National Energy Efficiency Plan 2018–2037**.
- The plan aims to **reduce Energy Intensity (EI) by 30% by 2037**, compared with the 2010 baseline.
- Key measures include financial support and incentives for energy conservation, renewable energy, and research and development projects.
- The government also promotes public awareness and provides energy efficiency training.
- By 2023, Thailand's Energy Intensity had decreased by **7.64% compared with 2010**, indicating progress toward the national target.

Thailand's Designated Factories

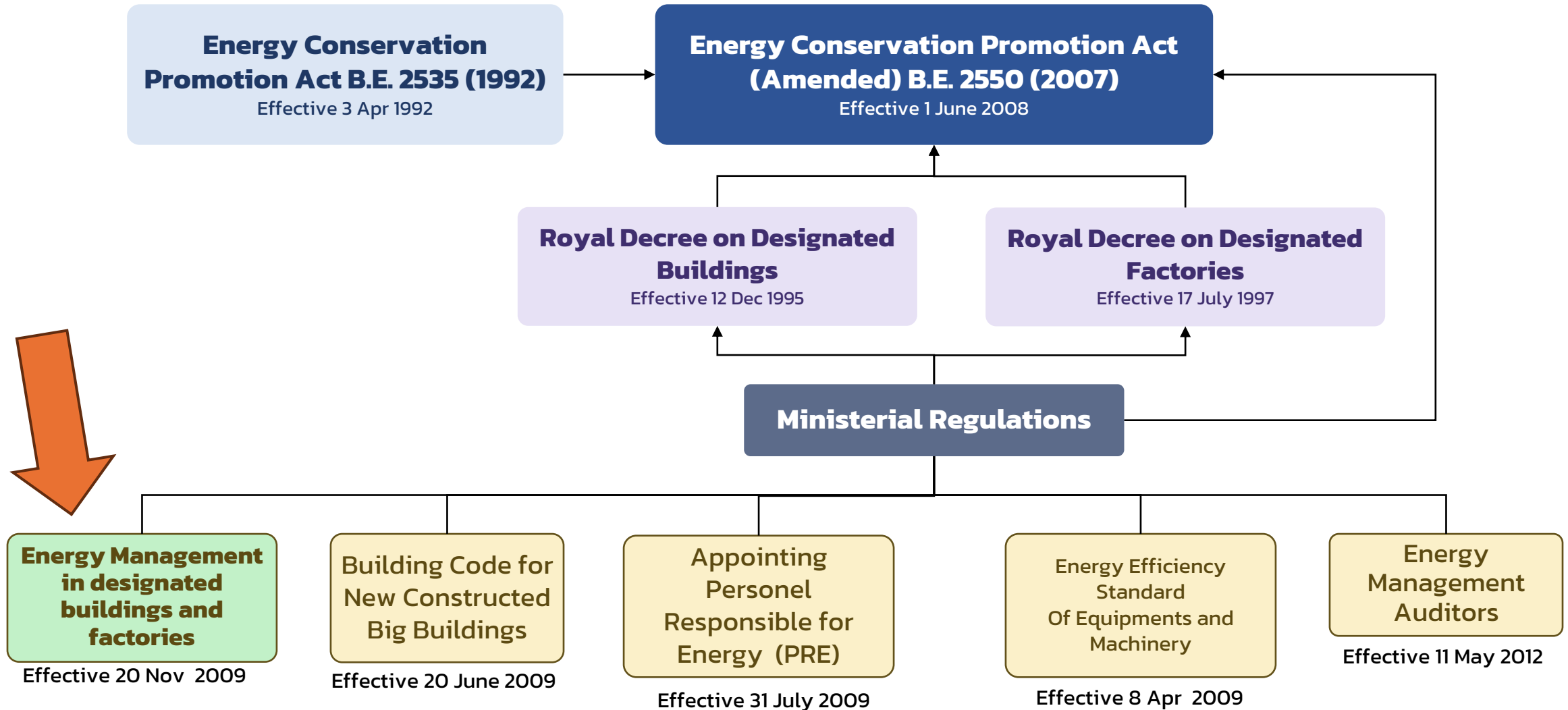
Criteria for a Designated Factory

- Transformer size from or above 1,175 kVA or
- Electrical power demand from or above 1,000 kW or
- Total energy consumption equivalent to at least 20 million MJ per calendar year



2. The Regulatory Framework

ENERGY CONSERVATION PROMOTION ACT, B.E. 2535 (1992) (as amended 2007)



Source: DEDE (Translated by author)

2

Net zero GHG:

Role of EE to achieve climate target

Impact of energy efficiency measure in national action plan

GHG Emission Mitigation Target by 2030 by Sector — Thailand's **NDC Mitigation Action Plan**

Sector	GHG emission mitigation target by 2030					
	Domestic action		International support ^a			
			Under implementation ^b		To be mobilized	
	MtCO ₂ e	%	MtCO ₂ e	%	MtCO ₂ e	%
1. Energy	124.6	22.5	–	–	32.0	5.8
2. Transport	45.6	8.2	–	–	2.5	0.4
3. Waste management	9.1	1.6	–	–	1.9	0.3
4. Industrial Processes (IPPU)	1.4	0.3	0.1	0.02		
5. Agriculture	4.1	0.7	1.0	0.18		
Total	184.8	33.3	1.1	0.2	36.4	6.5
			37.5 MtCO ₂ e or 6.7%			
			222.3 MtCO ₂ e or 40%			

Note :

^a International support may be provided in any form — for example, grants or soft loans — with implementation results that can be concretely assessed as greenhouse gas emission mitigations.

^b Maximum achievable greenhouse gas emission mitigation target.

Source: Thailand's NDC Action Plan on Mitigation 2021–2030 (December 2024 edition), <https://www.dcce.go.th/datacenter/653/>



GHG Emission Mitigation Target

Thailand's NDC Action Plan on Mitigation 2021–2030



ก-๑ มาตรการและเป้าหมายการลดก๊าซเรือนกระจกประจำปี สาขาพลังงาน

มาตรการ	เป้าหมาย (MtCO ₂ e)									
	๒๕๖๔	๒๕๖๕	๒๕๖๖	๒๕๖๗	๒๕๖๘	๒๕๖๙	๒๕๗๐	๒๕๗๑	๒๕๗๒	๒๕๗๓
สาขาพลังงาน										
๑. กลุ่มมาตรการอนุรักษ์พลังงานและการเพิ่มประสิทธิภาพการผลิตพลังงาน										
๑.๑. การบังคับใช้มาตรฐานการอนุรักษ์พลังงานในโรงงาน/อาคารควบคุม	๐.๗๐๐๐	๑.๓๐๐	๒.๒๒๘	๒.๗๕๘	๔.๐๘๐	๕.๒๖๐	๕.๔๑๐	๕.๕๖๐	๕.๗๑๐	๕.๘๖๐
๑.๒. การบังคับมาตรฐานอาคารก่อสร้างใหม่เพื่อการอนุรักษ์พลังงาน	-	-	-	-	-	๐.๓๕๐๐	๐.๔๒๐๐	๐.๔๙๐๐	๐.๕๖๐๐	๐.๖๓๐๐
๑.๓. การกำหนดมาตรฐานและติดฉลากอุปกรณ์เครื่องใช้และวัสดุเพื่อการอนุรักษ์พลังงาน (Labeling)	๐.๔๕๐๐	๑.๓๖๘๐	๒.๒๒๒๐	๒.๘๗๕๐	๔.๓๓๒๐	๖.๒๓๐๐	๖.๗๗๐๐	๗.๓๑๐๐	๗.๘๖๐๐	๘.๔๑๐๐
๑.๔. การบังคับใช้เกณฑ์มาตรฐานการอนุรักษ์พลังงานสำหรับผู้ผลิตและจำหน่ายพลังงาน (EERS)	-	-	-	-	-	๐.๑๕๕๐	๐.๑๖๘๐	๐.๑๘๑๐	๐.๑๙๔๐	๐.๒๐๗๐
๑.๕. การช่วยเหลือ/อุดหนุนการดำเนินงานเกี่ยวกับการอนุรักษ์พลังงาน	-	-	-	-	-	๖.๘๗๐๐	๗.๔๑๐๐	๗.๙๕๐๐	๘.๕๐๐๐	๙.๐๕๐๐
๑.๖. การเพิ่มประสิทธิภาพการผลิตพลังงานไฟฟ้า	๔.๕๕๐๐	๓.๕๐๐๐	๔.๐๐๐๐	๔.๕๐๐๐	๖.๐๐๐๐	๖.๕๐๐๐	๗.๐๐๐๐	๗.๕๐๐๐	๘.๐๐๐๐	๘.๕๐๐๐

A-1 Annual GHG Emission mitigation Target — Energy Efficiency measures

Measure	Target (MtCO ₂ e)									
	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Energy Sector										
1. Energy conservation and energy efficiency improvement measures										
1.1 Enforcement of energy conservation standards in designated factories/buildings	0.7000	2.310	2.628	2.958	5.080	5.260	5.410	5.560	5.710	5.860
1.2 Enforcement of energy conservation standards for new building construction	-	-	-	-	-	0.3400	0.4200	0.4900	0.5700	0.6600
1.3 Standards and labeling of equipment, machinery and materials for energy conservation (Labeling)	0.8500	1.9680	2.2620	2.8740	4.3920	6.2300	6.8700	7.7100	8.4700	9.6300
1.4 Enforcement of energy efficiency resource standards for energy producers and distributors (EERS)	-	-	-	-	-	0.1550	0.1620	0.1850	0.1890	0.2020
1.5 Assistance/subsidies for energy conservation activities	-	-	-	-	-	6.8900	7.1800	8.0400	8.4900	9.0400
1.6 Improving electricity-generation efficiency	5.1400	3.5000	4.0000	5.5000	6.0000	6.5000	7.0000	7.5000	7.5000	8.0000

Note: “-” indicates that the measure had not yet produced GHG-mitigation results in that year.

Source: Thailand's NDC Action Plan on Mitigation 2021–2030 (December 2024 edition), <https://www.dcce.go.th/datacenter/653/>

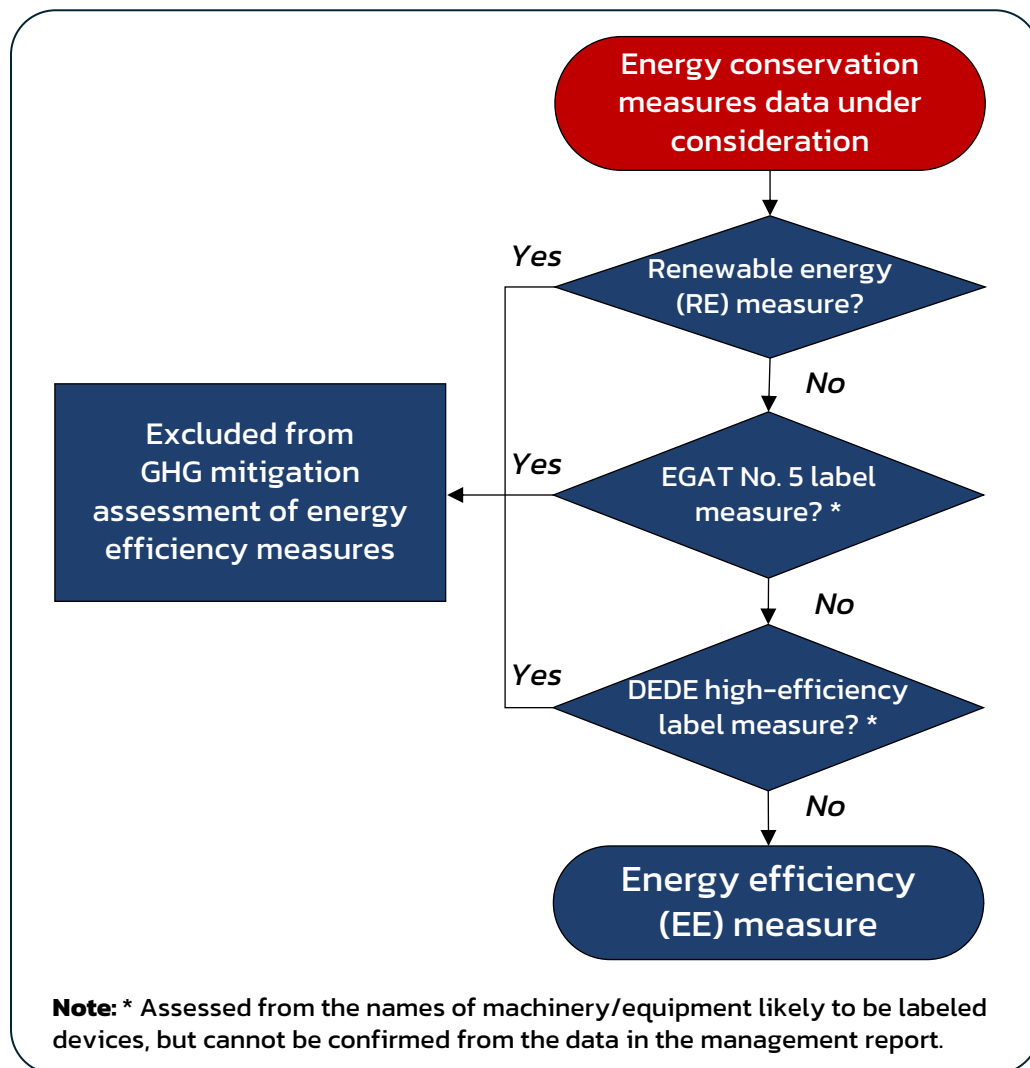
Total 33.392 MtCO₂
(26.7% of energy sector target)

3

Methodology: GHG mitigation from EE measures in Designated facilities

From double counting to calculation concept

Double Counting Concern and Methodological Integrity



Energy conservation measure data from the annual energy management reports of designated factories/buildings

- Includes both energy efficiency (EE) and renewable energy (RE) measures
- Data may overlap with other promotion programs, e.g., EGAT No. 5 label, DEDE high-efficiency label

Consider only energy efficiency (EE) measures, excluding the following:

Exclusion by measure type

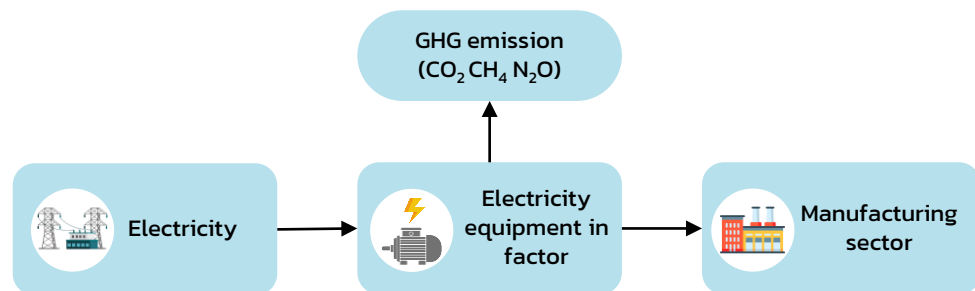
- ❌ **Renewable energy measures**
— e.g., Solar Rooftop
- ❌ **Waste-energy recovery**
— only waste-heat recovery for electricity generation (already reported under the EE measure for recovering waste heat to generate electricity for in-plant use in the cement industry, since 2019)

Exclusion by equipment

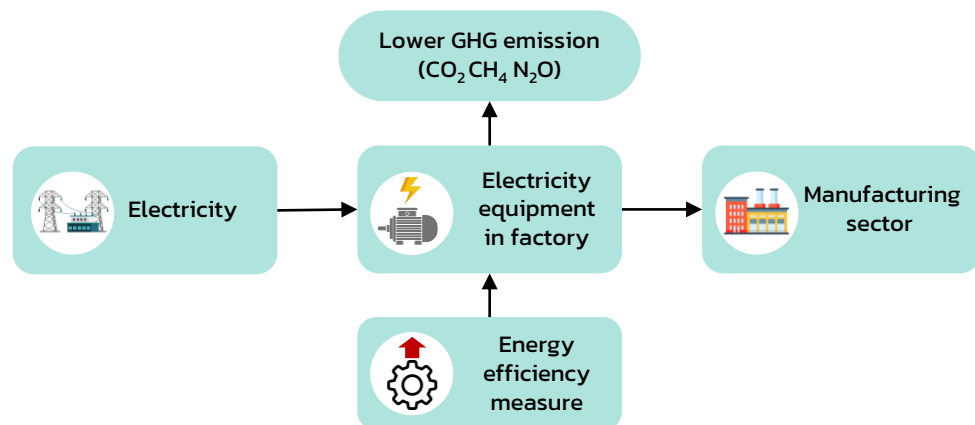
- ❌ **Measures qualifying for the EGAT No. 5 label**
Except LED lamps
- ❌ **Measures qualifying for the DEDE high-efficiency label**
Except motor variable-speed drives (VSD)

GHG mitigation assessment method from electricity efficiency measure in manufacturing sector

Baseline emission



Implementation case (Project emission)



Equation

$$ER_y = EC_{\text{saving},y} \times EF_{EC,2015}$$

Parameter	Definition	Data Source
ER_y	An amount of GHG mitigation in year y (tCO ₂ /year)	Calculation
$EC_{\text{saving},y}$	Cumulative electricity savings * from electrical energy efficiency measures implemented in designated factories up to Year y (MWh/year)	Department of Alternative Energy Development and Efficiency (DEDE)
$EF_{EC,2015}$	Electricity Consumption Emission Factor in 2015 (tCO ₂ /MWh)	Summary report of Emission Factor calculation of transmission line

* Cumulative energy saving is being counted since 2021

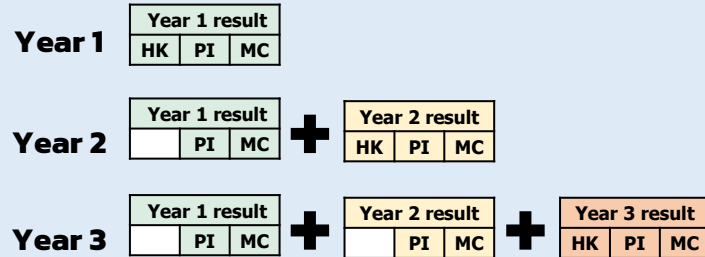
Concept of Cumulative Energy-Savings Assessment

Cumulative Energy-Savings Assessment

Assess energy conservation results:
Electricity (MWh) and heat (TJ)
from Energy Efficiency measures
classified by measure type : HK, PI, MC

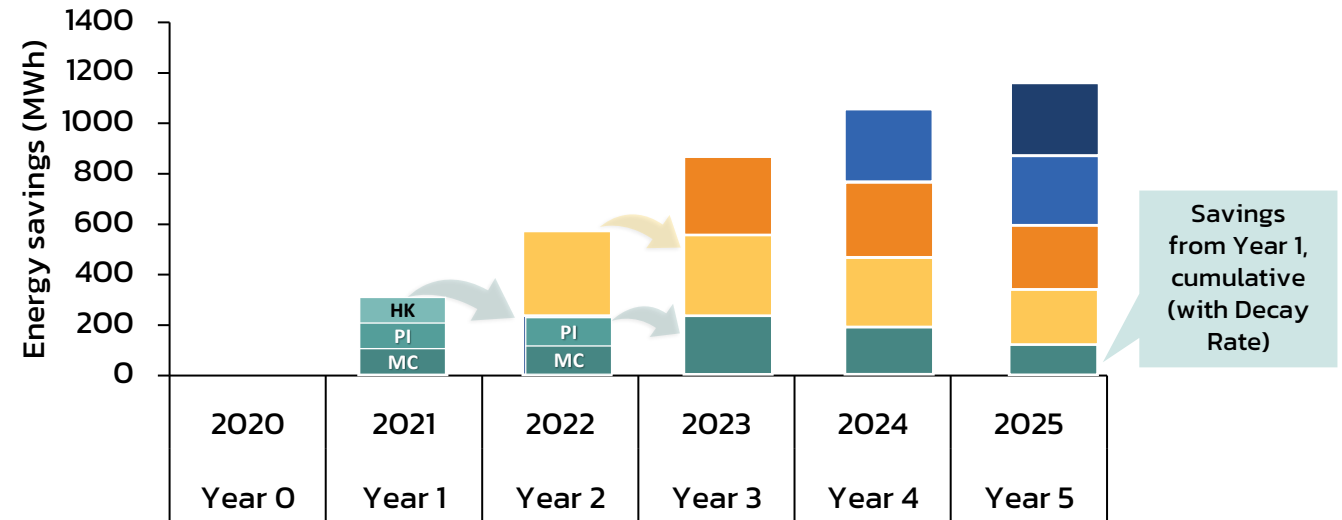


Assess cumulative results



Assess other relevant factors in accumulating
energy savings, such as the degradation
(Decay Rate) of machinery efficiency and
technology age

Example of cumulative energy-savings assessment



Energy conservation process type	Cumulative energy savings	Cumulative with depreciation (Decay Rate)	Accumulated savings life (years)
1) Housekeeping (HK)	Not cumulative	×	–
2) Process Improvement (PI)	Cumulative	×	3
3) Machine Change (MC)	Cumulative	×	Per equipment service life
• Technology age under 3 years	Cumulative	×	
• Technology age 3 years or more	Cumulative	✓	

Concept of Cumulative Energy-Savings Assessment

Energy-savings assessment for Machine change (MC)

Weibull distribution

$$\text{Energy Saving} = \text{FY Saving} \times R(t)$$

$$\text{Reliability at time : } R(t) = e^{-(t \times \lambda)^\beta}$$

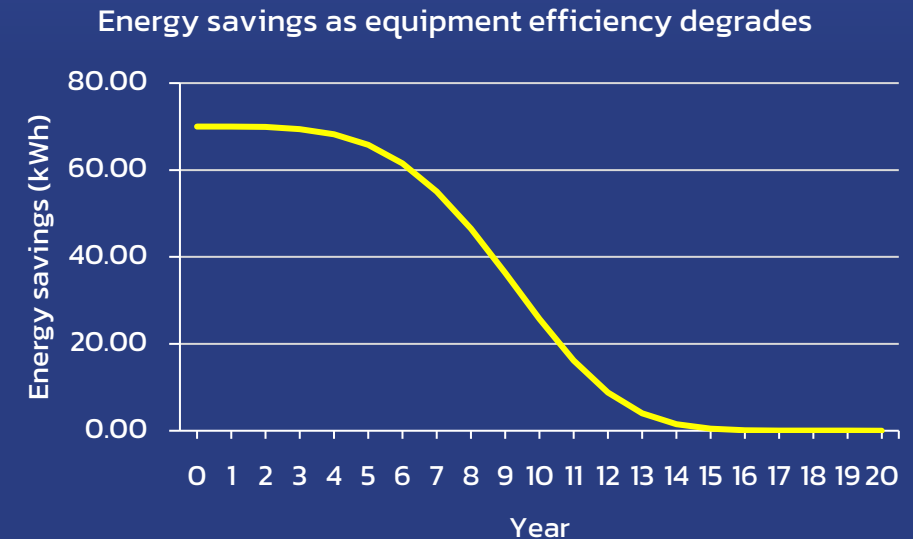
Where:

Parameter	Definition	Data source
FY Saving	First-year energy savings	Summary report of GHG emission calculations from heat production using fossil fuels
t	Number of equipment years (1,2,3,...,n)	Academic journals and research by EGAT in collaboration with Naresuan University
λ	Equipment decay rate (Decay Rate)	Academic journals and research by EGAT in collaboration with Naresuan University
β	Shape Parameter	A constant equal to 4 from EGAT research in collaboration with Naresuan University

Source: TGO and CMU

Example Replacing electrical equipment

- Year 1 energy savings = 70 kWh
- Decay rate over service life = 10%
- Service life = 10 years



GHG mitigation result from energy efficiency measure

Energy efficiency measure	GHG mitigation (ktCO ₂)			
	2021	2022	2023	2024 **
1. Measure to improve electricity efficiency in manufacturing sector *	406.54	784.52	1,198.39	- In Progress -
2. Measure to improve efficiency of thermal production in manufacturing sector	407.05	589.67	999.56	- In Progress -
Manufacturing sector total	813.59	1374.19	2,197.95	- In Progress -
3. Measure to improve electricity efficiency in buildings*	102.17	127.63	201.64	244.46
4. Measure to improve efficiency of thermal production in buildings	1.59	2.28	3.39	2.17
Building sector total	103.76	129.91	205.03	246.63
Total	917.35	1,504.10	2,402.98	In progress

Remark:

* Exclude replacement of appliance with label no.5 (except LED) and exclude the replacement of appliance with high-efficiency labels from 2023 onwards (except variable speed drive equipment)

** The 2024 results are unofficial estimates.

Source: TGO and CMU

Key Takeaways



Policy Regulatory

Revise the National Energy Plan for **H2** and **CCUS** along with **Net Zero target 2050** and Research & innovation plan

Cap-and-Trade (ETS) under Climate Change Act will be key to raise hydrogen and CCUS demand along with clear carbon market and regulatory/standard



Finance

New financial mechanisms, both domestically and internationally, that incentivize those techs.

Apply Tax benefits and other support to cover all sectors.

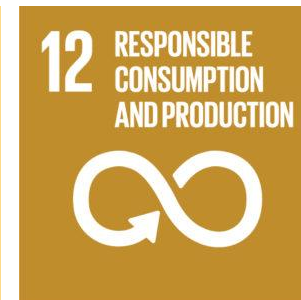
Minimize drawbacks of initial and O&M cost by maximize domestic actions



Technology and infrastructure

Sector specific use of **CCUS & H2** in “Hard to abate” where electrification is difficult (**Iron & steel** in heat generation etc)

Infrastructure plan and preparation is essential as same as **R&D Networking** (Triple helix) and tech database



THANK YOU

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