Asia LCS scenarios and actions: How to achieve sustainable low-carbon society

National Institute for Environmental Studies (NIES)
Tsukuba, Japan, February 19-21, 2011

Asia Low-Carbon Society: LCS scenario in Thailand

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Sirindhorn International Institute of Technology
Thammasat University, THAILAND
To propose measures for avoiding climate change, and precursors to zero carbon society and renewable-energy economy.

To discuss the possibility of developing a low-carbon society in Thailand.

To create awareness among Thailand’s authorities, government, stakeholders, and communities for low-carbon Thailand.
QUANTITATIVE ASSUMPTIONS

Population

HH size

No. of HH
## ESTIMATED SOCIO-ECONOMIC INDICATORS

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>60,991,000</td>
<td>68,815,004</td>
</tr>
<tr>
<td>No. of HH</td>
<td>19,016,784</td>
<td>36,265,390</td>
</tr>
<tr>
<td>GDP (mil Baht)</td>
<td>8,016,595</td>
<td>30,802,306</td>
</tr>
<tr>
<td>Gross output (mil Baht)</td>
<td>18,755,884</td>
<td>68,456,651</td>
</tr>
<tr>
<td><strong>Primary industry</strong></td>
<td>1,116,621</td>
<td>2,801,864</td>
</tr>
<tr>
<td><strong>Secondary industry</strong></td>
<td>11,453,496</td>
<td>38,008,931</td>
</tr>
<tr>
<td><strong>Tertiary industry</strong></td>
<td>6,185,767</td>
<td>27,645,856</td>
</tr>
</tbody>
</table>

| Floor space for commercial (mil m²) | 88 | 394 |
| Passenger transport demand (mil p-km) | 191,520 | 216,088 |
| Freight transport demand (mil t-km)  | 188,524 | 589,859 |

**Remarks:**
- Primary industry \(\rightarrow\) Agriculture, Mining, and Construction
- Secondary industry \(\rightarrow\) Textiles, Food & beverage, Chemical, Metallic, Non-metallic, and Others
- Tertiary industry \(\rightarrow\) Service sector
Scenario & CO₂ Countermeasure

• Energy demand in 2030 BAU scenario

• Energy demand in 2030 CM scenario

CO₂ Mitigation:
Only cost-effective energy savings of CO₂ mitigation options are considered.

CO₂ mitigation measures in 2030CM must be complied with national constraints.
Thailand’s RE & EE Technologies

Net Cost Curve of CO₂ Avoided (2006 - 2030) for Deploying RE & Efficient EE Technologies

- Negative net cost = cost saving due to avoided energy use
- Comm. = commercial
- Res. = residential
ENERGY DEMAND

<table>
<thead>
<tr>
<th>Category</th>
<th>2005</th>
<th>2030 BAU</th>
<th>2030 CM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>57,327</td>
<td>164,863</td>
<td>128,963</td>
</tr>
<tr>
<td>Commercial</td>
<td>49%</td>
<td>21%</td>
<td>22%</td>
</tr>
<tr>
<td>Industry</td>
<td>9%</td>
<td>5%</td>
<td>3%</td>
</tr>
<tr>
<td>Passenger transport</td>
<td>16%</td>
<td>5%</td>
<td>9%</td>
</tr>
<tr>
<td>Freight transport</td>
<td>16%</td>
<td>9%</td>
<td>16%</td>
</tr>
</tbody>
</table>

Remarks: BAU is Business as Usual
CM is Countermeasure

4.3% p.a.

35,895 ktoe 22%
GHG EMISSIONS

- Residential
- Commercial
- Industry
- Passenger transport
- Freight transport

GHG Emissions (kt-CO₂)

<table>
<thead>
<tr>
<th>Year</th>
<th>Residential</th>
<th>Commercial</th>
<th>Industry</th>
<th>Passenger transport</th>
<th>Freight transport</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>185,983</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2030 BAU</td>
<td>563,730</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2030 CM</td>
<td>324,170</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Remarks: BAU is Business as Usual
CM is Countermeasure

239,560 kt-CO₂

43%

4.5% p.a.
GHG EMISSIONS/REDUCTIONS

Remarks: BAU is Business as Usual
CM is Countermeasure

- Power: 91,615 kt-CO₂
- Freight: 23,118 kt-CO₂
- Passenger: 15,159 kt-CO₂
- Industry: 79,984 kt-CO₂
- Commercial: 18,734 kt-CO₂
- Residential: 10,950 kt-CO₂

2005 GHG Emissions (kt-CO₂): 185,983
2030 BAU GHG Emissions (kt-CO₂): 563,730
2030 CM GHG Emissions (kt-CO₂):

4.5% p.a.
MEASURES

POWER GENERATION

- Efficiency improvement in the *Power generation sector*
  - *T&D loss* will improve to be 5%.
  - *Technology transfer*: New power plant technology will be added such as IGCC and CCGT → Eff. Improve to be 48% and 56%.

<table>
<thead>
<tr>
<th>Fuel type</th>
<th>Share in 2030 BAU</th>
<th>Share in 2030 CM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural gas</td>
<td>71.4</td>
<td>39.0</td>
</tr>
<tr>
<td>Oil</td>
<td>6.6</td>
<td>–</td>
</tr>
<tr>
<td>Coal</td>
<td>15.1</td>
<td>23.6</td>
</tr>
<tr>
<td>Hydro</td>
<td>4.4</td>
<td>20.5</td>
</tr>
<tr>
<td>Nuclear</td>
<td>–</td>
<td>11.2</td>
</tr>
<tr>
<td>Renewable energy</td>
<td>2.5</td>
<td>5.7</td>
</tr>
</tbody>
</table>

MEASURES

RESIDENTIAL

- Energy efficiency improvement in **Households (Electric)**
  - Efficiency improvement by 30%
  - Penetration rates up to 100% in 2030

- Energy efficiency improvement in **Households (Non-electric)**
  - Efficiency improvement
  - by 30% in wood stove
  - by 5% in LPG stove
  - Penetration rates up to 100% in 2030

**MEASURES**

**RESIDENTIAL**

- **Supply side** 56%
  - EEI (Elec.) 38%
  - EEI (Non-elec.) 6%

**GHG emissions (kt-CO₂)**

<table>
<thead>
<tr>
<th>Year</th>
<th>2005</th>
<th>2030 BAU</th>
<th>2030 CM</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEI (power sector)</td>
<td>20,889</td>
<td>55,838</td>
<td>30,979</td>
</tr>
<tr>
<td>EEI (non electrical app.)</td>
<td>13,909 (56%)</td>
<td>1,620 (6%)</td>
<td>9,330 (38%)</td>
</tr>
<tr>
<td>EEI (electrical app.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GHG emissions</td>
<td></td>
<td>44.5%</td>
<td></td>
</tr>
</tbody>
</table>

Diagram showing Residential Grid Connected PV System with EEI (power sector), EEI (non electrical app.), EEI (electrical app.), and GHG emissions.
MEASURES

COMMERCIAL

- Energy efficiency improvement in **Buildings**
  - Efficiency improvement by 30%
  - Penetration rates up to 100% in 2030

- Energy efficiency improvement in **Buildings (Building Codes)**
  - Building insulation
  - Building envelope
  - Penetration rates up to 100% in 2030

**MEASURES**

**COMMERCIAL**

- **Supply side** (65%)
  - EEI (Elec.) (31%)
  - Building insulation (4%)

GHG emissions (kt-CO₂)

- **2005**
  - 22,686
- **2030 BAU**
  - 101,391 (52.9%)
- **2030 CM**
  - 47,761

GHG emissions breakdown:
- EEI (electrical app.)
- Building insulation
- EEI (power sector)

GHG emissions reduction:
- 53,630
- 34,896 (65%)
- 2,350 (4%)
- 16,384 (31%)
MEASURES

INDUSTRY

- Energy efficiency improvement in *Industry (Electric)*
  - *Efficiency improvement*

<table>
<thead>
<tr>
<th>System</th>
<th>Motor</th>
<th>Others</th>
<th>Lighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEI</td>
<td>10%</td>
<td>20%</td>
<td>30%</td>
</tr>
</tbody>
</table>

- Penetration rates up to 100% in 2030

- Energy efficiency improvement in *Industry (Non-electric)*
  - *Efficiency improvement by 30%*

- Fuel switching in *Industry*
  - *Reduce the penetration level in coal and oil by 50%*
  - *Replace the penetration level remaining in biomass and LPG.*
**MEASURES**

**INDUSTRY**

Supply side 35%
EEI (Elec.) 10%
EEI (Non-elec.) 21%
Fuel switching 35%

**GHG emissions (kt-CO2)**

- 86,034
- 276,045
- 153,554

2005 2030 BAU 2030 CM

- 42,508 (35%)
- 41,336 (35%)
- 26,268 (21%)
- 12,380 (10%)

**GHG emissions (kt-CO2)**
- EEI (power sector)
- Fuel switching
- EEI (non electrical app.)
- EEI (electrical app.)
- GHG emissions
Fuel economy improvement (FEI) in Transport sector
- Efficiency improvement by 30% in
- Penetration rates up to 100% in 2030

Travel demand management (TDM) in Transport sector
- Efficiency improvement by 7.38%
- Using (eco-driving, bus priority, and non-motorized transport)

MEASURES

TRANSPORTATION

- Fuel switching in Transport sector
  - CNG engines will increase by 20% in 2030
  - Hybrid engines can save energy consumption by 30%

- Modal shift in Transport sector

<table>
<thead>
<tr>
<th></th>
<th>SV</th>
<th>LV</th>
<th>Bus</th>
<th>Motor bike</th>
<th>Bike</th>
<th>Walk</th>
<th>Train</th>
<th>Plane</th>
<th>Ship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Passenger</td>
<td>2005</td>
<td>24.3</td>
<td>6.7</td>
<td>42.3</td>
<td>14.6</td>
<td>0.8</td>
<td>10.7</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>2030</td>
<td>15.0</td>
<td>5.0</td>
<td>20.0</td>
<td>10.0</td>
<td>12.8</td>
<td>25.0</td>
<td>12.0</td>
<td>0.2</td>
</tr>
<tr>
<td>Freight</td>
<td>2005</td>
<td>2.2</td>
<td>80.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2.3</td>
<td>0.02</td>
<td>14.8</td>
</tr>
<tr>
<td></td>
<td>2030</td>
<td>2.2</td>
<td>58.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>24.9</td>
<td>0.02</td>
</tr>
</tbody>
</table>

MEASURES

PASSENGER TRANSPORT

Supply side
Fuel Switching 19%
FEI 27%
Modal shift 52%

GHG emissions (kt-CO₂)

<table>
<thead>
<tr>
<th>Year</th>
<th>GHG emissions</th>
<th>FEI (%)</th>
<th>Fuel switching (%)</th>
<th>Modal shift (%)</th>
<th>EEI (power sector) (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>22,933</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2030 BAU</td>
<td>25,875</td>
<td>59.7%</td>
<td>19%</td>
<td>52%</td>
<td></td>
</tr>
<tr>
<td>2030 CM</td>
<td>10,423</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- GHG emissions
- FEI
- Fuel switching
- Modal shift
- EEI (power sector)

293 (2%)
2,921 (19%)
8,087 (52%)
4,151 (27%)

E-20 20% Ethanol
E85 Ethanol Flex-Fuel
CNG
B5
Supply side 0.04%

FEI 28%

Modal shift 41%

Fuel switching 31%

GHG emissions (kt-CO₂)

2005  33,441

2030 BAU 104,581

2030 CM 81,454

GHG emissions

FEI

Modal shift

EEI (power sector)

Fuel switching

9 (0.04%)

7,062 (31%)

9,469 (41%)

6,588 (28%)
GHG EMISSIONS/REDUCTION

GHG REDUCTION:
239,560 kt-CO₂

Unit: kt-CO₂

GHG Emission 324,170

GHG emissions
Residential
Commercial
Industry
Passenger transport
Freight transport
Power generation

TOTAL

2%
3%
16%
14%
3%
4%
## SUMMARY OF GHG MITIGATION MEASURES

<table>
<thead>
<tr>
<th>Action</th>
<th>GHG Reduction (kt-CO₂)</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Energy efficiency improvement (EEI) in households</td>
<td>10,950</td>
<td>4.6%</td>
</tr>
<tr>
<td>- EEI in electric devices</td>
<td>9,330</td>
<td>3.9%</td>
</tr>
<tr>
<td>- EEI in non-electric devices</td>
<td>1,620</td>
<td>0.7%</td>
</tr>
<tr>
<td>2. Energy efficiency improvement in buildings</td>
<td>16,384</td>
<td>6.8%</td>
</tr>
<tr>
<td>3. Building codes</td>
<td>2,350</td>
<td>1.0%</td>
</tr>
<tr>
<td>4. Energy efficiency improvement in industries</td>
<td>38,648</td>
<td>16.1%</td>
</tr>
<tr>
<td>- EEI in electric devices</td>
<td>12,380</td>
<td>5.1%</td>
</tr>
<tr>
<td>- EEI in non-electric devices</td>
<td>26,268</td>
<td>11.0%</td>
</tr>
<tr>
<td>5. Fuel switching in industry</td>
<td>41,336</td>
<td>17.3%</td>
</tr>
<tr>
<td>6. Fuel economy improvement in transportation</td>
<td>10,739</td>
<td>4.5%</td>
</tr>
<tr>
<td>- Passenger transport</td>
<td>4,151</td>
<td>1.7%</td>
</tr>
<tr>
<td>- Freight transport</td>
<td>6,588</td>
<td>2.8%</td>
</tr>
<tr>
<td>7. Fuel switching in transportation</td>
<td>9,983</td>
<td>4.2%</td>
</tr>
<tr>
<td>- Passenger transport</td>
<td>2,921</td>
<td>1.2%</td>
</tr>
<tr>
<td>- Freight transport</td>
<td>7,062</td>
<td>3.0%</td>
</tr>
<tr>
<td>8. Modal shift in transportation</td>
<td>17,556</td>
<td>7.3%</td>
</tr>
<tr>
<td>- Passenger transport</td>
<td>8,087</td>
<td>3.3%</td>
</tr>
<tr>
<td>- Freight transport</td>
<td>9,469</td>
<td>4.0%</td>
</tr>
<tr>
<td>9. Efficiency improvement and fuel switching in the power sector</td>
<td>91,614</td>
<td>38.2%</td>
</tr>
<tr>
<td>Total GHG mitigation in 2030</td>
<td>239,560</td>
<td>100.0%</td>
</tr>
<tr>
<td>Total GHG emissions in the 2030 BAU scenario</td>
<td>563,730 kt-CO₂</td>
<td></td>
</tr>
<tr>
<td>Total GHG emissions in the 2030 CM scenario</td>
<td>324,170 kt-CO₂</td>
<td></td>
</tr>
</tbody>
</table>
# RENEWABLE POTENTIALS (MOEN, TH)

<table>
<thead>
<tr>
<th>Energy type</th>
<th>Potential</th>
<th>Existing</th>
<th>2008-2011</th>
<th>2023-2030</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MW</td>
<td>MW</td>
<td>GWh</td>
<td>kW</td>
</tr>
<tr>
<td>Electricity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solar</td>
<td>50,000</td>
<td>38.6</td>
<td>46</td>
<td>55</td>
</tr>
<tr>
<td>Wind</td>
<td>1,600</td>
<td>5.13</td>
<td>10</td>
<td>115</td>
</tr>
<tr>
<td>Small hydro</td>
<td>700</td>
<td>67</td>
<td>293</td>
<td>165</td>
</tr>
<tr>
<td>Biomass</td>
<td>4,400</td>
<td>1,644</td>
<td>11,521</td>
<td>2,800</td>
</tr>
<tr>
<td>Biogas</td>
<td>190</td>
<td>79.6</td>
<td>573</td>
<td>60</td>
</tr>
<tr>
<td>Waste</td>
<td>400</td>
<td>5.6</td>
<td>44.8</td>
<td>78</td>
</tr>
<tr>
<td>Total</td>
<td>57,290</td>
<td>1,840</td>
<td>12,487.8</td>
<td>3,273</td>
</tr>
<tr>
<td>Thermal</td>
<td>ktoe</td>
<td>ktoe</td>
<td>ktoe</td>
<td>ktoe</td>
</tr>
<tr>
<td>Solar</td>
<td>154</td>
<td>0.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biomass</td>
<td>7,400</td>
<td>3,071</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biogas</td>
<td>600</td>
<td>201</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste</td>
<td>1.09</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8,154</td>
<td>3,273</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bioenergy</td>
<td>ML/day</td>
<td>ML/day</td>
<td>ML/day</td>
<td>ktoe</td>
</tr>
<tr>
<td>Ethanol</td>
<td>3.00</td>
<td>1.24</td>
<td>3.00</td>
<td>805</td>
</tr>
<tr>
<td>Biodiesel</td>
<td>4.20</td>
<td>1.56</td>
<td>3.00</td>
<td>950</td>
</tr>
<tr>
<td>Total</td>
<td>7.20</td>
<td>2.80</td>
<td>6.00</td>
<td>1755</td>
</tr>
<tr>
<td>Required energy (ktoe)</td>
<td>66,248</td>
<td></td>
<td>70,300</td>
<td>112,868</td>
</tr>
<tr>
<td>Required renewable energy</td>
<td>4,237</td>
<td></td>
<td>7,492</td>
<td>15,468</td>
</tr>
<tr>
<td>RE share (%)</td>
<td>6.4%</td>
<td></td>
<td>10.6%</td>
<td>13.7%</td>
</tr>
<tr>
<td>NGV (M.cu./Day)</td>
<td>147</td>
<td>393.0</td>
<td>3,469</td>
<td>800</td>
</tr>
<tr>
<td>Alternative energy used (ktoe)</td>
<td>10,961</td>
<td></td>
<td>22,532</td>
<td></td>
</tr>
<tr>
<td>AE share (%)</td>
<td>16.6%</td>
<td></td>
<td>19.96%</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions on Thailand’s LCS Scenario

- The GHG emissions in 2030 BAU scenario without mitigation measures will increase to 563,730 kt-CO$_2$.

- By adopting CMs in all sectors, GHG emissions can be decreased to 324,170 kt-CO$_2$ or by 42.5%.

- If those policies are planned in early stage, Thailand will be able to serve as a model for LCS.

- However, to increase more CO$_2$ mitigation, more CMs & leapfrogging technologies are needed under national appropriate mechanism.
1st Thailand’s LCS Scenario 2030 Brochure

The 3 versions of Thailand’s LCS brochures had been distributed and disseminated in Thailand.

2. Climate change focal point of Thailand: ONEP.
3. Bangkok Metropolitan Administration (BMA).
4. Energy Planning and Policy Office (EPPO), MOEN.
5. Department of Alternative Energy Development and Efficiency (DEDE), MOEN.
6. Research Institutes & Universities.
7. NGOs.

Note: TGO & MOEN are looking towards 2030, instead of 2022.
1st Thailand’s LCS Scenario 2030 Brochure

The 2nd version of Thailand’s LCS brochures had been distributed and disseminated during CTC2010 conference, organized by TGO during 19-21 August 2010.

Thailand’s LCS scenario development was presented in CTC2010. In addition, 2 papers on Thailand LCS were also presented.
TGO provided one session on LCS Scenario: Methodology, cases of Japan & Thailand

CTC2010
21 August 2010
MOU between NIES and SIIT-TU
Low-Carbon Scenario Development in Thailand

29th Oct 2010 at NIES, Tsukuba

Prof. Dr. Ohgaki (President of NIES)
Prof. Dr. Chongrak (Director of SIIT/TU)
Asia LCS scenarios and actions:
How to achieve sustainable low-carbon society

Dissemination & ExSS Workshop in Thailand
Low-carbon society model capacity building workshop
Bridge simulation scenarios and sustainable LCS policy implementation using AIM (Asia-Pacific Integrated Model)

Organized by TGO, SIIT-TU, JGSEE, NIES

November 19, 2010. Pullman King Power Hotel, Bangkok
Objective:
1. To introduce LCS scenario.
2. To operate LCS model. (ExSS tool)
3. To communicate among policy makers, researchers, and business on feasible LCS development.
Low-Carbon Society Model Capacity Building Workshop

LCS methodology
LCS Thailand, SIIT & AIT
Prof. Ho (MTU)
Mr. Boyd (IRDA)

Dr Savitri (KMUTT)
LCS India, Prof. Aashish
Chair, TGO Board
Dr Kainuma Dr Komi

ExSS Training
ExSS Training
ExSS Training
ExSS Training
Low-Carbon Society Model Capacity Building Workshop

ExSS Training

Prof Nishioka (iGES & NIES)
Bridge simulation & LCS Policy

Bridge simulation & LCS Policy
Closing Remarks

Dr Kainuma  Dr Sirin (KMUTT)
Thailand’s Low-Carbon Society Model Capacity Building Workshop

http://2050.nies.go.jp/sympo/101119/

Proceeding of LCS

Low-carbon society model capacity building workshop
Bridge simulation scenarios and sustainable LCS policy implementation using AIM (Asia-Pacific Integrated Model)
November 19 (Fri), 2010
Venue: Pullman King Power Hotel, Bangkok, Thailand
Language: English-Thai Simultaneous translation is available.
Organizer: TGO, SIIT-TU, JGSEE, NIES

Objectives
1) Introduce LCS scenario making process to stakeholders for better understanding how to use simulation studies for policy formulation and implementation
2) Learn to operate LCS simulation model (simple version) and assess the CO2 reduction possibilities affected by change of driving forces (population, GDP etc.) and countermeasures (energy savings in buildings and industries, modal shift in transportation etc.)
3) Communicate between policymakers, business, researchers to discuss how to develop feasible LCS scenarios and policy options

Workshop Proceedings
All presentations and discussions are summarized in a proceedings.
Download the Proceedings (PDF:17MB)
Thailand’s LCS Brochure in the TGO Homepage is available at http://www.tgo.or.th/index.php?option=com_content&task=view&id=441&Itemid=2
2nd Thailand’s Low-Carbon Society Scenario

- Improved analysis of 2030CM to 2050CM scenario using ExSS tool.

- 2nd LCS 2050CM Scenario brochure using AIM/EndUse for the power sector with carbon tax.

- AIM/CGE for 2050 CM Scenario.
AIM/Enduse Thailand’s Power Sector

- Coal
  - Coal Existing
  - Lignite Existing
  - Coal_New1
  - Coal_New2
  - Coal CHP Existing
- Diesel
  - EL_DIE_Existing1
  - EL_DIE_Existing2
- Gas
  - EL_NGS_Existing1
  - EL_NGS_Existing2
  - EL_NGS_Existing3
  - EL_LNG_NEW
  - EL_Gas CHP_Existing
- Oil
  - EL_HFO_Existing
  - EL_HFO_CHP_EXT
- Hydro large
  - Hydro, Large Existing
- Hydro small
  - Hydro, Small, Existing
- Wind
  - Wind, Existing
- Biomass
  - Biomass, Existing
- Geothermal
  - Geothermal, Existing
- Nuclear
  - Nuclear, New
- Biogas
  - Biogas, Existing
- MSW
  - MSW, Existing
- SOL
  - Solar PV, Existing

Net electricity → EL_LST_EXT → Electricity

Graph: MtCO2eq

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<th>Year</th>
<th>BAU</th>
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<td>2015</td>
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AIM/Enduse
Thailand’s Reasidential Sector

Cooling, lighting, Electric appliances

- Air Conditioner
- Incandescent
- Fluorescent
- Electric Appliances
- RCL
- RLT
- ROT

Hot water

- Water Heater
- ELY_R
- SOL_R

Cooking

- Microwave
- Kitchen stove
- RCK
- ELY_R
- MSW_R
- WOD_R
- LPG_R
- CHA_R

Graph:
MtCO2eq

- 2005: 12.12
- 2010: 13.19
- 2015: 14.72
- 2020: 15.57
- 2025: 18.26
- 2030: 20.26

Legend:
- MtCO2eq
- 2005
- 2010
- 2015
- 2020
- 2025
- 2030

Region:
- RCL
- RCK
- RHW
AIM/Enduse
Thailand’s Commercial Sector

Cooling system

General lighting and electric appliance

- Fluorescent
- Incandescent
- Electric appliance

Cooking

- Microwave/Kitchen stove
- Kitchen stove
- Kitchen stove
- Kitchen stove

Thailand’s Commercial Sector
AIM/Enduse
Thailand’s Transport Sector (T-1)

Fuel process
- OLG
  - Gasoline
  - T_ZOLG
- BFOT
  - Bio fuel
- OLD
  - Diesel
  - T_ZOLD
- BFOT
  - Bio fuel

Energy

Passenger train, passenger ship, passenger air
- ELYT
  - Frg.Vehicle-Light, Ele.EXT
  - Frg.Vehicle-Light, Ele.New
- Sky train

Car transport
- T_ZOLG
  - Vehicle-Gsl.EXT
  - Vehicle-Gsl.NEW
- T_ZOLD
  - Vehicle-LPG.EXT
  - Vehicle-LPG.NEW

Car
- OLH
  - Frg.Vehicle-Light, Gsin.EXT
  - Pss.ship. Heavy oil NEW
  - Pss.ship. Heavy oil EXT

- Pss.ship.
  - Heavy oil EXT

- OLJ
  - Pss.Air. Jet Oil EXT
  - Pss.Air. Jet Oil NEW

Air transport
AIM/Enduse
Thailand’s Transport Sector (T-2)

Freight Vehicle

Frg.Vehicle-Light,Gsin.EXT
Frg.Vehicle-Light,Gsin.NEW
Frg.Vehicle-NGS.EXT
Frg.Vehicle-NGS.EXT

T_ZOLD

Freight car

Passenger train, passenger ship, passenger air

Train-DIE.EXT
Train-DIE.NEW

Frg.ship. Heavy oil NEW
Frg.ship. Heavy oil EXT

T_ZOLD

Train transport

HFO

Freight ship

MtCO2eq

<table>
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AIM/Enduse
Thailand’s Industrial Sector (Food Industry)
Fuel making process

Grinding process

Burning process

Finishing process

Other process

Electricity Production

Purchased electricity

Exhaust heat

Owen steam power

AIM/Enduse
Thailand’s Industrial Sector
(Cement Industry)
どうもありがとうございます

THANK YOU