Analytical Tools for Assessing Low Carbon Society Measures: Country-level Examples

THAILAND

6 February 2017
AIT

Bundit Limmeechokchai
SIIT-TU
Asia-Pacific Integrated Model (AIM)
AIM family for mitigation analysis

Top-down approach
- AIM/Material
- AIM/Extended Snapshot

Hybrid approach
- AIM/Backcast
- AIM/Energy Snapshot

Bottom-up approach
- AIM/Enduse[Country]

Global scale
- AIM/Impact[Policy]
- AIM/CGE[Global]

National scale
- AIM/CGE[Country]

Model

Output

Mitigation potentials and costs curves
Macro-economic driving forces
Industrial production, transportation volume, etc
Element / transition (service demand)

Global emission paths to climate stabilization
Mitigation potentials and costs curves
Macro-economic driving forces
Industrial production, transportation volume, etc
Element / transition (service demand)

Source: NIES Japan
AIM/ExSS

Four Steps

1. Setting framework
   - Area
   - Base year
   - Target year
   - Scenario name
   - LCS target
   - Unit
   - Classification

2. Information collection
   - Demography
   - Economy
   - Transport
   - Building
   - Energy demand
   - Energy efficiency
   - Power supply
   - Emission factor

3. Estimate future socio-economic variables and “BaU” emissions
   - Population growth
   - Household size
   - GDP growth
   - Industrial structure
   - Transport demand

4. Setting low-carbon measures and analyzing the result
   - Residential
   - Commercial
   - Industry
   - Passenger and freight Transport
   - Power supply
   - Carbon sink

Source: AIM
Methodology (AIM/Enduse), NIES

Energy
- Oil
- Coal
- Gas
- Solar
- (Electricity)

Energy Technology
- Boiler
- Power generation
- Blast furnace
- Air conditioner
- Automobile

Energy Services
- Lighting
- Steel products
- Cooling
- Transportation

Energy Consumption
CO₂ Emissions

Energy Database
- Energy type
- Energy price
- Energy constraints
- CO₂ emission factor

Technology Database
- Technology price
- Energy consumption
- Service supplied
- Share
- Lifetime

Socio-economic Scenario
- Population growth
- Economic growth
- Industrial structure
- Employees
- Lifetime
Thailand’s RES

Source: SIIT-TU
What's CGE?

- "Computable": quantitative
- "General": treatment of all commodities, sectors and production factors in the treated society
- "Equilibrium": demand and supply of each commodity and factor are balanced through the price mechanism

Source: AIM
AIM/CGE - Top-down approach -

Market: through price mechanism, supply and demand are balanced for all commodities and production factors. 
- demand > supply → price increase
- demand < supply → price decrease

Producers

Maximizing profit $\Pi$ under technology set (production function).

$\max \Pi_i = P_i Q_i - rK_i - wL_i$
$s.t. Q_i \leq f_i(K_i, L_i)$

U: Utility in final demand sector
$\Pi$: Profit of producer
$P_i$: Commodity price
$Q_i$: Production of commodity
$C_i$: Demand of commodity in household
$r$: Capital price
$K$: Capital
$w$: Wage
$L$: Labor

Source: AIM
LCS Modelling for Thailand

1. LCS Scenario 2030 by AIM/ExSS
2. Appropriate CO\textsubscript{2} mitigation target in 2020 by AIM/Enduse
3. Roadmap to Low Carbon Thailand 2050 by AIM/Enduse
4. Economic impacts of CO\textsubscript{2} mitigation targets by AIM/CGE
5. Peak CO\textsubscript{2} Scenario for Thailand
6. 1.5 Degree Scenario for Thailand
1st LCS Scenario by AIM/ExSS

2nd LCS Roadmap by AIM/Enduse
Methodology (LCS Action Plan)

Information and data collection

- Identification of Data needs and data sources. Preliminary data Formulation.

Synthesis and Preliminary Analysis

- Information collection for present practices and policies
- Data compilation and putting the data in required formats

Modeling and Analysis

- Estimation of energy and emissions
- Developing Scenarios
- Developing Narratives & Story lines

Developing LCS Action Plan

- Analysis of findings and Developing LCS Action plan
- Recommendations of LCS Action Plan
Role of Integrated Assessment Model (IAM) in Thailand domestic discussion

I. Review, Analyze mitigation potentials Thailand’s contributions
   - Review of UNFCCC and Thailand CDM and Pre2020 Mitigation
   - Status/Readiness of Thailand for contributions
   - Countermeasures/Priority areas of Contributions

II. AIM/Enduse and Multi-benefit analyses
   - **AIM Modeling Energy** ➔ **Result From Model**
     (Energy Consumption, CO₂ Emission, Abatement Costs)
   - **GHG Mitigation Potential**
   - **Pre2020 Assessment**
     (Cost Effectiveness, Co-benefit, Energy Security)
   - **Policy measures for agreement**

III. Consultation and Pledge preparation
   - Stakeholders Involvement
   - Thailand’s Readiness and Contributions

NCCC & Gov’t Decision
Successful Application of IAM to Thailand LCS

• **Co-benefits** are also assessed, and they reveal positive aspects of GHG mitigation under NAMA/NDC frameworks.

• **Abatement costs** of actions are identified across the sectors.

• The **MRV** process of NAMA/NDC needs cooperation among related ministries.
High Potential Scenario:
Potentials of CO$_2$ Countermeasures in 2020 at 20%
Policy Package for Roadmap to “LOW CARBON THAILAND”

- **POWER GENERATION**
  - Implementation of energy efficiency improvement
  - Promotion of technology transfer
  - Reduce own usage and transmission loss
  - Promotion of alternative energy
  - Promotion of renewable energy

- **INDUSTRY**
  - Implementation of energy efficiency improvement
  - Promotion of technology transfer
  - Promotion of alternative and renewable energy

- **PASSENGER TRANSPORT**
  - Implementation of energy efficiency improvement
  - Promotion of technology transfer
  - Promotion of alternative and renewable energy
  - Promotion of mass transit system
  - Promotion of new technology

- **FREIGHT TRANSPORT**
  - Implementation of energy efficiency improvement
  - Promotion of new technology
  - Promotion of alternative and renewable energy
  - Promotion of mass transit system

- **RESIDENTIAL**
  - Building insulation
  - Energy efficiency labeling
  - Energy performance standard of equipment
  - Promotion of new technology

- **COMMERCIAL**
  - Building codes
  - Building insulation
  - Energy efficiency labeling
  - Energy performance standard of equipment
  - Promotion of new technology

- Incentive to introduce energy efficiency improvement and advanced technology
- Mitigation of GHG emissions
Clean Power

Energy efficiency improvement
- Large emitter programs
- Promotion of new & renewable energy
- Power generation by alternative energy
- Power generation by renewable energy

Diffusion of new technology
- Clean technology
- Promotion of Research & Development
- Power generation from solid waste incineration
- Construction of bio-methanol plant

Promotion of new & renewable energy
- Diffusion of energy saving managing systems
- Implementation of IGCC
- Improvement of transmission and distribution loss
- Implementation of large programs
- Implementation carbon capture storage (CCS) technology
- R&D of gasified biofuel development
- R&D of new technology
- Power generation from solid waste incineration
- Power generation from municipal solid waste (MSW)
- Construction of bio-methanol plant
- Construction of bio-methanol plant

Energy efficiency improvement

Renewable energy
- Biogas
- Biomass steam power plant
- Solar
- Wind
- Municipal Solid Waste (MSW)

New technology
- Nuclear
- Steam power plant with CCS
- IGCC with CCS
- Supercritical power plant with CCS

MOST 2010 2020 2030 2040 2050
592,571 kt-CO2
298,550 kt-CO2
27,235 kt-CO2
221,158 kt-CO2
613,250 kt-CO2
26,128 kt-CO2
15,630 kt-CO2
8,398 kt-CO2
81,607 kt-CO2
212,657 kt-CO2
106,329 kt-CO2
212,657 kt-CO2

DEDE, EGAT

18th AIM International Workshop, NIES
Implementation of basic energy efficiency improvement
- Heating process
- Cooling system
- Motor system
- Lighting system
- Others system

New technology
- Diffusion of high performance equipments by large emitter programs
  * Heating process
  * Cooling system
  * Motor system
  * Lighting system
  * Others system

Diffusion of advanced technology in industrial processes
* Heating process
* Cooling system
* Motor system
* Lighting system
* Others system

Fuel shift from coal and oil to natural gas and LPG
Combined heat and power system

<table>
<thead>
<tr>
<th>Year</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>88,836 kt-CO₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>49,050 kt-CO₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8,668 kt-CO₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>25,269 kt-CO₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2,811 kt-CO₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>836,094 kt-CO₂</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>268,850 kt-CO₂</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>42,137 kt-CO₂</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>123,369 kt-CO₂</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14,973 kt-CO₂</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13,723 kt-CO₂</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,485,292 kt-CO₂</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1,022,198 kt-CO₂</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>622,430 kt-CO₂</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>86,850 kt-CO₂</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>253,435 kt-CO₂</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>51,268 kt-CO₂</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>28,176 kt-CO₂</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>581,734 kt-CO₂</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>504,750 kt-CO₂</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>581,734 kt-CO₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>504,750 kt-CO₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>504,750 kt-CO₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>504,750 kt-CO₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>504,750 kt-CO₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>504,750 kt-CO₂</td>
</tr>
</tbody>
</table>

Energy efficiency improvement
Energy saving behavior
Diffusion of new technology
Diffusion of high performance equipment
Environmental management system standard
**Transport Demand Management**

**Shift mode**
- Bus to Electric train
- non-motorized implementation
- Promotion of walkable city

**New technology**
- Hybrid (Battery)
- Hybrid (Plug-in)
- Electric car
- Electric railway

**Fuel switching**
- Biodiesel (B-5)
- Biodiesel (B-10)
- Biodiesel (B-20)
- Ethanol

**LCP-ABS Action 3: Smart Passenger Transport**

Diffusion of new technology
- Promotion of buying eco-vehicle
- Promotion of buying alternative vehicle

Mobility management
- TDM promotion
- Implementation of alternative energy

Fuel switching
- Electric railway
- Electric car

Modal shift
- Increase of non-motorized vehicle
- Increase of public transport
- Park & Ride

Smart Passenger Transport

Diffusion of new technology
- Promotion of buying eco-vehicle
- Promotion of buying alternative vehicle

Mobility management
- TDM promotion
- Implementation of alternative energy

Fuel switching
- Electric railway
- Electric car

Modal shift
- Increase of non-motorized vehicle
- Increase of public transport
- Park & Ride

Transport Demand Management

Shift mode
- Bus to Electric train
- non-motorized implementation
- Promotion of walkable city

New technology
- Hybrid (Battery)
- Hybrid (Plug-in)
- Electric car
- Electric railway

Fuel switching
- Biodiesel (B-5)
- Biodiesel (B-10)
- Biodiesel (B-20)
- Ethanol
Effective Freight Transport

Modal shift

Diffusion of new technology

Promotion of buying alternative vehicle

Fuel switching

Implementation of alternative energy

Increase of public transport

Transport Demand Management

New technology
- Hybrid (Battery)
- Electric railway

Fuel switching
- Biodiesel (B-5)
- Biodiesel (B-10)
- Biodiesel (B-20)

<table>
<thead>
<tr>
<th>Year</th>
<th>Transport Demand Management</th>
<th>New technology</th>
<th>Fuel switching</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>223 kt-(\text{CO}_2)</td>
<td>17,666 kt-(\text{CO}_2)</td>
<td>51,358 kt-(\text{CO}_2)</td>
</tr>
<tr>
<td>2020</td>
<td>17,278 kt-(\text{CO}_2)</td>
<td>388 kt-(\text{CO}_2)</td>
<td></td>
</tr>
<tr>
<td>2030</td>
<td>20,154 kt-(\text{CO}_2)</td>
<td>15,332 kt-(\text{CO}_2)</td>
<td></td>
</tr>
<tr>
<td>2040</td>
<td>15,873 kt-(\text{CO}_2)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Hybrid (Battery)
- Electric railway
- Biodiesel (B-5)
- Biodiesel (B-10)
- Biodiesel (B-20)

- Fuel shift of vehicle from oil to biofuel
- Biofuel promotion
- Biofuel vehicle subsidy
- Planning of light rail transit
- Increase of railway use

18th AIM International Workshop, NIES
Energy efficient building appliances
- Lighting system
  * Compact fluorescent Lamp
  * T5 Lamp
  * LED Lamp
- Cooling system
  * AC with COP-6
  * AC with COP-9
- Cooking system
  * Efficient gas stove

Building code

<table>
<thead>
<tr>
<th>Year</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO₂</td>
<td>205</td>
<td>850</td>
<td>1200</td>
<td>2000</td>
<td>2500</td>
</tr>
</tbody>
</table>

Modern buildings

Energy saving behavior
- Environmental education
  - Environmental education in school
  - Promotion of eco-community association
  - Promotion of energy saving behavior
  - Planning and operating of consultation system for energy efficient buildings

Energy efficiency improvement
- Diffusion of energy saving management systems
  - Diffusion of energy efficient building appliances
  - Planning of public building insulation management system
  - Energy saving information of public buildings

Improvement of insulation level
- Energy and environmental standard labeling
  - Differentiation of energy saving labeling
  - Diffusion of energy saving labeling
  - Diffusion of environmental energy level

Diffusion of new technology
- Promotion of insulation
  - Planning of insulation
  - Promotion of insulation

Diffusion of high performance equipment
- Implementation of advanced energy saving equipment
  - Planning of consultation system for energy efficient buildings
  - Promotion of energy saving equipment
  - Promotion of planting tree area
  - Promoting the tree planting area
  - Operating subsidy system of tree planting

18th AIM International Workshop, NIES
Robust Roadmap to Thailand’s LCS Scenario

**Power sector**
- Energy efficiency improvement
- Environmental education
- Diffusion of energy management systems
- Energies and environmental standard labeling
- Promotion of utilization
- Diffusion of high-performance equipment

**Industries**
- Energy efficiency improvement
- Diffusion of energy management systems
- Energies and environmental standard labeling
- Promotion of utilization
- Diffusion of high-performance equipment

**Buildings**
- Energy efficiency improvement
- Diffusion of energy management systems
- Energies and environmental standard labeling
- Promotion of utilization
- Diffusion of high-performance equipment

**Transport sector**
- Energy efficiency improvement
- Diffusion of energy management systems
- Energies and environmental standard labeling
- Promotion of utilization
- Diffusion of high-performance equipment
Total GHG Emissions 2005-2050 (Peak CO$_2$)
Acknowledgement

どうもありがとうございました

Thank You