Thailand Energy System Model

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AIT
Asian Institute of Technology

Key Design Characteristics

- ***Participating Model:*** Thailand Energy System Model (Country Model)
- ***Model Type:*** Bottom-up cost optimization (both AIM-Enduse and MARKAL versions) along with AIM Energy Snapshot (decomposition analysis)
- ***Participating Modelers:*** Ram M. Shrestha, Shreekar Pradhan, Migara Liyanage
- ***Time Step:*** 5 years
- ***Time Frame:*** 2005 to 2050
- ***Solution Type:*** Linear intertemporal Optimization
- ***Equilibrium Type:*** Partial Equilibrium
- ***Underlying Computing Framework:*** GAMS

Inputs and Outputs

Key inputs

- ***Demographics:*** Population (urban and rural)
- ***Economic:*** GDP, GDP growth rates, fuel prices, end-use service demands
- ***Resources:*** Depletable resources by grade (e.g. fossil fuels); renewable resources by grade (e.g. wind, solar, biomass).
- ***Technology:*** Extraction, transformation, process and end-use technologies (incl. emerging technologies e.g., hybrid vehicles, flex-fuel vehicles, CCS)

Key outputs

- ***Energy:*** Optimal energy mix in production, transformation and end uses.
- ***Technology:*** Optimal technology mix in energy supply, production and end use.
- ***Energy Efficiency:*** Transformation and final demand Sectors
- ***Emissions:*** CO_2 emissions, non-CO2 emissions (SO_2, NOx)
- ***Cost:*** Total cost and its break down

Regional Scope & Other Detail

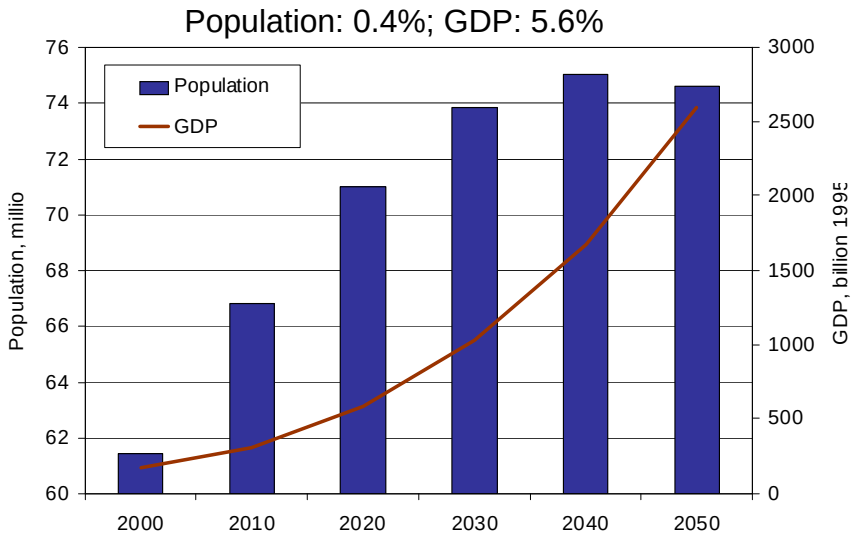
Regional Details:

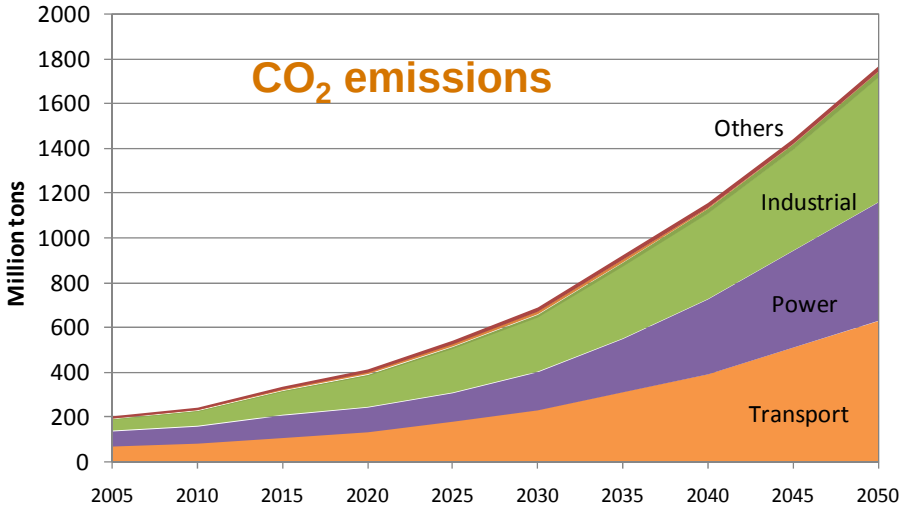
- ***Regional Scope:*** Country Model
- ***Number of Sub-Regions:*** Single region
- ***Asian Regions:*** Thailand

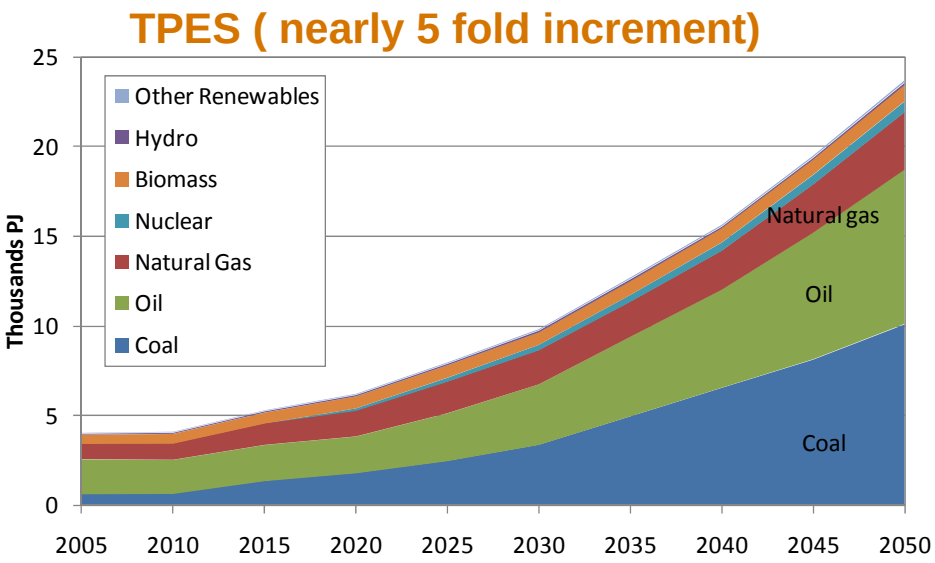
Other Details:

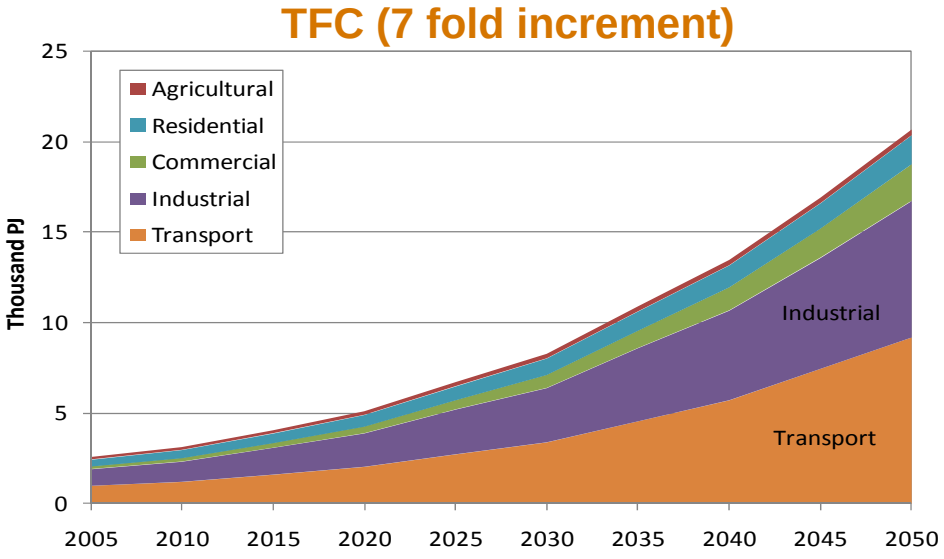
- ***Energy Demand Sectors:*** Residential (disaggregated into urban and rural household subsectors), Commercial, Industry and Transportation and Agriculture
- ***Energy Supply Sectors:*** Fossil Energy Production, Electricity Generation, renewables e.g., biomass, biogas, biofuels, nuclear (after 2020)
- ***Others:*** Learning effects (Solar, Wind, CCTs), Autonomous energy efficiency improvement (AEEI) of RE and CC technologies.

Thailand Base case: 2005-2050 (1)

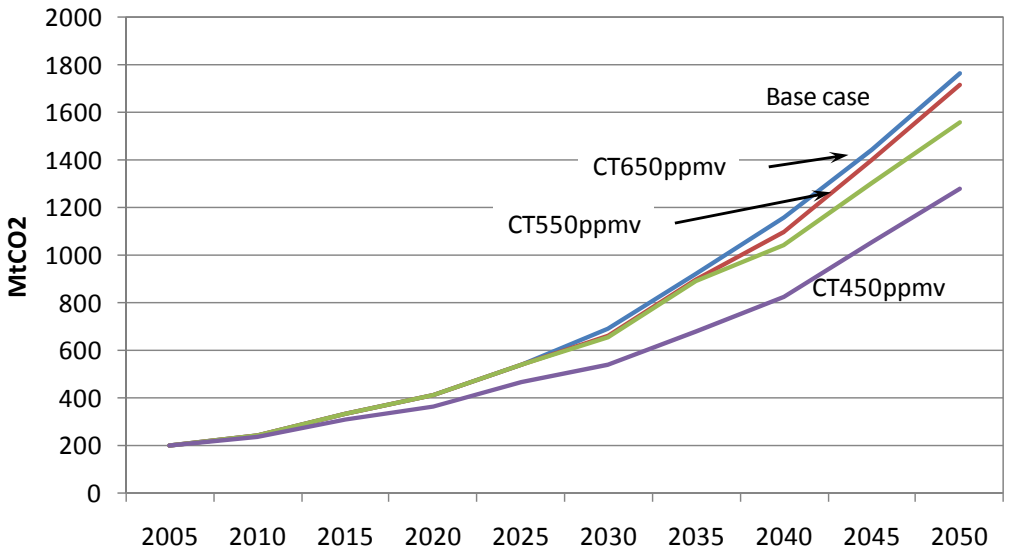








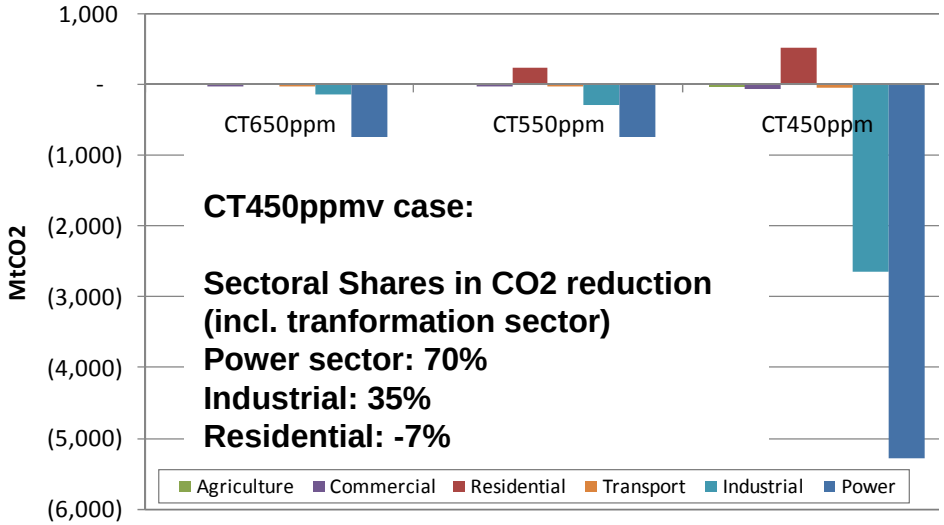
Effects of Carbon tax during 2005-2050: Thailand

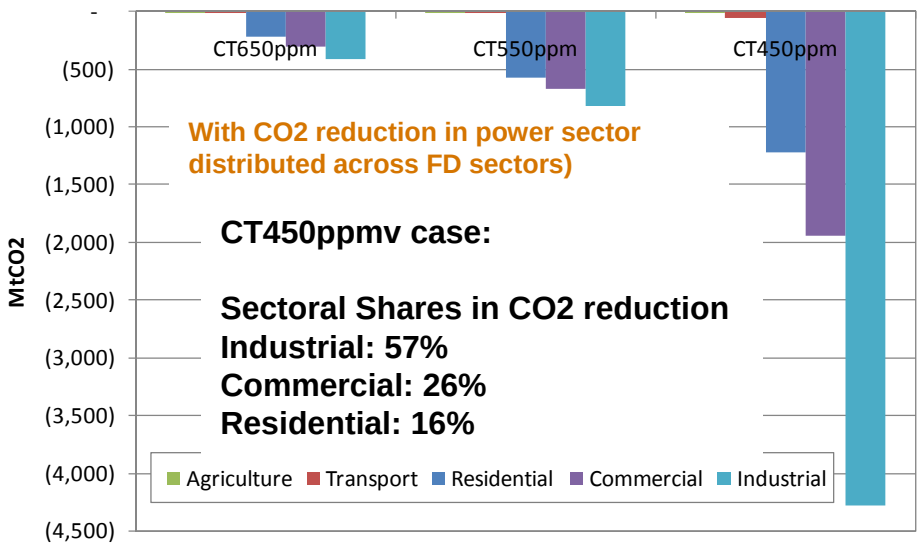


Base case: with LR and AEEI

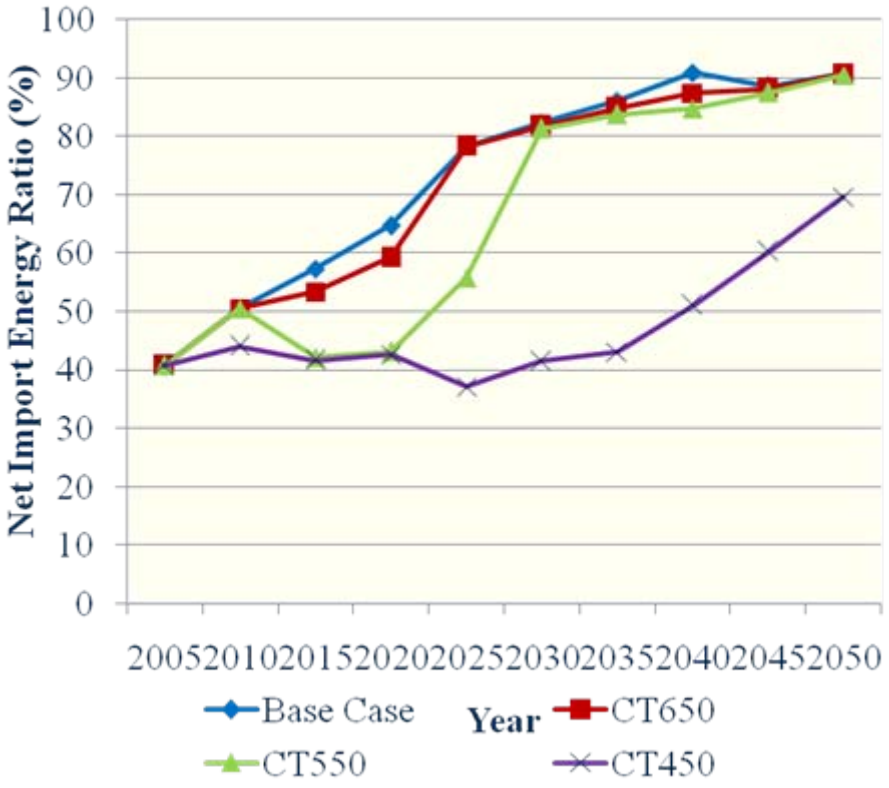
CO2 reduction from Base case emissions:

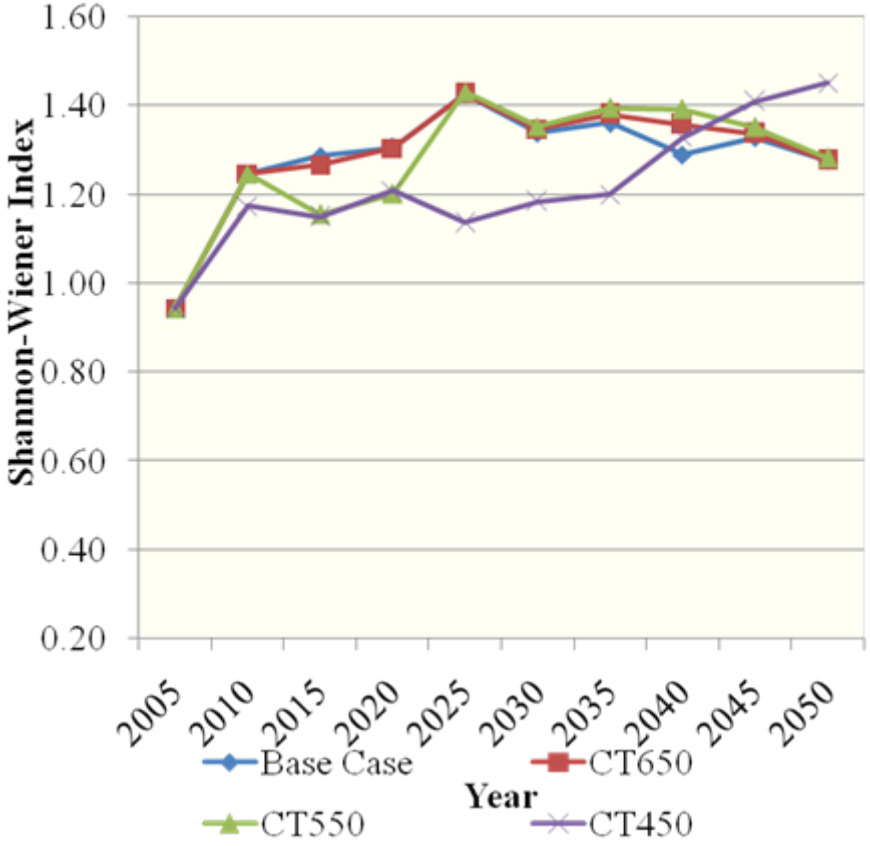
- 3% in CT650ppmv
- 6% in CT550ppmv
- 22% in CT450ppmv





Effect of carbon Tax on energy security: Sri Lanka





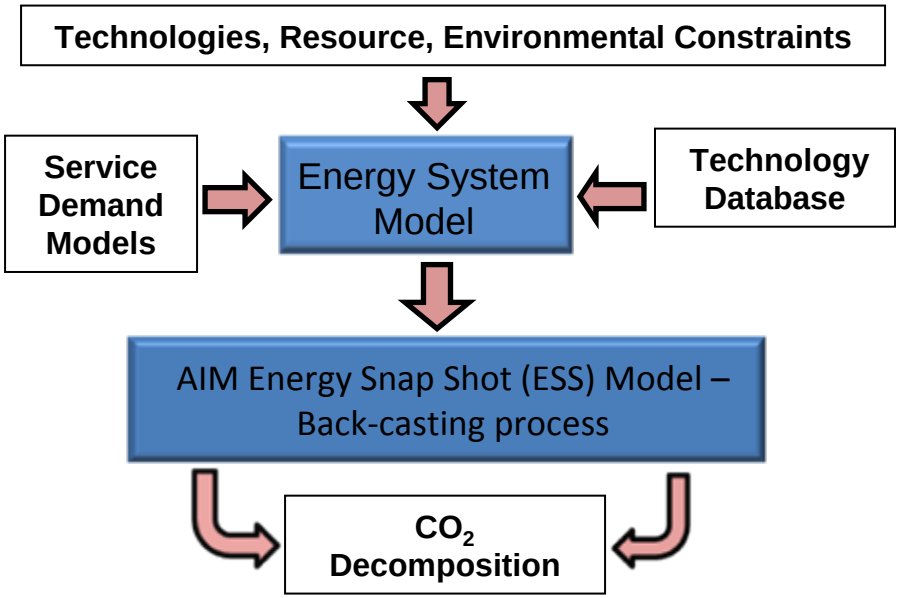
Other AIT Modeling Works on Asian Countries

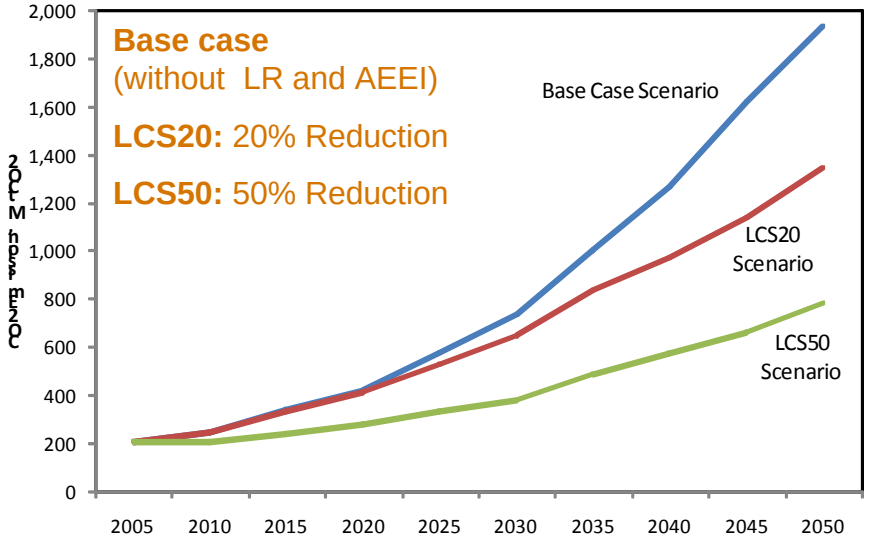
- AIM Enduse/Vietnam (Tung & Shrestha); AIM Enduse/Indonesia (Marpaung & Shrestha)
- GMS-MARKAL for Greater Mekong Subregion— covering 5 countries: Cambodia, Laos, Myanmar, Thailand and Vietnam (Mayurachat W. and R. Shrestha) – analysis of cross-border cleaner energy resource development and "trade", CO2 emission reduction targets (regional vs. national level)
- National Energy System Models (MARKAL based) : Bangladesh, Bhutan, Nepal, Pakistan, Sri Lanka, Vietnam

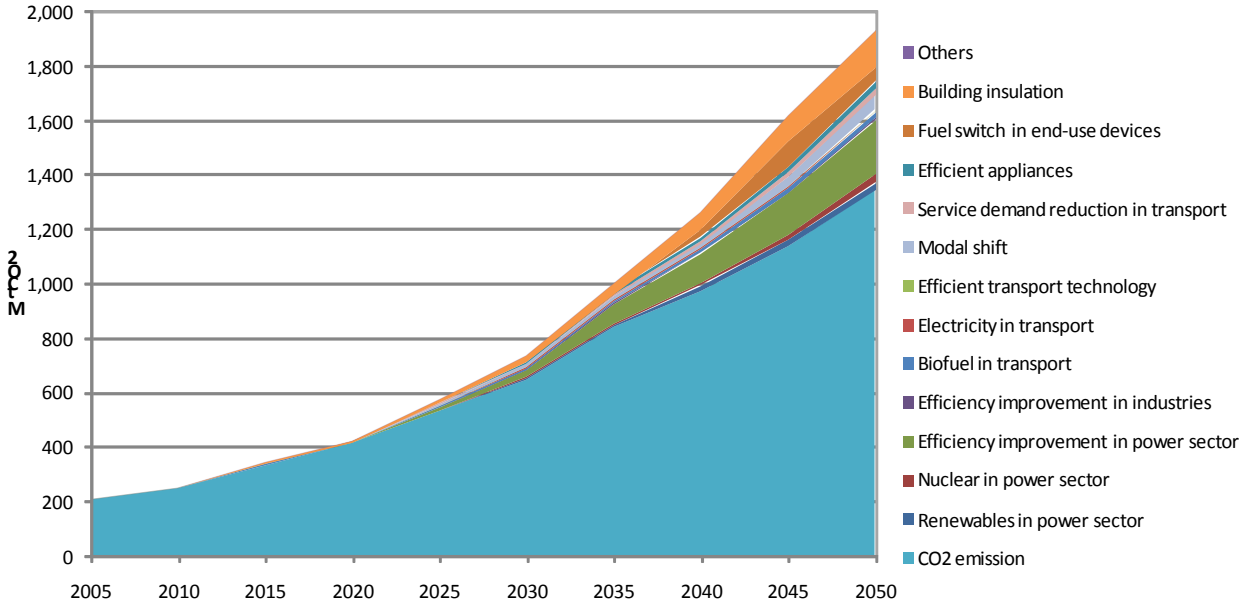
  (for CO2 reduction targets, carbon tax, RPS, energy security policy (energy import limitation policy)) (R. Shrestha and several others)

  - Potential Use: ADB Study on economics of climate change in 5 countries of South Asia
- City level Energy System Model of Kathmandu Valley (Rajbhandari and Shrestha)
- AIM CGE/Thailand (for energy- and carbon tax analyses; S. Malla)
- Thailand CGE (for Carbon tax and CDM analyses; Timilsina and Shrestha)
- IRP models of power sector of 7 countries: China, India, Indonesia, Nepal, Sri Lanka, Thailand and Vietnam (for carbon tax and energy tax analysis; R. Shrestha and several national experts)

Thailand Low Carbon Scenarios: 2005-2050
Energy Supply-Energy Snapshot-Backcasting approach







Major CO2 reduction Measures:

In LCS20:

- Efficiency improvement in the power sector and
- Building insulation

Co-benefits of Carbon Tax: Reduction of Local Pollutant Emissions (Thailand)

Total NO_X and SO_2 Emission Reduction in Carbon Tax Scenarios during 2005-2050

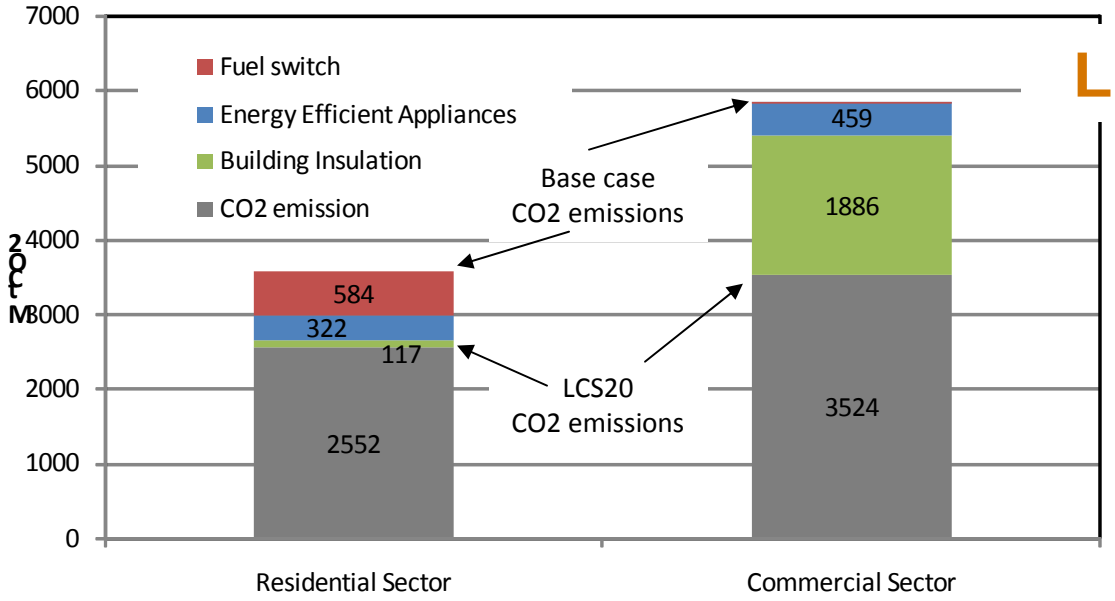
Sector	Base case NOx emission Mtons	NO_x emission reduction, Mtons			Base case SO_2 emission Mtons	SO_2 emission reduction, Mtons		
		C10+	C75	C100		C10+	C75	C100
Industrial	27.8	0.7	1.9	2.5	65.8	9.0	18.9	17.7
Power	26.4	3.6	9.2	11.3	123.5	6.8	64.7	82.5
Transport	90.9	0.0	0.0	0.0	36.2	1.8	1.9	2.0
Others	10.0	0.0	0.1	0.0	5.6	0.0	0.1	0.0
Total	155.1	4.3	11.2	13.8	231.1	17.6	85.6	102.2

- NO_X emission reduction would be the highest in the power sector followed by the industrial sector.
- Similarly, the power sector accounts for the highest level of SO_2 emission reduction and is followed by the industrial and the transport sectors.

Source: Shrestha et al., 2008

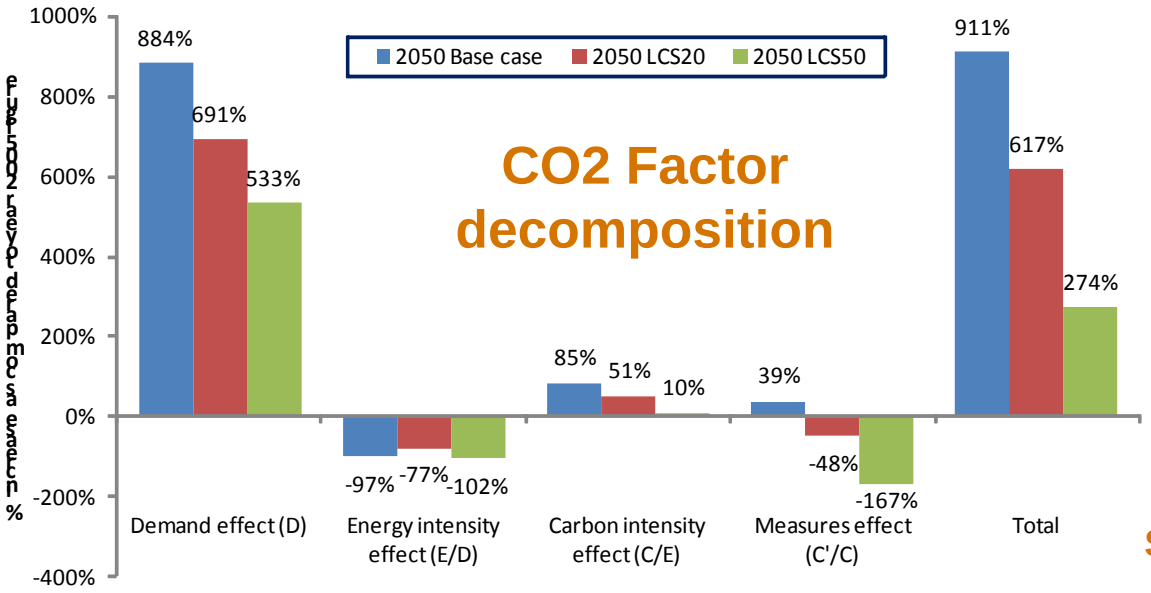
AIM/Enduse-Thailand

Decomposition of CO2 Emission Reduction- Based on AIM-ESS Model



LCS20

- **Residential and Commercial sector:** about 9% of CO2 reduction from base case cumulative CO2 emissions.



- **In LCS20, carbon intensity is decreased but major reduction takes place due to service demand reduction measures .**
- **In LCS50, carbon intensity is very low and also energy efficiency would gain.**
- **Demand reduction and power generation measures have a larger effect in CO2 reduction.**

Source: Thailand LCS scenarios

Carbon Tax Cases

CT 650:
Using carbon tax of 0.7US$/$tCO_2$ in 2010 and increase up to 10.1US$/$tCO_2$ by 2050. This is the carbon tax level required to achieve the 650ppm stabilization target

CT550:
Using carbon tax of 1.5US$/$tCO_2$ in 2010 and increase up to 20.7US$/$tCO_2$ by 2050. This is the carbon tax level required to achieve the 550ppm stabilization target.

CT450:
Using carbon tax of 8.3US$/$tCO_2$ in 2010 and increase up to 111.6US$/$tCO_2$ by 2050. This is the carbon tax level required to achieve the 450ppm stabilization target