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Analyzing Co-benefits of Greenhouse Gas Mitigation Targets and Measures in Thailand

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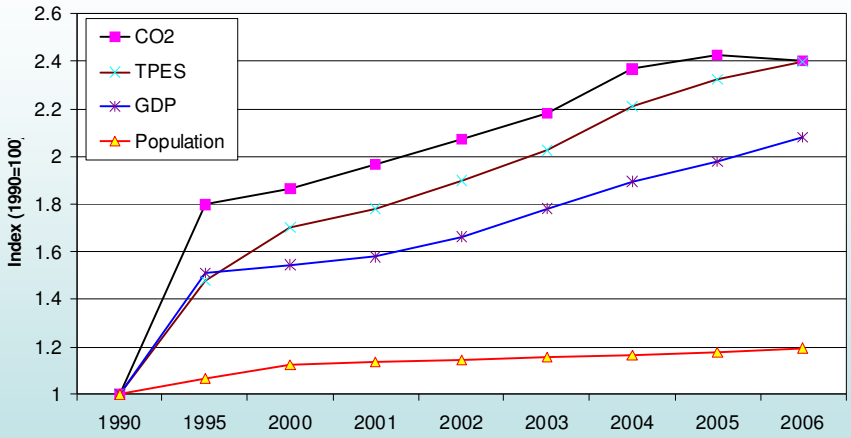
Outline

- Introduction
- What would be the impact on SO_2 and NOx emission when CO_2 reduction is targeted (ERT)?
- How would the impact vary with different level of ERT?
- How would the CO_2 reduction target impact the fuel efficiency of end-use sector?
- What would be the role of emerging technologies like hybrid, CCS etc.?
- What would happen to energy security?
- Conclusions and final remarks

2

CO_2, TPES, GDP and Population Growth during 1990-2006



AAGR (2001-2006):
CO_2: 4.35% Population: 1.02%
TPES: 5.91% GDP: 5.07%

Source: DEDE, 2006, IMF, 2008, IEA, 2007 and 2008

3

Scenario Description

Base case and three emission reduction target scenarios as follows:

1) Base case
2) 10% Emission reduction target (ERT10)
3) 20% Emission reduction target (ERT20)
4) 30% Emission reduction target (ERT30)

- MARKAL modeling framework – the least cost optimization model is used for the analysis.
- All prices are given in US$ 2000 price.

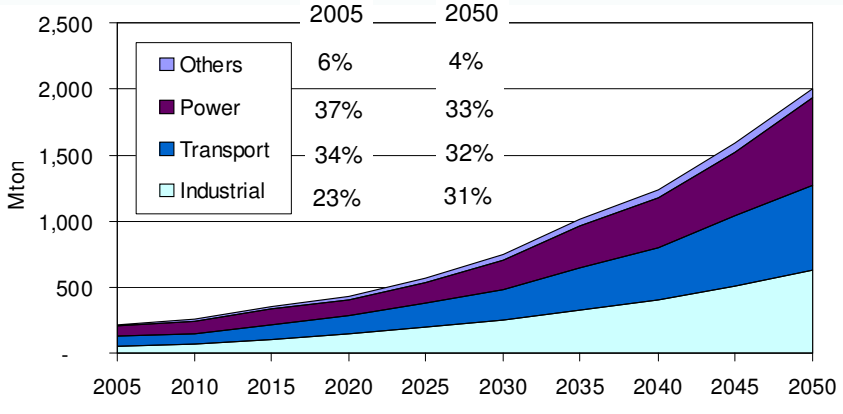
4

What are the assumptions in the Base Case?

- CAGR (2000-2050): Population: 0.4%; GDP: 5.6%
- No greenhouse gas (GHG) mitigation policy intervention.
- Nuclear power generation would be introduced from 2020 onwards (2000 MW is proposed to be installed in 2020 and similarly in 2021 (EGAT, 2007)).
- Minimum of 3 million liters of ethanol per day and 4 million liters of biodiesel per day would be used by 2015 in the transport sector.
- 64,000 thousands tons of feedstock (e.g., cassava, molasses, sugarcane and others) for ethanol production and 2,550 thousands tons of oil seed (palm oil and coconuts) for biodiesel production would be available from 2015 onward during the planning horizon.
- Emerging technologies like hybrid vehicles are considered to be available from 2015 onward; fuel cell vehicles and power generation with carbon capture and storage technology are considered to be available from 2020 onward.

5

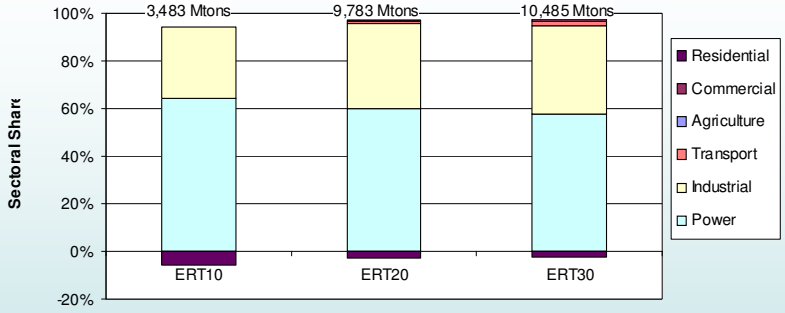
How much CO_2 would be emitted in the base case during 2005-2050?



Total CO_2 emission would increase by more than 7 folds during 2005-2050 (AAGR 4%), i.e., 223 million tCO_2 in 2005 to 2,006 million tCO_2 in 2050.

6

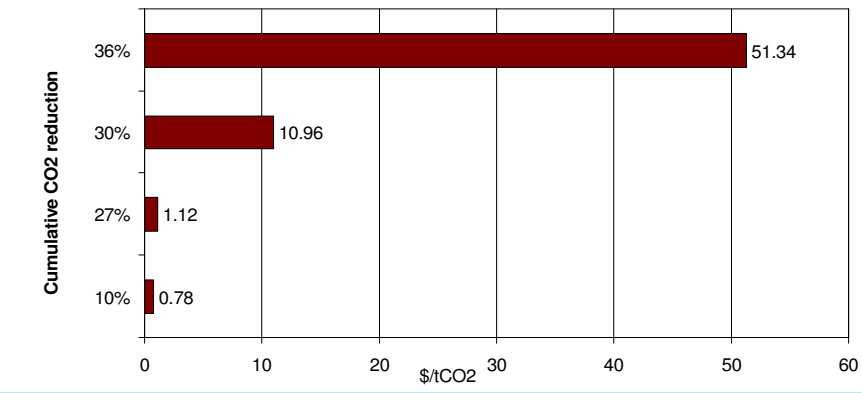
How would different sectors contribute to the CO_2 emission reduction targets?



- Highest CO_2 emission reduction from the power sector, followed by the industrial and transport sectors.
- Over 73%, 64% and 61% of the total CO_2 emission reduction from the power sector in ERT10, ERT20 and ERT30 cases respectively.
- Major role of natural gas based advanced combined cycle power generation, carbon capture and storage (CCS) and nuclear based power generation in the power sector CO_2 emission reduction.
- Up to a maximum of 36% reduction from the base case emission could be feasible under the present framework.

7

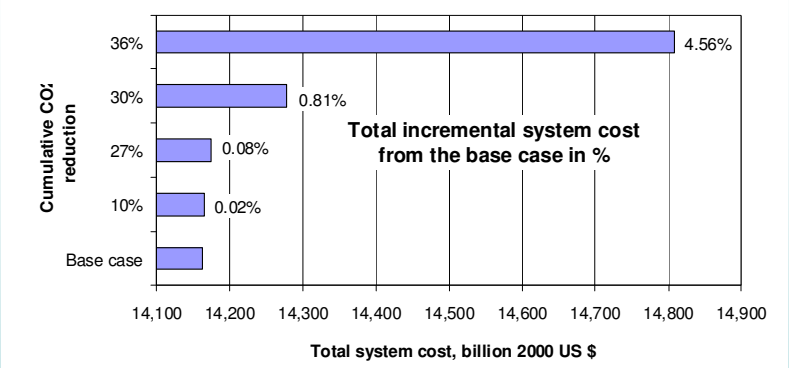
What would be the CO_2 abatement cost ($/t$CO_2$) under different ERTs?



- Up to 27% of the total CO_2 emission could be cost effectively mitigated at $ 1.12 per ton of CO_2.
- The cost for CO_2 abatement higher than 27% would be much higher and would increase from $ 10.96 to $ 51.34 for 30% to 36% emission reduction from the base case respectively.

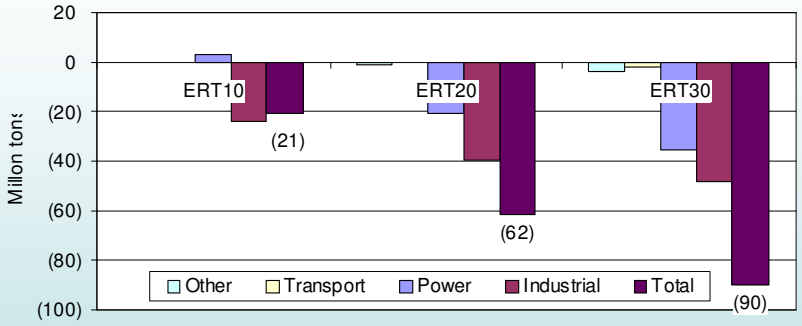
8

How would the total cost increase with emission reduction?



- A maximum of 36% of CO_2 emission reduction would be possible from that in the base case as has been considered in the study (e.g., assuming there would be no modal shift to MRTs and electric railways, no reduction in service demand etc.).
- Total cost increases drastically for targets above 27% of emission reduction.

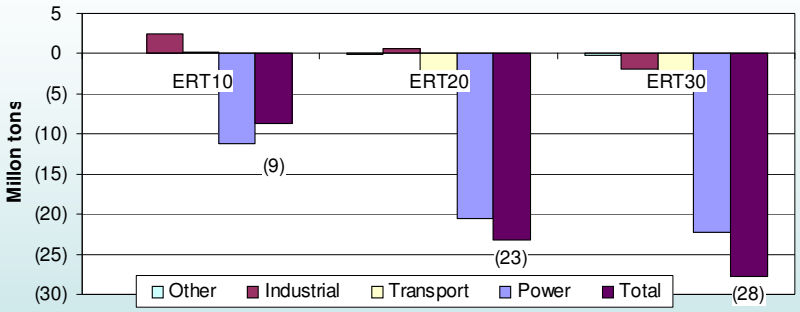
How much co-benefit in terms of SO_2 reduction?



- SO2 reductions of 10%, 28% and 41% from the base case value under ERT10, ERT20 and ERT30.
- The highest SO2 reduction (over 54%) from the industrial sector followed by the power sector.

10

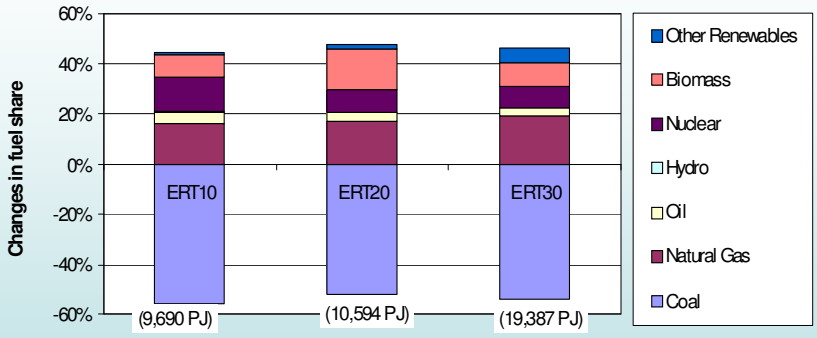
How much co-benefit in terms of NOx reduction?



- % reduction of NOx relatively lower than % reduction of SO_2 emission.
- NOx reduction of 2%, 6% and 7% of from the base case value under ERT10, ERT20 and ERT30 respectively.
- The highest NOx reduction (over 80%) would take place in the power sector followed by the transport sector.

11

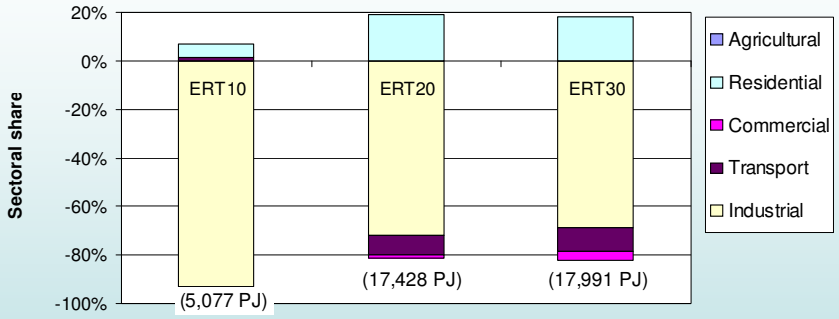
How much reduction in primary energy requirement?



- Total primary energy requirement would decrease by 1.9%, 2.0% and 3.7% under ERT10, ERT20 and ERT30 respectively.
- Coal requirement would significantly decrease in all the cases.

12

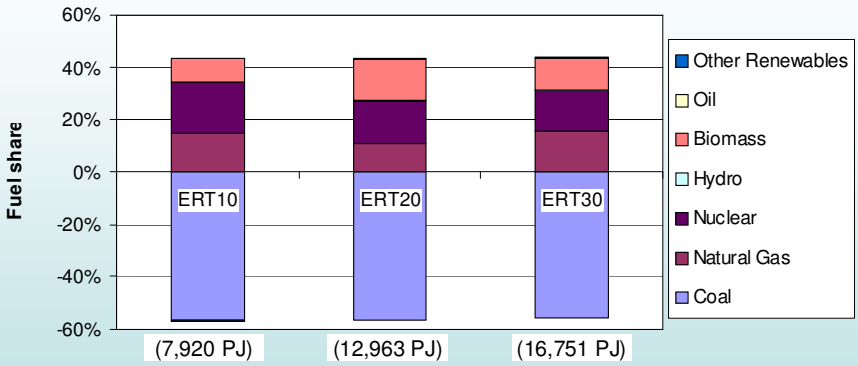
How much reduction in final energy demand?



- Final energy demand would decrease by 1.2%, 4.2% and 4.3% under ERT10, ERT20 and ERT30 respectively.
- The industrial sector would gain most in terms of energy efficiency.

13

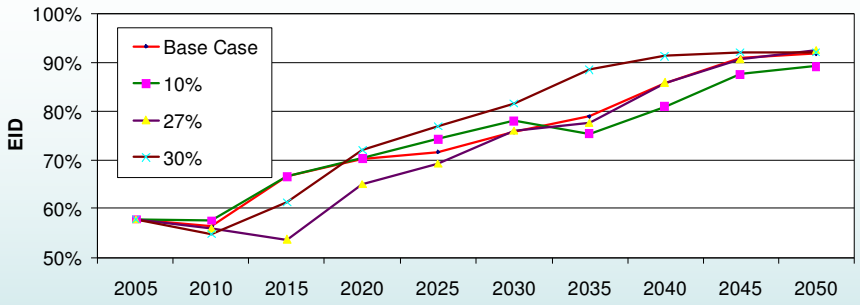
Reduction in energy requirement for power generation under ERT?



- Energy requirement in power generation would be reduced by 5.0%, 8.2% and 10.6% under ERT10, ERT20 and ERT30 respectively.

14

Energy security as a co-benefit ??



- TPES would be reduced by 1.9%, 2.0% and 3.7% under ERT10, ERT20 and ERT30 respectively.
- Cumulative energy import dependency (EID) in base case would be 80.6%. EID would decrease from the base case by 1.9% and 1.7% in ERT10 and ERT20. **On the contrary, EID would increase by 2.9% in ERT30.**
- The level of energy import dependency in year 2050 in ERT20 and ERT30 would be similar to that in the base case (i.e., 92%). In ERT10, EID would slightly decrease (to 89%) in 2050.

Conclusions and final remarks

- In the base case, total cumulative CO2 emission during 2005-2050 would increase from 223 million tons in 2005 to 2,006 million tons by 2050.
- Total cost increases drastically for emission reduction targets above 27%.
- Incremental CO2 abatement cost would be in the range of US$ 0.78 to US$ 10.96 per ton CO2 under ERT10 and ERT30 respectively.
- SO2 emission would decrease in the range of 10% to 41% under the emission reduction targets of 10% to 30%.
- NOx emission would decrease by a relatively smaller percentage than SO2 emission under ERTs (i.e., in the range of 2% to 7%). .
- Total primary energy requirement would decrease in the range of 1.9% and 3.7% under ERT10 to ERT30 reflecting improvements in energy efficiency in various sectors.
- Cumulative energy import dependency increment would decrease from the base case by 1.9%, 1.7% in ERT10 and ERT20 respectively. In ERT30, it would increase by 2.9% suggesting an adverse impact on the energy security.
- The role of demand side management in building sector and modal shift to MRT and other public transport systems not fully captured by the present model. The emission reduction potential could be higher if these options were also captured. Further works in these respects would be useful.

16

Thank you

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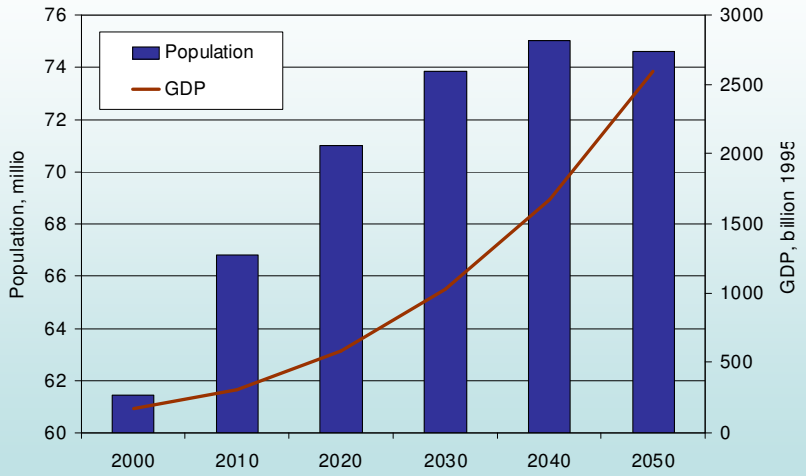
17

Brief Background on Thailand

- **Location**:
  - Area of 513,115 km^2 and extends about 1,620 km from north to south and 775 kilometres from east to west.
- **Population:** 64.76 million (2005)
- **Population Density:** 126 people/km^2
- **GDP:** US$ 176 billion in 2005
- **GDP per capita:** US $ 2727 (year 2005)
- 2nd largest economy in the ASEAN

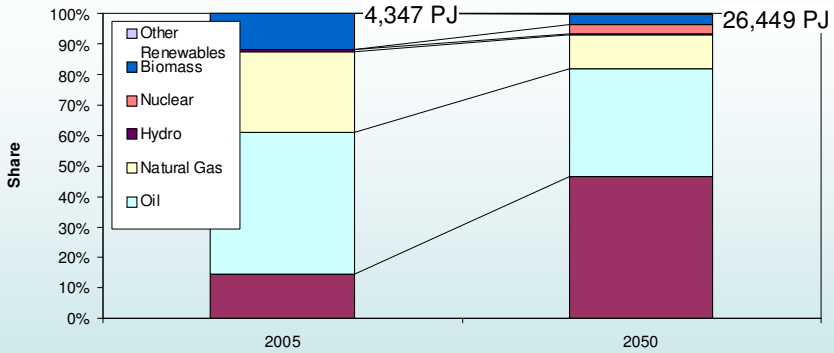
GDP and Population in the Base Case (2000-2050)



CAGR (2000-2050):
Population: 0.4% GDP: 5.6%

Sources: TDRI, 2004; UN, 2006

How would the primary energy supply mix change in the base case?

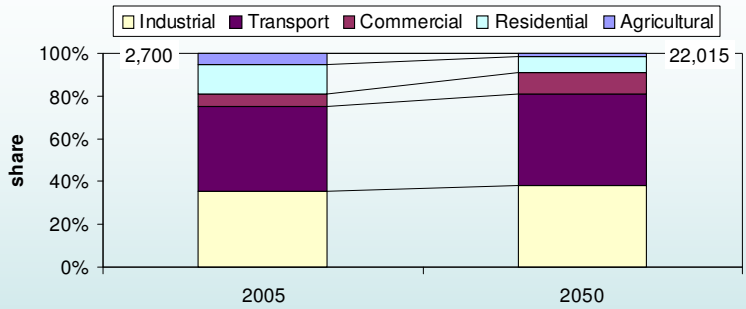


TPES would grow by 5 folds during the planning horizon.
In the base case, the shares of natural gas, oil and biomass would decrease and that of coal would increase.

- natural gas and oil share would decrease from 72% to 47%
- coal share would increase from 14% to 46%.
- biomass share would decrease from 11% in 2005 to 3% in 2050
- nuclear share would reach to 3% in 2050.

20

How would the final energy consumption change in the base case?



Final energy consumption would increase by 7 folds during 2005-2050, which is higher than the growth of TPES (gross energy efficiency of the economy increase from 62% in 2005 to 83% in 2050).

- transport sector share increase from 40% to 43%.
- Industry sector share increase from 36% to 39%.
- commercial sector share increase from 5% to 10%.
- residential sector share decrease from 14% to 7%.
- agriculture sector share decrease from 5% to 1%.

21