

Scenario-based Analyses of Energy System Development and its Environmental Implications in Thailand

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Prepared for

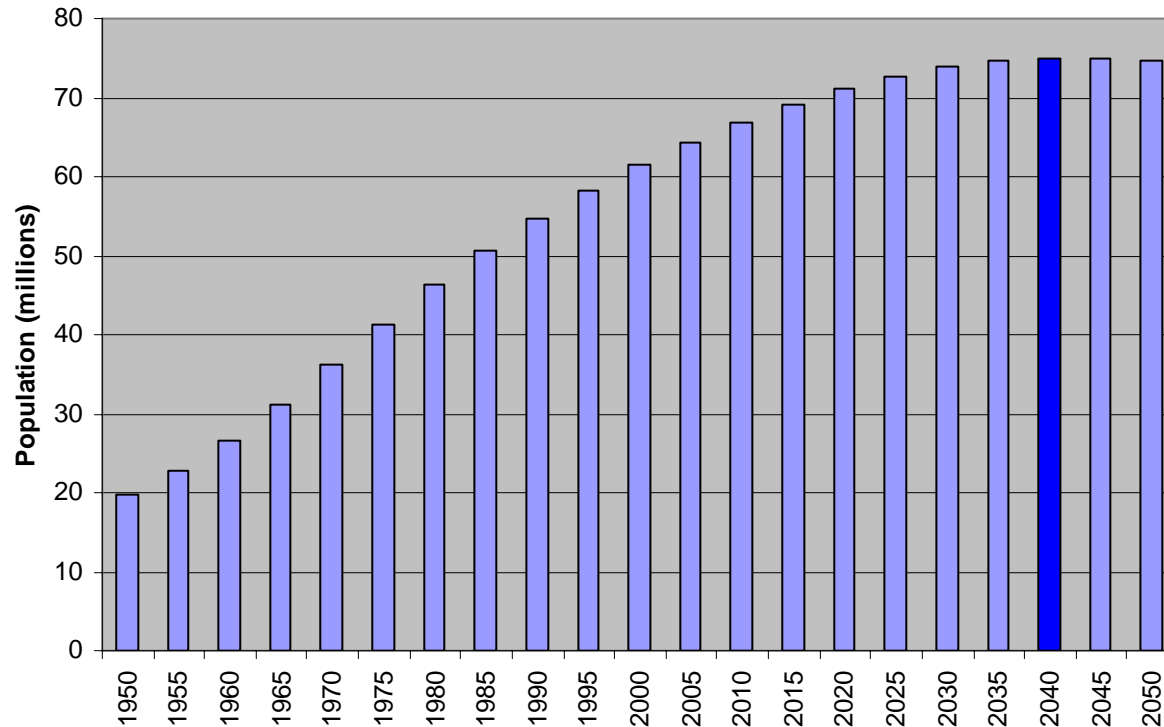
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Outline

- Socio-economic and energy profile/transitions in Thailand
- Scenario-based analysis
- Some current/planned policies favoring LCS

Demographic profile/transition

Population (millions)

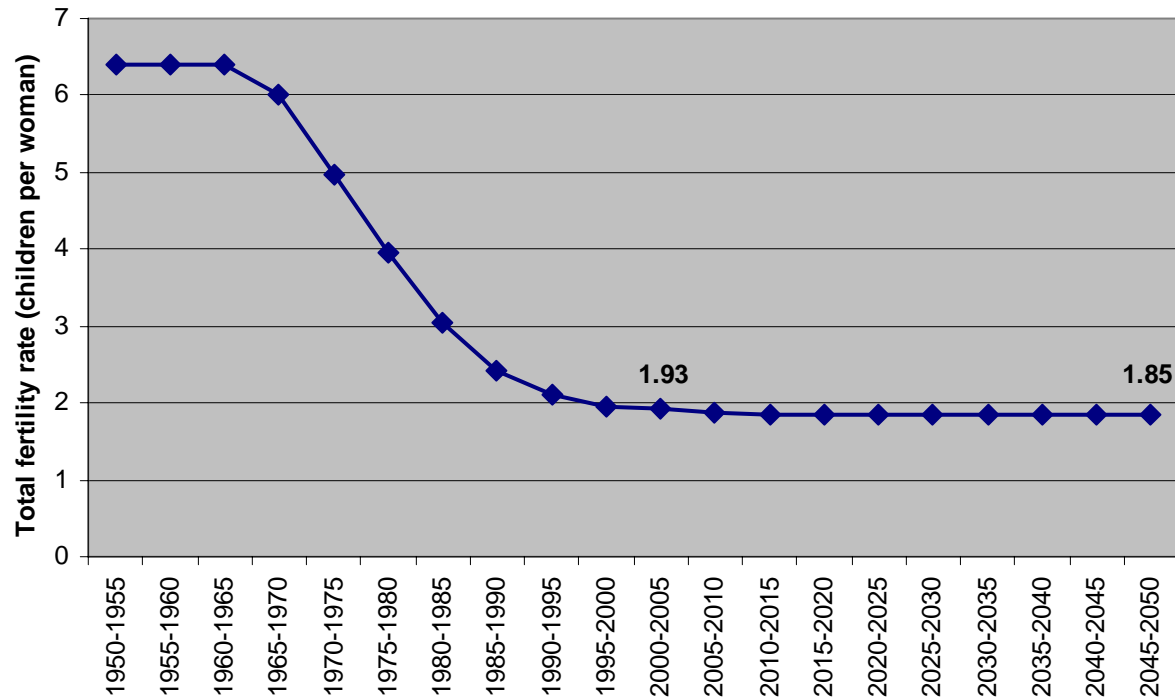


AAGR :	
1950-2000 :	2.3%
2000 – 2050:	0.4%

Source: UN's World Population Prospects: The 2004 Revision and World Urbanization Prospects: The 2003 Revision. Medium Variant.

- Total population is estimated to peak by 2040 (75 millions).
- Main reasons for slow projected growth rate is due to decline in total fertility rate and life expectancy improvement.

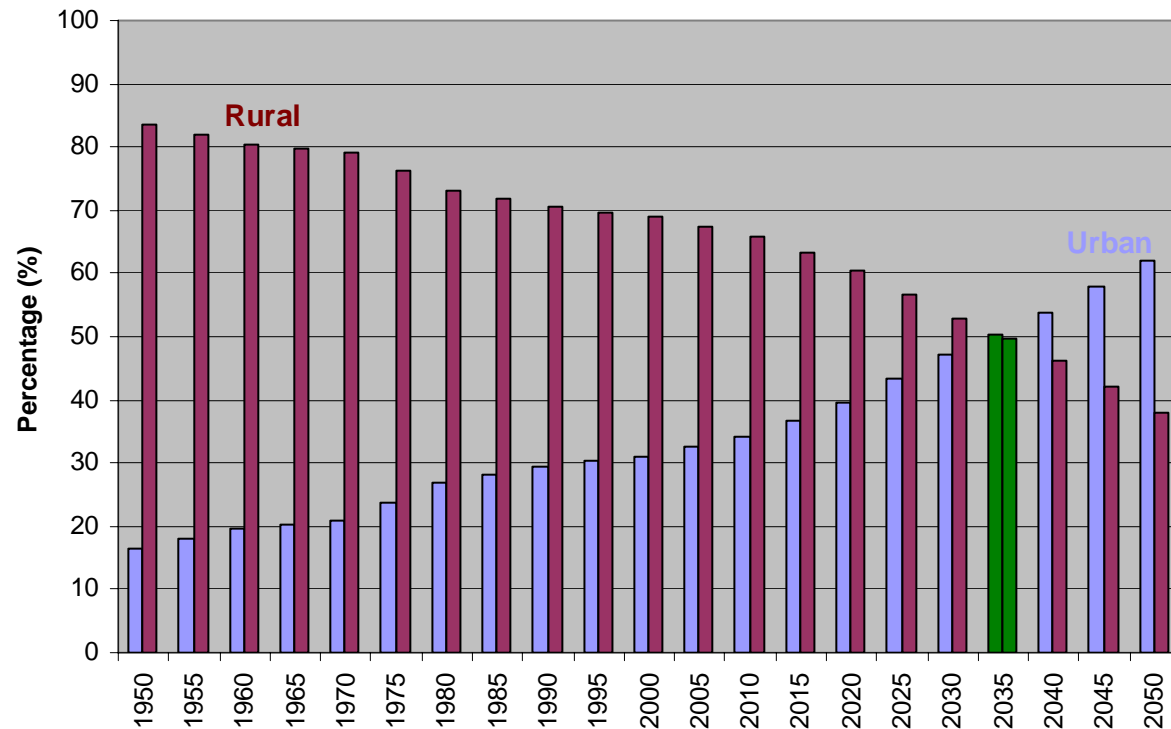
Total fertility rate (children per woman)



Source: UN's World Population Prospects: The 2004 Revision and World Urbanization Prospects: The 2003 Revision. Medium Variant.

- The total fertility rate falls from 1.93 children per woman between the period of 2000-2005 to about 1.85 children per woman by the period of 2045-2050.

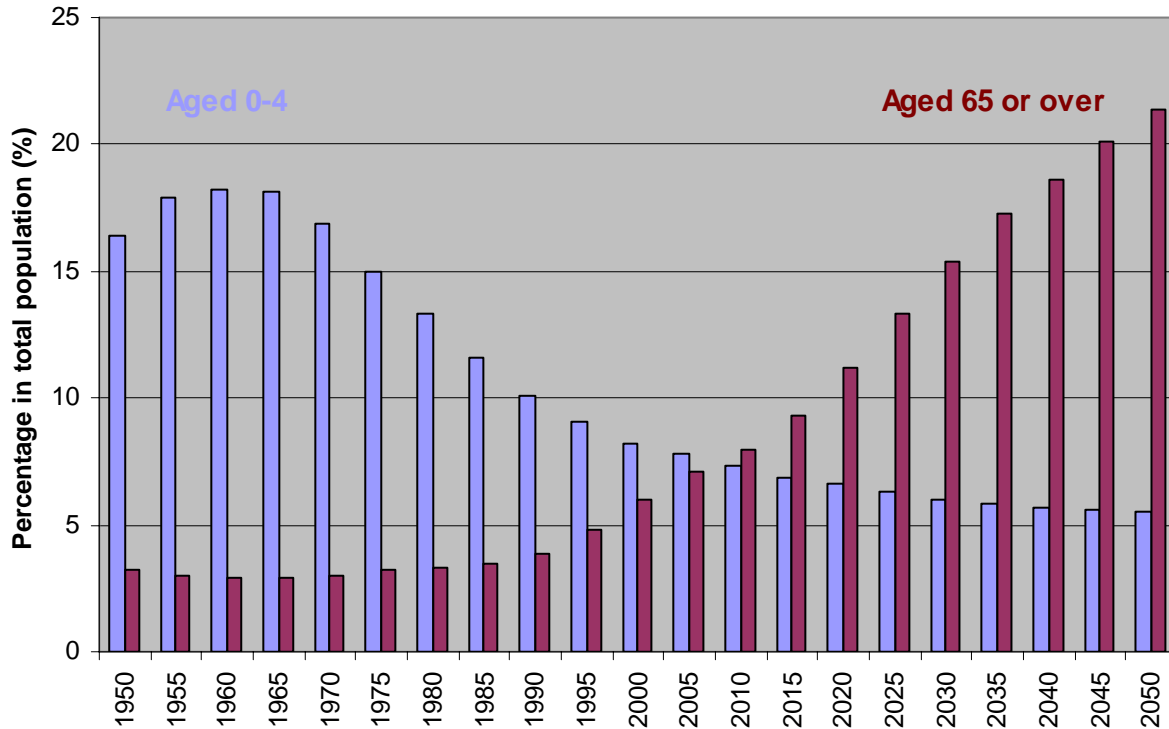
Urban-Rural Population (%)



Source: UN's World Population Prospects: The 2004 Revision and World Urbanization Prospects: The 2003 Revision. Medium Variant. Values for 2035-2050 are estimated.

- In 2000, urban population was 31% of total population and it is projected to double (62%) by 2050.
- By 2035, the share of both urban and rural population estimated to reach about 50%.

Population by age group (%)



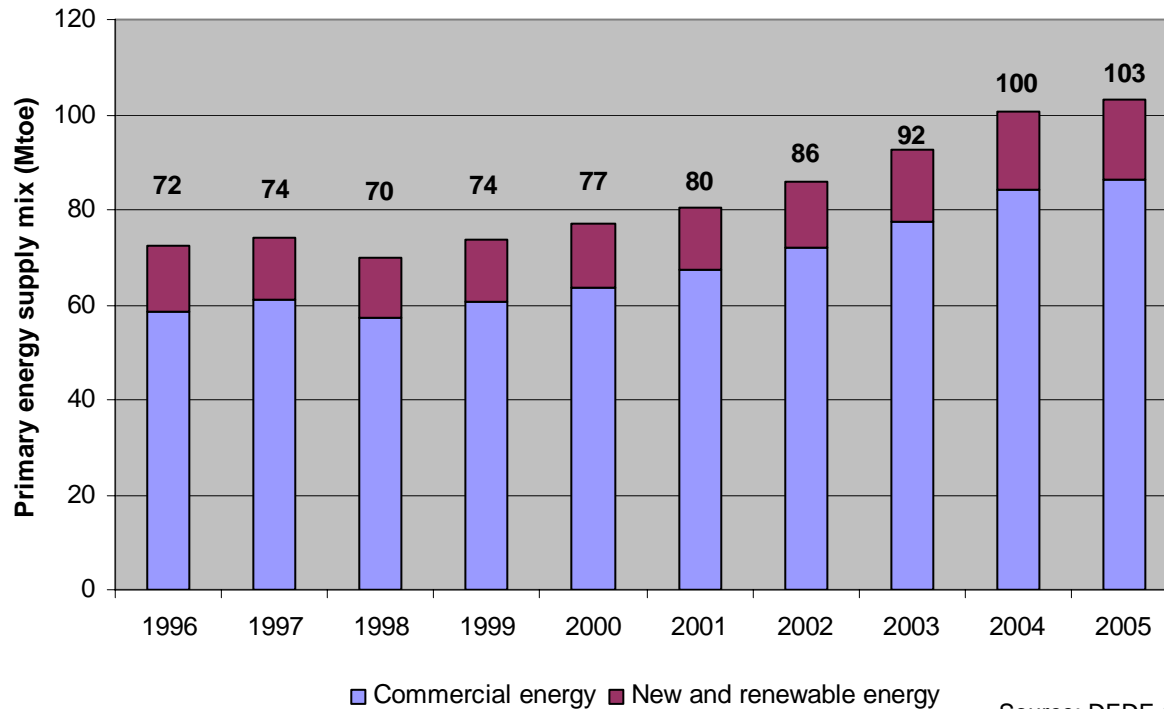
AAGR (2000-2050) :
 Aged 0-4: -0.8 %
 Aged 65 and over: 2.6 %

Source: UN's World Population Prospects: The 2004 Revision and World Urbanization Prospects: The 2003 Revision. Medium Variant.

- The number of people aged 65 and over rose from 0.6 million in 1950 (3.2% of total population) to 3.7 millions in 2000 (6% of total population) and it is projected to increase by 21.4% (16 millions) in 2050.
- On the other hand, the number of people aged 0-4 is estimated to decline in the future.

Energy and economy profile/transition

Primary energy supply mix (Mtoe)

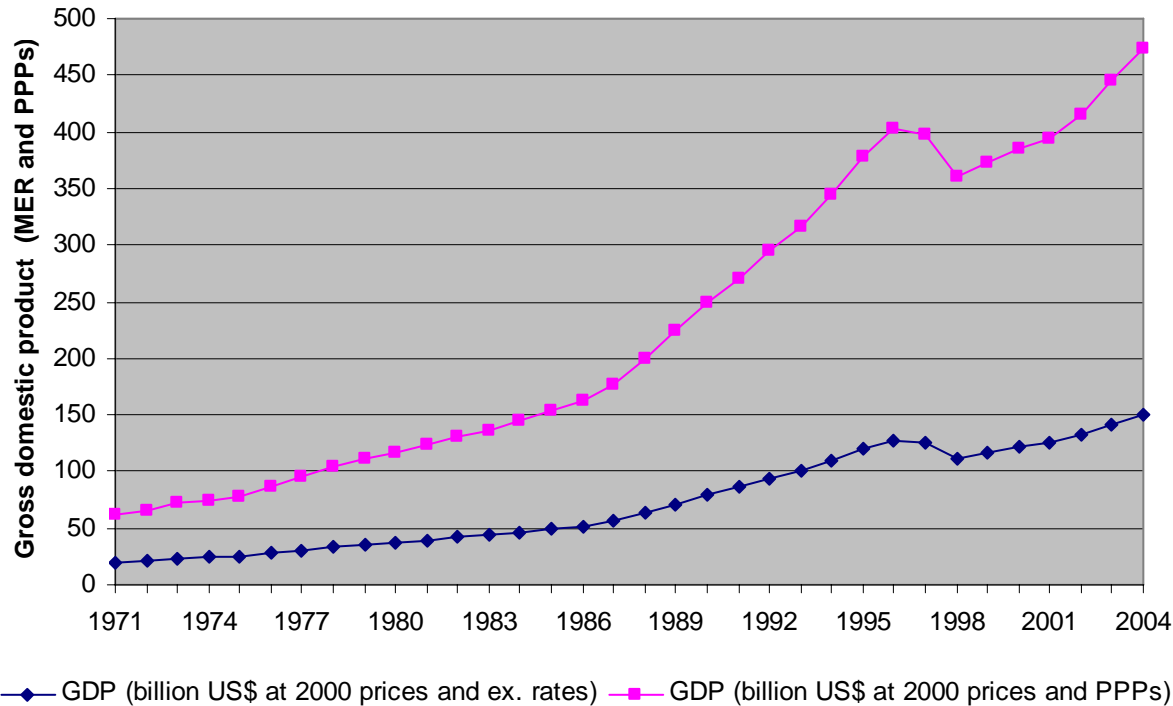


Source: DEDE (2007)

AAGR (1996-2005):
Commercial: 4.2%
New and renewable: 2.0%

- The total primary energy supply grew at an AAGR of 4.1% during last decade, from 72 Mtoe in 1996 to 103 Mtoe in 2005.

Gross domestic product (GDP)

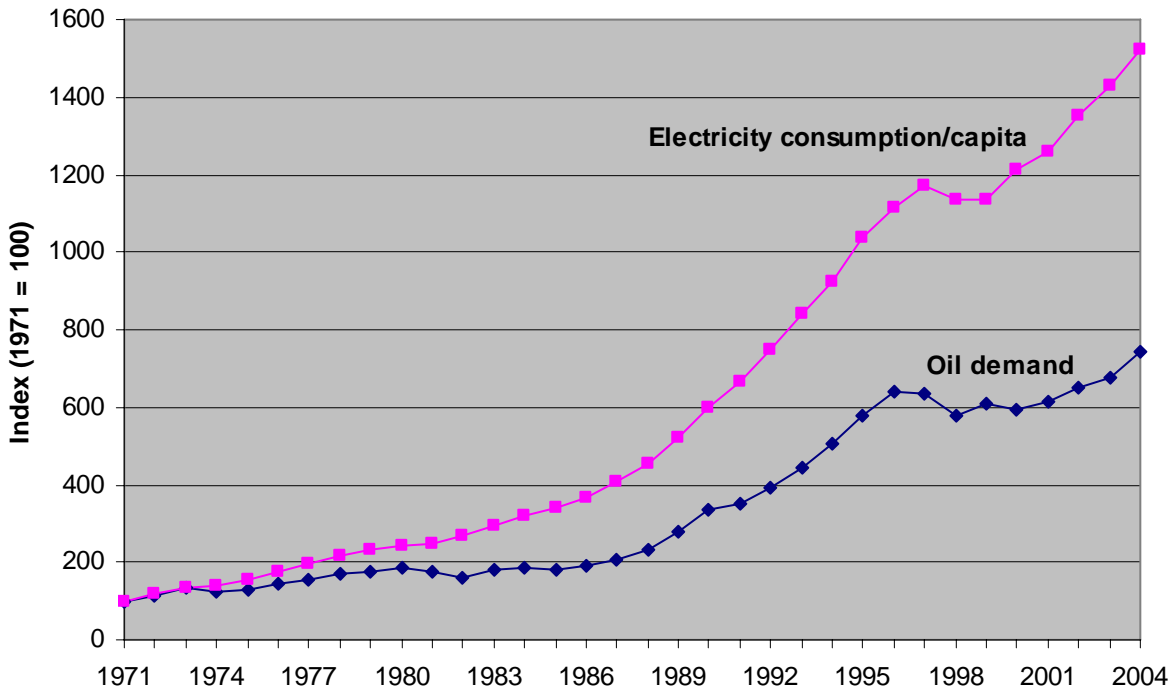


AAGR (1971-2004): 6.3%

Source: IEA (2006)

- In 1971, the country's GDP was it roughly US\$ 20.2 billion (at 2000 prices and exchange rate) and increased by more than seven-folds in size to approximately US\$150 billion by 2004.
- Over the period of 1971-2004, GDP grew with AAGR of 6.3%.

Electricity consumption per capita and Oil demand



Source: IEA (2006)

AAGR (1971-2005):

Electricity consumption per capita:	8.6%
Oil demand:	6.3%

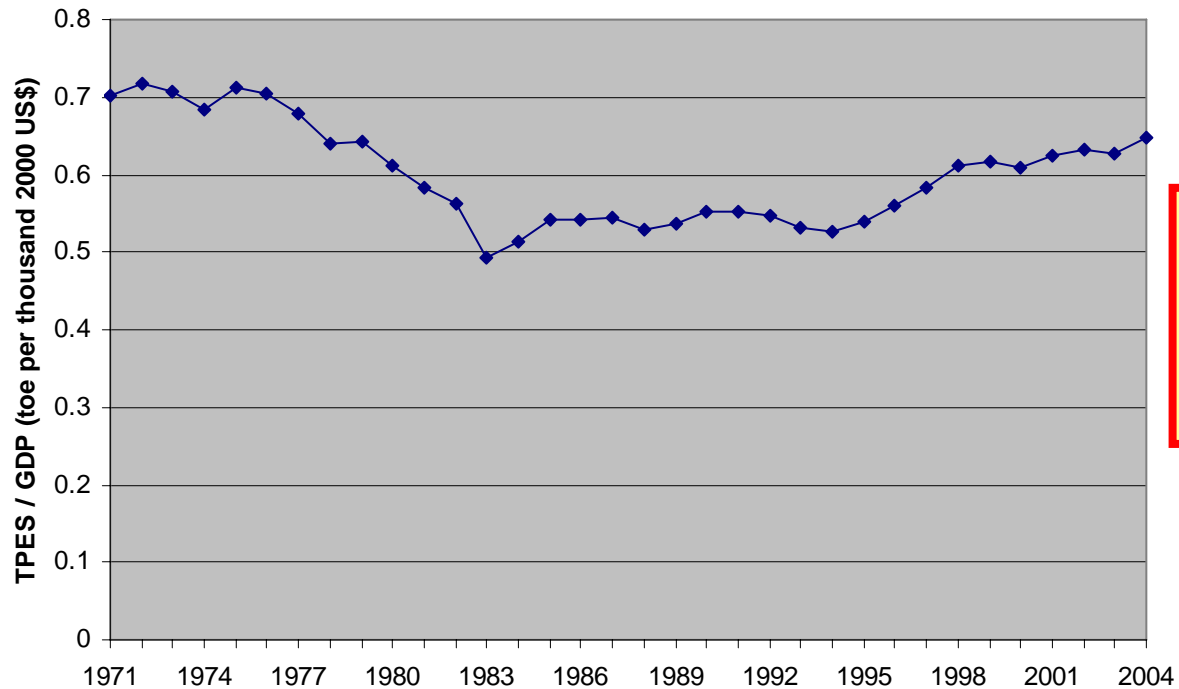
- During 1971-2004:

- Total electricity demand rising very rapidly: it grew by 8.6% per year from 126 kWh/capita in 1971 to 1,865 kWh/capita in 2004.

- Oil demand grew by 6.3% per year from 124 thousand bbl/day in 1971 to 920 thousand bbl/day in 2004.

Primary energy intensity

(toe per thousand 2000 US\$ using MER)



Source: IEA (2006)

AAGR (1990-2004):

Thailand:	1.1%
OECD average:	- 1.0%
World average:	- 1.6%

- Over the past decade (1990-2004), primary energy intensity in Thailand is in increasing trends unlike in the OECD and the world average.

Energy System Development and Emissions in Thailand under Selected Scenarios

Energy and emissions scenarios for Thailand

- Time horizon: 2000 – 2050
- No explicit climate intervention policies
- New and emerging technologies considered
- Main scenario drivers:
 - socio-economic dynamics
 - energy efficiency improvements
 - penetration of renewable energy technologies

Scenario description

Scenario Description		Economy	Demography	Technology
TA1	Global market	High growth 2000-2020: 7.5% 2021-2050: 5.5%	Low population growth: 0.02% p.a	Energy efficiency improvement: 0.3% p.a
TA2	Dual track	Moderate growth 2000-2020: 6% 2021-2050: 5%	High population growth: 0.74%	Energy efficiency improvement: 0.2% p.a
TB1	Sufficiency economy	Medium growth 2000-2020: 6.5% 2021-2050: 5.5%	Low population growth: 0.02%	Energy efficiency improvement: 0.4% p.a
TB2	Local stewardship	Low growth 2000-2020: 4% 2021-2050: 3%	Medium population growth: 0.39%	Energy efficiency improvement: 0.1% p.a

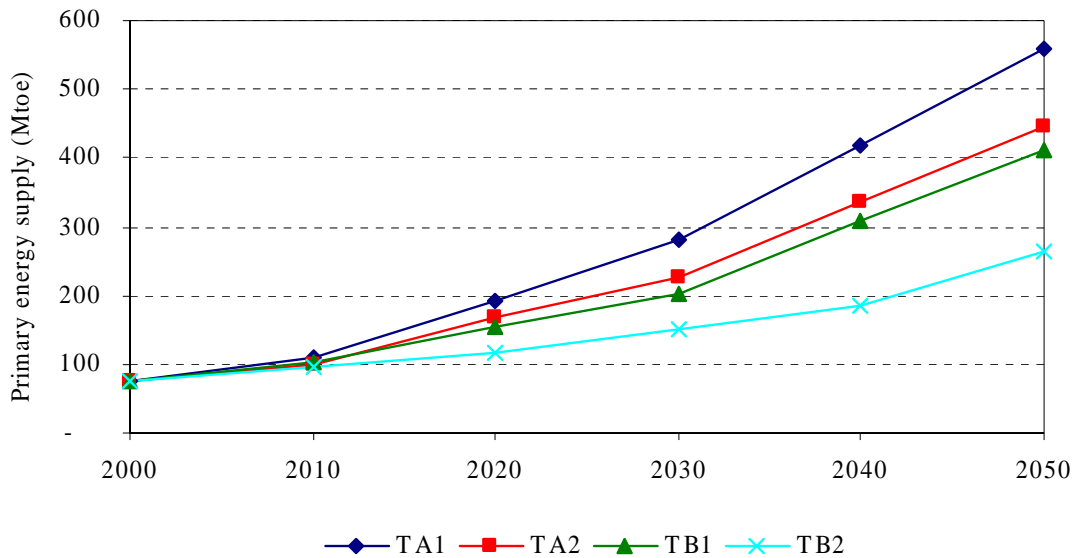
Existing and candidate power generation technologies considered in the study

Technology	Fuel type
<p>A. Fossil fuel and biomass based technologies</p> <ul style="list-style-type: none"> Conventional steam Integrated gasification combined cycle (IGCC) Pressurized fluidized bed combustion (PFBC) Combined cycle Combined cycle – advanced Gas turbine Biomass integrated gasification combined cycle (BIGCC) 	<ul style="list-style-type: none"> Lignite, natural gas, fuel oil, biomass Lignite and bituminous coal Lignite and bituminous coal Natural gas and fuel oil Natural gas Natural gas and fuel oil Biomass
<p>B. Renewables based technologies</p> <ul style="list-style-type: none"> Hydro, wind, solar photovoltaic, solar thermal and geothermal 	-
<p>C. CCS</p>	Coal and Natural gas

Altogether 18 existing and new power generation technologies are considered

Results and Discussions

Pre-dominance of fossil fuels



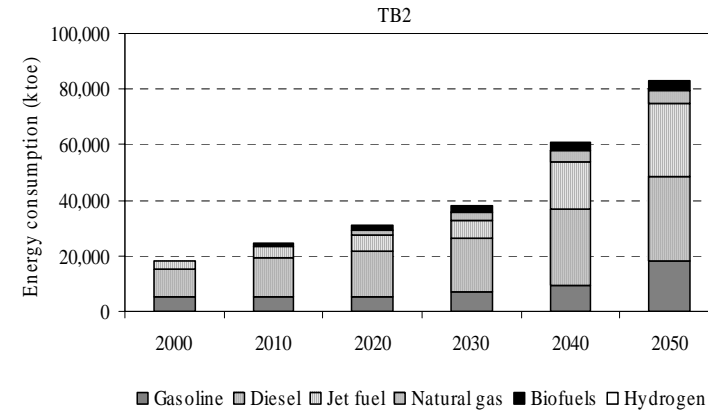
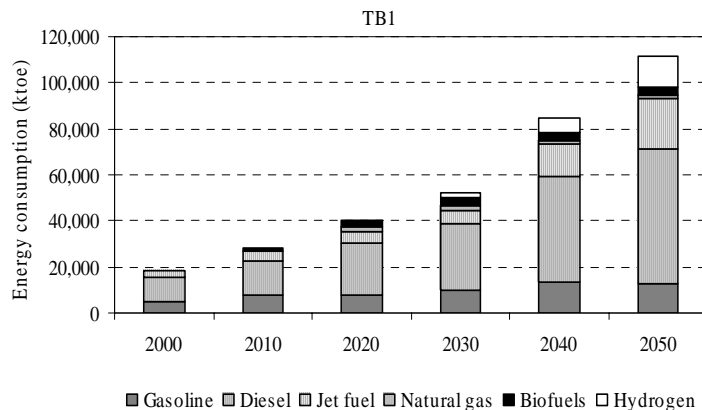
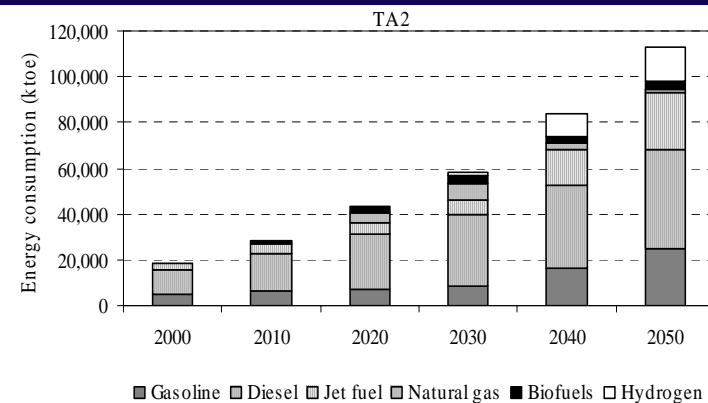
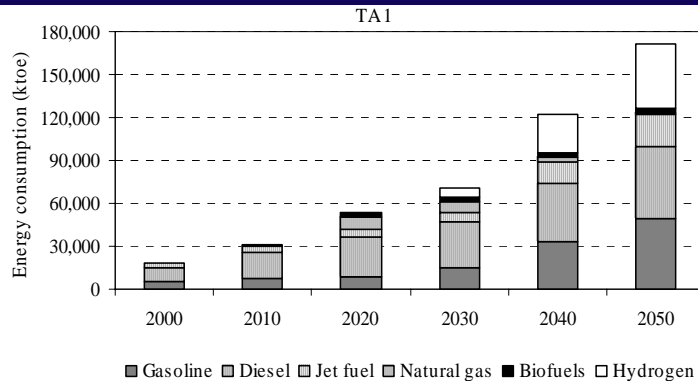
	AAGR (%)	Ratio 2050/2000
TA1	4.1	7.4
TA2	3.6	5.9
TB1	3.4	5.4
TB2	2.5	3.5

Dominance of fossil fuels in the primary energy mix:

2000: 81%

2050: 95% (TA1), 92% (TA2), 93% (TB1) and 87% (TB2)

Transportation energy requirements by energy type under the four scenarios during 2000-2050 (ktoe).



Energy mix:

Share of fossil fuels: **100%** in 2000

Share of alternative fuels (biofuels and hydrogen):

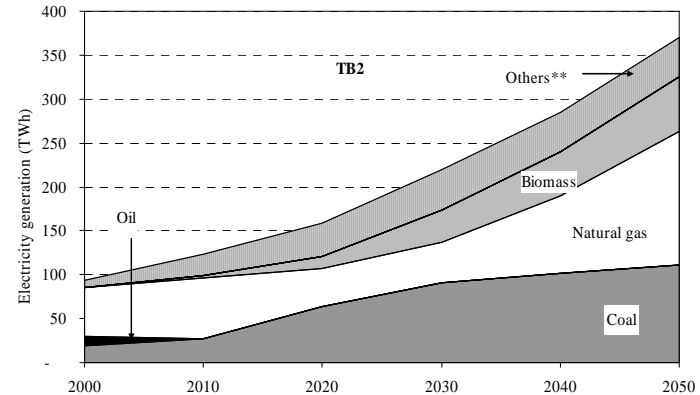
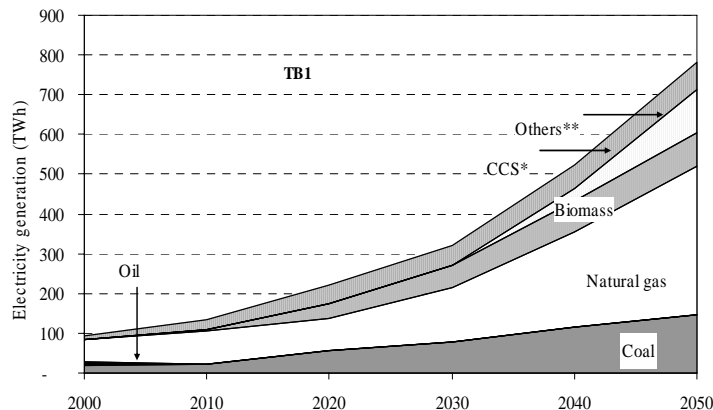
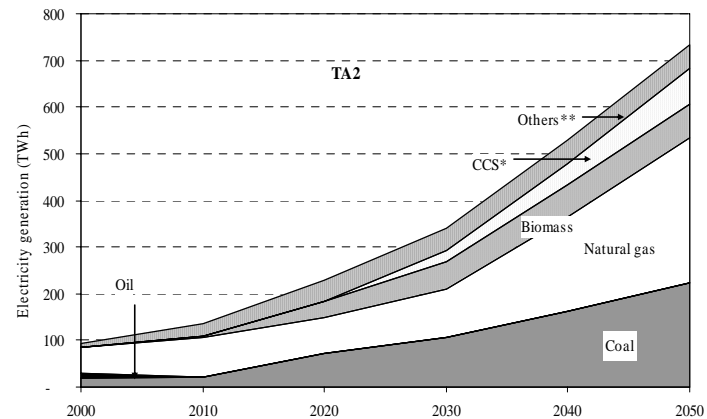
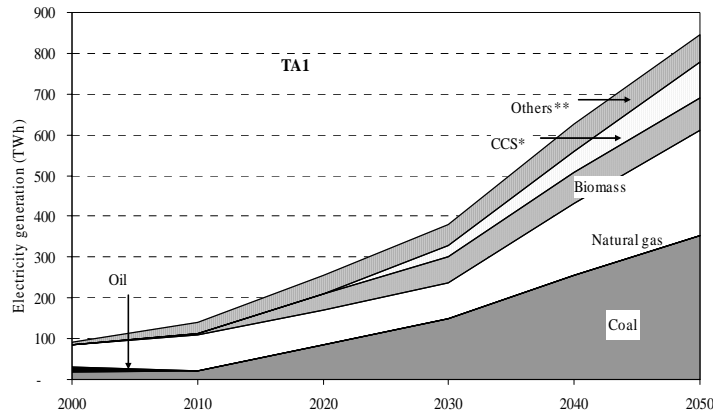
38% (TA1); **17%** (TA2); **15%** (TB1); and **4%** (TB2) in 2050. Large share in TA1 due to large share of hydrogen.

Residential sector energy use patterns by end-use services under four scenarios during 2000-2050

	Share (cumulative) of end-use energy demand in residential sector (%)					Cumulative residential sector energy consumption during 2000-2050 (Mtoe)	Share of residential sector in cumulative total energy consumption (%)
	Cooking	Air conditioning	Lighting	Others	Refrigeration		
TA1	66.5	14.7	8.9	5.9	4.0	63.8	14.6
TA2	64.8	15.4	8.6	6.8	4.4	68.6	20.6
TB1	64.0	15.9	8.7	6.8	4.6	48.6	15.1
TB2	68.6	12.1	9.0	6.2	4.1	55.8	27.8

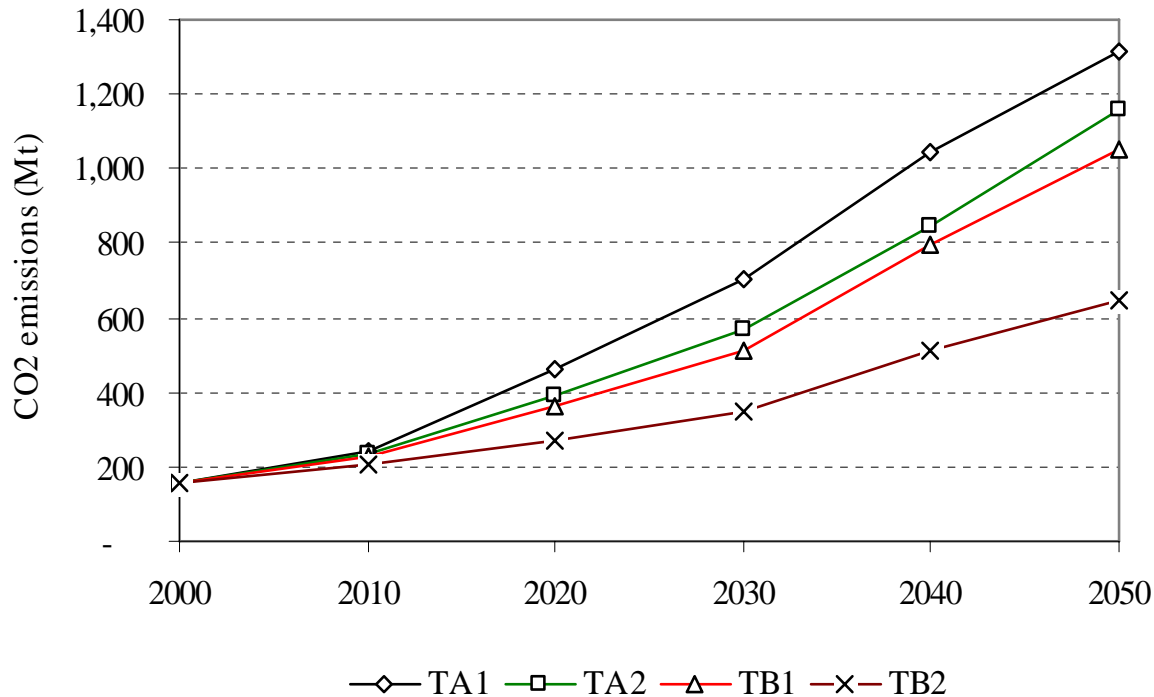
- Share of residential sector's share in cumulative total energy consumption vary from **14.6%** (63.8 Mtoe) under **TA1** to **27.8%** (55.8 Mtoe) under **TB2**.
- **Cooking** requires about **two-thirds** of total residential energy requirements under all four scenarios.

Electricity generation mix under four scenarios during 2000-2050 (TWh)



- **Coal and natural gas: Main fuels for electricity generation under all four scenarios (71% under TA2 in 2050).**
- **CCS based electricity generation in TA1, TA2 and TB1. (CCS share: 10% under TA2 in 2050).**

Energy related total CO₂ emissions, Mt

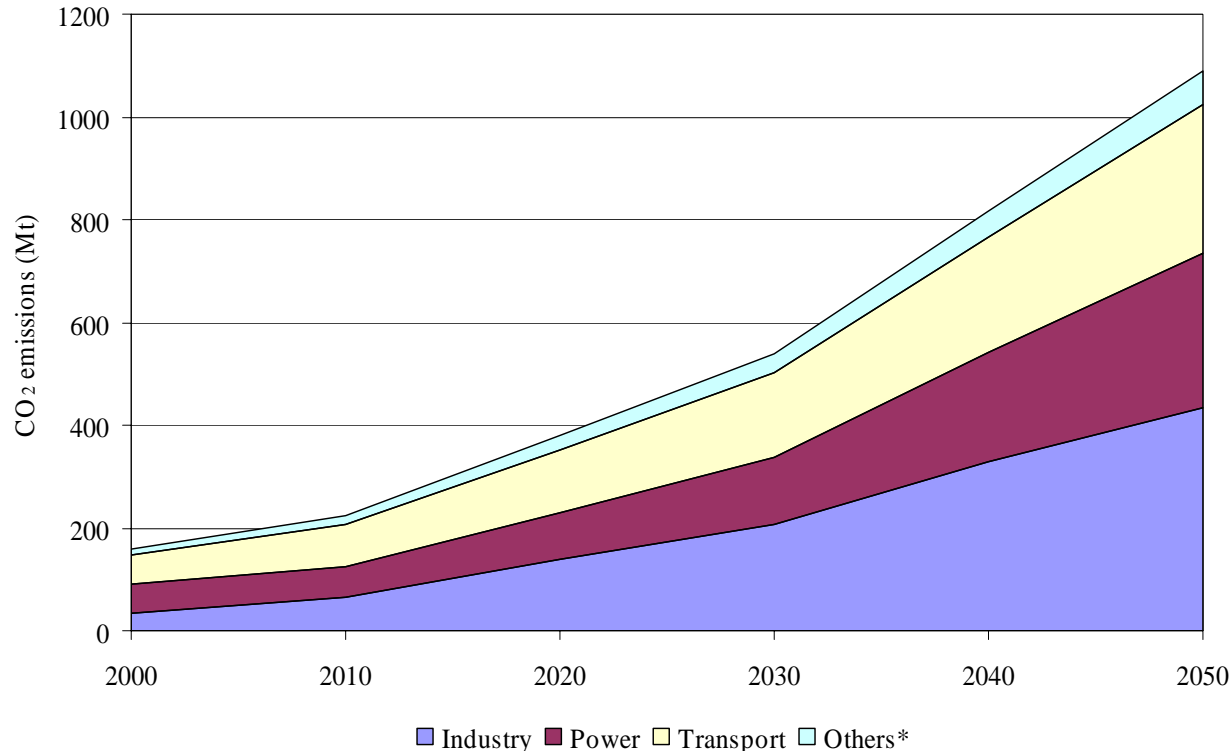


	AAGR (%)	Ratio 2050/2000
TA1	4.4	8.5
TA2	3.9	6.9
TB1	3.7	6.2
TB2	2.8	4.2

In the reference scenario (TA2), annual CO₂ emission in 2050 (1088 Mt) would be 1,088 Mt compared to 158 Mt in 2000.

CO₂ emission figures in 2050 under TA1: 1,343; TB1: 973 and TB2: 660 Mt.

Sectoral CO₂ emissions in reference scenario (TA2), Mt

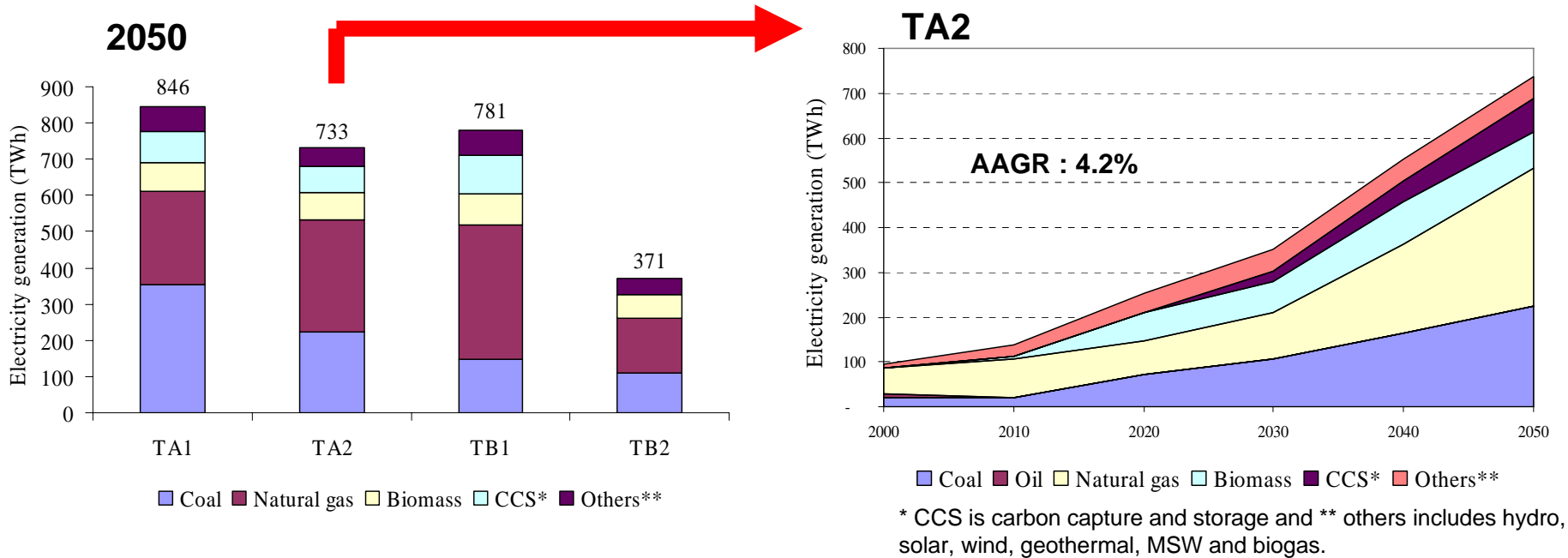


From 2000 to 2050:

Power	: 37 to 28%	↓
Transport	: 35 to 27%	↓
Industry	: 21 to 40%	↑
Others	: 7 to 5%	↓

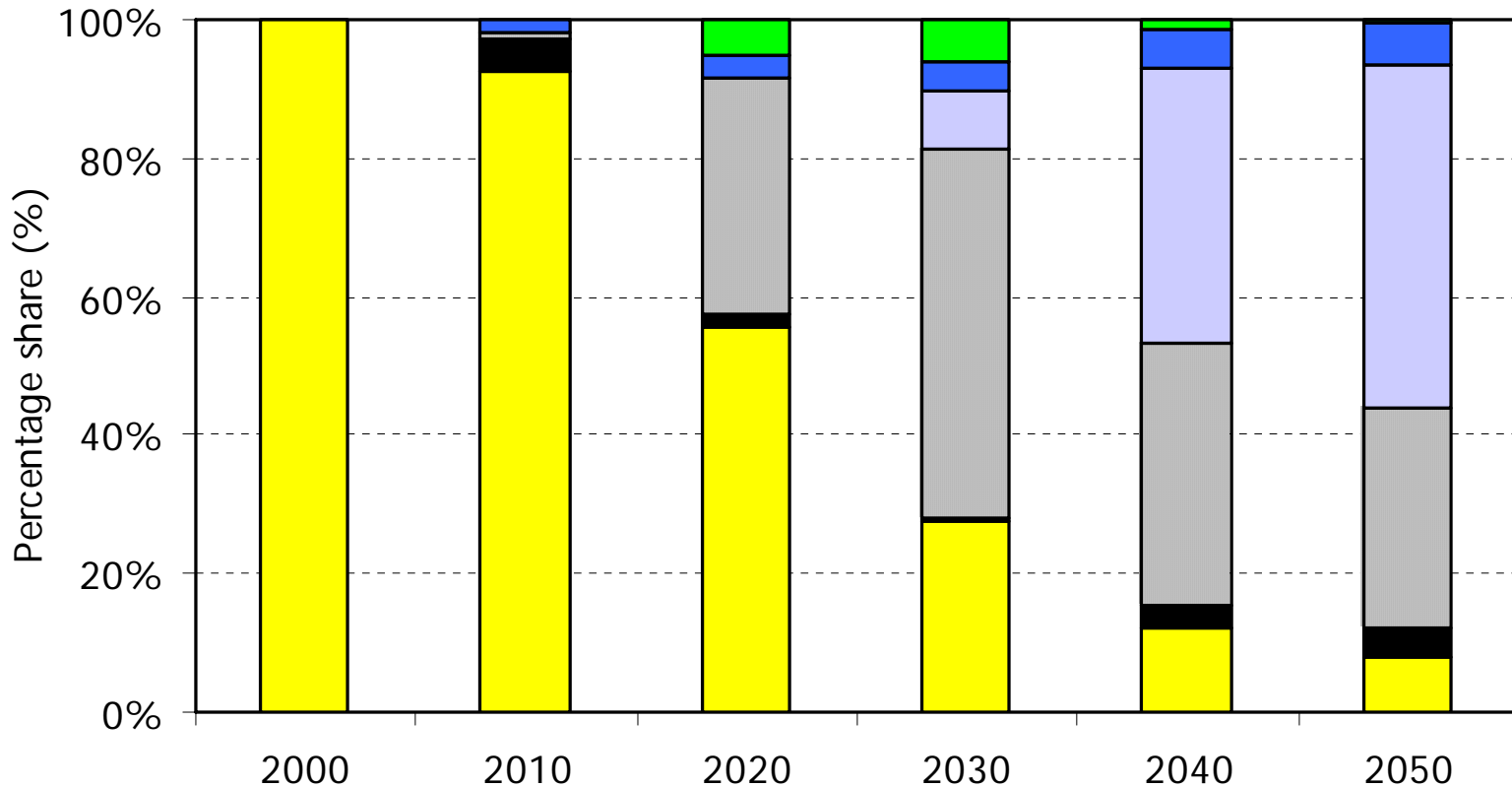
Industry sector has the largest share in total CO₂ emissions after 2020, followed by **power**, **transport** and **others** sectors.

Energy/technology mix in electricity generation, TWh



- In 2050, **coal** and **natural gas** contribute more than **70%** of total electricity generation under all scenarios.
- In the reference case:
 - **CCS** based electricity generation would be cost-effective after **2020**.
 - Role of **RETs** remain low (**7%** in 2050) due to limited availability of domestic RE resources e.g., biomass, wind and hydro and high cost of solar power generation.

Technology deployment in road transportation under reference scenario (TA2)



By 2050: ■ Conventional ■ Conventional efficient ■ Hybrid ■ Fuel cell ■ Electric ■ Natural gas

- **Conventional vehicle technologies would represent about 8% of total vehicle stocks.**
- **Most the vehicle stocks would be based on fuel cell (45%) followed by hybrid (36%) electric (6%) and efficient and NGV (5%).**
- **Both hybrid and fuel cell technologies would be cost effective starting from year 2020 onwards.**

CO2 emissions per capita, CO2 emissions intensity and primary energy intensity in 2000 and selected future years under four scenarios

	2000	Global market		Dual track		Sufficiency economy		Local stewardship	
		2030	2050	2030	2050	2030	2050	2030	2050
		Per capita CO ₂ emissions (tons/capita)	2.6	9.2	21.6	6.8	12.2	7.0	15.7
CO ₂ emission intensity (kg/US\$,1995price)	0.92	0.52	0.39	0.56	0.49	0.47	0.38	0.62	0.62
Primary energy intensity (kgoe/US\$,1995price)	0.44	0.21	0.16	0.23	0.20	0.20	0.16	0.26	0.25

In the Reference Scenario (TA2): Per capita CO2 emission increases and is higher than in the other scenarios.

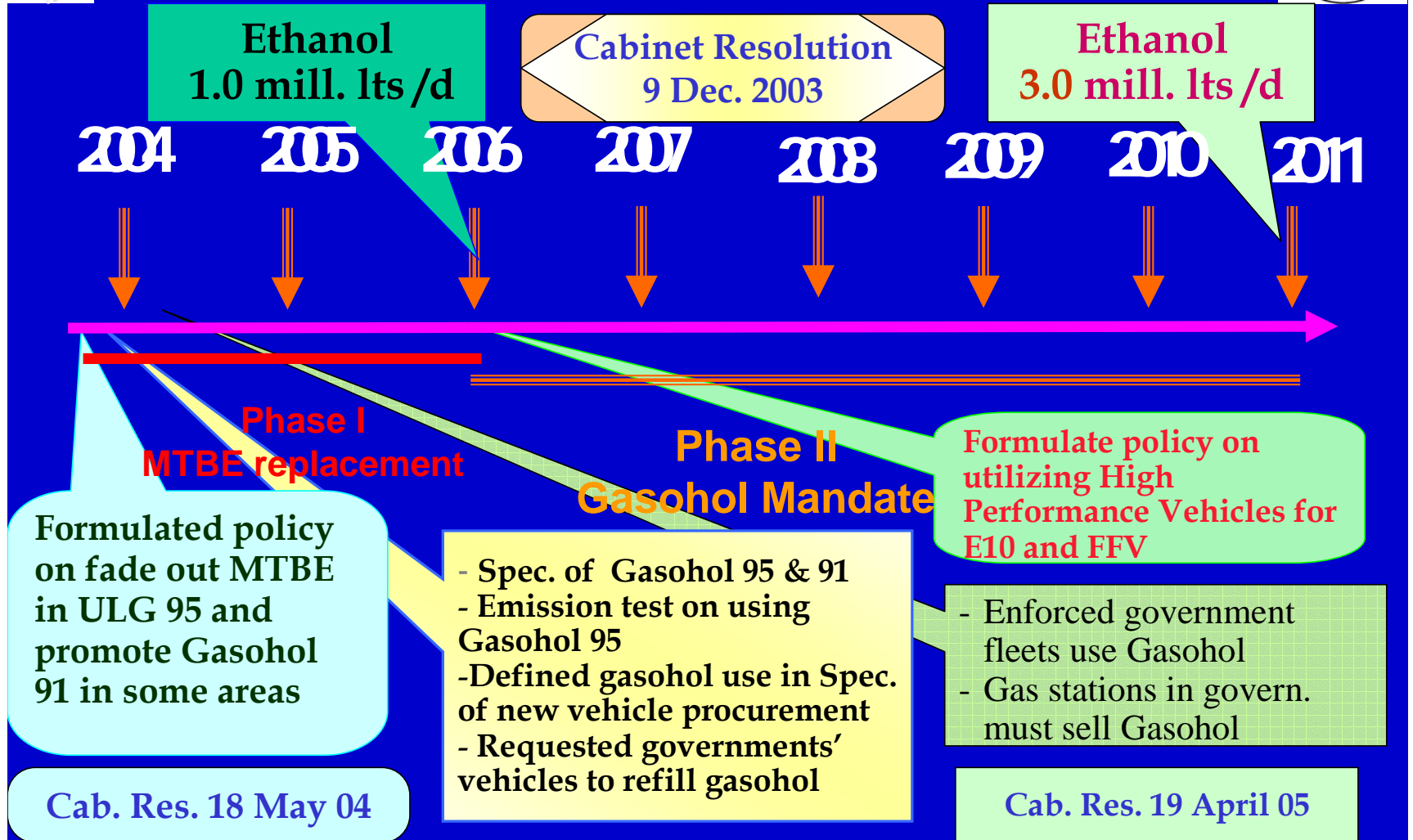
• CO2 emission intensity: **0.92** in 2000 to **0.49** in 2050 ↓

• Primary energy intensity: **0.44** in 2000 to **0.20** in 2050 ↓

Environmental Friendly Policy/Program Developments in Thailand



Gasohol Strategic Plan

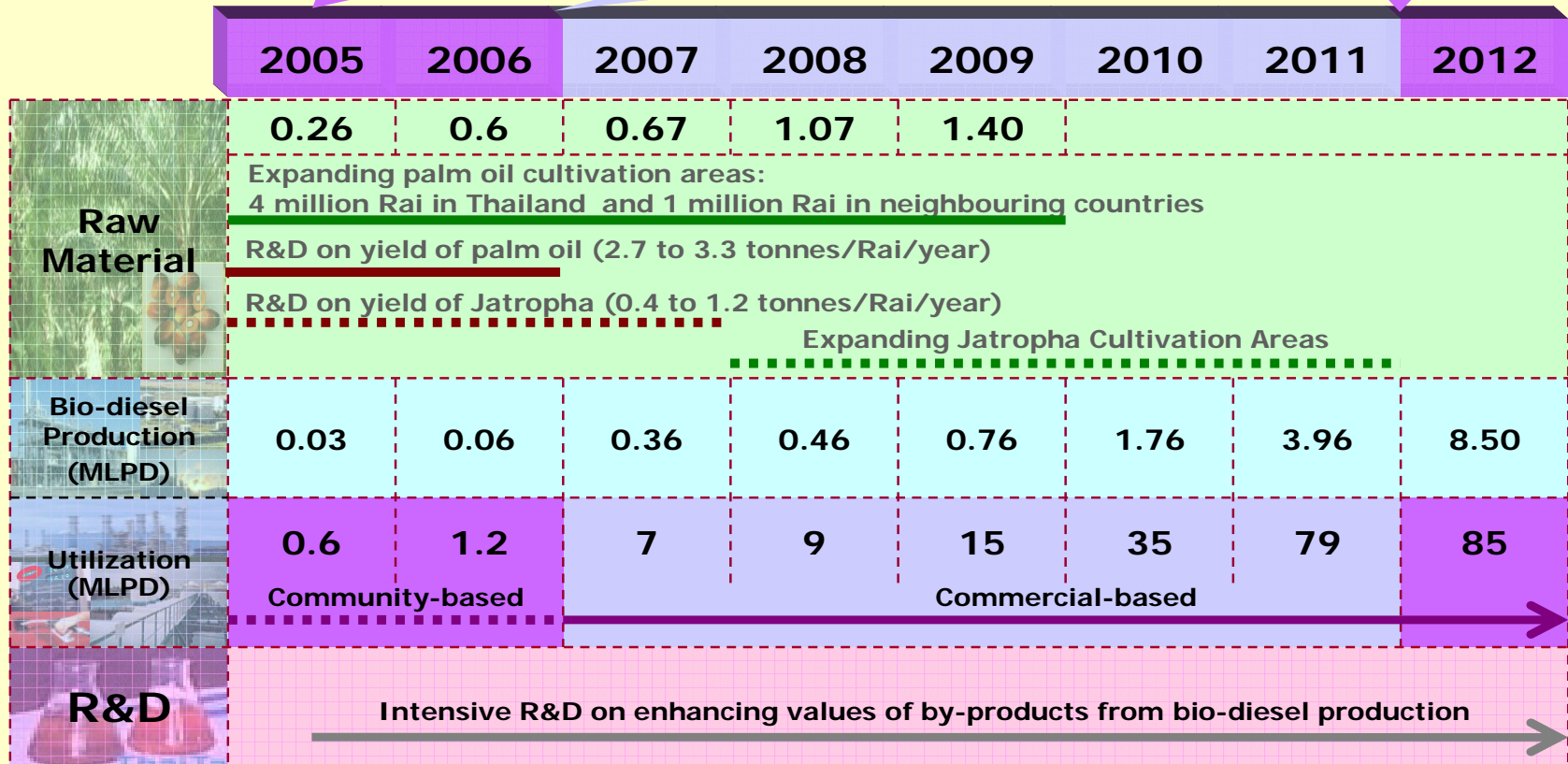


Action Plan on Bio-diesel Utilization Promotion and Development

Community Scale development and B100 Specification Establishment

Commercial Scale of B100 Production and Utilization of B5 in the South and the Central Part of Thailand

Substitute B100 to 10% Diesel



Some policies towards low carbon society

- Ministry of Agriculture and Cooperatives has a target to increase productivity of cassava production by 50% and sugarcane production by 66.6%:
- Gasohol95 price lower than gasoline price; Price reduced further recently. Difference of 1.75 Baht/liter.
- Tax cuts/elimination on NGV auto parts
- Small biomass waste based power generation to get higher buyback rate (0.3 Baht per unit more)– 30MW by 2012.
- Renewable portfolio standard set at 8% in 2011(0.5% in2003).
- Local production of eco-car (small fuel efficient) planned
- Labeling of electrical appliances to be extended to additional devices.
- Double track rail construction being planned.

Some policies towards low carbon society (2)

- Government subsidy of over USc 6.7/kWh for wind power
- Feed-in rate for solar power at 15 Baht per kWh (> \$ 0.40/kWh), but cap on total volume.

Publication

- Ram M. Shrestha, Sunil Malla, and Migara H. Liyanage, Scenario-based analysis of energy system development and its environmental implications in Thailand, [Energy Policy \(2007\)](#), doi:10.1016/j.enpol.2006.11.007

Thank you



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