IPCC Expert Meeting: Application of the 2006 IPCC Guidelines to Other Areas
1-3 July 2014, Sofia, Bulgaria

National Greenhouse Gas Inventory for Thailand's Second National Communication and Mitigation Aspects

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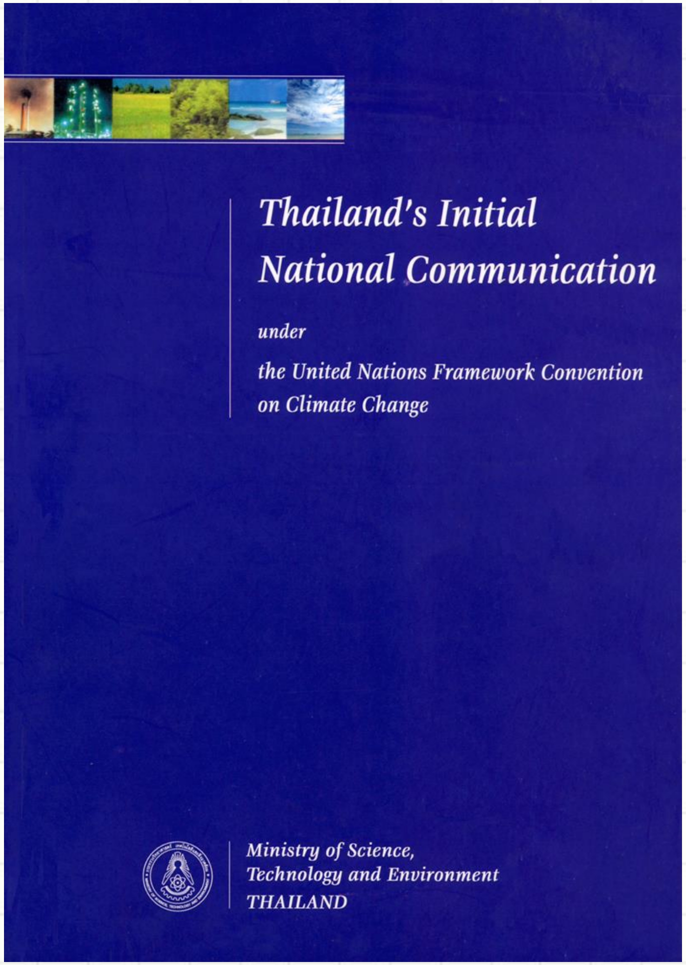
Outline

- History of Thailand’s National GHG Inventory
- Second National Communication (SNC) and National GHG Inventory
- Mitigation Assessment
  - National Level – Energy Sector
  - Subsector Level – Road Transport Sector
- Conclusion and Recommendation

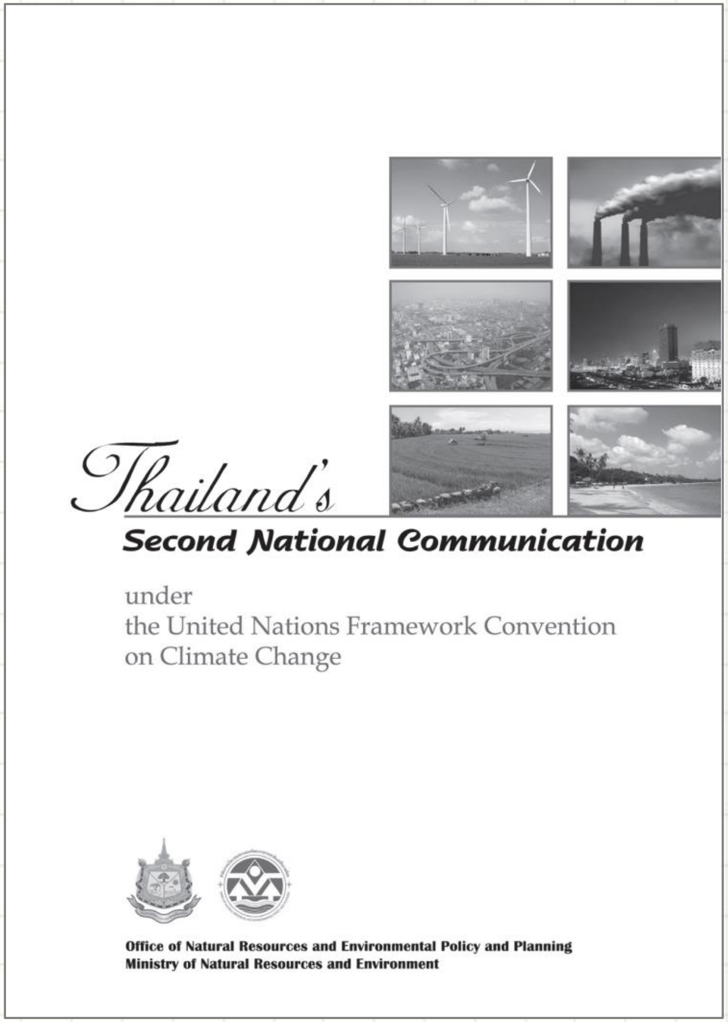
History of Thailand's National GHG Inventory



1st National GHG Inventory

- As a part of Thailand's Initial National Communication (INC)
- Using the Revised 1996 IPCC Guidelines to estimate the emissions in 1994
- Prepared by Office of Environmental Policy and Planning (OEPP), Ministry of Science and Technology (MOST)
- Submitted to UNFCCC on November 13, 2000

History of Thailand's National GHG Inventory

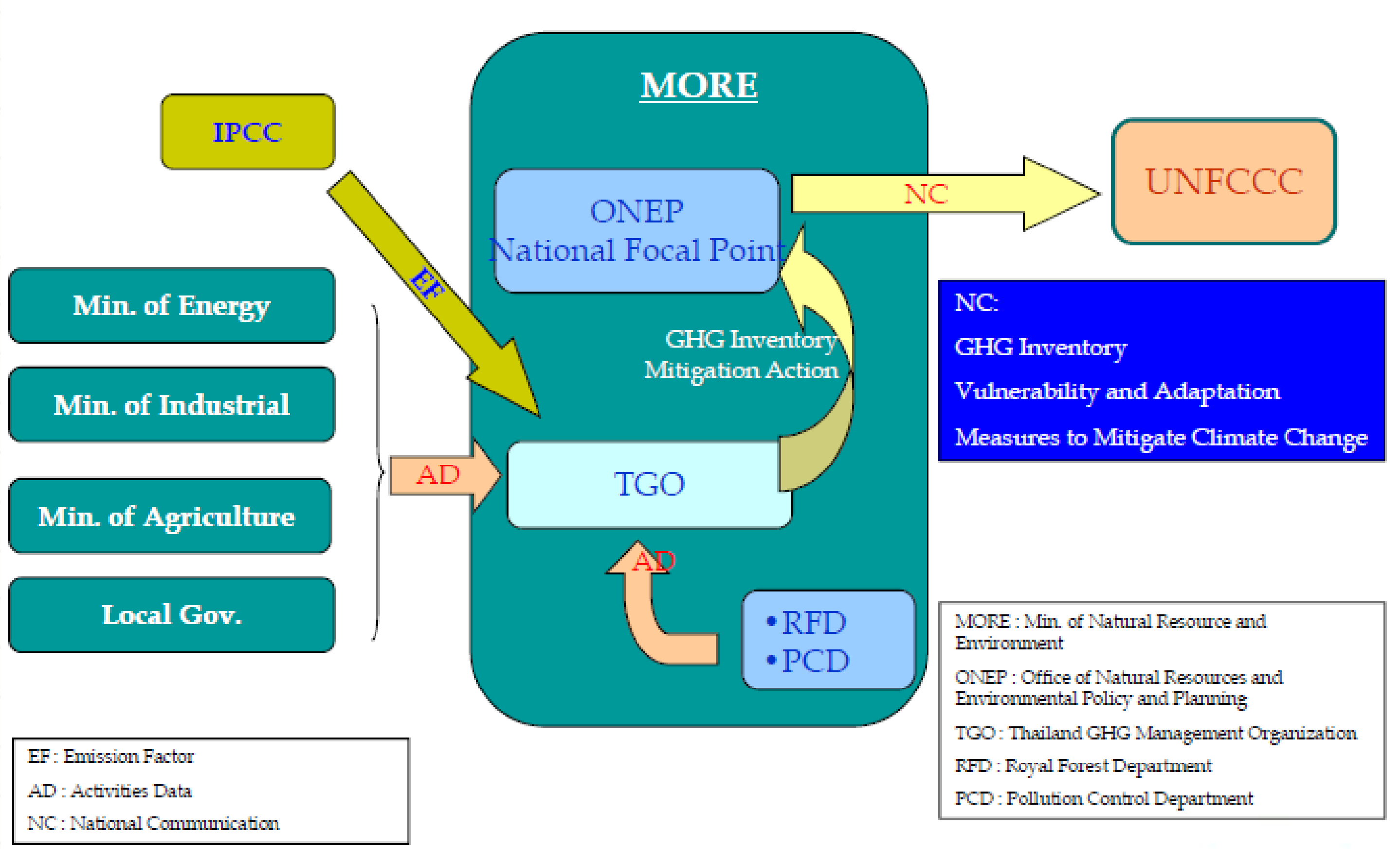


2nd National GHG Inventory

- As a part of Thailand's Second National Communication (SNC)
- Followed the guidelines:
  - Revised 1996 IPCC Guidelines to estimate the emissions
  - 2000 IPCC Good Practice Guidance and Uncertainty Management in Nation Greenhouse Gas Inventories
  - 2003 Good Practice Guidance for Land Use, Land-use Change and Forestry
- Prepared by Office of Natural Resources and Environmental Policy and Planning (ONEP), Ministry of Natural Resources and Environment (MORE)
- Submitted to UNFCCC on March 24, 2011

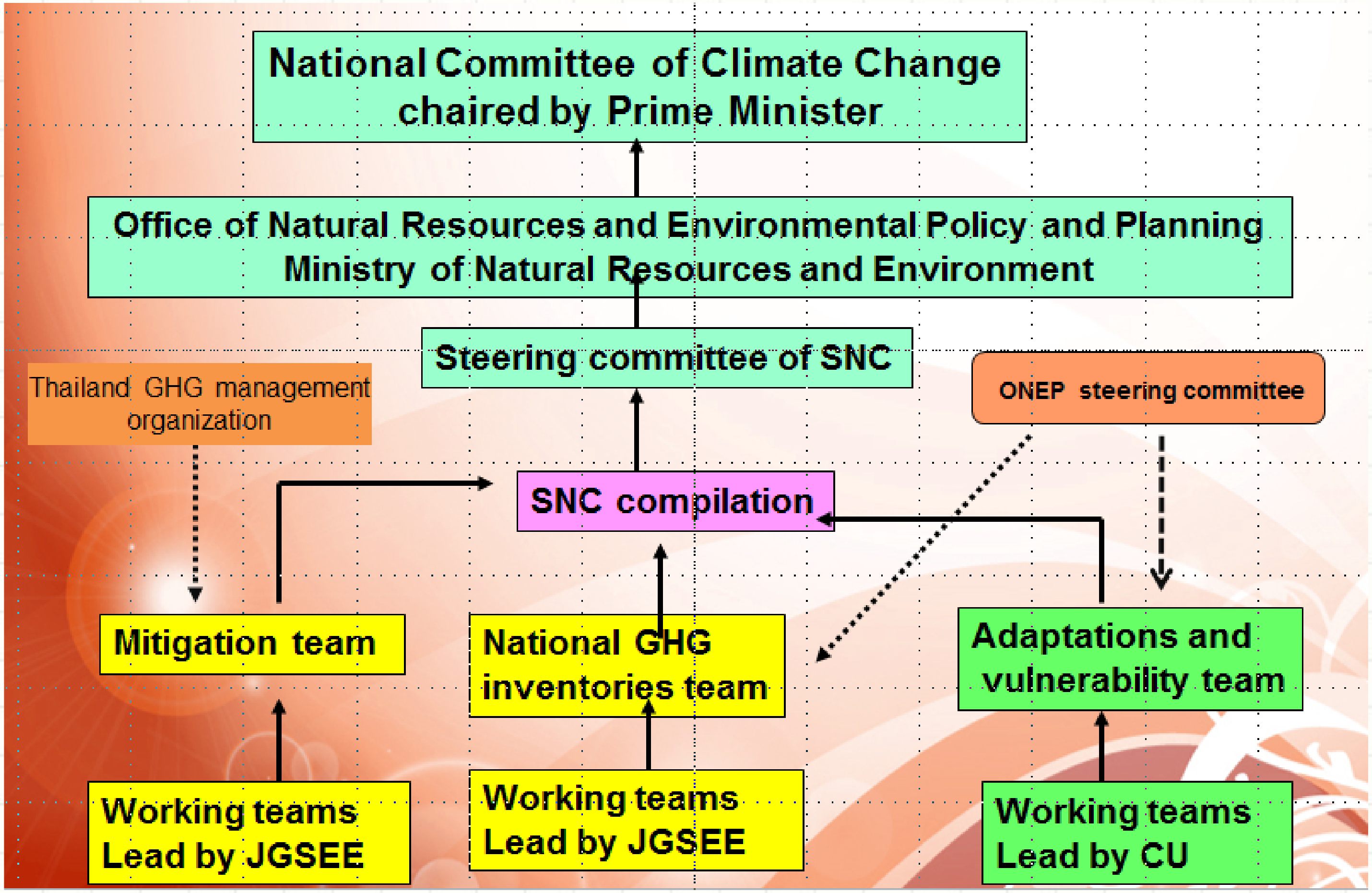
SNC and National GHG Inventory

Institutional Framework of SNC



Source: TGO

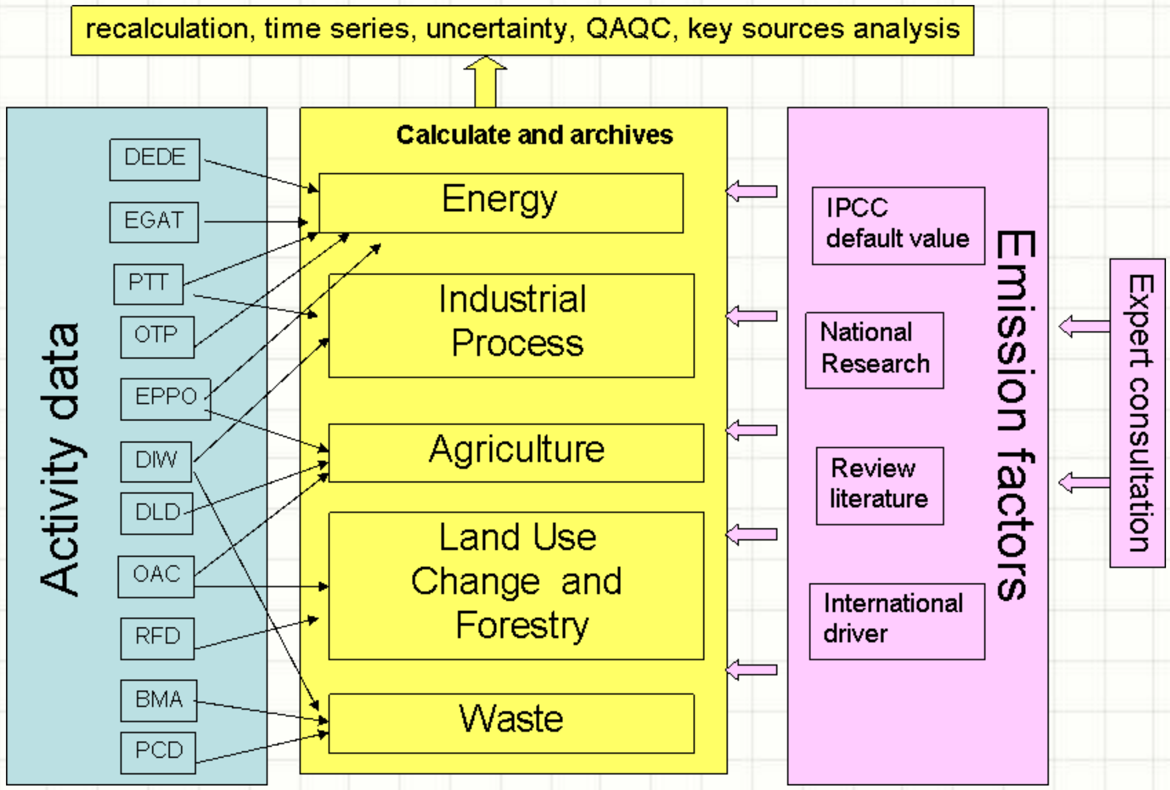
Structure of SNC Organization



JGSEE – the Joint Graduate School of Energy and Environment, King Mongkut's University of Technology Thonburi
CU – Chulalongkorn University

Source: JGSEE, KMUTT

Conceptual Framework of National GHG Inventory



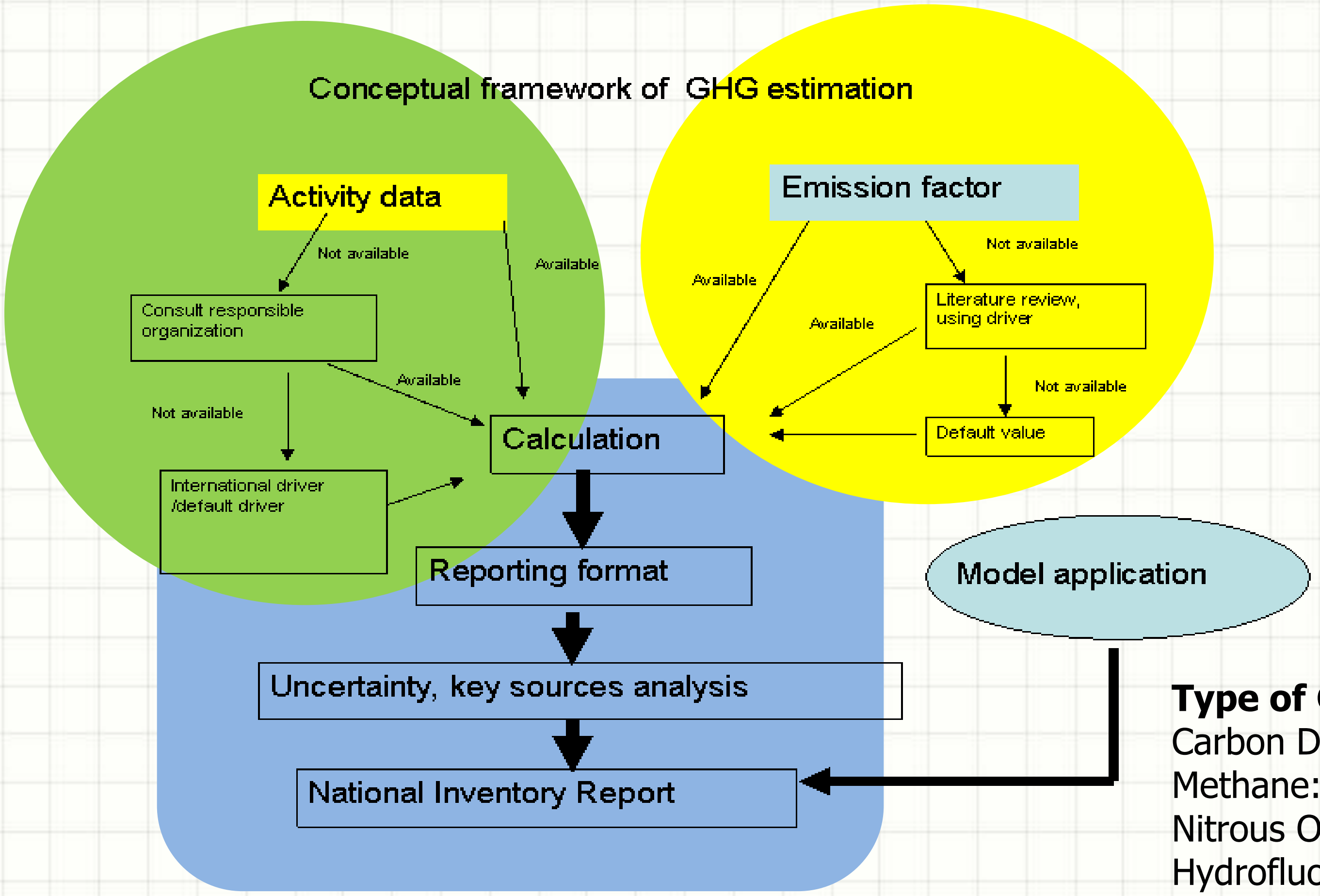
Guideline

1. Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories
2. 2000 IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories
3. 2003 Good Practice Guidance for Land Use, Land-Use Change and Forestry

DEDE = Department of Alternative Energy Development and Efficiency
EGAT = Electricity Generating Authority of Thailand
PTT = Petroleum Authority of Thailand
OTP= Office of Transport and Traffic Policy and Planning
EPPO = Energy Policy and Planning Office
DIW = Department of Industrial Work
DLD = Department of Land Development
OAC = Office of Agriculture Economics
RFD = Royal Forest Department
BMA= Bangkok Metropolitan Administrative
PCD = Pollution Control Department

Source: Thailand's Second National Communication

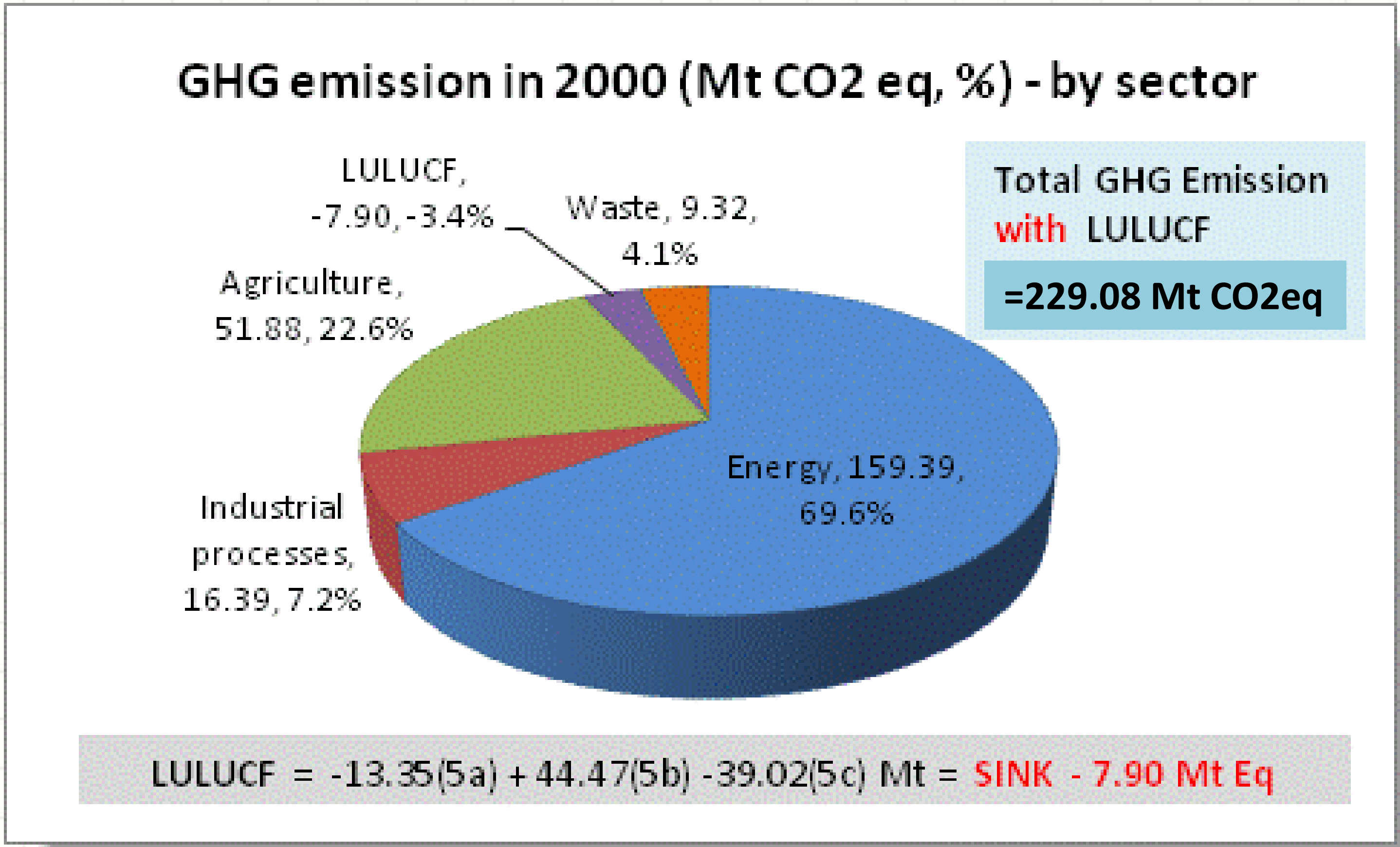
Framework of GHG Inventory Methodology



Type of GHG
Carbon Dioxide: CO_2
Methane: CH_4
Nitrous Oxide: N_2O
Hydrofluorocarbon: HFC
Perfluorocarbon: PFC
Sulfur Hexafluoride: SF_6

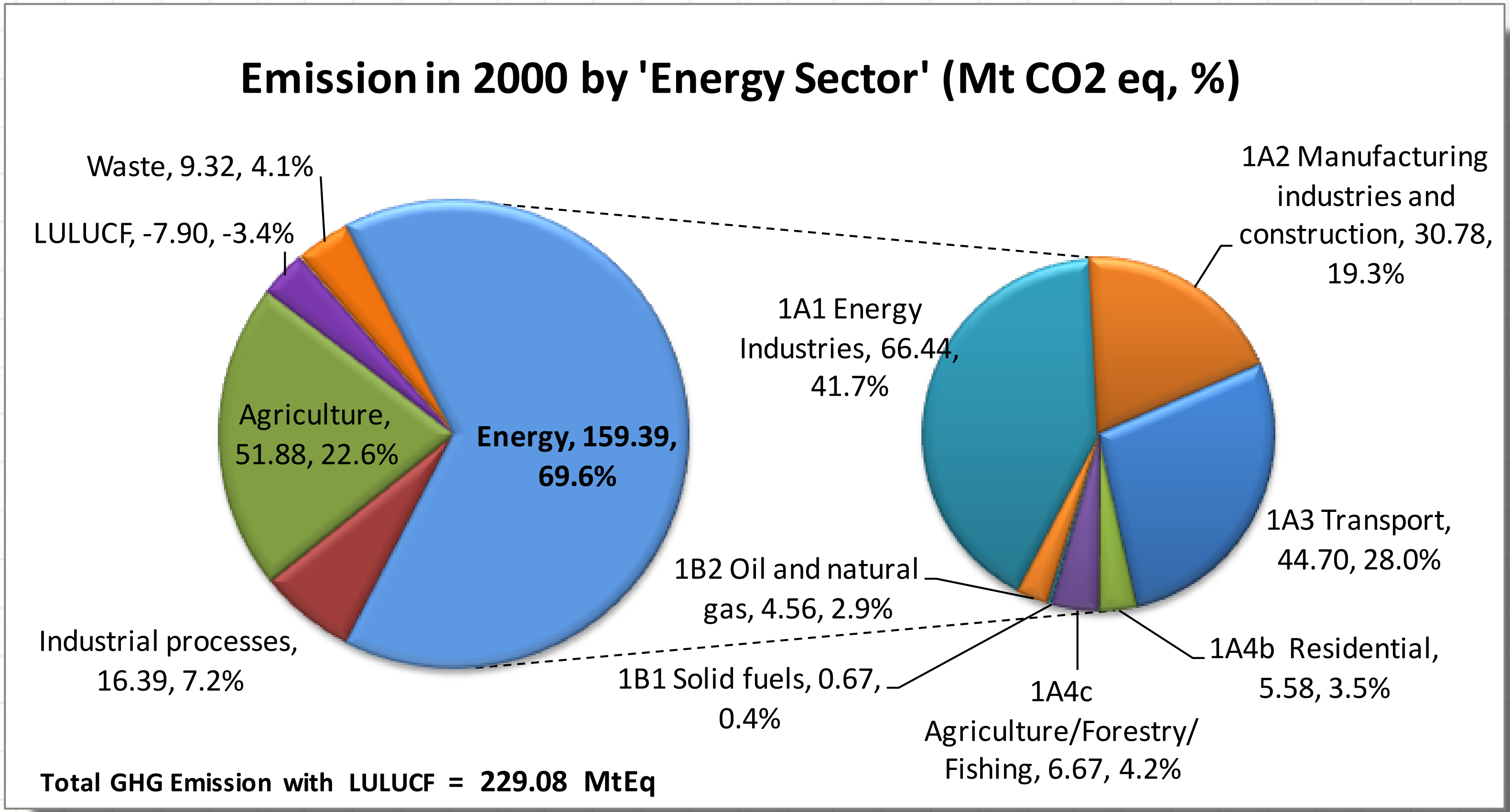
Source: Thailand's Second National Communication

Total GHG Emission



Source: Thailand's Second National Communication

GHG Emission from Energy Sector

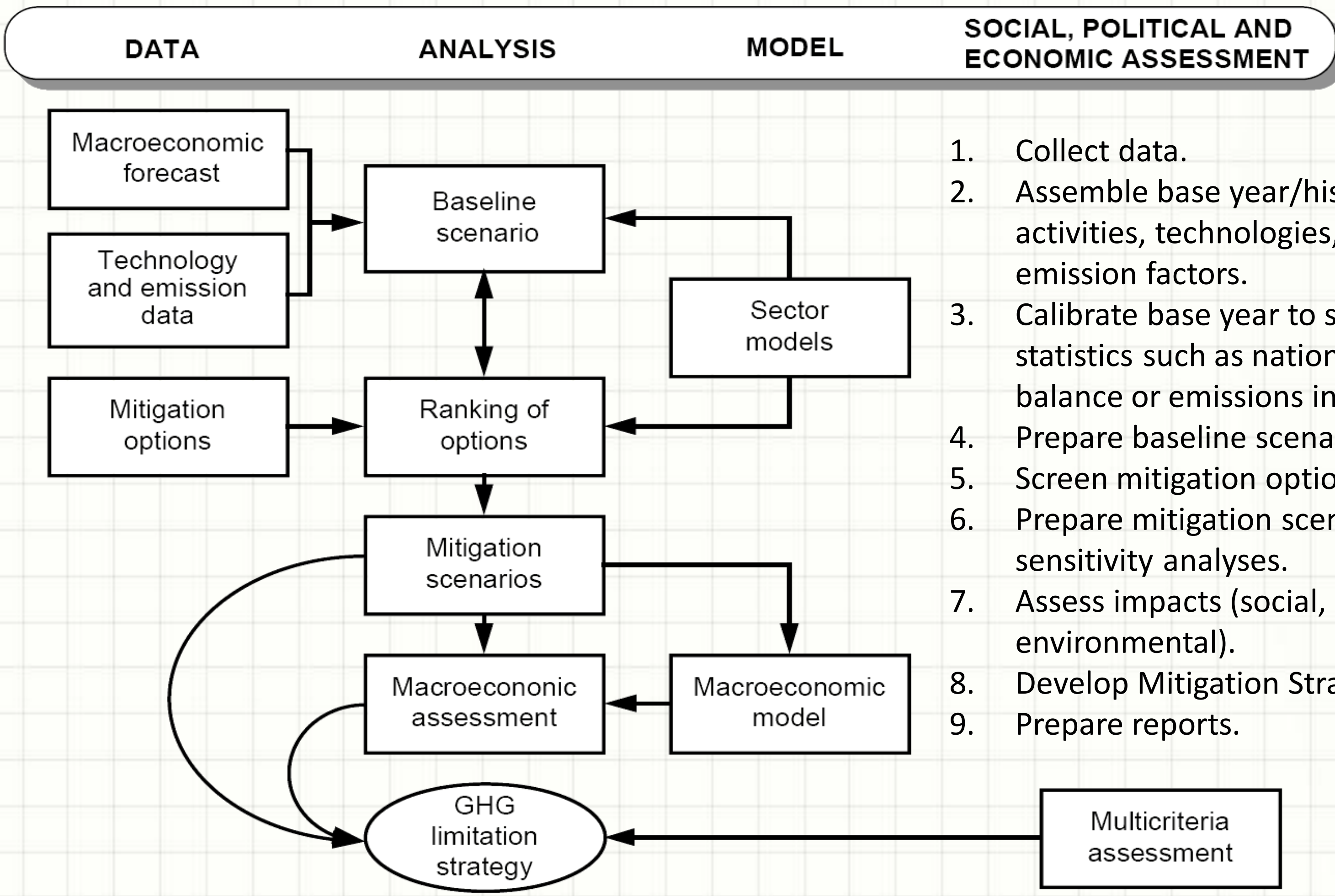


Source: Thailand's Second National Communication

Mitigation Assessment : National Level

Mitigation Assessment : National Level

Concept, Structure and Steps



1. Collect data.
2. Assemble base year/historical data on activities, technologies, practices and emission factors.
3. Calibrate base year to standardized statistics such as national energy balance or emissions inventory.
4. Prepare baseline scenario(s).
5. Screen mitigation options.
6. Prepare mitigation scenario(s) and sensitivity analyses.
7. Assess impacts (social, economic, environmental).
8. Develop Mitigation Strategy.
9. Prepare reports.

Source: Module2 mitigation concept, UNFCCC

Estimation of GHG Emission

Methodology

Macroeconomic – Econometric Model
AD = f (GDP, Pop, Price, Irrigation Area, Crop Area, etc.)

Default EF from 2006 IPCC Guideline

$$E = AD \cdot EF$$

E = Emissions or Removals
AD = Activity Data - data of a human activity resulting in emissions or removals
EF = Emission Factor - coefficients which quantify the emissions or removals per unit activity

Sectors

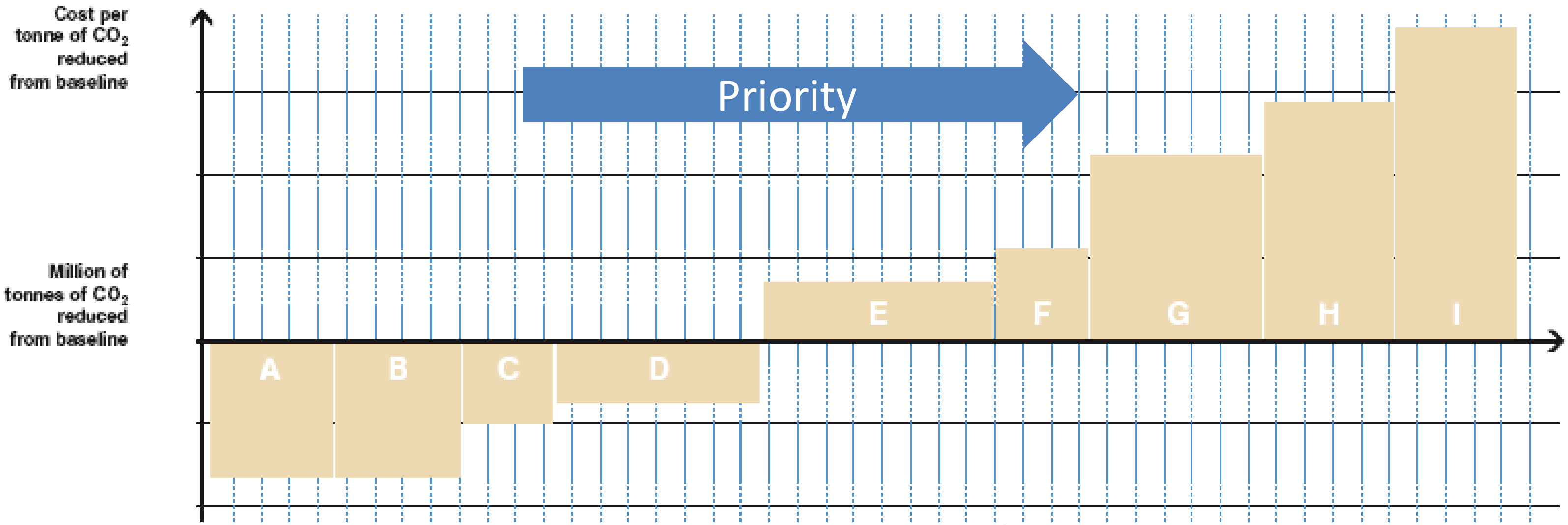
Energy, Industrial Processes and Product Use (IPPU), Agriculture, Forestry and Other Land Use (AFOLU), and Waste

Scenario Analysis

- Baseline Scenario (Business-as-usual)
  - Socio-economic Assumptions
    - Population growth rate
    - GDP growth rate
    - Irrigation area
    - Crop area, etc.
- Mitigation Scenario (Energy Sector)
  - Electricity Generation
    - Promotion of technologies for electricity generation from renewable energy and low-carbon fossil fuel
    - Improve efficiency of generation and transmission system
  - End-use Sectors
    - Introduction of high energy efficiency technology and renewable energy for heat in industrial sector, building sector and transport sector.

Mitigation Scenario

Screening Cost Curve for Mitigation Technology Selection



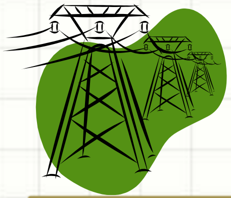
- Ton of CO_2 Avoided
- Cost of Saved Carbon ($/tCO2)

Source: Sathaye and Meyers. *Greenhouse Gas Mitigation Assessment: A Guidebook* (1995)

Criteria

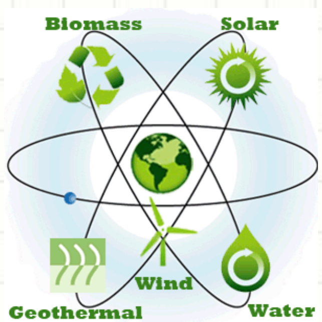
- Potential for large impact on greenhouse gases (GHGs)
- Consistency with national development goals
- Consistency with national environmental goals
- Potential effectiveness of implementation policies
- Sustainability of an option
- Data availability for evaluation
- Institutional considerations

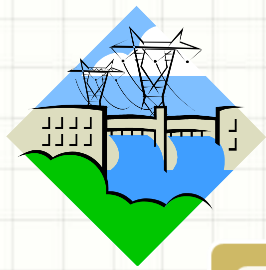
Mitigation Scenario – Energy Sector



- Power Generation
  - T& D Losses
  - Renewable Promotion
  - Power Plant Efficiency
  - Fuel Switching
  - Coal + CCS

- Mitigation(Industry)
  - Efficient Boiler (16% savings)
  - Efficient Furnace (20% savings)

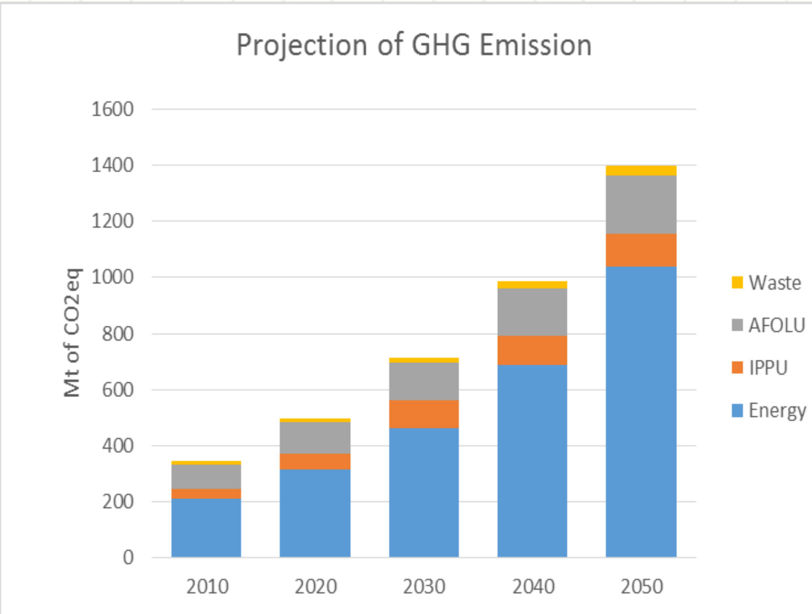


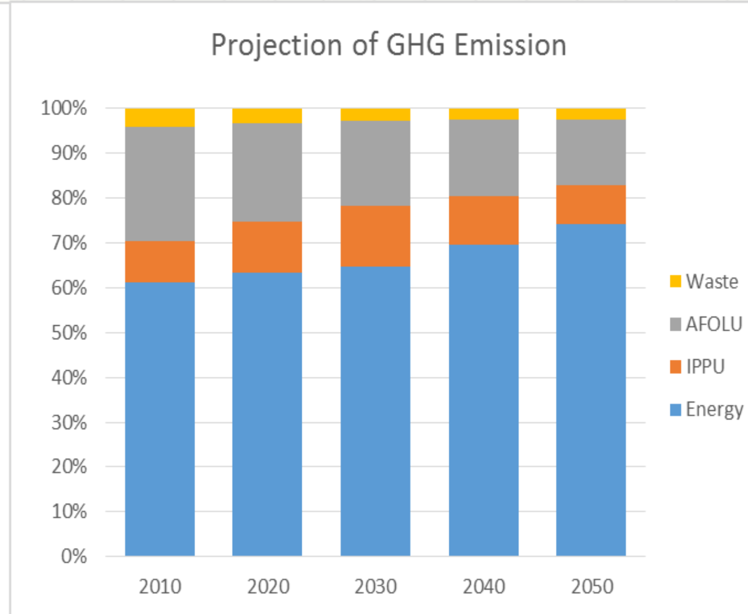


- Mitigation (Transportation)
  - Biodiesel
  - Gasohol
  - Hybrid Car
  - Eco Car

- Mitigation (Commercial & Residential)
  - Cooking stove
  - LPG stove
  - Standby power
  - Electric Kettle
  - Freezer

GHG Emission Projection – BAU Scenario



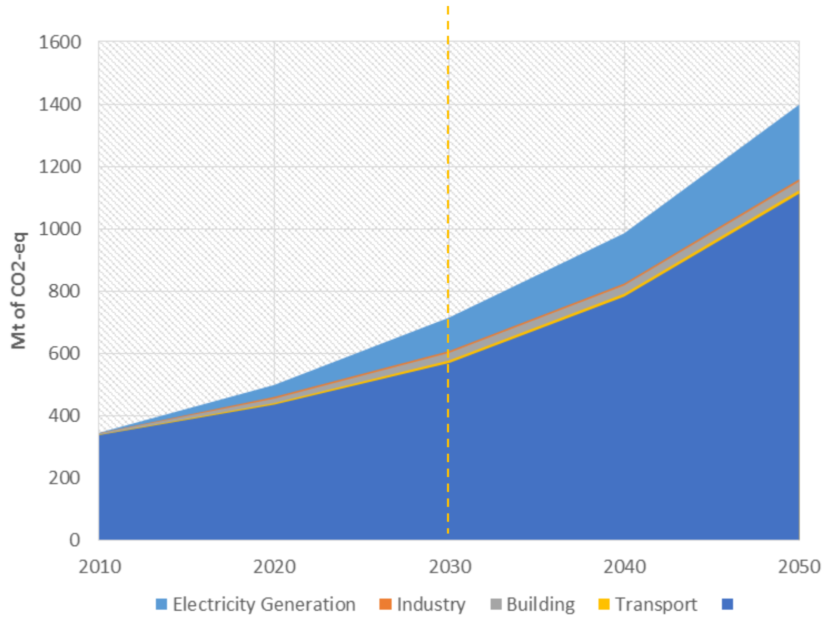


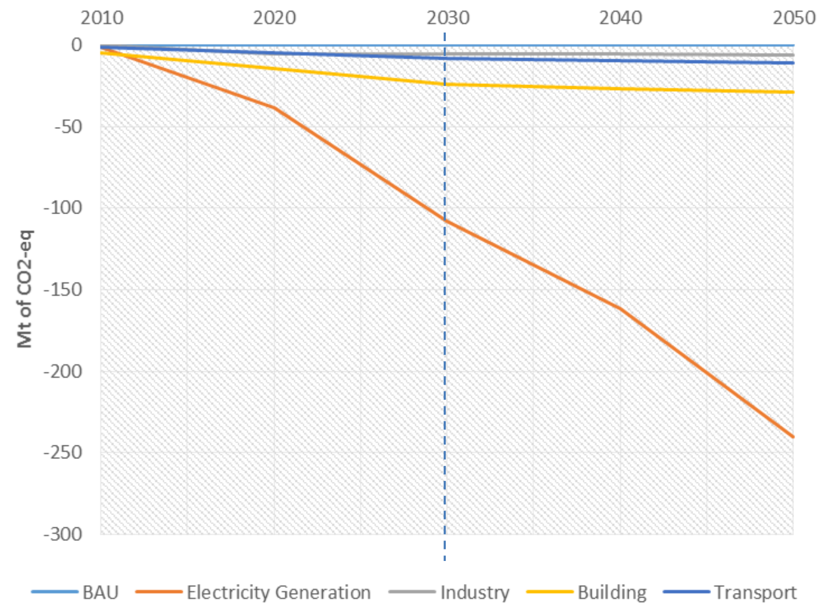
Mt of CO2eq

Sector	2010	2020	2030	2040	2050
Energy	211.5	315.5	463.6	687.2	1036.9
IPPU	32	57.1	96.1	106	120.7
AFOLU	88.1	109.4	135	166.8	208.1
Waste	13.8	16.6	20.4	25.7	33.1
Total	**345.4**	**498.6**	**715.1**	**985.7**	**1398.8**

Assumptions: average GDP growth rate ~4% per year (NESDB, 2008)

GHG Emission Mitigation





Mt of CO2-eq

	2010	2020	2030	2040	2050
BAU	0	0	0	0	0
Electricity Generation	-1.4	-38.6	-107.7	-161.6	-239.9
Industry	-0.3	-5.3	-5.5	-5.8	-6.4
Building	-4.5	-14.2	-24.4	-26.6	-28.7
Transport	-1.5	-4.9	-8.4	-9.6	-10.8
Total	**-7.7**	**-63.0**	**-146.0**	**-203.6**	**-285.8**
% Reduction	**-2.2%**	**-12.6%**	**-20.4%**	**-20.7%**	**-20.4%**

Mitigation Assessment : Road Transport Sector

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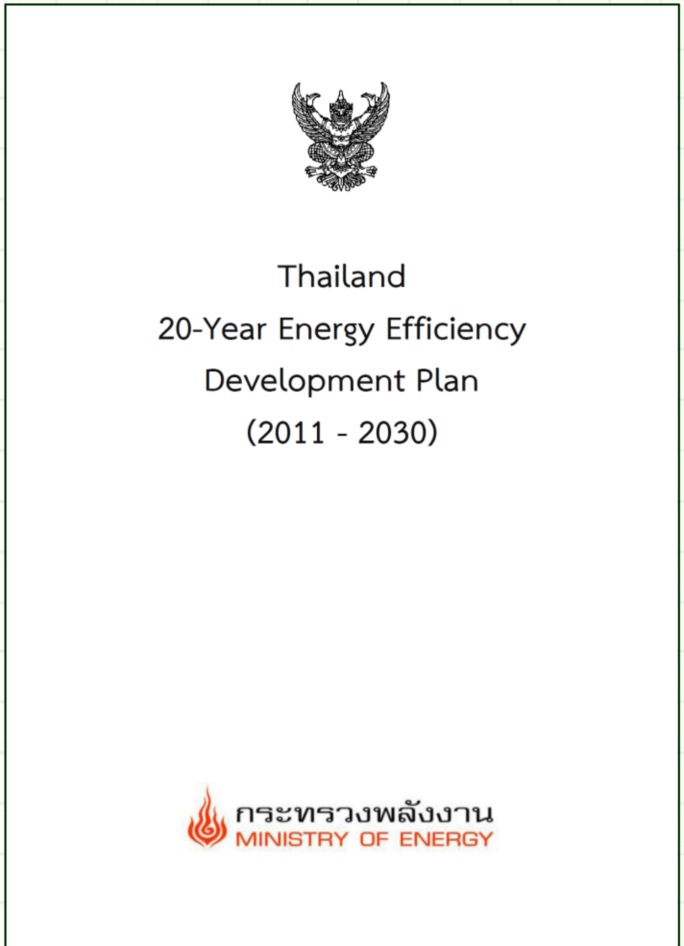
20-Year Energy Efficiency Development Plan (EEDP 2011-2030)


Thailand
20-Year Energy Efficiency
Development Plan
(2011 - 2030)

กระทรวงพลังงาน
MINISTRY OF ENERGY

Target: reducing **"energy intensity"** (the amount of energy used per unit of GDP) by **25% by 2030** compared with 2005 as base year, accounting for total energy saving of 30,000 kilotons of oil equivalent (ktoe) in 2030

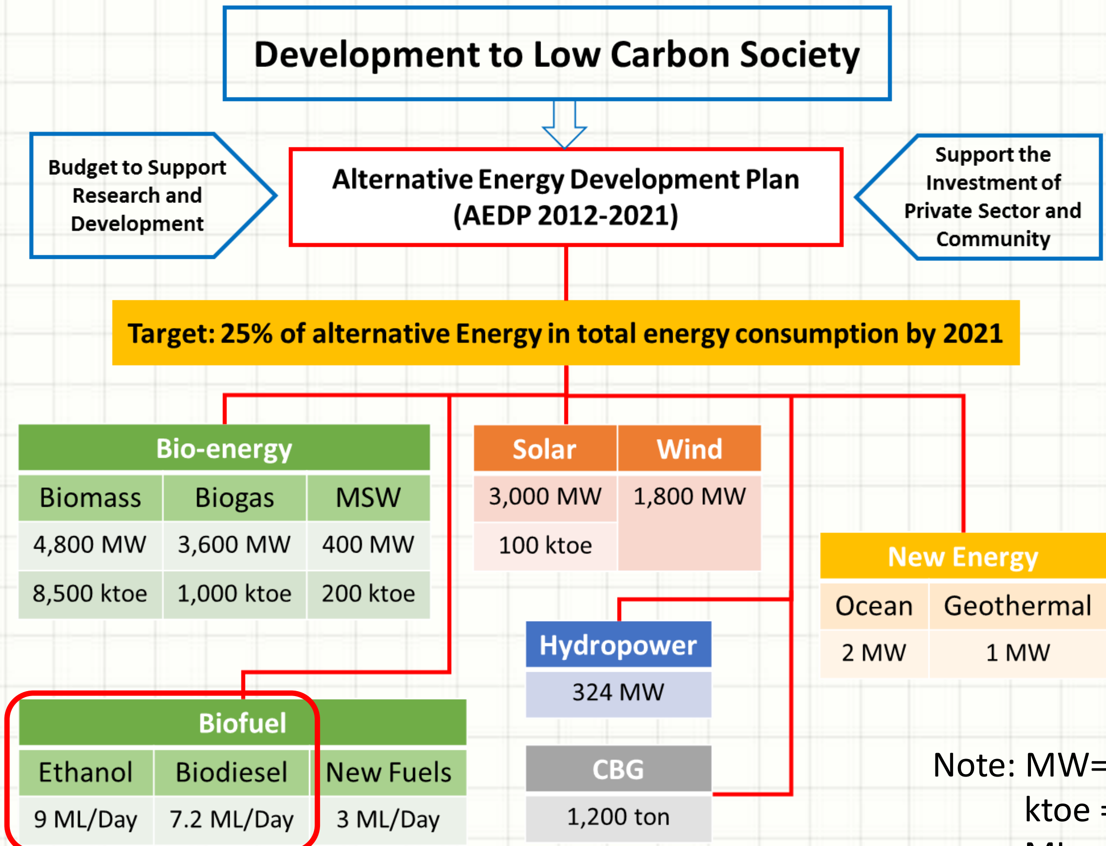
Energy saving targets by sector

Sector	Energy Saving (ktoe)	% share
Transportation	13,400	44.7%
Industry	11,300	37.7%
Large Commercial Building	2,300	7.6%
Small Commercial Building & Residential	3,000	10.0%

Source: Energy Policy and Planning Office (2011)

Mitigation Assessment : Road Transport Sector

10-Year Alternative Energy Development Plan (AEDP 2012-2021)



Target: using 25% of renewable energy for total energy consumption (heat and electricity generation) by the year 2021

Note: MW=Megawatt
ktoe = kilotons of oil equivalent
ML = Million liters

Source: Department of Alternative Energy Development and Efficiency (2012)

Energy Policies in Thailand

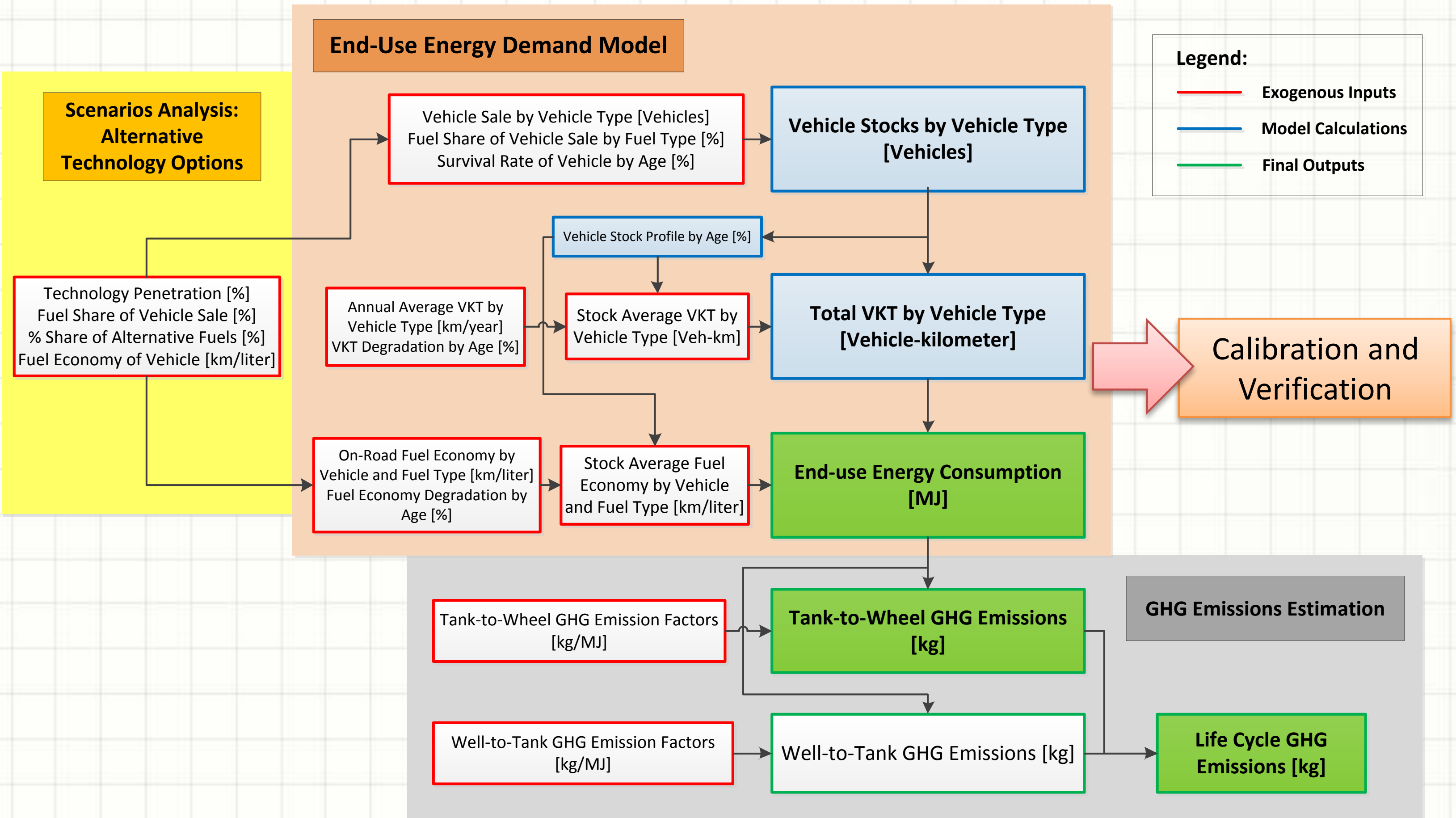
- **Alternative Energy Development Plan (2012-2021)**
  - Switch conventional fossil fuel, such as gasoline and diesel, to biofuels, i.e. bioethanol and biodiesel

- **Energy Efficiency Development Plan (2011-2030)**
  - Promotion of high energy efficiency vehicle technologies for private vehicles, such as eco-car, hybrid car and electric vehicle





Overview of Methodology



End-use Energy Demand Model

$$\boldsymbol{ED(t)} = \sum_{i}\sum_{j}\left[\boldsymbol{V_{stock,i,j}(t)} \times \boldsymbol{VKT_{stock,i,j}(t)} \times \boldsymbol{FE^{-1}_{stock,i,j}(t)}\right]$$

Where $ED(t)$ is the total energy demand in a calendar year *t* (MJ)

$V_{stock,i,j}(t)$ is the total stock of vehicle type *i* , which use fuel type *j*, in a calendar year *t* (vehicles)

$VKT_{stock,i,j}(t)$ is the stock's average annual vehicle kilometer of travel of a given vehicle type *i*, which use fuel type *j*, in a calendar year *t* (kilometers)

$FE_{stock,i,j}(t)$ is the stock's average fuel economy of that given vehicle type *i*, which use fuel type *j*, in a calendar year *t* (vehicle-kilometer per MJ)

t is the calendar year of consideration for a vehicle stock estimation

i is the type of vehicles

j is the type of fuels.

➢ Vehicle Stock Model

- Stock Turnover Analysis

$$V_{stcok,i,j}(t) = \sum_{v=v'}^{v=t} \left[V_{sale,i}(v) \times \varphi_i(k) \times \Psi_{i,j}(v) \right]$$

Where $V_{stock,i,j}(t)$ is the number of vehicle stock type *i* which use fuel type *j* in a calendar year *t* (vehicles)

$V_{sale,i}(v)$ is the number of new vehicle type *i* that sold in vintage year *v* (vehicles)

$V_{sale,i}(v)$ is the number of new vehicle type *i* that sold in vintage year *v* (vehicles)

$\varphi_i(k)$ is the survival rate of vehicles type *i* with age *k* (%)

$\Psi_{i,j}(v)$ is the percentage share of fuel type *j* within the sales of vehicle type *i* in the vintage year *v* (%)

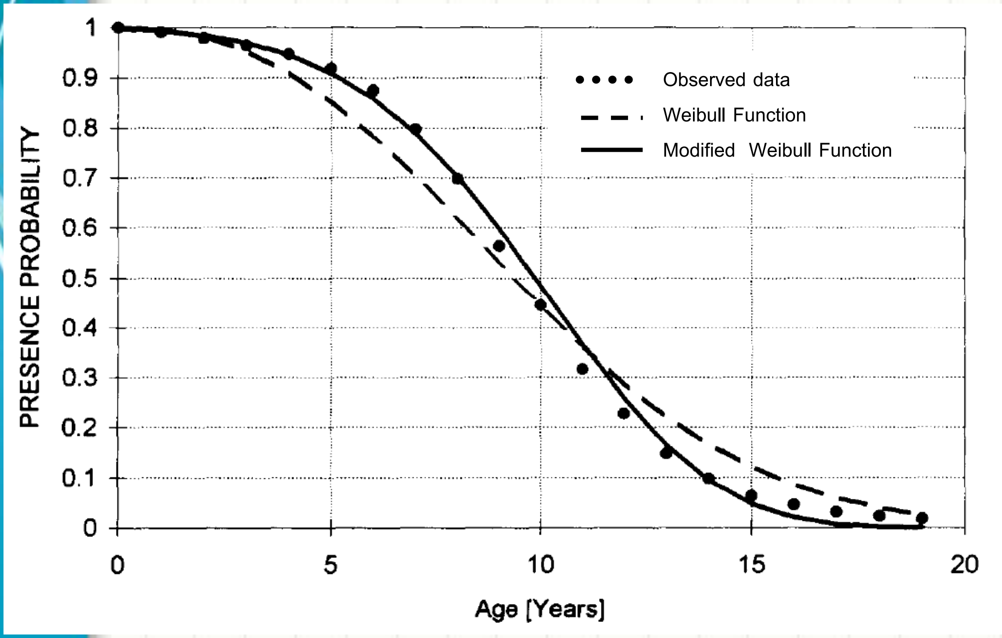
v is the vintage year of vehicles, of which *v* < *t*

v' is the oldest vintage year of vehicles in the stock.

k is the age of vehicle, where *k* = *t* – *v* (years)

Survival Rate of Vehicles $(\varphi_i(k))$

- Survival rate of vehicles is a probability that vehicles are survived with increasing ages after they entered the market.



S-shaped Gompertz scrapping curve

$$\boldsymbol{\varphi_i(k) = exp\left[-\left(\frac{k+b_i}{T_i}\right)^{b_i}\right], \varphi_i(0) \equiv 1}$$

Where $\varphi_i(k)$ is the survival rate of vehicle type *i* with age *k*

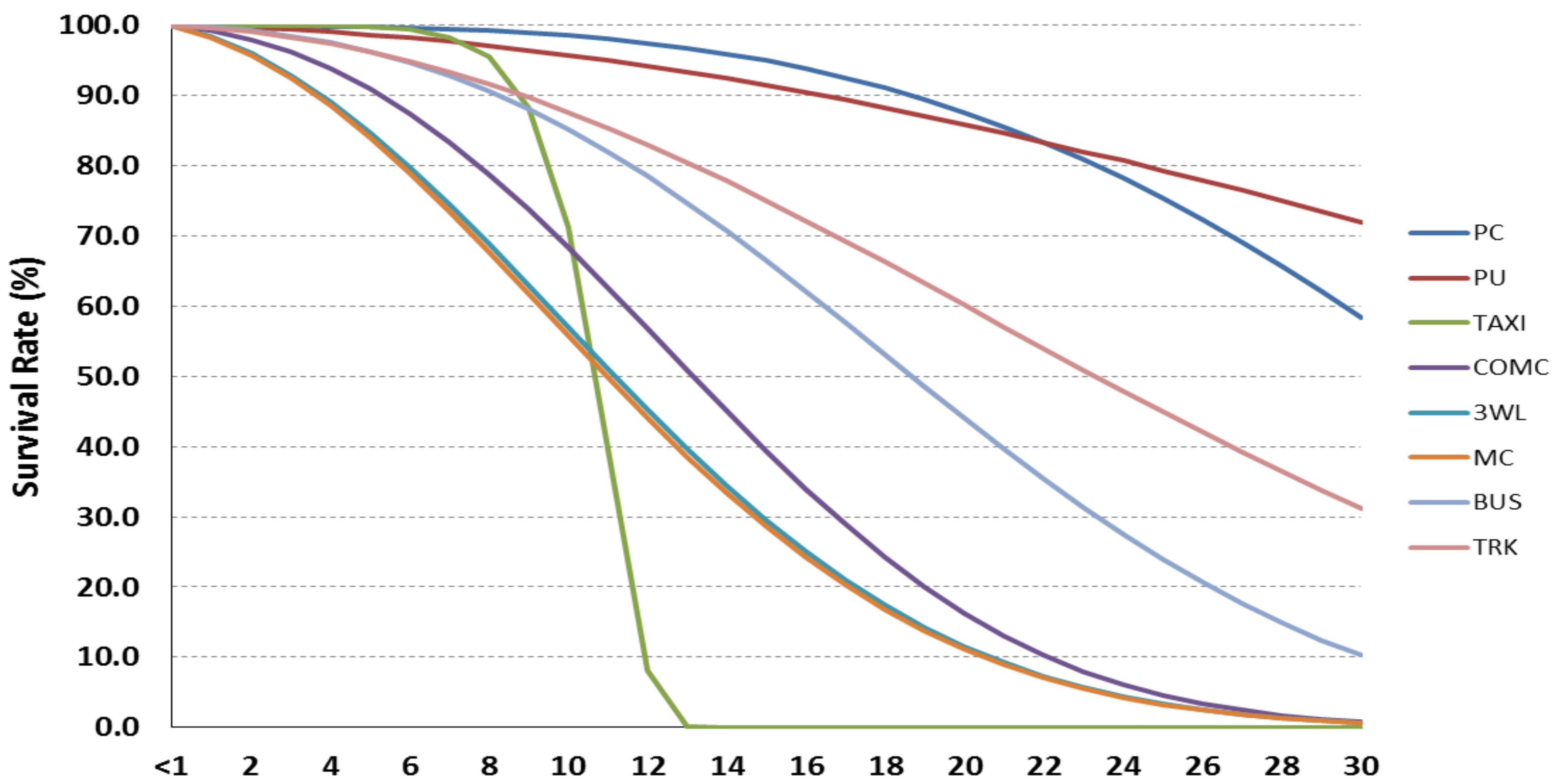
k is the age of vehicles

b_i is the failure steepness for vehicles type *i* (b_i>1, i.e. failure rate increase with age)

T_i is the characteristic service life for vehicle type *i*.

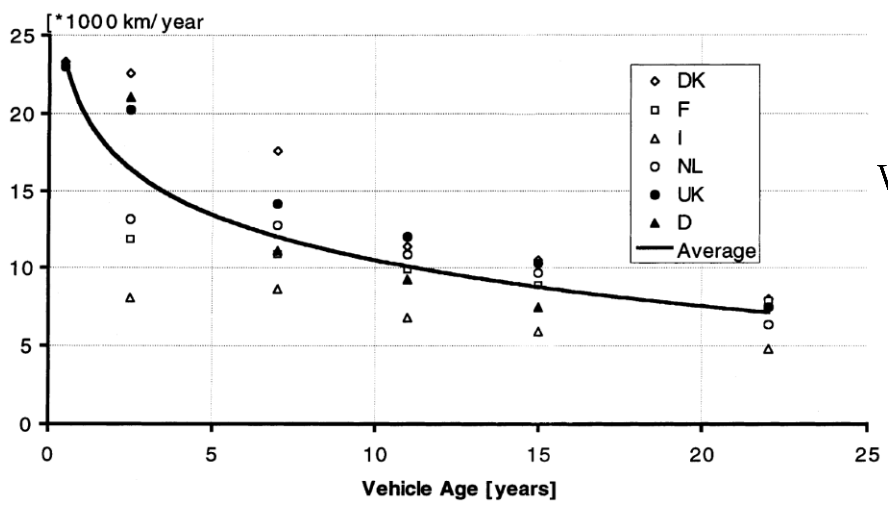
Data sources: Department of Land Transport (DLT)

Survival Rate of Vehicles (cont.)



Age (Years)	PC	PU	TAXI	COMC	3WL	MC	BUS	TRK
b_i	4.02	2.04	7623.24	2.66	2.22	2.18	2.80	2.22
T_i	39.70	55.17	7634.32	18.09	15.68	15.42	24.46	30.05
R^2	0.79	0.91	0.94	0.77	0.90	0.97	0.84	0.84

➢ Vehicle Kilometer of Travel ($VKT_{stock,i,j}(t)$)



$$\delta_{i,j}(k) = \alpha_{i,j}k^{\beta_{i,j}}$$

Where $\alpha_{i,j}$ and $\beta_{i,j}$ are coefficients of variable k (vehicle age) of vehicle type i which uses fuel type j.

$$VKT_{veh,i,j}(k) = \delta_{i,j}(k) \times VKT_{veh,i,j}(0) = \alpha_{i,j}k^{\beta_{i,j}} \times VKT_{veh,i,j}(0)$$

Where $\delta_{i,j}(k)$ is the degradation factor of VKT of vehicle type *i* which use fuel type *j* with age *k*

$VKT_{veh,i,j}(k)$ is the annual average VKT of vehicle type *i* which use fuel type *j* with age *k* (kilometers)

$VKT_{veh,i,j}(0)$ is the annual average VKT of new vehicle type *i* which use fuel type *j* (kilometers)

$\alpha_{i,j}$ and $\beta_{i,j}$ are coefficients of variable *k* (vehicle age) of vehicle type *i* which use fuel type *j*.

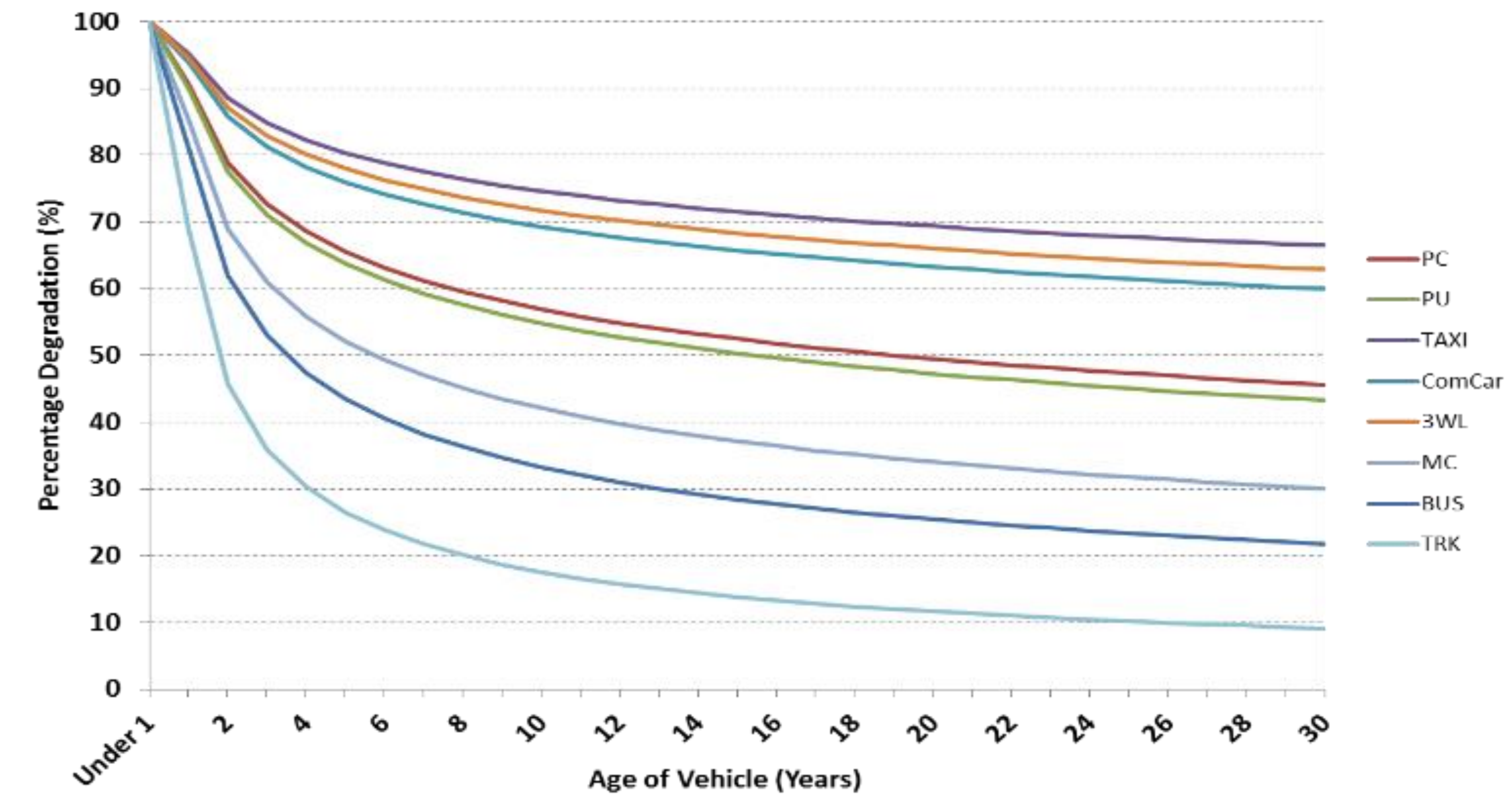
$$VKT_{stock,i,j}(t) = \frac{\sum_{v=v'}^{v=t}\left[V_{remain,i,j}(t,v) \times VKT_{veh,i,j}(k)\right]}{V_{stock,i,j}(t)}$$

Where $VKT_{stock,i,j}(t)$ is the stock's annual average vehicle kilometer of travel of vehicles type *i* which use fuel type *j* in a calendar year *t* (kilometers per vehicle)

$V_{remain,i}(t,v)$ is the number of vehicle type *i* that sold in vintage year *v*, which still remains on road in a calendar year *t* (vehicles)

Data sources: King Mongkut's Institute of Technology Thonburi (KMITT)

➢ Vehicle Kilometer of Travel (cont.)



Vehicle Type	PC	PU	TAXI	COMC	3WL	MC	BUS	TRK
VKT of New Vehicle (km/year)	23,248	37,955	72,154	26,758	13,766	14,690	98,395	98,111
α_i	0.907	0.900	0.953	0.939	0.946	0.853	0.811	0.689
β_i	-0.202	-0.215	-0.106	-0.132	-0.120	-0.307	-0.387	-0.594
R^2	0.98	0.98	0.99	0.99	0.99	0.98	0.98	0.97

➤ Fuel Economy of Vehicles ($FE_{stock,i,j}(t)$)

- Fuel economy is an average vehicle-distance travelled per unit of fuel used. It is generally presented in term of vehicle-kilometer per liter.
- The efficiency of a vehicle is normally reducing when the vehicle get older.
- According to a survey data of KMITT, relationship between the degradation of vehicle efficiency and its age could not be found.
- Therefore, in this study, we assumed that age of vehicle does not affect to the fuel economy of vehicles. <u>The fuel economy of vehicles was also assumed to be constant.</u>

Vehicle Type	Fuel Economy (Vehicle-kilometer per liter)			
	Gasoline	Diesel	LPG	CNG*
PC	12.27	11.31	10.69	10.86
PU	11.82	11.93	11.06	10.78
TAXI	13.50	10.00	9.66	11.16
COMC	9.37	8.34	11.22	8.71
3WL	17.68	15.37	10.80	10.25
MC	28.71	-	-	-
BUS	-	3.91	-	2.26
TRK	-	4.14	-	1.67

Note: * Unit of CNG fuel economy is veh-km per kg.

Data sources: King Mongkut's Institute of Technology Thonburi (KMITT) and Energy Policy and Planning Office (EPPO)

GHG Emissions Estimation

- Default GHG Emission Factors

CO_2 Emission

$$CO_2 = FC_j \times E_{C,j}$$

Where CO_2 is the carbon dioxide emission (t CO_2)
FC_j is the fuel consumption of fuel type *j* (ktoe)
$E_{C,j}$ is the carbon emission factor of fuel type *j* (t C/TJ)

Non-CO_2 Emissions

$$CH_4 = FC_j \times E_{CH4,j}$$

$$N_2O = FC_j \times E_{N2O,j}$$

Where CH_4 is the methane emission (kg)
N_2O is the nitrous oxide emission (kg)
$E_{CH4,j}$ is the methane emission factor of fuel type *j* (kg/TJ)
$E_{N2O,j}$ is the nitrous oxide emission factor of fuel type *j* (kg/TJ).

TABLE 3.2.1
ROAD TRANSPORT DEFAULT CO_2 EMISSION FACTORS AND UNCERTAINTY RANGES [a]

Fuel Type	Default (kg/TJ)	Lower	Upper
Motor Gasoline	69 300	67 500	73 000
Gas/ Diesel Oil	74 100	72 600	74 800
Liquefied Petroleum Gases	63 100	61 600	65 600
Kerosene	71 900	70 800	73 700
Lubricants [b]	73 300	71 900	75 200
Compressed Natural Gas	56 100	54 300	58 300
Liquefied Natural Gas	56 100	54 300	58 300

Source: Table 1.4 in the Introduction chapter of the Energy Volume.

Notes:
[a] Values represent 100 percent oxidation of fuel carbon content.
[b] See Box 3.2.4 Lubricants in Mobile Combustion for guidance for uses of lubricants.

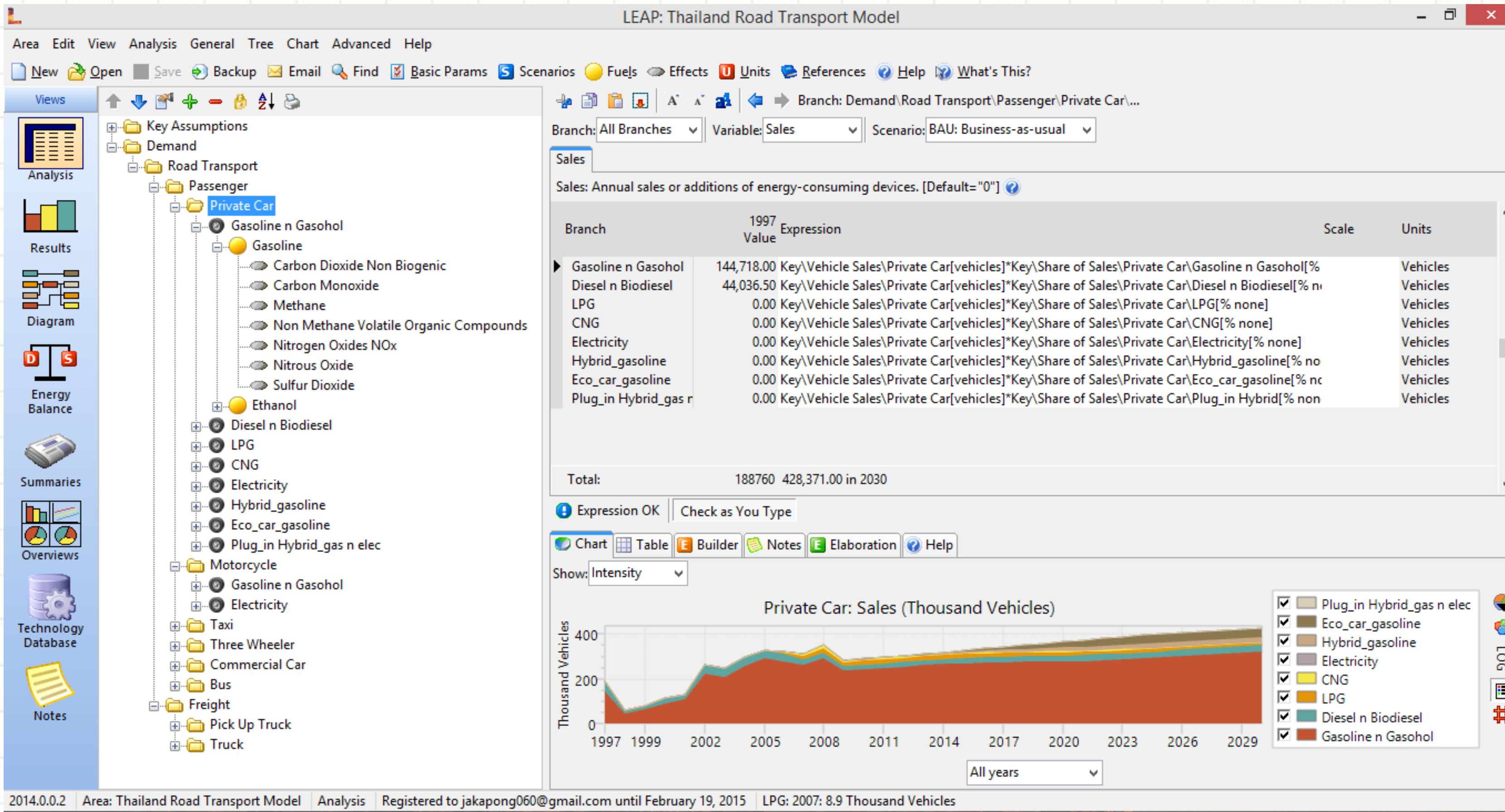
TABLE 3.2.2
ROAD TRANSPORT N_2O AND CH_4 DEFAULT EMISSION FACTORS AND UNCERTAINTY RANGES [(a)]

Fuel Type/Representative Vehicle Category	CH_4 (kg /TJ)			N_2O (kg /TJ)		
	Default	Lower	Upper	Default	Lower	Upper
Motor Gasoline -Uncontrolled [(b)]	33	9.6	110	3.2	0.96	11
Motor Gasoline –Oxidation Catalyst [(c)]	25	7.5	86	8.0	2.6	24
Motor Gasoline –Low Mileage Light Duty Vehicle Vintage 1995 or Later [(d)]	3.8	1.1	13	5.7	1.9	17
Gas / Diesel Oil [(e)]	3.9	1.6	9.5	3.9	1.3	12
Natural Gas [(f)]	92	50	1 540	3	1	77
Liquified petroleum gas [(g)]	62	na	na	0.2	na	na
Ethanol, trucks, US [(h)]	260	77	880	41	13	123
Ethanol, cars, Brazil [(i)]	18	13	84	na	na	na

Long-range Energy Alternatives Planning (LEAP) System

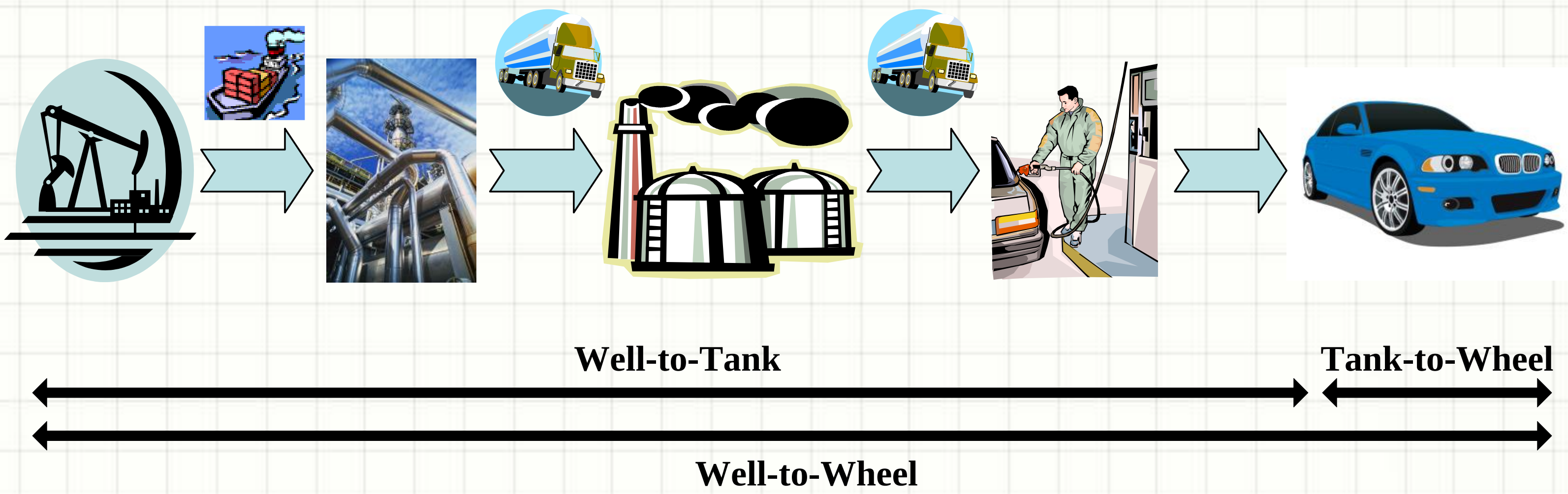
SEI STOCKHOLM ENVIRONMENT INSTITUTE

LEAP

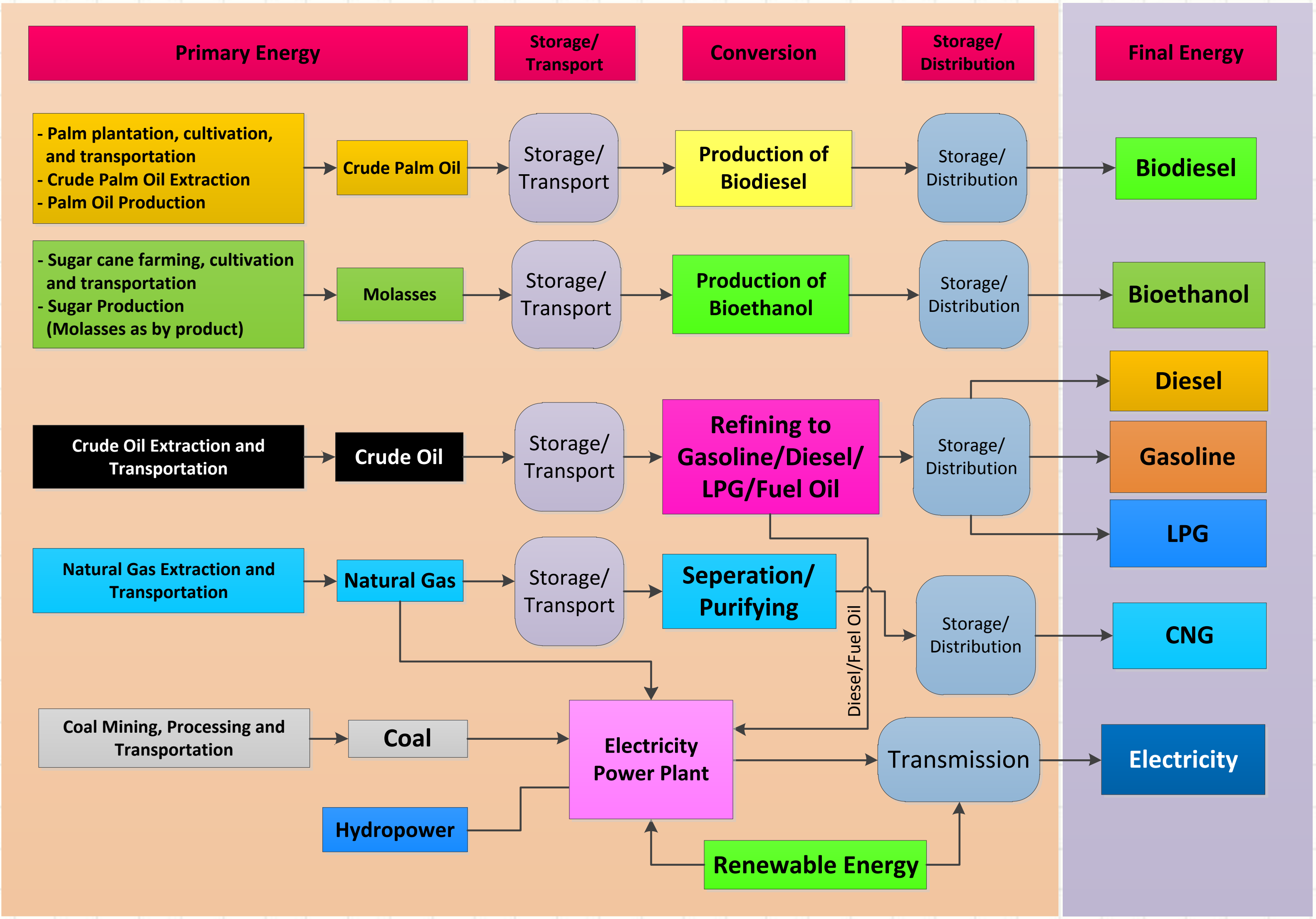


Life Cycle of Fuel Supply-Demand of Road Transport Sector

- Well-to-Wheel Analysis for Transport Fuel Systems
  - Well-to-Tank: Fuel Production
  - Tank-to-Wheel: Fuel Utilization



Supply Chain of Road Transport Fuels



Life Cycle GHG Emissions Estimation

- Life Cycle (well-to-wheel) GHG Emissions

$$GHG_{wtw,j} = GHG_{wtt,j} + GHG_{ttw,j} = ED_{ttw,j} \times f_{GHG,j}^{wtt} + ED_{ttw,j} \times f_{GHG,j}^{ttw}$$

Where $GHG_{wtw,j}$ is the well-to-wheel greenhouse gas emission of fuel type *j* (g of CO_2 eq.)

$GHG_{wtt,j}$ is the well-to-tank greenhouse gas emission of fuel type *j* (g of CO_2 eq.)

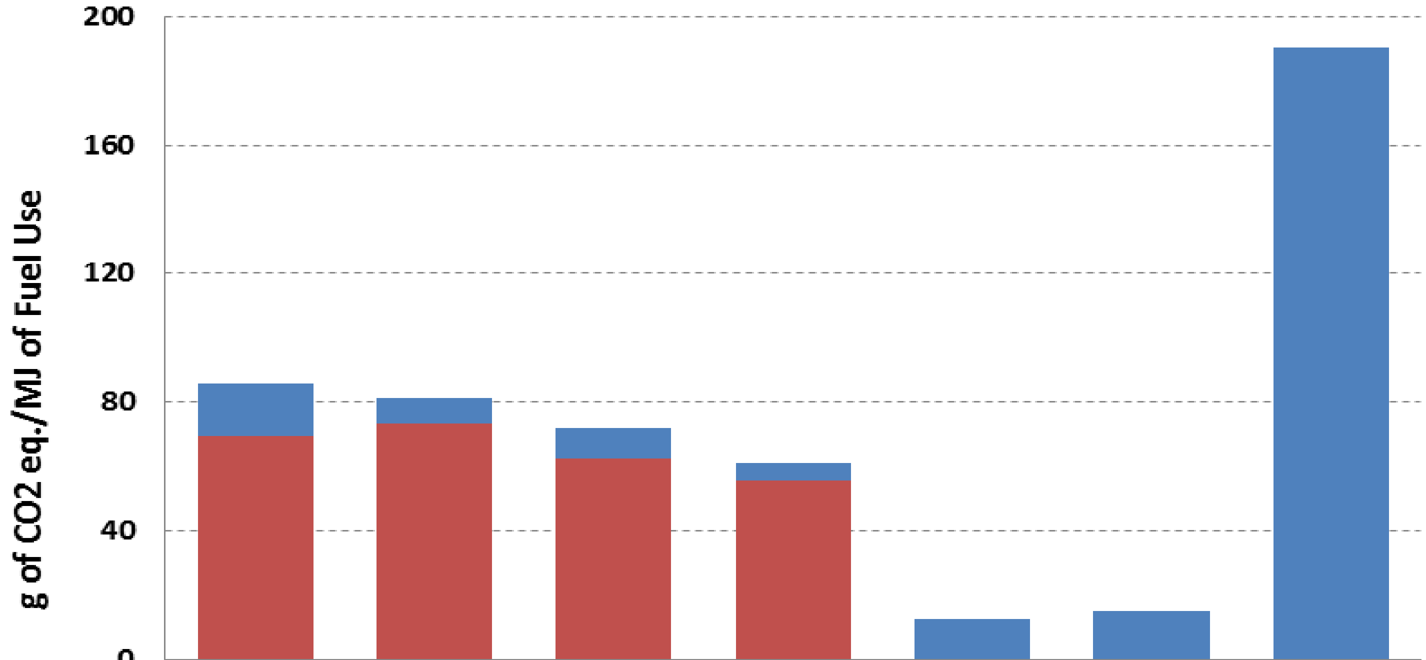
$GHG_{ttw,j}$ is the tank-to-wheel greenhouse gas emission of fuel type *j* (g of CO_2 eq.)

$ED_{ttw,j}$ is the tank-to-wheel energy supply to end-use (or consumption at end-use) of fuel type *j* (MJ)

$f_{GHG,j}^{wtt}$ is the corresponding factor of well-to-tank GHG emission of fuel type *j* (g of CO_2 eq./MJ of fuel use)

$f_{GHG,i}^{ttw}$ is the corresponding factor of tank-to-wheel GHG emission of fuel type *j* (g of CO_2 eq./MJ of fuel use).

Life Cycle GHG Emission per Unit of Energy Consumption by Fuel Type



	Gasoline	Diesel	LPG	CNG	Bioethanol (Molasses)	Biodiesel (Palm Oil)	Electricity
Well-to-Tank	16.5	7.6	9.2	5.5	12.6	14.9	190.4
Tank-to-Wheel	69.3	73.6	62.8	55.5	0.2	0.2	0.0

Scenarios Analysis

- Business-as-usual scenario
- Government's plans scenarios
  - Alternative Energy Development Plan (AEDP) (Fuel Switching Option)
  - Energy Efficiency Development Plan (EEDP): (Energy Efficiency Option)
  - Combination of REDP and EEDP
- Maximum potential scenario

Business-as-usual (BAU) Scenario

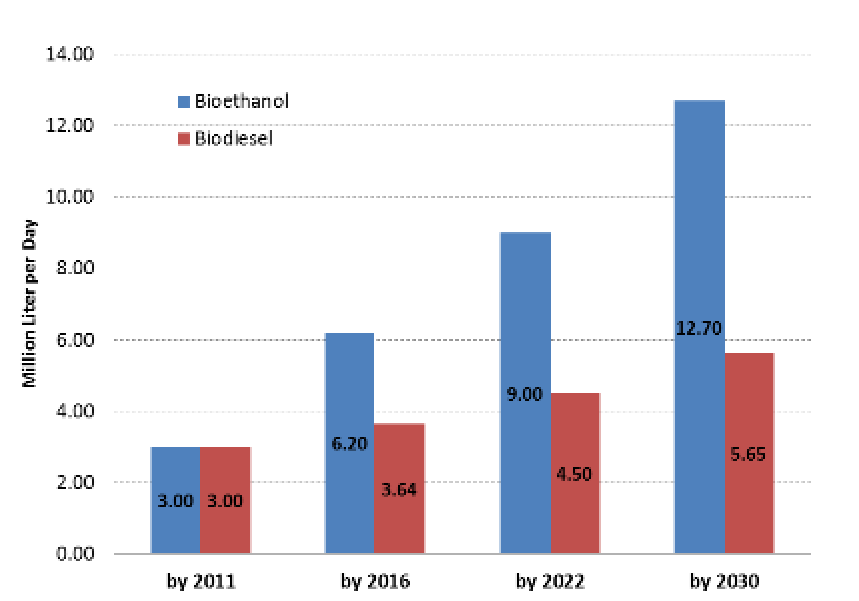
- Assumptions
  - Socio-economic Parameters
    - Average GDP growth rate 3.5% per year,
    - Average population growth rate 0.6% per year, and
    - Average crude oil price constant during 2009 to 2015 and growth with 1.5% per year after 2016.
  - Fuel Share and Fuel Economy
    - Assumed to be constant to 2030.

References:

- GDP and Population: *the Office of National Economic and Social Development Board (NESDB)*
- Crude Oil Price: *International Energy Agency (IEA)*

Scenarios Analysis (cont.)

- **Alternative Energy Development Plan (AEDP)**
  - Promotion of biofuels (ethanol and biodiesel) to substitute for conventional gasoline and diesel.
- **Energy Efficiency Development Plan (EEDP)**
  - Promotion of high energy efficiency vehicles technology, such as eco-car, hybrid car, and electric motorcycle.



Year	Penetration Rate for Vehicle Sale (%)		
	HEV for PC	ECO for PC	EMC for MC
2010	0.4	0.4	0.8
2015	3.6	4.6	8.2
2020	14.6	18.3	32.9
2025	19.4	24.3	43.7
2030	20.0	25.0	45.0

Type of Vehicle/Model	Fuel Economy
Hybrid Car	14.14 km per liter
Plug-in Hybrid Car	15.77km per liter and 4.41 km per kWh
Electric Car	4.74 km per kWh
Eco-Car	20 km per liter
Electric Motorcycle	24.27 km per kWh

- **Combination of AEDP and EEDP (COMB)**

Sources: Department of Alternative Energy Development and Efficiency (2008) and Energy Policy and Planning Office (2011)

Scenarios Analysis (cont.)

Maximum Potential (MAX) Scenario

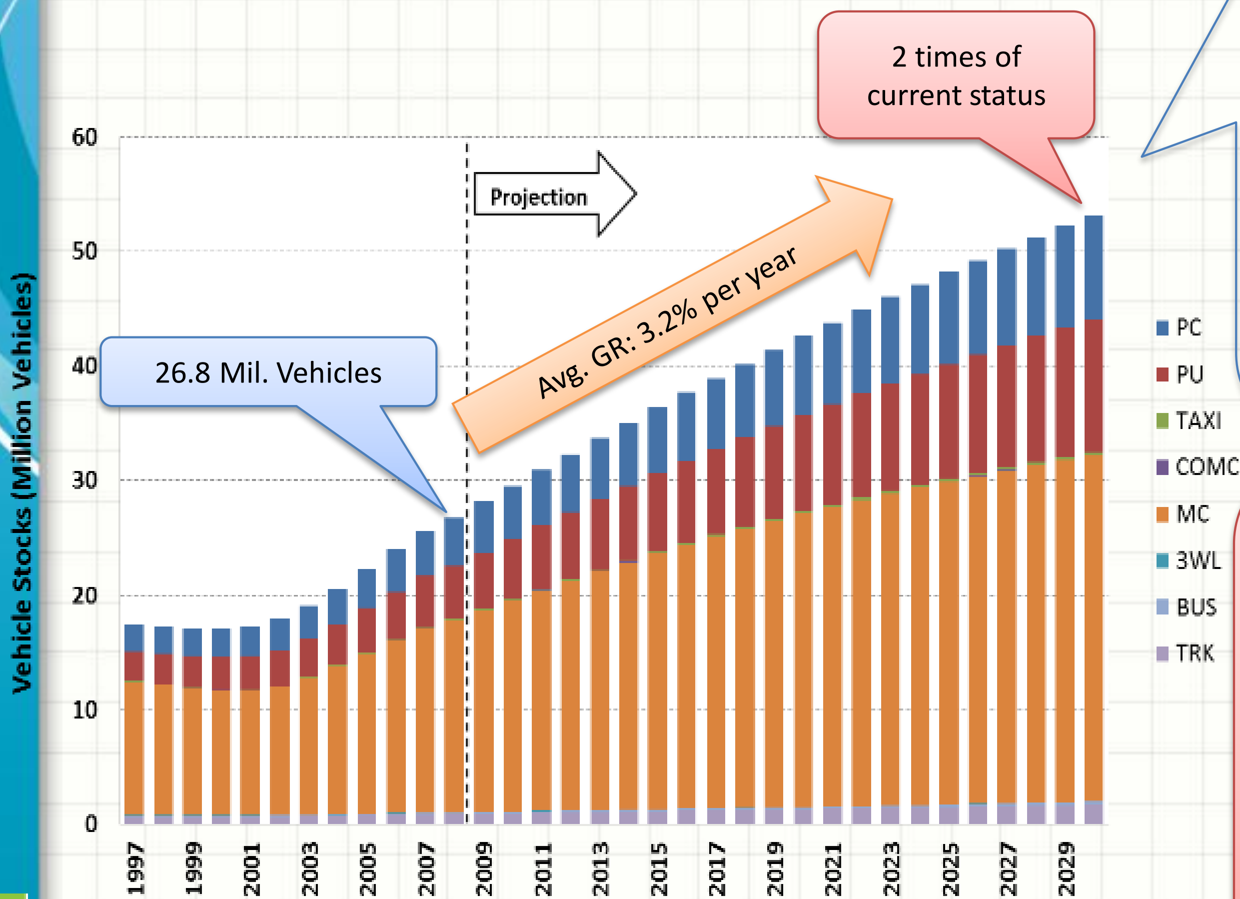
- Fuel Switching Option Assumptions
  - Bioethanol is expected to substitute for gasoline 9.72 million liters per day by 2030.
  - Biodiesel is expected to substitute for diesel 7.85 million liters per day by 2030.
- Energy Efficiency Option Assumptions
  - High energy efficiency ICE (Eco-car)
  - Hybrid Electric Vehicle (HEV)
  - Plug-in Hybrid Electric Vehicle (PHEV)
  - Electric Motorcycle (EMC)
  - Electric Vehicle (EV)

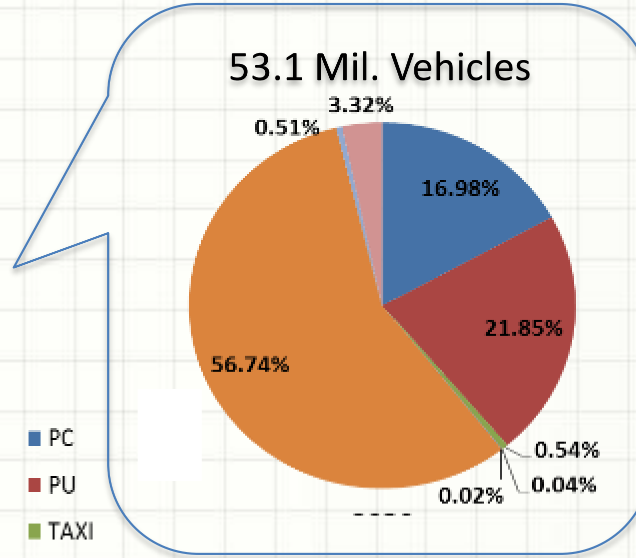
Year	Penetration Rate for Vehicle Sale (%)				
	HEV for PC	ECO for PC	PHEV for PC	EV for PC	EMC for MC
2010	0.5	0.5	-	-	1.8
2015	5.5	5.5	-	-	18.2
2020	21.9	21.9	-	-	73.1
2025	29.1	29.1	3.6	4.3	97.1
2030	30.0	30.0	7.3	8.6	100.0

Soures: International Energy Agency (IEA) and Nagayama, H. (2011)

Projection under BAU Scenario

- Vehicle Stocks



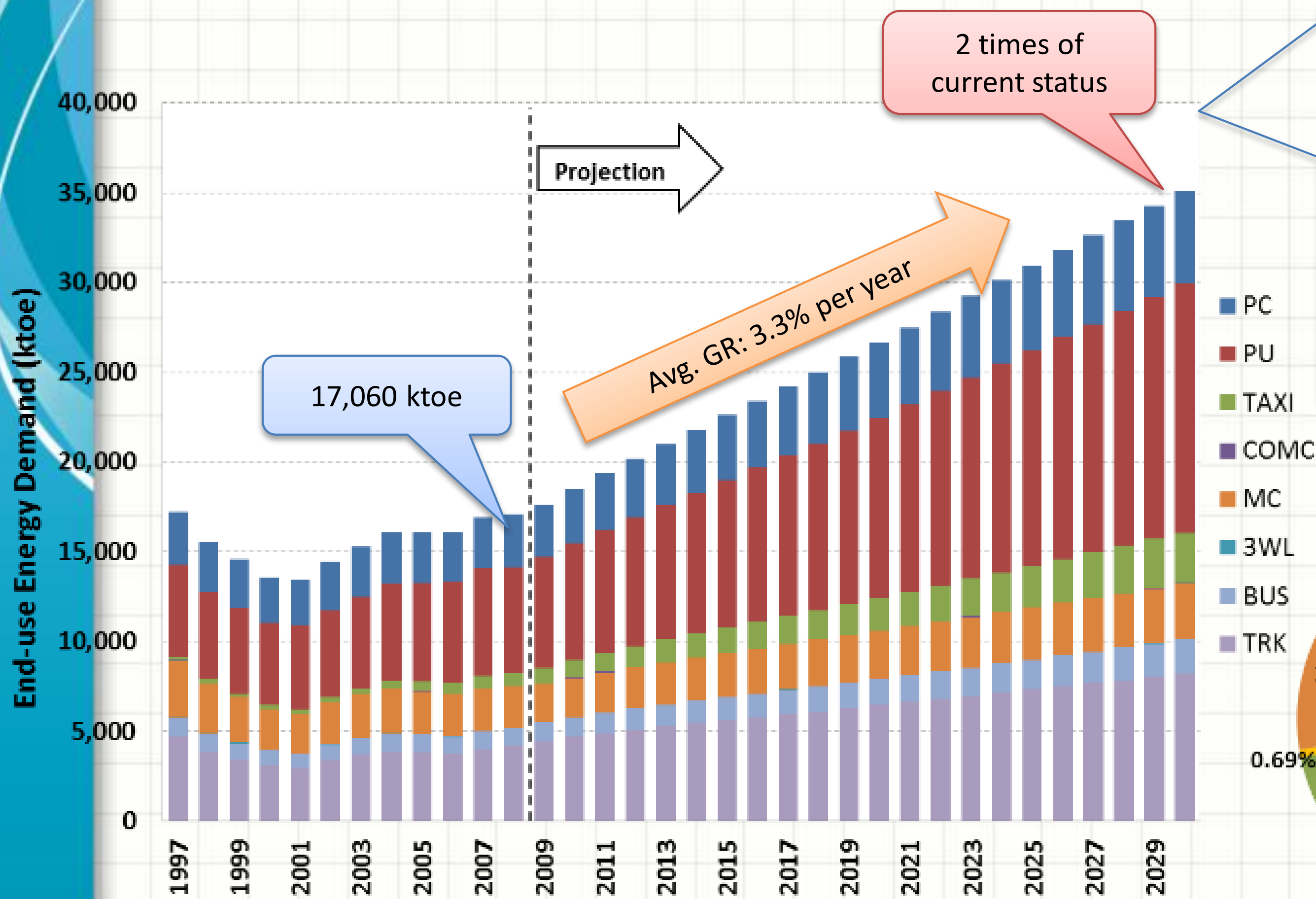


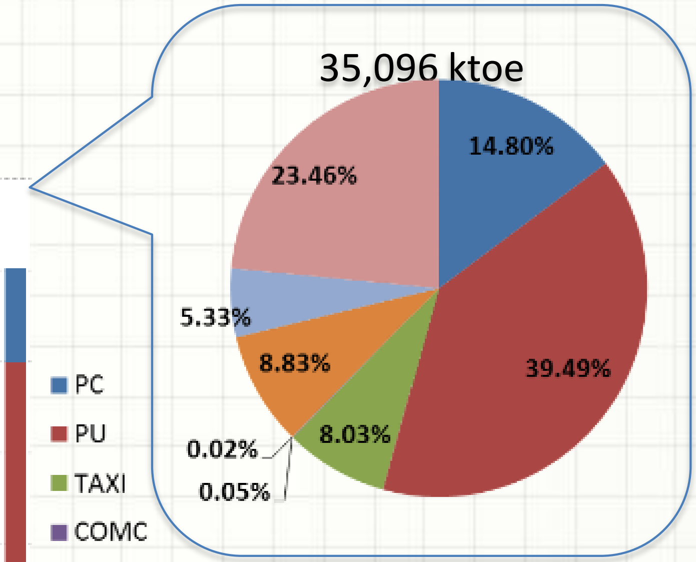
In 2030
Vehicle Stocks:
PC 9.0 Mil. Vehicles
PU 11.6 Mil. Vehicles
MC 30.1 Mil. Vehicles
Others 2.35 Mil. Vehicles

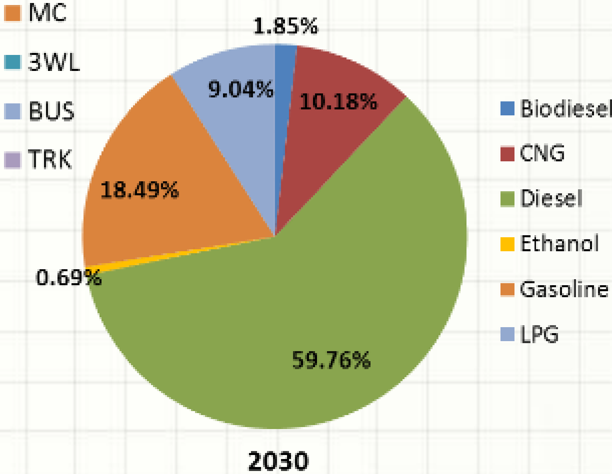
Vehicle Ownership:
PC 119 veh./1,000 persons
PU 153 veh./1,000 persons
MC 397 veh./1,000 persons
Other 31 veh./1,000 persons

Projection under BAU Scenario (cont.)

- End-use Energy Demand

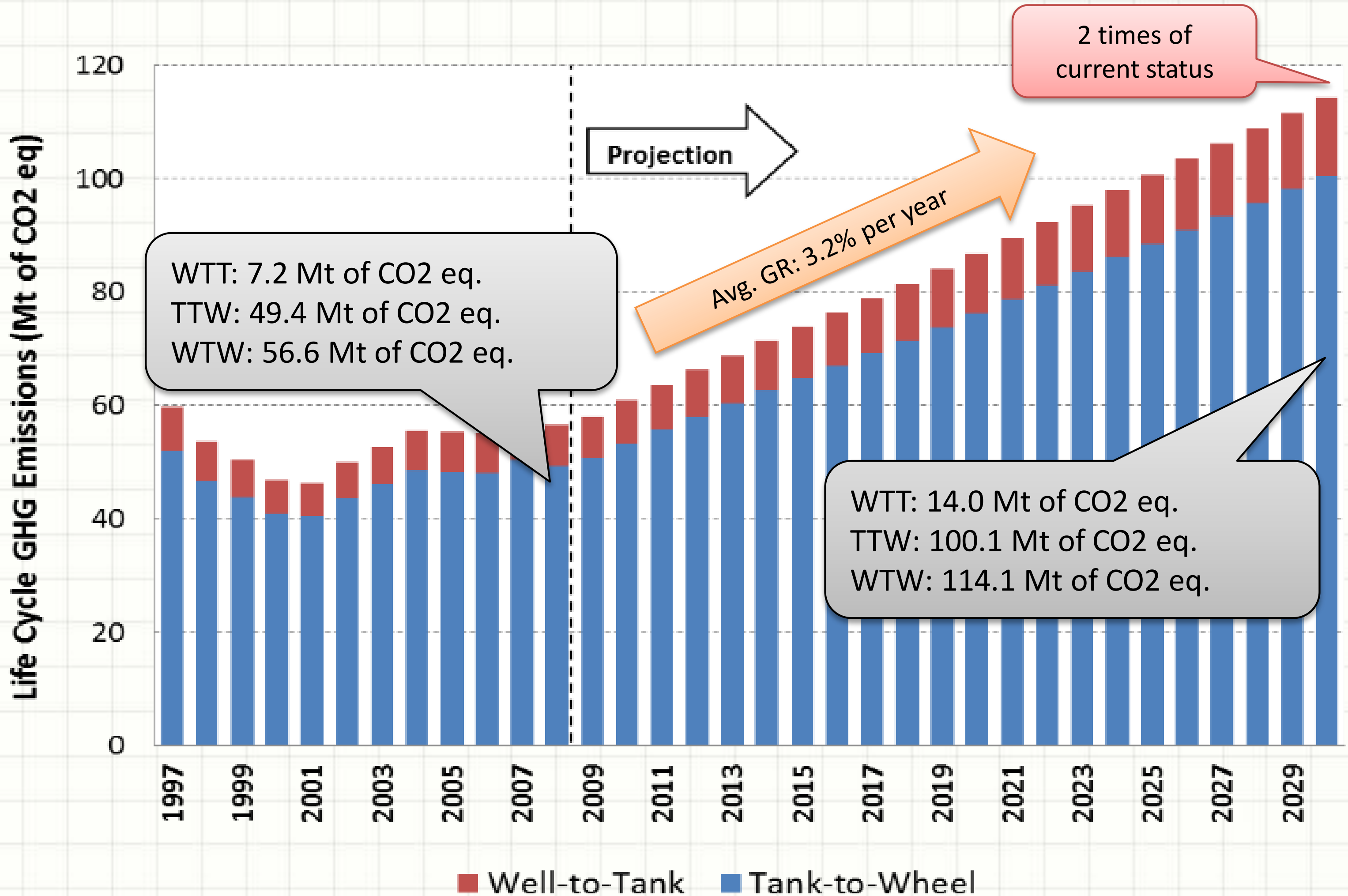




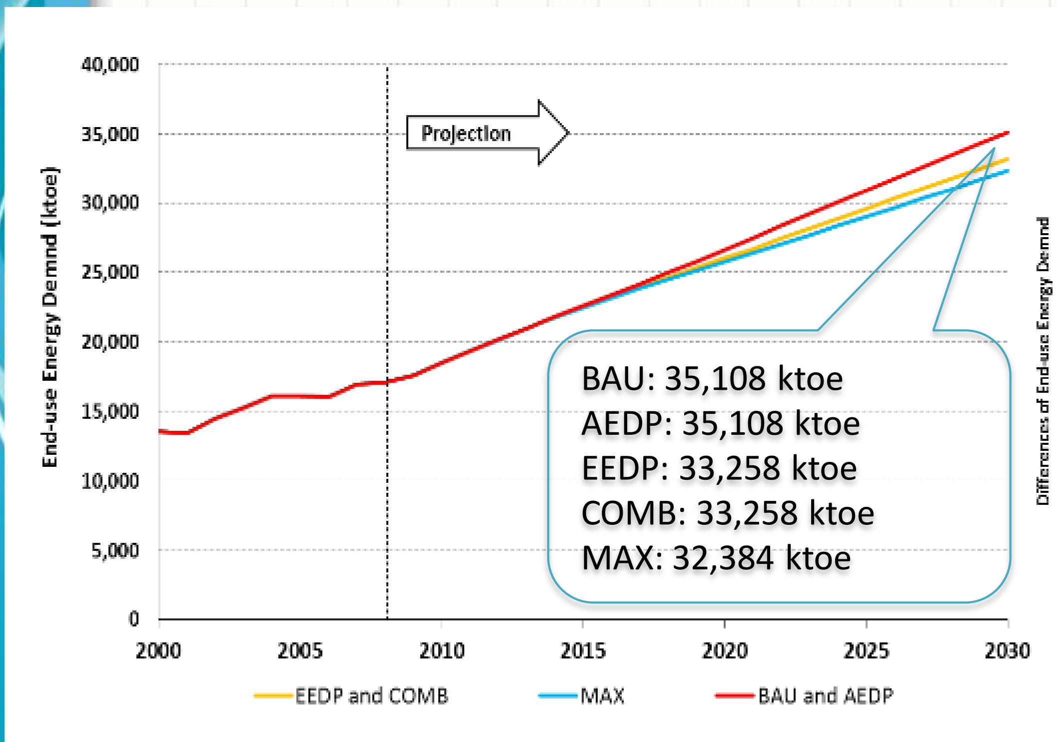


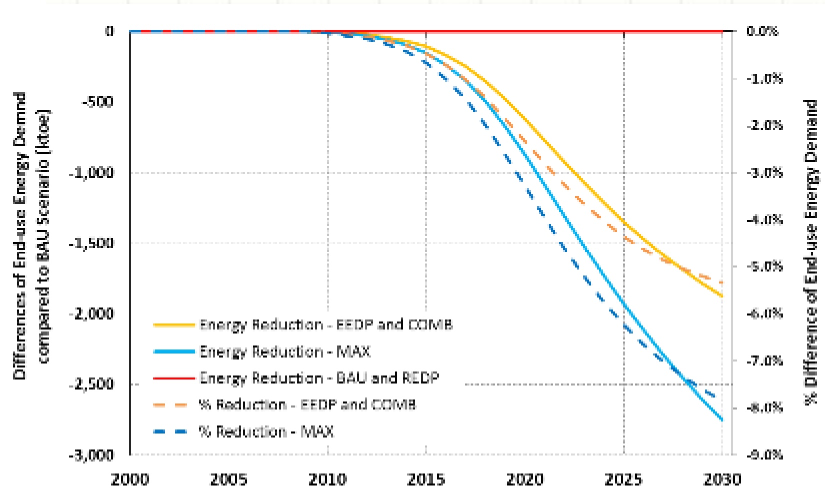
Projection under BAU Scenario (cont.)

- GHG Emissions



End-use Energy Demand Reduction

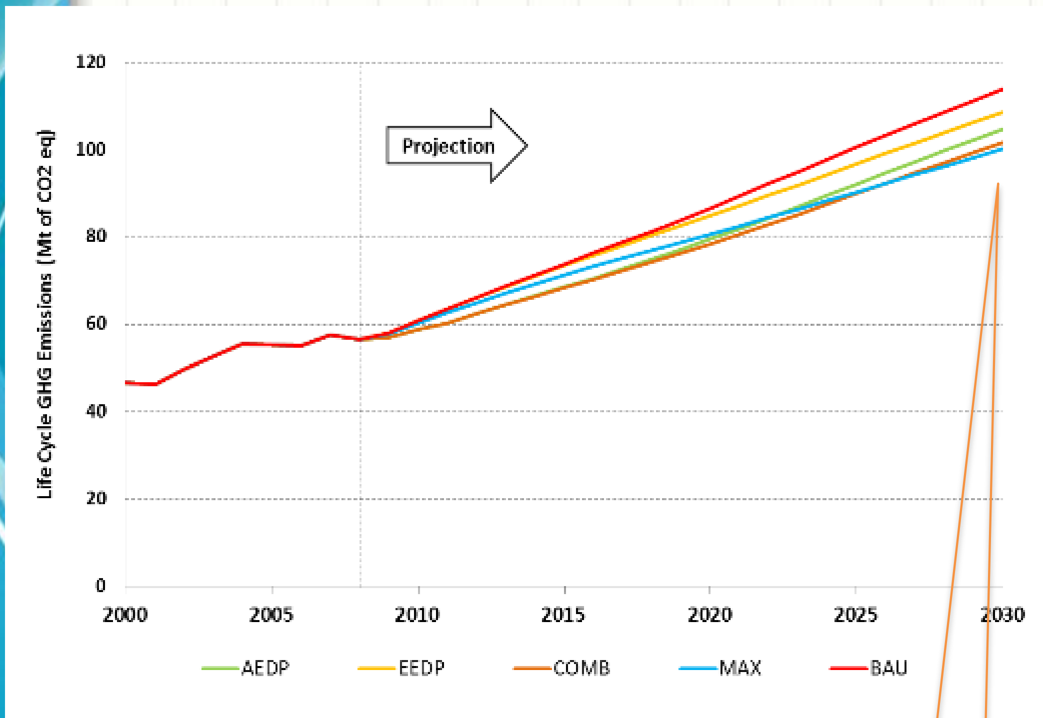


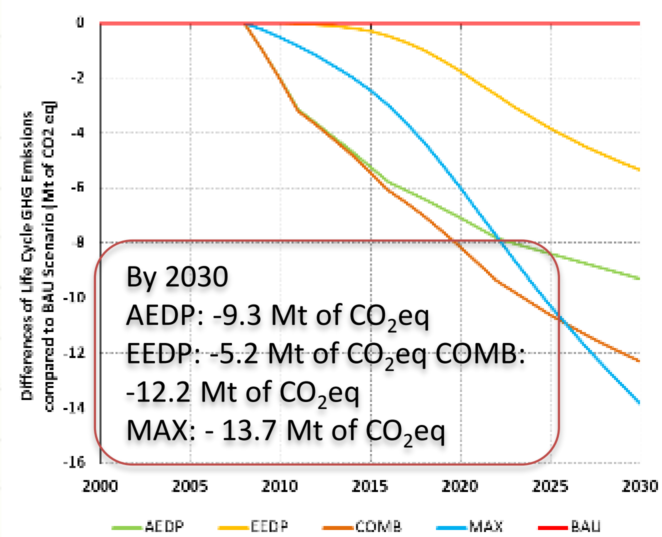


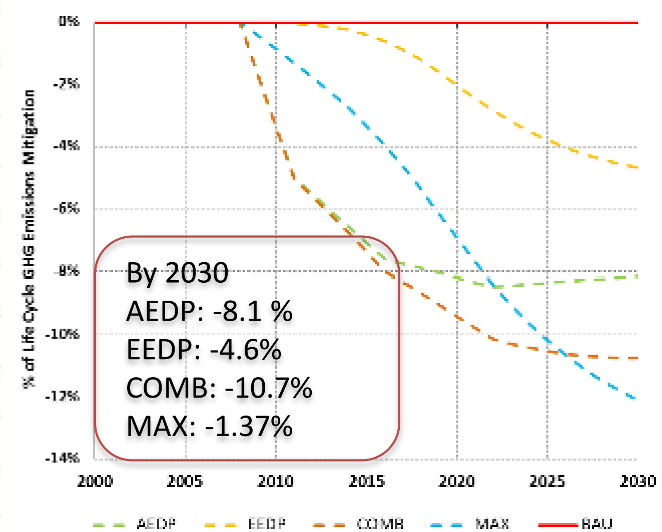
By 2030
AEDP: 0 ktoe
EEDP: -1,850 ktoe
COMB: -1,850 ktoe
MAX: -2,724 ktoe

By 2030
AEDP: 0 %
EEDP: -5.3%
COMB: -5.3%
MAX: -7.8%

Life Cycle GHG Emissions Mitigation







Scenarios	GHG Emissions (Mt of CO_2eq.)		
	Well-to-Tank	Tank-to-Wheel	Well-to-Wheel
BAU	13.8	100.3	114.1
AEDP	14.0	90.8	104.8
EEDP	14.3	94.5	108.8
COMB	14.6	87.3	101.9
MAX	15.2	85.2	100.3

Conclusion

- GHG inventories are complied for both scientific activity and policy planning
  - Use for modeling activities
  - Use for future projections and setting targets for emission reduction
  - Use for policy and measures planning and their monitoring
  - Use for mitigation measure and technology assessment
- Previous national GHG inventories have done with tier 1 level, because lacking of activity data and country-specific emission factors in higher tier level in most sectors.
- For some subsector, i.e. road transport sector, data is available to develop end-use energy demand model for activity data (energy consumption) estimation, but still lacking of country-specific emission factors.

Recommendation

Greenhouse Gas Inventory

Areas that need further technical support to improve inventory activities for Thailand are as follows:

- ❖ Local emission factors in major sectors and those sectors that are important to economic development. The priority sectors are agriculture and forestry.
- ❖ Develop appropriate activity data to support the estimation of greenhouse gas inventory. The priority sectors are energy, agriculture, forestry and waste management.
- ❖ Develop estimation method for key sectors to higher tier. These are the energy, agriculture, and forestry sectors.
- ❖ Train relevant officials and agencies to carry out the estimation regularly.
- ❖ Develop technical personnel in specific areas to develop appropriate estimation methodologies or techniques for Thailand.
- ❖ Develop techniques in greenhouse gas emission forecast.

Recommendation

Greenhouse Gas Mitigation

Techniques, know-how and technologies to mitigate GHGs are needed, as follows:

- ❖ Analytical techniques to prioritize mitigation options for energy conservation and renewable energy
- ❖ Advanced technologies for energy conservation for electricity production and consumption
- ❖ Efficient technologies and systems for traffic and mass transport, especially for logistics
- ❖ Technologies for biomass and biogas energy production appropriate for local conditions
- ❖ Environment-friendly technologies for cement production
- ❖ Development of knowledge and infrastructure for innovation of clean technologies
- ❖ Technologies to mitigate GHG from rice paddy fields

THANK YOU FOR YOUR ATTENTION

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