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Low Carbon Society Scenario Toward 2050
Case: Indonesia Energy Sector

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Background

- Indonesia CO_2 emission generation (2005) is 0.3 ton C (1.1 ton CO2-eq) per capita and it will achieve 2.9 ton C (10.7 ton CO2) per capita in 2050 in line with population and GDP growth if current development and society behavior will continue until 2050;
- World's LCS target (2050): 0.5 ton C (2.0 CO2-eq) per capita
- Indonesia's LCS dream is to use the World's LCS target not as the goal of the development but as direction for longterm vision of the development;
- LCS is a relatively new concept for Indonesia. Therefore, most existing government action plans are not developed as roadmap to achieve Low Carbon Society (LCS) target of the country.
- However, all the action plans actually are in lined with and supportive to the LCS concept.

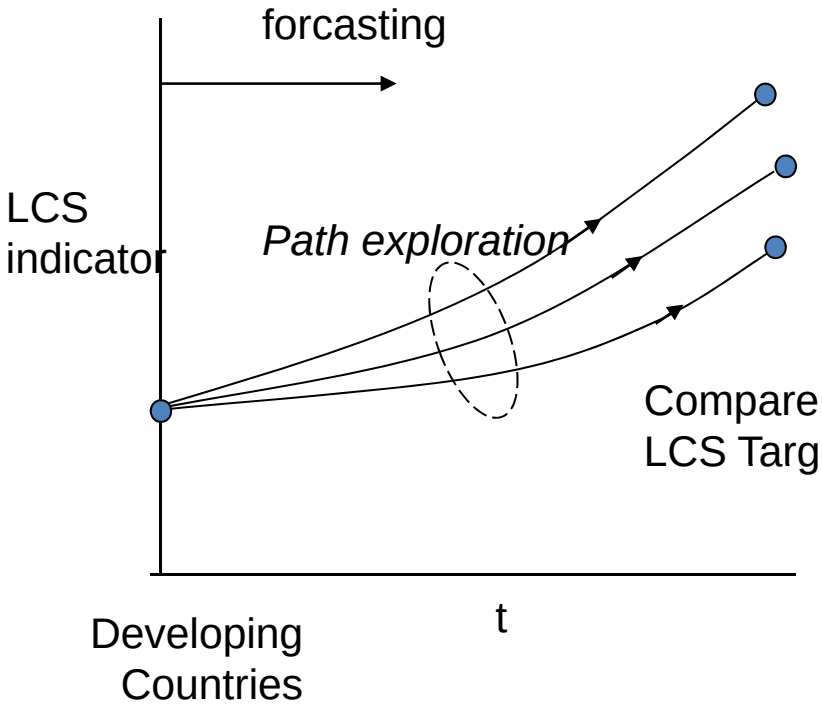
Objective

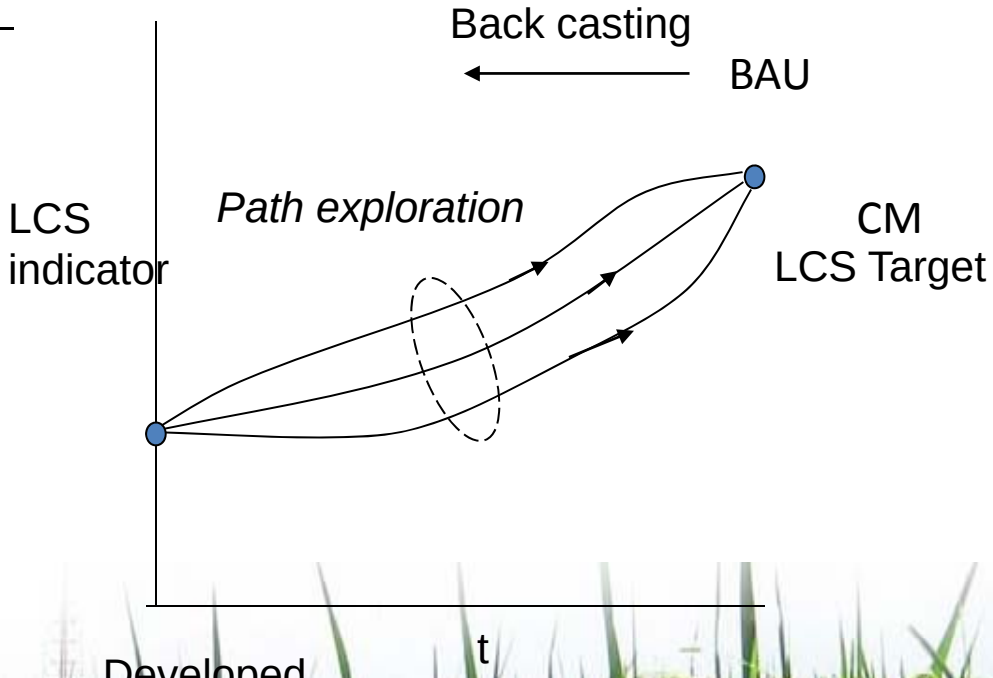
- To describe future visions for achieving the goals of LCS.
- LCS actions development for Indonesia is not to achieve a certain target; it is more to explore various possibilites of Indonesian future within the context of LCS
- A study to develop model for Indonesian toward LCS visions 2050. Three scenarios are developed to depict the direction of future socio economic visions for achieving the LCS goals.
- Roadmap to achieve these visions are assesed. The roadmap covers actions and policies needed to materialize the LCS goals

Development scenarios to 2050 with respect to LCS

Particular interest:
(a) socio-economic, (b) energy use, (c) associated emission level

- Base year: 2005
- Projection 2050
  - BaU (moderate scenario): current socio-economic development, society behavior, energy systems/structure will continue until 2050;
  - CM1 (moderate scenario): economic growth is similar with BAU, more energy efficient and lower carbon emitting energy technology compared to BAU, slight change in society behavior (depicted as calmer, slower, and nature oriented)
  - CM2 (high scenario): high economic growth, very energy efficient, lower carbon emitting technology, much better energy related infrastructure compared to BAU, with society behavior depicted as active, quick changing, and technology oriented


forcasting
LCS
indicator
Path exploration
Compare with
LCS Target
Developing
Countries
t


Back casting
BAU
LCS
indicator
Path exploration
CM
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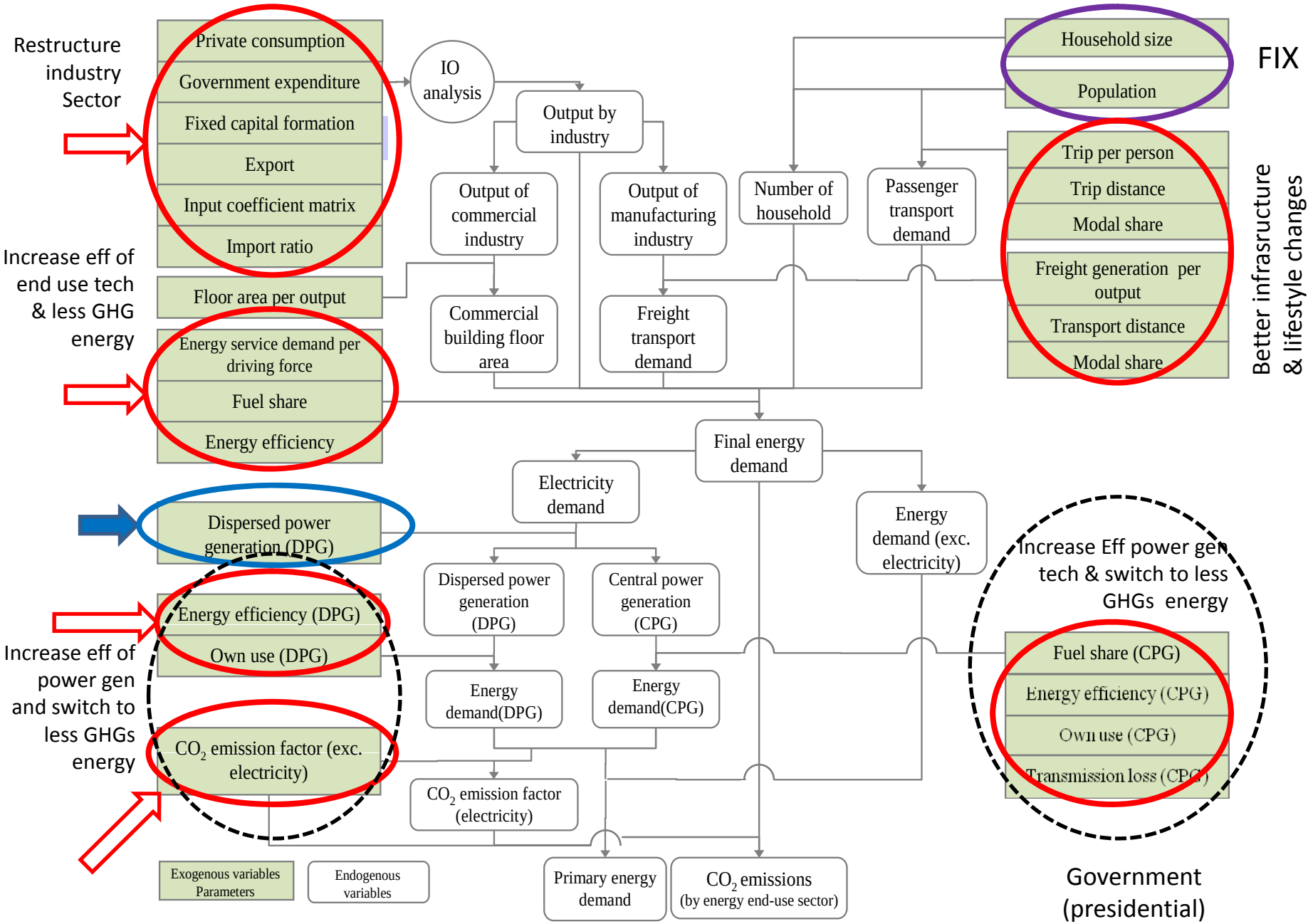
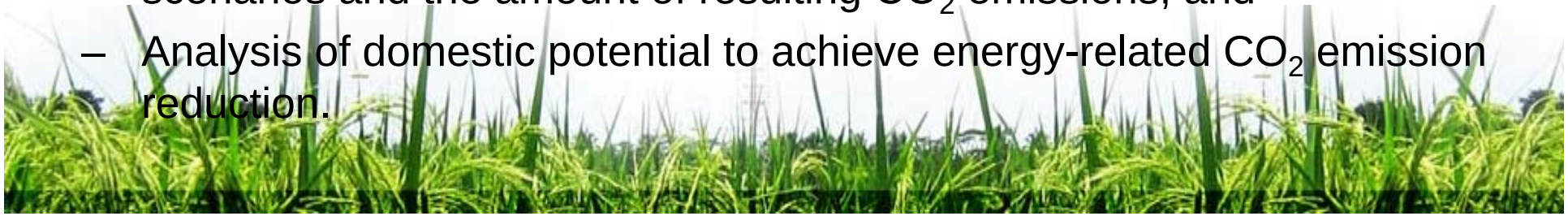

Restructure industry Sector
Private consumption
Government expenditure
Fixed capital formation
Export
Input coefficient matrix
Import ratio
IO analysis
Output by industry
Output of commercial industry
Output of manufacturing industry
Household size
Population
FIX
Number of household
Passenger transport demand
Trip per person
Trip distance
Modal share
Freight generation per output
Transport distance
Modal share
Better infrasructure & lifestyle changes
Increase eff of end use tech & less GHG energy
Floor area per output
Energy service demand per driving force
Fuel share
Energy efficiency
Commercial building floor area
Freight transport demand
Final energy demand
Electricity demand
Energy demand (exc. electricity)
Dispersed power generation (DPG)
Increase Eff power gen tech & switch to less GHGs energy
Dispersed power generation (DPG)
Central power generation (CPG)
Energy efficiency (DPG)
Own use (DPG)
Fuel share (CPG)
Energy efficiency (CPG)
Own use (CPG)
Transmission loss (CPG)
Increase eff of power gen and switch to less GHGs energy
Energy demand(DPG)
Energy demand(CPG)
CO2 emission factor (exc. electricity)
CO2 emission factor (electricity)
Exogenous variables Parameters
Endogenous variables
Primary energy demand
CO2 emissions (by energy end-use sector)
Government (presidential) regulation
Decreasing energy demand (energy supply security) & CO2 (close to world target)

Modeling Tools and Steps

- The tool used in this research is ExSS (Extended Snap Shot) using GAMS (General Algebraic Modeling System) 23.3 supported by various technical, economic, and social parameters.
- In developing the proposed roadmap, there are 5 important steps, i.e.:
  - Depicting socio economic visions of Indonesia in energy sector toward 2050;
  - Estimating current energy service demand-supply and resulting CO_2 emission that cover quantifying society behavior on energy utilization (activities to spend time and type of services), analyzing the impact of city and transport infrastructure (include travel behavior) and industrial structure to energy consumption and resulting CO_2 emission;
  - Exploring innovations for energy demand-supply;
  - Estimating energy service demand and supply in BAU and two set scenarios and the amount of resulting CO_2 emissions; and
  - Analysis of domestic potential to achieve energy-related CO_2 emission reduction.

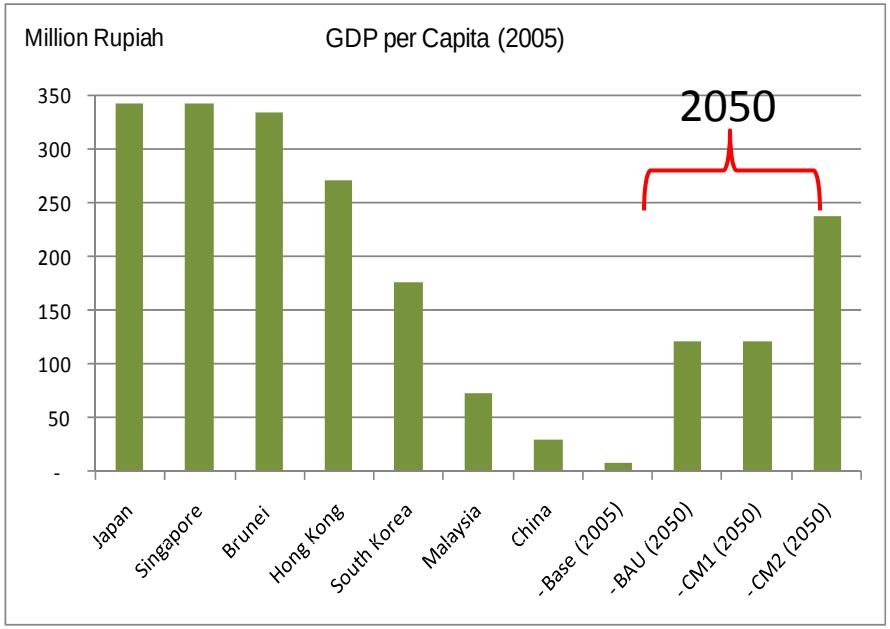


Summary of modeling results

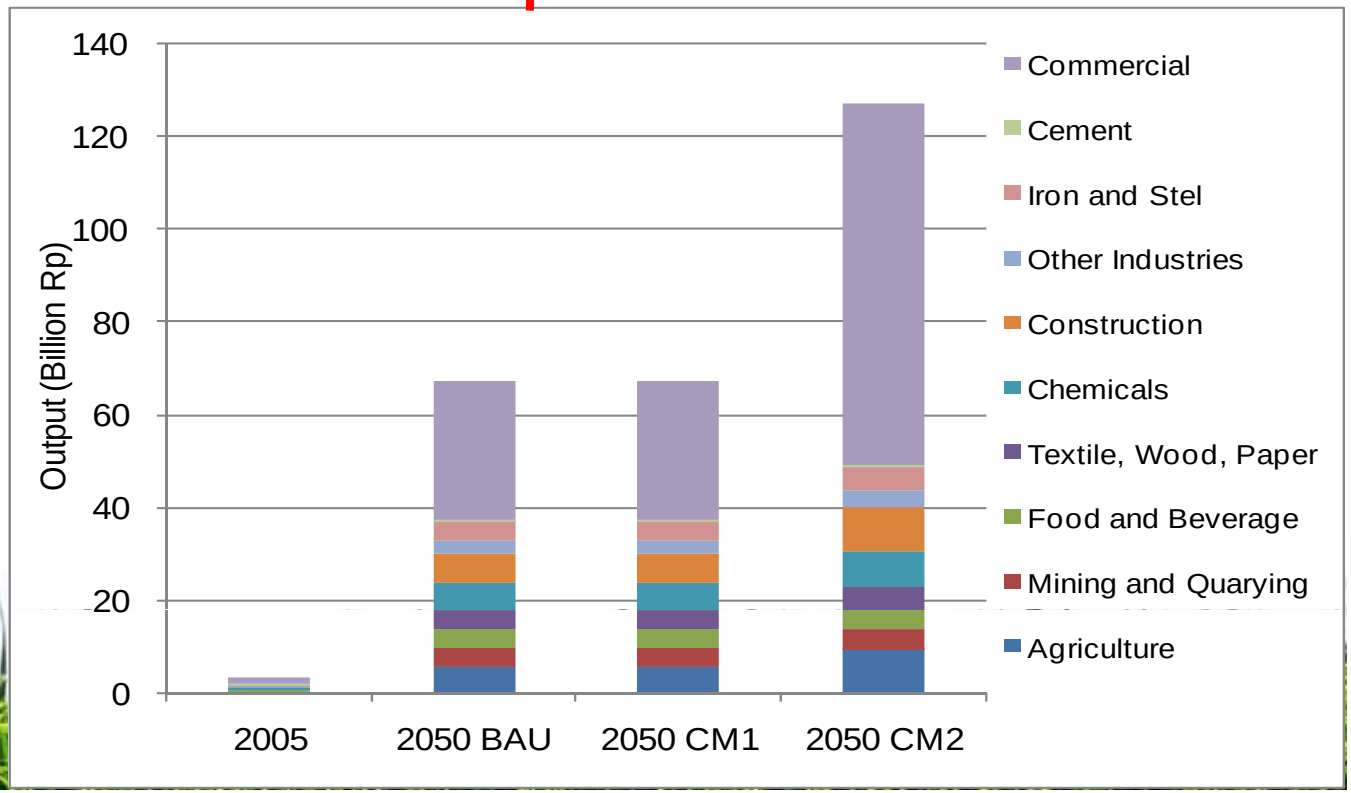
Socio Economic, energy, emission	2005	2050			2050/2005		
Parameter	BASE	BAU	CM1	CM2	BAU	CM1	CM2
Population, Million	219	288	288	288	1.31	1.31	1.31
GDP, Trillion rupiah	1,786	34,882	34,882	68,251	19.53	19.53	38.21
GDP per capita, million rupiah	8	121	121	237	14.86	14.86	29.07
Gross output, trillion rupiah							
Primary	329	5,779	5,779	9,617	17.57	17.57	29.23
Secondary	1,953	31,904	31,904	39,637	16.34	16.34	20.30
Tertiary	1,251	29,704	29,704	77,557	23.75	23.75	62.00
Passenger transport demand, millio	1,620	2,130	1,324	1,324	1.31	0.82	0.82
Freight transport demand, million to	1.07	17.67	15.84	20.84	16.51	14.81	19.48
Energy Demand, Million Toe							
Passenger Transport	19	25	5	57	1.31	0.27	3.02
Freight Transport	7	108	23	119	16.50	3.55	18.14
Residential	43	89	64	55	2.08	1.50	1.28
Industry	22	460	400	612	20.99	18.27	27.93
Commercial	4	88	22	129	23.75	6.04	34.85
Total demand	94	770	516	972	8.19	5.48	10.34
Energy Demand per capta, toe/cap	0.43	2.67	1.79	3.38	6.23	4.17	7.87
Emissions, million Ton C	67.16	842.16	395.25	161.02	12.54	5.89	2.40
Emision per capita Ton C / capita	0.31	2.92	1.37	0.56	9.54	4.48	1.82
Emision per capita Ton CO2 / capita	1.12	10.72	5.03	2.05	9.54	4.48	1.82
GDP Growth		0.07	0.07	0.08			
Energy demand growth		0.05	0.04	0.05			
Energy elasticity		0.70	0.56	0.63			

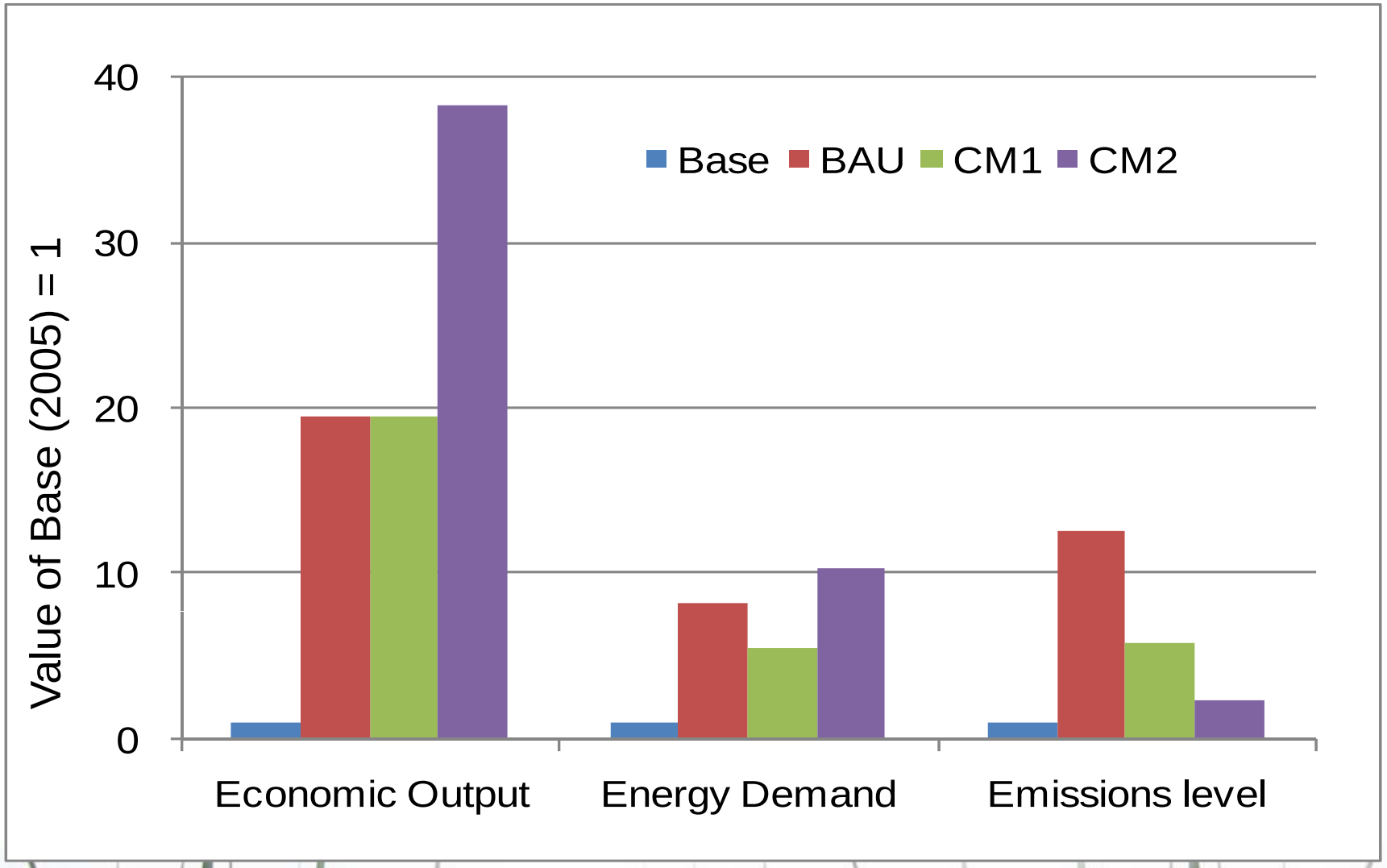
Economy, Energy, and Emissions

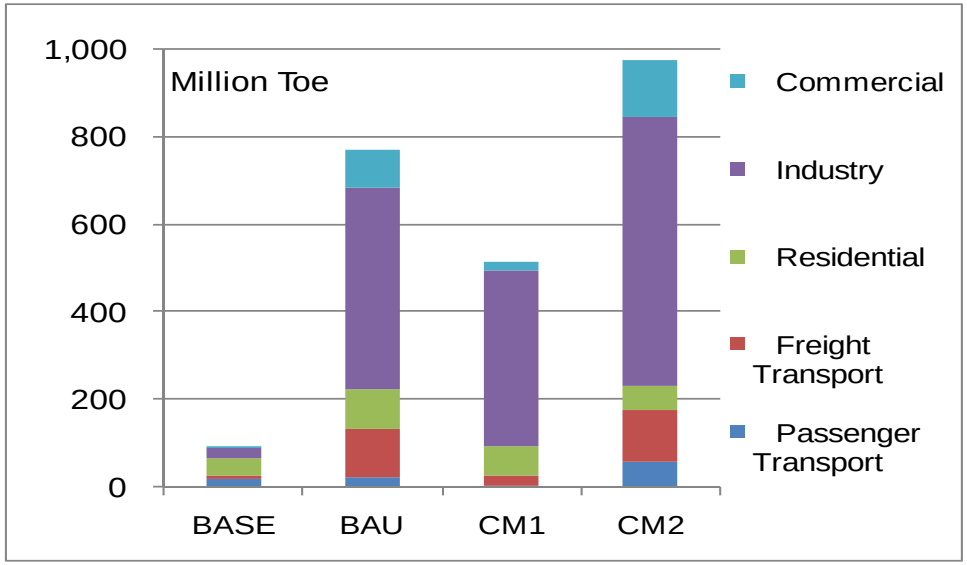
- BAU
- CM1
- CM2
- Conclussions?



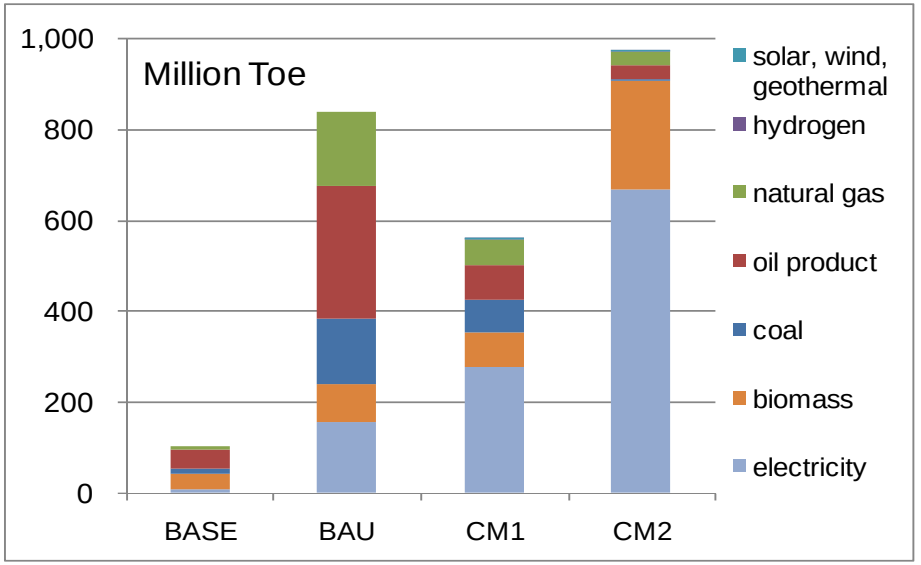
Change in GDP structure toward tertiary industry



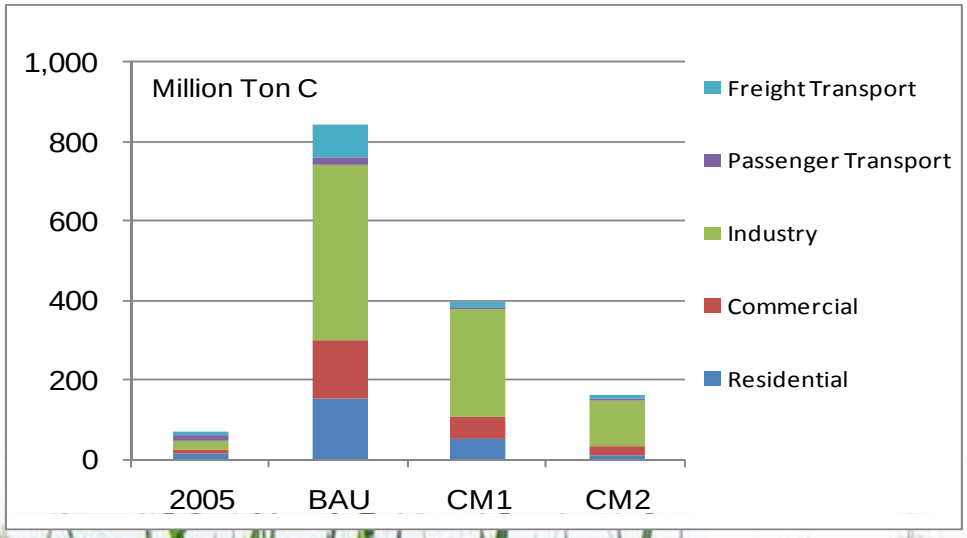

40
30
20
10
0
Value of Base (2005) = 1
Base
BAU
CM1
CM2
Economic Output
Energy Demand
Emissions level



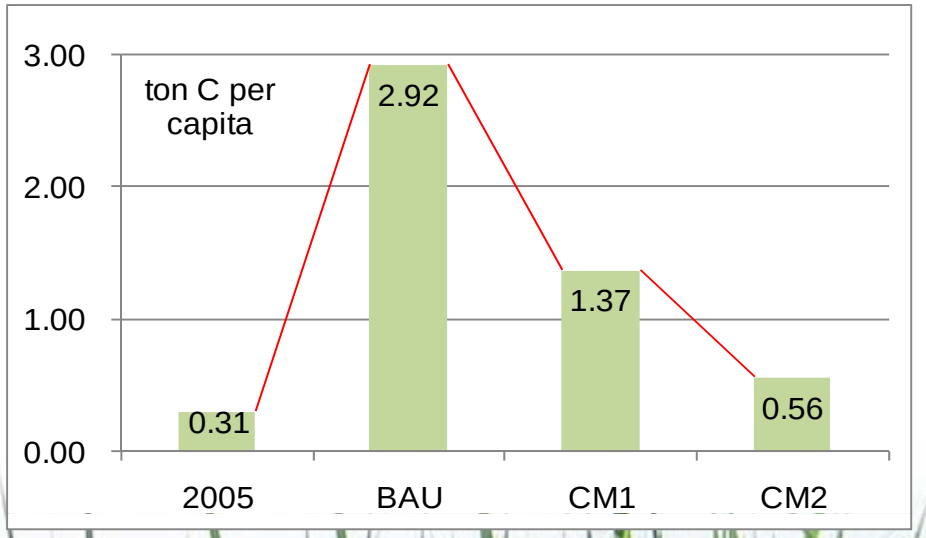
Final energy demand by sector



Final energy demand by type of energy

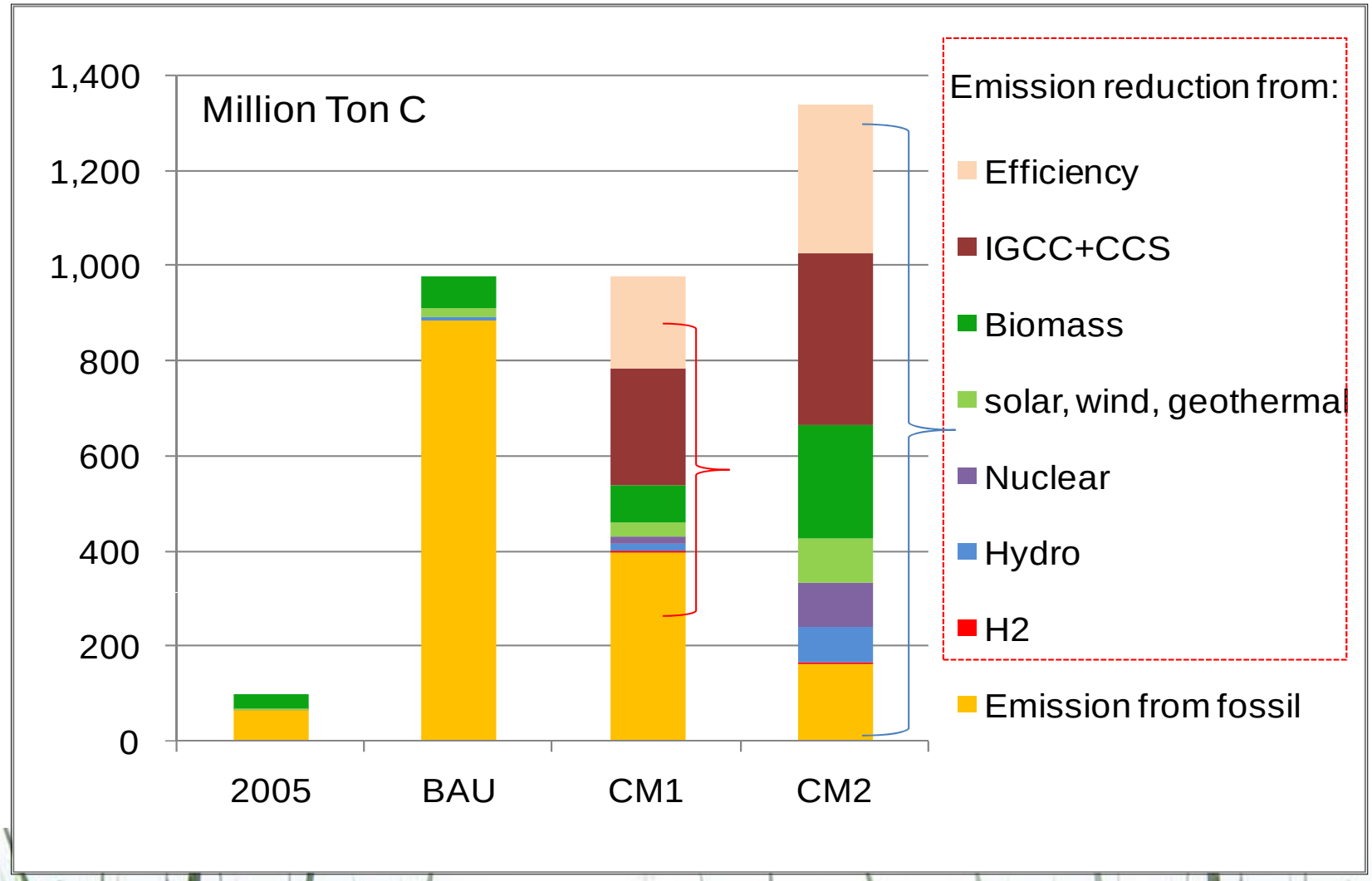


CO_2 emissions by sector, million ton C

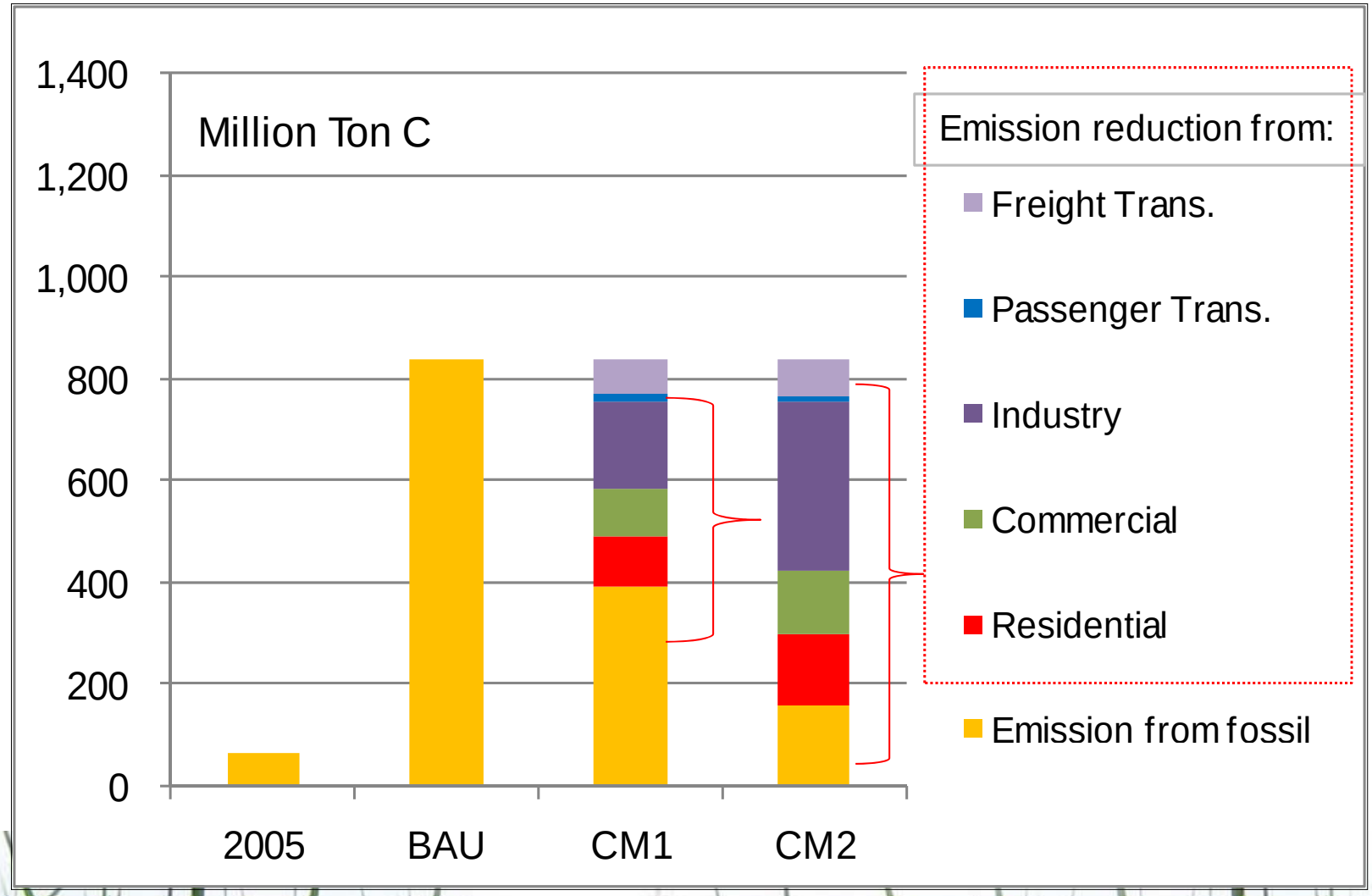


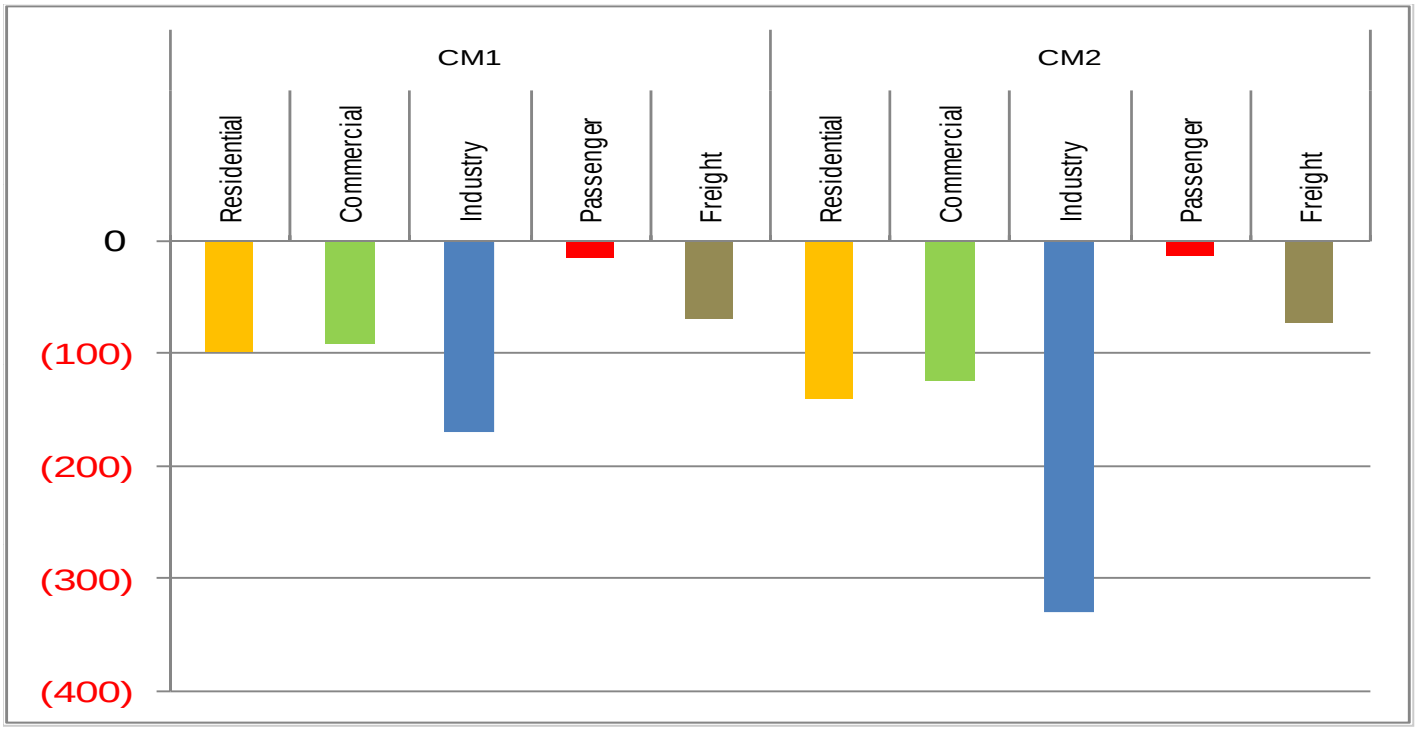
Per capita CO_2 emission

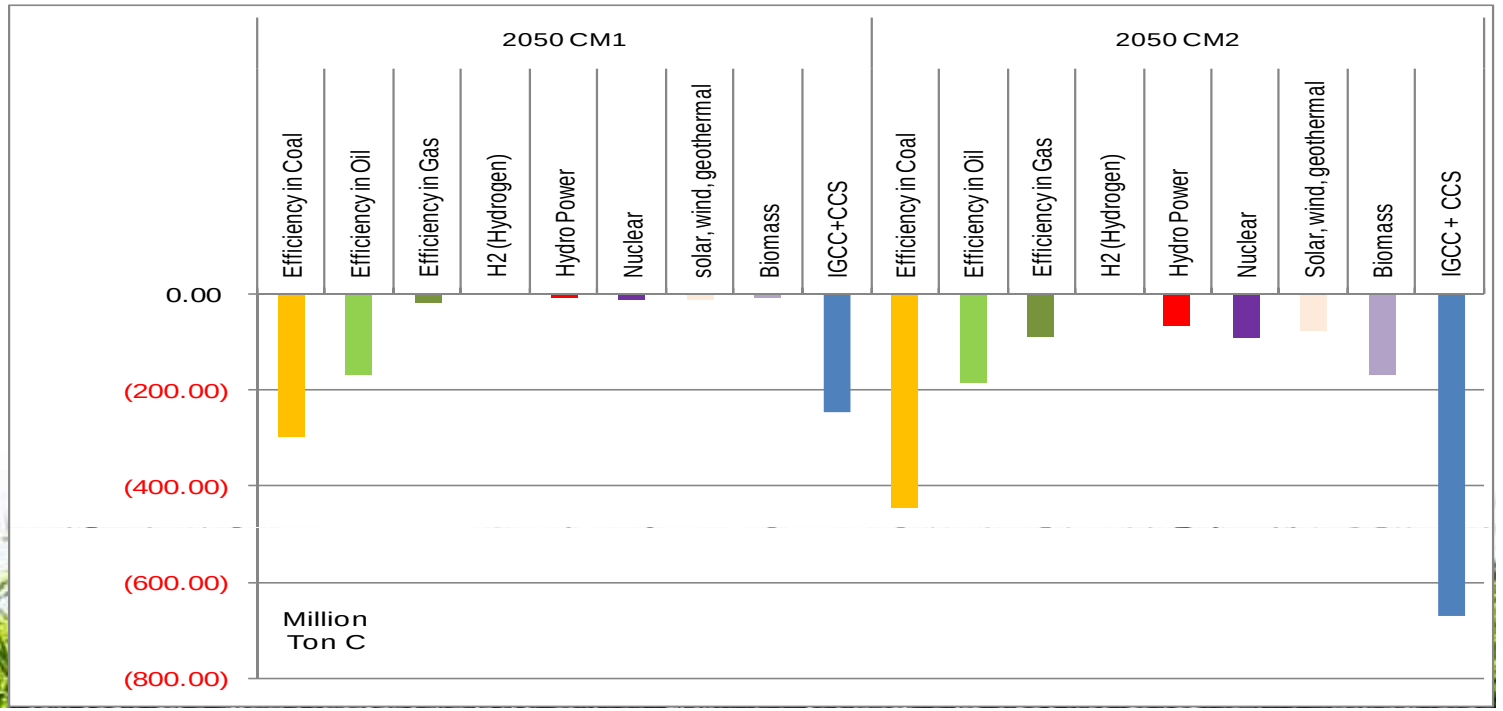
Emission Level and avoided emissions in energy supply side



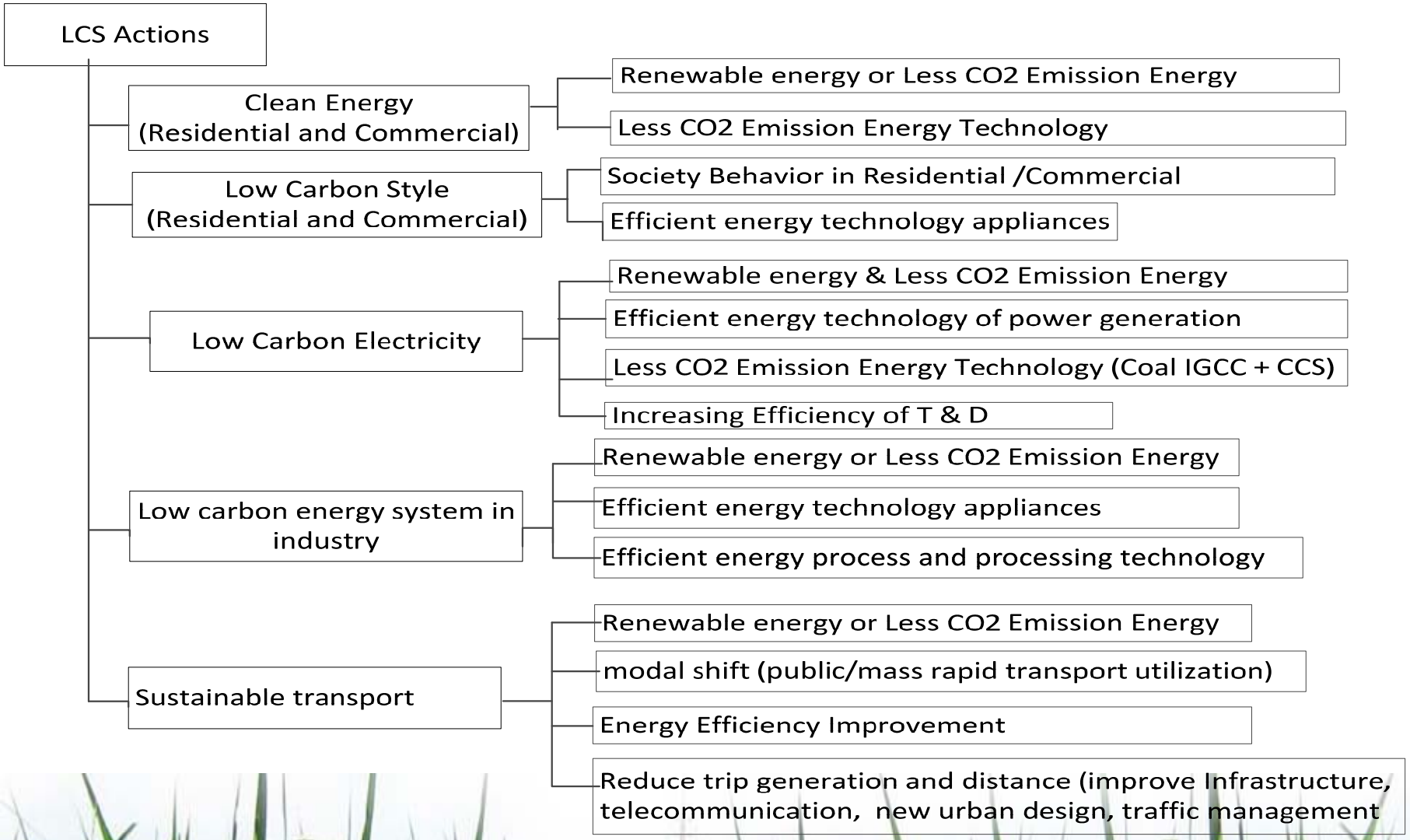
Emission Level and avoided emissions in demand side



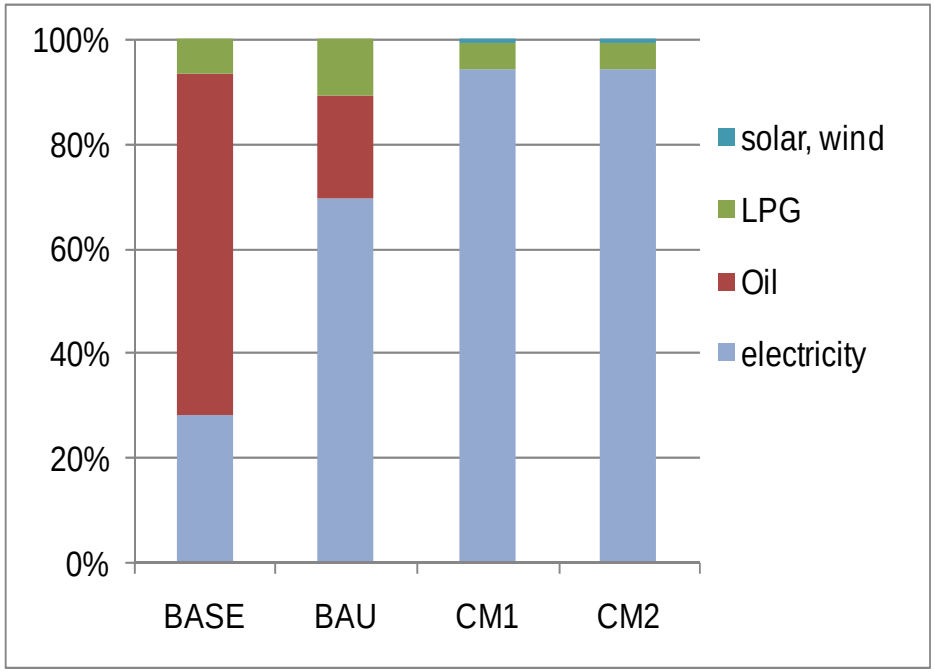

CM1
CM2
Residential
Commercial
Industry
Passenger
Freight
Residential
Commercial
Industry
Passenger
Freight
0
(100)
(200)
(300)
(400)


2050 CM1
2050 CM2
Efficiency in Coal
Efficiency in Oil
Efficiency in Gas
H2 (Hydrogen)
Hydro Power
Nuclear
solar, wind, geothermal
Biomass
IGCC+CCS
Efficiency in Coal
Efficiency in Oil
Efficiency in Gas
H2 (Hydrogen)
Hydro Power
Nuclear
Solar, wind, geothermal
Biomass
IGCC + CCS
0.00
(200.00)
(400.00)
(600.00)
(800.00)
Million
Ton C

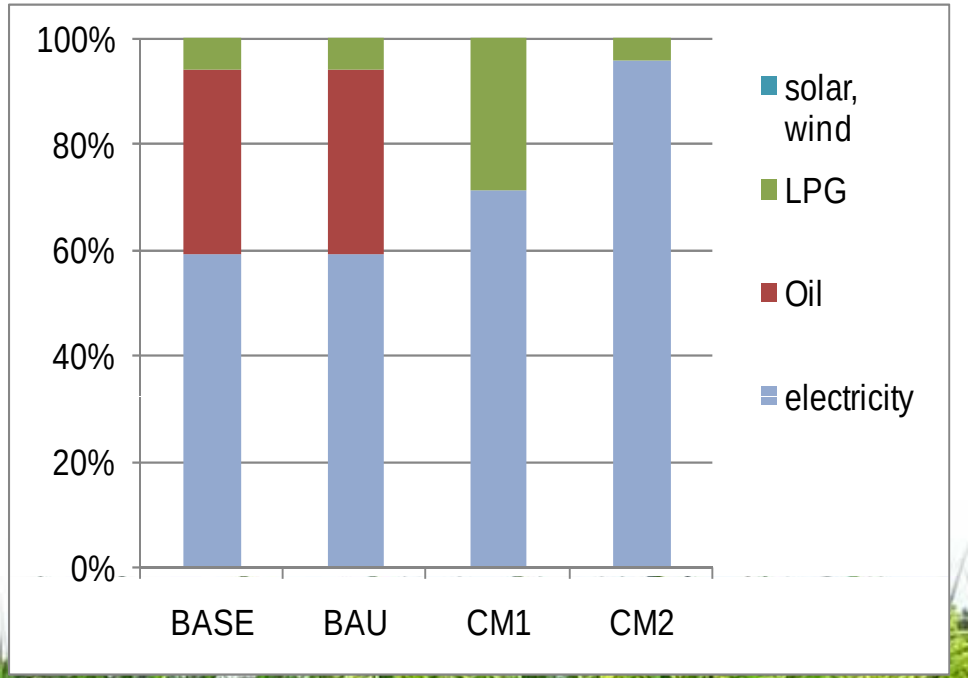
Actions


LCS Actions
Clean Energy (Residential and Commercial)
Renewable energy or Less CO2 Emission Energy
Less CO2 Emission Energy Technology
Low Carbon Style (Residential and Commercial)
Society Behavior in Residential /Commercial
Efficient energy technology appliances
Low Carbon Electricity
Renewable energy & Less CO2 Emission Energy
Efficient energy technology of power generation
Less CO2 Emission Energy Technology (Coal IGCC + CCS)
Increasing Efficiency of T & D
Low carbon energy system in industry
Renewable energy or Less CO2 Emission Energy
Efficient energy technology appliances
Efficient energy process and processing technology
Sustainable transport
Renewable energy or Less CO2 Emission Energy
modal shift (public/mass rapid transport utilization)
Energy Efficiency Improvement
Reduce trip generation and distance (improve Infrastructure, telecommunication, new urban design, traffic management

Action 1 Clean Energy:
Increase share of renewable and less carbon emitting fuels



Residential

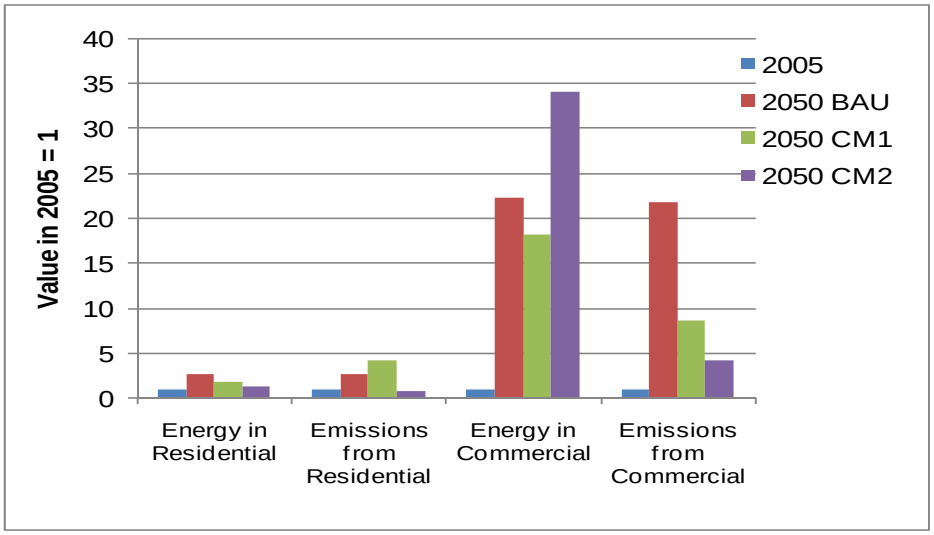


Commercial

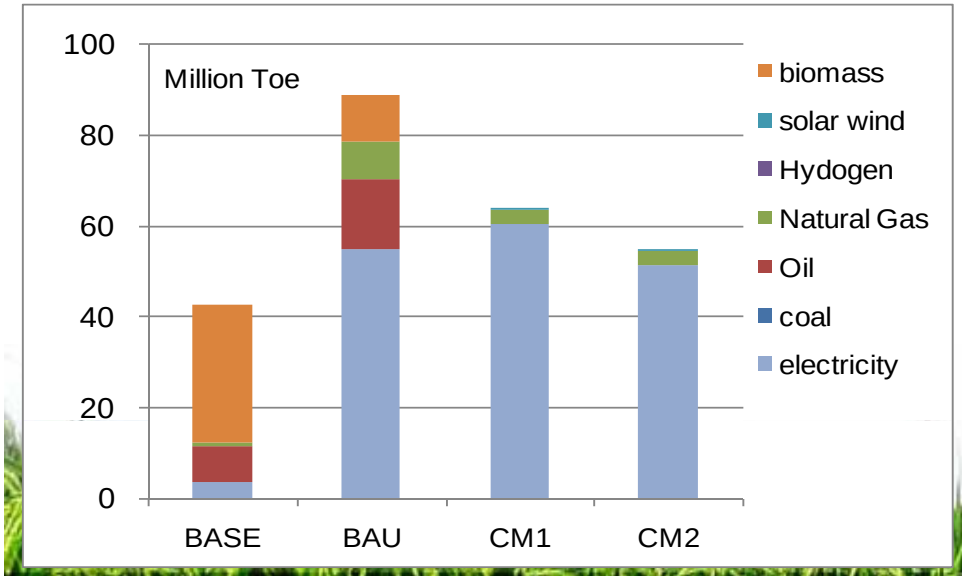
Action 2 Low Carbon Lifestyle:

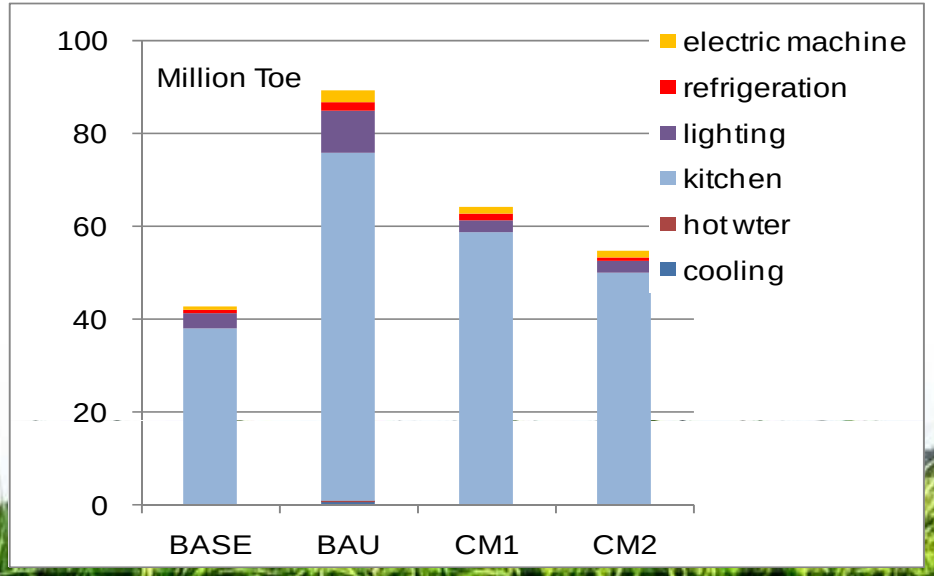
- Efficiency improvement of electric appliances and other technologies in residential and commercial
- Improvement of society behavior (efficiency through house keeping).
- Beside efficiency in energy, this action reduces the CO_2 emissions level in both sectors

- **Impact of clean energy & low carbon lifestyle to energy and emissions**



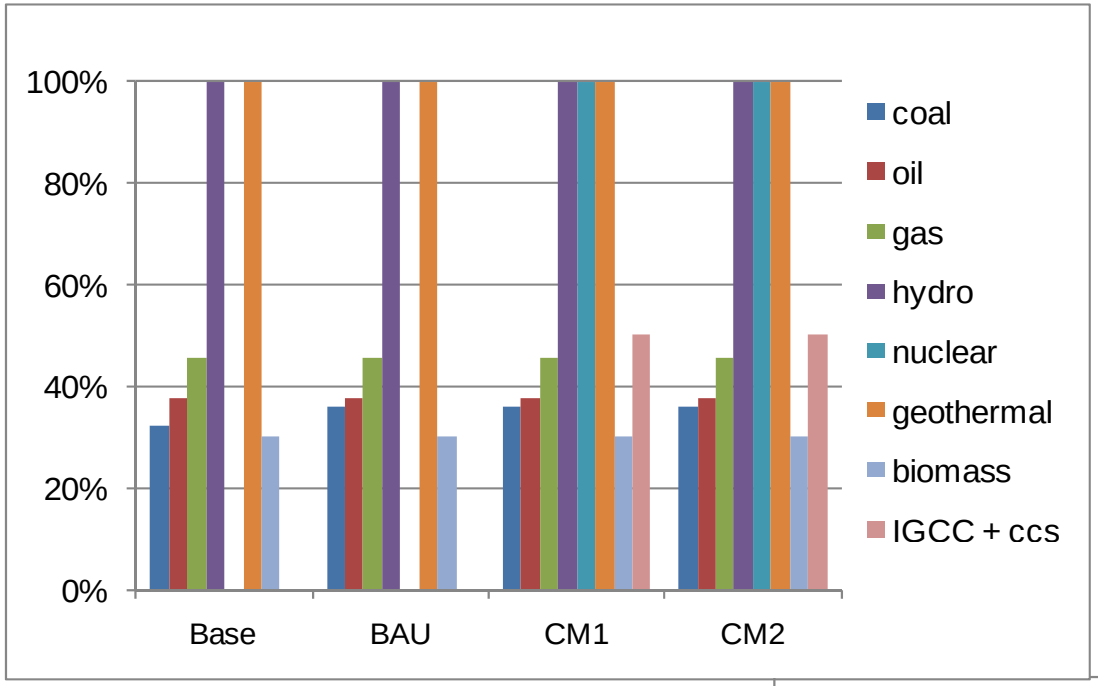
- **Impact of efficient appliances/equipments to energy use in residential**





Action3: Low Carbon Electricity

- Increasing the use of renewable energy in energy supply mix of the power generation,
- Developing more efficient power generation (from pulverized to supercritical or IGCC),
- Reducing losses in transmission and distribution (T&D) of electricity grids, and
- CCS (carbon capture and storage) application



Energy efficiency level of power generation

Share of each energy type in power generation

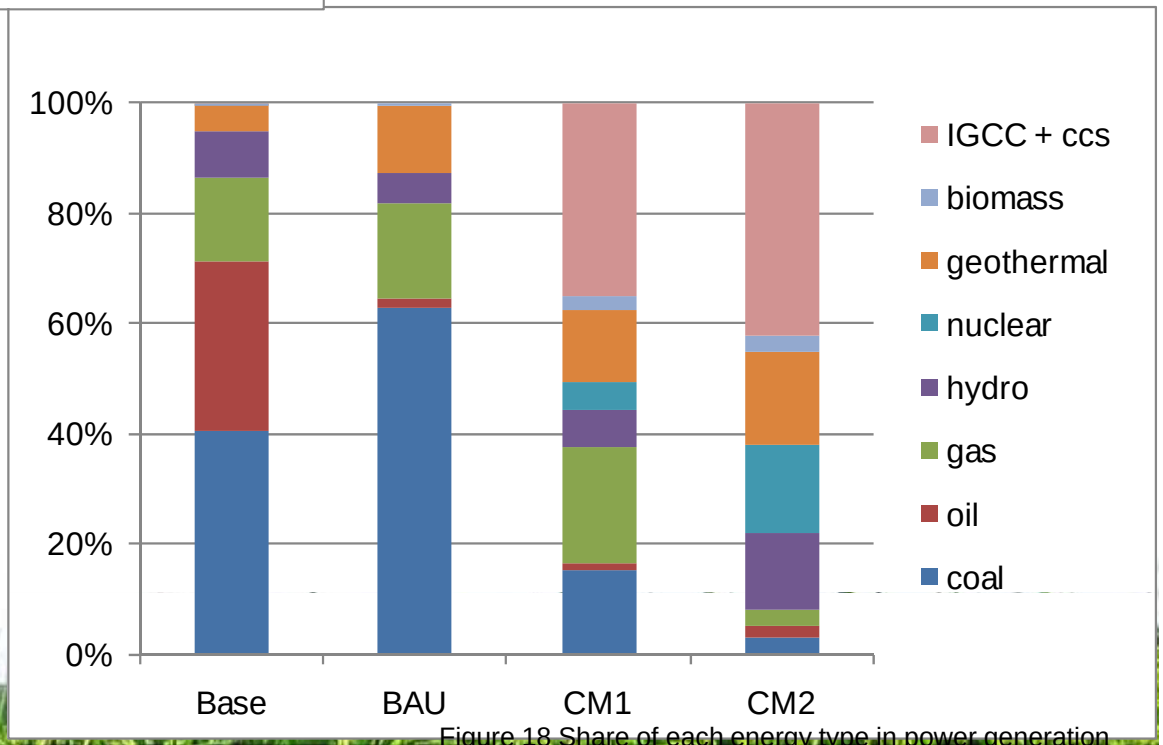
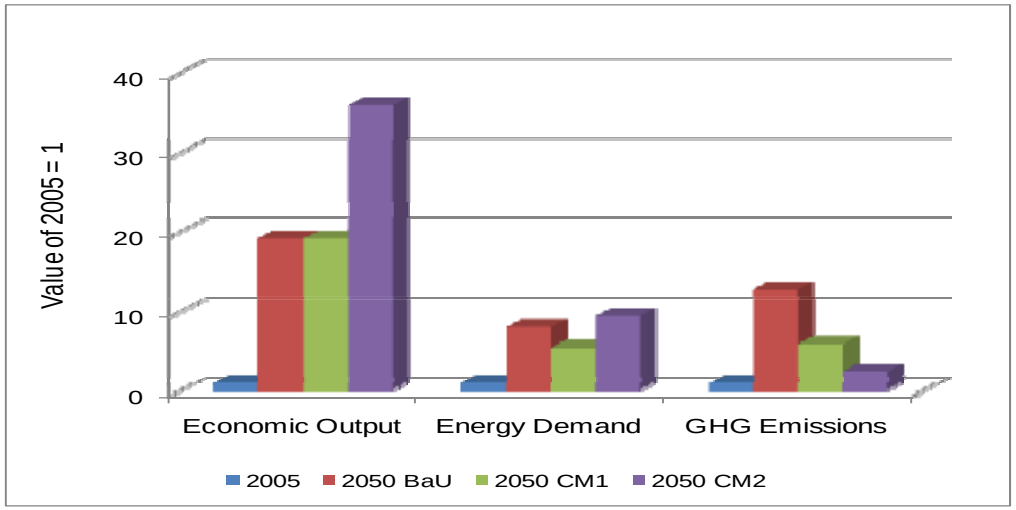
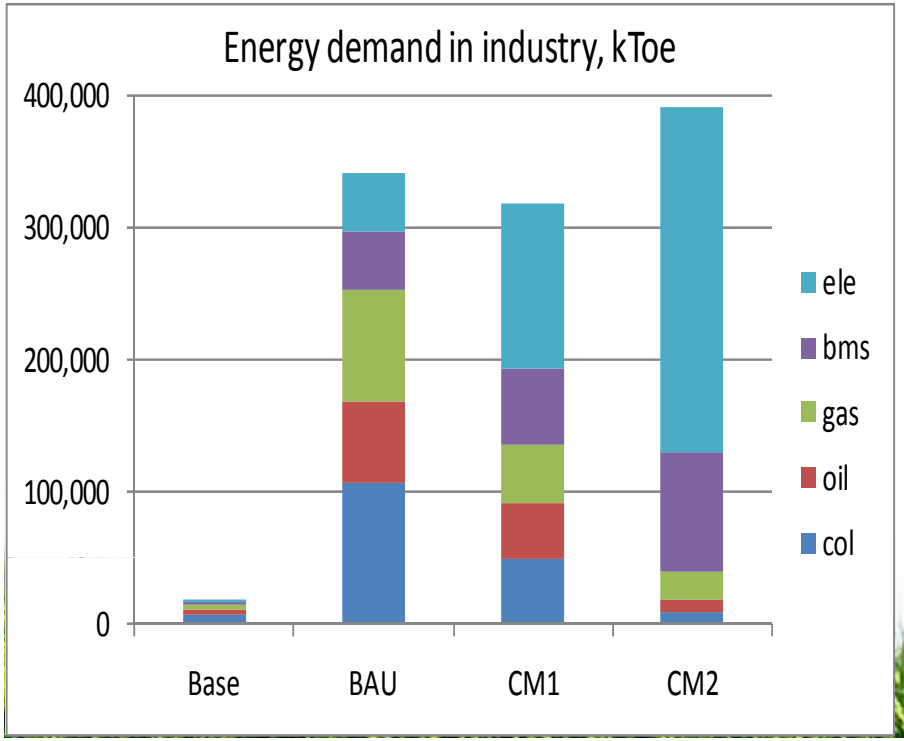


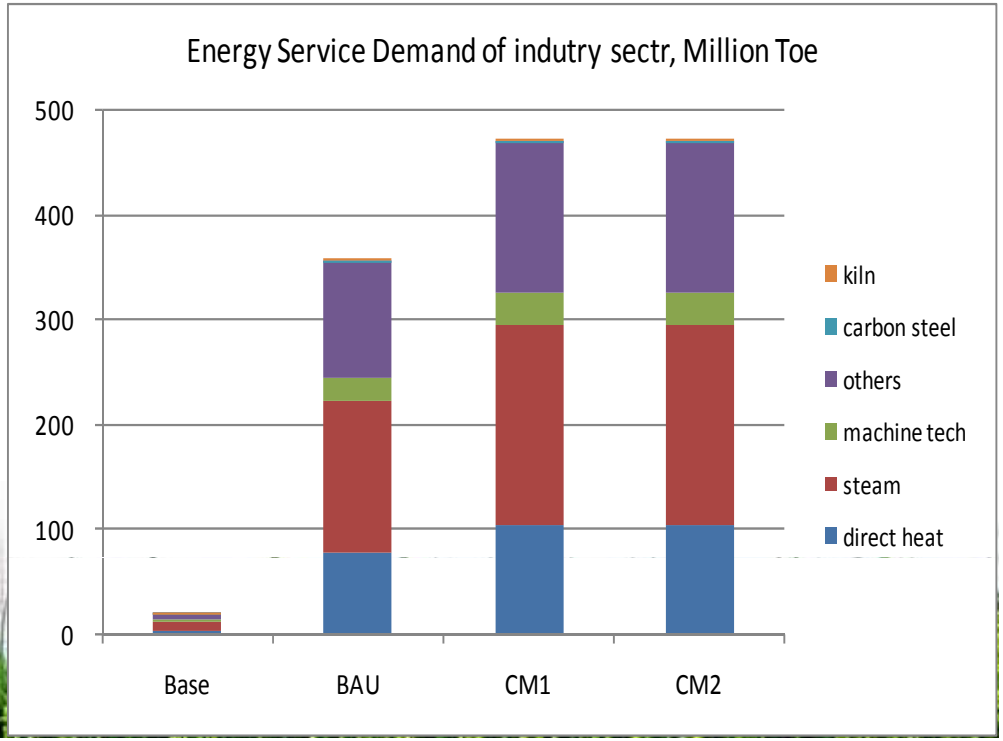
Figure 18 Share of each energy type in power generation

Action 4: Low Carbon Fuels Industry

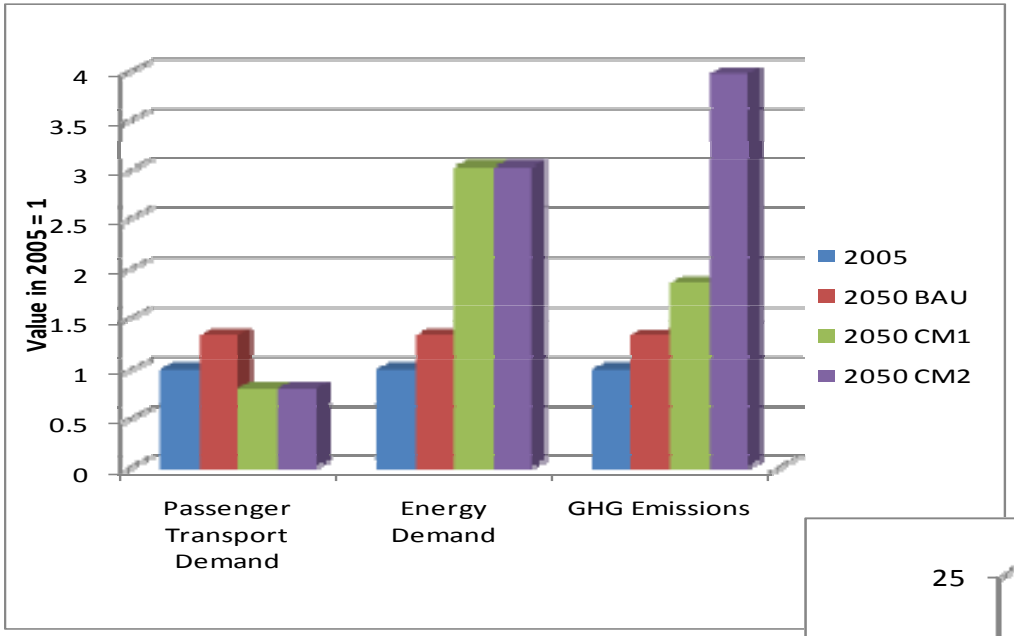


Impact of economic output of energy demand and CO_2 emissions

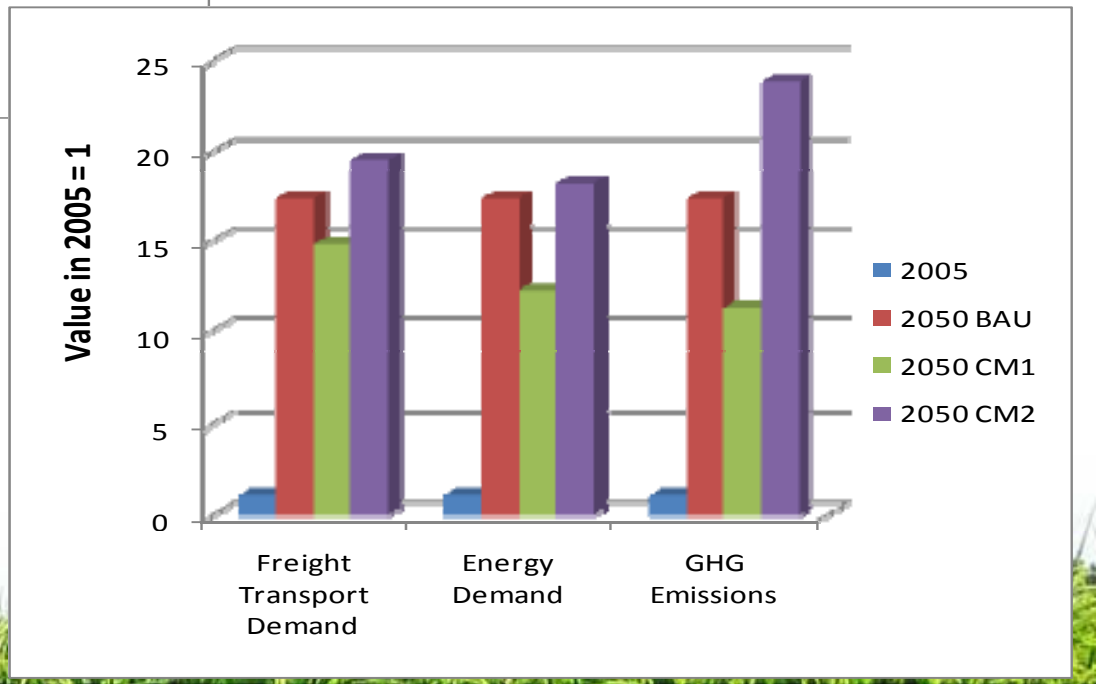


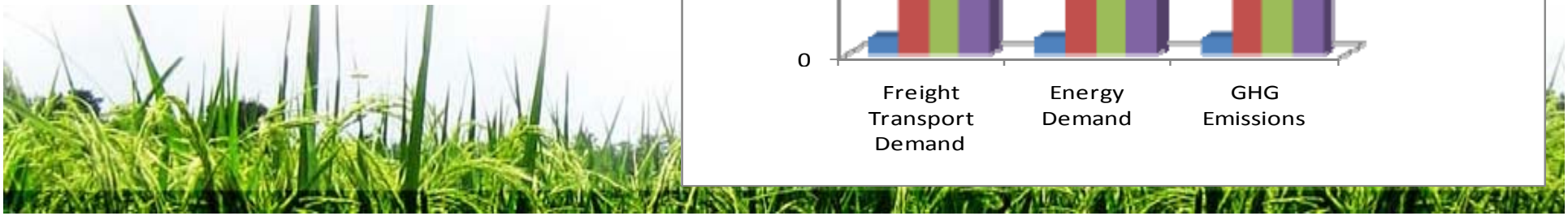


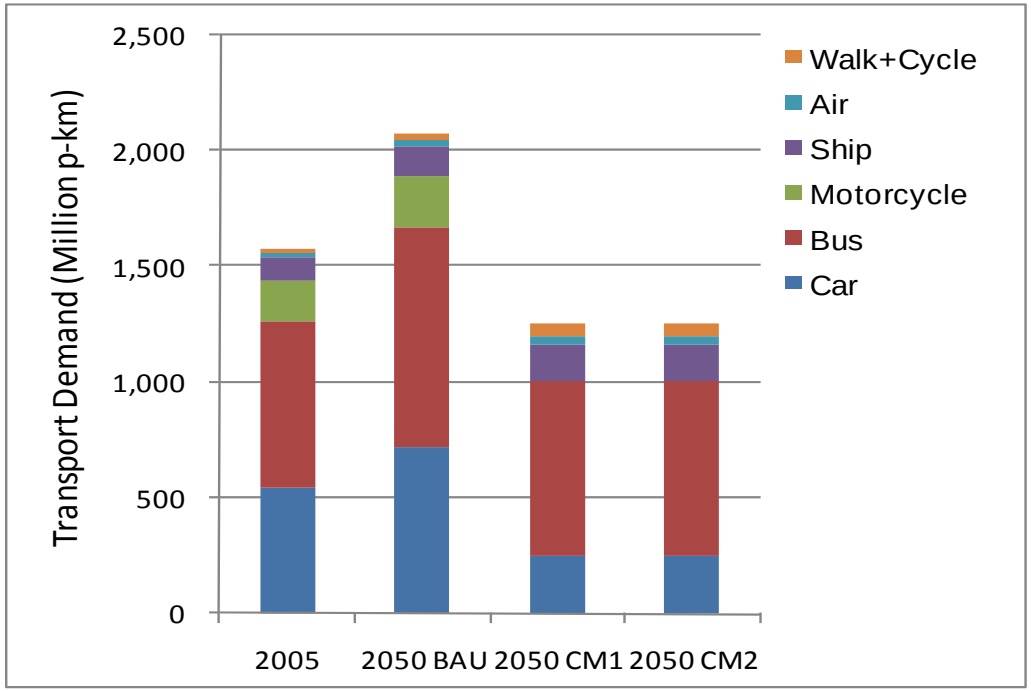
Action 5: Sustainable Transport



Effect of passenger and freight transport demand to energy and emissions

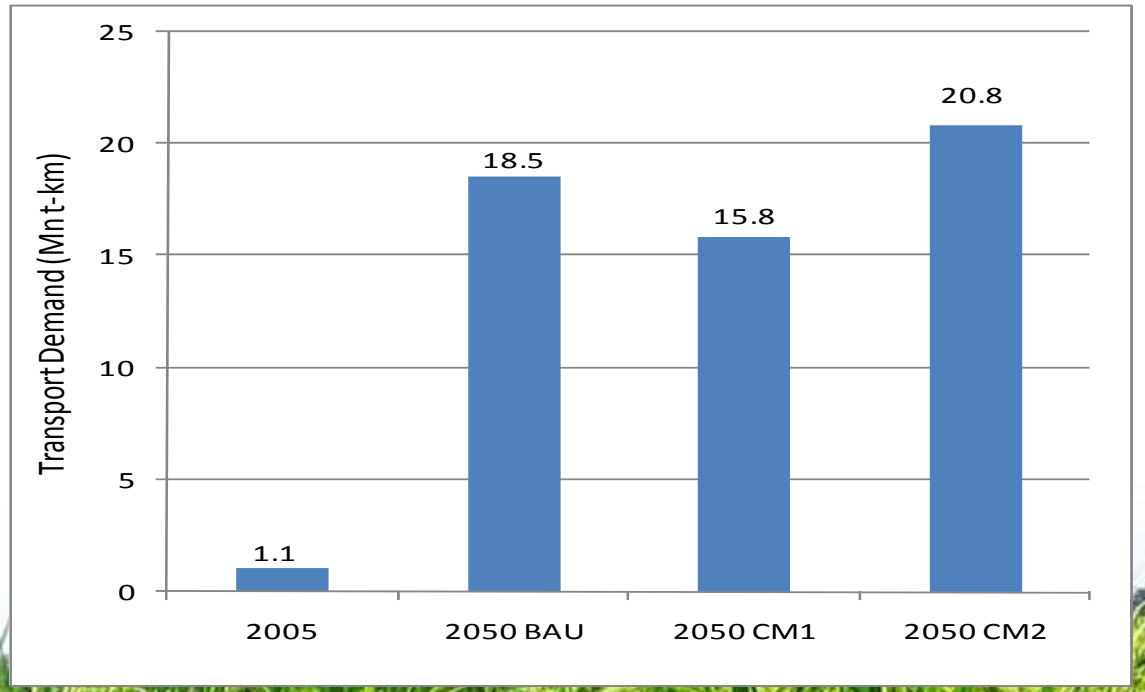


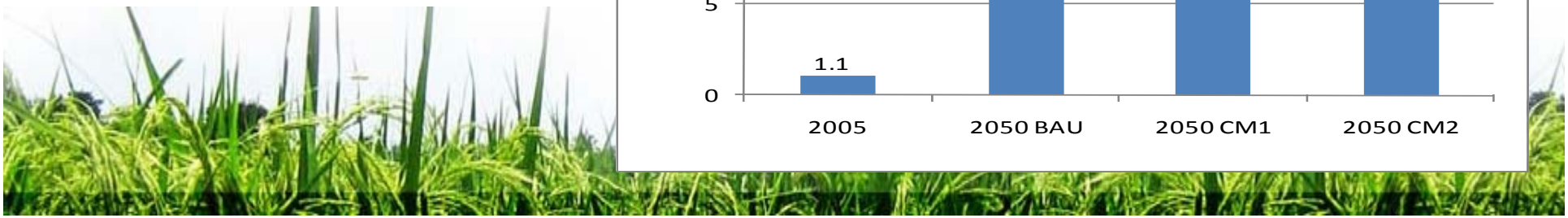




Passenger transport demand by type of vehicle

Freight transport demand by type of vehicle





Policies and Regulations

- _ There are numerous energy-climate policy initiatives, regulations, and actions in energy sector that could result in CO_2 emission reduction. The latest policy initiative is non-binding emission reduction target of 26% lower than baseline in 2020 using domestic budget and further increased to 41% with international support. To implement non-binding commitment, GOI prepares National Actions Plan 2010 -2020 to Reduce CO_2 Emissions.

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- There are numerous energy-climate policy initiatives, regulations, and actions in energy sector that could result in CO_2 emission reduction.
- The latest policy initiative is non-binding emission reduction target of 26% lower than baseline in 2020 using domestic budget and further increased to 41% with international support.
- To implement non-binding commitment, GOI prepares National Actions Plan 2010 -2020 to Reduce CO_2 Emissions.
- In addition to the policy initiatives, most actions plan developed for achieving the LCS target will still need policy measures to support the implementations of these actions

(1) Increasing share of new/renewable energy and less carbon emitting fuels (include less carbon emitting technology) in energy supply mix to support implementation of Presidential Regulation 5/2006.

On-going programs considered to meet energy supply mix target are power generation crash program I and II (which include clean coal and geothermal), kerosene to LPG, mandatory of bio-fuel utilization in power plant, transportation, and industry (MEMR 32/2008);

(2) Increasing share of new/renewable (hydro, geothermal) and oil switch to natural gas as stated in the National Plan of Electricity Development (RUPTL) PLN 2008 - 2018;

(3) Regulations that lead to the formulation of national master plan on energy efficiency;

(4) Policies to support MRT development, diversification of fuels (CNG/LPG, bio-fuel, electricity) in transportation, and emissions monitoring and control of local emission and combustion efficiency that has implication to the CO_2 emissions generation.

Conclussion

- If current economic growth and socitey behavior continues until 2050 in the BaU scenario the energy demand will increase by 8.2 times and the associated emissions will increase by 12.5 times, both compared to 2005 levels.
- CM1 and CM2 both lead to the CO2 emisssions reduction compared to BAU
- CM1
  - Moderate economic gowth, with current policies and regulations and efficiency efforts will lead to 33% energy conservation and 53% emisions avoidance, both compared to the Bau levels
  - Low energy conservation and emisions avoidance due to moderate economic growth will limit efforts in improving energy efficiency and investment in infrastrucures related to energy supply – demand

Conclusion

- CM2
  - High economic, high energy demand, high emissions
  - However, LCS achieveable in terms of emissions avoidance without sacrificing high economic developmen
  - Requirement to achieve LCS (CM2) is high econmic development that make investment in better infrastructure (with efficient and low carbon emitting energy systems) possible

Indonesia Low Carbon Society Vision of 2050 In Energy Sector

February, 2010

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