ILO’s Project on Labour Market Assessment of Indonesia’s INDC

A summary on the CGE modelling and initial results

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Indonesia's INDC (1)

- **Brief outline**
  - Indonesia submitted its INDC with the mitigation targets of 26% of GHGs (0.767 GtCO2e) by 2020 and 29% by 2030 based on the BAU scenario.
  - The BAU scenario is projected as 2.95 GtCO2e in 2020 (Perpres 61/2011), starting in 2010 based on historical trajectory of 2000-2010 with increase in the energy sector and the absence of mitigation actions.
  - In addition, a more ambitious target of 41% reductions by 2020 (1.189 GtCO2e) is set under the condition of receiving international support and through international cooperation.
- **Mitigation contribution type**
  - GHG and non-GHG targets

GHG target type	Baseline scenario target
Non-GHG target type	Renewable energy target

ILO's project on the labor market assessment of Indonesia's INDC

➢ Scope of the study

- Using a CGE model for the assessment of the labor market implications of Indonesia's INDC at the national level
- Focus on energy sector
  - Renewable energy target
  - Energy efficiency improvement
- Disaggregation of the labor market based on rural vs. urban, agriculture vs. non-agriculture, waged vs. non-waged, service and professional service. However, skill requirements are not included due to data availability and can be considered for future project.
- Disaggregation of households based on rural and urban, rural farmers of different sizes and rural agriculture labor, and different income levels.

Mitigation Actions in Energy Sector (32.53 $MtCO_2e$)

- Energy efficiency improvement (22.02 MtCO2e)
  - Mandatory to implement energy management in energy intensive users (10.16 MtCO2e)
  - Implementation of energy conservation partnership program (2.11 MtCO2e)
  - Energy efficiency improvement through implementation of energy efficiency appliances (9.75 MtCO2e)
- Development and management of new and renewable energy (NRE) and energy conservation (4.4 MtCO2e)
- Biogas Utilization (0.13 MtCO2e)
- Natural gas (3.22 MtCO2e)
  - Use of natural gas as city public transportation fuel (3.07 MtCO2e)
  - Enhancement of the pipe connection of natural gas to houses (0.15 MtCO2e)
- Construction of Liquid Petroleum Gas (LPG) Mini Plants contribute to the Kerosene to LPG conversion program (0.03 MtCO2e)
- Post-mining land reclamation (2.73 MtCO2e)

Sector classification

3 fossil fuels, 1 geothermal, 14 power generation sectors (7 types of energy carriers), 6 AgLivFor, 8 manufacturing sectors, 4 transport sectors, 1 mining, 1 service, 1 other industry and 1 government R&D.

No.	Name	No.	Name	No.	Name	No.	Name
1	Paddy	11	Mining	21	c ElecGas from coal/generation	31	c ElecGas from geothermal/generation
2	Biofuel crops	12	MachiElectTranRep (conventional)	22	c ElecGas from natural gas/new installation	32	c ElecGas from solar&wind/new installation
3	Other Agriculture	13	MachiElectTranRep (en-efficient)	23	c ElecGas from natural gas/generation	33	c ElecGas from solar&wind/generation
4	Livestock	14	Metal Process (conventional)	24	c ElecGas from oil (diesel)/new installation	34	c Rest of industry
5	Forestry	15	Metal process (Low-carbon)	25	c ElecGas from oil (diesel)/generation	35	c Rail transport (conventional)
6	Sustainable forestry management	16	Chemical conventional (including biofuels)	26	c ElecGas from biomass/new installation	36	c Rail transport (electric)
7	Coal	17	Chemical low-carbon (including biofuels)	27	c ElecGas from biomass/generation	37	c Road transport
8	Crude oil	18	Non-metalic manufacture (conventional)	28	c ElecGas from hydro/new installation	38	c AirWaterTrp Communication
9	Natural gas	19	Non-metalic manufacture (low-carbon)	29	c ElecGas from hydro/generation	39	c SrvGovDefEduHlthFilm
10	Geothermal	20	ElecGas from coal/new installation	30	c ElecGas from geothermal/new installation	40	c GovR&D

Factors of production

16 labor-related factors and 1 capital. 8 rural (2 Agriculture, 2 Non-Agriculture, 2 Services and 2 Professional Services) and 8 urban (same categories).

No.	Name of the account	Explanations	No.	Name of the account	Explanations
1	RuAgWageEarner	Factor of production, rural agriculture wage earner	10	UrSrvWageEarner	Factor of production, urban service wage earner
2	UrAgWageEarner	Factor of production, urban agriculture wage earner	11	RuSrvNonWageEarne r	Factor of production, rural service non-wage earner
3	RuAgNonWageEar ner	Factor of production, rural agriculture non-wage earner	12	UrSrvNonWageEarner	Factor of production, urban service non-wage earner
4	UrAgNonWageEar ner	Factor of production, urban agriculture non-wage earner	13	RuProSrvWageEarner	Factor of production, rural professional service wage earner
5	RuNonAgWageEar ner	Factor of production, rural non-agriculture wage earner	14	UrProSrvWageEarner	Factor of production, urban professional service wage earner
6	UrNonAgWageEar ner	Factor of production, urban non-agriculture wage earner	15	RuProSrvNonWageEa rner	Factor of production, rural profession service non-wage earner
7	RuNonAgNonWag eEarner	Factor of production, rural non-agriculture non-wage earner	16	UrProSrvNonWageEa rner	Factor of production, urban professional service non-wage earner
8	UrNonAgNonWage Earner	Factor of production, urban non-agriculture non-wage earner	17	Capital	Factor of production, capital
9	RuSrvWageEarner	Factor of production, rural service wage earner			

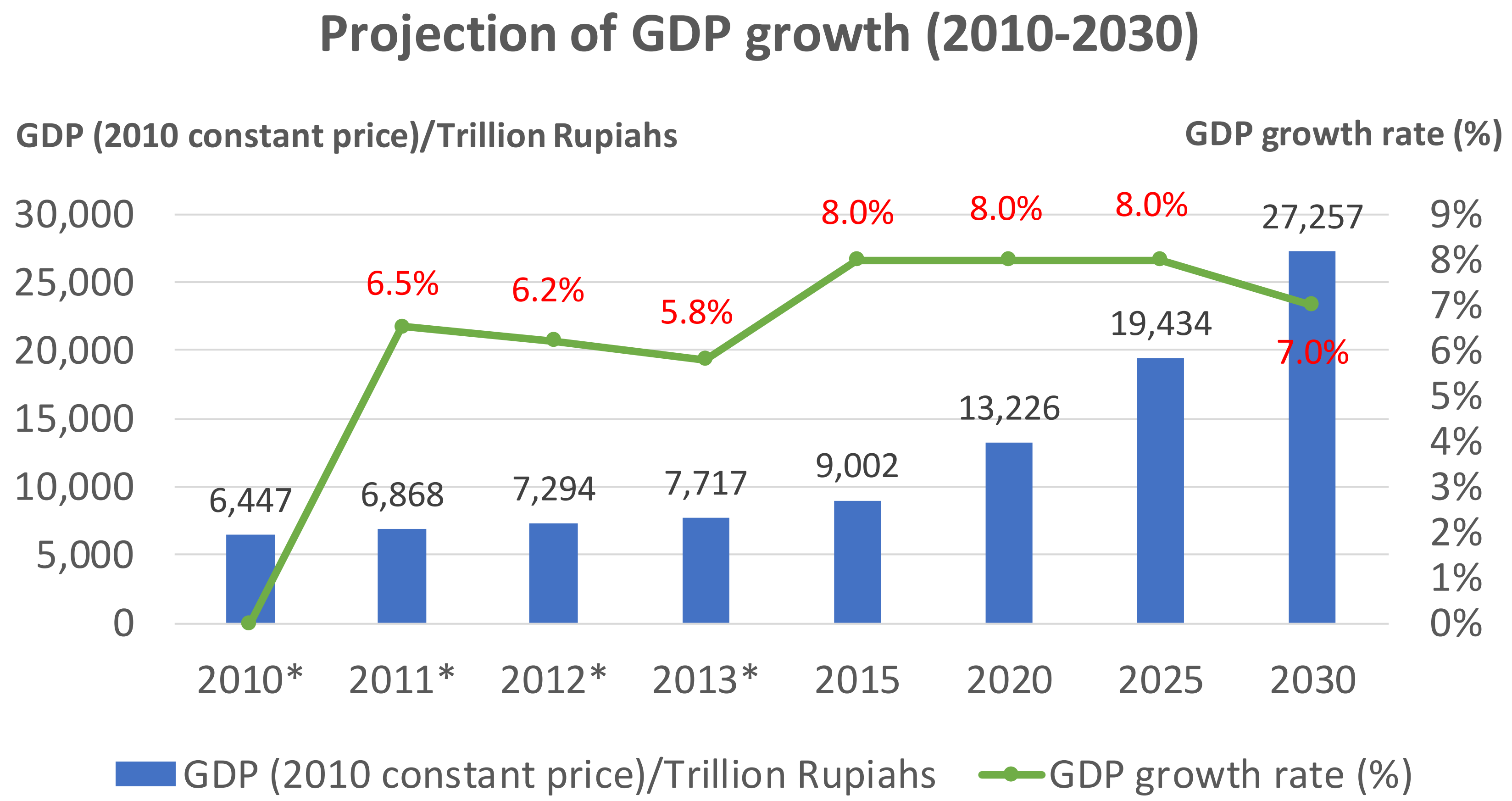
Households

Name of the account	Explanation
ih RuAgLab r2	Institution, rural agriculture labor
ih RuAgFarmSmall r2	Institution, rural agriculture small farmer
ih RuAgFarmMedium r2	Institution, rural agriculture medium farmer
ih RuAgFarmLarge r2	Institution, rural agriculture large farmer
ih RuNonAg Low r2	Institution, rural non-agriculture low income
ih RuNec r2	Institution, rural not elsewhere classified
ih RuNonAg MedUp r2	Institution, rural non-agriculture medium and upper income
ih Ur Low r2	Institution, urban low income
ih Ur Nec r2	Institution, urban not elsewhere classified
ih Ur MedUp r2	Institution, urban medium and upper income

Modelling the BAU

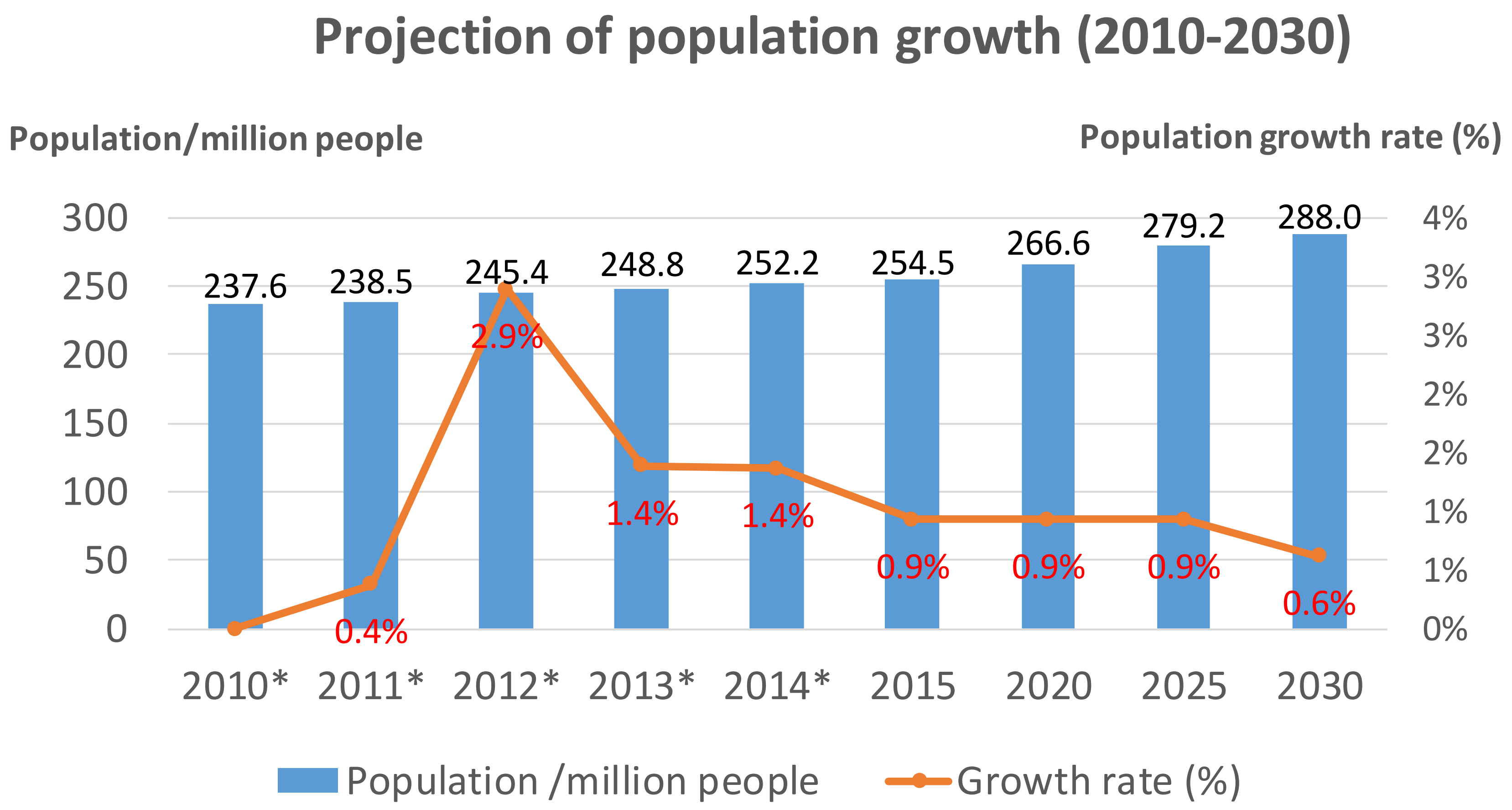
- Recursive-dynamic CGE model based on 2010 which projects the results for 2011 - 2030.
- Major exogenous variables for the BAU case
  - GDP growth
  - Population growth
  - Interest rate
  - Depreciation rate
  - Emission factors

GDP growth



Source: GHG emission inventory on energy sector (2015)
Note: * Represents the actual data (2015 Handbook of Energy and Economic Statistics of Indonesia).

Population growth



Source: GHG emission inventory on energy sector (2015)
Note: * Represents the actual data (2015 Handbook of Energy and Economic Statistics of Indonesia).

Emission factors

Fossil fuels		tCO2-e/BOE
Gas		0.3358
LPG		0.3358
Oil product	Aviation gasoline (Avgas)	0.4146
	Aviation turbine fuel (Avtur)	0.4264
	Premium	0.4069
	RON 88	0.4069
	Bio Premium	0.3657
	Pertmax	0.4069
	RON 92	0.4069
	Bio Pertamax	0.3657
	Pertamax Plus	0.4069
	RON 95	0.4069
	Mogas	0.4069
	Biodiesel	0.3657
	Bio Solar	0.3657
	Dimethyl Ether (DME)	0.3657
	Kerosene	0.4246
	Automotive diesel oil (ADO)	0.4363
	Industrial diesel oil (IDO)	0.4363
	Solar 51	0.4363
	Fuel oil	0.4539
Coal		0.5665

Source: GHG emission inventory on energy sector (2015)

Modelling the climate policy

- The aggregate effects of policy intervention, such as the kerosene to LPG program, mandatory biofuel blending targets and renewable energy targets, etc. is to charge an additional carbon cost to energy supply and consumption, which works the same way as imposing a carbon tax.
- In this research, a carbon tax by different rates at different time is charged on fossil fuels to approximate the emissions reduction targets for the energy sector.
- The carbon tax, τ^{CO2}, increases the gross of the ad-valorem tax price of each fossil fuel, $(1 + \tau^{Y_e})p_e$, by a margin of $\tau^{CO2}\varphi_e$ based on the emissions factor of each fuel.
- Imposing a carbon tax can directly impact on the price of fossil fuels, and indirectly impact on the the cost of production of various sectors. These direct and indirect impacts will influence sectoral employment and the distribution of the labor market.
- Carbon tax revenue, $\tau^{CO2}Q^{CO2}$, is transferred by the government directly to the households as a lump sum supplement to the factor income.

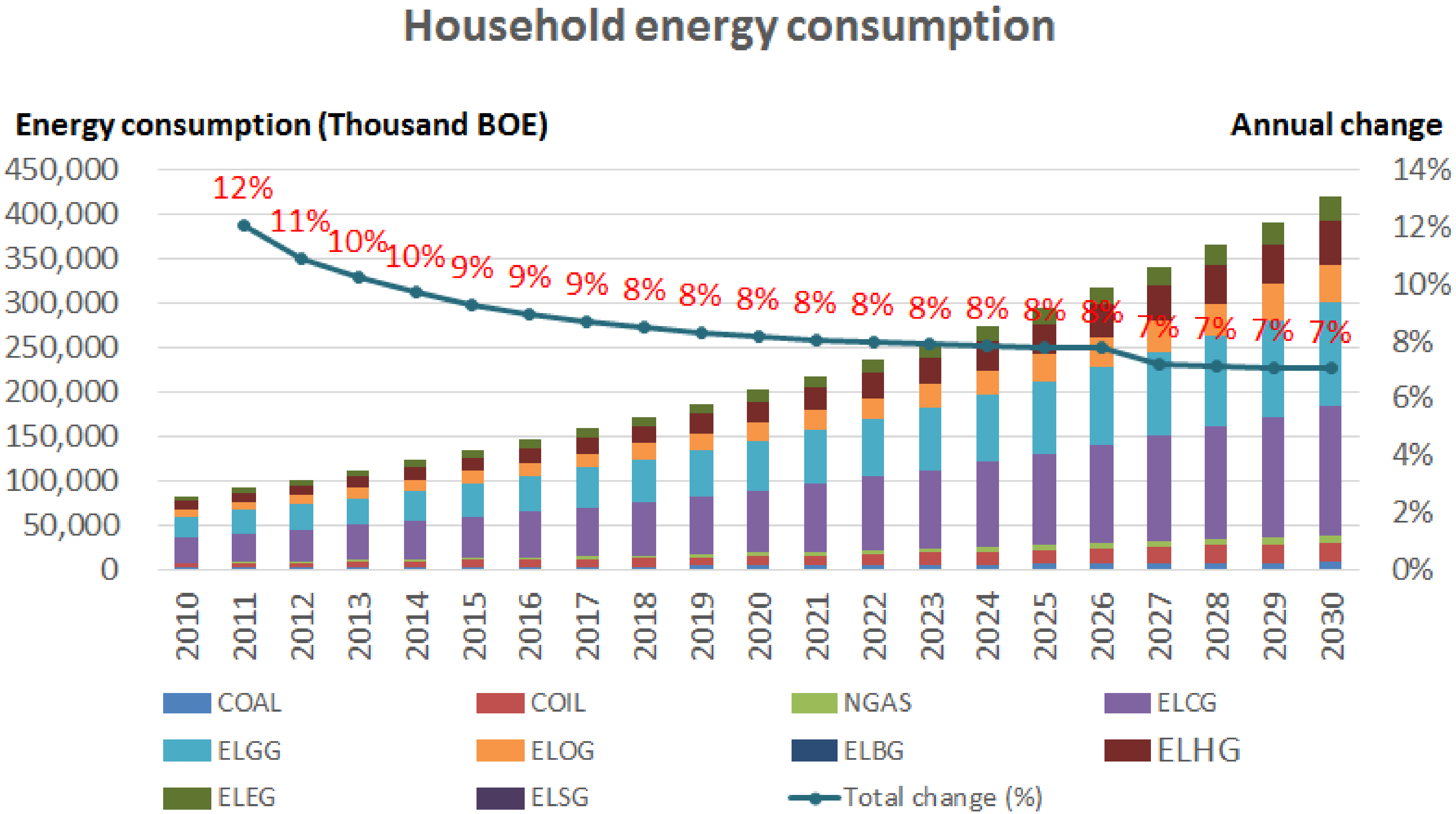
Modelling the energy target (1)

- **Share of renewable energy (23%) in the fuel mix of electricity generation by 2025**
  - Seven energy sources for electricity generation: 3 fossil fuels (coal, gas and oil) and four renewable energy (hydro, geothermal, biomass and solar PV&wind).
  - By imposing a carbon tax on fossil fuel use, the price of fossil fuels increases which will change the relative prices among energy sources, in particular non-fossil fuels, such as renewables.
  - As a response from energy users, low carbon-fossil fuels and in particularly, renewable energy will be used more through the CES nesting structure, therefore increasing the share of renewable resources.
  - We estimate at what carbon tax rate that can help achieve the renewable energy target, i.e. the associated policy cost.

Modelling the energy target (2)

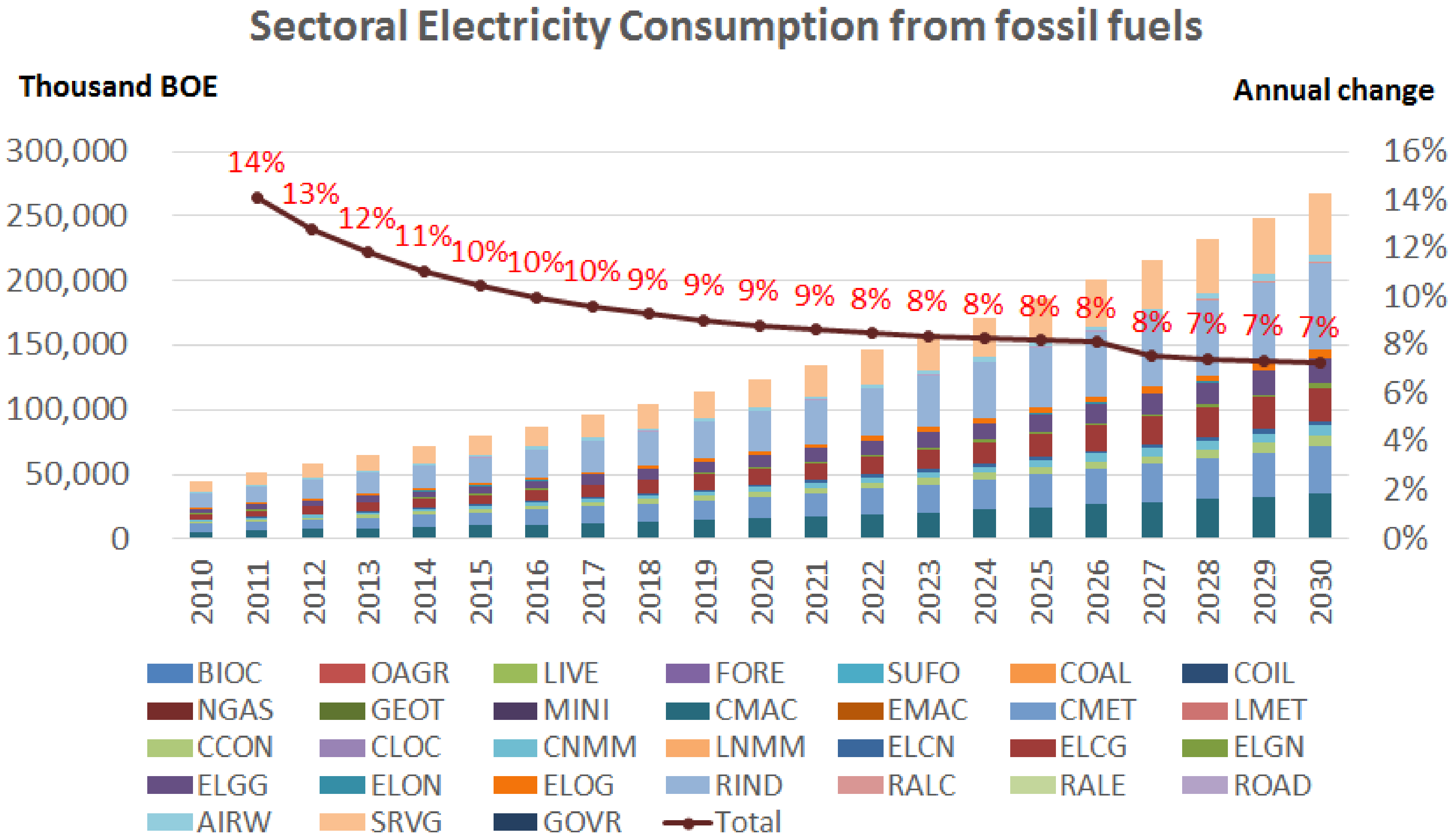
- **Improvement in energy intensity by 1% annually by 2025**
  - In this study, energy intensity is defined as energy use per unit sectoral output.
  - The technical coefficients for energy input bundle in each sector's production function and households' consumption function can be used to reflect associated energy intensity.
  - By imposing a carbon tax at different rates on fossil fuel use, the price of fossil fuels increases which will affect the relative prices of energy bundle and other non-energy goods and services as well as the value-added composite.
  - As a response from energy users, less energy will be used and more non-energy goods and services and VC composite will be used through the CES nesting structure resulting an improvement in the energy intensity.
  - We can know at about what carbon tax rate that can help achieve the renewable energy target, i.e. the associated policy cost.

Projection of the BAU

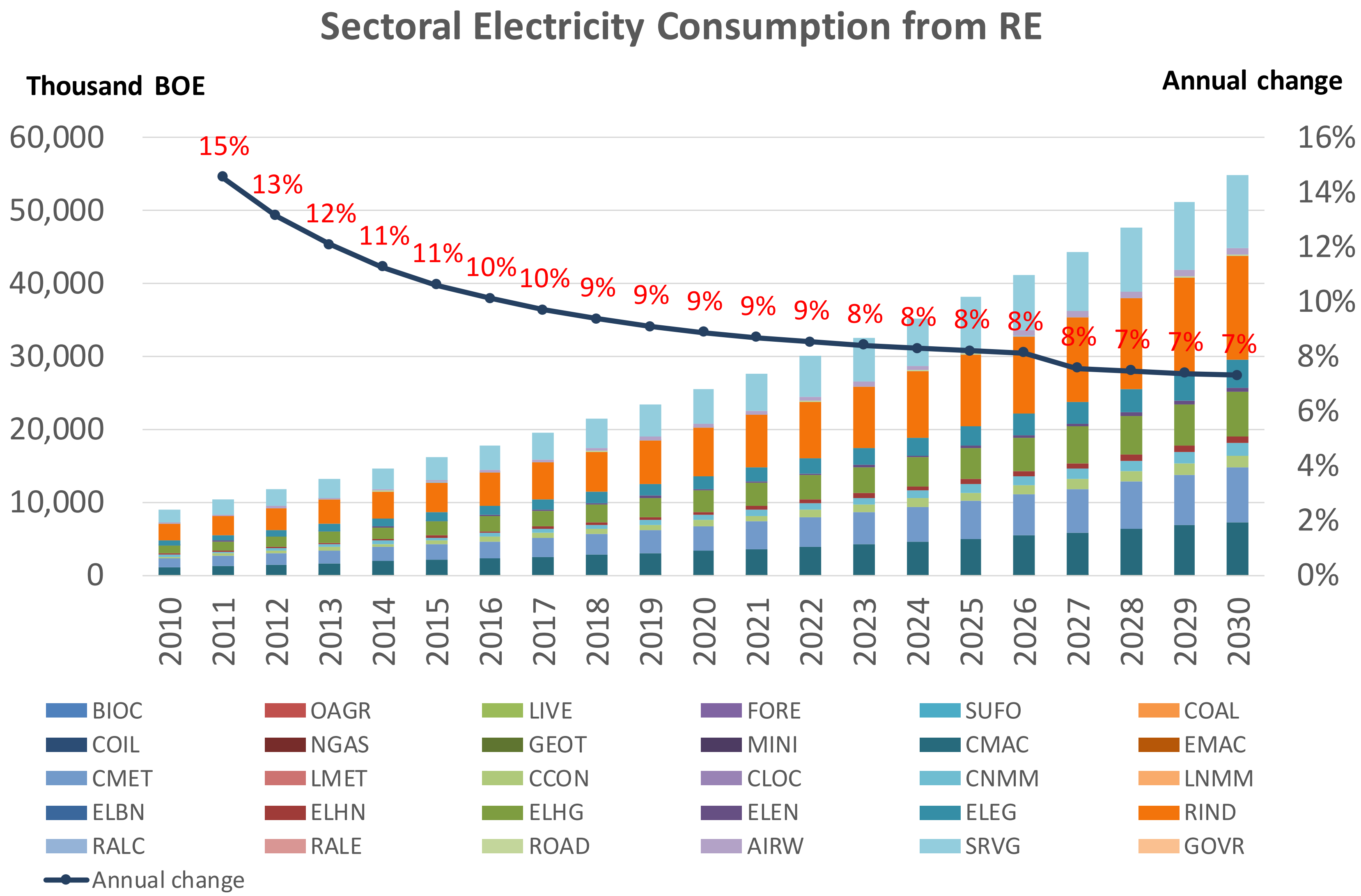


Household energy consumption in 2020 will be 2.5 times as much as of the 2010 level, . In 2030, household energy consumption will be twice as much as of the 2020 level. The largest share is from ELCG (35%), followed by ELGG (28%), ELHG (12%) and ELOG (10%)

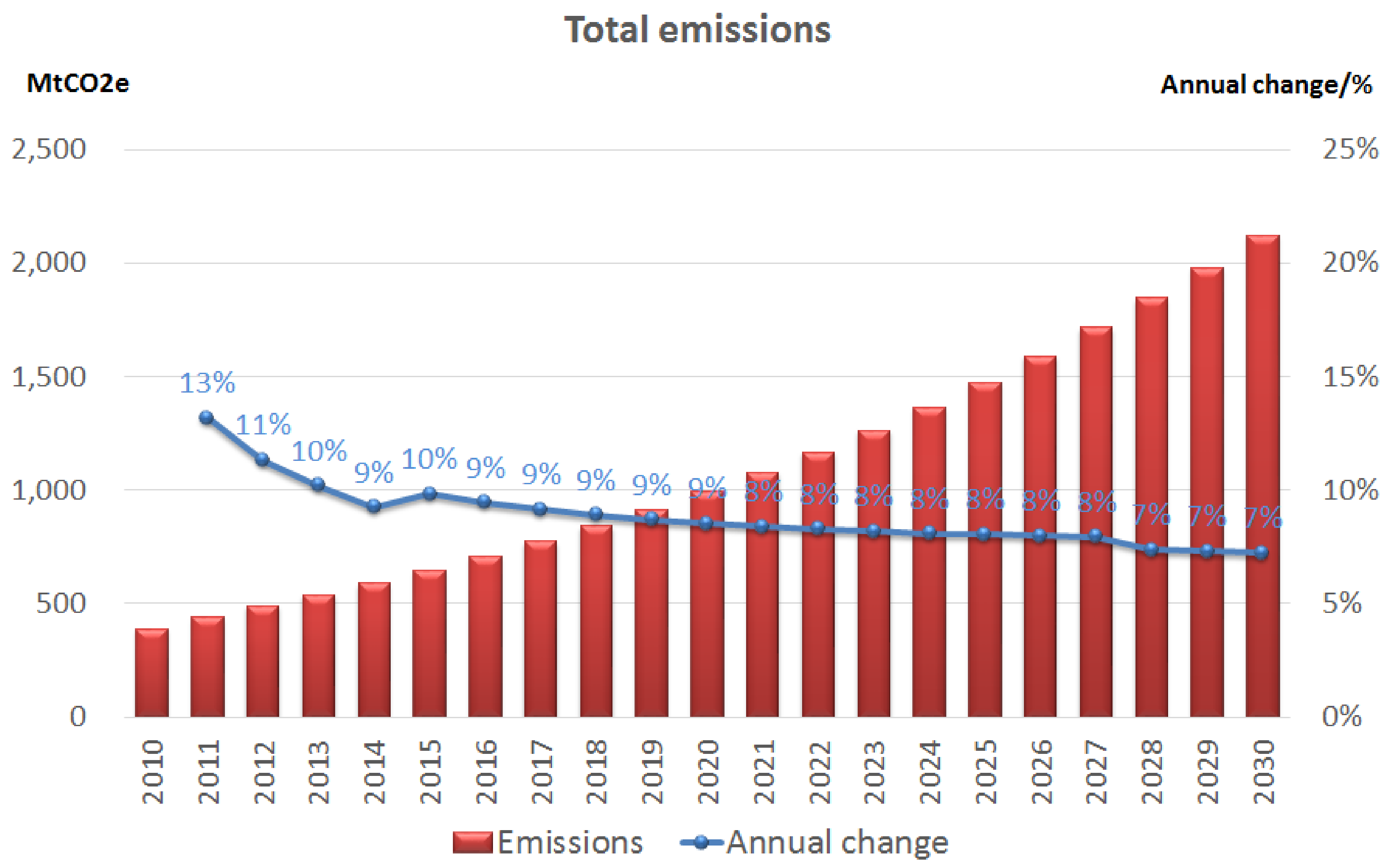
Projection of the BAU



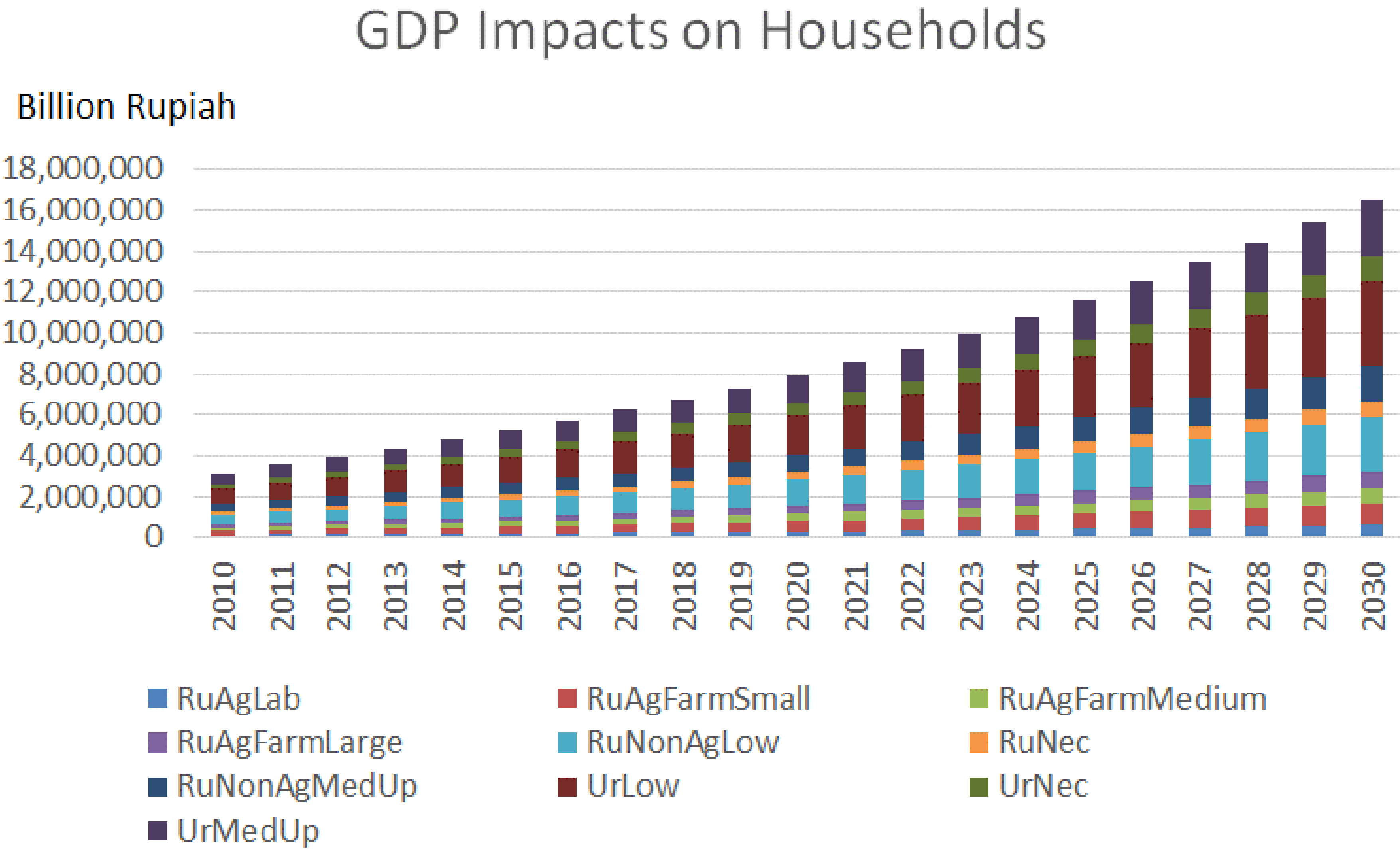
Projection of the BAU



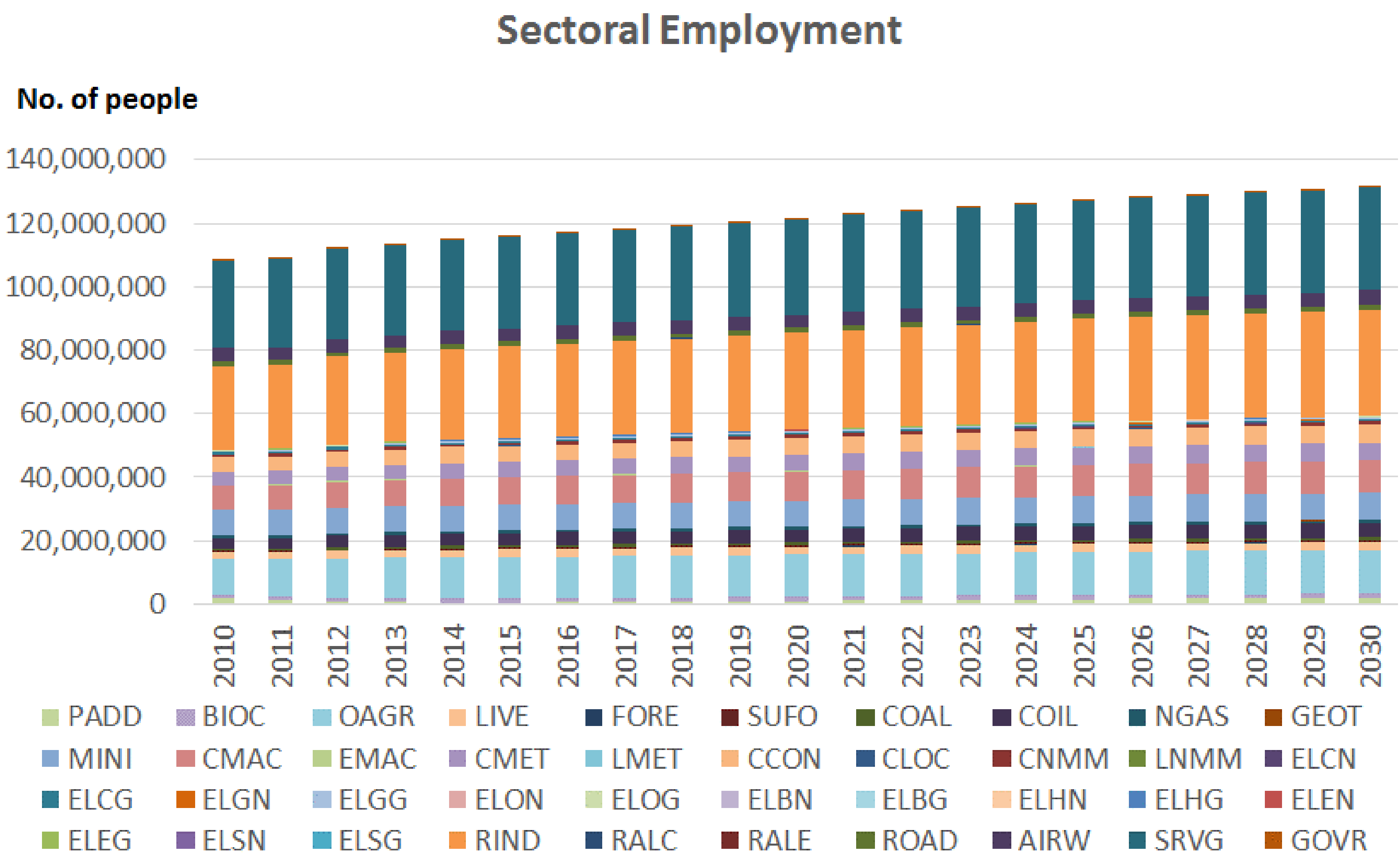
Projection of the BAU



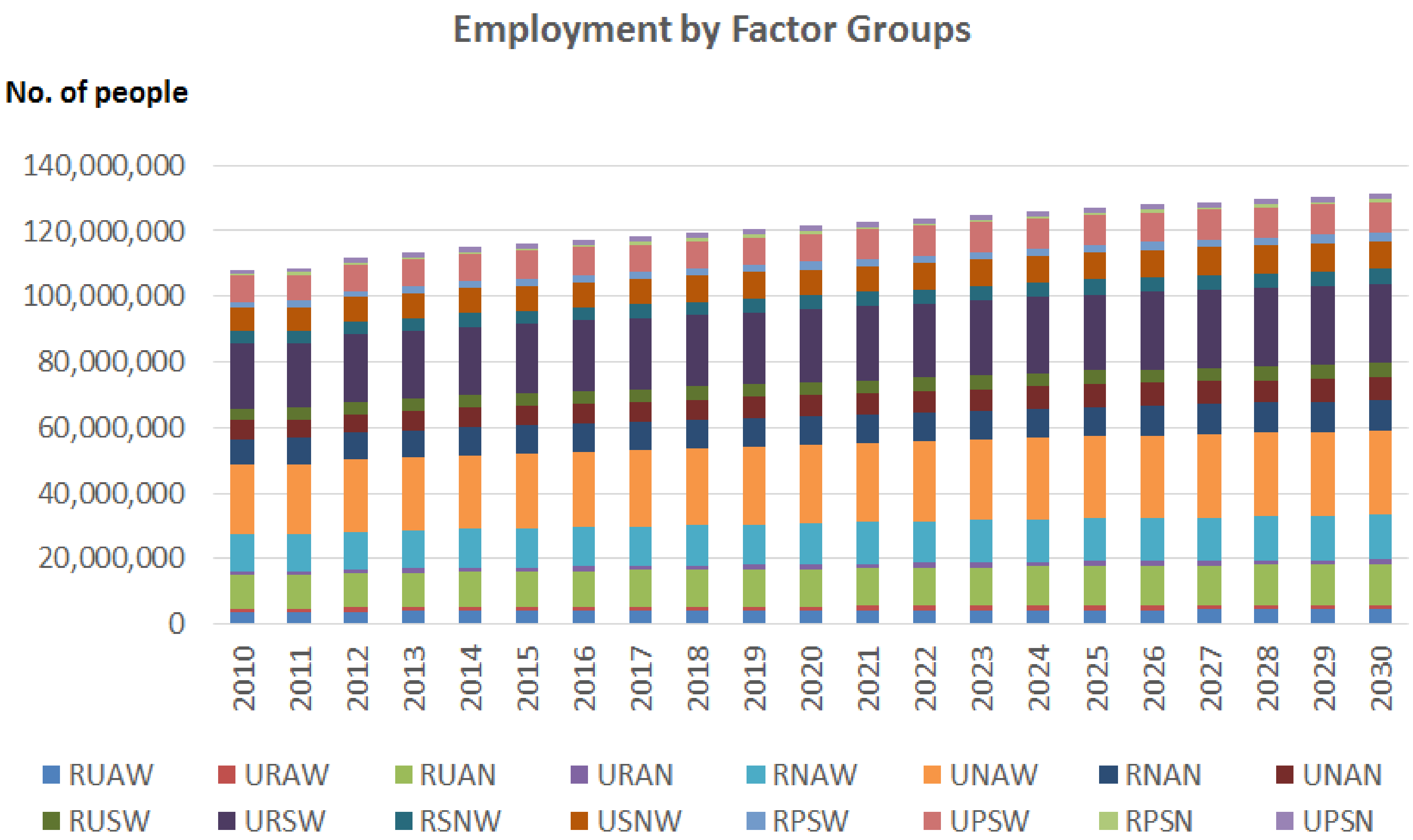
Projection of the BAU



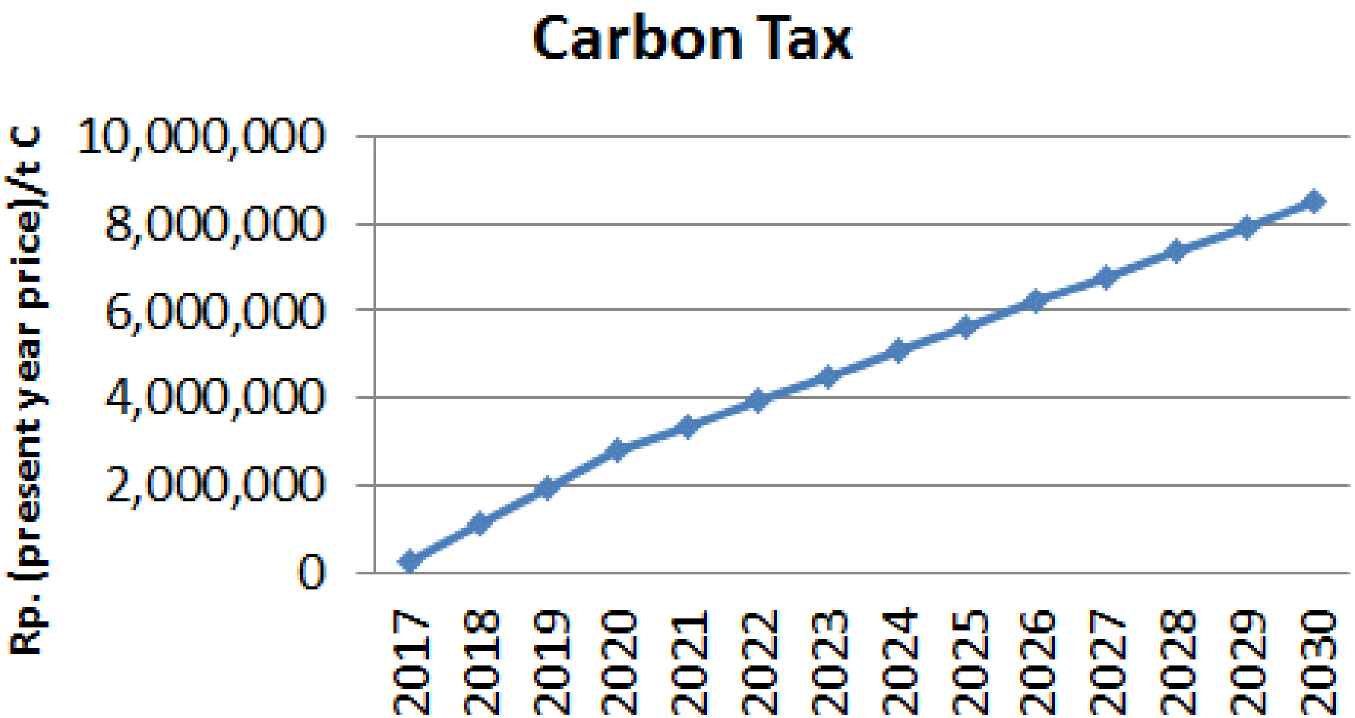
Projection of the BAU



Projection of the BAU

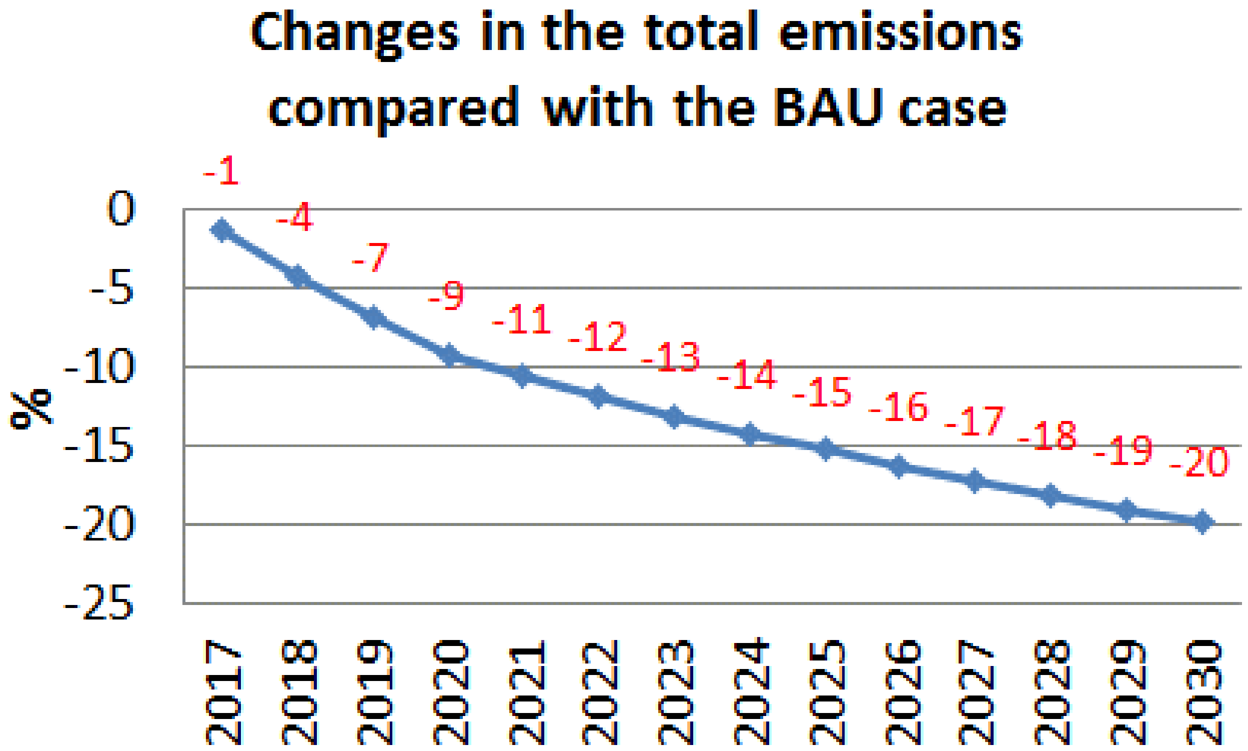


Simulation results



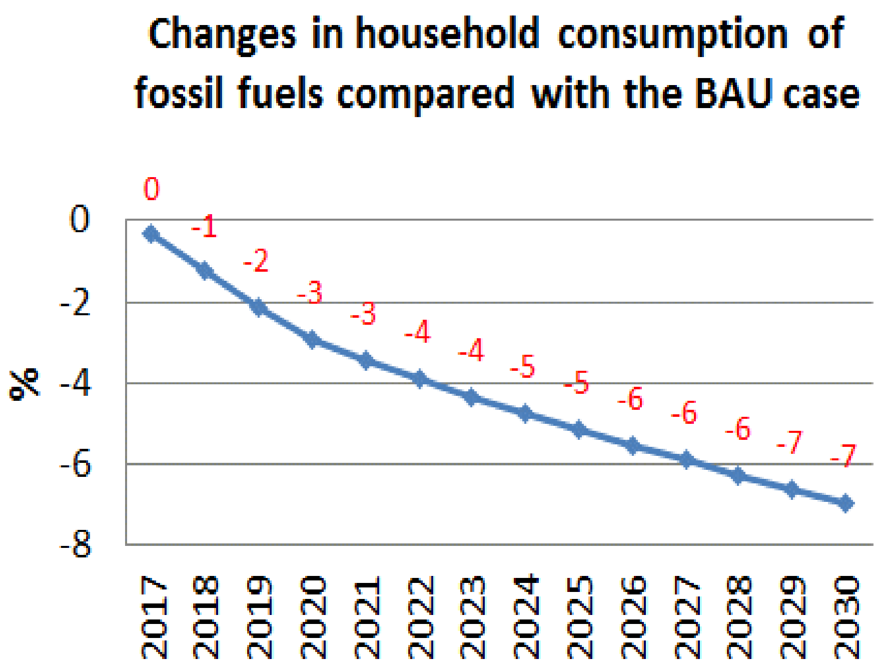
Carbon tax at different rates (i.e. 2.8 million Rp/t C or 0.764 million Rp/t CO2 in 2020 and more than 8 million Rp/t C or 2.29 million Rp/t CO2 in 2030 at present year price) are simulated to approximate the emissions targets set for the energy sector at 9.8% reductions from BAU by 2020 and 20.9% by 2030 (Ref. GHG emissions Inventory for Energy Sector, 2015. Data and Information Technology Center, MEMR)

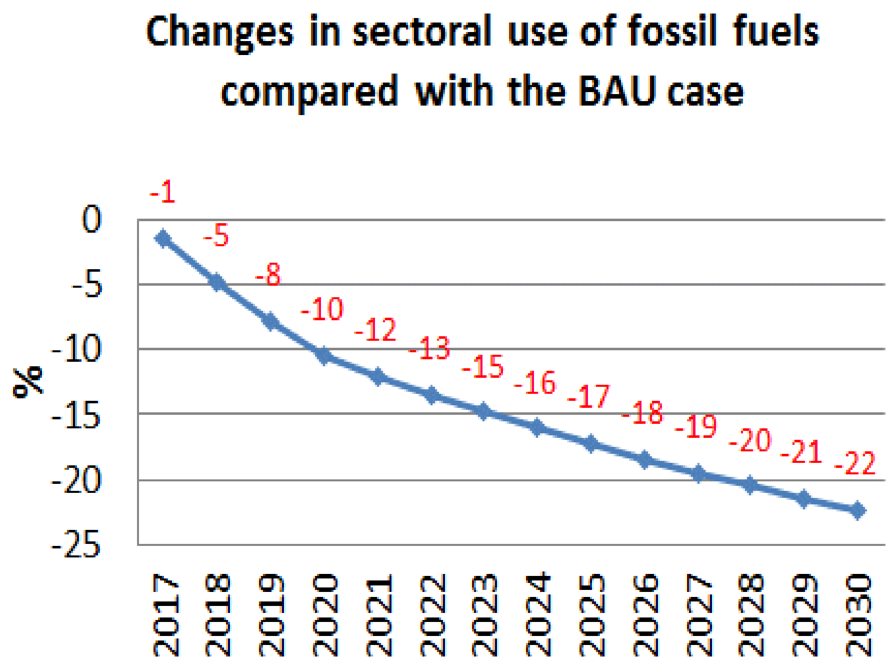
Climate policy simulation results



Presented as the changes in the total emissions by imposing the carbon tax compared with the BAU case, i.e. (total emissions under carbon tax - total emissions under BAU) / total emissions under BAU * 100%. The results mimic the emissions reduction targets of 9.8% in 2020 and 20.9% in 2030.

Climate policy simulation results

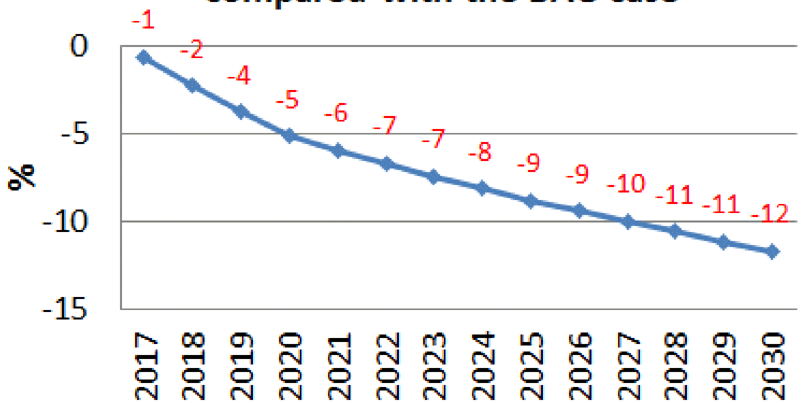




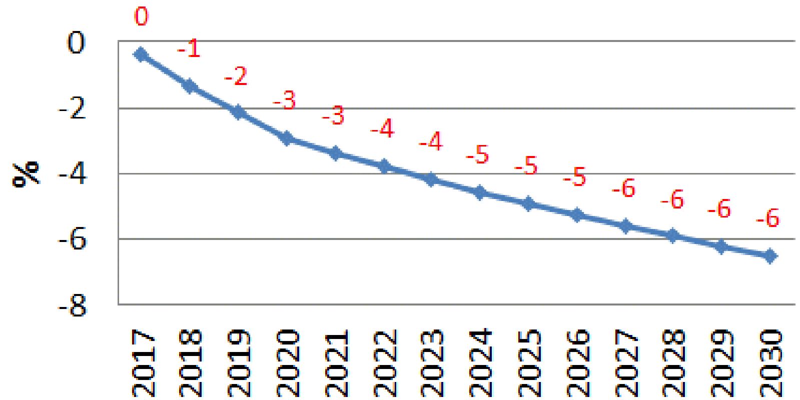
By introducing a carbon tax, fossil fuel consumption by both households and economic sectors will decrease substantially, in particular for the economic sectors.

Climate policy simulation results

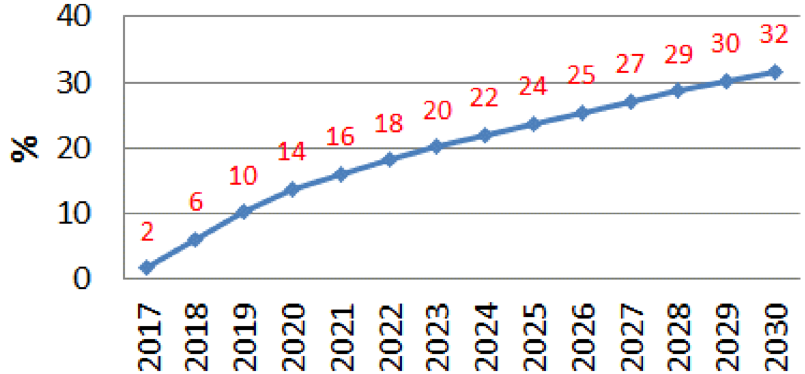
Changes in household consumption of electricity generated from fossil fuels compared with the BAU case



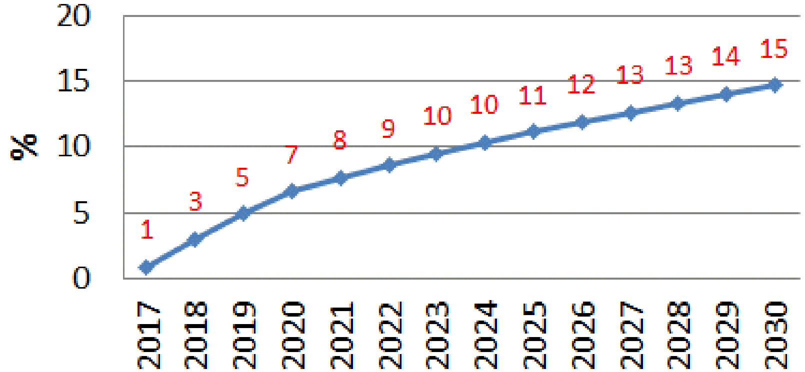
Changes in sectoral use of electricity generated from fossil fuels compared with the BAU case



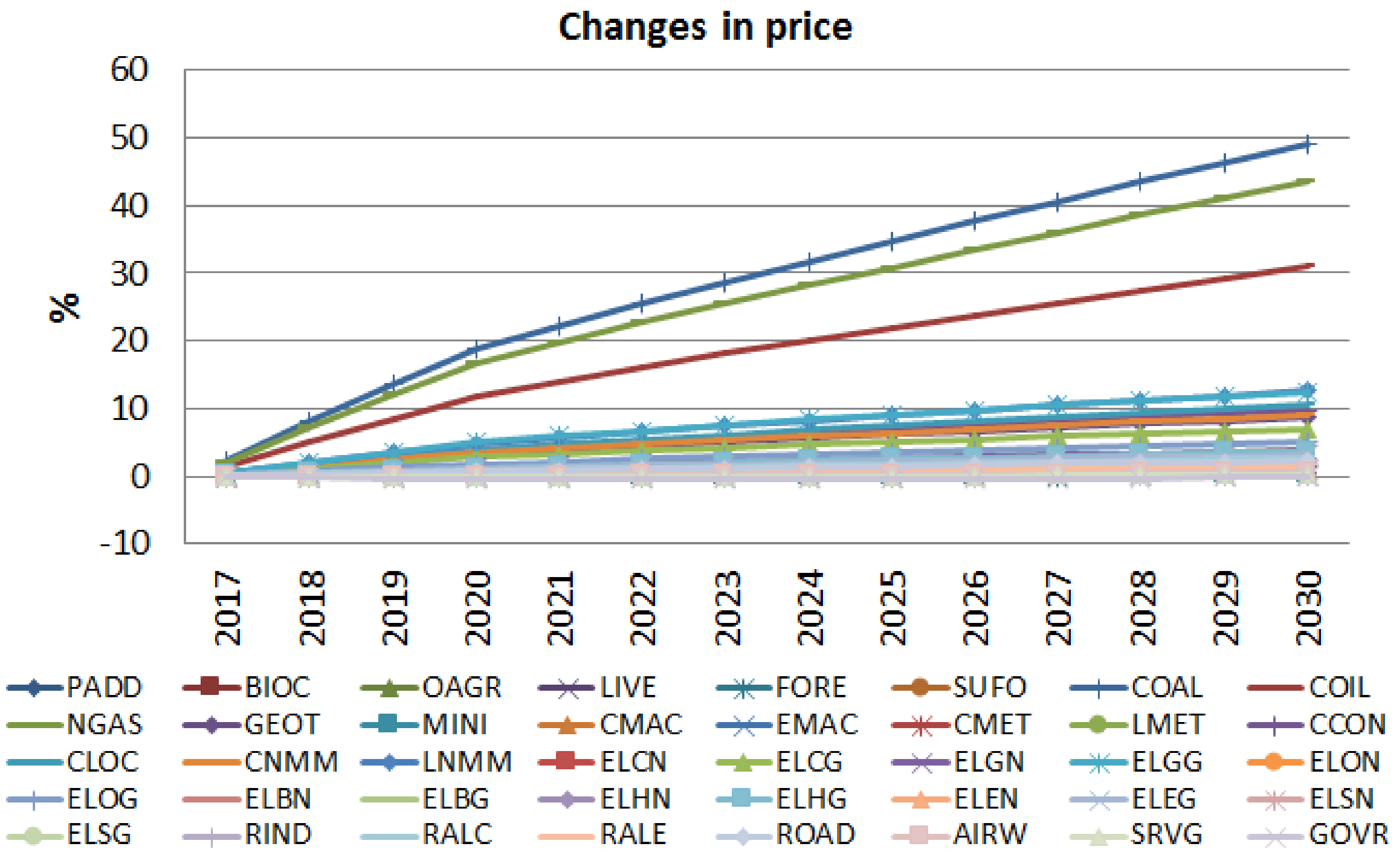
Changes in household consumption of electricity generated from RE compared with the BAU case



Changes in sectoral use of electricity generated from RE compared with the BAU case

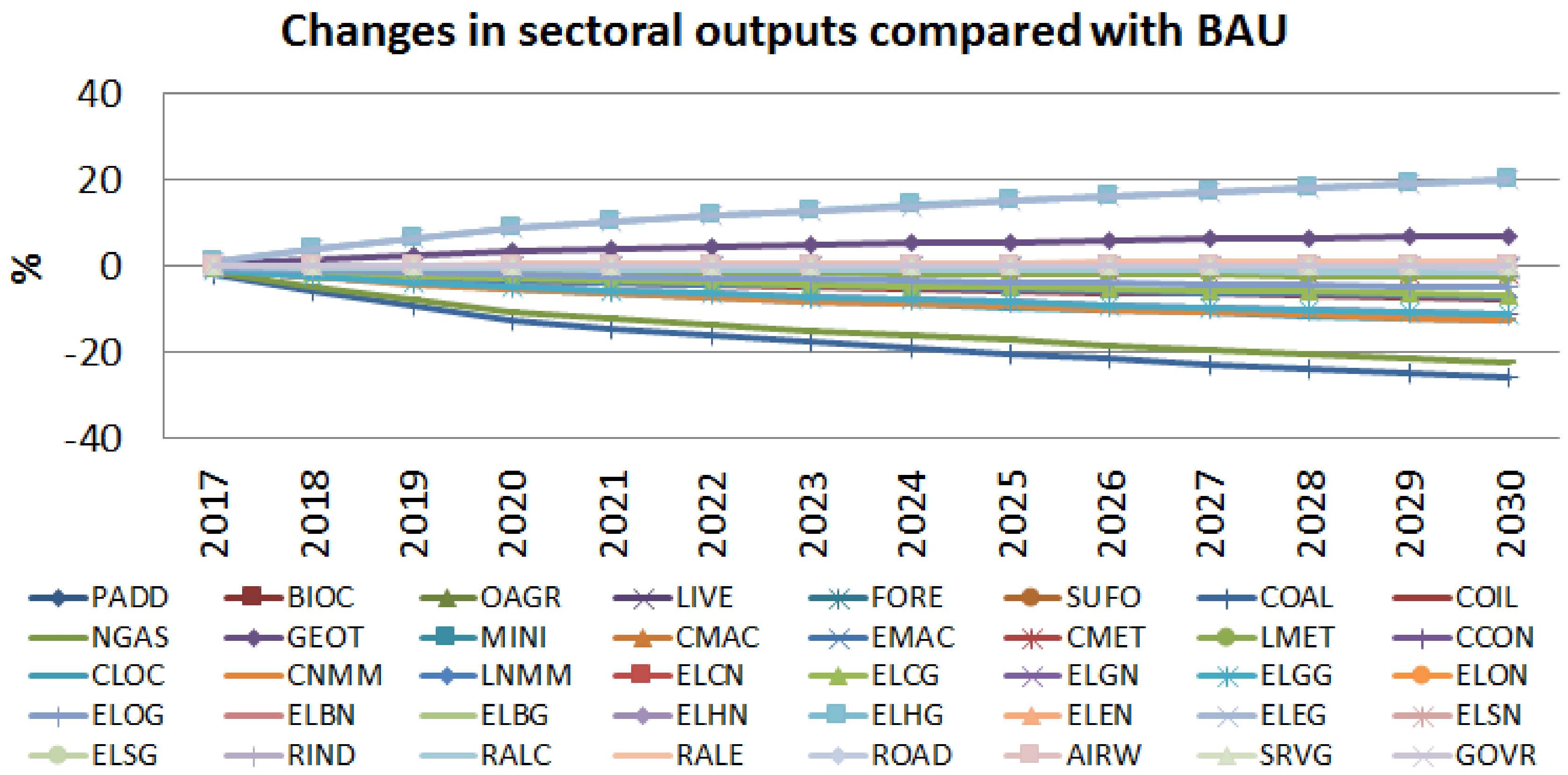


Climate policy simulation results



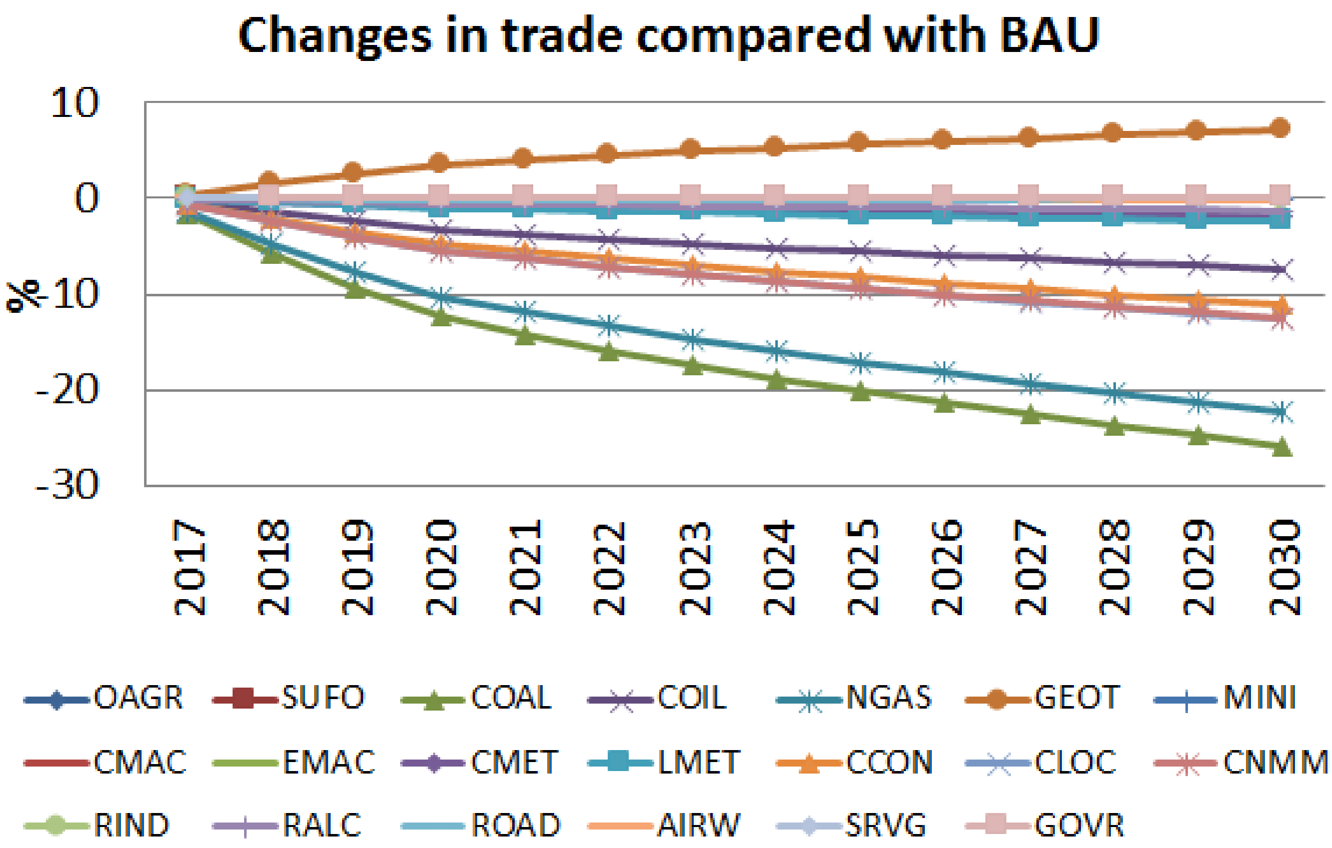
The price of coal, gas and oil will go up substantially, followed by the price of electricity generated from gas and energy-intensive sectors of chemicals and non-metallic manufacture.

Climate policy simulation results



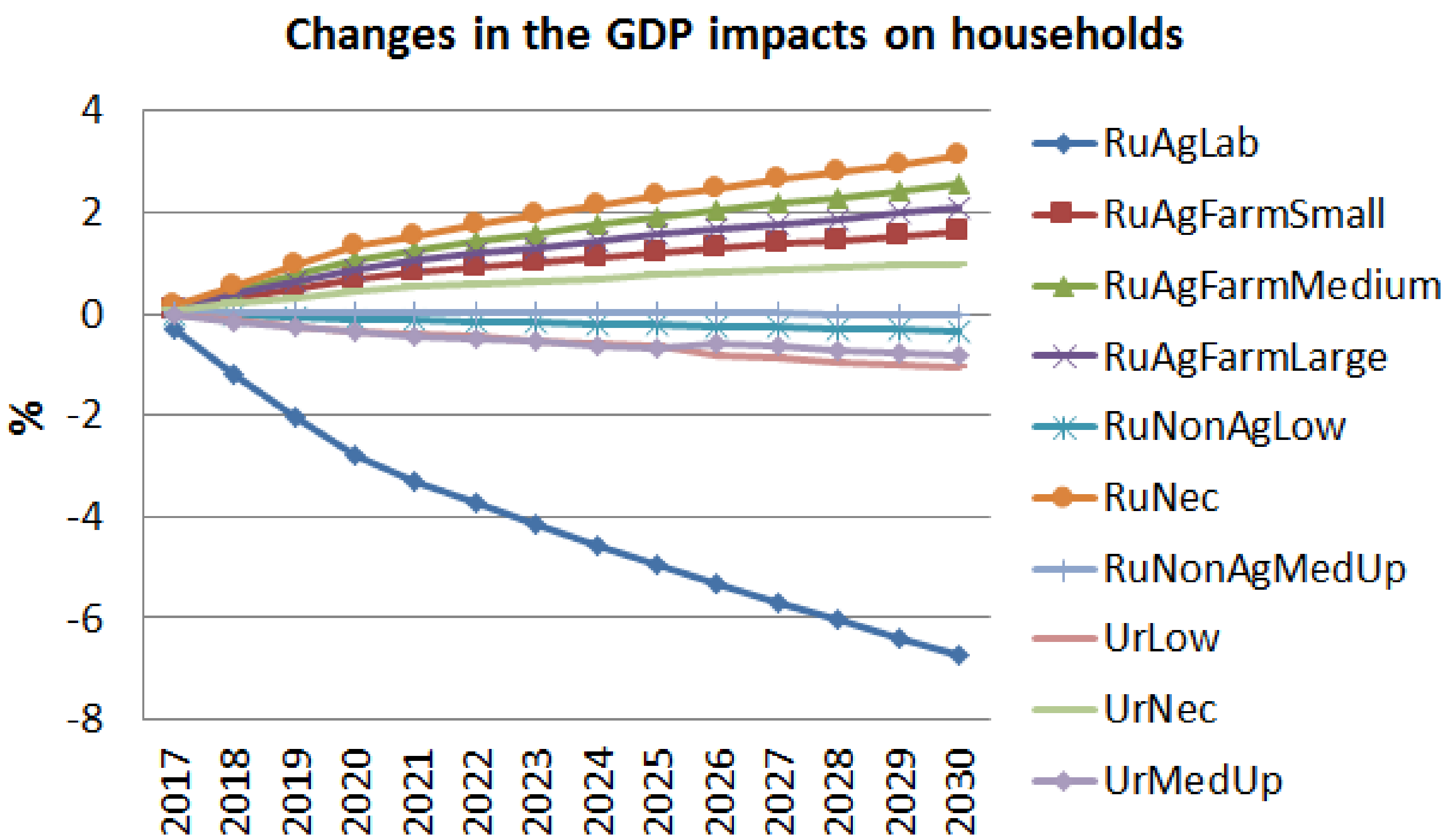
The quantity outputs of coal will be negatively impacted the most, followed by gas and chemicals and non-metallic manufacture. To the opposite, electricity generation from geothermal will positively impacted the most, followed by geothermal extraction.

Climate policy simulation results



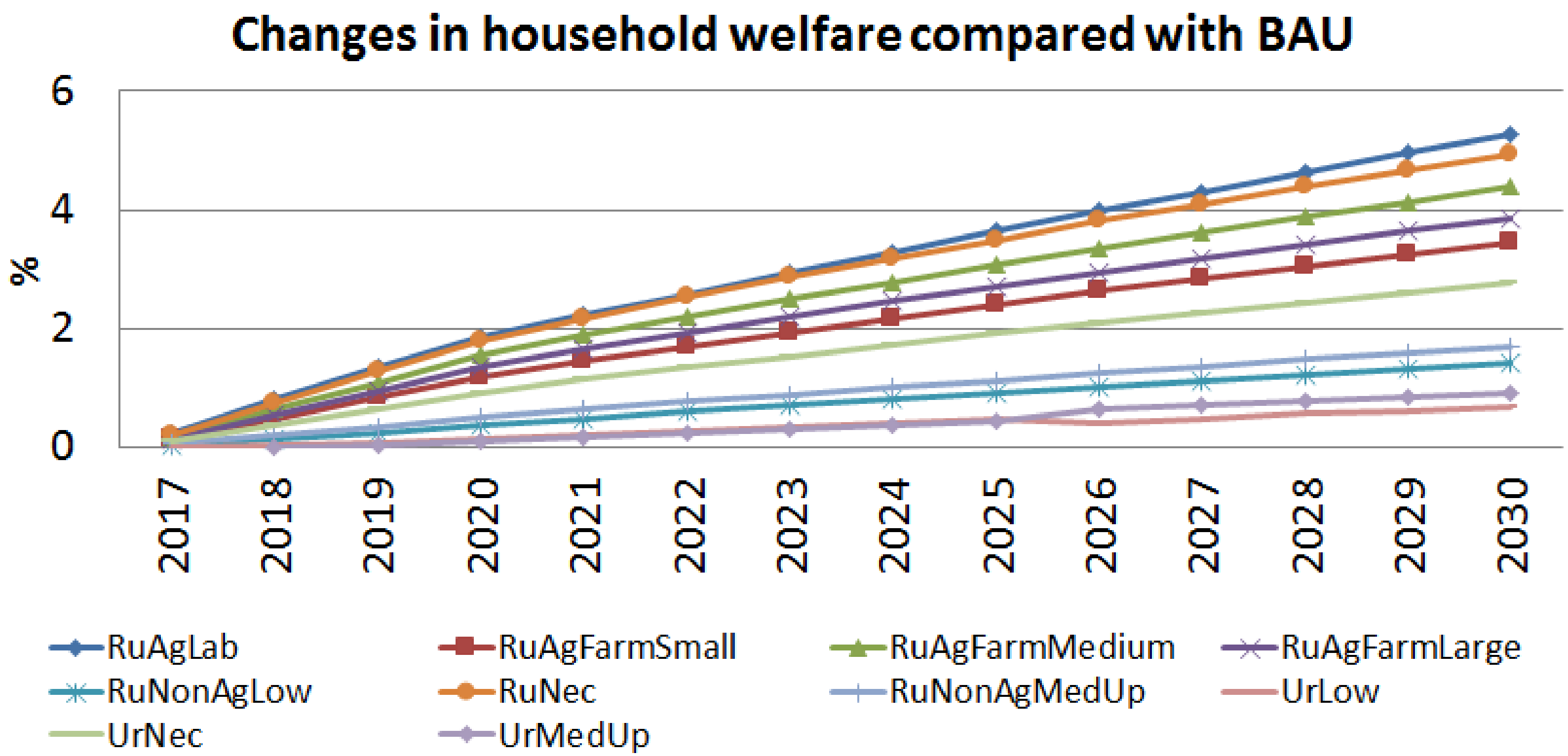
Trade (exports) of most sectors will be negatively impacted due to the imposing a carbon tax. In particular, coal and gas will be impacted the most, followed by non-metallic and chemical sectors. On the other hand, trade in geothermal will increase.

Climate policy simulation results



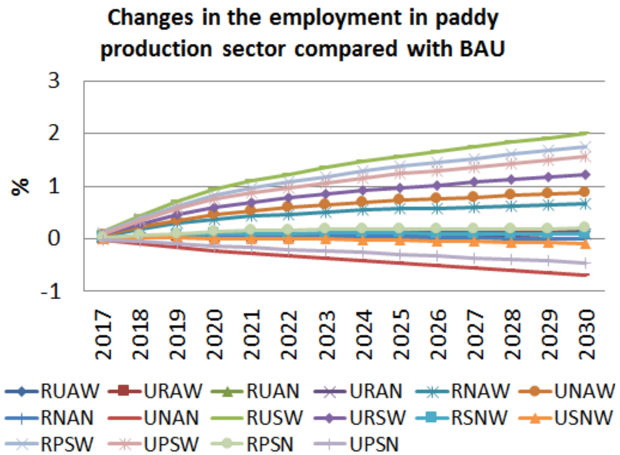
Rural agriculture labor households will be impacted the most negatively (about 3% in 2020 and 7% in 2030), followed by both urban low income and medium and high income households. On the other hand, rural others (about 1.3% in 2020 and more than 3% in 2030) and rural farms of three different sizes will impact positively.

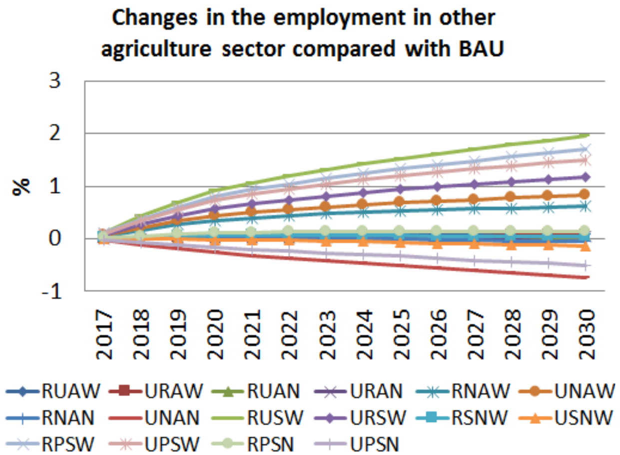
Climate policy simulation results

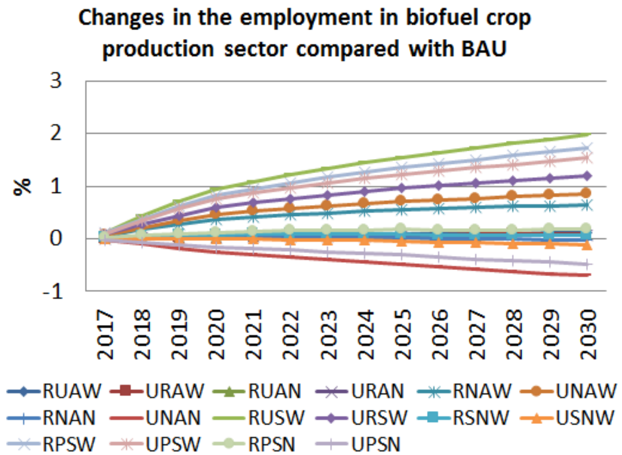


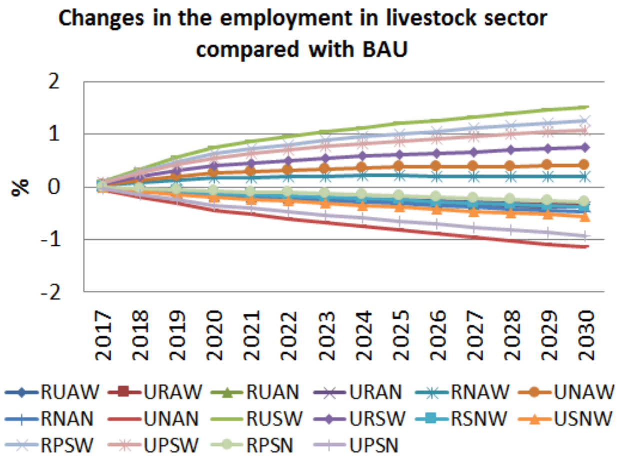
Welfare, representing the utility function of households, is based on Hicksian equivalent variation, i.e. welfare = f (saving, consumption, capital endowment, labor endowment, investment, and the lump sum transfer of the collected carbon tax). The welfare of all the household groups will be impacted positively, and in particular, opposite to the GDP impacts, rural agriculture labor households will be impacted the most, followed by rural others and rural farmers with different sizes.

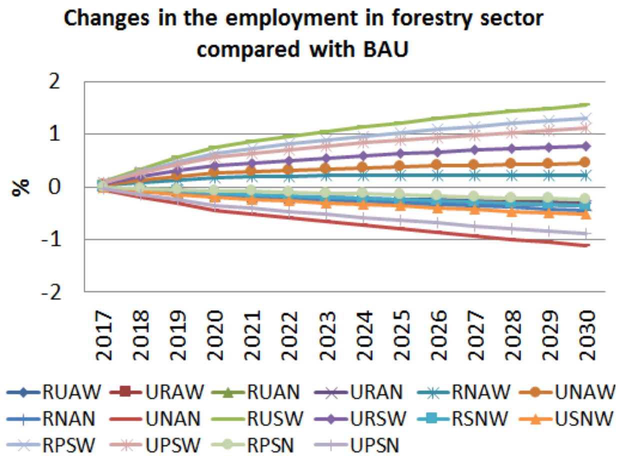
Simulation results: Employment in AgrLivFor

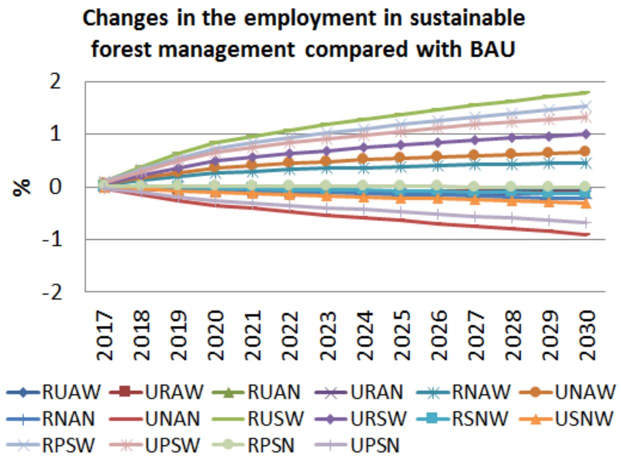






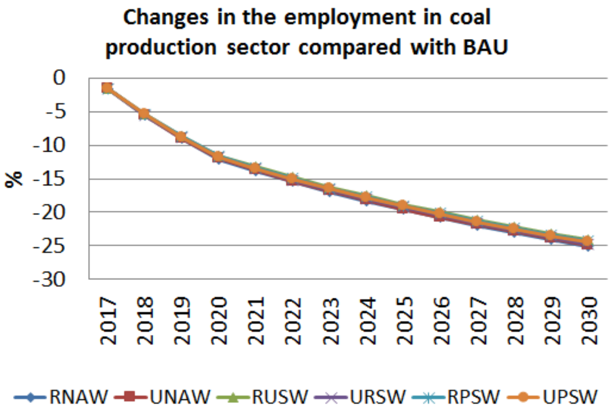


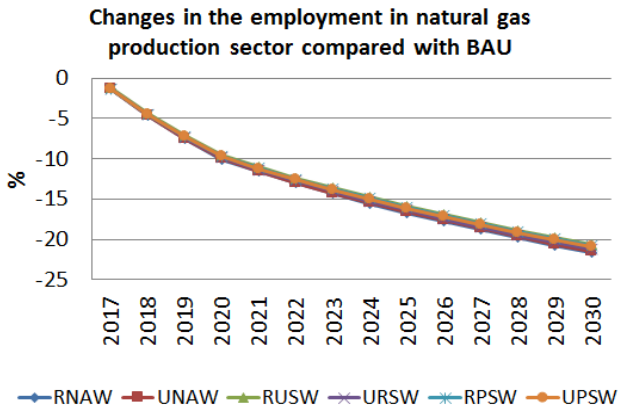


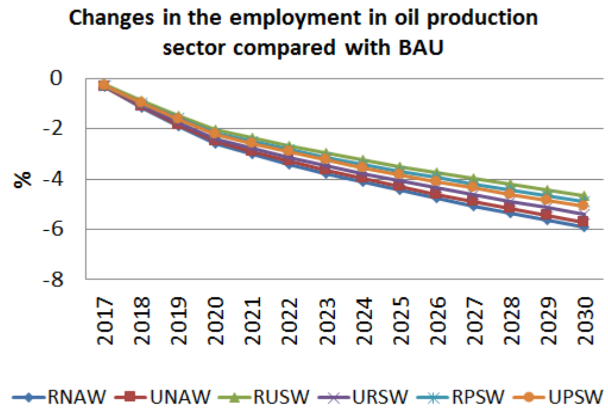


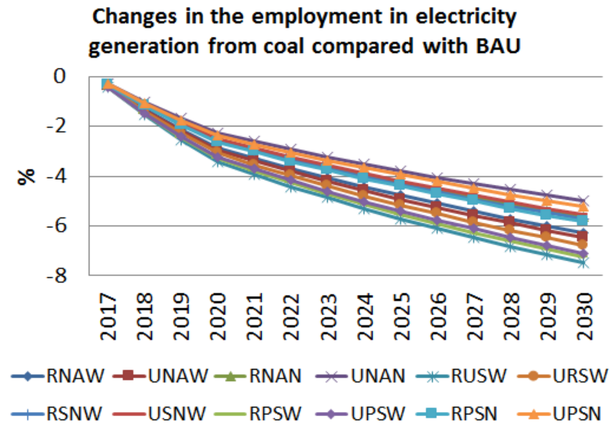
Employment impacts in six agriculture sectors are similar but different in the scale of impacts. Rural and urban non-agriculture, rural and urban service and rural and urban professional service-related labor will increase while other groups will decrease. Urban agri non-waged labor will adversely impact the most.

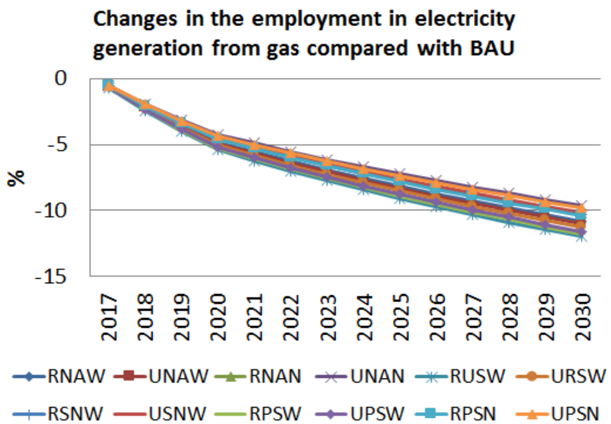
Simulation results: Employment in fossil fuel extraction and electricity gen. from fossil fuel

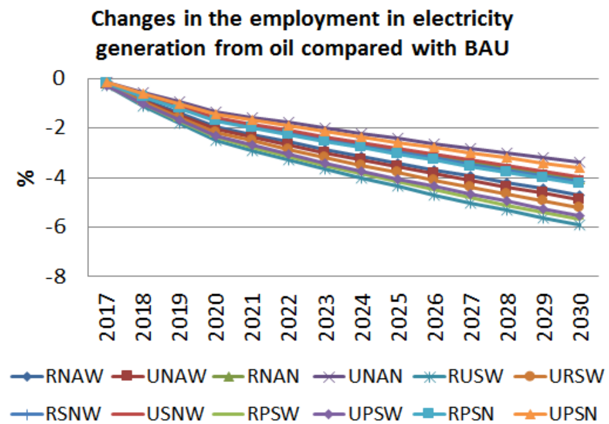






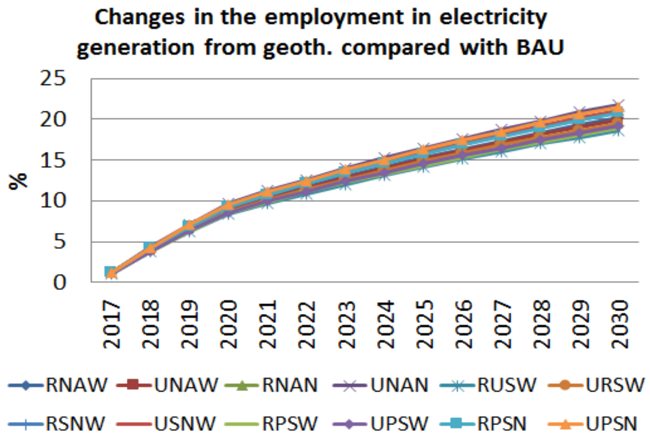


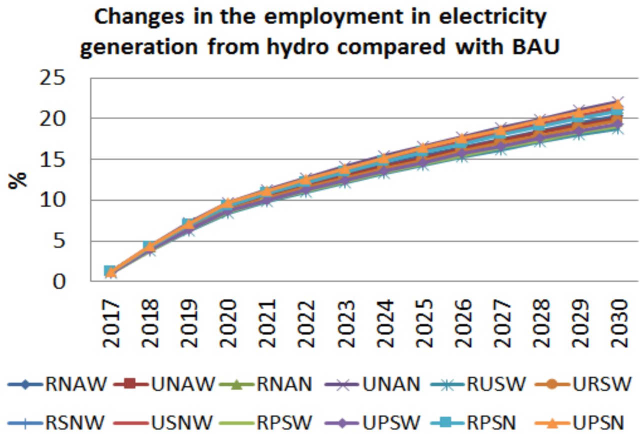


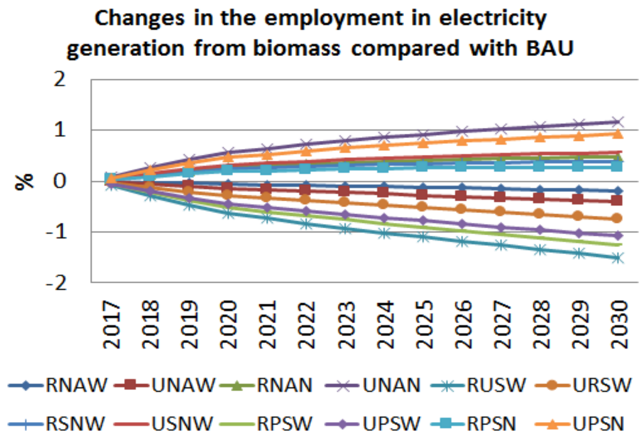


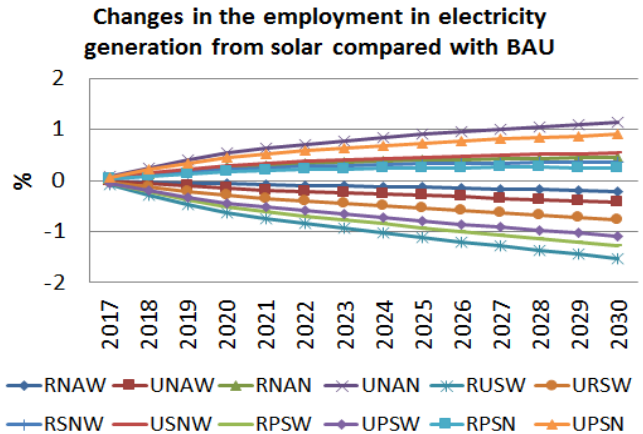
Employment in fossil fuel extraction sectors and electricity generation from fossil fuels will decrease for all labor factors. For different sectors, the employment impacts on different labor factors are different.

Simulation results: Employment in power generation from RE



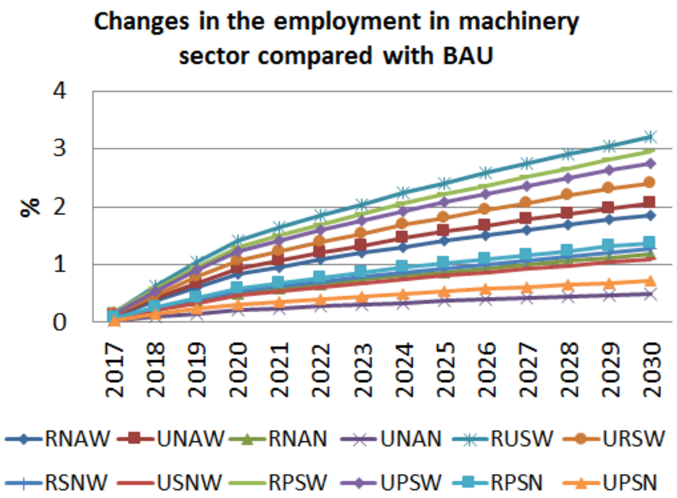


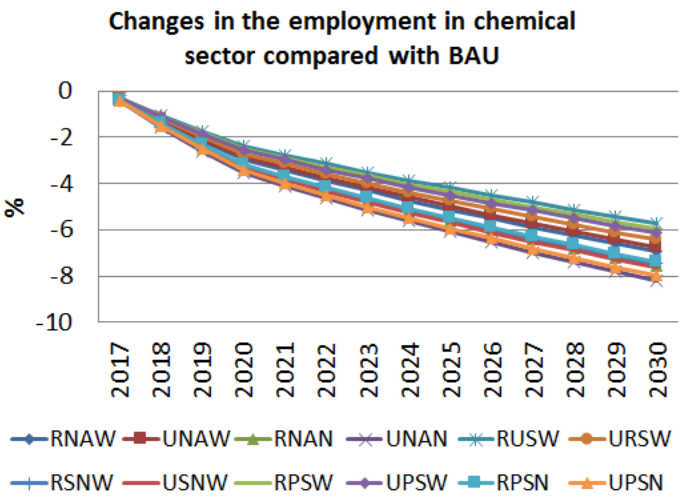


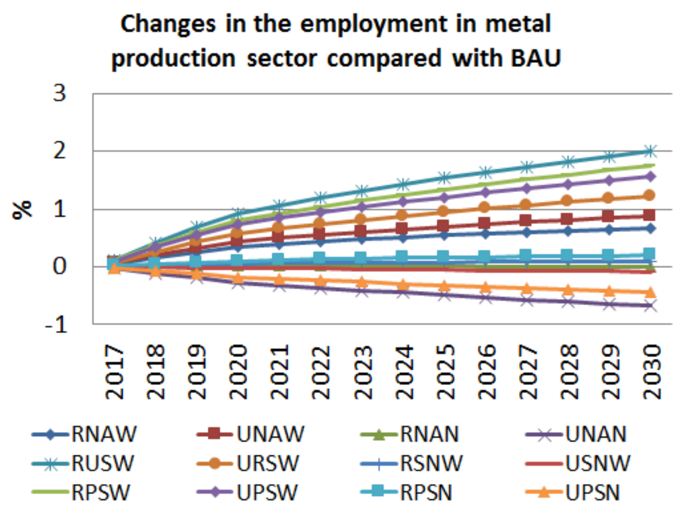


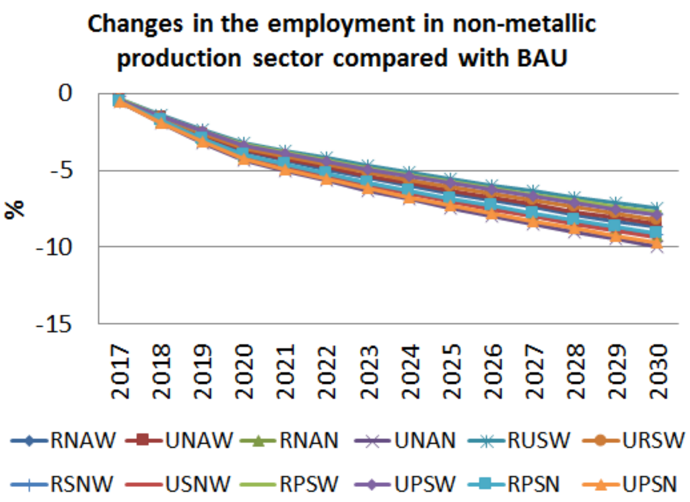
Employment in power generation from geothermal and hydro follow the same trend of increase. The employment impacts in power generation from biomass and solar/wind are similar by mixture of positive and negative impacts on different labor factors.

Simulation results: Employment in manufacturing sectors

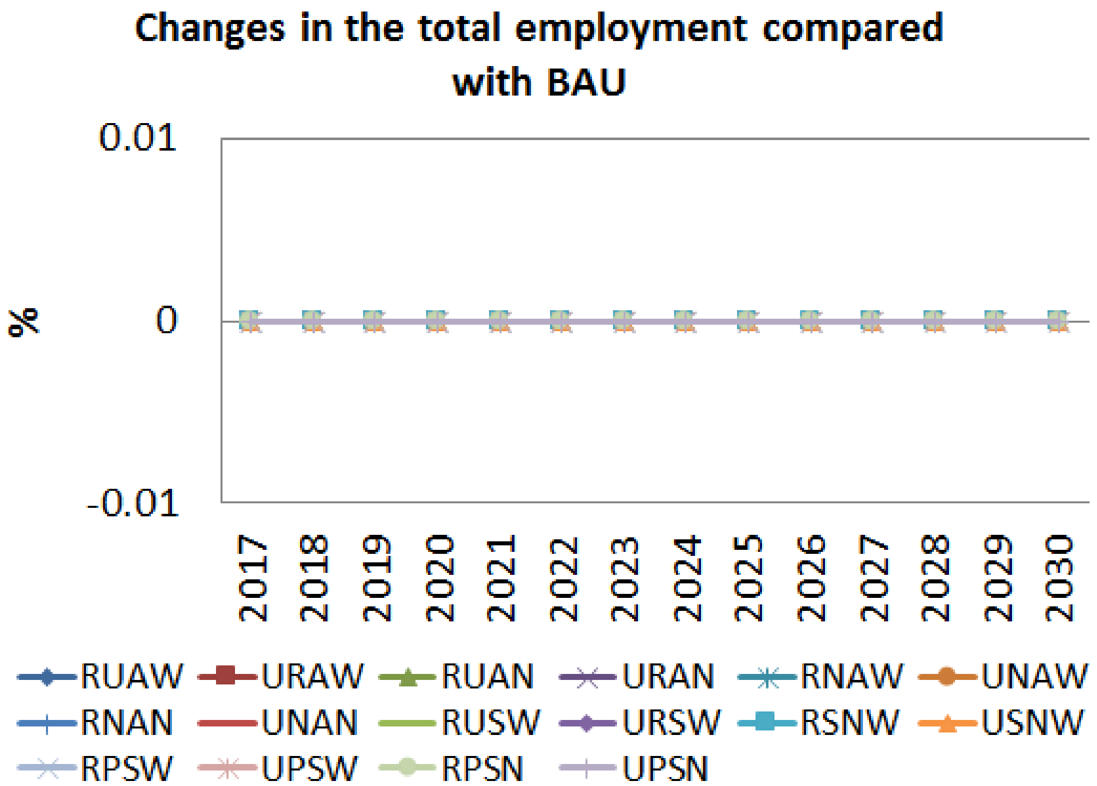








Simulation results: Total employment impacts



Total employment impacts and the impacts for each type of labor factors will be near zero, indicating labor will shift from some sectors (in particularly fossil fuel extraction and energy-intensive technologies) to other sectors (particularly renewable energy and energy-efficient technologies) with total employment impacts keeping near 0. Please note that the results are based on the assumption that there is no sectoral differences in using the same type of labor factors and full employment.

Limitations

- CGE modelling, using a top-down approach, has limitations to simulation many individual policies, such as the kerosene to LPG switch program and the fuel mix for power generation, etc. whereas bottom-up approaches can usually handle.
- CGE by performing well for the economic impact assessment in monetary term has limitations in dealing with physical accounting such as GHG emissions, the installed capacity and electricity generation (e.g. in TWh).
- CGE modelling shows the economy-wide and aggregate impacts from a complicated system model, for which the explanations on the results of detailed variables can be difficult which requires further analysis.

Conclusions

- To achieve the emissions targets by imposing a carbon tax on fossil fuels will have some negative impacts on the economy, including the impacts on the outputs and exports through the changes in domestic price.
- For export impacts, if carbon pricing in the rest of the world is included, the impacts on the outputs can be neutral or even positive depending on the levels of carbon pricing both domestically and overseas.
- In current model, the cost of inaction and the risk of climate change impacts are not taken into account, which can be larger than the cost of carbon pricing on the economy.

Conclusions

- In addition, due to the lump sum transfer of the carbon tax revenue to the households, welfare impacts on most of the households types will be positive.
- Energy saving can be expected from both industrial sectors and households.
- Fuel switch from fossil fuels to RE for electricity generation is very prominent, leading to more RE in the fuel mix of power generation and in the energy mix of primary energy supply.
- Employment in the sectors of coal, oil and gas extraction will be impacted adversely. However labor will shifted from one sector to another keeping the total employment and employment for each labor factor the same.

Thank you!

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