Carbon neutral developmet in Bhutan towards 2050

17 June, 2018

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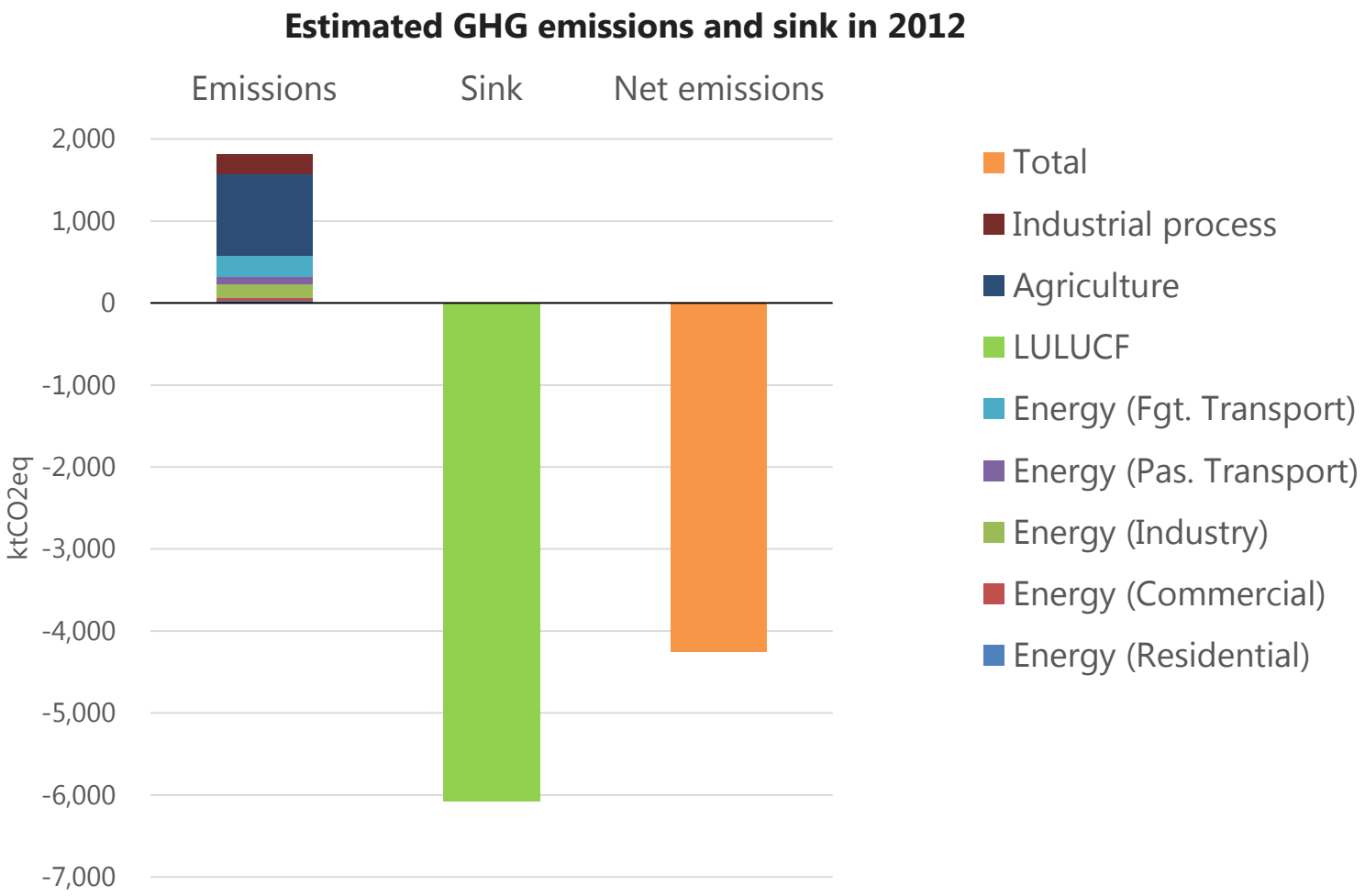
About Bhutan Carbon Neutral Scenario

- Bhutan is a carbon neutral country. The government of Bhutan declared that Bhutan remain **carbon neutral** in future in their NDC.



Framework of the Scenario simulation

Region	■ Bhutan • Thimphu • Rest of Bhutan (ROB)
Base year	■ 2012
Target year	■ 2050
Types of scenarios	■ BaU scenario ■ CM scenario
Target activities	■ Energy use • Commercial sector • RIndustry sector • esidential sector • Transport sector ■ Industrial processes ■ AFOLU • Agriculture • Landuse

Scenarios

BaU (Business as Usual) Scenario

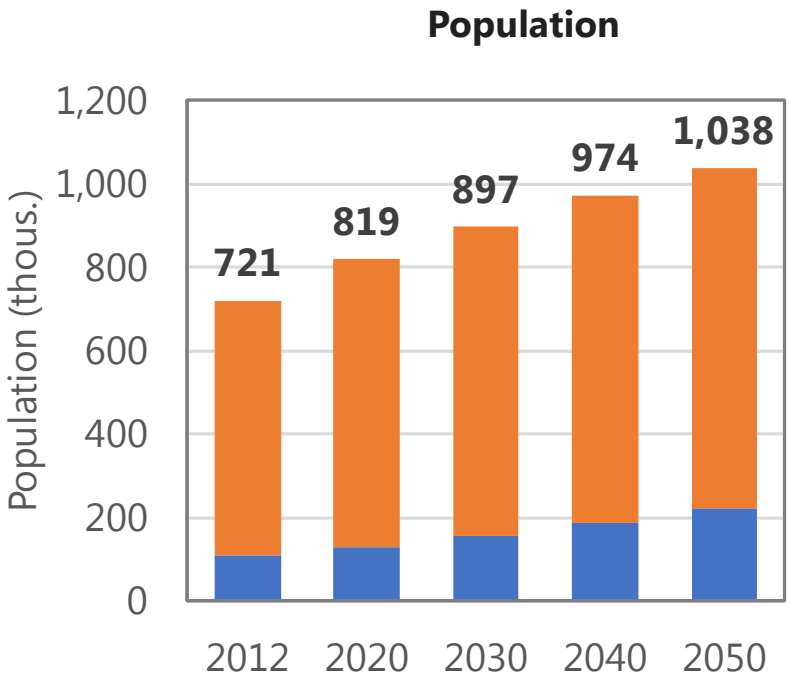
- Social and economic development based on future plan of the region
- Without implementation of LCS policy in future

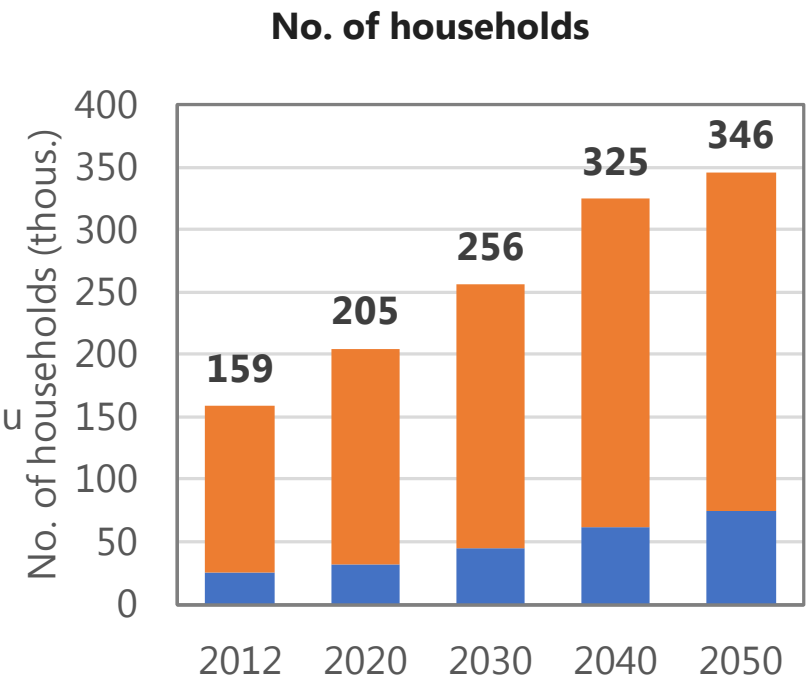
CM (Countermeasure) Scenario

- Same assumption as BaU scenario about social and economic development
- With implementation of LCS policy

Population and Households

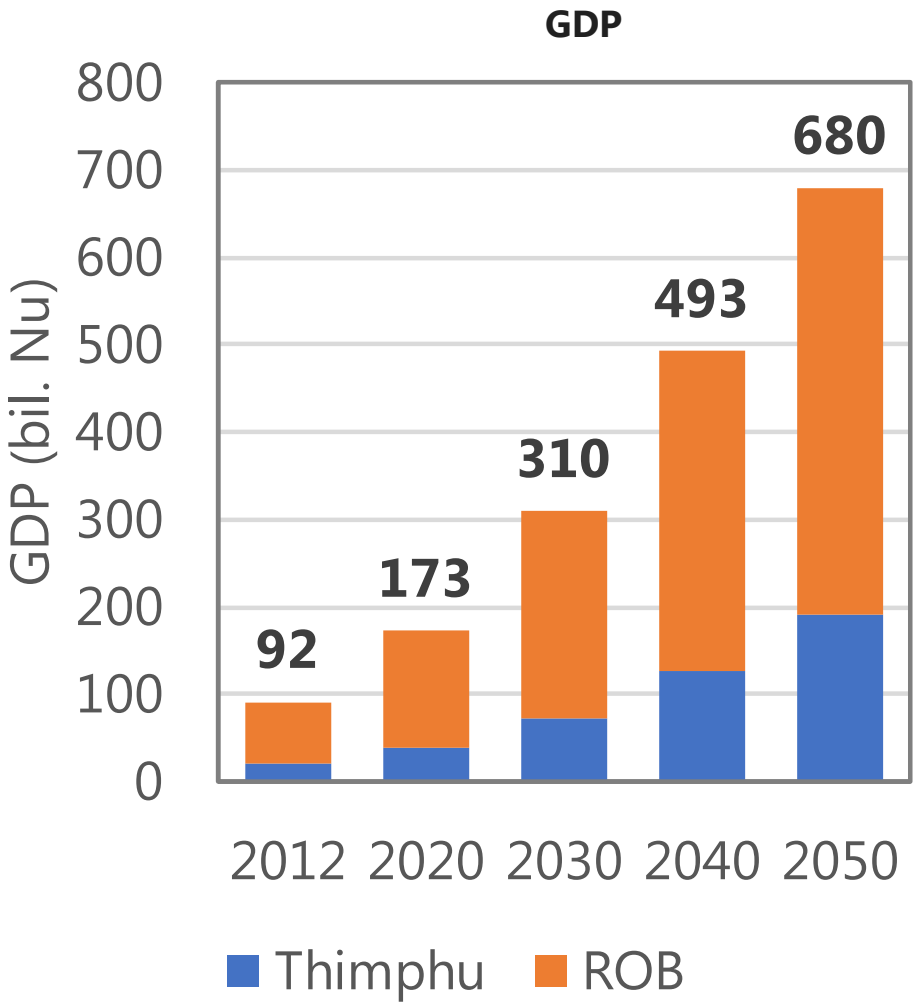
- Population of Bhutan will amount to 1 million in 2050.
- Population of Thimphu will become twice as large as that in 2014.





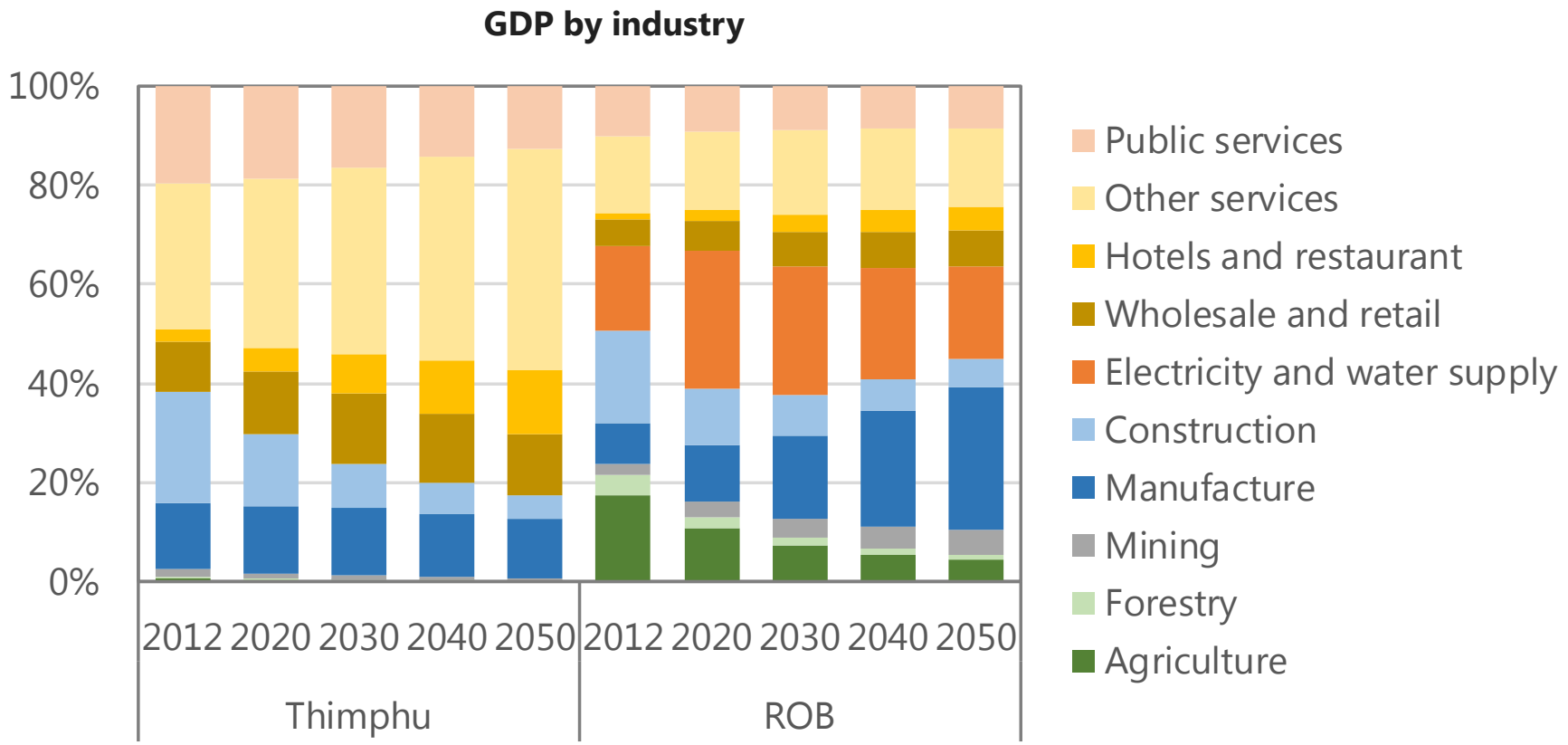
Economy (GDP growth)

- GDP will grow by 5.4%/year on average in Bhutan.



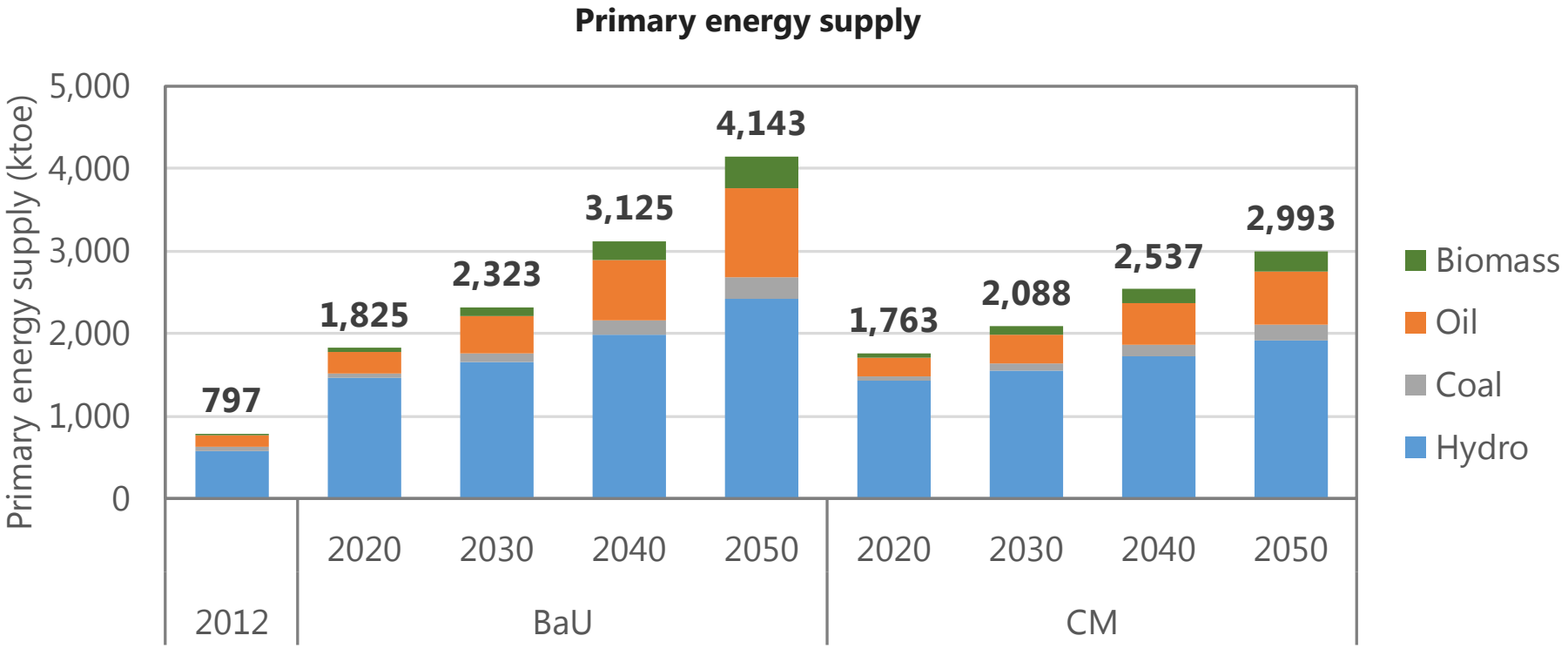
Economic structure

- Tertiary industry leads economic growth in Thimphu.



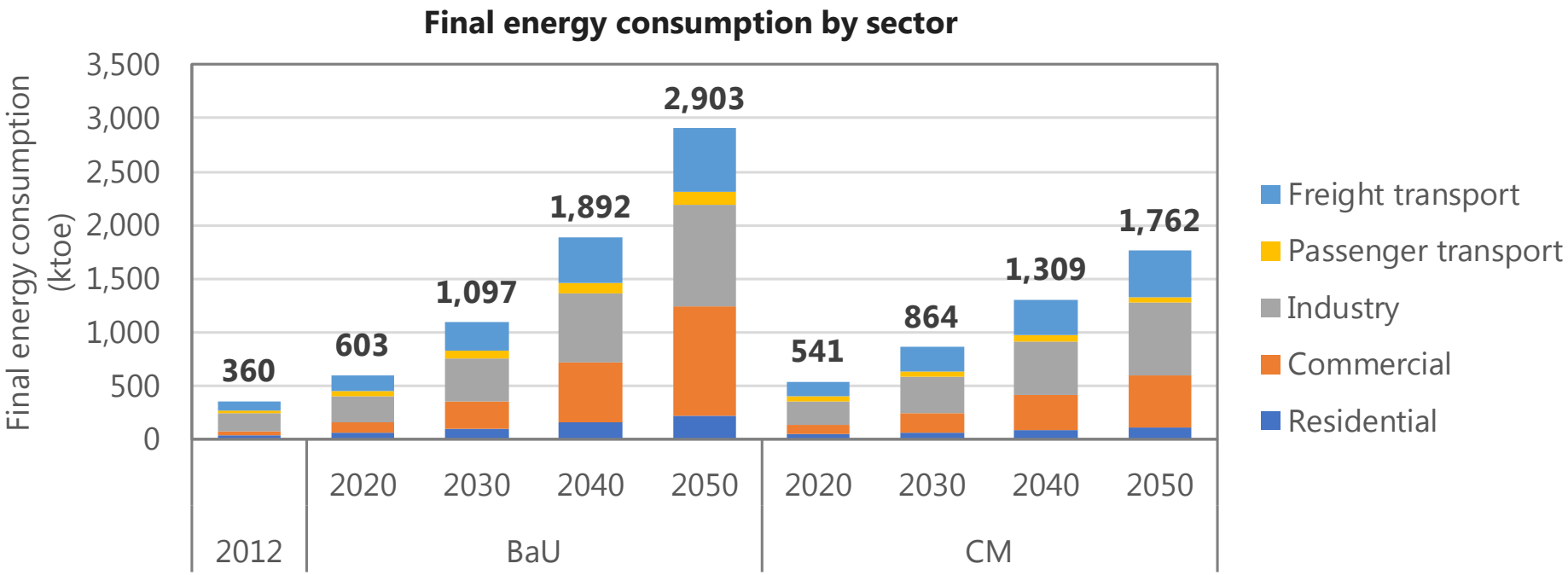
Primary energy supply

- Primary energy supply will increase more than 5 times from 2012 level in 2050 BaU.
- The largest energy source is Hydropower in both scenarios in all years.
- Oil consumption of oil will increase mainly because of transport demand increase.



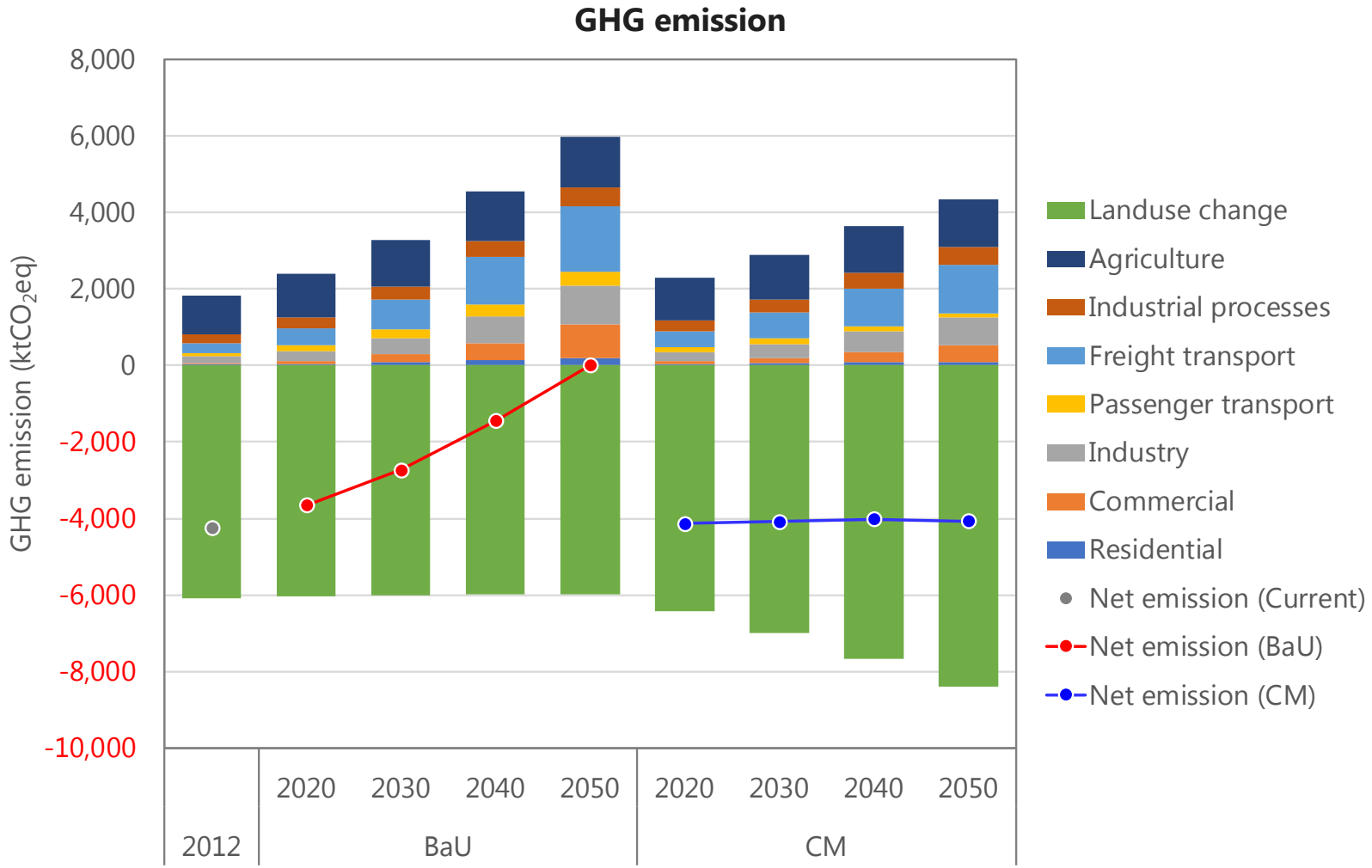
Energy demand by sector

- Final energy demand will increase more than 8 times from 2012 level in 2050 BaU.
- Energy consumption in commercial sector will grow remarkably.
- A lot of energy demand in passenger transport sector will be reduced in CM scenario owing to improvement of fuel economy, diffusion of EV and modal shift to buses.



GHG Emission

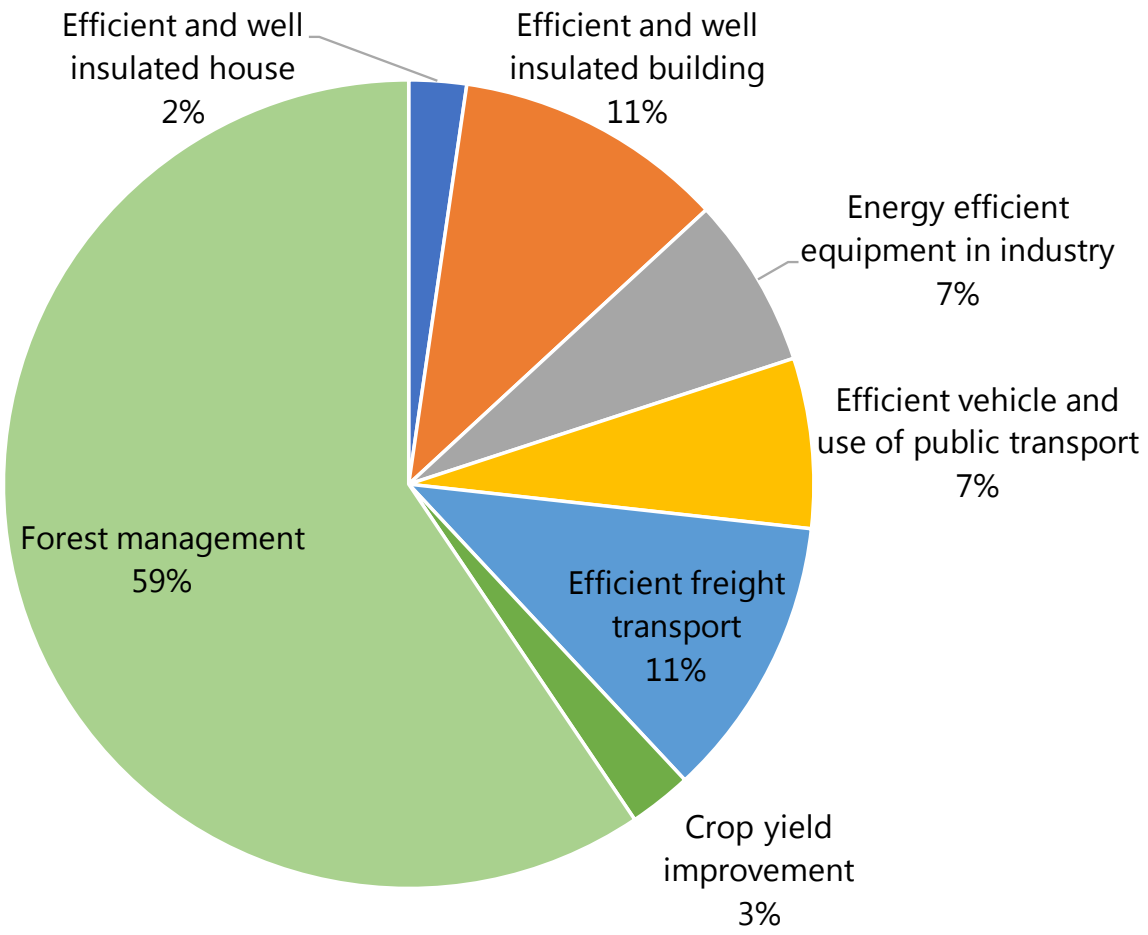
- In the BaU scenario, GHG emissions will exceed carbon sequestration, changing into positive in 2050.
- GHG emission will also increase in CM scenario, but net emission can keep negative up to 2050, due to implementation of low-carbon measures and increase in carbon sink.



GHG Reduction

- The most contributed measure is forest management. Its carbon reduction is more than half of total reduction.
- Commercial sector and transport sector also have large potential to reduce emission.

Emission reduction contribution by measures in 2050 CM against 2050 BaU in Bhutan



Quantification of future GNH

- We intend to quantify a variety aspects of GNH.
- We would like to collaborate with Bhutan in this research.

		Sectors and Variables in the model							
		Demography	**Economy**	**Transport**	**Energy**	**Agriculture**	**Land-use**	**Waste**	**GHG**
GNH Domains	**Psychological wellbeing**	Household structure **Household size 4.5 ⇒ 3.0**	Employment		Electrification - both on and offgrid	Food self-sufficiency	Land ownership and recreation facilities		
	Health	Age structure	Healthcare services	Walking facilities	Electrification - both on and offgrid	Organic farming	Urban plan whereby there is a provision for footpath and recreation area	Proper waste management	GHG emission **4.3MtCO$_2$eq**
	Time use	Family time	Work life balance	Smooth traffic movement		Farm mechanization			
	Education	Literacy in traditional knowledge and values		Awareness in the mass transit		Traditional knowledge and values		Awareness in waste management	
	Cultural diversity and resilience	Household structure **Household size 4.5 ⇒ 3.0**				Indigenous farming	Protection of cultural landscape		
	Community vitality	Social network and family support		Mass transit and car pooling			Provision of green spaces and community centers	Community based waste management	
	Good Governance	Lietracy rate	Employment	Well managed public transport		Government subsidy /incentives		1. Waste management 2. Segregation of wastes (3Rs)	
	Ecological diversity and resilience		Climate resilient development	Energy Efficiency Road Construction (EFRC) practices	Renewable and hydropower energy	Organic farming		Waste management	GHG emission **4.3MtCO$_2$eq**
	Living standard	Employment rate	1. GDP **680 tril.Nu** 2. Income distribution		Energy efficiency building	Commercial farming	Provision for affordable housing		GHG emission **4.3MtCO$_2$eq**

Conclusion

- In Bhutan, GHG emission will exceeds carbon sink in 2050 in BaU scenario.
- Hydropower will always be main energy source, however, oil demand will increase remarkably in 2050 in BaU.
- In the CM scenario, Bhutan can remain carbon neutral. More than half of the emission reduction is by forest management. b
- Considering GNH in the quantification is the next challenge.

appendix

Framework of the Scenario

Framework

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Data Preparation

- A variety of data and information of Bhutan were collected to estimate current status and future vision.
- We estimated regional data of Thimphu and ROB by downscaling of national statistics when regional data is not available.

	Source
Demography	■ National Statistics Bureau (2009): Population Projections of Bhutan 2005-2030 ■ National Statistics Bureau (website): Dzongkhag Population Projection 2011-2015 ■ Gross National Happiness Commission, Bhutan (2013): Eleventh Five Year Plan ■ National Statistics Bureau and Asian Development Bank (2012): Bhutan Living Standards Survey 2012 Report ■ World Bank (2016): World Development Indicators
Economy	■ National Statistics Bureau (2015): National Accounts Statistics 2015 ■ National Statistics Bureau (2013): Statistical Yearbook of Bhutan 2013 ■ Gross National Happiness Commission, Bhutan (2013): Eleventh Five Year Plan
Transport	■ Ministry of Information and Communications: Current Status of National Transport Polices, Systems and Projects in Bhutan ■ National Statistics Bureau (2015): Statistical Yearbook of Bhutan 2015
Energy	■ National Statistics Bureau (2015): National Accounts Statistics 2015 ■ Department of Renewable Energy and United Nations Development Programme (2012): Bhutan Energy Efficiency Baseline Study Final Report ■ Ea Energy Analyses and COWI (2012): Bhutan: A national strategy and action plan for low carbon development Final report ■ S. Jamtsho (2015): Energy Efficiency & Conservation Initiatives in Bhutan ■ Bhutan Statistical Services & Environmental Consultancy: Assessment of Fuel Consumption and Baseline Health Impact Study in Bhutan
Agriculture	■ Ministry of Agriculture & Forests (2015): Bhutan RNR Statistics 2015
Landuse	■ Ministry of Agriculture & Forests (2015): Bhutan RNR Statistics 2015

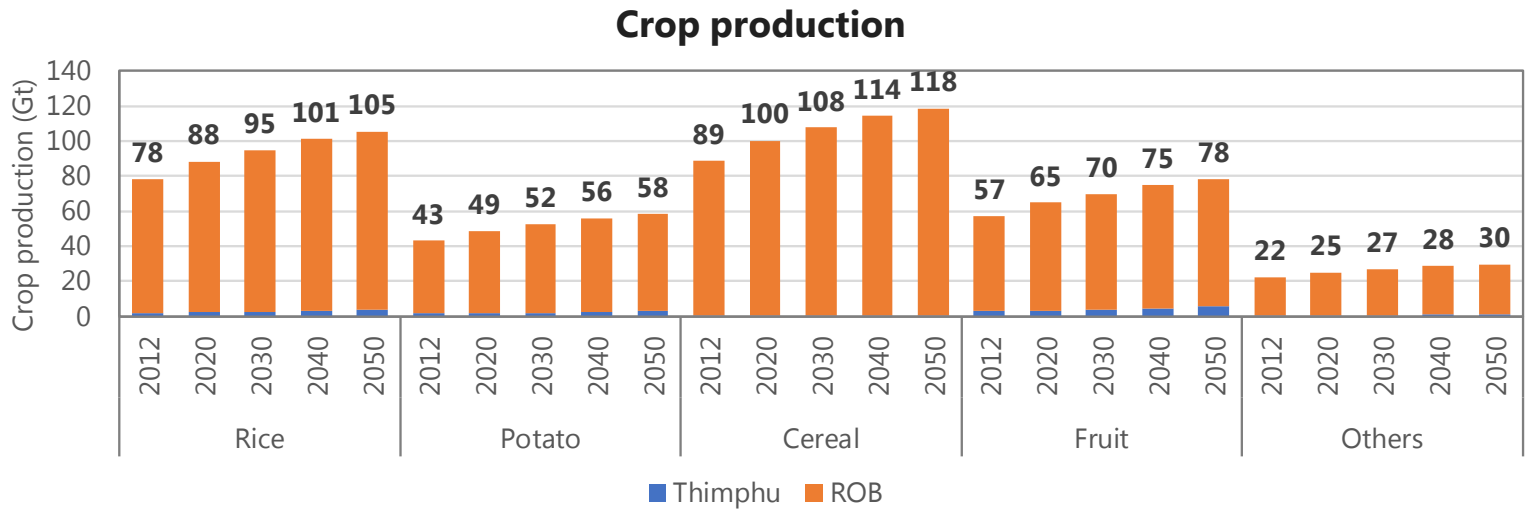
Collected Data

	Base year		Future	
	Bhutan	Thimphu	Bhutan	Thimphu
Demography	■ Population ■ No. of households	■ Population ■	■ Population ■	X
Economy	■ GDP ■ No. of firms	■ No. of firms	■ GDP growth rate	X
Transport	■ No. of vehicles ■ Modal share by vehicle type ■ No. of Drivers Licenses Issued	X	X	X
Agriculture	■ Crop production ■ Cultivated area	■ Crop production ■ Cultivated area	X	X
Landuse	■ Land area	■ Land area	X	X
Energy	■ Energy consumption ■ Power generation	■ Electricity consumption	X	X

X: cannot find yet

Agriculture

- Crop production in Bhutan in 2050 will become twice as much as that in 2012.
- Most of crops are produced in ROB now and in future.
- Rice and fruit are main crops made in Thimphu.

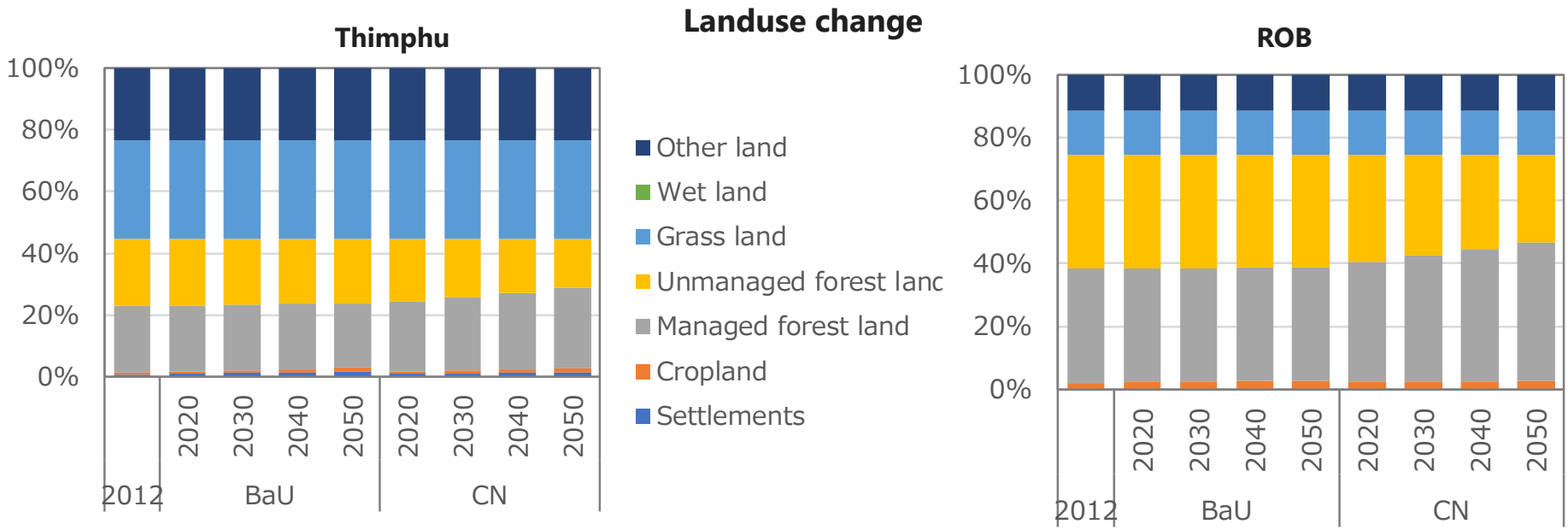


Reference and Assumption

2012	2050
Source	**Assumption**
■ Ministry of Agriculture & Forests (2015): **Bhutan RNR Statistics 2015**	**BaU and CM** ■ Crop production and cultivated area will increse in proportion to population **CM** ■ Yield will be improved.

Landuse

- Landuse is different between Thimphu and ROB. Share of forest in Thimphu is much less than that in ROB.
- Settlements and cropland will expand with population growth. However, Increase of these area is controlled in CM scenario by urbanization and improvement of crop yield.



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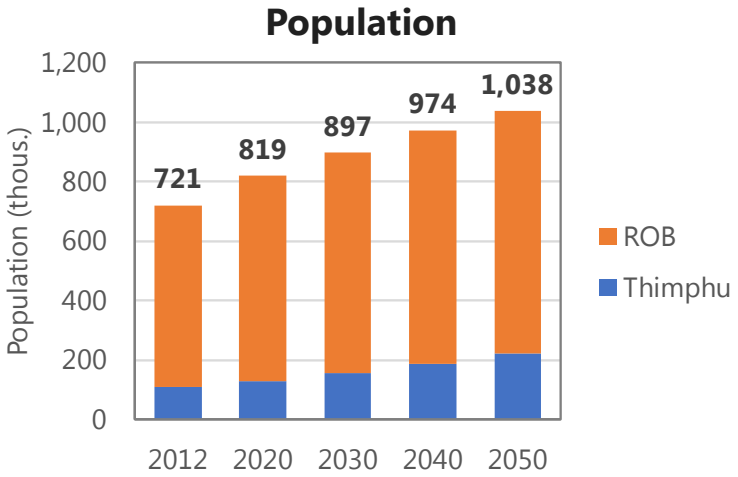

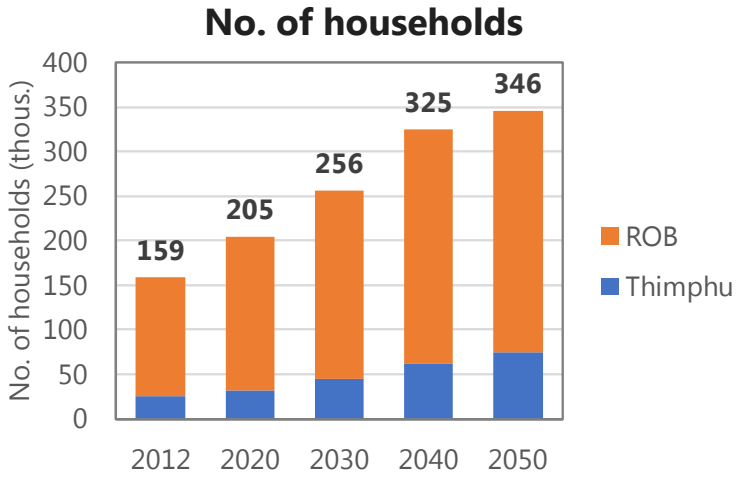

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2012	2050	
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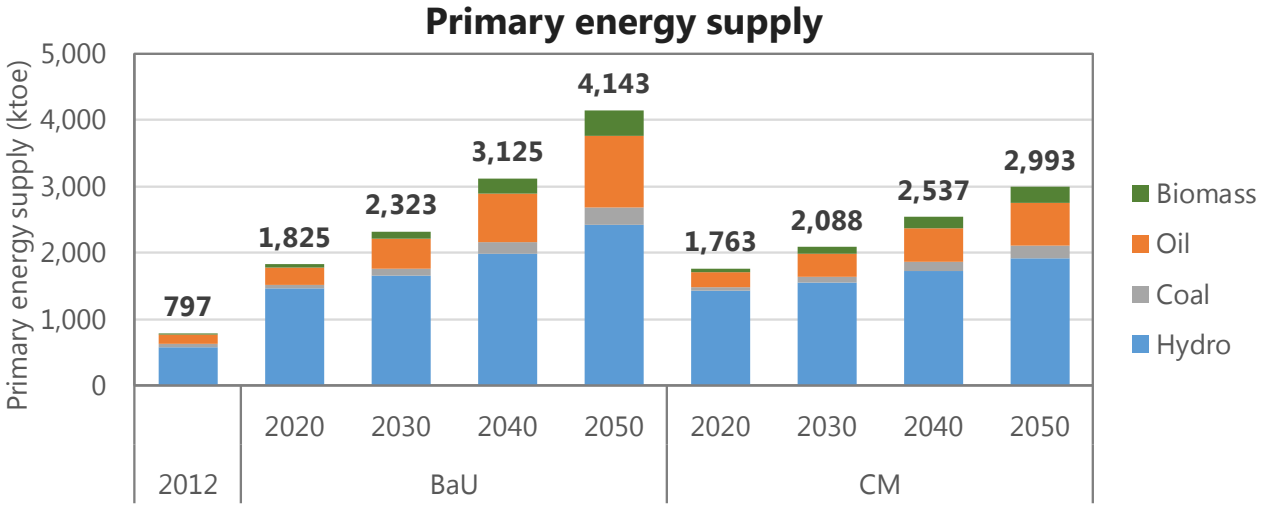
Energy

- Primary energy demand will increase more than 5 times from 2012 level in 2050 BaU.
- The largest energy source is Hydropower in both scenarios in all years.
- Oil consumption of oil will increase mainly because of transport demand increase.



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Energy demand

- Final energy demand will increase more than 8 times from 2012 level in 2050 BaU.
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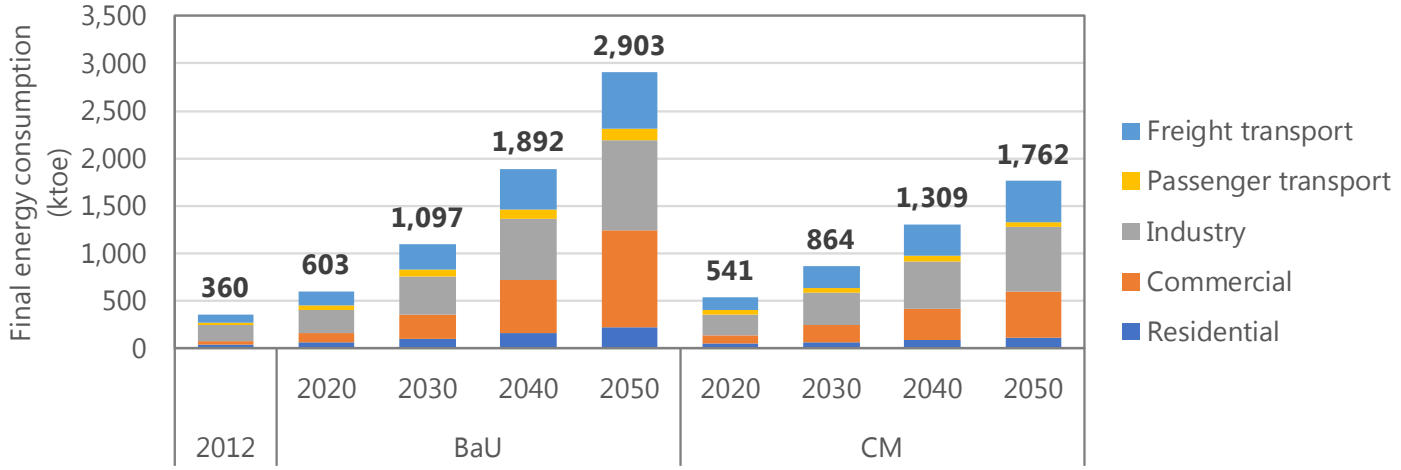
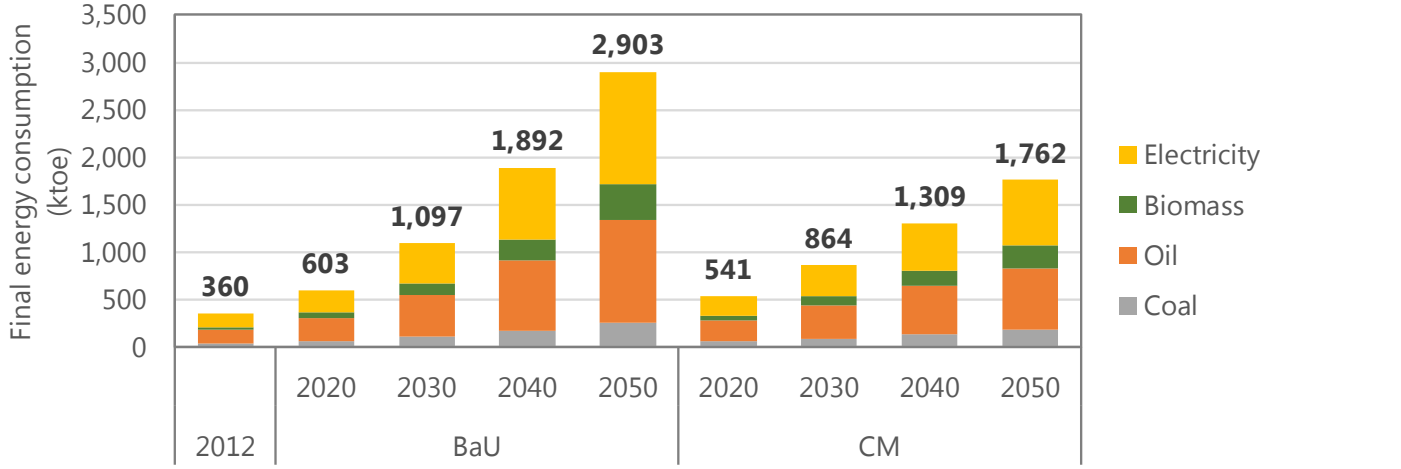
Final energy consumption

By sector



By fuel



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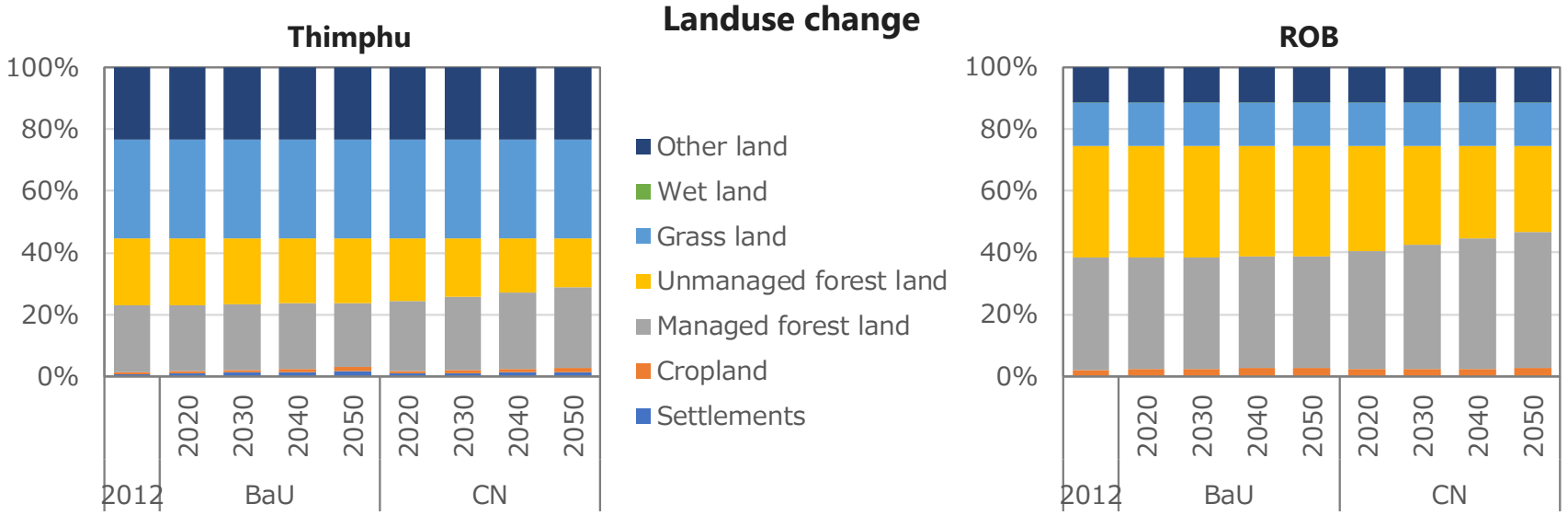
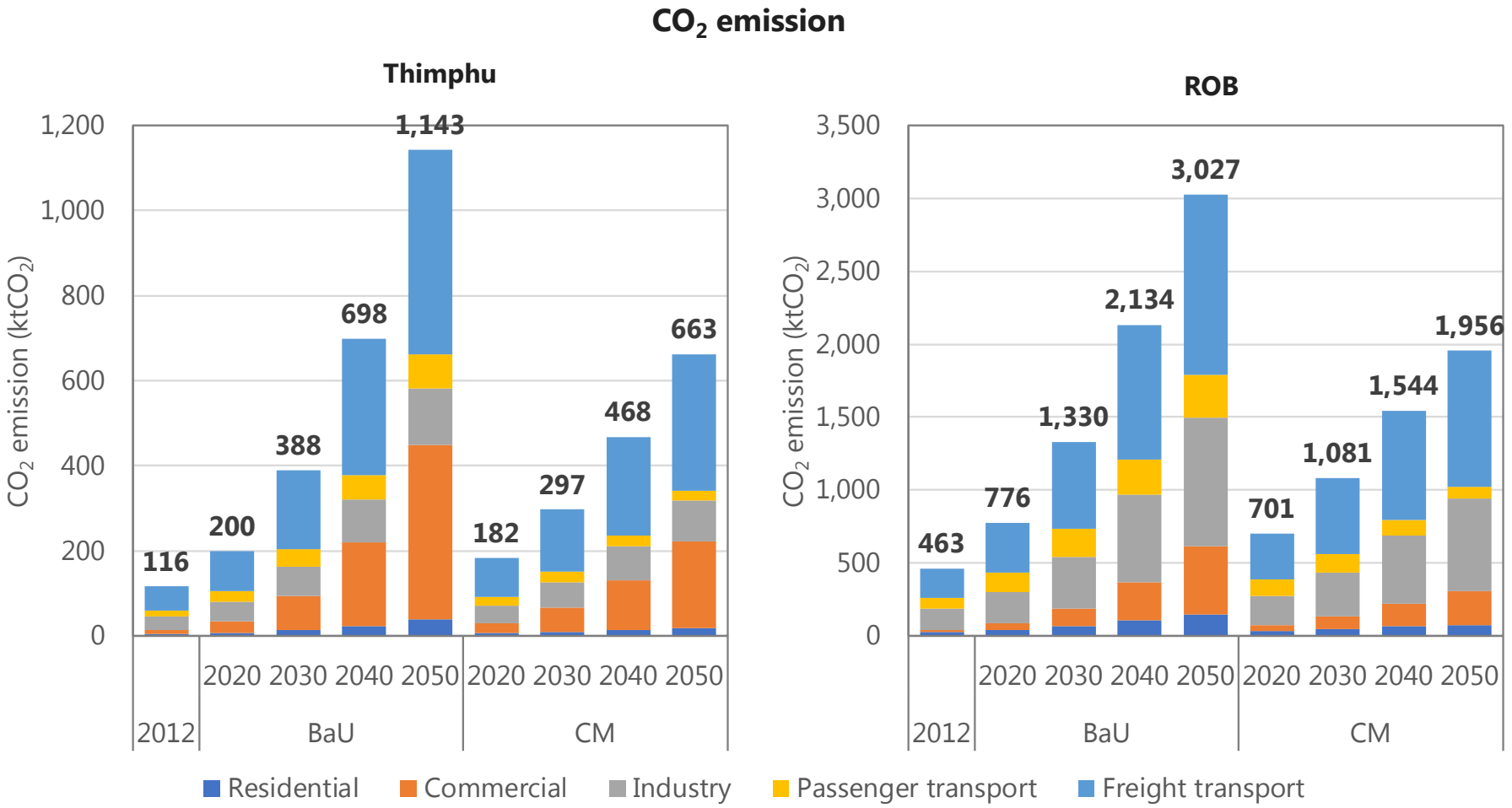


Reference and Assumption

2012		2050
Source	**Assumption**	**Assumption**
■ Ministry of Agriculture & Forests (2015): **Bhutan RNR Statistics 2015**	■ Half of forest land is managed.	**BaU and CM** ■ Area of settlement will increse in proportion to population. **CM** ■ Population density becomes higher. ■ Managed forest land will increase.

CO_2 Emission from Energy Use

- Commercial sector and Freight transport sector will be main emitters in Thimphu.
- Industry sector and Freight transport sector will be main emitters in ROB.
- CO_2 emission in 2050 CM can be reduced by 42% in Thimphu and 35% in ROB compared with BaU.



Relation matrix between GNH and ExSS

- We developed a relation matrix between GNH domains and variables in ExSS in the Training Programmme on Climate Change for Bhutanese Policymakers on Feb. in Japan.

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	Education	Literacy in traditional knowledge and values		Awareness in the mass transit		Traditional knowledge and values		Awareness in waste management	
	Cultural diversity and resilience	Household structure				Indigenous farming	Protection of cultural landscape		
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	Ecological diversity and resilience		Climate resilient development	Energy Efficiency Road Construction (EFRC) practices	Renewable and hydropower energy	Organic farming		Waste management	GHG emission
	Living standard	Employment rate	1. GDP 2. Income distribution		Energy efficiency building	Commercial farming	Provision for affordable housing		GHG emission

Connect ExSS with GNH

- ExSS describes future change of not only GHG emissions but also social and economic aspects.
- Some variables of ExSS are related with GNH domains.
- ExSS can be utilized for estimating indicators about GNH.