

CO₂ emission projection for South Korea

- AIM/Enduse model -

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01 Introduction

01 Introduction

Background

- Adverse impacts of climate change will be increased
- The studies to identify the relationship between GHG and impacts have been conducted
- There are limited study on these topics
- In order to mediate negative impact of climate change in Korea peninsula, identifying GHG substances in East Asia is necessary
- Korea-China-Japan collaborative study on relevant topic is in progress, and this is the result from Korea

Objective

- Estimating the amount of GHG and air pollutant emissions through developing the scenarios about forecasting socio-economic change in Korea

02 Scope and Methodology

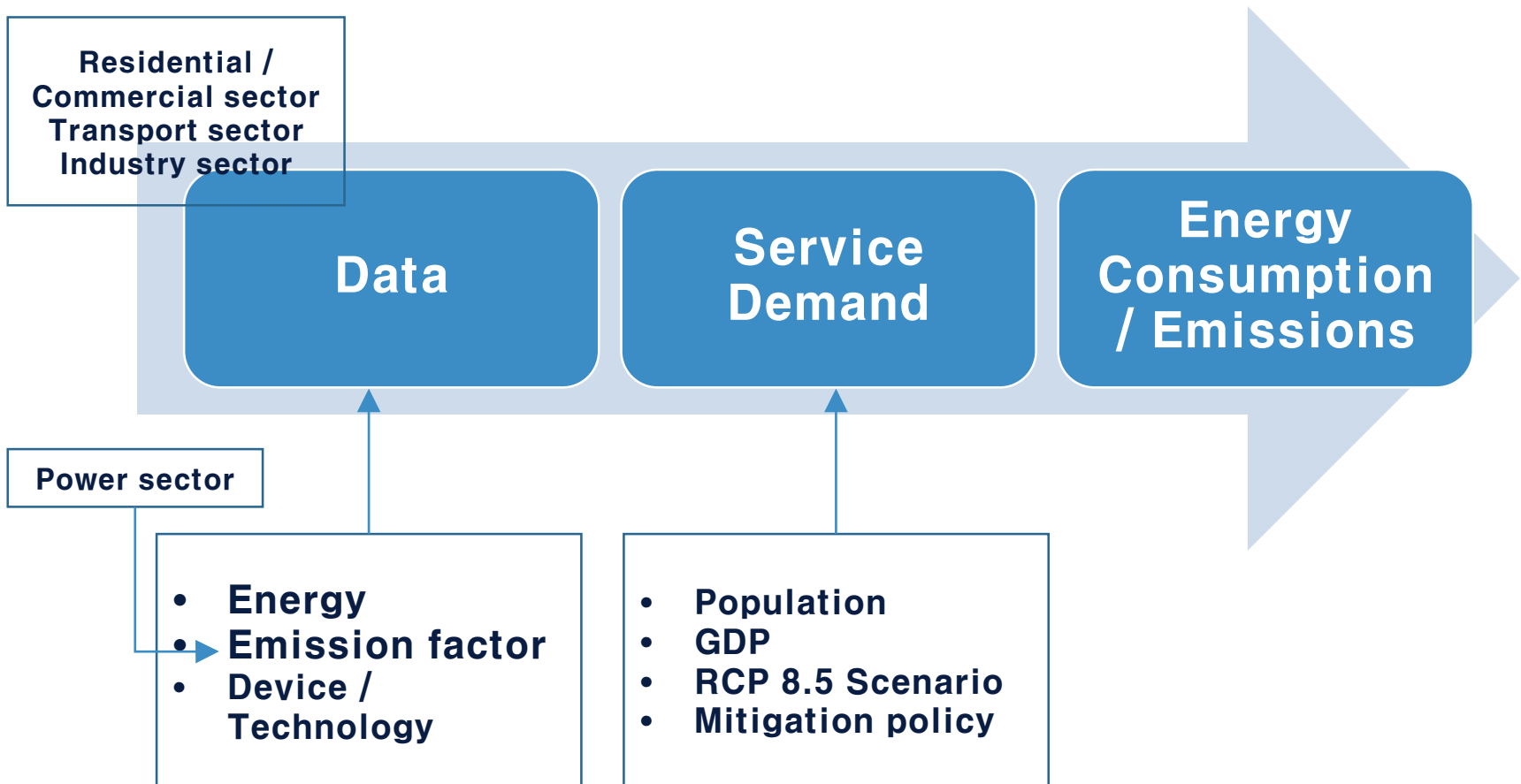
02 Scope and Methodology

Scope

- **Time**
 - **2010 – 2100**
 - Base Year : 2010
 - Target Year : 2030, 2050, 2100
- **Sectors**
 - Residential sector
 - Commercial sector
 - Transport sector
 - Industry sector (Steel, Cement, Other industries)
- **Data**
 - Population, GDP : OECD, IIASA
 - Mitigation policy : National policy, National research institutes

02 Scope and Methodology

Methodology



02 Scope and Methodology

Methodology

1) Residential and Commercial sector

- Service demand calculated as follow equation

$$\text{Energy service per capita} = \text{service area} \times \text{service time} \times \text{service intensity}$$

- Specific factors

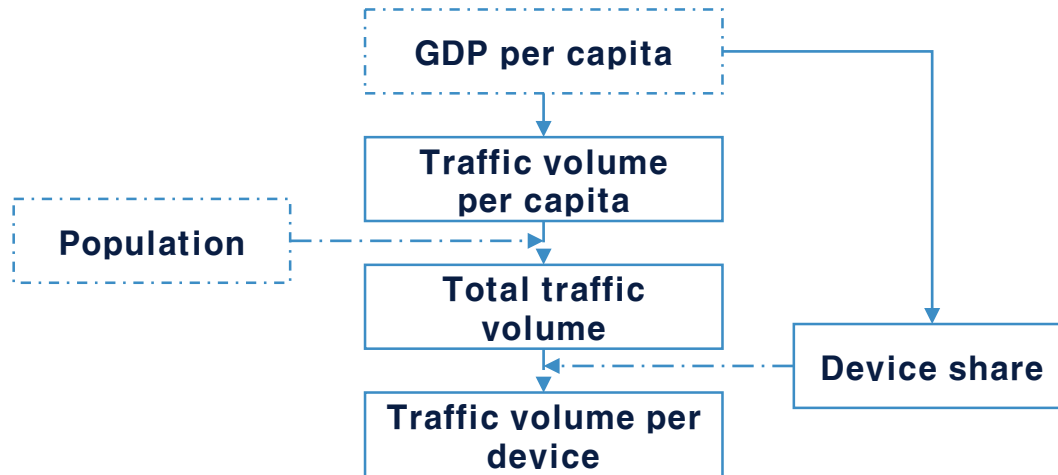
Services	Area	Time	Intensity
Heating	area per person	Staying time / Business hour	Heating days
Cooling	area per person	Staying time / Business hour	Cooling days
Hot water	-	Times of dish-washing and shower	-
Cooking	-	Ratio of eating at home	-
Lighting	area per person	Staying time / Business hour	
Others	-	-	GDP per capita

02 Scope and Methodology

Methodology

2) Transport sector

- Service demand of transport sector are based on population and GDP



- Service demand of freight are calculated with logistic curve

$$PKTOTP_{i,t} = \frac{pka_i}{1 + \exp\left\{-pkc \cdot \left(\overline{GDPP}_{i,t} - pkb_i\right)\right\}}$$

02 Scope and Methodology

Methodology

3) Industry sector

- demand per capita are used to project the service demand in steel industry and cement industry
- 1.4 ton/person in steel industry, 1.1 ton/person in cement industry after 2050

Service demand

= service demand per capita x population

- In case of other industries, we used the rate of GDP change in Japan
- From 2010–2030 in Japan to 2030–2050 in Korea, from 2030–2050 in Japan to 2050–2100 in Korea

03 Results and Discussion

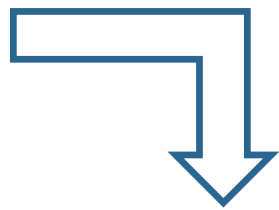


03 Results and Discussion

1) Mitigation Policies

- BAU scenario contained the national policy of mitigation

Index	Variant	Major area, region, country or area	Notes	Country code	Average annual rate of population change (percentage)															
					1950-1955	1955-1960	1960-1965	1965-1970	1970-1975	1975-1980	1980-1985	1985-1990	1990-1995	1995-2000	2000-2005	2005-2010				
1	Estimates	World		800	1.785	1.828	1.909	2.085	1.959	1.778	1.782	1.797	1.523	1.301	1.223	1.198				
2	Estimates	More developed regions	a	901	1.204	1.162	1.080	0.860	0.776	0.656	0.600	0.569	0.434	0.336	0.302	0.420				
3	Estimates	Less developed regions	b	902	2.055	2.124	2.258	2.537	2.386	2.150	2.148	1.813	1.541	1.420	1.372					
4	Estimates	Least developed countries	c	941	2.003	2.213	2.399	2.555	2.330	2.473	2.547	2.640	2.770	2.511	2.413	2.284				
5	Estimates	Less developed regions, excluding least developed countries	d	904	2.063	2.110	2.240	2.535	2.393	2.168	2.094	2.081	1.676	1.396	1.268	1.218				
6	Estimates	Less developed regions, excluding China	e	948	2.070	2.357	2.453	2.465	2.429	2.433	2.405	2.275	2.054	1.858	1.722	1.623				
7	Estimates	Sub-Saharan Africa	f	947	1.992	2.186	2.383	2.525	2.660	2.777	2.810	2.795	2.690	2.614	2.609	2.658				
8	Estimates	AFRICA		903	2.096	2.223	2.458	2.551	2.603	2.750	2.781	2.721	2.514	2.411	2.404	2.405				
9	Estimates	Eastern Africa		910	2.201	2.406	2.620	2.778	2.862	2.840	2.919	2.975	2.535	2.874	2.736	2.782				
10	Estimates	Burundi		108	1.843	1.919	1.995	2.316	1.233	2.307	2.916	3.212	2.047	1.442	3.045	3.449				
11	Estimates	Comoros		174	2.142	1.808	1.768	2.176	2.345	3.682	3.930	2.607	2.420	2.515	2.559	2.599				
12	Estimates	Djibouti		262	2.311	3.678	6.363	6.570	6.793	9.426	3.325	5.695	2.365	1.699	1.433	1.427				
13	Estimates	Eritrea		232	1.935	2.219	2.409	2.515	2.791	3.269	3.388	2.893	0.810	2.899	4.176	3.257				
14	Estimates	Ethiopia		231	1.913	2.096	2.451	2.500	2.729	3.577	3.918	3.279	3.427	2.931	2.858	2.681				
15	Estimates	Kenya		404	2.771	2.990	3.185	3.376	3.622	3.750	3.788	3.523	3.130	2.639	2.688	2.676				
16	Estimates	Madagascar		450	2.135	2.308	2.468	2.619	2.830	2.874	2.641	2.913	3.057	3.147	2.997	2.839				
17	Estimates	Malawi		454	1.892	2.148	2.397	2.618	3.139	3.257	3.051	2.524	1.065	2.554	2.640	2.996				
18	Estimates	Mauritius	1	480	2.915	2.910	2.643	1.854	1.531	1.590	1.004	0.774	1.334	0.976	0.481	0.293				
19	Estimates	Mozambique		175	4.524	4.705	4.794	3.029	4.148	3.849	5.045	5.209	5.548	3.985	3.221	3.102				
20	Estimates	Mozambique		508	1.581	1.849	2.053	2.188	2.328	2.678	1.880	0.341	3.275	2.683	2.789	2.633				
21	Estimates	Rwanda		638	3.234	2.812	3.039	3.350	3.981	3.985	1.953	1.776	1.963	1.776	1.438	1.311				
22	Estimates	Rwanda		645	2.695	2.894	1.944	2.992	2.986	3.299	3.453	3.316	4.840	3.872	2.323	2.392				
23	Estimates	Seychelles		690	1.349	1.257	2.358	2.275	2.549	2.058	0.981	0.142	1.646	1.119	1.756	0.923				
24	Estimates	Somalia		796	1.915	2.020	2.152	2.310	2.381	3.010	-0.070	0.819	0.078	3.032	2.733	2.587				
25	Estimates	South Sudan		728	1.040	1.651	1.987	2.021	2.428	2.653	2.940	1.134	-1.178	1.047	3.786	4.246				
26	Estimates	Uganda		800	2.683	2.809	3.321	3.287	2.729	2.953	3.110	3.579	3.358	3.147	3.366	3.364				
27	Estimates	United Republic of Tanzania	2	834	2.667	2.840	2.962	3.046	3.216	3.132	3.120	3.078	3.225	2.552	2.642	2.840				
28	Estimates	Zambia		894	2.484	2.144	2.096	3.148	3.384	3.277	3.132	2.745	2.892	2.664	2.424	2.835				
29	Estimates	Zimbabwe		918	2.484	2.144	2.096	3.148	3.384	3.277	3.132	2.745	2.892	2.664	2.424	2.835				
30	Estimates	Zimbabwe		918	2.484	2.144	2.096	3.148	3.384	3.277	3.132	2.745	2.892	2.664	2.424	2.835				



<For example>

- Distribution rate of high efficiency electronic device in residential sector from 2010 to 2050
- Distribution rate of electric cars in transport sector from 2010 to 2020
- National development plan in power sector to 2020
- Energy plan in industrial sector

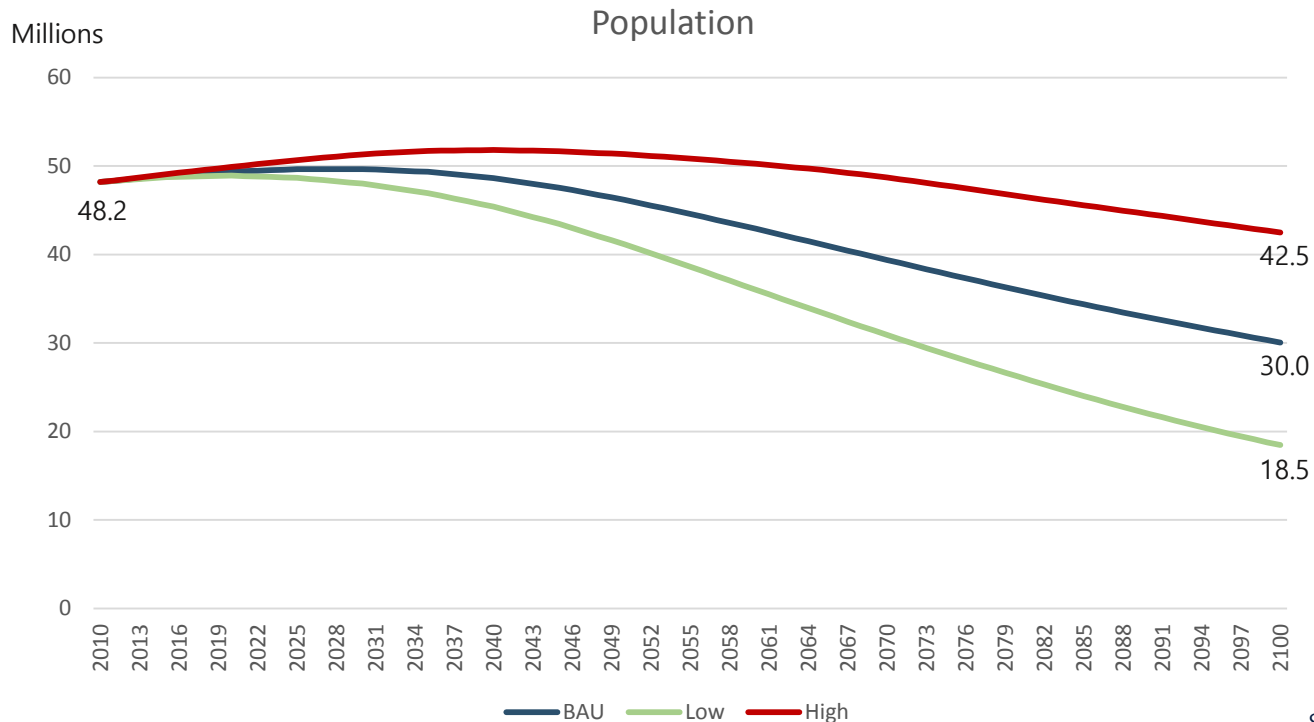
<Template for policy research>

주요부문	정책	년도별 정량적 목표	정성적 목표	BAU or CM	공표/공개연기	출처	자료
상호연결기	강화 건축법 제59조 '건축물의 에너지 이용과 패시브 활용'	20%	BAU			에너지경제연구원(2012)	12-33국가 에너지
냉장고	12.2%, 에어컨 5.4%, 일반세탁기 21.9%	04년	CM			에너지경제연구원(2012)	12-33국가 에너지
에너지경제연구원(2008)						에너지경제연구원(2008)	08-10국가 에너지
에너지경제연구원(2009)						에너지경제연구원(2009)	09-17저탄소 경
냉방부품							
2010		100%					
2020		100%					
2030		100%					
2040		100%					
2050		100%					
가전기기	국립연구개발 도입						
2010		20%					
2020		100%					
2030		100%					
2040		100%					
2050		100%					
연료전지발전 도입							
2015		0.9MW					
2020		13.8MW					
2030		33.93MW					
2040		8013.3MW					
2050		100%					

03 Results and Discussion

2) Population projection

- Population will be declined after 2030 in the most of scenarios
- Population in 2100 will be 62% in BAU, 38% in low emission scenario, 88% in high emission scenario

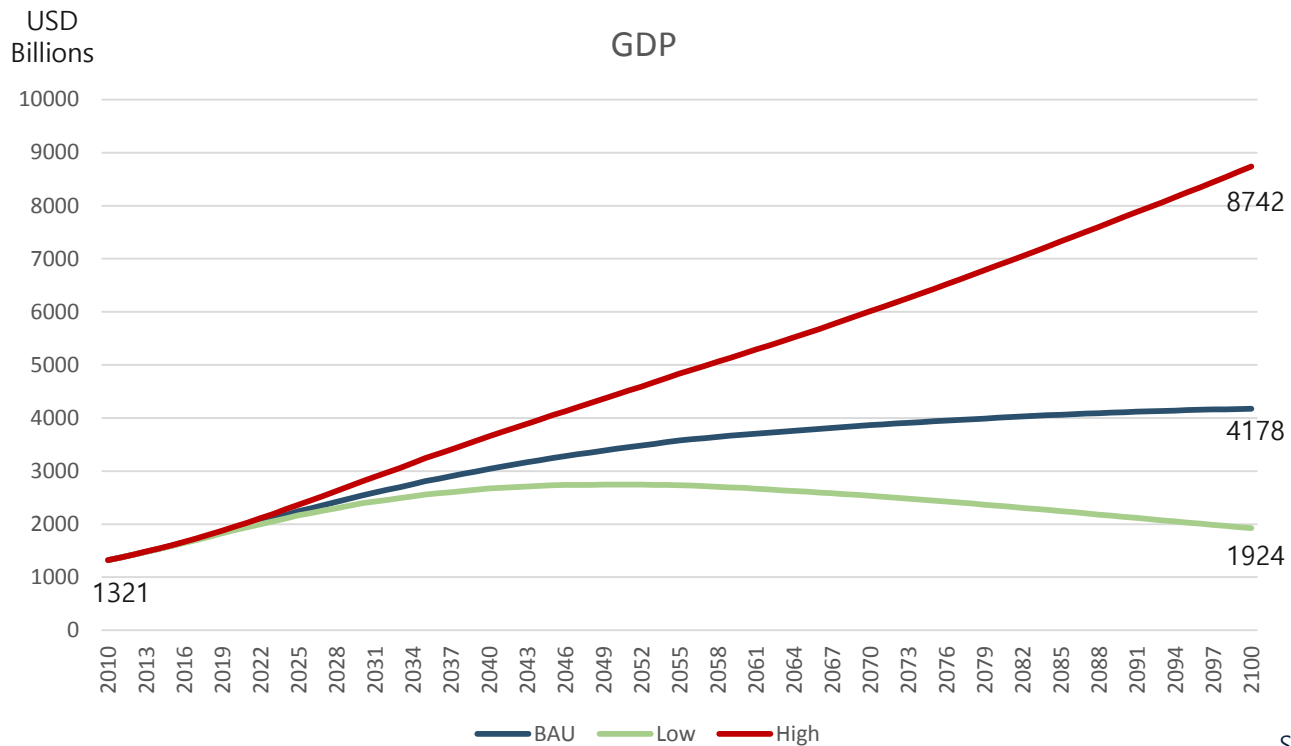


Source : IIASA

03 Results and Discussion

2) GDP projection

- GDP in 2100 will be 316% in BAU, 146% in low emission scenario, 662% in high emission scenario

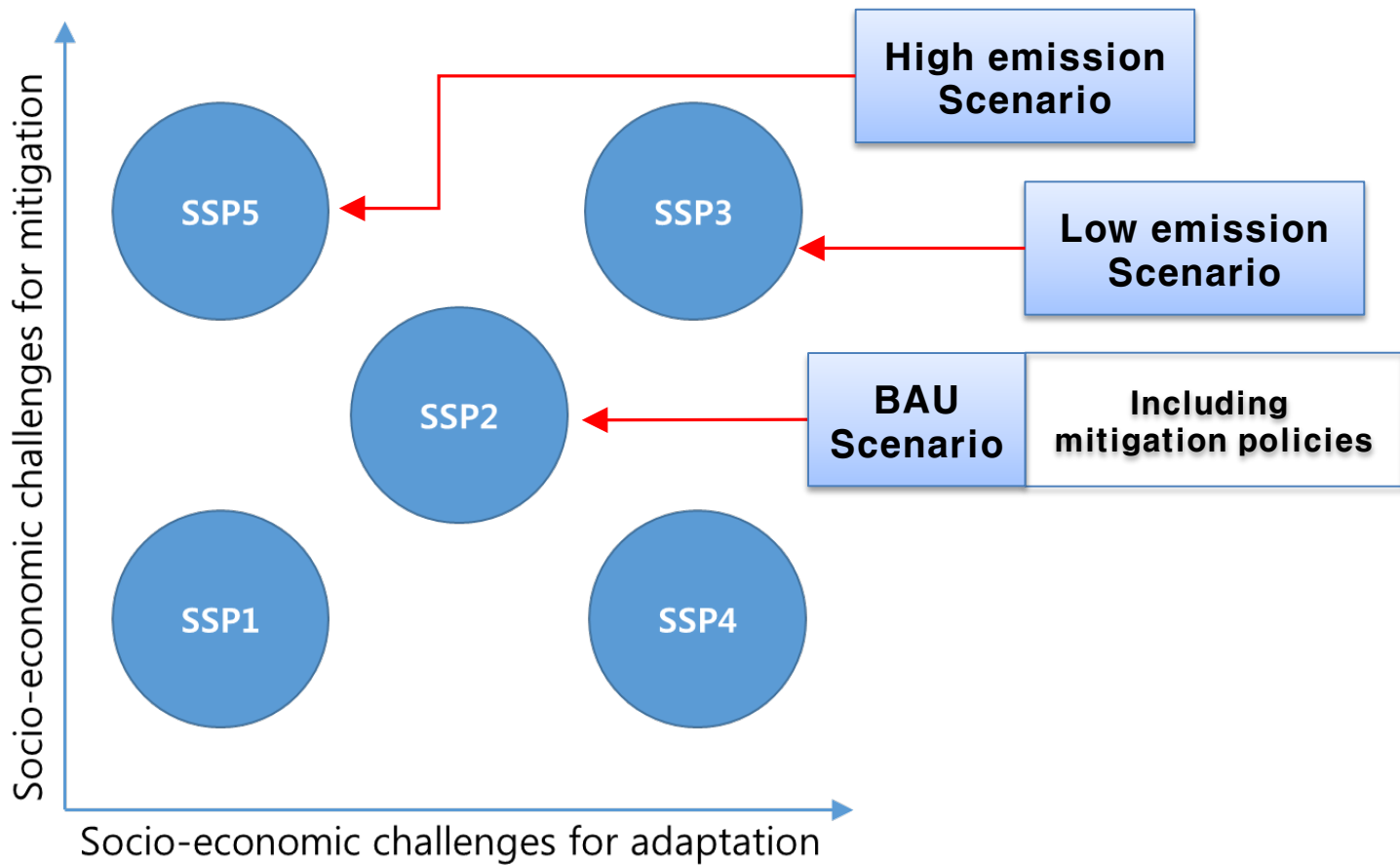


Source : IIASA

03 Results and Discussion

3) Social economic condition

- Socio-economic scenarios will be matched SSP2, 3, 5



03 Results and Discussion

4) Service demand

- Residential sector

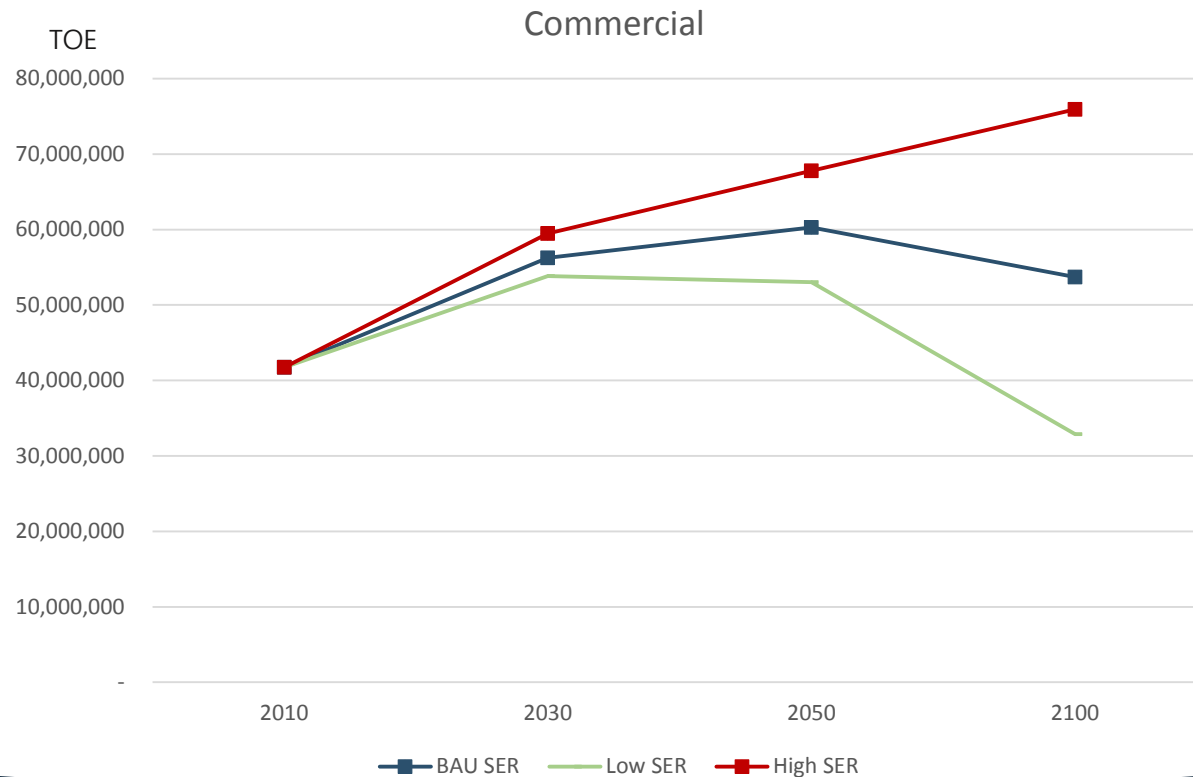
- Service demand are based on population growth
- Service demand will be decreased after 2030 in BAU scenario
- Differences of service demand are caused from population in 2100



03 Results and Discussion

4) Service demand

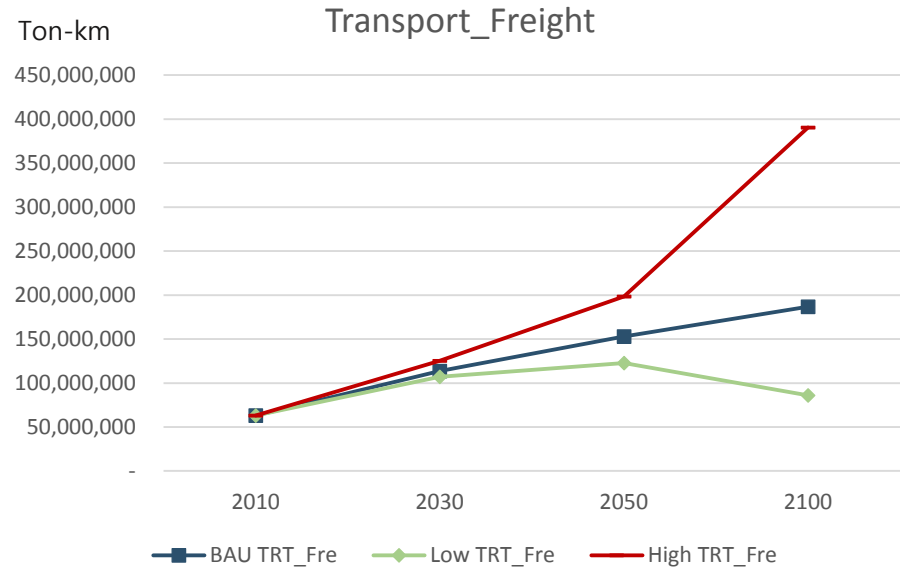
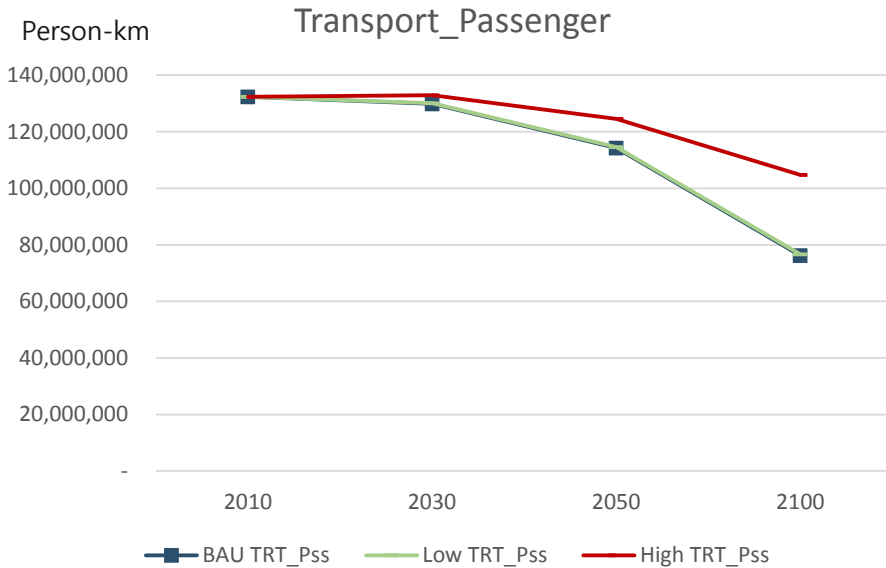
- **Commercial sector**
 - **Service demand is based on GDP and climate, and will be increased in BAU scenario**
 - **Differences of service demand is caused by GDP in 2100**



03 Results and Discussion

4) Service demand

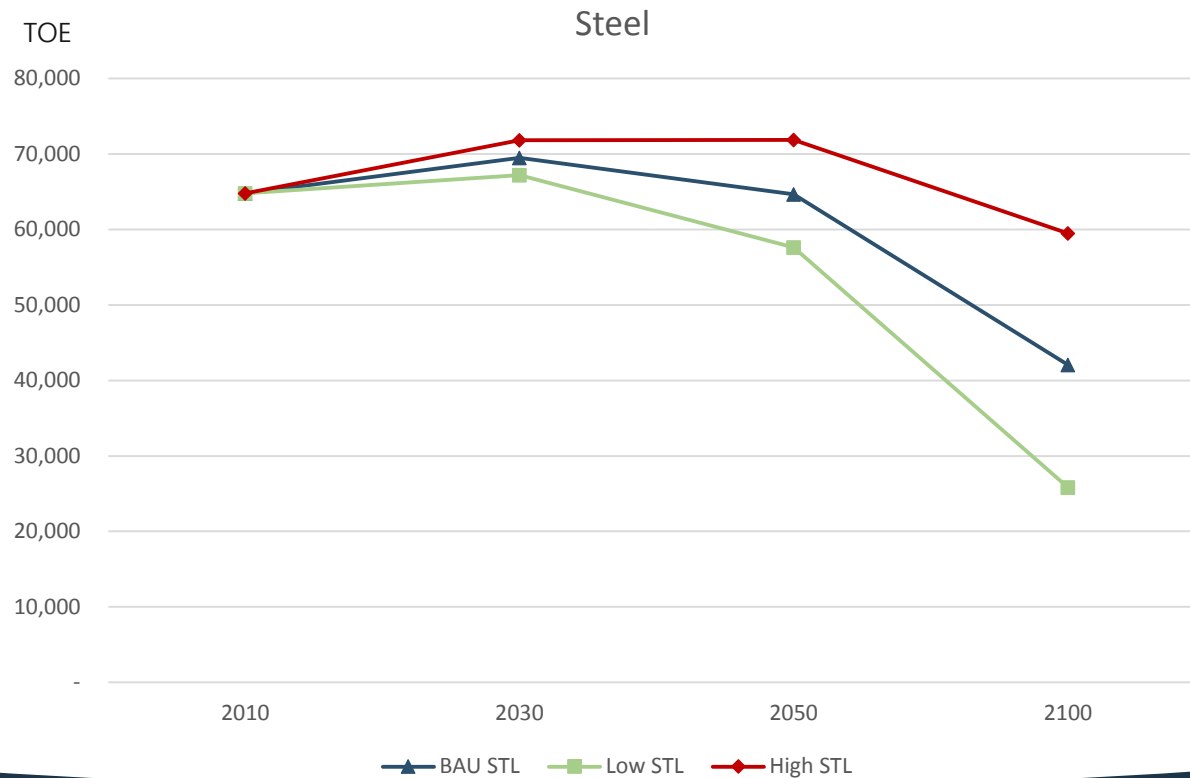
- **Transport sector**
 - **Service demand of passenger based on population will be decreased**
 - **Service demand of freight based on GDP will be increased**



03 Results and Discussion

4) Service demand

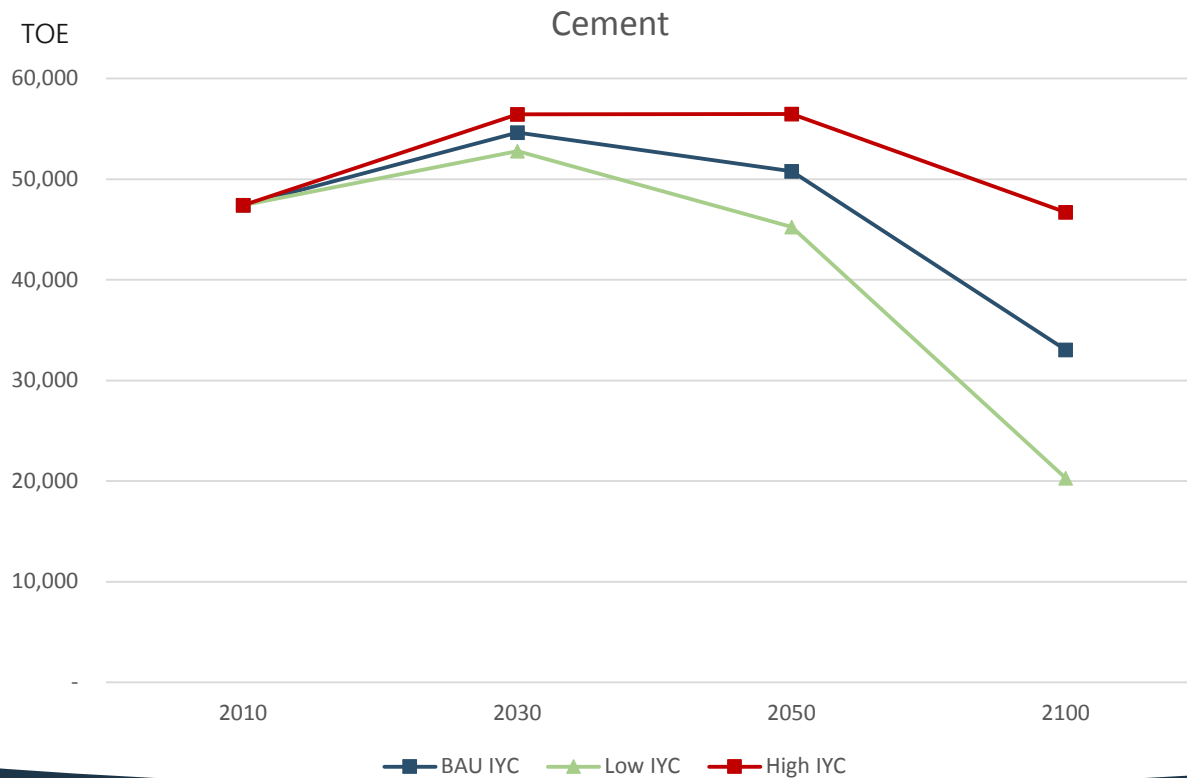
- **Industry sector (Steel)**
 - **Service demand is similar to population projection**
 - **Service demand will be declined after 2030 like population**



03 Results and Discussion

4) Service demand

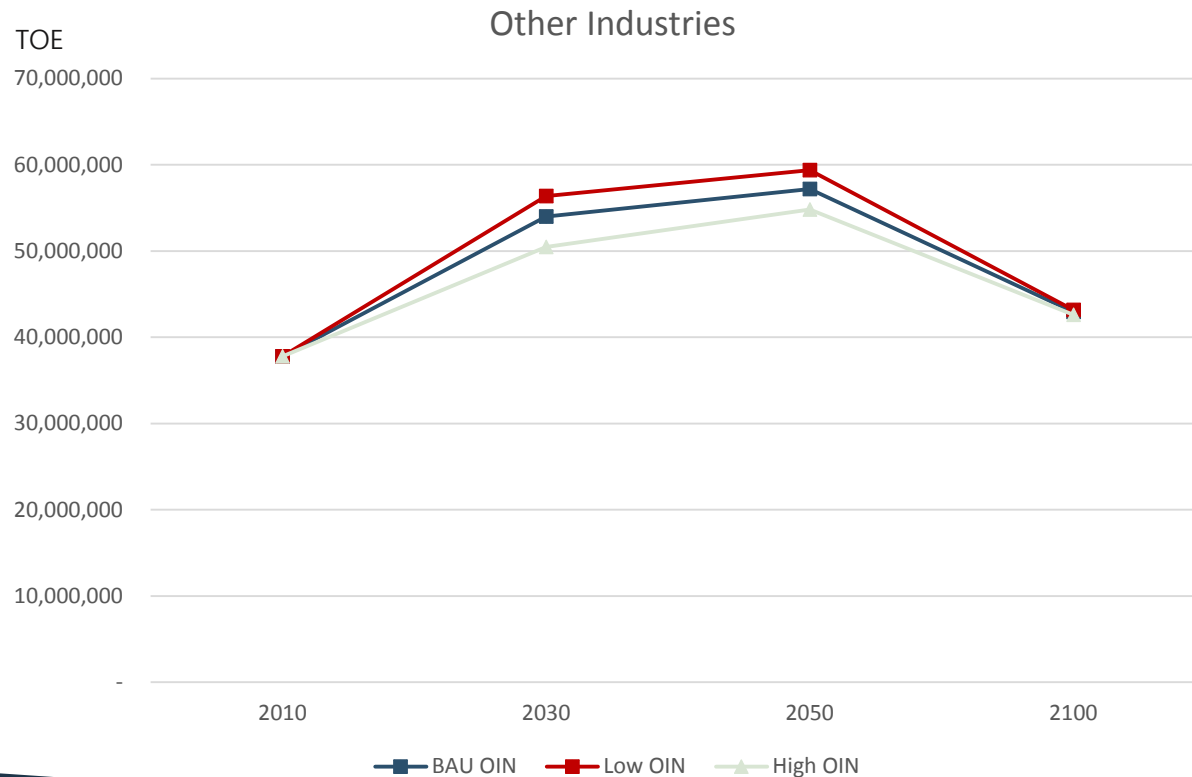
- **Industry sector(Cement)**
 - **Service demand shows similar pattern in steel industry**
 - **Service demand will be declined after 2030**



03 Results and Discussion

4) Service demand

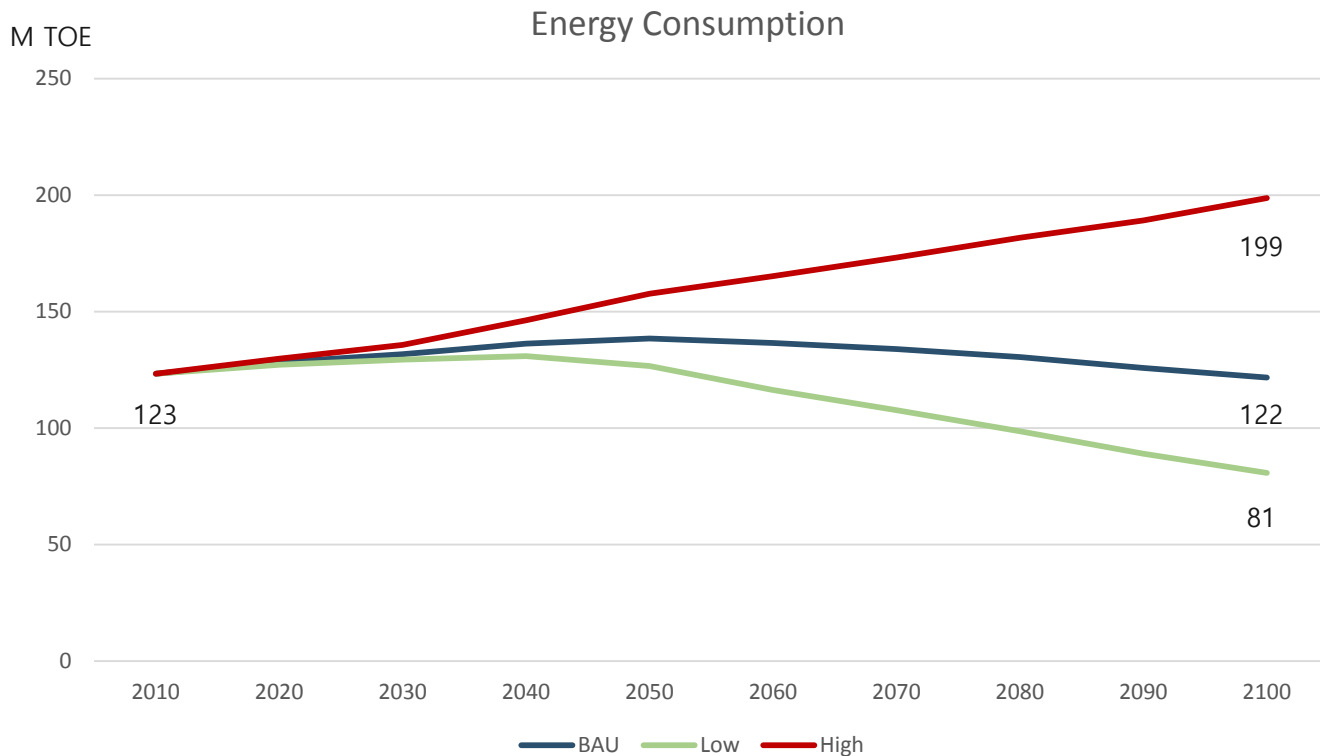
- **Industry sector (Other Industries)**
 - **Service demand of other industries based on GDP will be increased until 2050, after that will be decreased in 2100**



03 Results and Discussion

5) Energy Consumption (Total)

- Energy consumption shows little change in BAU between 2010 and 2100
- Energy consumption in 2100 will be 65% in low emission scenario, 161% in high emission scenario

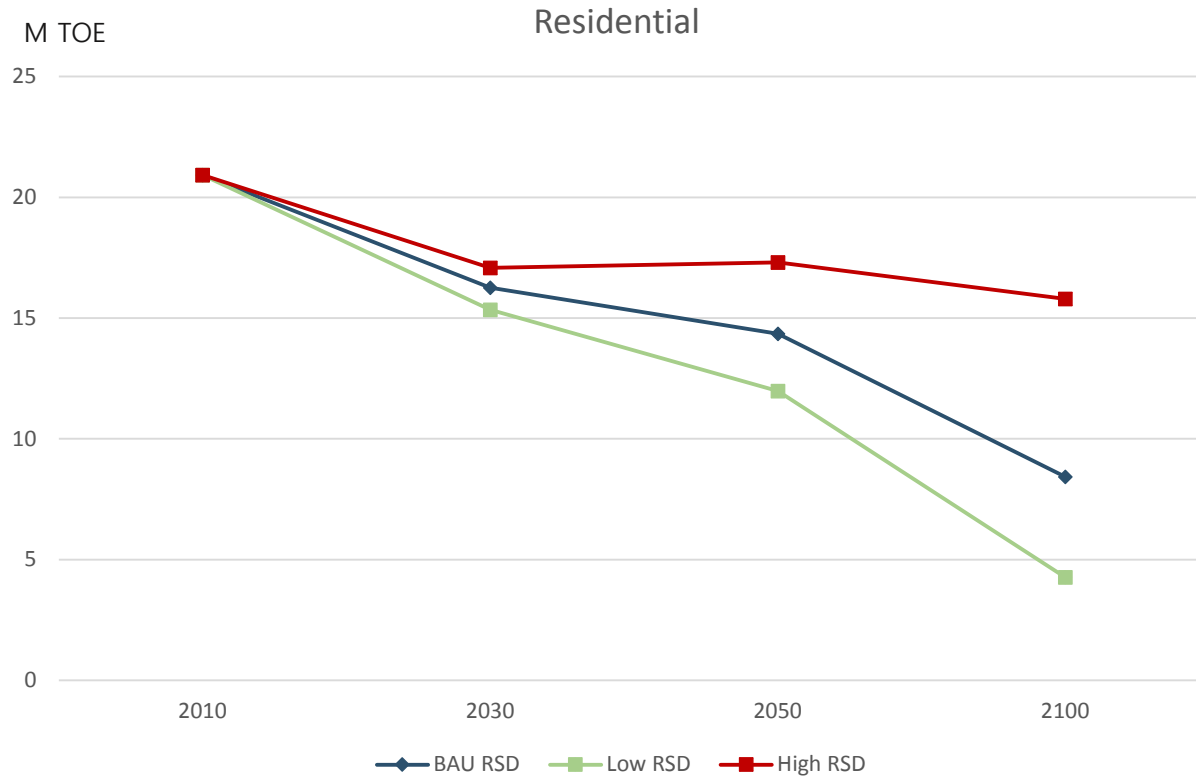


03 Results and Discussion

5) Energy Consumption

- Residential sector

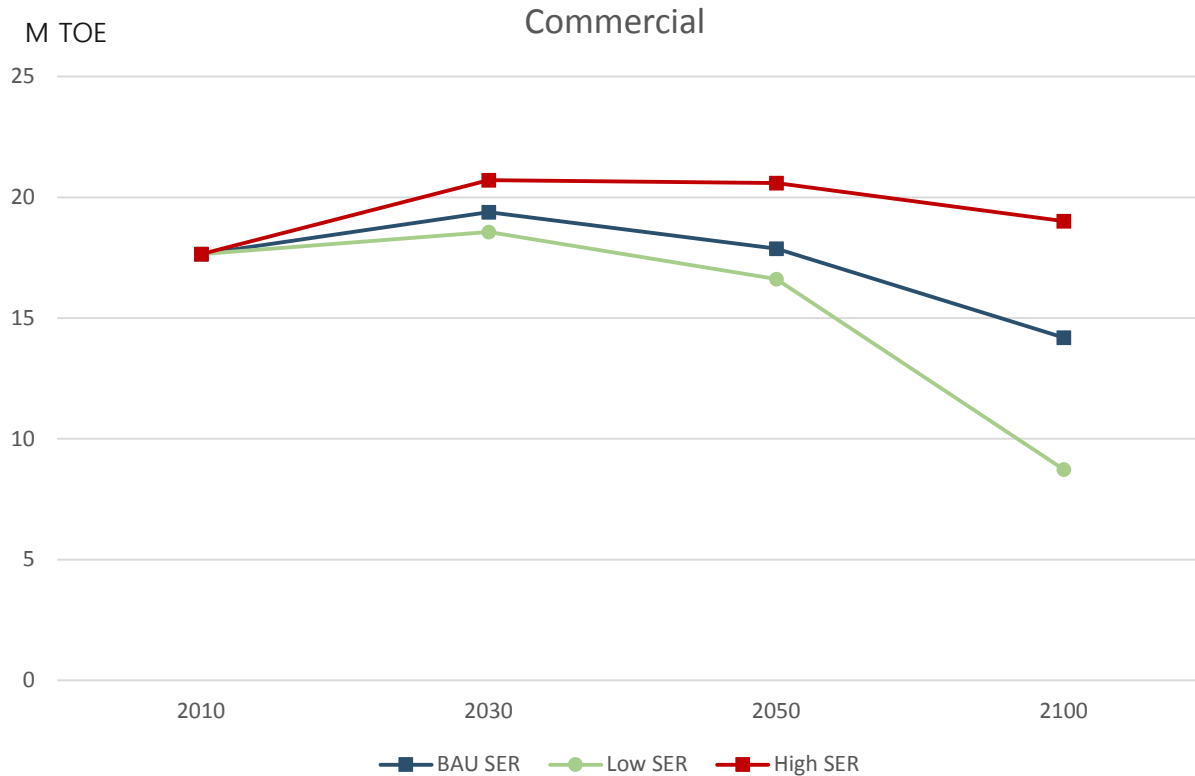
- Energy consumption will be declined continuously
- Improvement in technology and declining population contribute to the future energy consumption



03 Results and Discussion

5) Energy Consumption

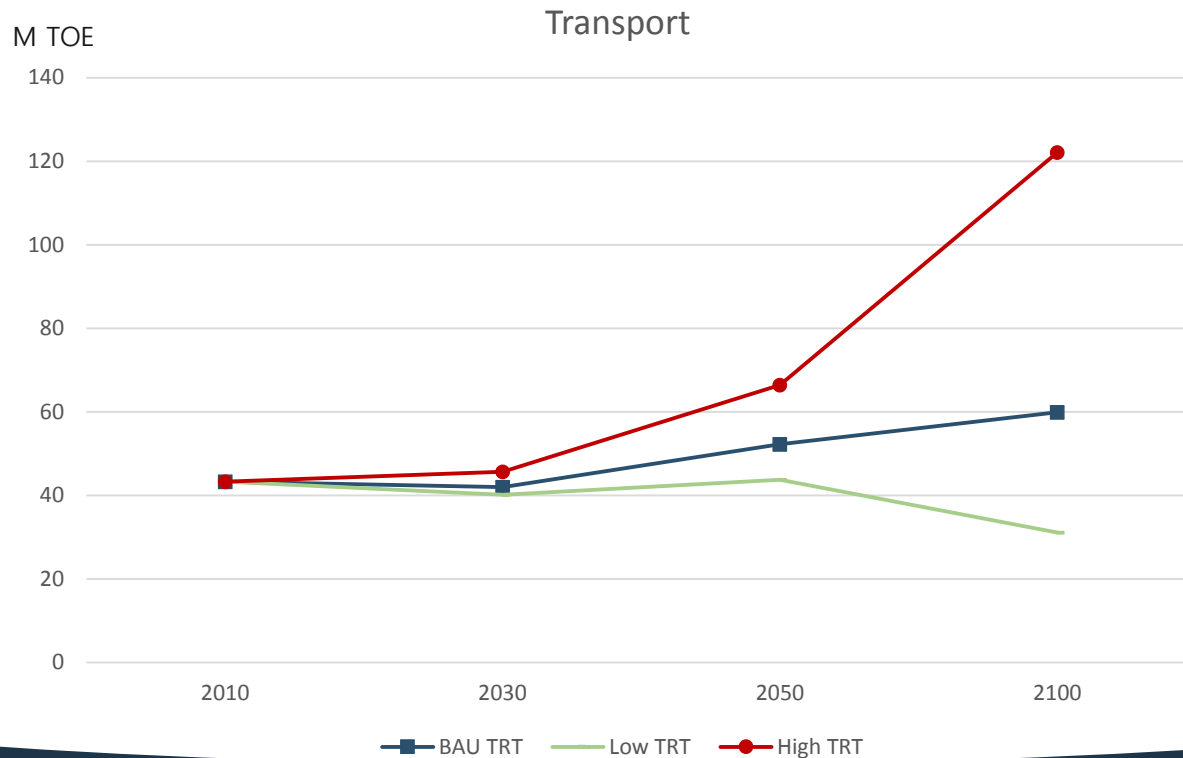
- **Commercial sector**
 - **Energy consumption is similar to service demand**
 - **Benefits of technology improvements have less contribution in results than residential sector**



03 Results and Discussion

5) Energy Consumption

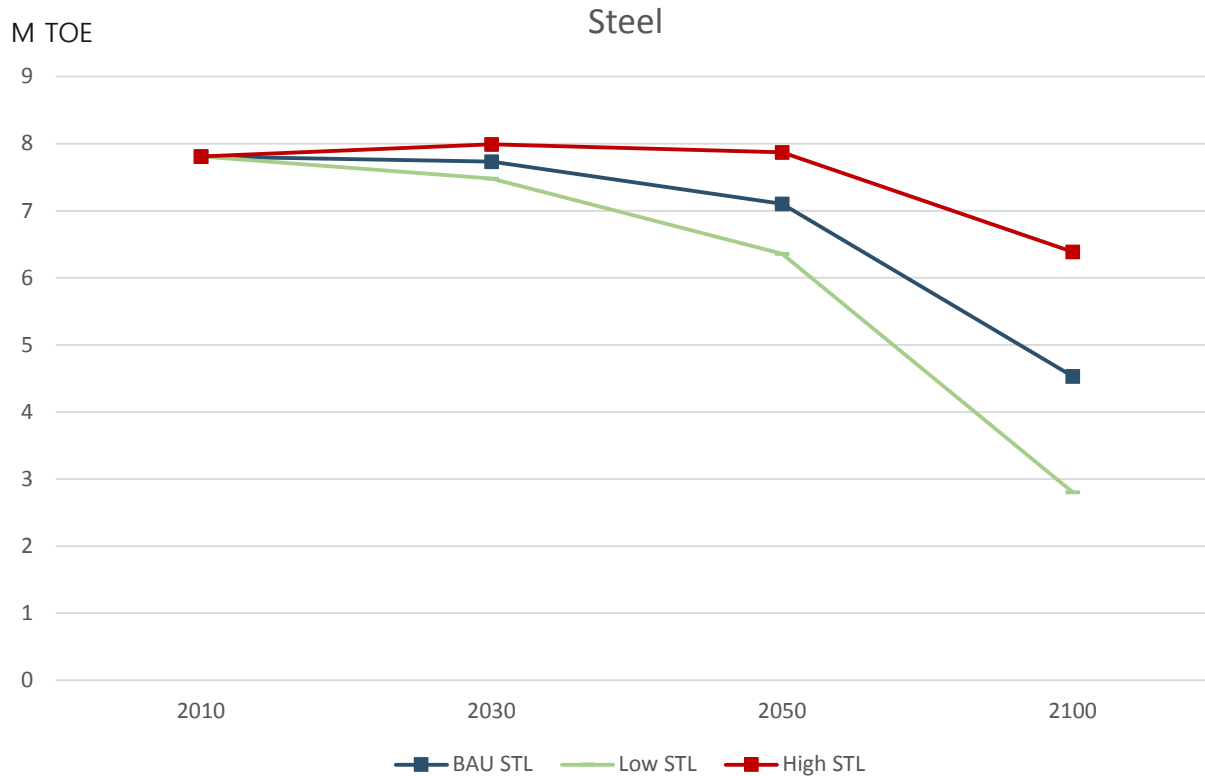
- **Transport sector**
 - **Energy consumption is more influenced by freight demand than passenger demands**
 - **Freight part has lesser benefit from technology improvement compare to passenger part**



03 Results and Discussion

5) Energy Consumption

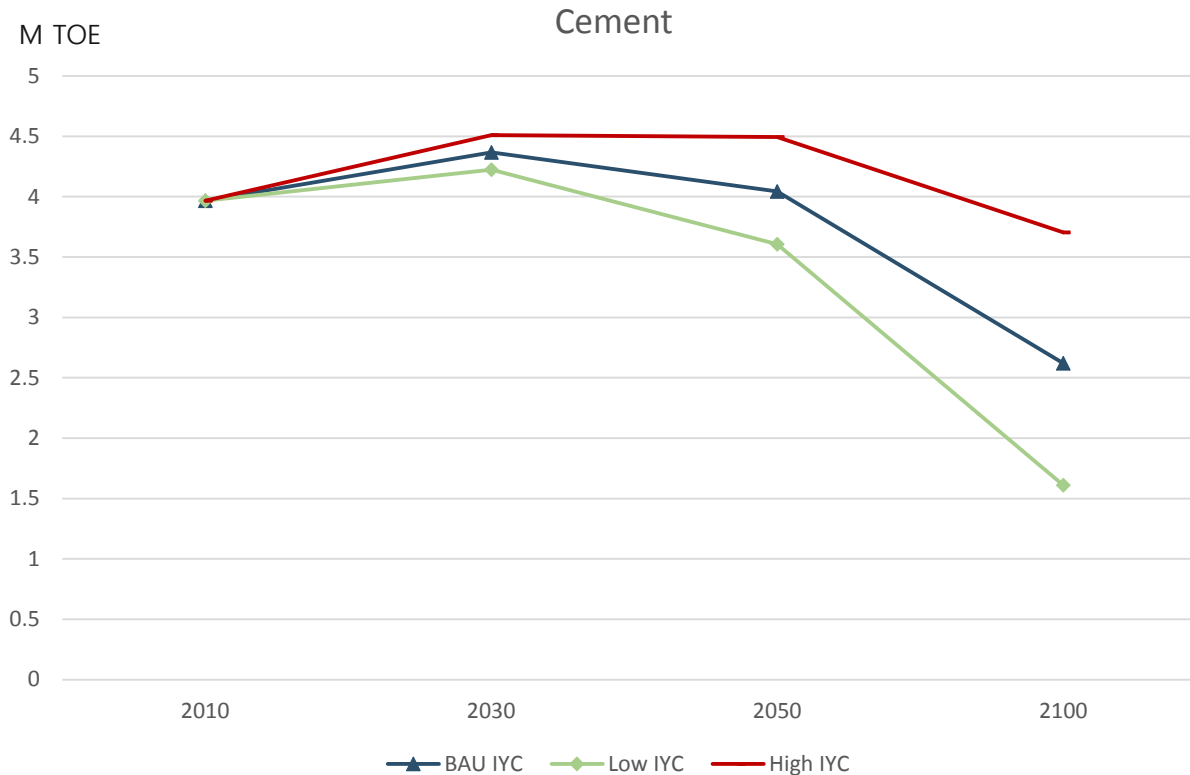
- **Industry sector (Steel)**
 - **Energy consumption in steel is maximum in present condition**
 - **Energy consumption will decline as population decrease**



03 Results and Discussion

5) Energy Consumption

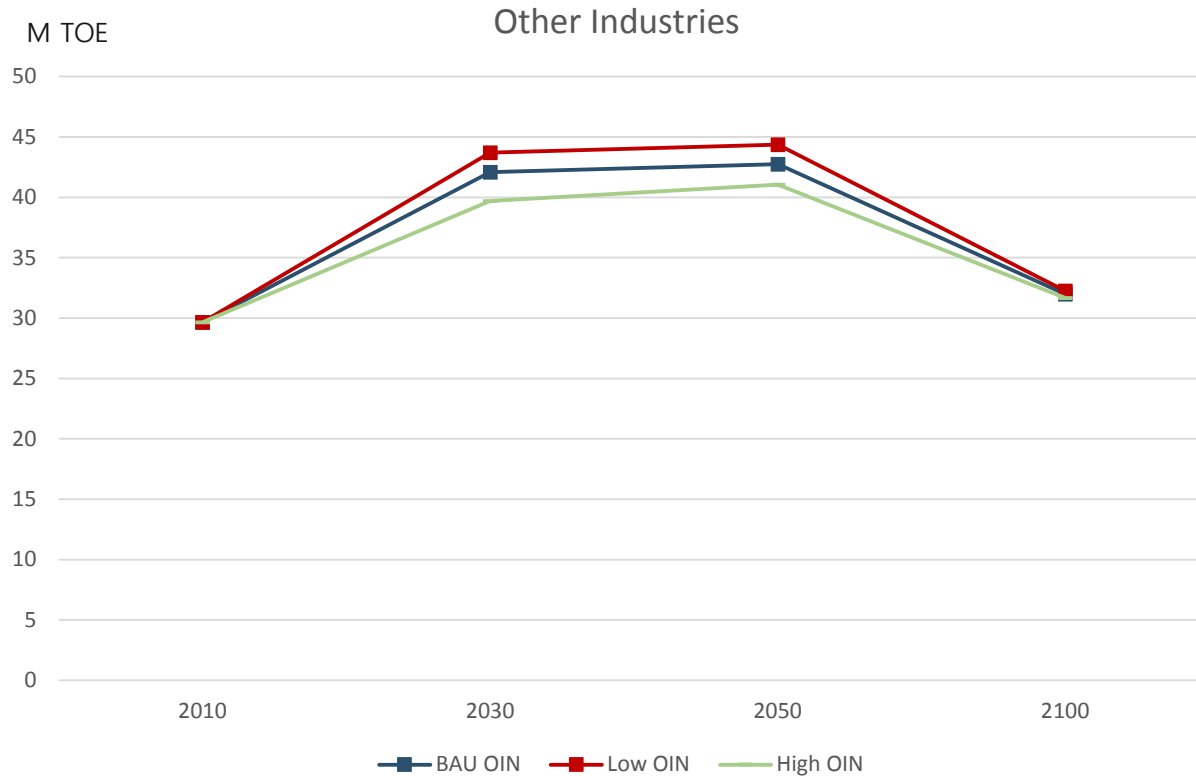
- **Industry sector (Cement)**
 - **Energy consumption shows similar pattern to population change**
 - **Energy consumption will be declined after 2030**



03 Results and Discussion

5) Energy Consumption

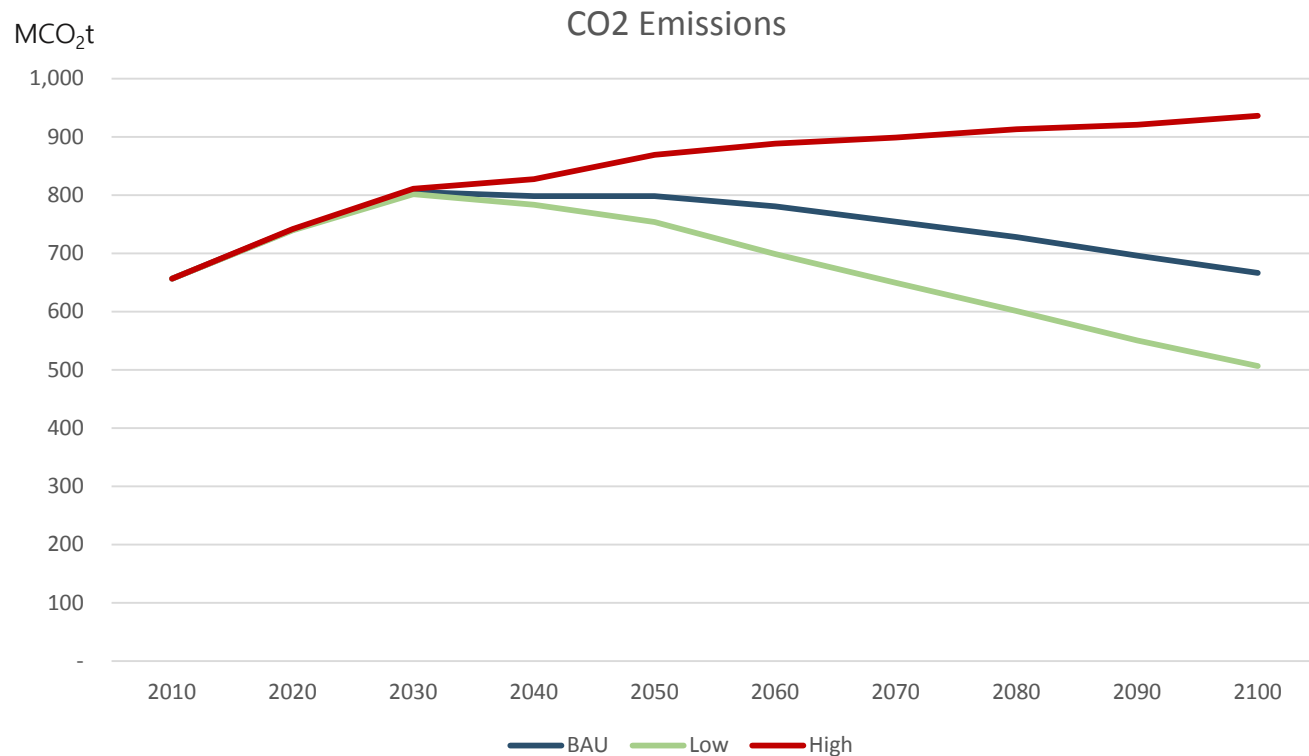
- **Industry sector (Other Industries)**
 - **Energy consumption will increase until 2050, and decrease in 2100 because of technology improvement**



03 Results and Discussion

6) CO₂ Emissions (Total)

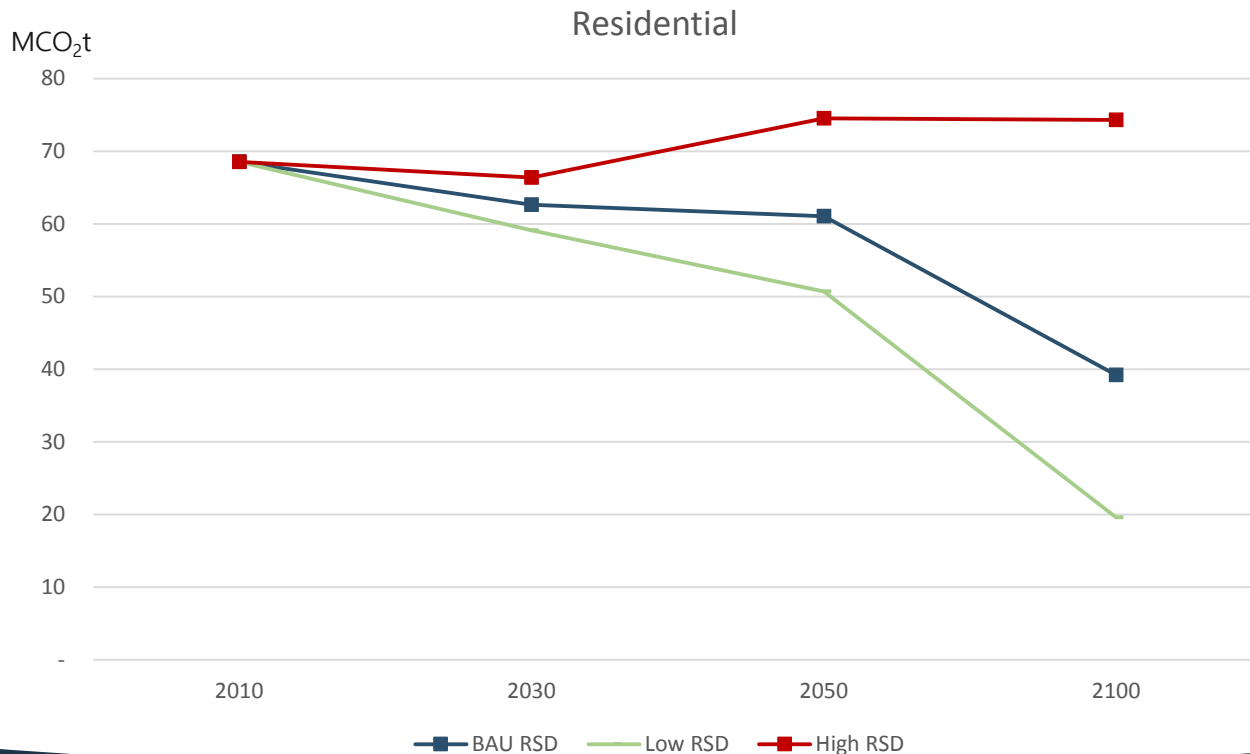
- CO₂ emission increase until 2030, regardless of the scenarios in Korea
- After 2030, emissions will be decreased in BAU and low emission scenario, and will be increased in high emission scenario



03 Results and Discussion

6) CO₂ Emissions

- Residential sector
 - CO₂ emissions will be decreased because of technology development and decreasing population
 - In case of high emission scenario, the emissions in 2050 and 2100 will be increased due to increasing electricity

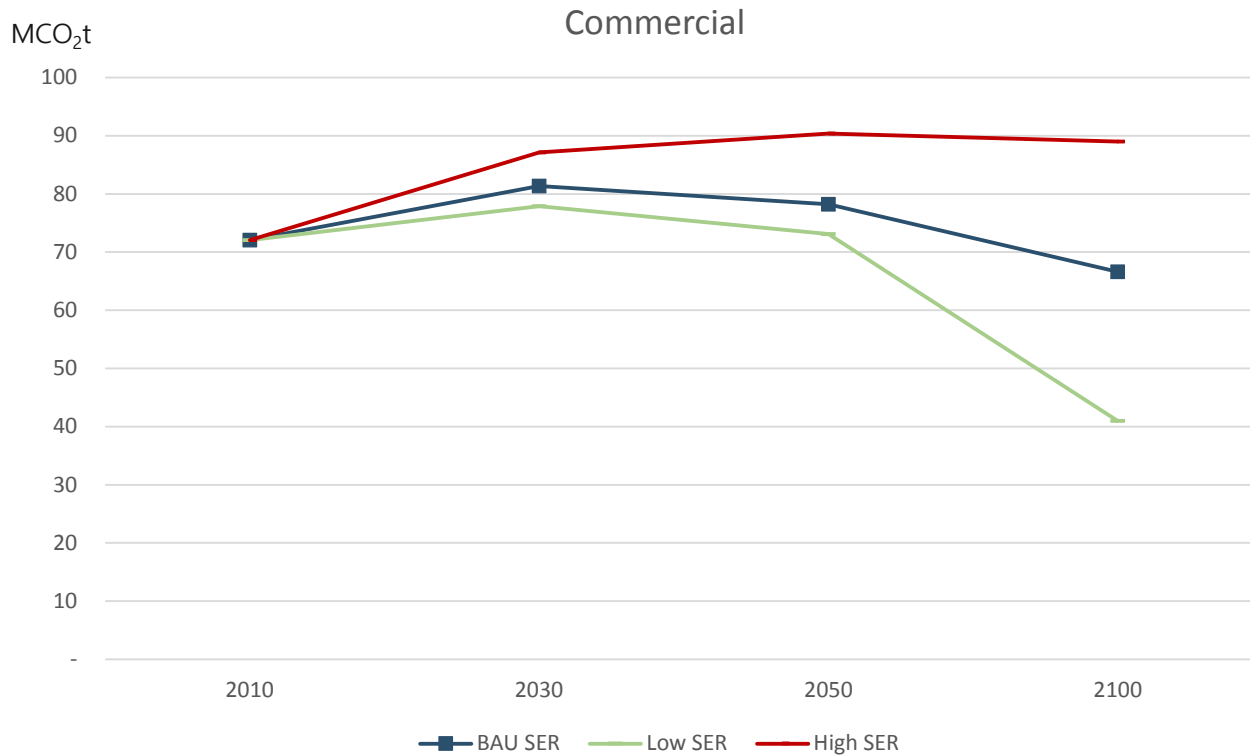


03 Results and Discussion

6) CO₂ Emissions

- **Commercial sector**

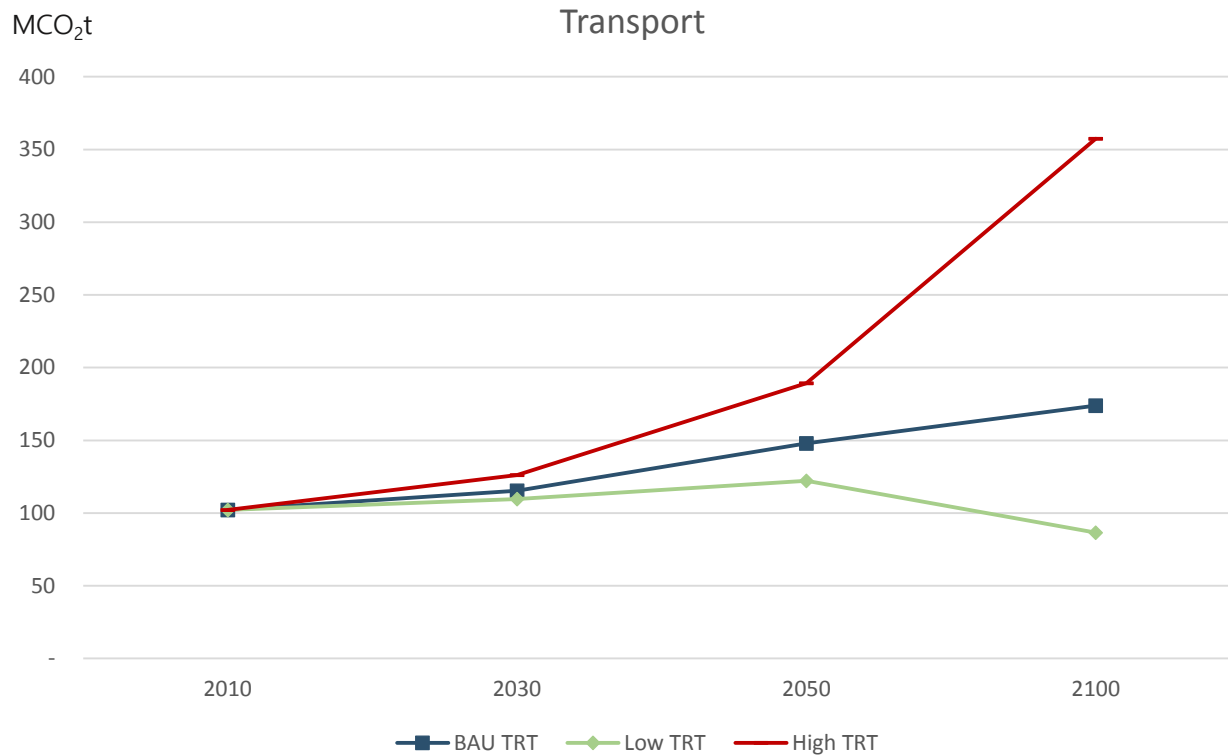
- **Emissions will increase in 2030, but will be decreased in 2050 and 2100**
- **In case of high emission scenario, emissions are similar between 2050 and 2100**



03 Results and Discussion

6) CO₂ Emissions

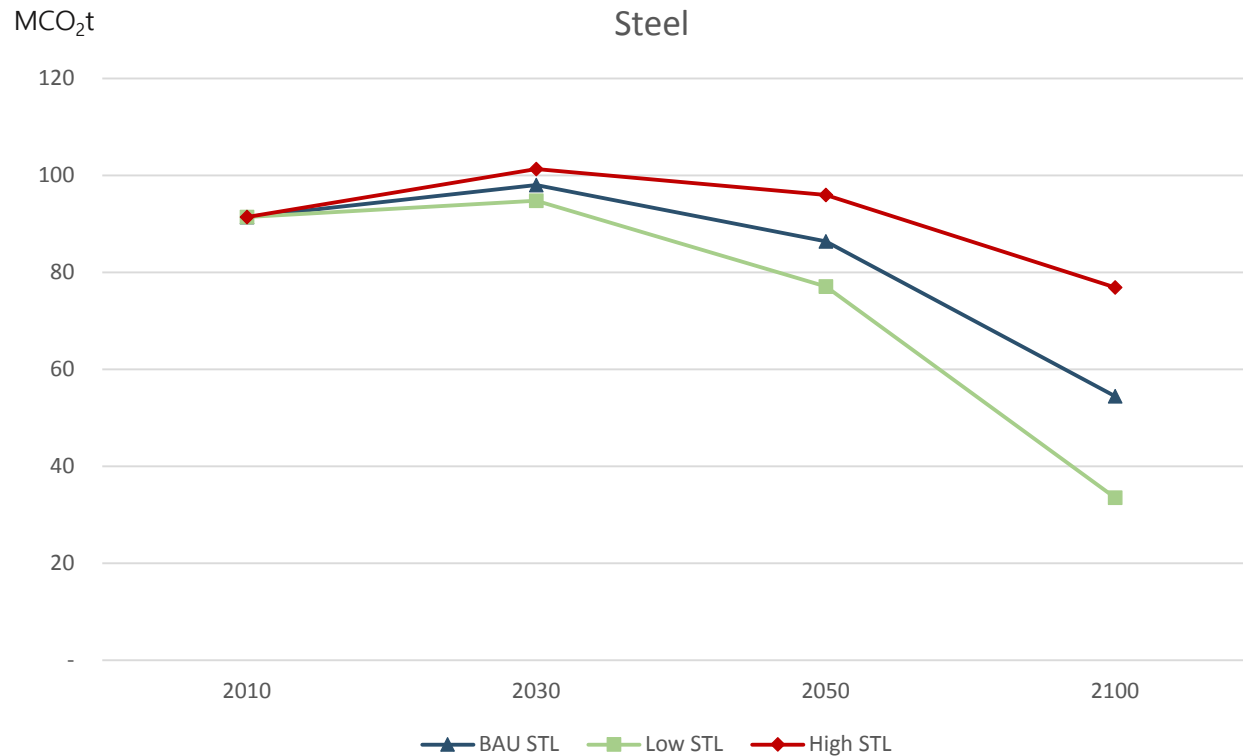
- **Transport sector**
 - **CO₂ emissions will be increased in transport sector**
 - **Freights seem to be more affected by emissions than passengers**
 - **Especially, emissions in high emission scenario increase significantly**



03 Results and Discussion

6) CO₂ Emissions

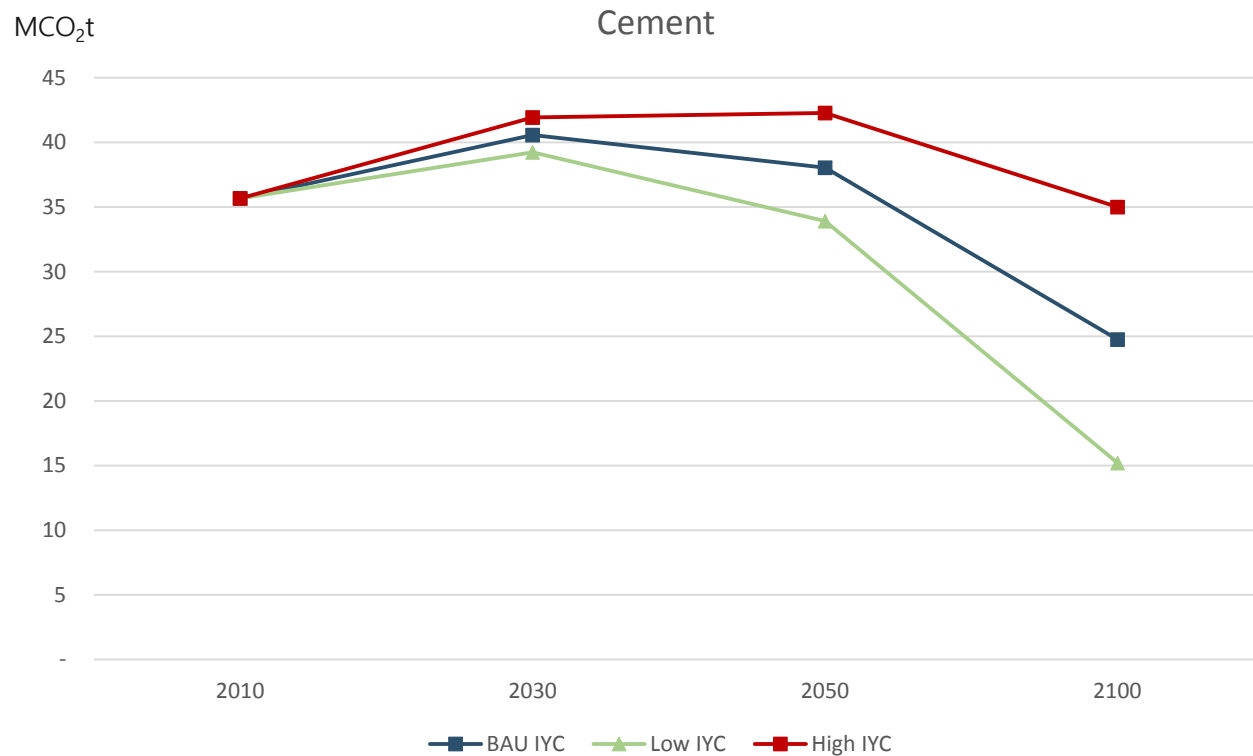
- Industry sector(Steel)
 - Emissions show a tendency to reduce after 2030 because of decreasing steel demand



03 Results and Discussion

6) CO₂ Emissions

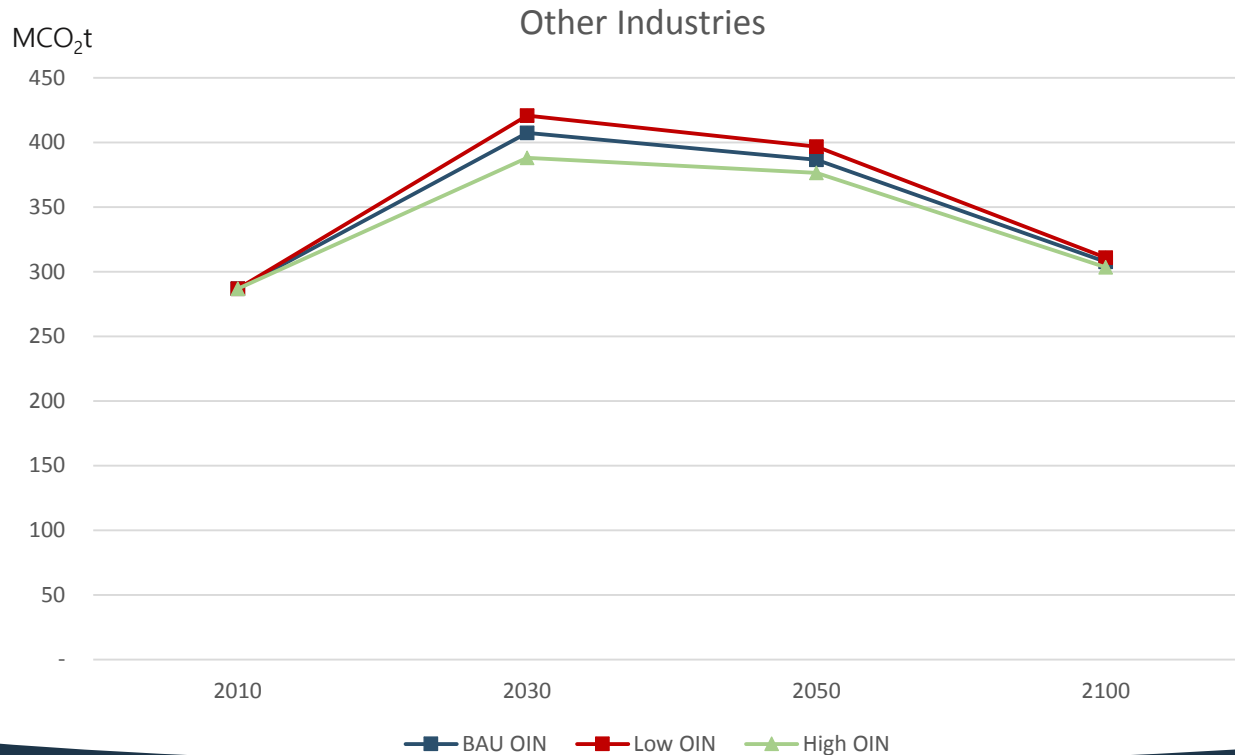
- Industry sector (Cement)
 - After maximum emissions in 2030, it will be reduced as steel industry



03 Results and Discussion

6) CO₂ Emissions

- **Industry sector (Other Industries)**
 - **Emissions in 2030 will be increased because of GDP and population growth**
 - **In case of 2050 and 2100, emissions will be decreased due to technology developments despite of the GDP growth**



04 Conclusion



04 Conclusion

- In transport sector, the emission differs significantly according to emission scenarios. Thus, technical improvement and energy advancement from fossil fuel to alternative energy are needed
- Technology improvement and dissemination are two most important factors to reduce emission (For example, residential sector could reduce emission by technology dissemination such as LED)
- This research could contribute to the designing the mitigation policy in Korea

Thank you