

Assessing strategies for reducing the carbon footprint of textile products in China under the Shared Socioeconomic Pathways framework

Si-yu Peng, Jing-yu Liu, Yong Geng, Shanghai Jiao Tong University

1. Introduction

- The textile industry was the first industry in China to promote the industry-level zero-carbon goal. It has a long industrial chain marked by high energy consumption and greenhouse gas (GHG) emissions, widely linking various consumers and producers.
- Textile enterprises can achieve decarbonization by improving energy efficiency and structure. Sustainable industrial ecology and collaboration within the industries are essential for GHG reduction.
- Quantitative and comprehensive analysis of the socioeconomic conditions on textile GHG has been lacking, as well as its performance under climate policies. Long-term product-level decarbonization pathways of textiles have not been done.
- This paper forecast the future carbon reduction pathway of textile products in China based on current GHG performance, and compared a set of mitigation strategies under scenarios characterized by different combinations of socioeconomic conditions and climate policies.

2. Methods

- We use a life cycle assessment (LCA) approach and the Asia-Pacific Integrated Model/Computable General Equilibrium (AIM/CGE) model to simulate Shared Socioeconomic Pathway (SSP) scenarios implementing climate policies through 2050.
- Using the LCA method, a GHG dataset for textile products is established. Cotton yarn and polyethylene terephthalate (PET) yarn are selected as study objects.
- The AIM/CGE models provide sector transformation pathways under different SSPs and climate policies, which influence LCA inputs. Textile industry GHG forecasts are dependent on activity data and emission factors provided by LCA inventory.
- The life cycle of textile products depends on a multi-sector chain that requires multi-sector carbon reduction strategies.

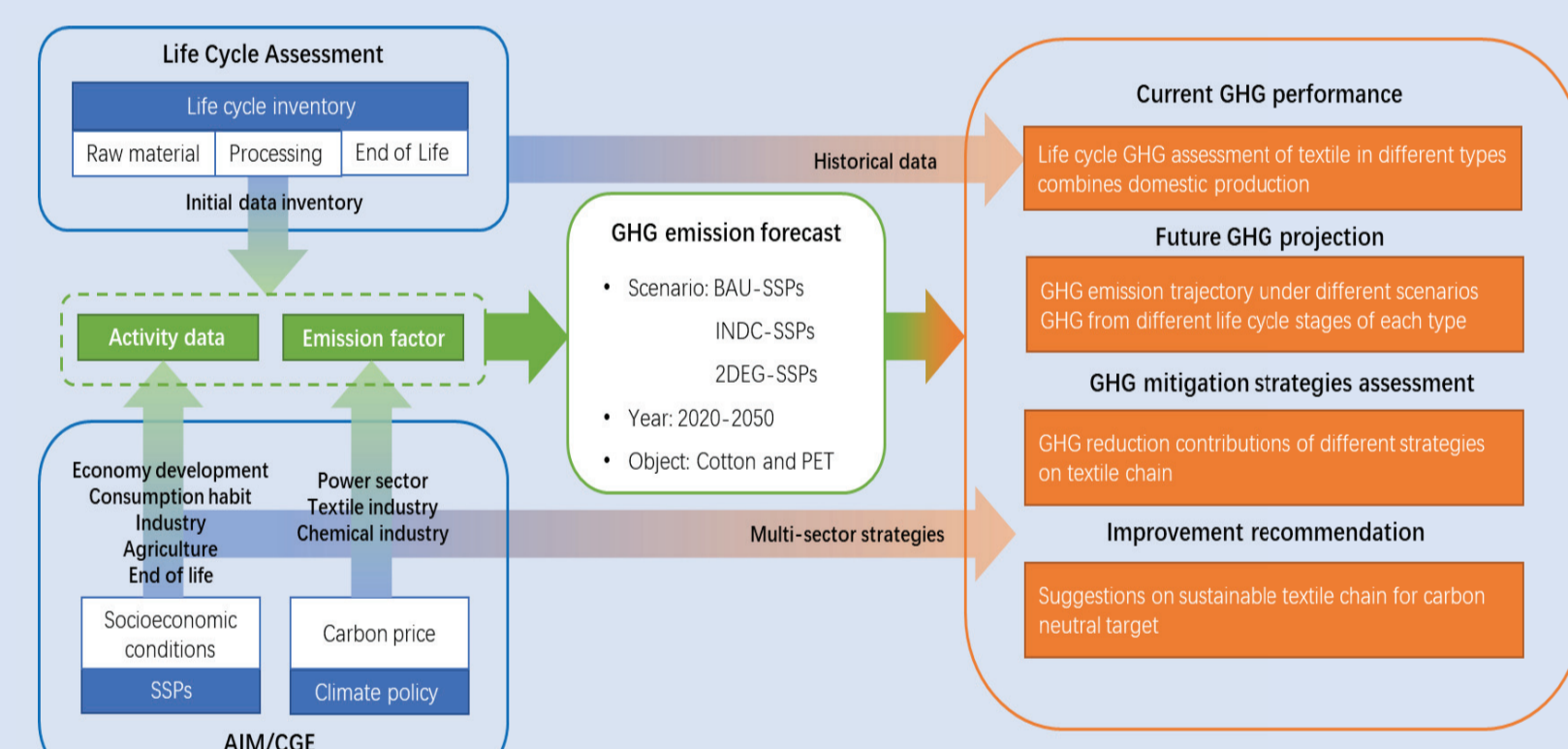


Figure 1. Hybrid LCA-RCP-SSP framework.

3. Scenario assumptions

- This study develops a socioeconomic scenario and a climate policy scenario.
- Socioeconomic conditions are based on SSPs, describing five scenarios. Related parameter settings of the SSPs are shown in Table 1.
- Climate policies are reflected by a national carbon price. We adopted BAU, INDC, and 2DEG climate policy scenarios.

Table 1. Assumptions of socioeconomic parameters

Element	SSP1	SSP2	SSP3	SSP4	SSP5
Consumptive habit					
Waste	Low	Med	High	Med	High
Bio-PET preference	High	Med	Low	High	High
Recycled PET preference	High	Med	Low	Med	High
Agriculture					
Pesticide	Low	Med	High	Low	High
Fertilizer	Low	Med	High	Low	High
Film	Low	Med	High	Low	High
Energy	Low	Med	High	High	High
Bio-fuel preference	High	Med	Low	High	Low
Industry					
Energy	Low	Med	High	Low	High
Bio-fuel preference	High	Med	Low	High	Low
EOL					
Garbage rate	Low	Med	High	Med	High
Recycling level	High	Med	Low	Low	High

4. Results

- Under the BAU, socioeconomic conditions have a huge potential influence on future GHG emissions. Under the INDC and 2DEG, power is decarbonized and GHG emissions from all five SSPs decline rapidly, achieving zero emissions in the near future.

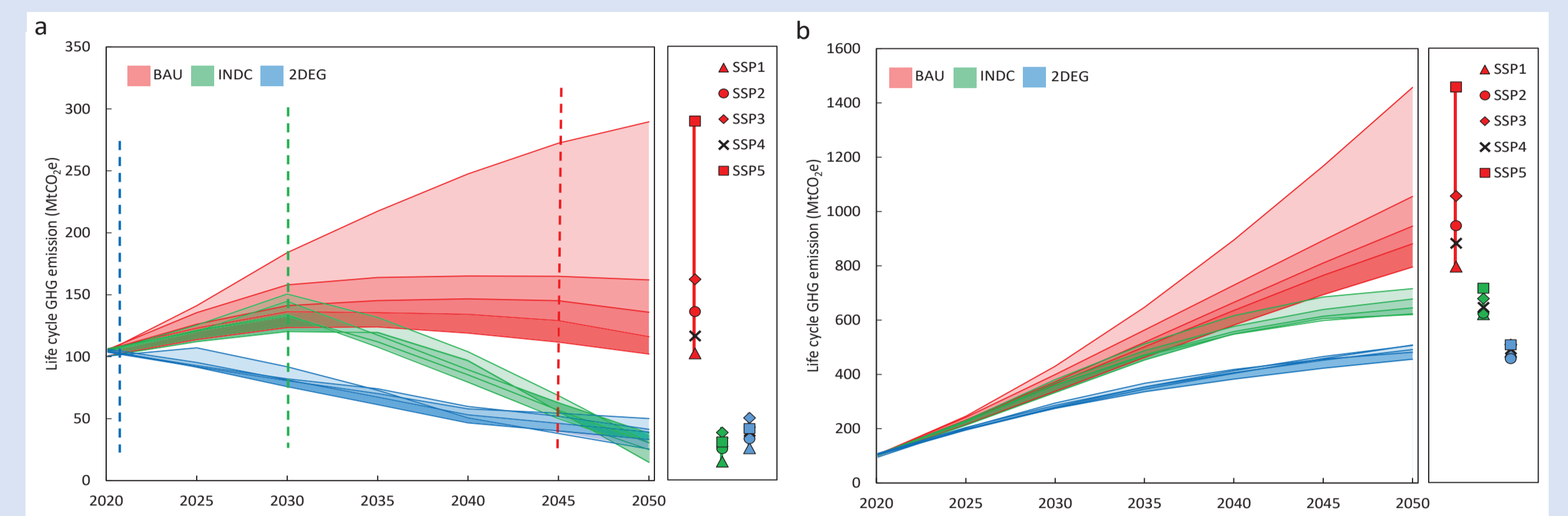


Figure 2. Life cycle GHG emissions of cotton yarn and PET in China under SSPs-BAU, SSPs-INDC and SSPs-2DEG. (a) Annual and (b) cumulative GHG

- The bio-based feedstocks and advanced processing make bio-PET the lowest-carbon product. Climate policies narrow the GHG emission gap between product types.

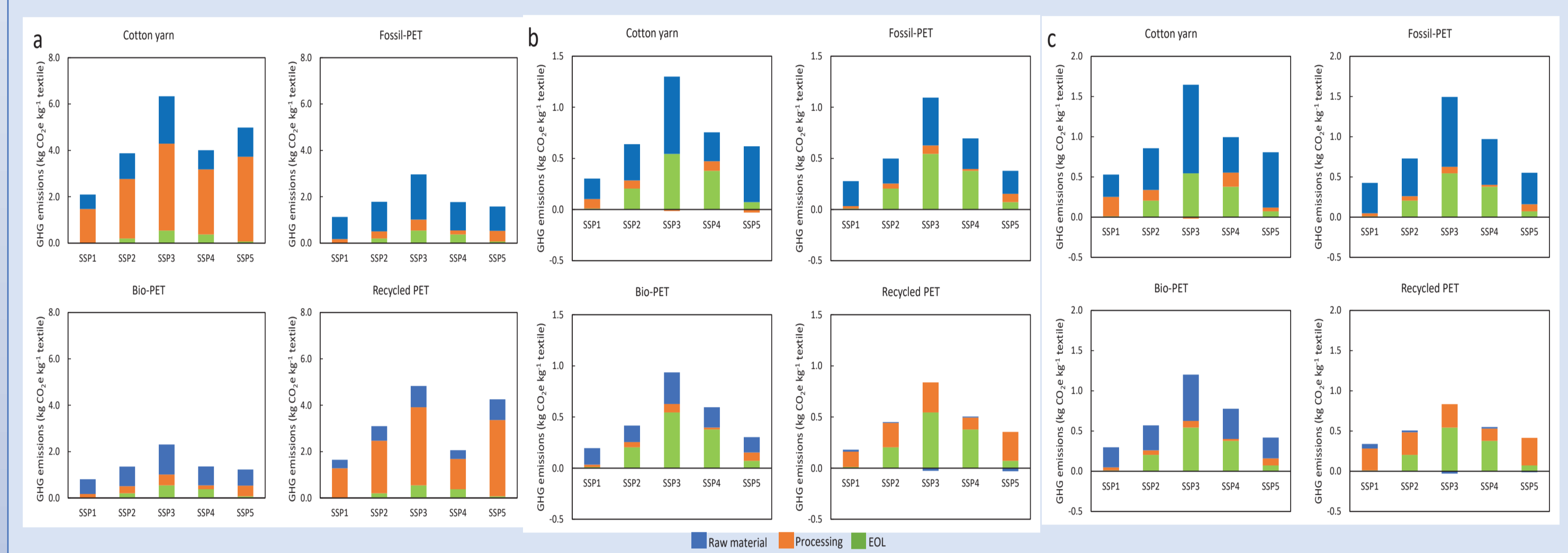


Figure 3. Breakdown of GHG by textile life cycle derived from different feedstock types in 2050. GHG emissions in (a) BAU, (b) INDC and (c) 2DEG

- Even if the production output grows with the domestic economy, actions in all sectors can offset its negative effects. Reducing the power consumption carbon footprint is critical to the textile emission mitigation pathway.

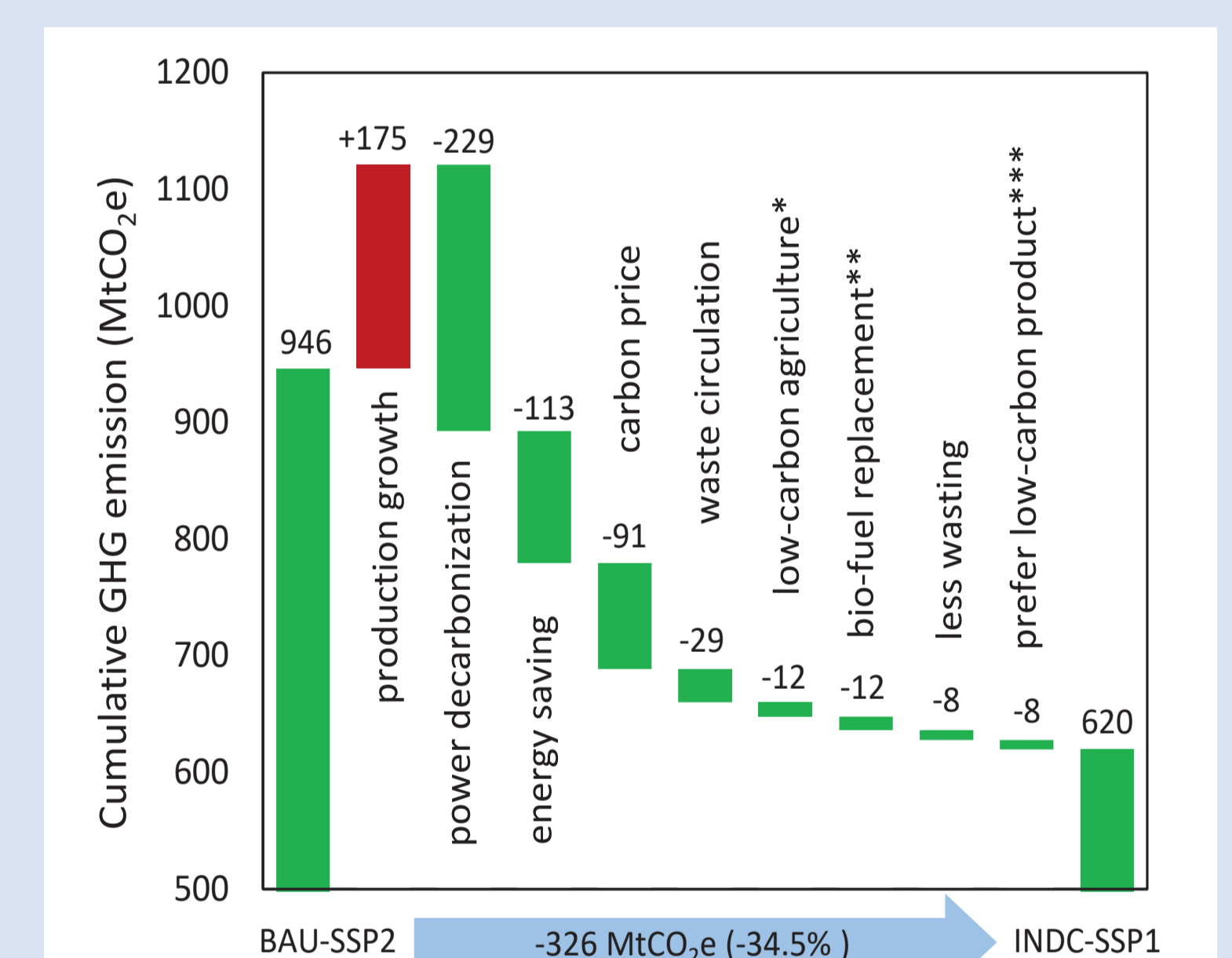


Figure 4. Cumulative GHG under different strategies in 2050.

*Increase the utilization rate of agricultural resources like fertilizer, pesticide and film.
**Replace fossil-diesel with bio-diesel, natural gas with biogas.
***Preference change from fossil-PET to bio-PET and recycled PET.

5. Discussions

- Power saving and power decarbonization play important roles in the GHG mitigation.
- Decarbonization of the power system is fundamental for textile product emission reduction. As an important part of China's INDC, a carbon-neutral goal requires transformation of the power system.
- Including the textile industry in the regional carbon market can support power conservation efforts. Market-related policies, such as carbon tax and trading, force enterprises to upgrade industrial technology by limiting emission quotas.
- Power cycle systems can reduce emissions by reducing power consumption in the textile industry. Interconnections among industries maximize the effectiveness of coordinated emission reduction strategies.
- The changes in attitudes assumed to occur under various socioeconomic conditions act as on-off switches in mitigation strategies. Such strategies depend on consumer awareness and remain in the early stages.