New Zealand's energy consumption and energy-related greenhouse gas emissions between 2006/2007 and 2012/2013

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Outline

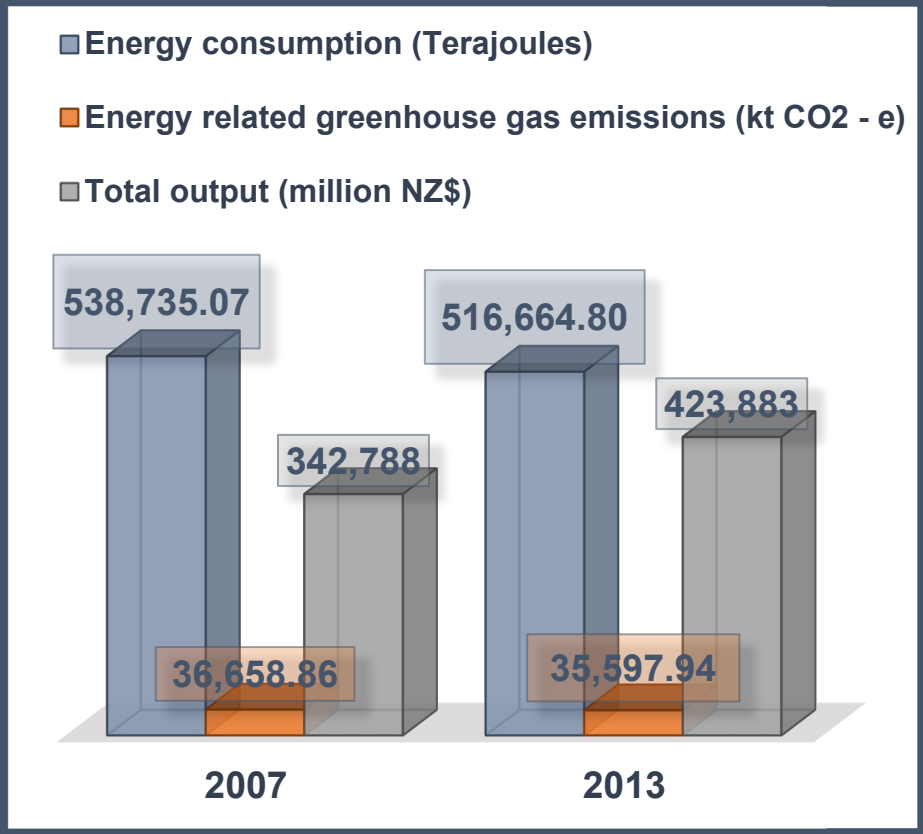
- Background
- Literature
- Research Questions
- Models
- Results
- Conclusions

NZ context

Low-emissions transition

- Government's target of net-zero carbon by 2050
- Energy sector accounts for 40% of the total GHG emissions
- Achieving government's target relies on the understanding of NZ's energy consumption
- Studying factors that influence energy consumption.

Energy consumption



Research questions

- What drives changes in energy consumption and co_2-e emissions?
- Which factor has increased/decreased energy consumption and co_2-e emissions ?
- Do the factors that influence energy consumption and co_2-e emissions vary across sectors?
- What key sectors should we pay attention to when designing energy and climate policies?

Sample of literature

Environmentally-extended input-output (EEIO) analysis:

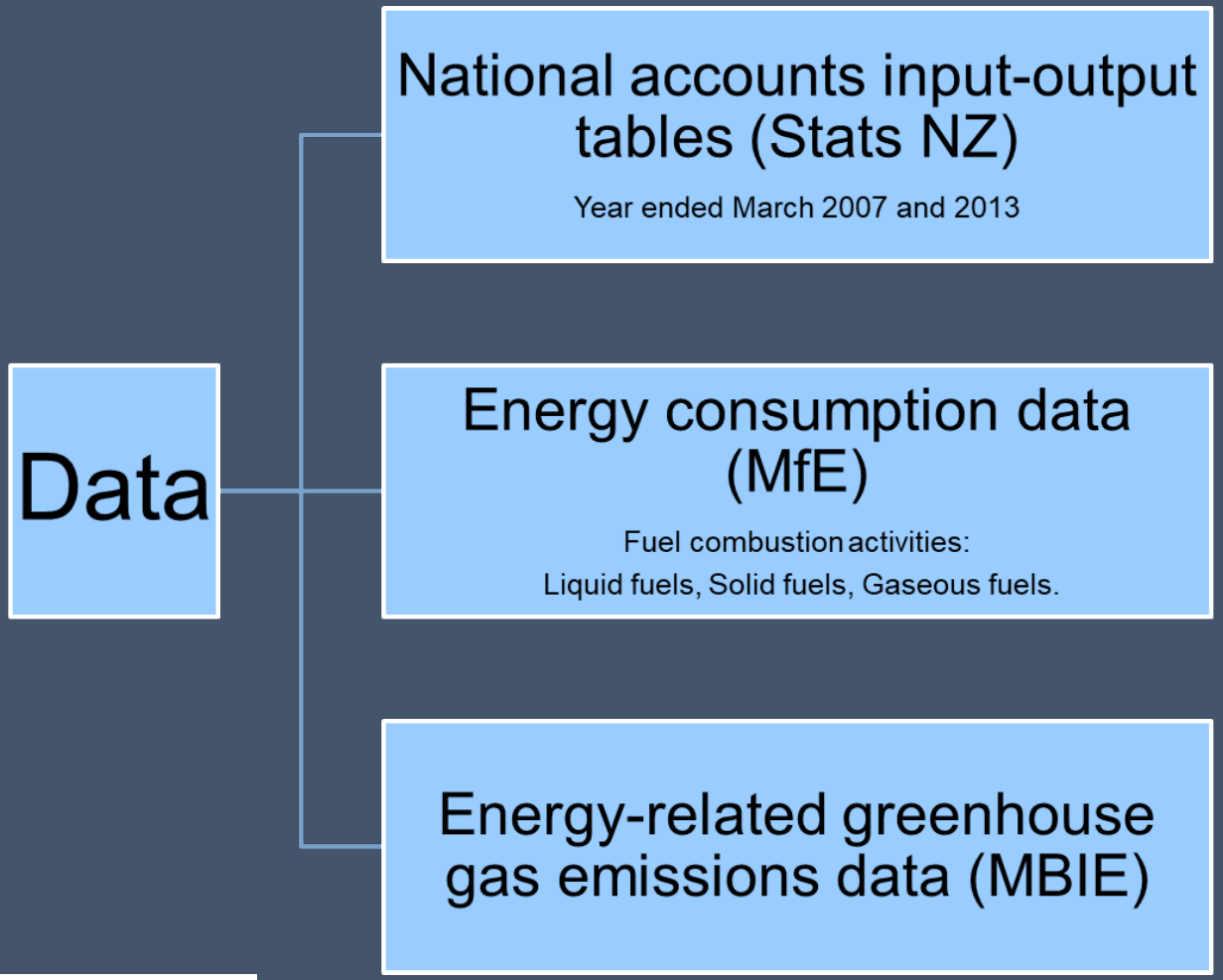
- An extended of traditional IO analysis first proposed by Leontief (1936).
- EEIO analysis establishes the linkage between economic activities and related natural resource utilization or pollutant emissions, thus integrating monetary flows with resource and emission flows (Cao et al., 2019).
- Moreover, it enables the calculation of direct and embodied resources consumption or pollutants emissions induced by different economic sectors and different final demand (Xie et al., 2019).
- Wide application:

  Estimate patterns of energy consumption (He et al.,2019a; Liang et al., 2010), carbon emissions (Jiang et al., 2019; Zhang 2019), NOx emissions (He et al., 2019b), and evaluate the consequences of energy policies (Wu et al., 2019)

Structural decomposition analysis (SDA):

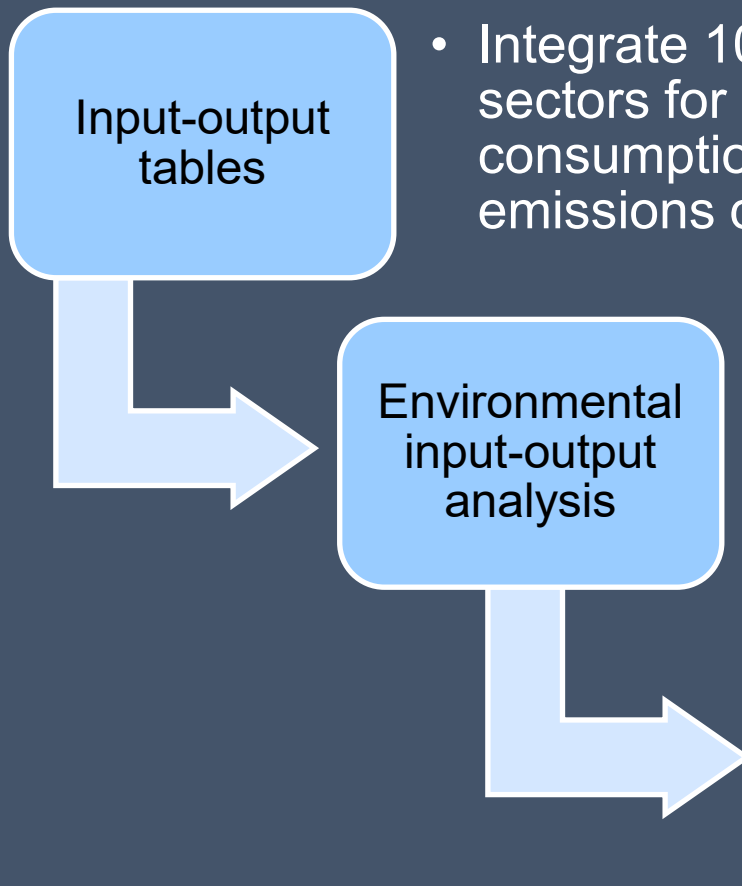
- SDA is based on IO analysis (Bagheri et al., 2018).
- The implementation of the SDA method is always for a given period (Guevara and Domingos 2017).
- The D&L technique - Dietzenbacher and Los (1998) because it involves fewer calculations.

Data



Wen et al. (2021)

Methodology



- Integrate 106 sectors into 15 sectors for matching energy consumption and co_2-e emissions data

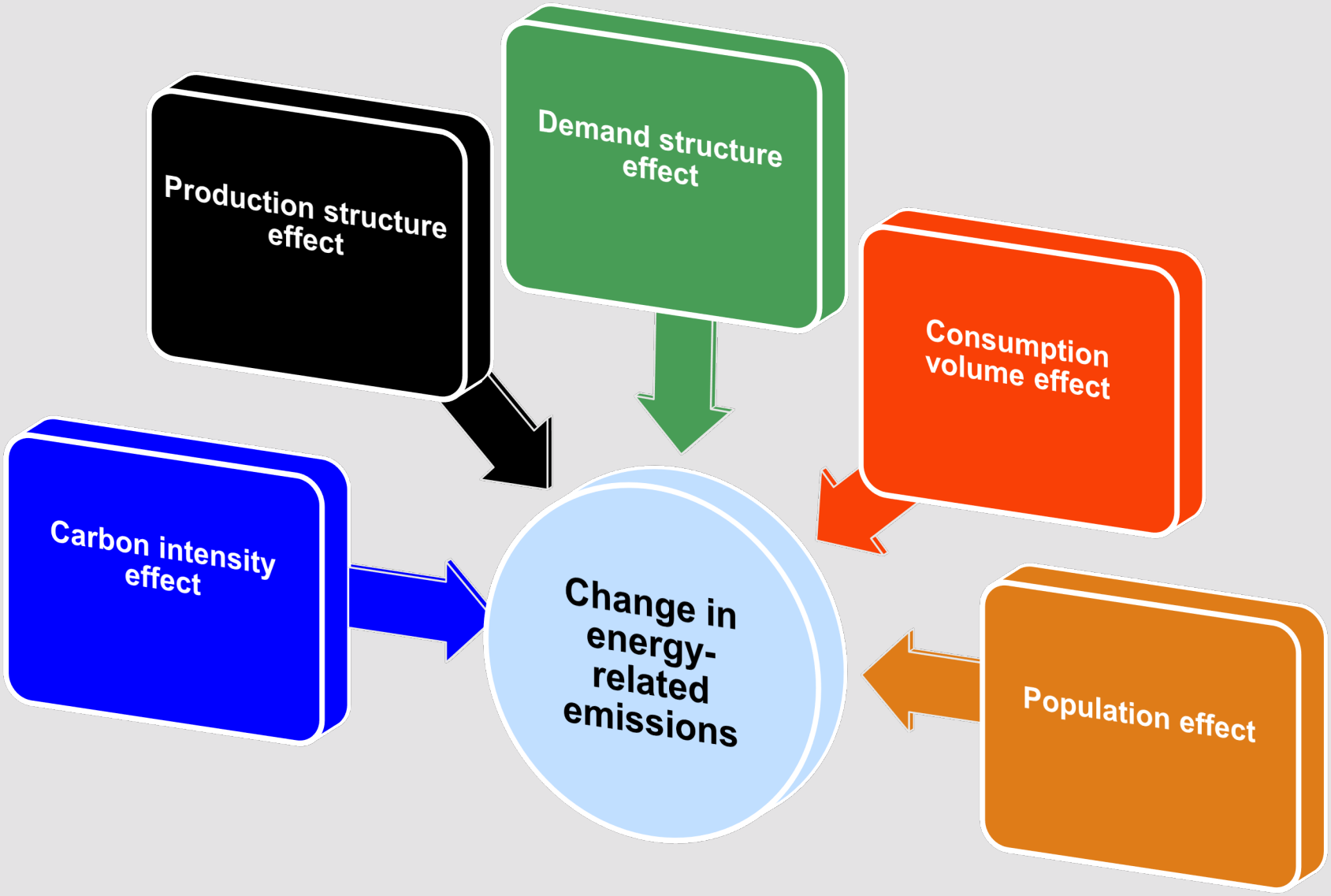
- Represent the economy based on input-output tables with energy consumption and co_2-e emissions data.

- Assess driving factors and trace the energy/emissions flow.

Scheme of input-output table of national economy

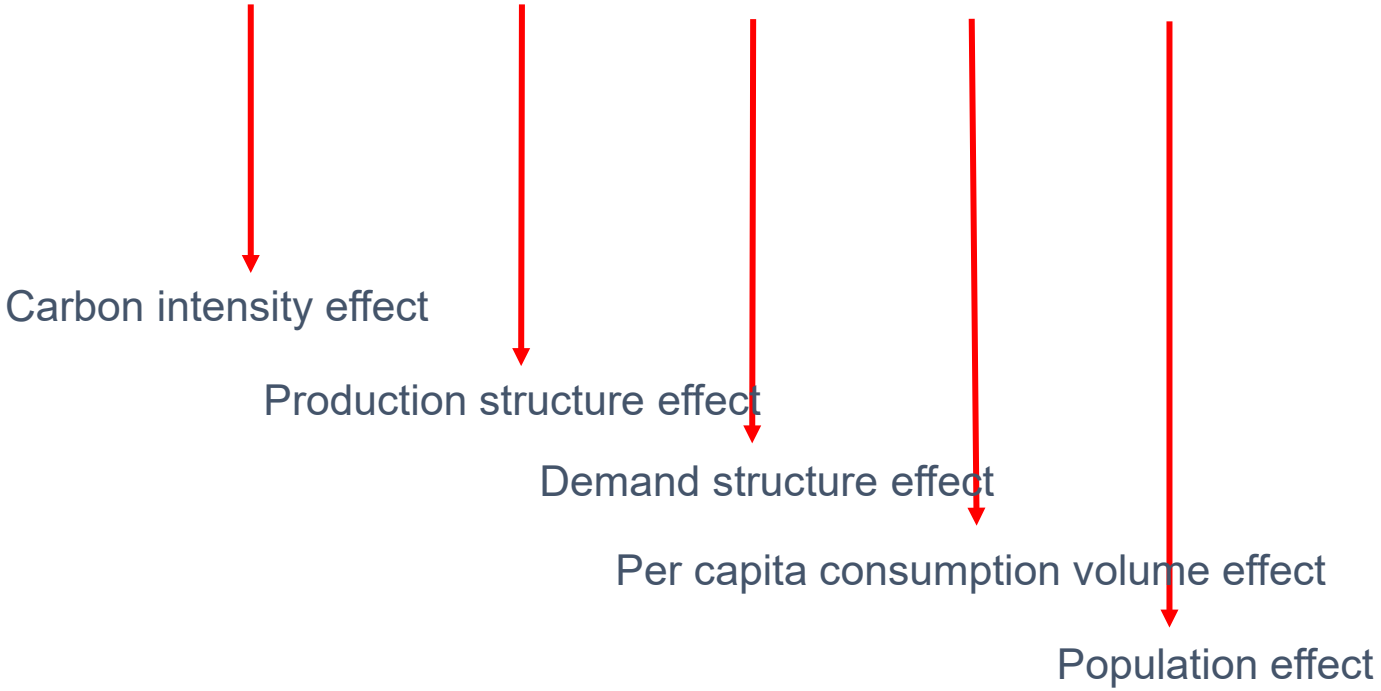
Sector	Intermediate use				Final use				Total output
	1	2	…	n	Household expenditures	Government expenditures	Capital investment	Exports	
1	x_{11}	x_{12}	…	x_{1n}	y_{11}	y_{12}	y_{13}	y_{14}	X_1
2	x_{21}	x_{22}	…	x_{2n}	y_{21}	y_{22}	y_{23}	y_{24}	X_2
…	…	…	…	…	…	…	…	…	…
n	x_{n1}	x_{n2}	…	x_{nn}	y_{n1}	y_{n2}	y_{n3}	y_{n4}	X_n
Imports	M_1	M_2	…	M_n					
Value added	v_1	v_2	…	v_n					
Total input	X_1	X_2	…	X_n					

Factors driving energy-related emissions change

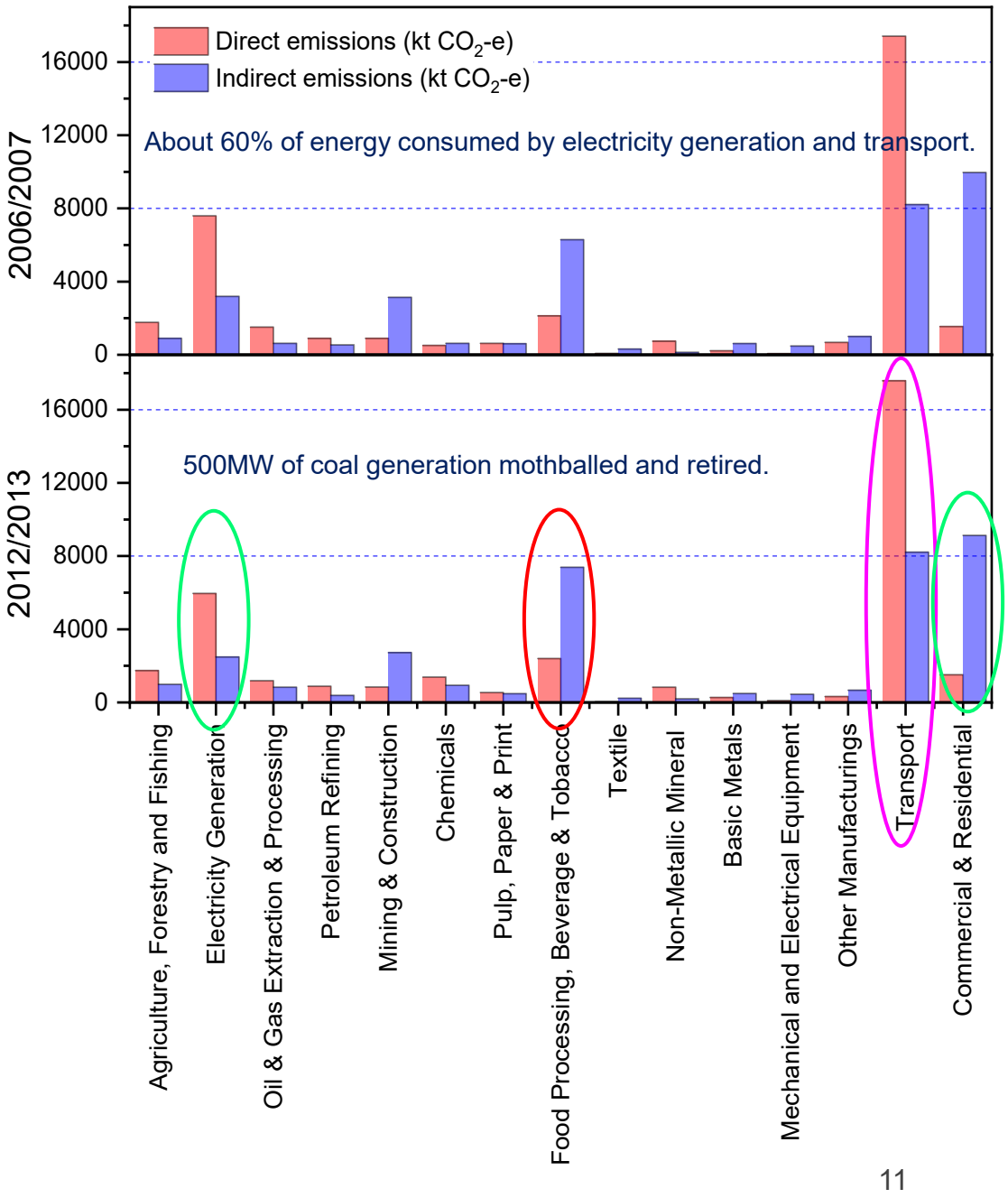


Structural decomposition analysis

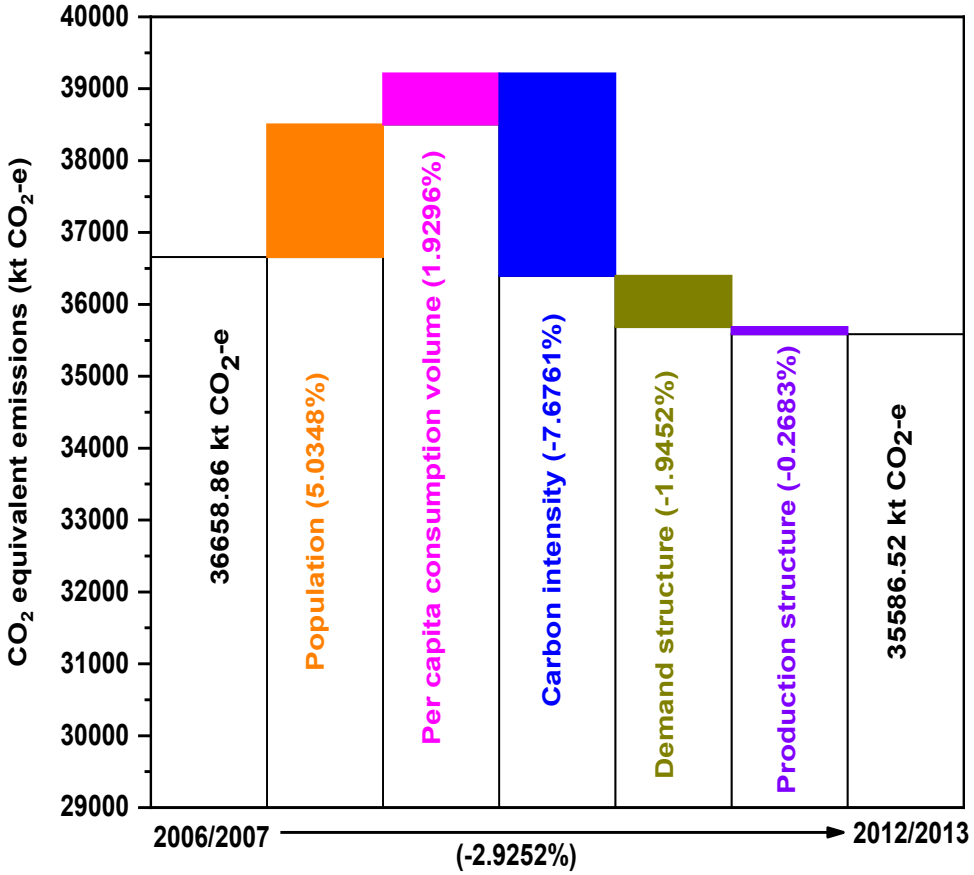
$$\Delta CO_{2\_e} = CO_{2-e}^{T} - CO_{2-e}^{t}$$
$$= (CI^{T} L^{T} D^{T} S^{T} P^{T}) - (CI^{t} L^{t} D^{t} S^{t} P^{t})$$
$$= \Delta E_{CI} + \Delta E_{L} + \Delta E_{D} + \Delta E_{S} + \Delta E_{P}$$



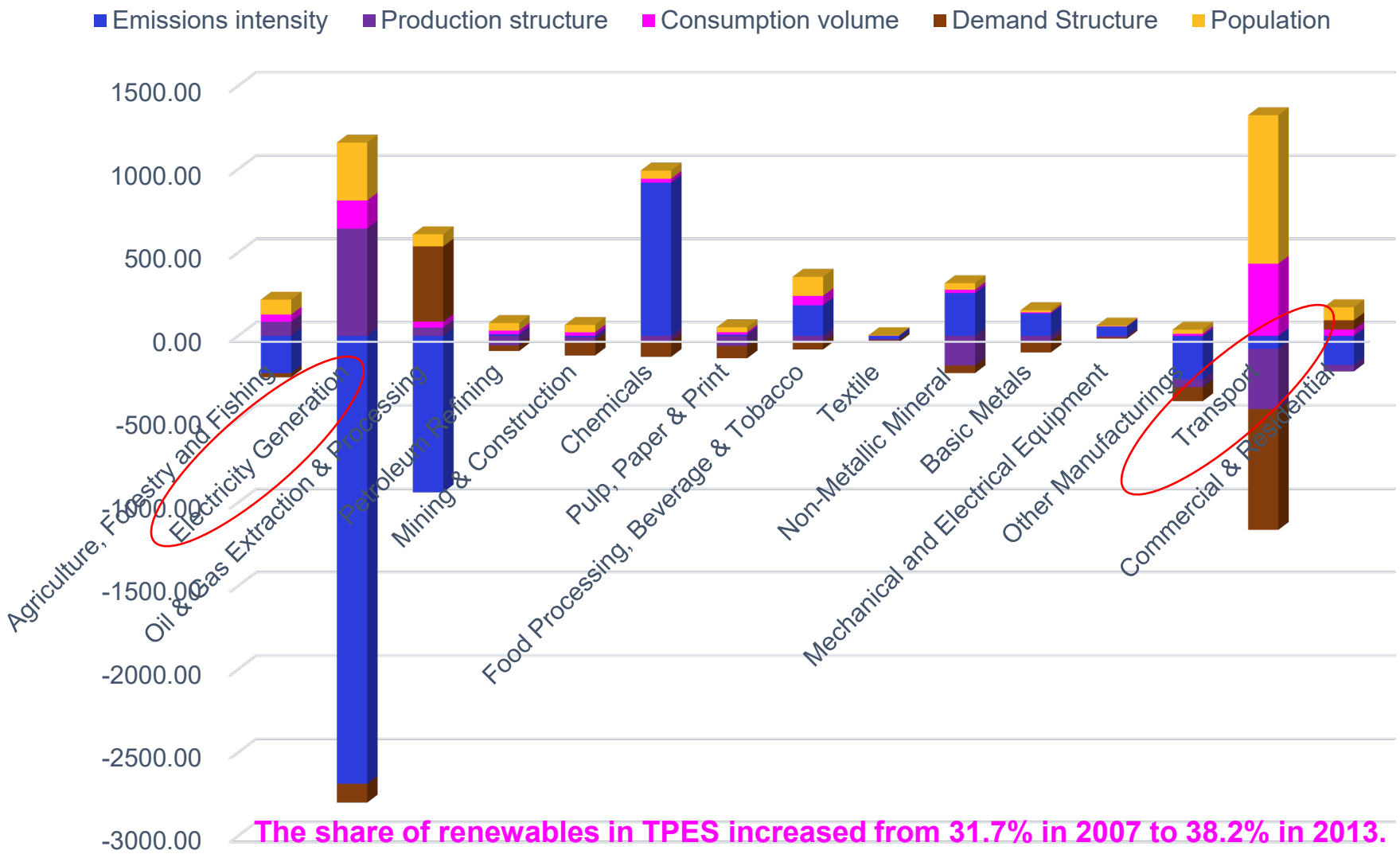
Direct and indirect energy-related CO_2 equivalent emissions by sector in 2006/2007 and 2012/2013



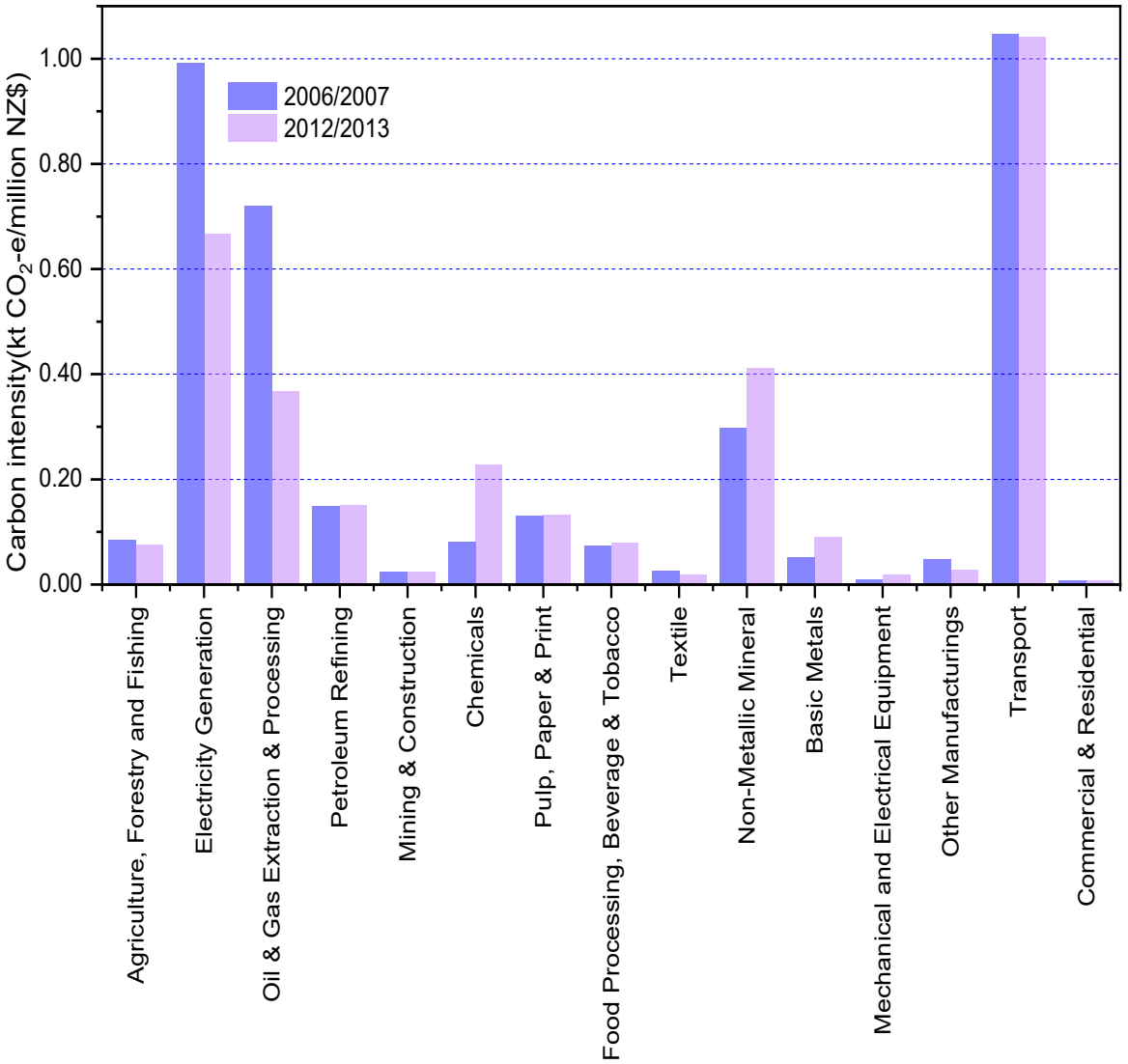
Contribution of each factor to the decrease in energy-related CO_2 equivalent emissions



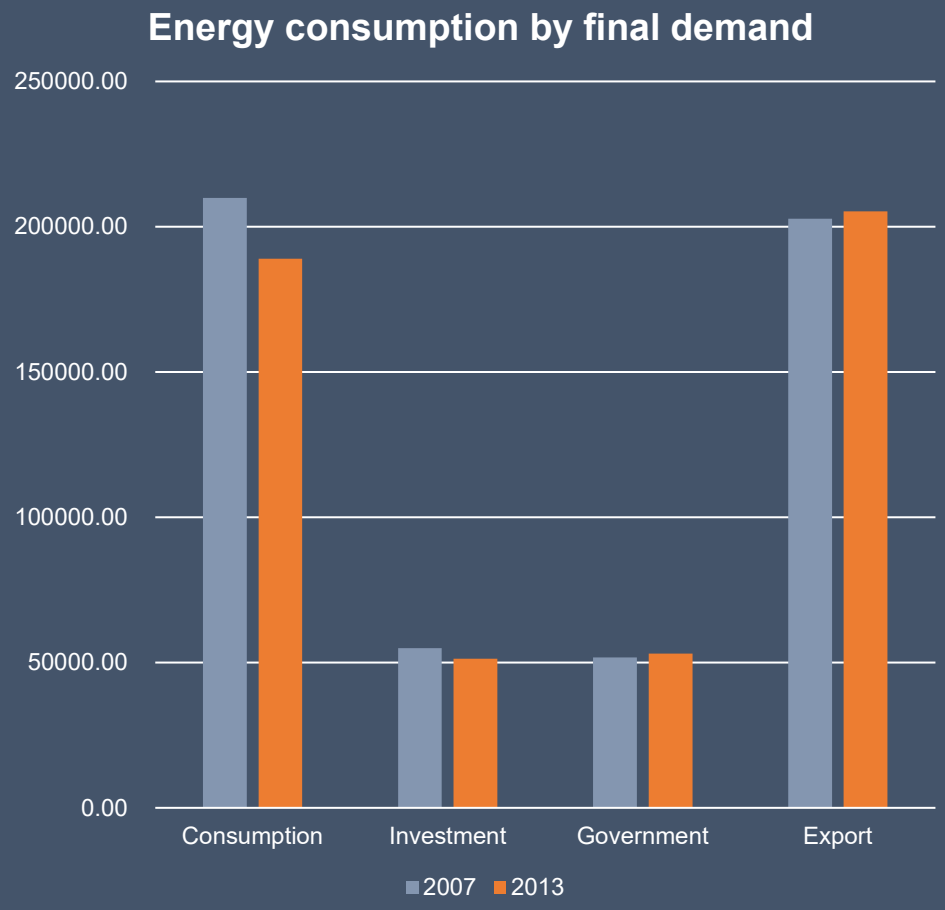
Contribution of decomposition factor to the decrease in energy-related CO_2 equivalent emissions by sector between 2006/2007 and 2012/2013

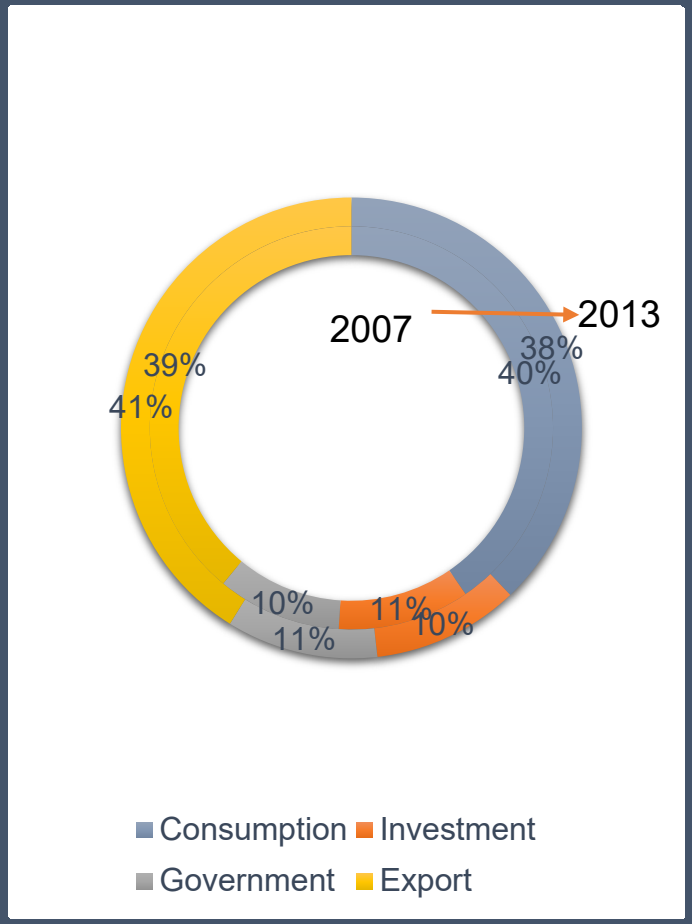


Carbon intensity by sector in 2006/2007 and 2012/2013

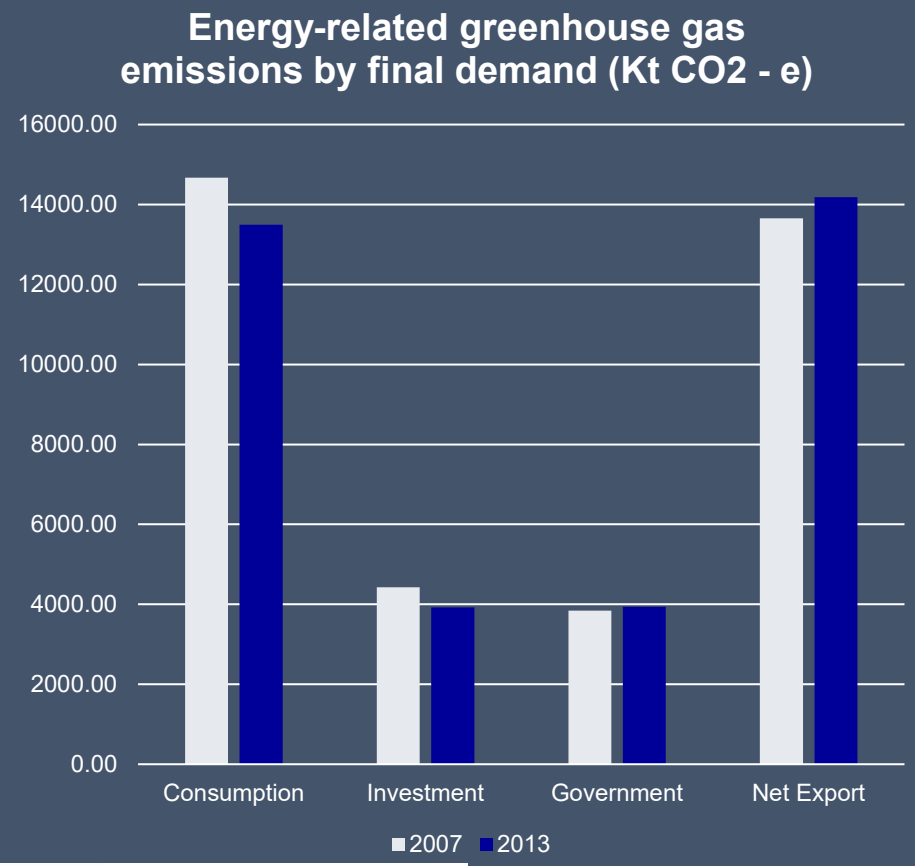


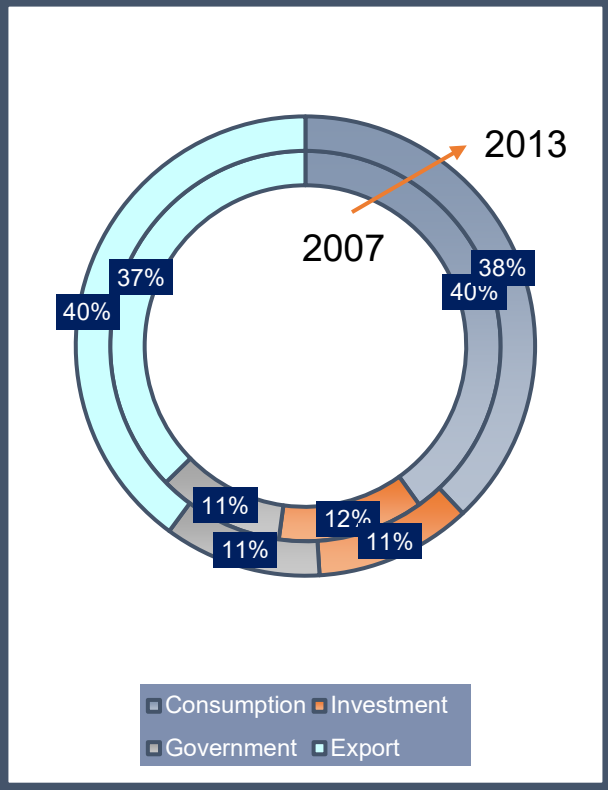
Energy consumption





Energy-related greenhouse gas emissions





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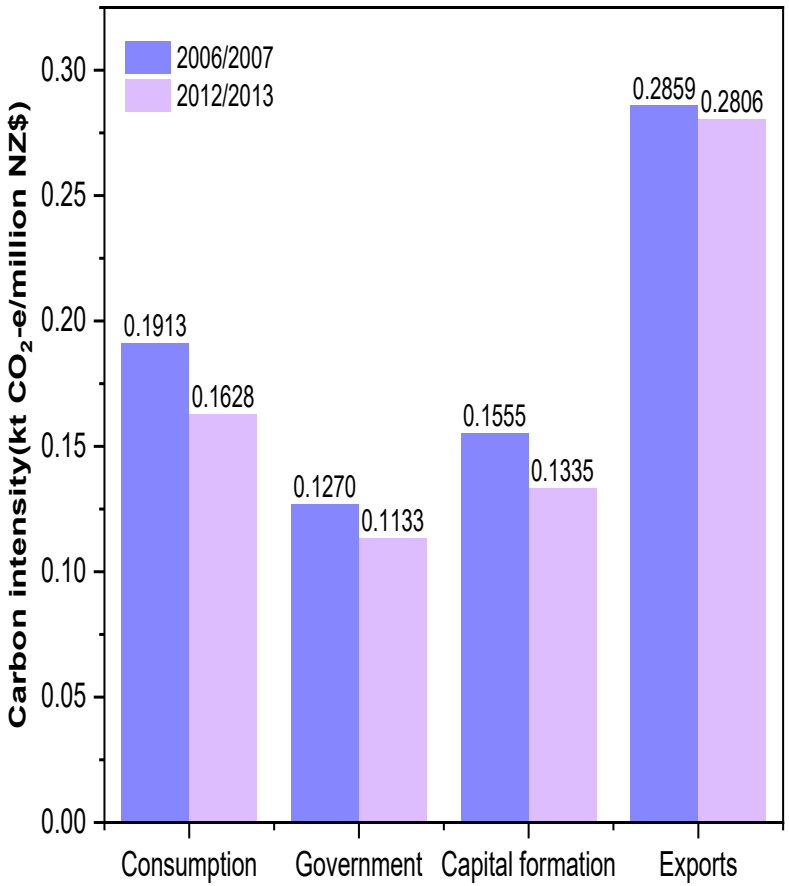
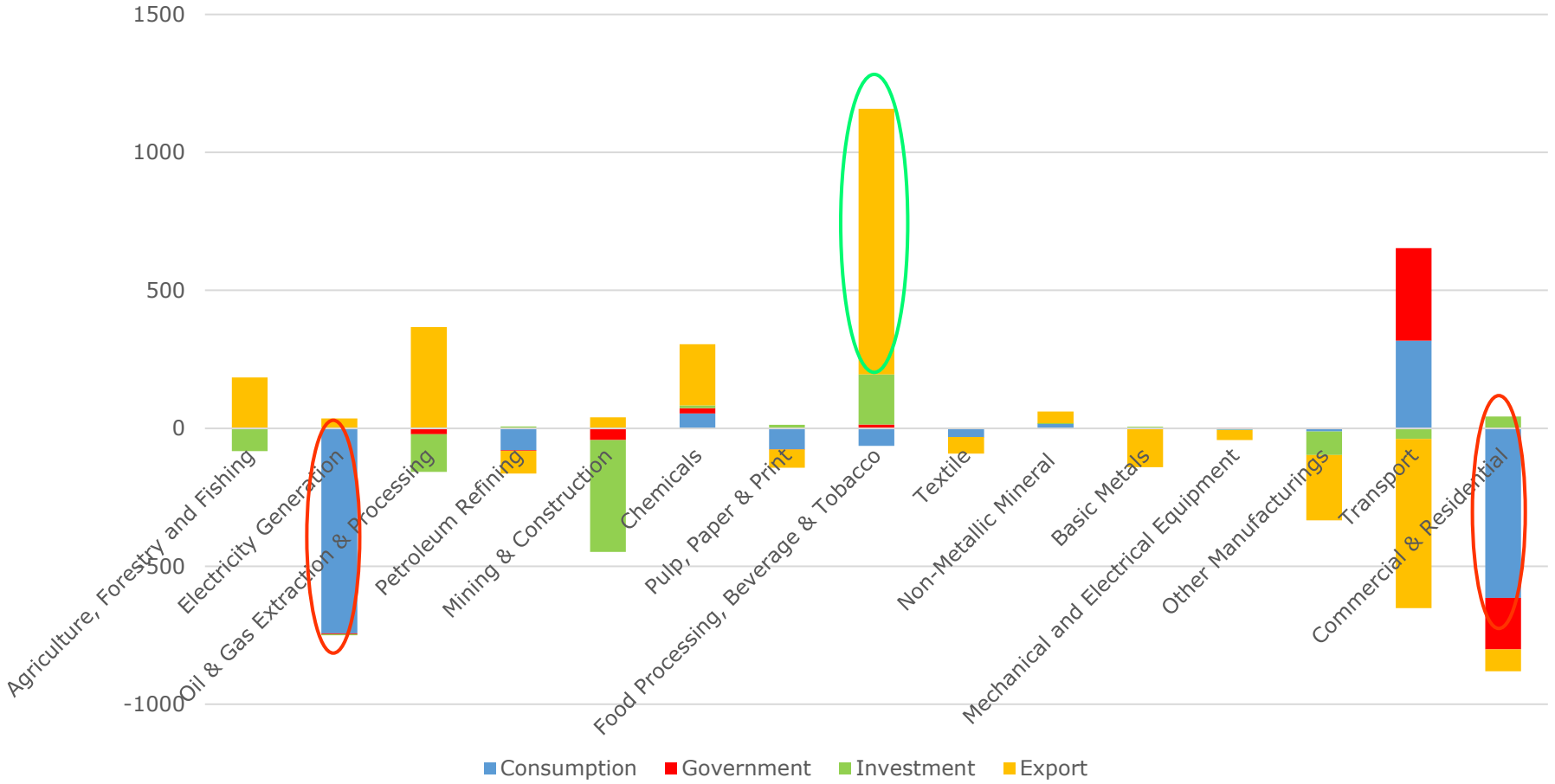
Carbon intensity by final demand category



Energy-related CO_2 equivalent emissions changes during this period by sector and demand component



Conclusions

- Reducing **carbon intensity** has been proven to be the most effective way to restrict the growth of energy-related GHG emissions.
- Changes in the **structure of production and demand** contributed to a decline in energy-related GHG emissions.
- Changes in **population and consumption volume** increased energy-related GHG emissions.
- **Private consumption** and **exports** were the main sources of energy-related GHG emissions.
- **"Energy Generation" and "Transport"** are the two key sectors for decarbonization in New Zealand.

Policy recommendations

- Promoting renewable energy
  - 100% renewable electricity by 2030
  - NZ battery project – pumped hydro storage (Lake Onslow)
  - Hydrogen projects
  - Offshore wind potential coupling with hydrogen production
- Decarbonize transportation - electrification of transport
  - Phase out fossil-fuel vehicles & increase low-carbon transport alternatives
  - Incentives for EV purchases (charging infrastructure, range anxiety, and peer effects)
  - Smart integrated traffic systems
  - Strict emissions standards

Policy recommendations

- Changes in carbon intensity drove emissions up for “Chemicals”, “Non-Metallic Mineral” and “Food Processing, Beverage & Tobacco”.
  - Electrification of those sectors may be a solution to reduce emissions
  - Coal/gas boilers transition
  - Adoption of the efficient production process
  - Replacement of outdated machinery equipment
- Private consumption and exports were the main sources of indirect energy-related emissions.
  - Retrofit insulation schemes
  - Energy-efficient building standards
  - Energy Star certificated appliances, e.g., hot water cylinder and refrigerator, washing machine, etc.
  - Optimize the mix of exports, e.g., increase the share of less carbon-intensive products.

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Thank you for your attention!

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  - Renewable energy & electricity price
  - Energy efficiency & energy consumption
  - EV adoption via consumer behaviour
  - GHG emissions & climate change
  - Offshore wind coupling with hydrogen production
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