

# Distributional Implications of GHG mitigation policies: Methods and Insights

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University of Latvia, Faculty of Business, Management and Economics,  
Towards climate neutrality: economic impacts, opportunities and risks.

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# Rationale (a)

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- The decarbonization of the energy system is not expected to impact uniformly all economic activities
- Countries and sectors producing materials, equipment and services related to reducing GHG emissions (such as RES technologies, batteries, energy saving equipment, RES fuels) will benefit from the transition
- Activities related to the generation of GHG emissions (such as fossil fuel mining/extraction, refineries, fossil based power generation, repair of conventional vehicles) are expected to decline.



# Rationale (b)

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- Changes in the structure of the energy and economic systems will be accompanied by changes in electricity prices and changes in financing requirements: the purchase and operation of energy and electrical equipment/appliances will change from low CAPEX high OPEX to high CAPEX and low OPEX.
- Changes in production levels and prices will affect households' disposable income.
- The impact will not be uniform across households.
- Households whose income is linked to fossil-based activities and low income households (that will face high upfront costs in purchasing energy saving equipment) will both be negatively affected.

# Rationale (c)

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- General equilibrium models often feature one representative household over the national economy. This aggregation although useful when large scale modelling is required (covering many countries and for many years) may mask critical insights regarding distributional implications among household types.
- This study uses a large scale CGE model soft-linked with a bottom up representation of multiple households in order to assess the distributional implications across households of EU ambitious GHG mitigation policies



# Metrics for Distributional Implications

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- Identification of the determinants of income inequality in a clean energy transition context
  - **Income Inequality:** i) Gini coefficient (among countries, among households), ii) Generalised entropy index, iii) Atkinson index...
- Identification of the determinants of energy poverty and affordability in a clean energy transition context
  - **Energy poverty can be dynamically** defined as the intersection of: i) below a low income threshold and b) above a threshold of energy costs as a ratio over income

# Essential Data (a)

Type of data	Variables	Source
Structure of population	Number of households	SILC
	Household size	
	Main occupation	
Income	Income sources per occupation	SILC
	Benefits and allowances	
	Dividends and property income	
	Transfer payments	
	Saving rates	Eurostat
Expenditures	Taxes	SILC
	Transfers	
	Consumption per purpose	HBS
Indicators	Energy poverty	Calculated
	Income inequality	Eurostat

# Essential Data (b)

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- Consumption by purpose (COICOP) by household and income class
- Sources of income of each income class: Labour, firms ownership, social benefits, pension...
- Distribution of income in each income class / Number of households / Household members



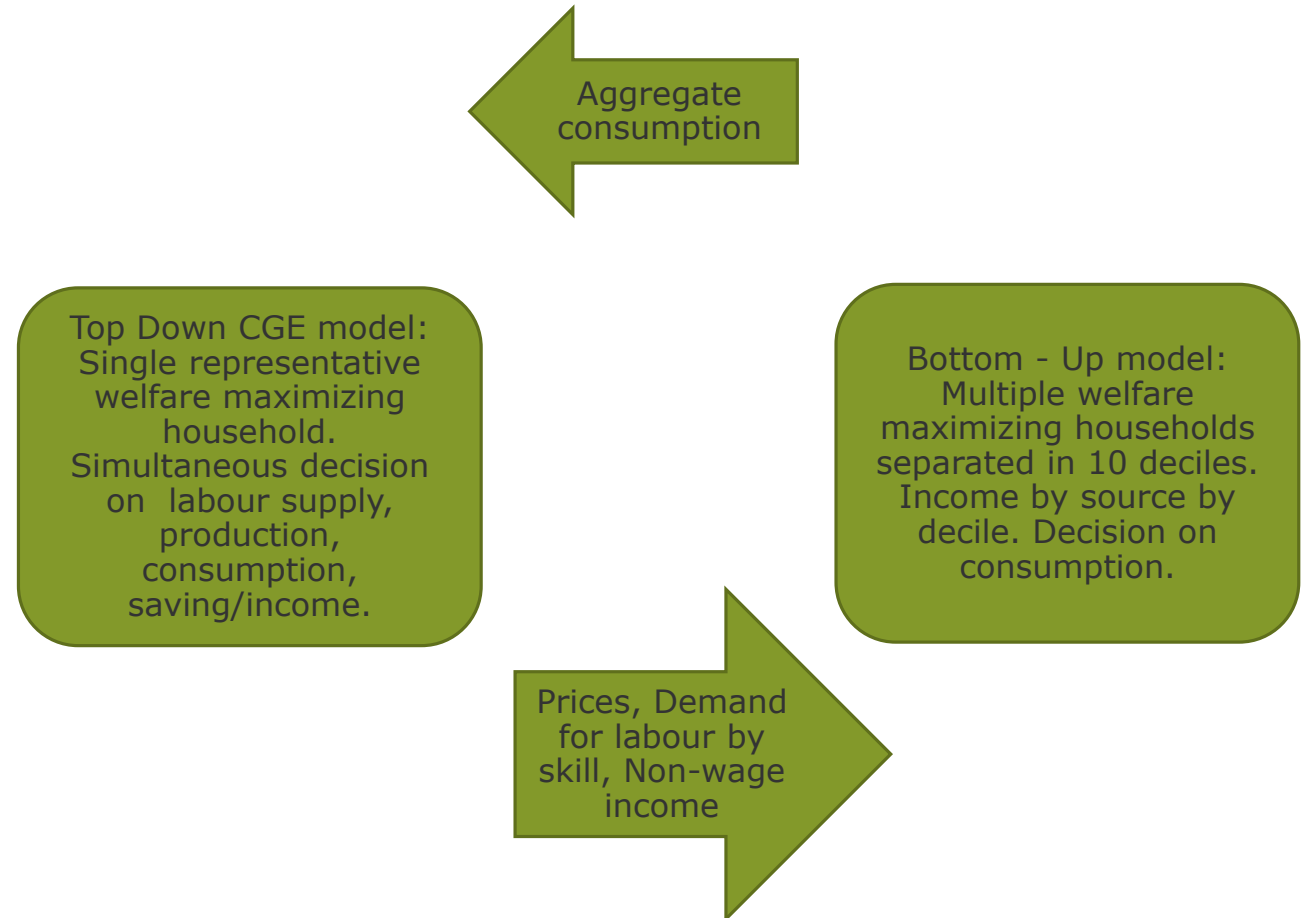
# Methods

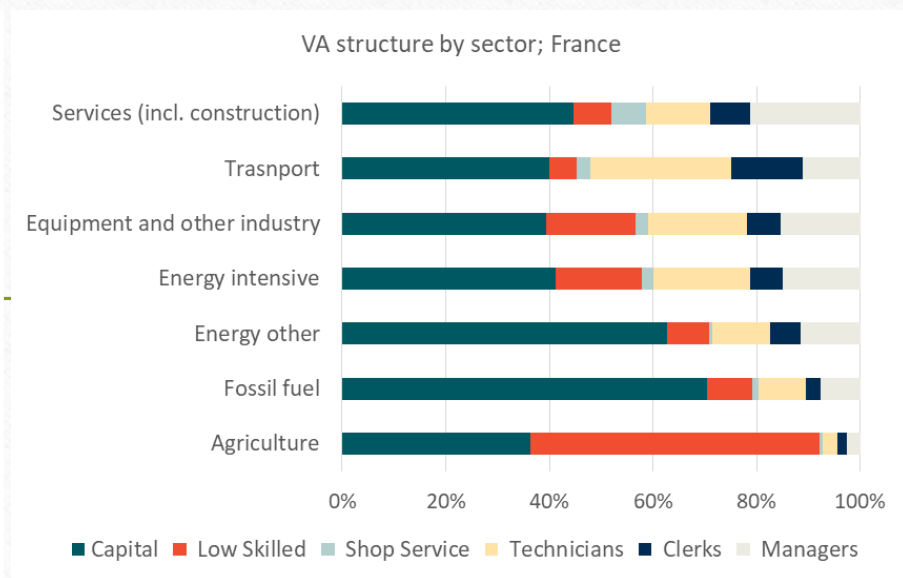
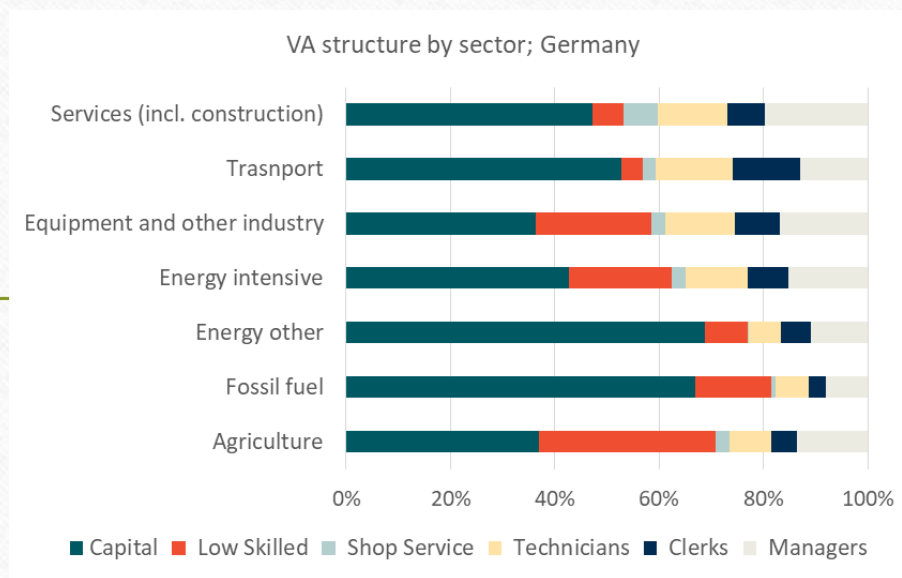
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- **Hard link:** Integration to the CGE model of many representative households (see Harrison et al, 2003 ; Rutherford et al, 2002 ; Vandyck and Regemorter, 2014 ). Consumption, production and income related decisions are taken simultaneously.
- **Sequential - Open loop - Soft link:** Two models are developed. A CGE model with single representative consumers and a satellite module with multiple or “real” households. The top down and bottom-up models are linked through a sequential exchange of prices, incomes and demands until an equilibrium or near equilibrium point is established. Depending on the implementation (Rutherford and Tarr (2004) and Rausch et al (2011) ) this may include many representative households or full representation of real households (i.e. one by one or microsimulation).



## Soft Link



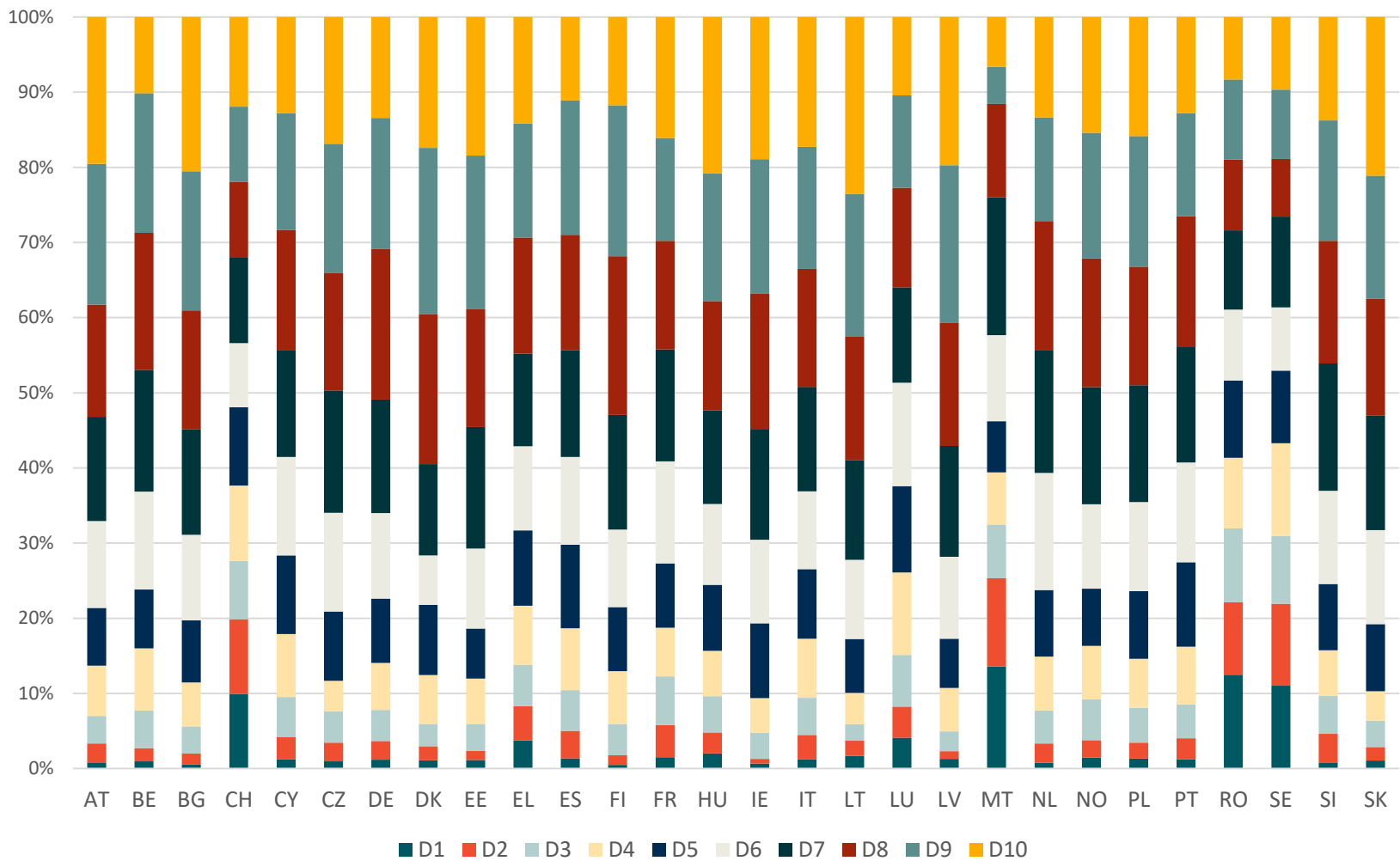


## Source of Income by occupation, source for each EU MS

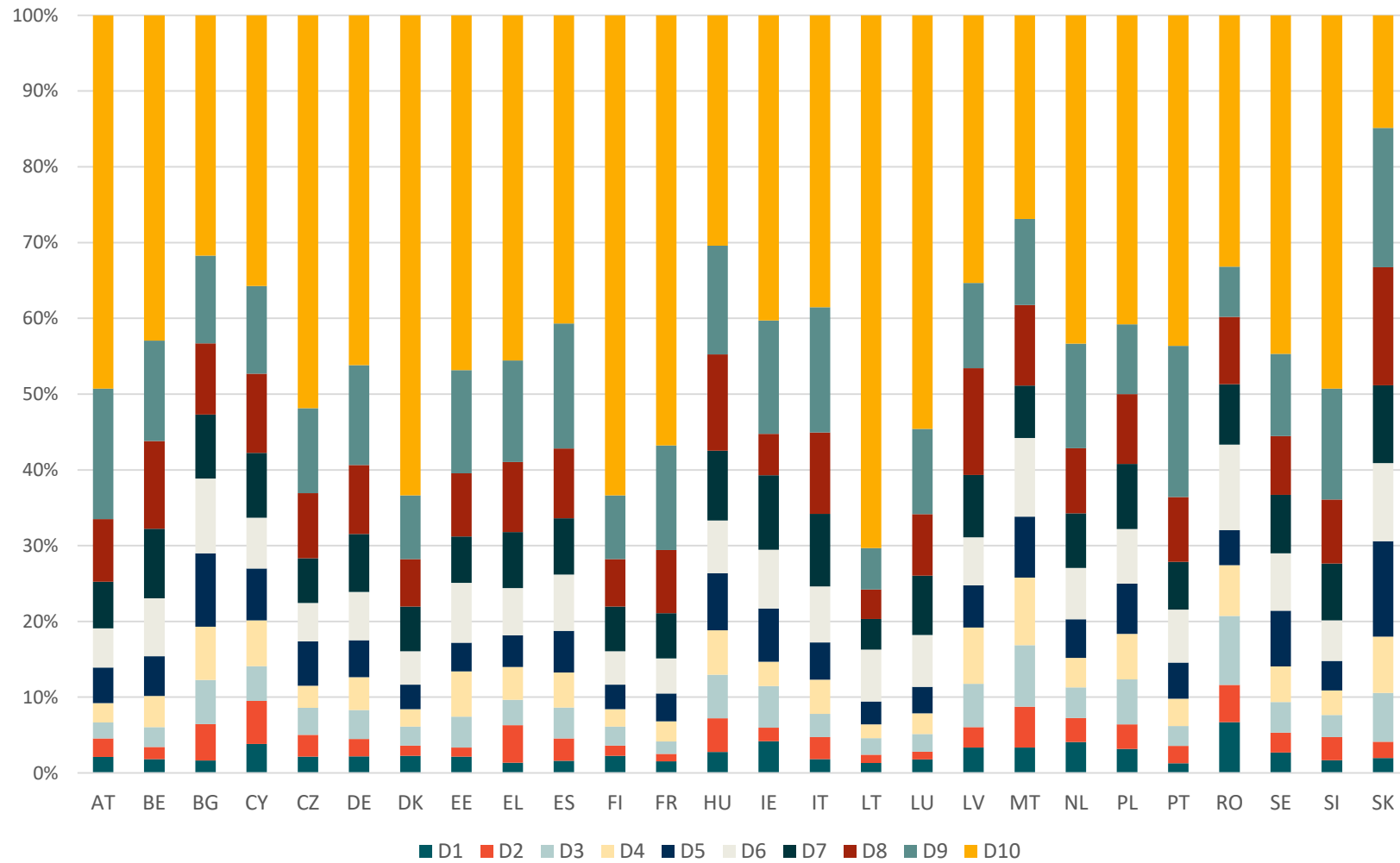
- ✓ low skilled wage income across deciles for each Member State
- ✓ wage income from service workers
- ✓ wage income from technicians and professionals
- ✓ wage income from clerks
- ✓ wage income from managers
- ✓ income from dividends
- ✓ income from benefits and allowances



Distribution of low skilled wage income across deciles for each Member State



Distribution of income from dividends by income decile





# Critical Issues

- The transformation of the energy system requires the timely coordination of many factors (infrastructure, maturity of technologies, availability of skills and financial resources etc...)
- Timely availability of human capital is essential to avoid capacity constraints and bottlenecks
- The transformation of the energy system and increasing energy bills may affect disproportionately households – not only through prices but also through income
- It is important for applied CGE models that are used to evaluate the socio-economic implications of energy and climate policies to capture the impacts on vulnerable income groups and calculate compensating measures
- Micro data are essential for this purpose – challenges in reconciling them with macro data

Thank you



# References

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- Harrison, Glenn W, Thomas F. Rutherford and David G. Tarr (2003), “Trade Liberalization, Poverty and Efficient Equity,” *Journal of Development Economics*, 71, June, 97-128.
- Rutherford, Thomas F. and David G. Tarr (2002), “Trade Liberalization, product variety and growth in a small open economy: a quantitative assessment,” *Journal of International Economics*, 56 (2), March, 247-272
- Vandyck, Toon & Regemorter, Denise. (2014). Distributional and regional economic impact of energy taxes in Belgium. *Energy Policy*. 72. 190–203. 10.1016/j.enpol.2014.04.004.
- Thomas Rutherford, David Tarr, (2004), “Poverty Effects of Russia’s WTO Accession: modelling “real” households and endogenous productivity effects” The World Bank, available at <http://documents.worldbank.org/curated/en/647481468780907855/Poverty-effects-of-Russias-WTO-accession-modeling-real-households-and-endogenous-productivity-effects>

# Literature: Multiple Households in a CGE framework

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- Methods:
  - "Incorporating household survey data into a CGE model", Xiao-guang Zhang, Australian Productivity Commission, GTAP, 2019
  - "Factor proportionality in multiple households closed CGE models: theory and illustrations", Yves Balasko, Octavio Tourinho, Econ Theory Bulletin, 2014
  - "Households heterogeneity in a global CGE model: an illustration with the MIRAGE-HH (MIRAGE-HouseHolds) model" Antoine Bouet, Carmen Estrades, David Laborde, 2013
- Applications:
  - 3,373 HHs for Nepal CGE (Cockburn, 2001)
  - 24,979 HHs for CGE of the Philippines (Cororaton & Cockburn, 2005)
  - 55,000 HHs for Russian CGE (Rutherford et al. 2005)
  - 3,278 HHs for CGE of Senegal (Annabi et al. 2005)



# Vulnerable Consumer

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- For the purpose of regulating universal service obligation for electricity supply, regulators need to define the concept of vulnerable consumer. For example, the Energy Community has adopted the following definition: A) the consumer does not exceed a basic level of electricity consumption per household (e.g. up to 200 kWh/month for a family with up to 4 members. B) The household belongs to a category of with lowest income. C) Have electricity consumption supplied through single-phase meter with a connection not exceeding up to 16 (or 8) Amperes.
- The proposed definition for a socially vulnerable customer in the gas sector is as above, except that consumption levels under the first point are total consumption of up 70 cubic meters/month.
- The regulatory measures for vulnerable consumers are usually including the following: A) protection from disconnection in the event of non-payment. B) Social tariffs (below cost). C) Deferred payments.

# Literature: Income Inequality Analysis in models

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1. Hans Lofgren, Sherman Robinson and Moataz El-Said, "Poverty and Inequality Analysis in a General Equilibrium Framework: The Representative Household Approach", Ch 15
2. "Methods for including income distribution in global CGE models for long-term climate change research", Bas J. van Ruijven, Brian C. O'Neill, Jean Chateau, Energy Economics, 2015
3. Franziska Schünemann, "Economy-wide policy modeling of the food-energy-water nexus: identifying synergies and tradeoffs on food, energy, and water security in malawi", 2017, Faculty of agricultural sciences, University of Hohenheim
4. Decaluwe, B., A. Patry, L. Savard et E. Thorbecke, "Poverty Analysis Within a General Equilibrium Framework", Cahier de recherche 99-09, CREFA, Département d'économie, Université Laval , 1999.
5. Decaluwé, Bernard, Jean-Christophe Dumont and Luc Savard (1999), "Measuring Poverty and Inequality in a Computable General Equilibrium Model", Cahier de recherche 99-20, CREFA, Département d'économie, Université Laval , 1999.
6. A Methodological note on computing FGT indicators from CGE models, by Dorothee Boccanfuso and Luc Savard (2001).
7. Procedures for conducting poverty/distribution analysis of CGE simulation results with DAD, by John Cockburn (2001);