ESTAP, December 2012

Soft-linking EMEC (TD) and TIMES-Sweden (BU) to improve energy and climate policy analysis

Anna Krook Riekkola, Luleå University of Technology (LTU)
Charlotte Berg, National Institute of Economic Research (NIER)
Erik Ahlgren, Chalmers University of Technology
Patrik Söderholm, Luleå University of Technology

The project is financed by the Swedish Energy Agency

CHALMERS

Project Aim

- The overall aim has been to develop a method for how to soft-link a CGE model with an Energy System model to improve energy and climate policy decision process.
- The philosophy has been to define a method that is transparent and where the strengths in both models are maintained.

CGE: EMEC (Environmental Medium term Economic model a general equilibrium model)
- Strengths: Provides a consistent description of how different economic sectors interact with each other.

Energy system model: TIMES-Sweden
- Strengths TIMES-Sweden: Provides a technology detailed description of the energy system and capture the most important interactions within the energy system.

Soft-linking EMEC and TIMES-Sweden Step by Step

1. Identify basic differences between the models.
2. *Identify common exogenous variables and decide which assumptions to use. For example import fuel prices, policy instruments.*
3. Identify overlapping model domain:
   - Map industry and sectors.
   - Identify the dominant model, when overlap.
4. Develop “translation models” – Decide how the model should “talk to each other”.
5. Calibration of a reference scenario.
6. Policy analysis.

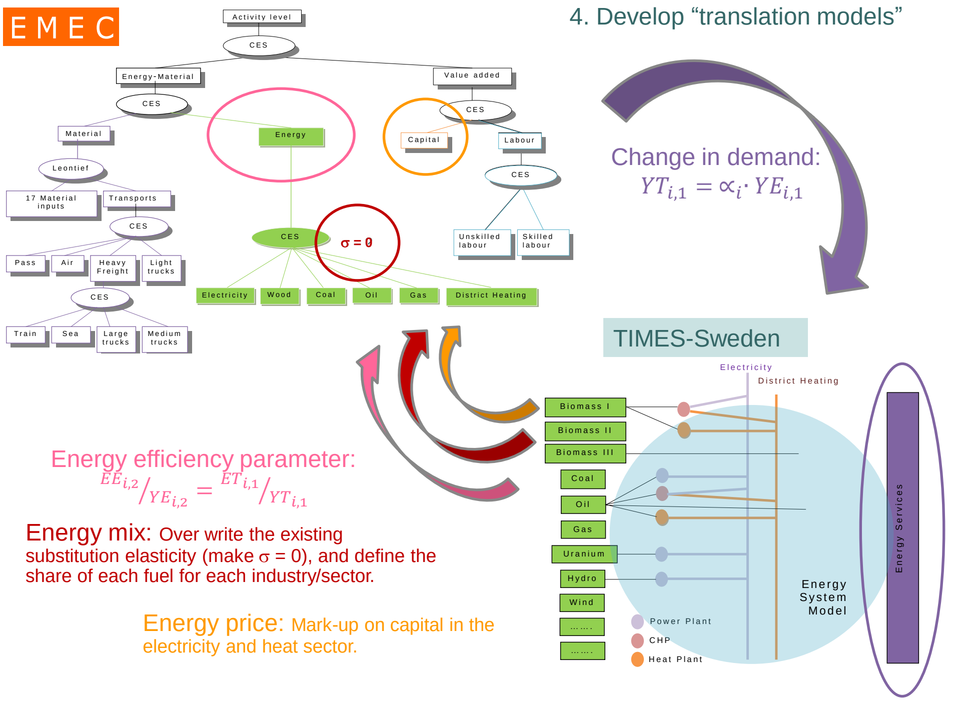
1. Identify basic differences

- Different flows are represented in the models
  - TIMES-Sweden focuses on physical flows of energy, materials, emission and certificates.
  - EMEC focuses on monetary flows from energy, materials, capital and labour, and in addition calculates emissions in metric tonnes.
- Different breakdown of industries and sectors
  - TIMES-Sweden is based on energy statistics and follows the industry and sector breakdown in the energy statistics.
  - EMEC is based on national accounts and follows the industry and sector breakdown in the national accounts.

3. Identify overlapping model domain

- Identify industry and sector breakdown in each of the model and map how they correspond with each other.
  - Which segment goes with which?
  - What does it mean that the segment/sector is growing?
    - EMEC: Internal trade within a sector can also generate growth
  - What to do when sectors don't match?
    - Sometimes it doesn't matter: what is big in the economy does not always have a big energy demand.

- Whenever overlapping endogenous variables: Identify the "dominant" model, and which model that should adapt.



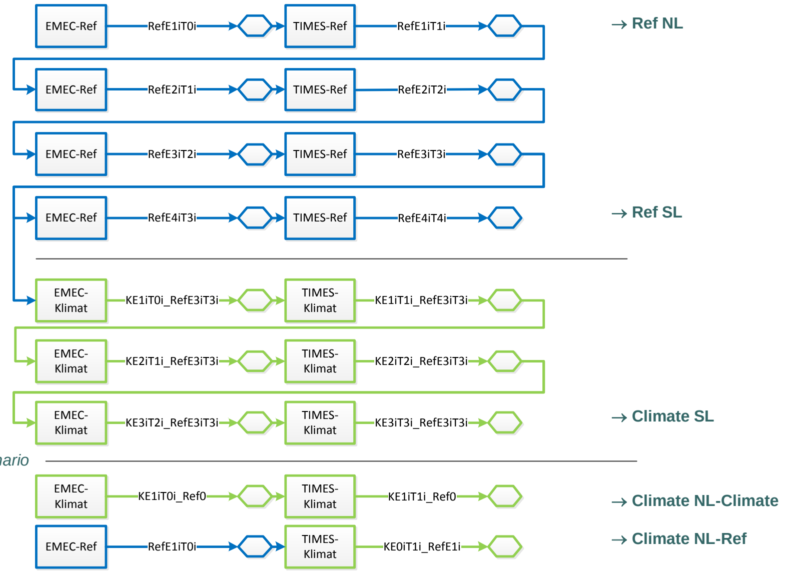
5. Reference Scenario
6. Policy analysis

- Reference scenario:
  - Philosophy: A reference scenario puts the economy and energy at the "right level".
  - Assumptions: Long-term scenario developed at the NIER (without energy efficiency parameters).
  - Question: Will the iteration between the models change the reference scenario?

- Climate scenario:
  - CO_2-taxes in the non ETS sectors increased with 50%
  - CO_2-prices within EU ETS increases to 30 €/ ton CO_2 in 2020 and stays on this level over the modelling period (2035).

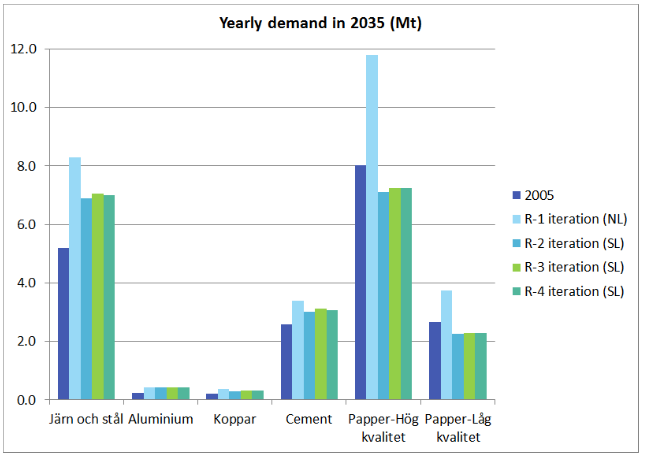
This is an illustrative example – We have not evaluated to what extent the results are plausible.

Iteration process



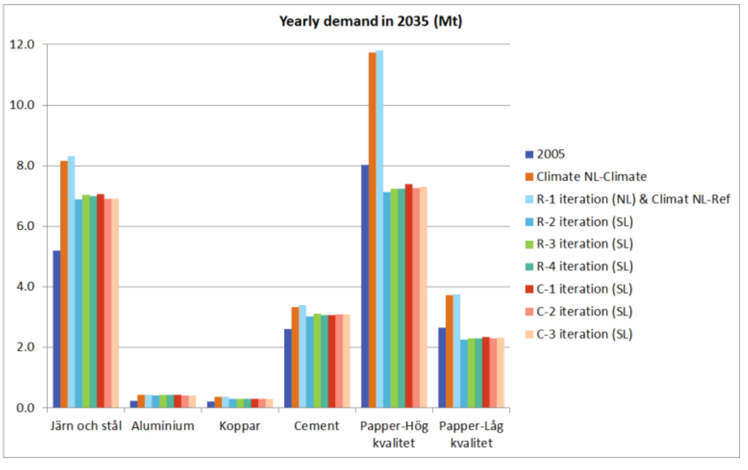
Ref: Reference Scenario
K: Climate Scenario
E: EMEC
T: TIMES-Sweden
xi: iteration nr x
NL: No Linking
SL: Soft-Linking

Change in demand as an input to TIMES from EMEC through the Transition model



NL: No Linking
SL: Soft-Linking

Change in demand as an input to TIMES from EMEC through the Transition model

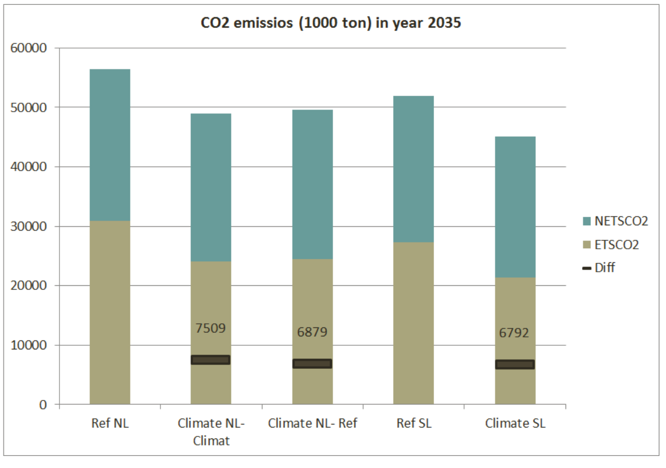


NL: No Linking
SL: Soft-Linking

Iteration process – Some conclusions

- Reference Scenario:
  - The difference is greatest for the energy-intensive industries.
  - Fuel mix change as the energy decreases.
  - The electricity price has been proven an important component
- Climate Scenario:
  - Economic development: Relatively small effects on industries' economic development.
  - Fuel use in TJ: Relatively large differences in fuel use in the electricity and district heating sector.
  - Choice of fuel: Large differences in the choice of fuel for road transport (freight, public transport and car traffic).
  - Fuel mix: The fuel mix changes differently than in the reference iteration.

Resulting CO_2-emissions in year 2035, and the reduction between the Reference and the Climate scenario



NL: No Linking
SL: Soft-Linking

ETSCO2: CO_2 in Emission Trading Sectors
NETSCO2: CO_2 in Non ETS

Main Conclusions

- Provides a consistent and transparent picture of the economy and energy.
  - Soft linking gives a new picture of the economy's energy use compared to model results without soft linking.
- The first iteration result in a significant adaptation of the economy affecting the energy use. The following iterations only result in smaller changes.
  - Essential that the demand represents the scenario assumptions
- Soft-linking has improved the result from the individual models
  - EMEC: The energy feed-back is proven to be important to get a consistent picture of the economy.
  - TIMES: The demand from EMEC provides a more transparent and consistent assumption, effecting both the resulting energy mix and quantity.

Further development

- Run a full scale scenario analysis
- Further analysis of the underlying mechanisms that effect the interaction between the energy system and the rest of the economy.
  - Improve the “Translation parameter” in the Translation model.
  - Investment Patterns.
- Develop the individual models in order to be able to exchange more information between the models.
  - EMEC: Expand the power plant file (incl. wind, hydro, etc.) allowing for greater coherence between price and investment in the two models.
  - TIMES: Allocate maintenance costs based on employees.

Soft-linking of EMEC and TIMES-Sweden
Opens up for new possibilities to study different policy packages of applicable regulations and taxes

Questions?

Anna.Krook-Riekkola@ltu.se