Energy technology and energy economics: Analyses of energy efficiency policy in two different model traditions

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Background

- Models are widely used for energy policy analyses
  - Top-down (economic) models
    - Behaviour of economic agents
  - Bottom-up (technology) models
    - Detailed technologies
  - Hybrid models
    - Demand effects in bottom-up models
    - Technology details in top-down models
- Why do the results differ?
  - Competitive market and social planner’s optimal solution should be similar
- Our focus is on the methods:
  - Differences and similarities between engineering and economics applications
  - Example: Analyse EU’s energy efficiency policy in 2030, applied to Norway

The numerical models

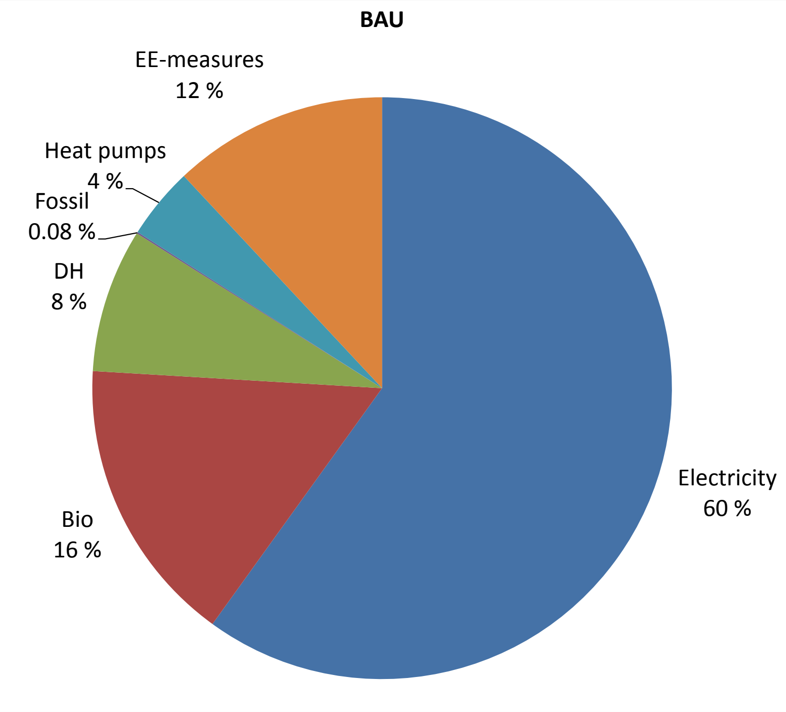
- Bottom-up (technology) model TIMES-Norway (IFE)
  - Partial model of the Norwegian energy system
  - Technology optimization model
    - Which combination of technologies and energy carriers minimizes the total system costs of meeting *given demand for energy services*?
  - Detailed description of current and future technology options
- Top-down (economic) model with hybrid features SNOW-NO (SSB)
  - General equilibrium model (CGE) of the whole Norwegian economy
    - Modelling of energy goods is less detailed than in TIMES
    - But energy markets are part of the wider economic context
    - Interactions between all markets
  - Market agents optimize
    - Consumers and producers maximise utility and profit
    - Supply and demand effects in the markets
  - Technologies are “aggregated” to substitution elasticities
    - Mostly based on historical or current data
    - NB! Investments in energy efficiency measures in households include the same technologies as in TIMES

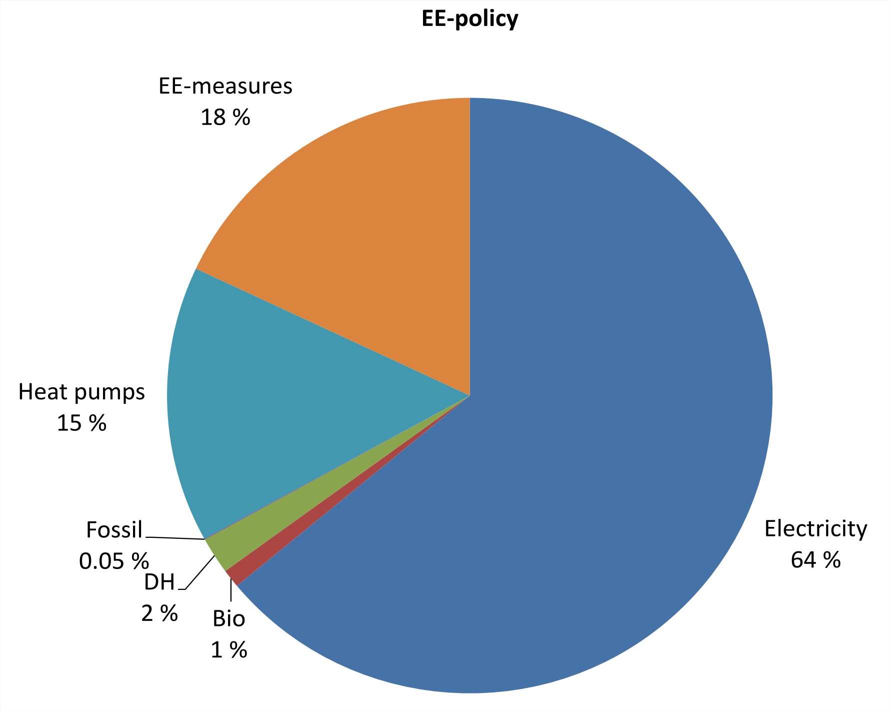
Modelling of energy efficiency policies

- Energy efficiency policies in EU and Norway focus on residental buildings
  - ➢ Increased energy efficiency in housing (for heating purposes) in 2030
- Baseline scenario for 2030
  - – Similar assumptions in TIMES and SNOW based on
    - Ministry of Finance (2013) long term projections for key economic indicators
    - Adopted energy and climate policies («New 2030 Policy»)
- Energy efficiency policies in 2030
  - – TIMES: 27% reduction in households’ use of purchased energy
    - Energy efficiency investments (insulation etc.)
    - Change in energy production technologies
  - – SNOW: 27% reduction in energy use for heating purposes
    - Energy efficiency investments (insulation etc.)
    - Reduced demand for housing services

Results: Households' energy use in TIMES

- Demand for energy services fixed
  - No change in behaviour
  - Composition effects:





Energy for heating purposes in households in BAU and EE-policy scenarios. 2030

Results: Comparison

- In TIMES-Norway: No behavioural changes
  - Demand for energy services fixed
  - 27% cap on purchased energy use:
    - Heat pumps become profitable and replace district heating and bio-energy (firewood)
  - Households' electricity use increases by 1%
  - Domestic electricity price does not change
  - No repercussions to the rest of the economy
- In SNOW-NO: Behavioural changes drive the results
  - 27% reduction in energy use
    - Investments in energy efficiency measures
    - Households' electricity demand is reduced a lot
    - Demand for housing services is reduced
    - Substitution towards other goods and services
  - Domestic electricity price falls
  - Electricity intensive industries expand

Results: Energy use and costs

Percentage change from baseline scenario	SNOW-NO	TIMES-Norway
Household electricity consumption	-26.7	1
Household energy consumption	-27.0	-27
Demand for housing services (SNOW) Demand for energy services (TIMES)	-5.8	0
Use of dwelling capital	-3.2	n.a.
Domestic price of electricity	-15.5	-1
Welfare	-1.0	n.a.
System costs	n.a.	3

Explanation behind the different outcomes

- Demand response effects omitted in TIMES
  - Disregard repercussions and interactions between different markets
- Technology details omitted in SNOW
  - Non-marketed energy (heat pumps, solar) is potentially important
    - Different energy carriers included, but not different technologies using the same energy carrier
  - However, the “aggregation” of detailed energy efficiency measures into elasticity of substitution performs well

Closing remarks

- Our comparison illustrates the importance of using different approaches when designing and evaluating policies
  - The models emphasize different aspects of energy policy effects
  - The models complement each other
    - Overlook important information if focus either on technology effects or on economy-wide effects
- Learning about each others' approach
  - The analyses provide quality checks of each other
  - Common language and better understanding of the other approach is part of the learning
  - Whether to strive for hybrid models or to use the different approaches together and iterate is less important

Thank you for your attention!

Bye. B., K. Espegren, T. Fæhn, E. Rosenberg, O. Rosnes (2017):

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