Danish Energy Agency

IntERACT

Working with TIMES and Monte Carlo in a Policy Setting

72TH SEMI-ANNUAL ETSAP MEETING, ETH Zürich, Switzerland*, December 11, 2017*

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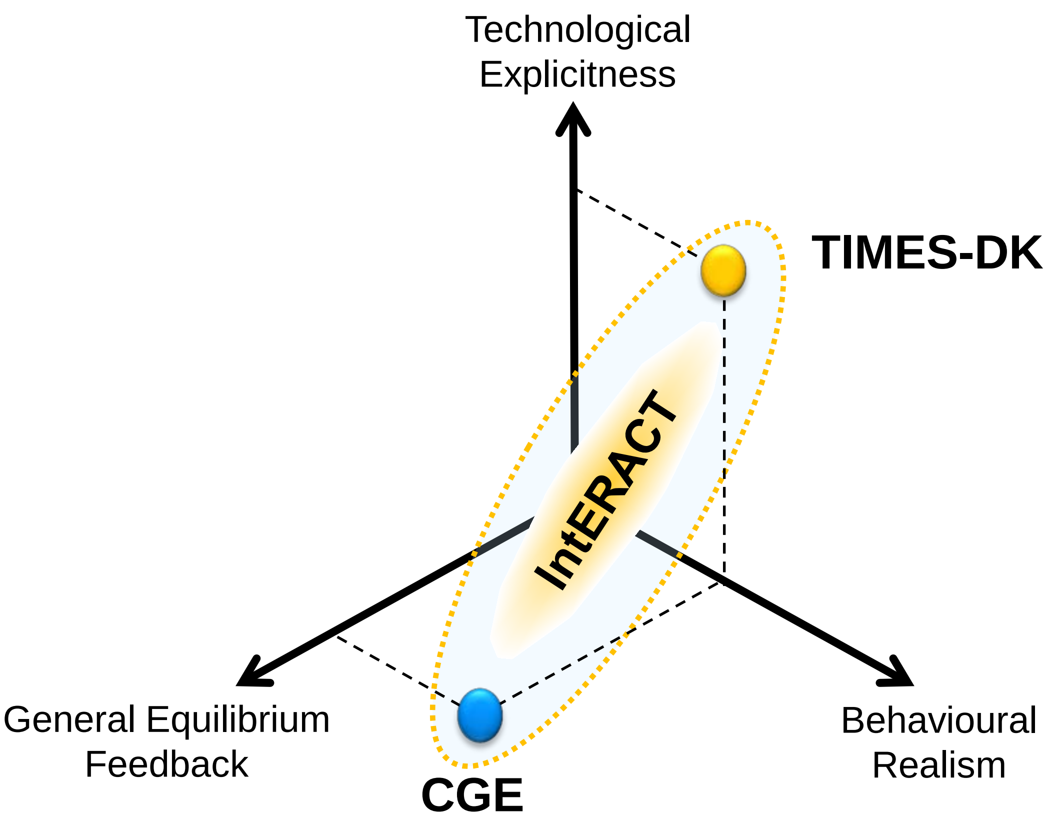
IntERACT

Integrated Energy and Economic Tool



Developers:

Danish Energy Agency

DTU

e4sma

Agenda

1. Why consider uncertainty

2. Implementing uncertainty in the IntERACT model

3. Working with uncertainty in a policy setting

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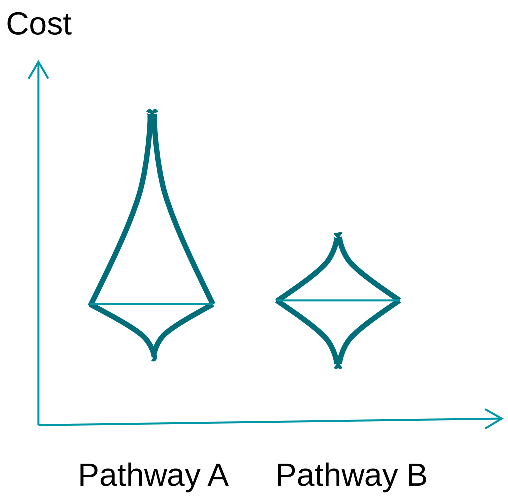
IntERACT

IntERACT: Two optimizing criterias

1. Determine least cost low carbon transition pathways

2. Minimize costs of pathway uncertainty related to:
   - ❑ Investment cost
   - ❑ Fuel and emission prices
   - ❑ Policy
   - ❑ Behavior



Why we consider uncertainty

Externally

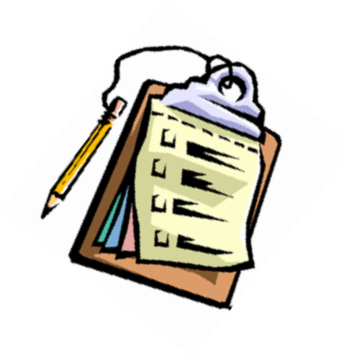
1. Means of quantifying the uncertainty associated with a policy proposal
2. Facilitates dialogue with stakeholders as it provide additional insight into a complex model (opening the black box)

Internally

1. A means of testing the model and identifying possible weakness in assumption and model structure
2. Gives a higher degree of confidence in the model

Agenda

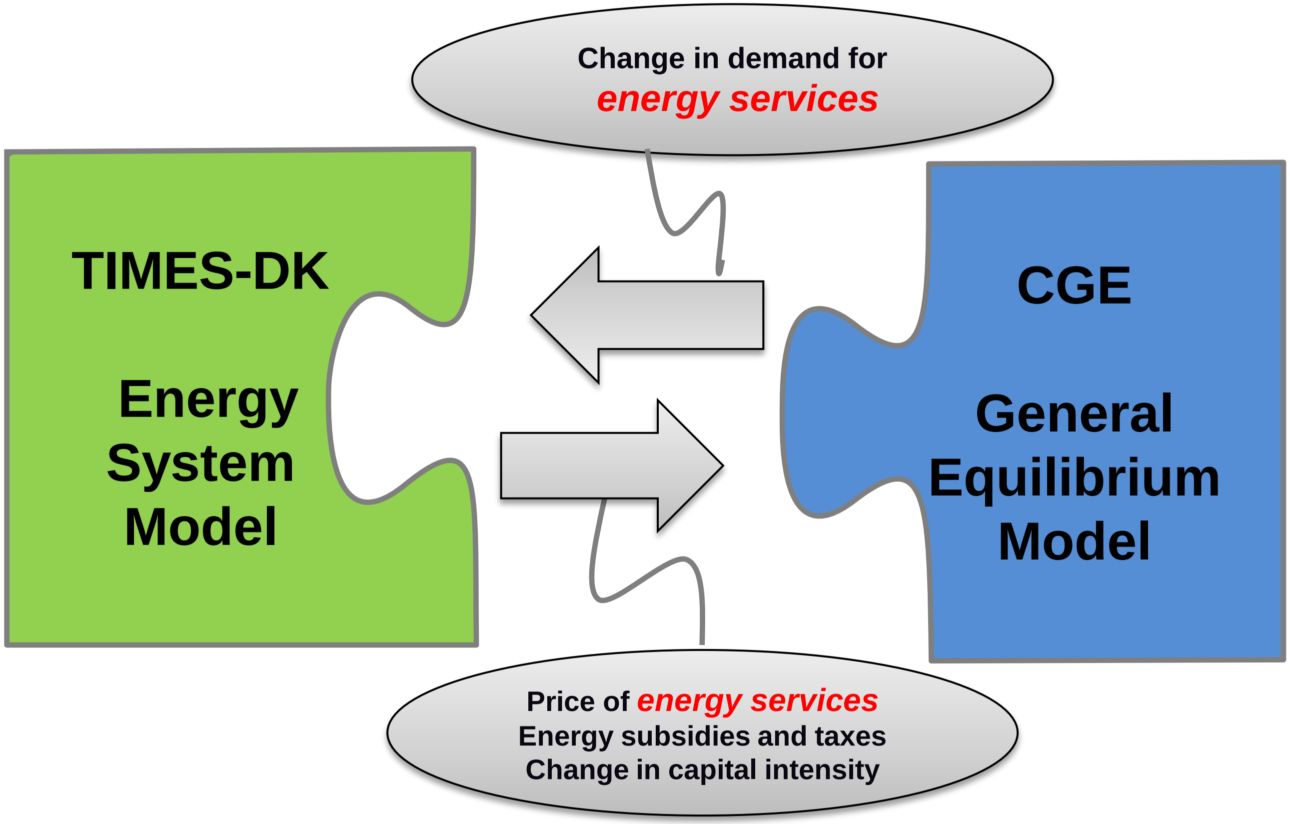
1. Why consider uncertainty



2. Implementing uncertainty in the IntERACT model

3. Working with uncertainty in a policy setting

Reconciling Engineers and Economists



TIMES-DK
- Optimizes Danish energy system towards 2050
- 12 Economic sectors
- Power and district heat sector
- Residential sector
- Transport sector
- Electricity exchange with neighbouring countries
- 32 time slices

CGE model
- 20 economic sector
- One household
- Government
- Foreign trade

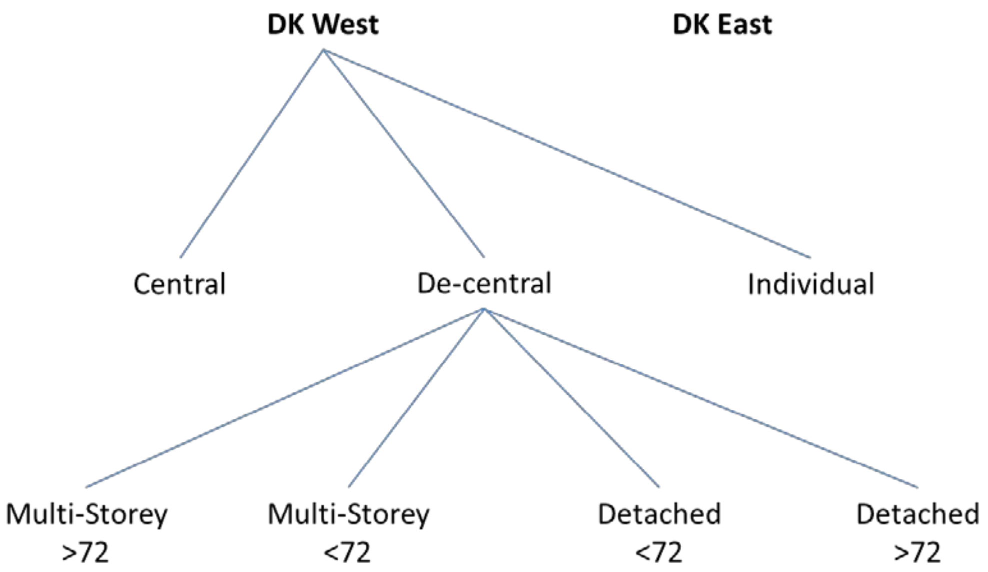
Soft-link
- 12 Economic sectors
- Power and district heating sect
- Residential sector

Household Heat Services in TIMES-DK

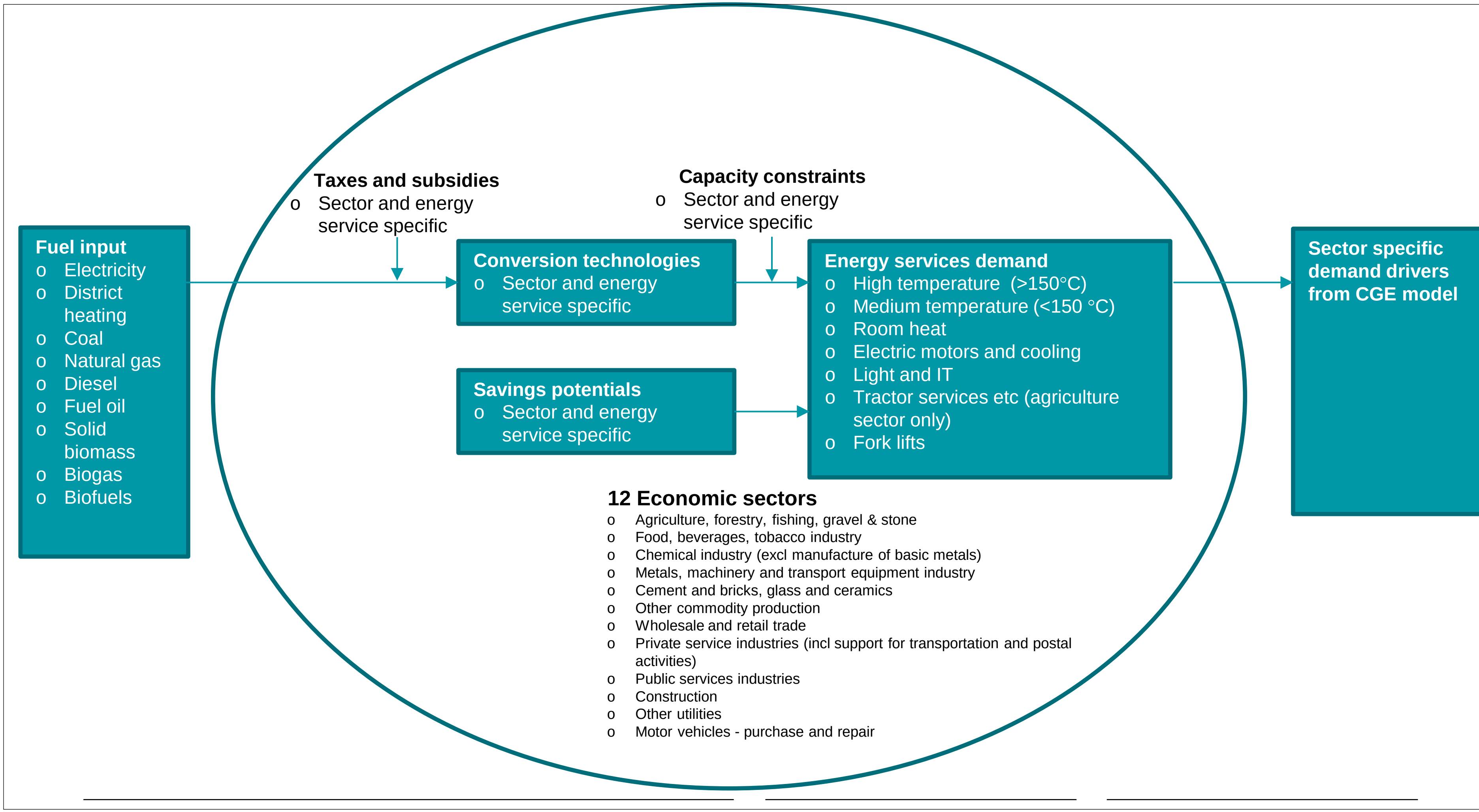
Heat services are measured as Mm2 in the model

The building are split in before and after 1972 and in multi-story (multi storey+non-detached) and detached (detached+farm houses)

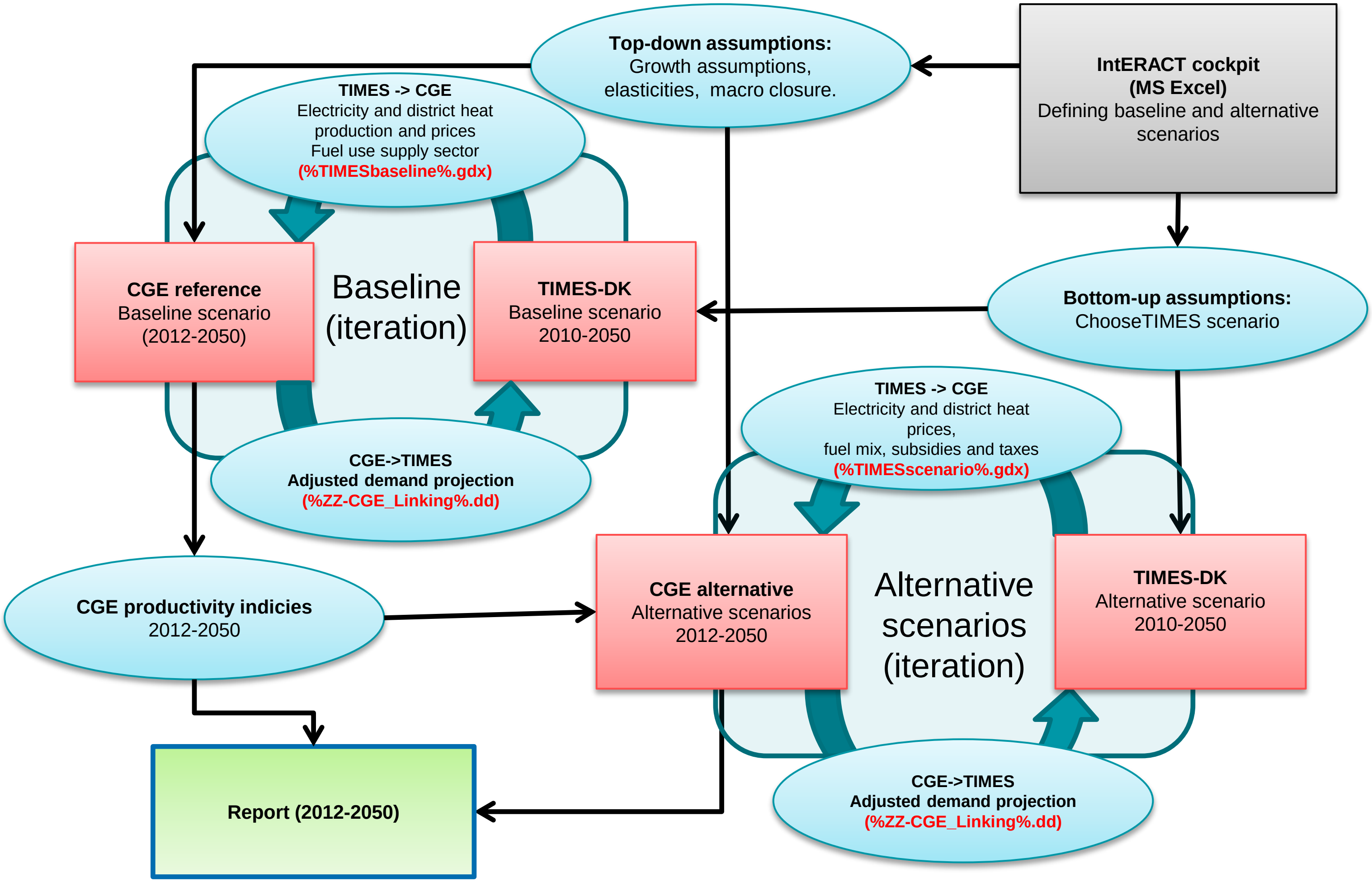
In the current version we do not assume any rebound effect on heat demand from chaning the price of heat service



Industry structure i TIMES-DK



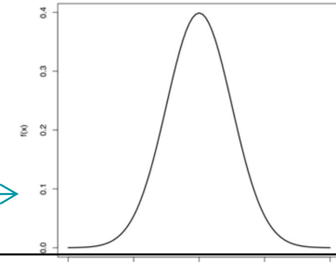
IntERACT: Iteration routine



IntERACT: Monte Carlo routine

1. Define the proces and/or commodity sets for which uncertainty is to be considered
2. Define the uncertainty distribution(s) in R
3. Start loop in R, where each loop-iteration draws samples from the uncertainty distribution(s).
   i. Write the draws into a dd-file used by TIMES
   ii. Run IntERACT iteration routine inside R
      i. Baseline
      ii. Policy
   iii. Save relevant output in R
4. Look at results

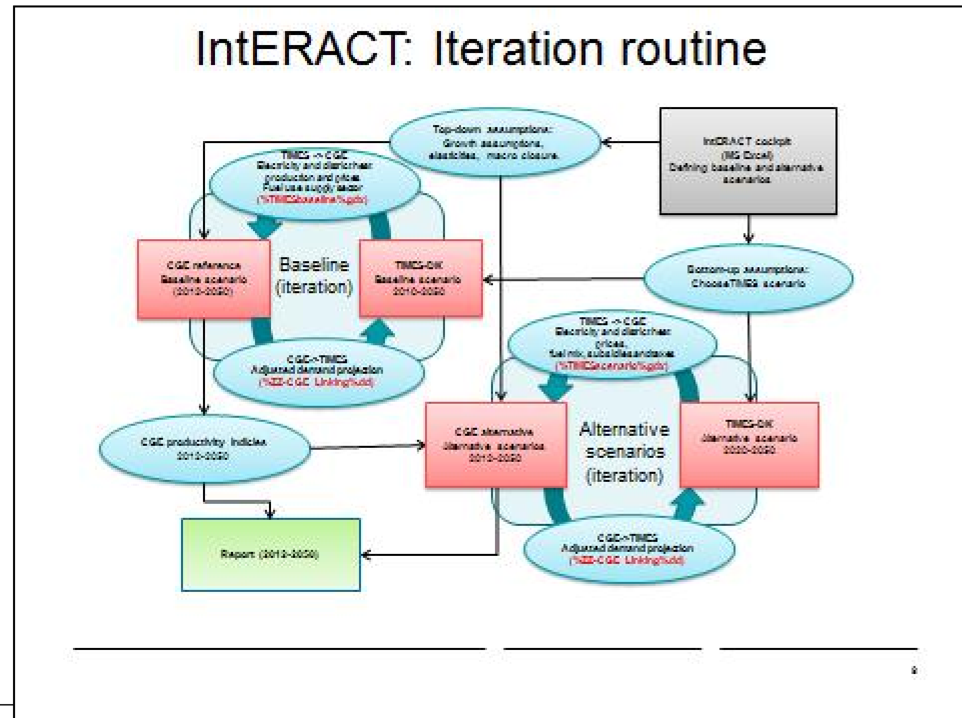
1) Define MonteCarloPRC(PRC)



2) Define Uncertainty Distribution

3) Run R loop, draw from distribution and write the draw into dd-file

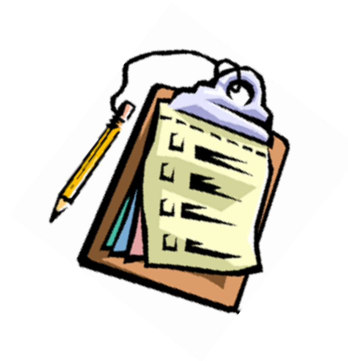
ACT_EFF(REG,ALLYEAR,PRC,"ACT",ALL_TS)$MonteCarloPRC(PRC) = ACT_EFF(REG,ALLYEAR,PRC,"ACT",ALL_TS)*0.97



Save relevant output in R

Agenda

1. Why consider uncertainty



2. Implementing uncertainty in the IntERACT model

3. Working with uncertainty in a policy setting

Working with uncertainty in a policy setting

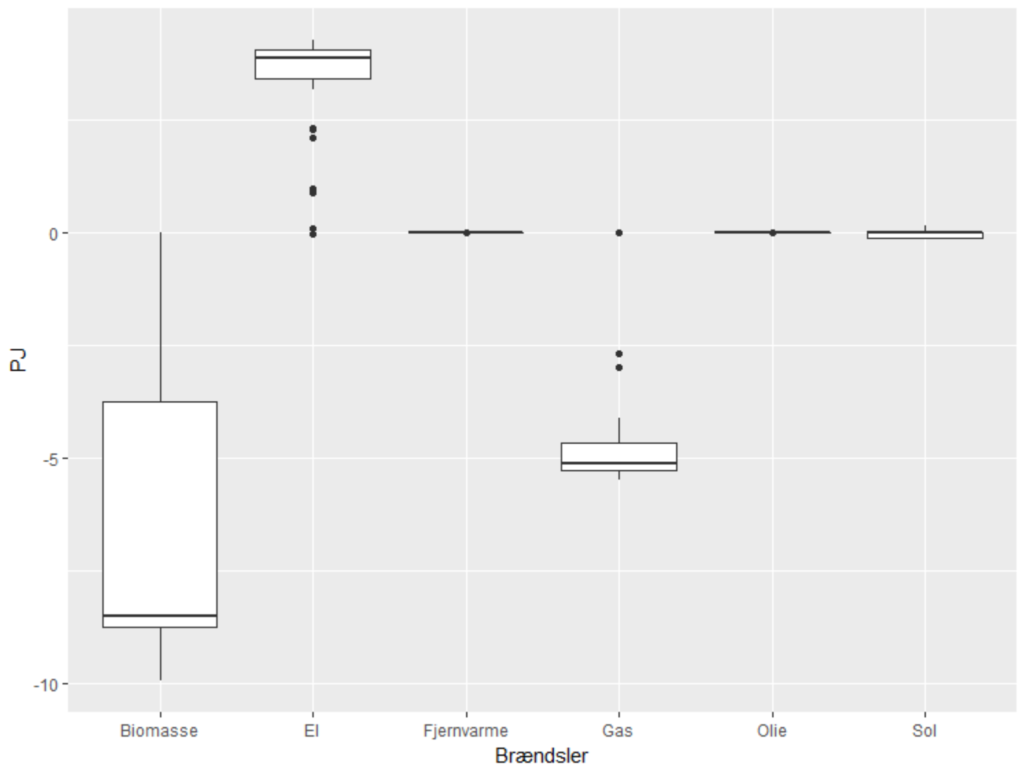
- Reduce tax on electricity for heating in order to incentivize the adoption of heat-pumps for room-heat in households and industry.

- How does uncertainty with to the cost effectiveness of heat pump and market price of electricity affect the adaption of heat pumps in IntERACT?

Working with uncertainty (timeline)

	September	Early October	Late October	November
# of sensitivity Iterations	100	100	50	50
# of sensitivity input parameters	1	1	2	2
# of scenarios	2	4	3	3
# of IntERACT iterations by each scenario	3	3	5	5
# of IntERACT model iterations	600	1200	750	750
# of hours	10	20	12.5	7.5

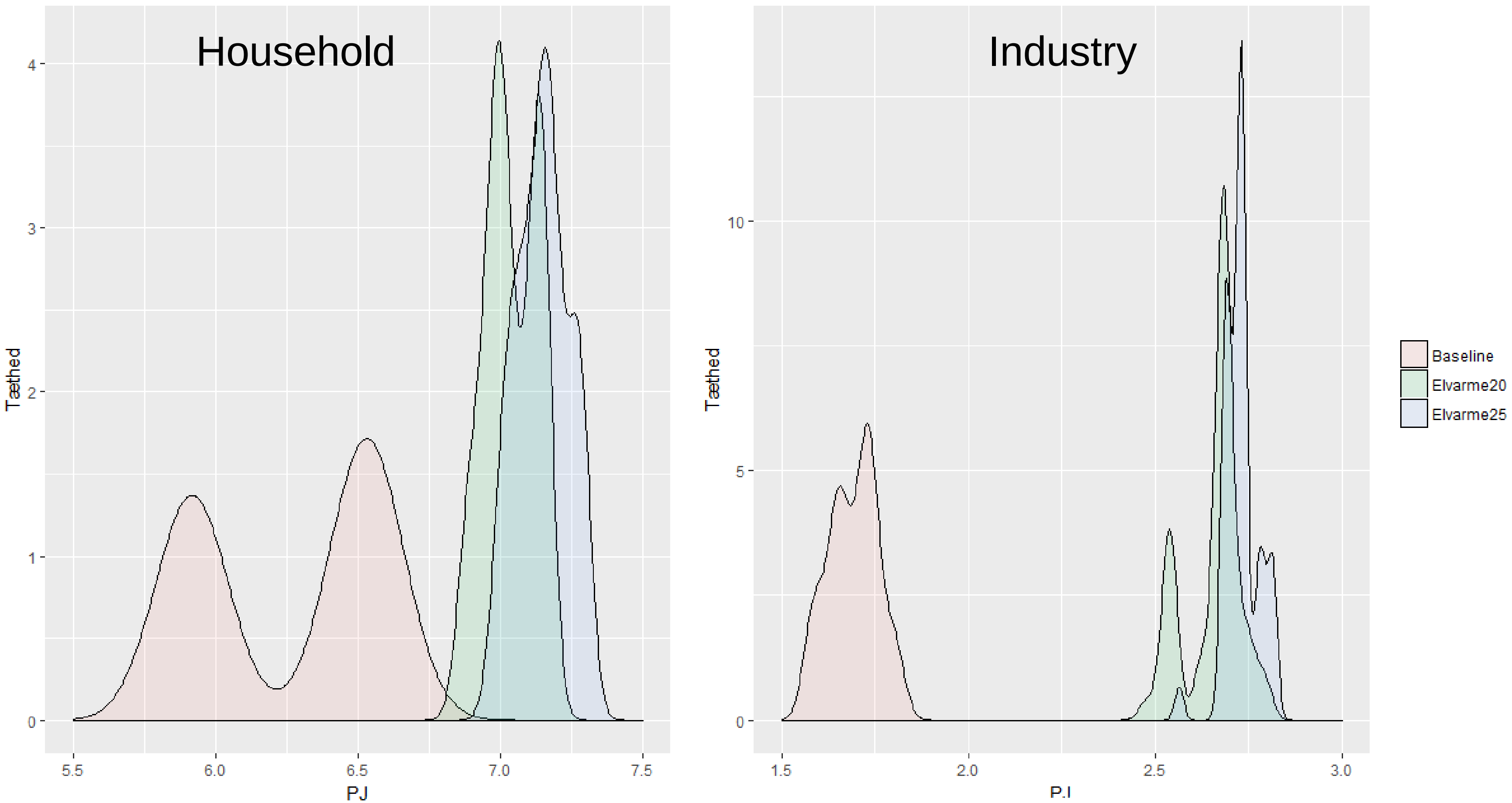
Household demand response from a reduction in tax on electricity for heat (PJ)



Biomass | Electricity | District heat | Natural gas | Olie | Solar heat

Preliminary results based on IntERACT v. 1.0.0

Household and industry electricity demand response following different levels of reduction in tax on electricity for heat (PJ)



Preliminary results based on IntERACT v. 1.0.4

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Take ways

1. Sensitivity analysis on TIMES
   can be implemented fairly easy
   in R, which allows for a high degree of flexibility
   in both in input variation and visualsation of
   results.

2. Using uncertainty analysis has proven to be a key tool both internally for model testing and externally for quantifying policy uncertainty.

3. Further work focus on how to develop and refine the use of sensitivity analysis in the IntERACT model.