

IntERACT: Method for linking TIMES with a CGE

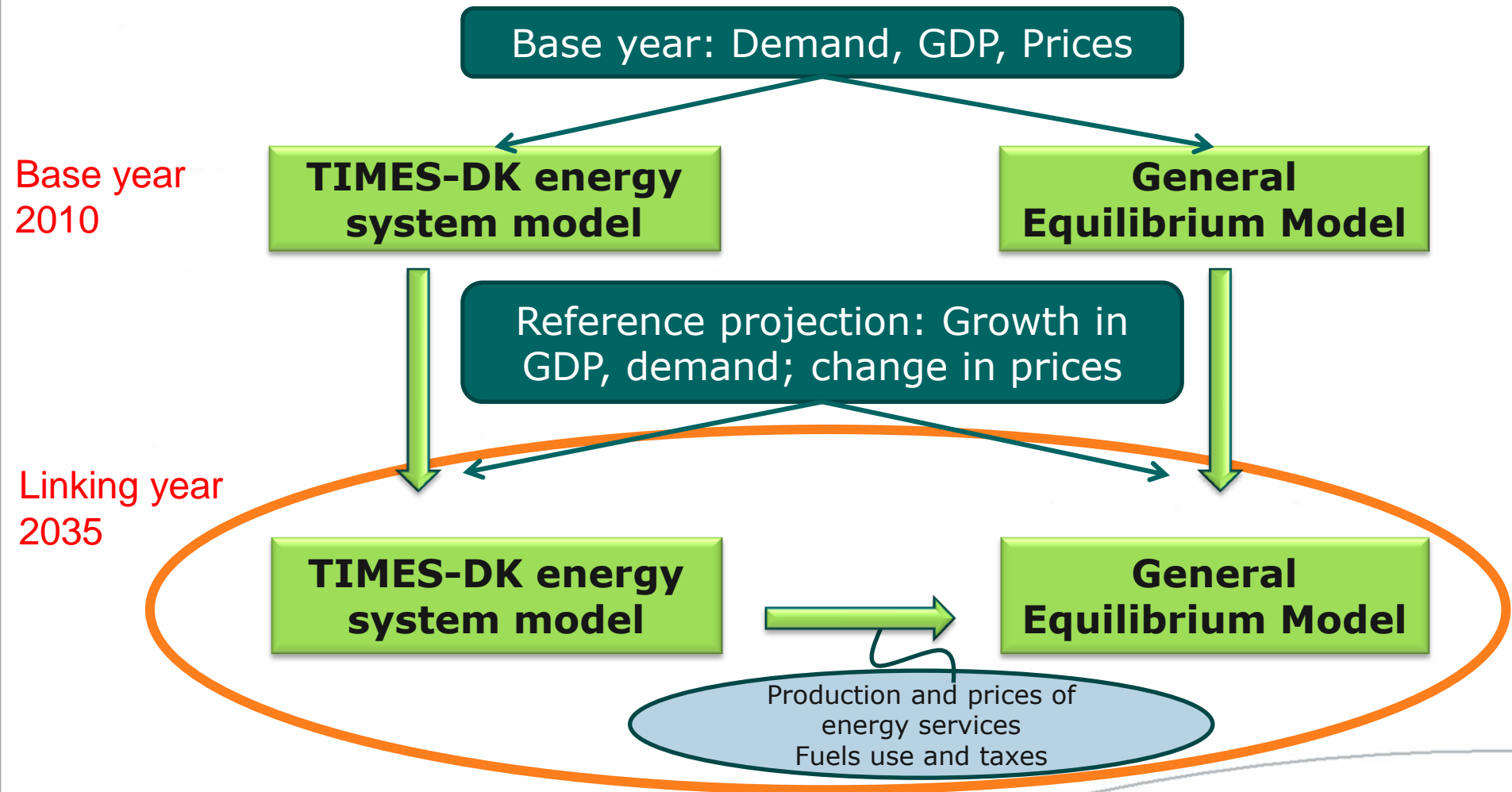
**66th semi annual ETSAP meeting
Copenhagen 2014**

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Plan of talk

- Principle behind the linking in IntERACT
- Why link to a CGE at all
- Linking in a toy-model
 - Softlinking vs. hardlinking (full linking)
- Conclusion

Reference scenario...



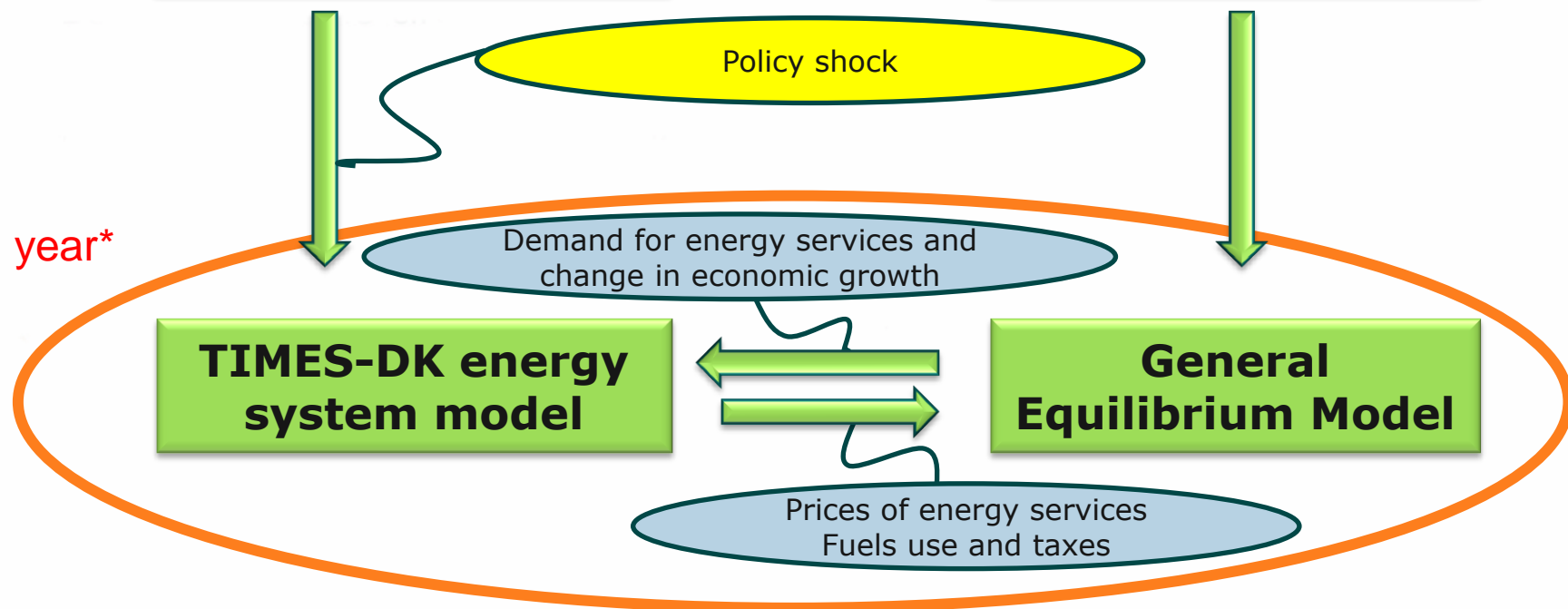
Alternative scenario...

Base year*
2010

**TIMES-DK energy
system model**

**General
Equilibrium Model**

Linking year*
2035



*Same assumptions on base year and growth as in reference scenario

Why use CGE model?

- Communication
- Fiscal book keeping
- Economy impacts (welfare measure other than cost)
- Structural change
- Competitiveness/trade

Toy model*: Linking bottom-up and top-down (1)

- Bottom-up model for energy production
 - Several production technologies, time segments
 - In the toy model, demand not modelled and is inelastic
 - Input: Capital and fuel price; energy demand
 - Output: Capital and fuel use; energy price
- Top-down CGE model for total macro economy
 - Models 2 goods: Energy and "all other goods" & capital
 - In its present version, fuel = "all other goods"
 - Input: Capital and fuel use in energy production; energy price
 - Output: Price of capital and "all other goods"; energy demand

*This work is largely inspired by Rutherford and Böhringer, i.e. http://www.mpsge.org/td_bu.pdf

Toy model: Linking bottom-up and top-down (2)

Bottom-up model

Minimize total cost of providing demand qE given fuel price pX and capital price pK

$$\min \sum_i (pK qK_i + pX qX_i) \text{ s.t.}$$

$$qX_i \leq f_i(qK_i)$$

$$\sum_i g(qX_i) = qE$$

where

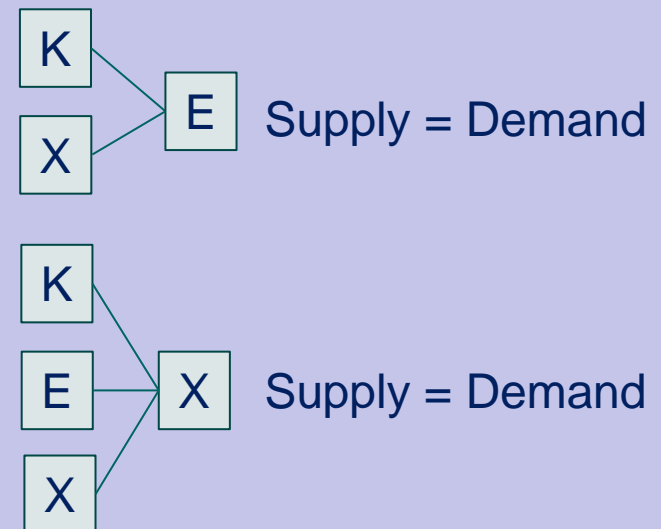
- $g()$ is energy production as function of fuel input
- $f()$ is capacity constraint as function of capital use
- pE is calculated ex post

qK, qX, pE

pK, pX, qE

Top-down CGE model

Find equilibrium prices for 2 goods and capital which balance demand against supply



* Red text indicates exogenous, green endogenous

Getting capital, labour and material cost from TIMES

- With **hard linking**, we transfer bottom-up information on composition of all inputs to calculate an energy price as a weighted average for use in the top down model. In this case the production function of the CGE model is fully replaced by information from the bottom-up model.
- With **soft linking**, we transfer only the energy output price and the fuel use to the top-down model
 - The top-down model can then implicitly calculate the use of capital as the residual between the fuel price and the energy price
- However, with more than 2 inputs (e.g. also labour and O&M materials), the residual covers not only capital but rather a mixed bag of capital, labour and materials
- So, soft linking may blur the information transferred between the two models

Deciding for hard or soft linking

- Considerations to be made when deciding for a link ...
 - Is somewhat blurred information from soft links a problem?
 - Are the data on cost composition of the energy system needed for hard links available in TIMES well enough suited for transfer to a CGE model?
 - What is the magnitude of omitting various data transfers
- How can a toy model help a decision of link strenght?
 - In our hard link toy model we send q_E , p_K and p_X to the bottom up model, and p_E , q_K and q_X to the top-down model
 - We can test what happens if some information is not passed
- The toy model can analyse the magnitude of the errors
 - The impact of TIMES energy price changes on demand?
 - The impact from TIMES on economy-wide cost of capital and labour, and in the magnitude of the feedback into TIMES

Conclusions

- From the engineer's point of view, it might be interesting to get feedback on the energy system's effect on the cost of capital, labour and other materials used in the energy system
- From the economist's point of view, it is interesting to be able to assess energy policies' impact on competitiveness & trade, public finance and general macro-economic impact and metrics, which is the core of CGE models
- From every point of view, it is interesting to know the magnitude of error committed by not linking energy models to CGE models
 - Magnitude of sensitivity analyses to make on capital costs and wages?
 - Which elasticities to use for energy demand?

Questions:

- Can small “toy” models be used to:
 - Help us understand linking issues better?
 - Approximate the answer we expect from coupling TIMES to CGE?

- Current version of toy-model:

<http://www.ens.dk/sites/ens.dk/files/info/facts-figures/scenarios-analyses-models/models/IntERACT/softlink.gms>

<http://www.ens.dk/sites/ens.dk/files/info/facts-figures/scenarios-analyses-models/models/IntERACT/hardink.gms>



Thank you for your attention

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