Improving the representation of modal choice into TIMES energy system models – A case study for Denmark

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**Background and motivation**

- TIMES is an energy-economy-environment-engineering (4E) model generator
- Partial equilibrium optimization model
- Identifies least-cost pathways for technology deployment to meet future energy service demands while complying with some environmental targets
- Powerful tool for long-term policy and scenario analysis in the energy system
- Bottom-up, technology rich model: it describes in detail the technical, economical and environmental characteristics of the technologies
- **Weak in representing consumer behaviour:** only one average-representative decision maker is considered
- Behavioural parameters cannot be neglected, as they are a fundamental aspect of decision making in the transportation sector

**MoCho-TIMES model description**

- **Modal Choice** in TIMES: It incorporates behaviourally realistic modal choice in TIMES
- The novel methodology is implemented in the standalone transportation sector of TIMES-DK, the integrated energy system model of Denmark
- The methodology requires two steps:
  1. Divide transport users into heterogeneous groups with different modal preferences
  2. Incorporate intangible costs (disutilities) that assume different values across the diverse groups of transport users
- Each group of consumers chooses its optimal modes, thus resulting in a variety of modes each year
- Support model required to know how travel demand is distributed and to obtain the intangible costs. This model is the LTM (Landstrafsikommdellen), the national inland 4-stage transport simulation model for Denmark, developed by Transport DTU

**Demand-side heterogeneity**

- The model represents 24 groups of transport users, characterised by homogeneous attitudes towards modal choice

**Intangible costs**

- Different propensity towards mode adoption across heterogeneous transport users is captured through monetization, with intangible costs
- The same mode has associated different intangible costs depending on the demand segment it fulfills

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\text{Intangible Cost}_{\text{mod},\text{seg}} = \text{Level of Service}_{\text{mod},\text{seg}} \times \text{Value of Time}_{\text{mod},\text{seg}}
\]

**Scenario Analysis**

- The model endogenously determines the modal shares for each year until 2050
- In the BAU scenario the increase of travel demand is mainly covered by cars, with a significant contribution by trains and bikes
- MoCho-TIMES allows exploring how modal shift occurs in the different regions and in urban, suburban and rural areas
- The model provides an insight on the modes adopted by the different consumer groups in the future
- The robustness of MoCho-TIMES is tested in a scenario analysis involving alternative levels of service for the modes, consumer perceptions, taxation schemes, infrastructure deployments and incentives to public transport

**Conclusions and further work**

- MoCho-TIMES incorporates modal choice within an integrated energy system framework
- The methodology presented can be easily replicated: it does not require editing TIMES code, but only changing the structure of the model
- A new set of variables is introduced in the model, regarding both the level of service of the modes and the consumer perception
- MoCho-TIMES improves the single “average decision maker” perspective and avoids the “winner-takes-all” phenomenon
- Possible to understand barriers to adoption of more sustainable modes and to perform new policy analyses
- Next steps:
  1. Incorporating the novel methodology within the rest of TIMES-DK
  2. Adding clones to improve the representation of variability of choice