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Large scale model for the microsimulation of energy and mobility demands as a function of individual activity-travel patterns

DAFNI – ICL Roadshow

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EPSRC
Engineering and Physical Sciences Research Council

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Overall aim

To develop an agent based microsimulation implementation of an activity-based model of energy demand, such that

- Demand is indirectly derived from the need to participate in activities
- Demand is predicted at the level of the individual consumer to capture a wealth of heterogeneity (behavioural drives, lifestyle preferences, adoption patterns)
- Demand vectors are spatio-temporally disaggregate, and can be predicted strategically as well as tactically
- The strengths of emerging big data sources and behaviourally rich ‘small data’ are combined
- The model can support the analysis and development of more effective methods of decentralised control and incentivisation

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Example use cases

- New business models related to consumption e.g. peer to peer trading
- Various emerging trends in mobility and activity participation such as virtual activities (online shopping, remote working etc undertaken at home, during travel and in public spaces)
- Emerging modes of transport, such as ride hailing, shared cars, shared bikes/e-bikes and e-scooters
- Electric vehicles, V2G and V2X
- Dematerialisation of products, the rise of internet shopping and related logistics

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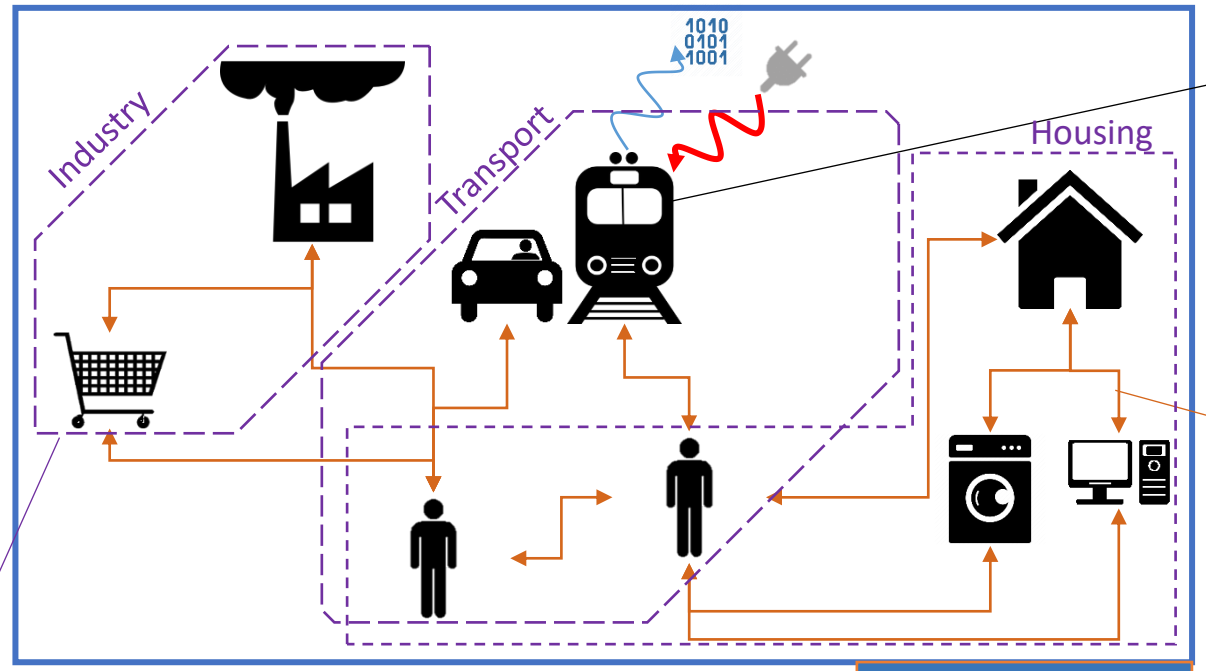
Conceptual framework



Agents: people, things, entities
Undertake activities, interact with other agents (are related to other agents), are affected by the environment.
Characterised by **attributes (properties)**
Use ***inputs*** (incl. energy, transport) ➔ Derived demand
Produce ***data*** that reflect their activities and interactions
Energy stakeholders interpreted as agents**.**

Relationships (interactions)
Describe how agents are related to each other, e.g. buying, selling, using, producing, etc.
Interactions are closely related to activities.

Environment: regulatory, natural, spatial (topography, urban layout), technological, societal
Taken as exogenous *given the time horizon of modelling.*
Can be modified to analyse scenarios.

Systems: subset of agents, relationships and environment with a functional focus

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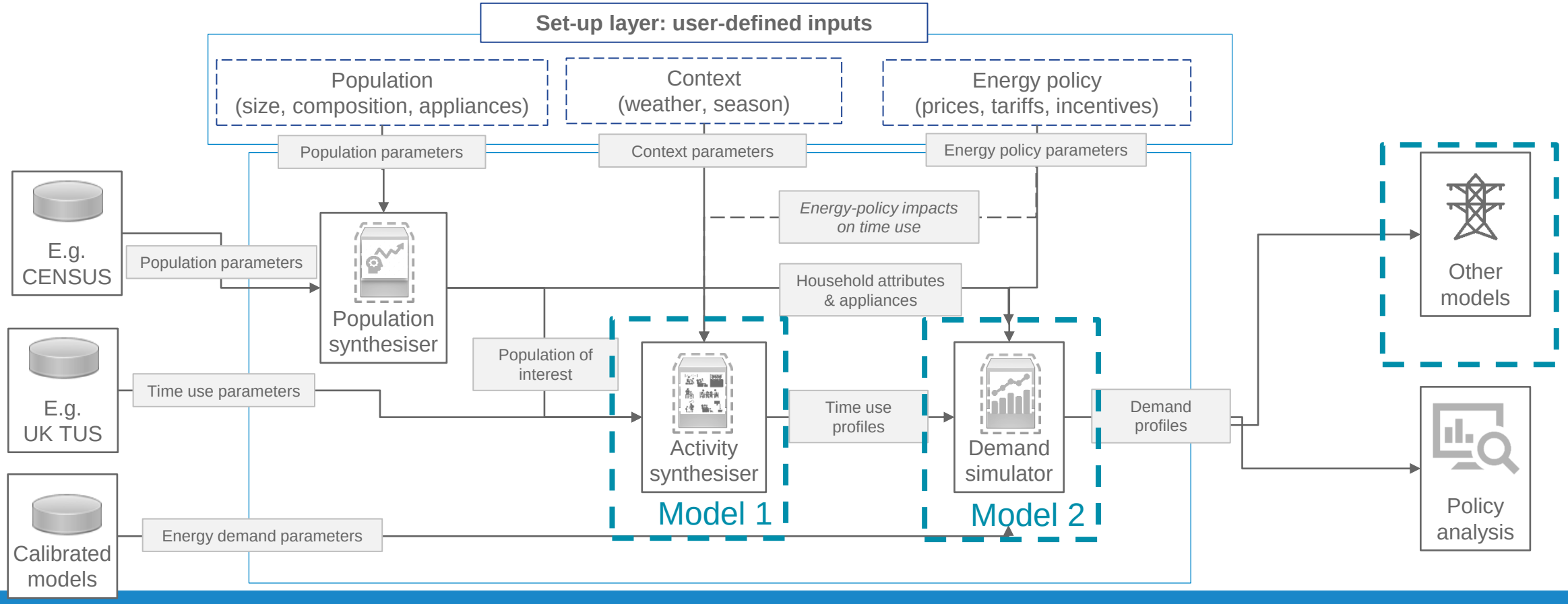
Activity-based energy demand simulator



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Activity generation model

- Developing in-home and out-of-home activity generation models (individuals/households)
  - Random utility maximisation models
  - Calibrated using the 2015 UK Time Use Survey data
- Capturing trade-offs between virtual and physical activities as a function of
  - Transport system characteristics (travel times, costs, accessibility…)
  - Personal context (household structure, income, vehicle availability, work location, ICT use…)
  - Characteristics of the home (building attributes, appliances…)
  - Energy system characteristics (tariff, EV charging infrastructure etc)
  - Other contextual factors (seasonality, weather…)

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In-home activity-based energy demand model

- Energy demand is closely linked to activities. Intensity of energy consumption can vary due to: -
  - Household attributes, e.g. size, composition
  - Season and time of day
  - Appliance ownership and use
  - Energy pricing
- Developing a methodology for characterisation of energy demand, by taking into account population attributes, activities and context (weather, energy policy)

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Thank You!

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