

# Simulating hybrid energy grids in smart cities

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## The vision: intelligent hybrid energy grids in smart cities



Image: National Grid – Smart Grid Pilot Proposal ([www.nationalgridus.com](http://www.nationalgridus.com))

## Modeling and simulation of hybrid energy grids

- **Analysis** and **design** of hybrid grids requires a **systemic approach**
  - focus not only on reactive components, but *dynamic interactions*
- Modeling and simulation **across domains** is essential
  - requires *hybrid models*
    - combining continuous, discrete, statistic and behavioral models
- If possible, make use of the existing **established tools**
  - take advantage of expertise of *domain-specific* simulation tools
- Comprises of potentially **large systems**
  - efficient algorithms and methods, parallel computing approaches, etc.
- More and more tools and methods are currently **emerging** to tackle these problems for the energy sector

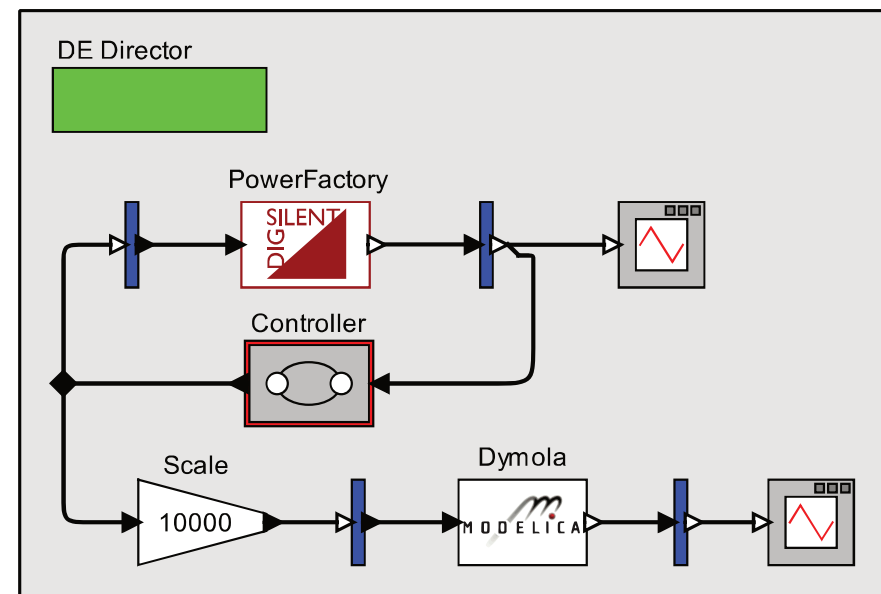
## OrPHEuS approach

- **Co-simulation** approach
  - *dynamic coupling* of domain-specific simulation tools
- Biggest advantage is **modularity**
  - use *best available tool* for modeling and simulation of sub-system
  - modelers of different domains can *continue* using their *preferred tools*
- Approach faces two main **challenges**
  - *interfacing* of models/applications
    - data access, start/resume/stop execution of model, etc.
  - *orchestration* of simulation components during runtime
    - synchronization of models/applications, data flow, parallelization, etc.
- Avoid re-inventing the wheel, but rely on existing state-of-the-art solutions
  - application interfacing: *Functional Mock-up Interface* (FMI) specification
  - simulation orchestration: *Ptolemy II* (simulation framework)

## Hybrid grid co-simulation example

- Scenario:
  - electrical grid (PowerFactory)
  - district heating network (Dymola)
  - coupled via hybrid domestic heat water supplies in residential buildings
  
- Ptolemy II hides complexity of the setup behind lean graphical user interface
  - blocks represent full models designed by domain experts
  - tools accessed via FMI-compliant interfaces

Graphical representation of co-simulation setup (Ptolemy II view)



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Heat load on secondary side of domestic heat water supply (blue: hybrid scenario, red: no coupling)

