MODELLING ENERGY SYSTEMS

- OR -

THE LINGUA FRANCA FOR THE ENERGY TRANSITION

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Photo: Nuon/Jorrit Lousberg
Energy Transition requires extensive information exchange

Infrastructure:
- Who can share a heat network topology with me?
- Matlab table with nodes and edges?
- Shapefile?

Profiles
- CSV, Comma, Semi-colon, Thousand-separator, Excel, Language-dependent
- Giga Joules or GWh, tce?
- UTC, Daylight savings?

KPIs, Facts
- Price of assets
- Emissions
- Data source references
A LANGUAGE FOR ENERGY

- We communicate the energy transition in:
  - Smart Energy Systems require system integration
    - (Simulation) models need to be integrated, but how?
    - Co-simulation
  - People use language to exchange information
    - English is a common natural language
  - Wouldn’t it be nice if we would invent a common digital language for our energy transition?
INFORMATION REQUIREMENTS

† System integration is complex
  † Lots of dependencies and relations

† Objective and complete information basis
  † Many asset types (pipes, cables, wind turbines, P2H, …)
  † Different scales (house/street/municipality/region/country)
  † Spatial – Geographical information (location, area, …)
  † Potential – Geothermal, Waste energy, Wind, Solar
  † Measures – deploy heat network, add wind turbine
  † Key figures – Cost, KPIs, References
  † Profiles – Static data, dynamic data
  † Energy carriers – Natural gas, H2, coal, heat, electricity
ENERGY SYSTEM DESCRIPTION LANGUAGE

- Describe energy system components
- Describe geographical information
- Describe profiles and potential
- Describe solution space

Asset Store

- PV installation
  - 10 panels
  - 2700 Wp
  - €3640,-

- Heatpump
  - Air/water
  - 3.0 kW
  - €2677,-

- Windturbine
  - Hor.Windgen.
  - 2kW 48V 96VAC
  - $1209,-
CAPABILITIES OF AN ENERGY SYSTEM

- **Production**: The ability to produce energy
- **Consumption**: The demand for energy
- **Storage**: The ability to store energy
- **Transport**: The ability to transport energy
- **Conversion**: The ability to convert energy

Aggregate:

- **By sector**
  - Households
  - Services
  - Industry
  - Mobility
  - Agriculture

- **By source**
  - Gas plant
  - Coal plant
  - Wind
  - Solar-PV
  - ... 

- **By commodity**
  - Electricity
  - Heat
  - Natural Gas
  - ... 

- **By province**
STATUS

- Digital languages need tool-support to get adopted
  - Open sourced at https://github.com/EnergyTransition/ESDL
  - Extensive documentation at https://energytransition.gitbook.io/
  - Detailed class documentation at: https://energytransition.github.io/
  - Extensive tooling
    - Web-based editor with GIS support: https://mapeditor.hesi.energy/
    - Eclipse visual plugin
    - Matlab plugin
    - Python and Java libraries

- What happened at TNO?
  - ESDL adoption in one year in a dozen tools
    - Better integration of our toolsets
    - Better understanding
  - Several projects with external partners
    - EnergyTransitionModel / PICO / VESTA

ESDL compatible tools within TNO
- HeatMatcher: Heat Network Controller
- CHESS: Heat Network simulator
- GEIS: Geographical Energy Information System
- EDR: Energy Data Repository
- EYE: Electricity price forecaster
- DIDO: Agent-based investment model
- Waterbattery: Storage tank calculator
- ESSIM: Energy System Simulator
THANK YOU FOR YOUR ATTENTION

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Take a look:
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