Energy System Description Language -TNO

FOSDEM - 31-January 2026

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TNO structure

TNO ICT, Strategy & Policy (ISP) is working on breakthroughs in societal challenges.

We develop innovations, strategies and policies for government and industry to accelerate transitions and increase economic growth and well-being.

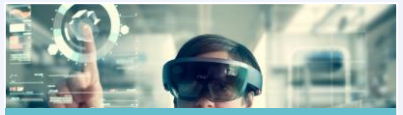
CONNECTION

We connect our mission, portfolio and knowledgebase

Our mission

We bring movement where transitions become stuck

Our portfolio

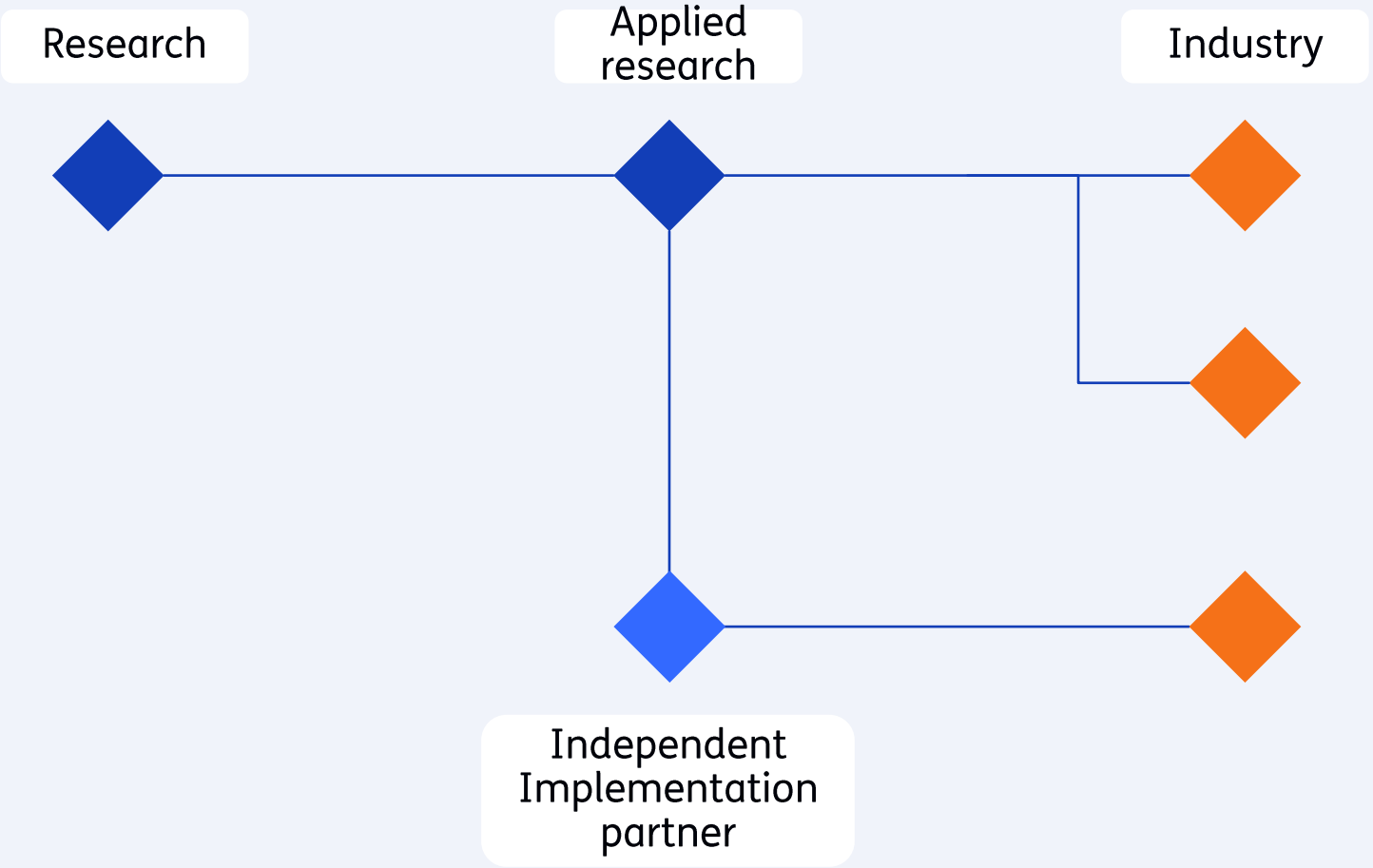
TNO Vector	Digital Systems	Digital Innovations		
				
Leading societal multi-transitions	Digital systems	Fast open digital infrastructures	Data sharing & AI	Trusted ICT

Our knowledgebase:

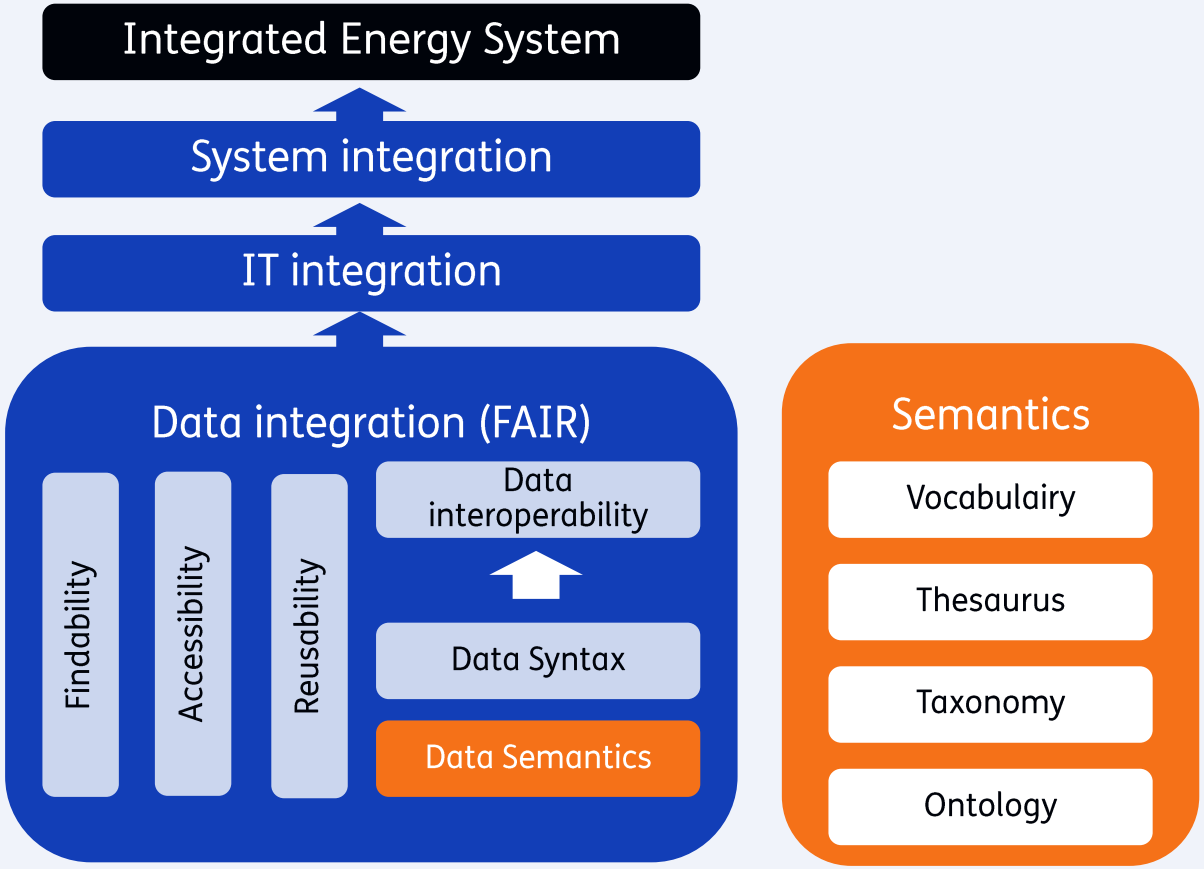
12 research groups

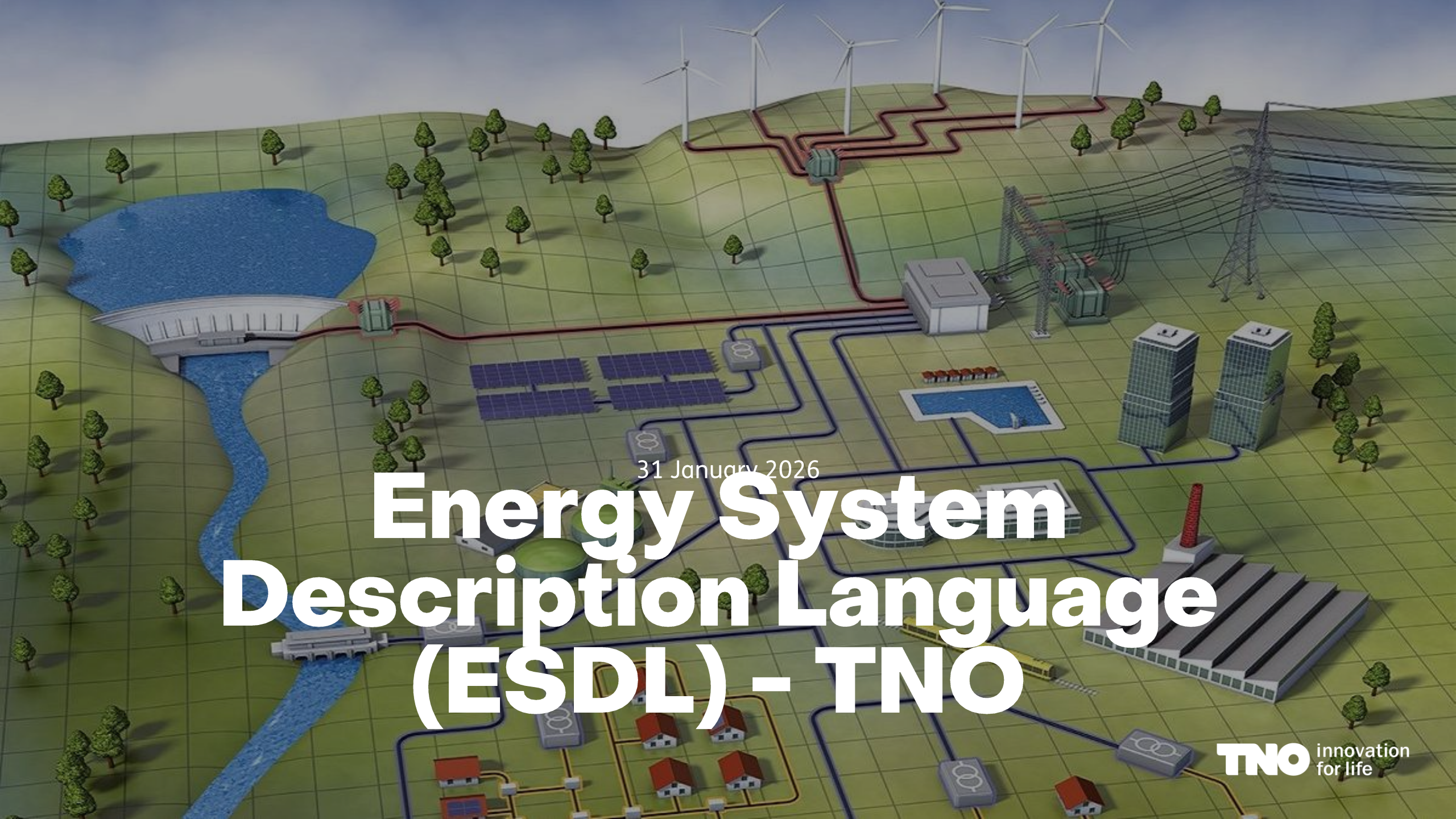
Digital Governance & Regulation	Economics & Innovation Policy	Embedded Systems Innovation	Advanced Computing Engineering	Data Ecosystems	Applied Crypto & Quantum Algorithms
Sustainability & Spatial Governance	Business & Finance Models	Intelligent Cyber-Physical Systems	Networks	Data Science	Cyber Security Technologies

Applied research



Standardisation and system integration





31 January 2026

Energy System Description Language (ESDL) - TNO

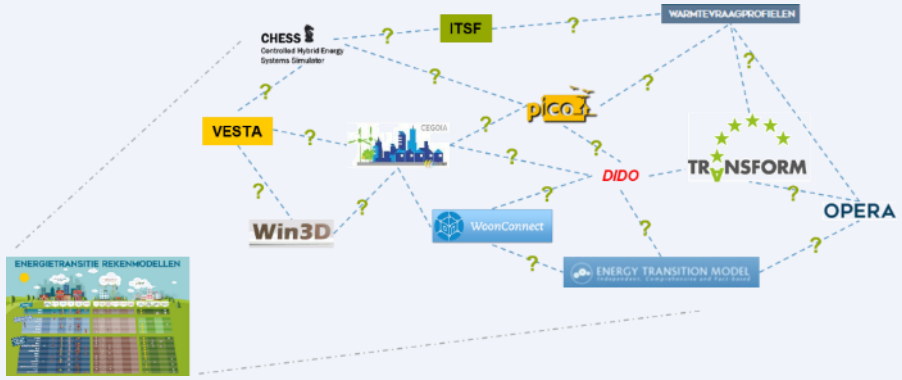
TNO innovation for life

Challenges – why we started with ESDL in 2017?

INTEROPERABILITY

1

Integration of multiple models / tools to properly address the broadness of relevant topics for the energy transition



TRANSPARANCY

2

Assure different models that try to answer the same question, more or less produce comparable results (or understand why outcomes differ)

Planbureau voor de Leefomgeving

Warmtevoorziening gebouwen in 2050

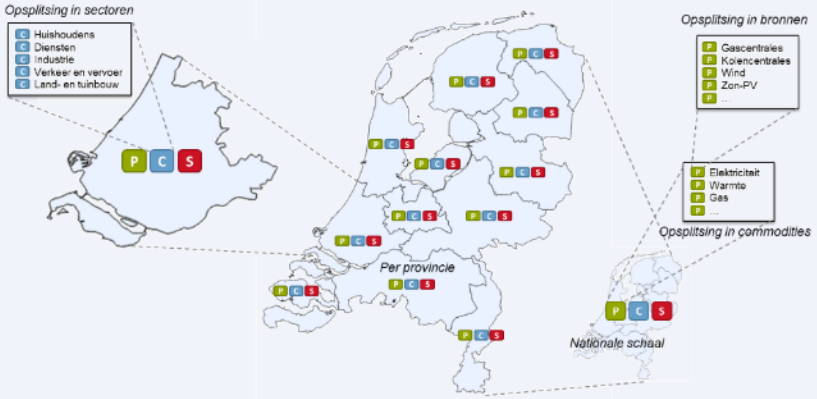
	volgens CE Delft woningen	volgens Vesta woningen	volgens Opera LT-warmte
	(PJ/j)		
Warmtevraag	386	320	Finaal ca. 400
Besparing	24	140	
Elektrisch + WKO	73	70	190
Warmtenetten	222	105	80
Gas	66	5	100
Biomassa	0	0	30

Bron: Nico Hoogervorst (PBL), Het regeerakkoord en de energietransitie, Tweede PICO gebruikersbijeenkomst - Vrijdag 24 november 2017

AGGREGATABILITY

3

Assure scenario calculations for different (geographical) scales properly sum up at national level



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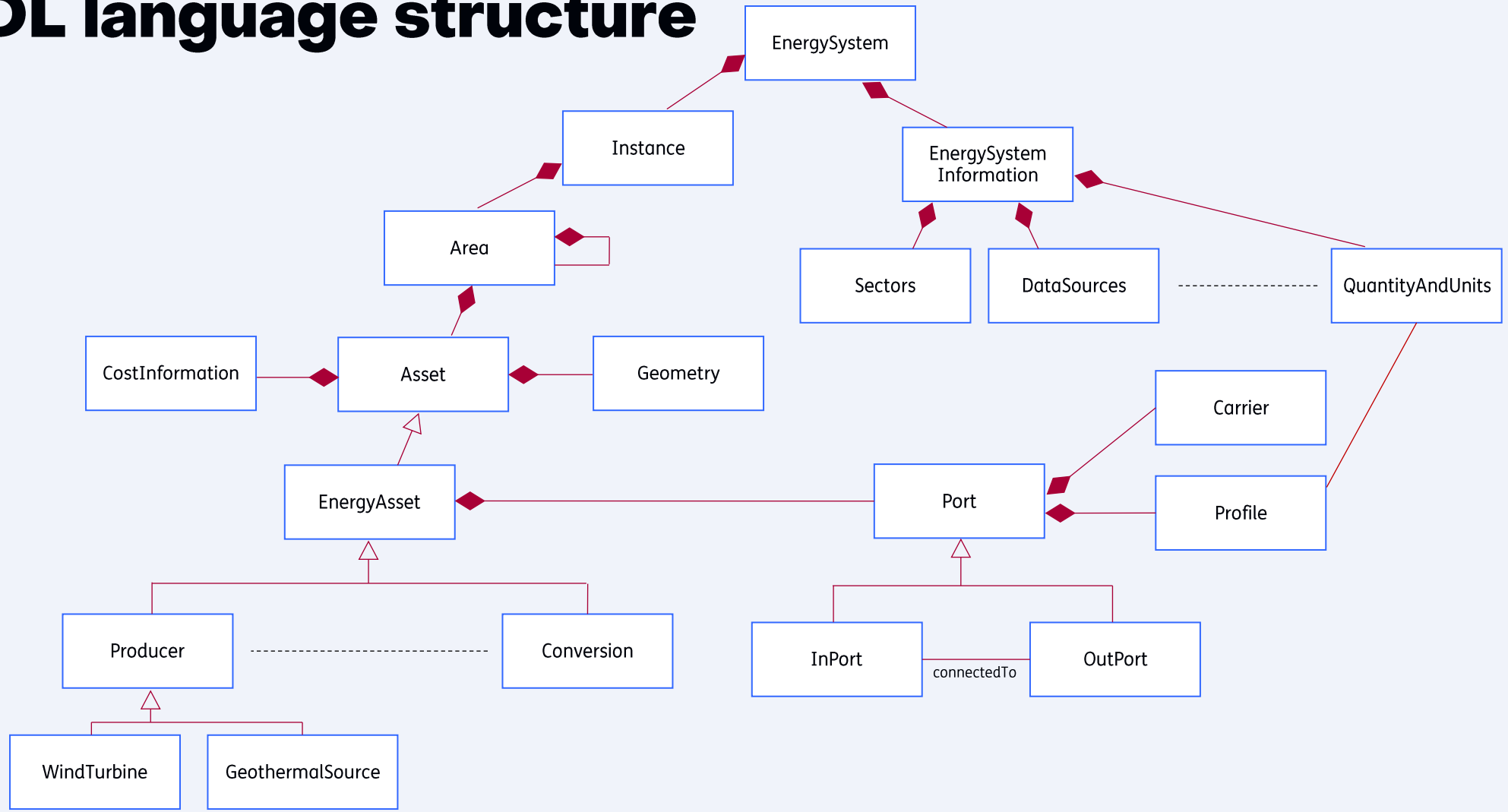
ESDL language structure



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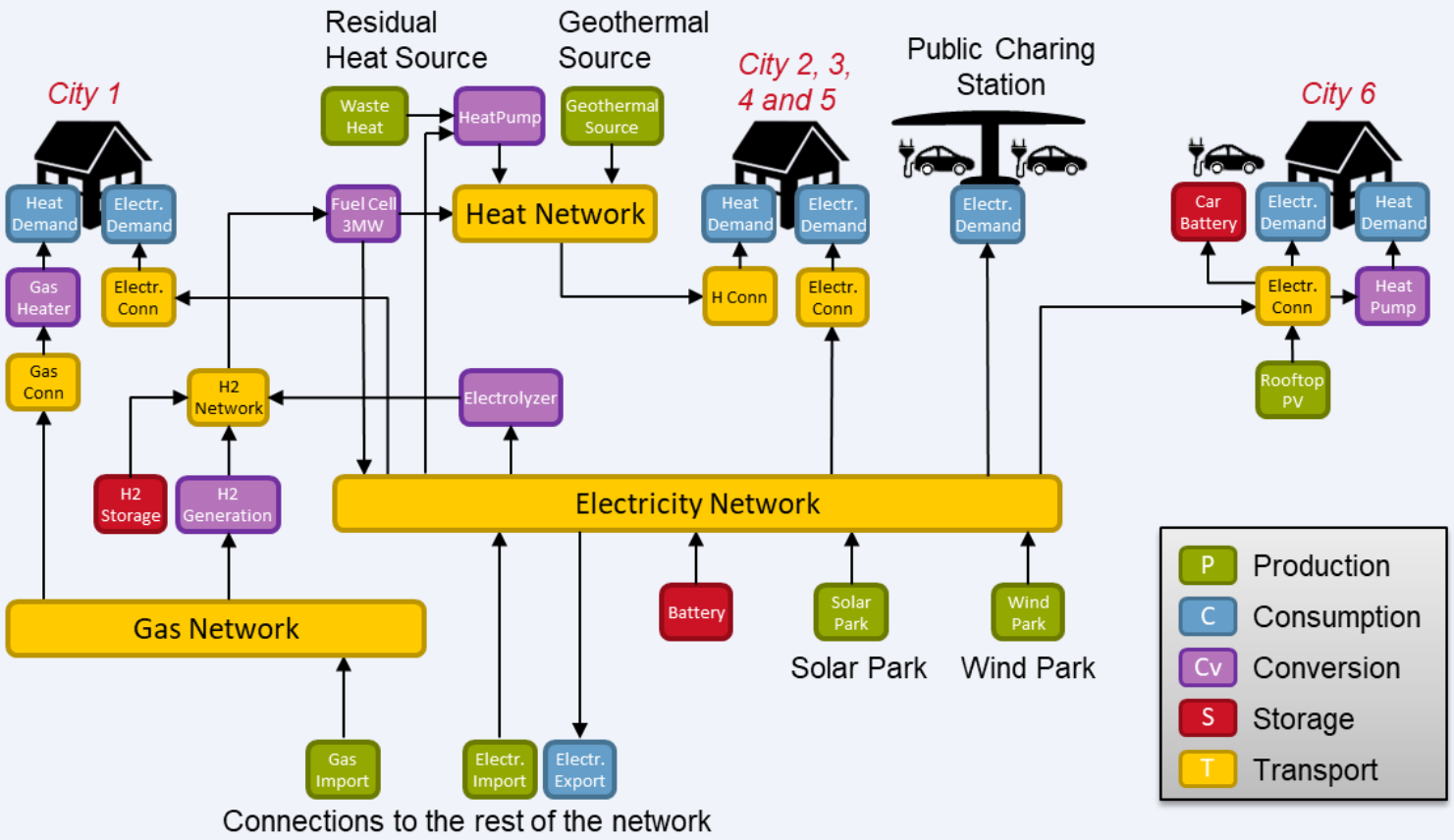
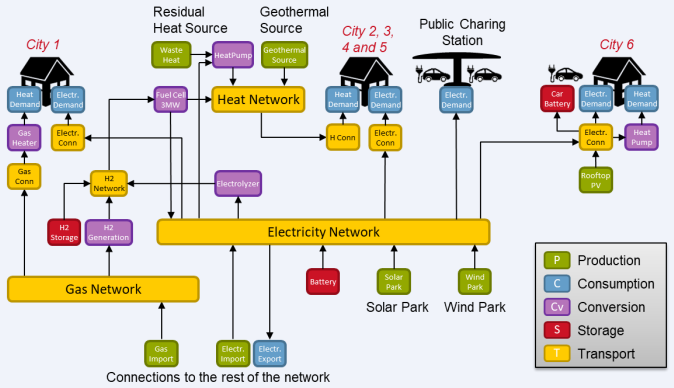
ESDL Energy Network



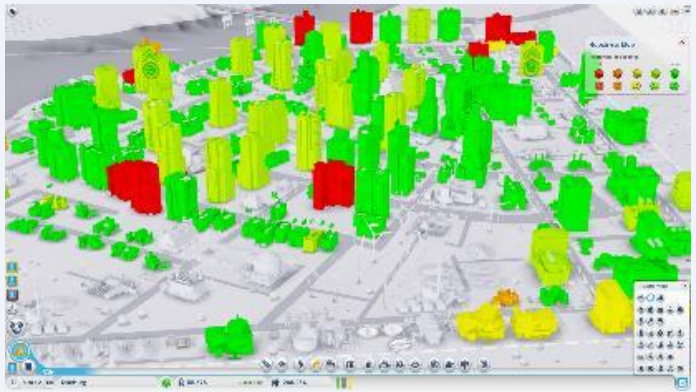
ESDL

Energy System Description Language

Energy system components and topology



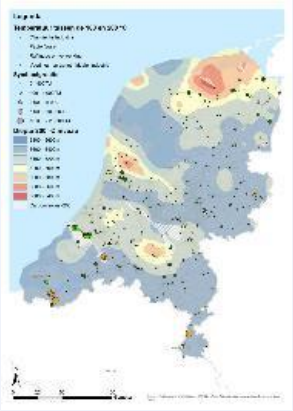
Location and spatial information

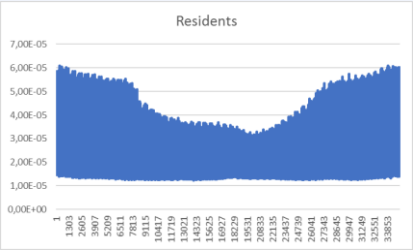


And:

- Energy carriers & commodities
- Quantities & units
- Sectors
- Parties & ownership
- KPIs
- (Regional) areas, plots
- Materials
- Measures
- Plans
- Energy markets
- Mobility / transport
- Control strategies
- Constraints
- Transfer functions
- Data sources
- ...

Energy potentials and profile information





Technology information

Technology Factsheets

PV installation	Heatpump	Windturbine
10 panels 2700 Wp € 3640,-	Air/water COP 4,3 3,0 kW €2677,-	Hor.Windgen. 2kW 48V 96VAC $1209,-

- - - - -

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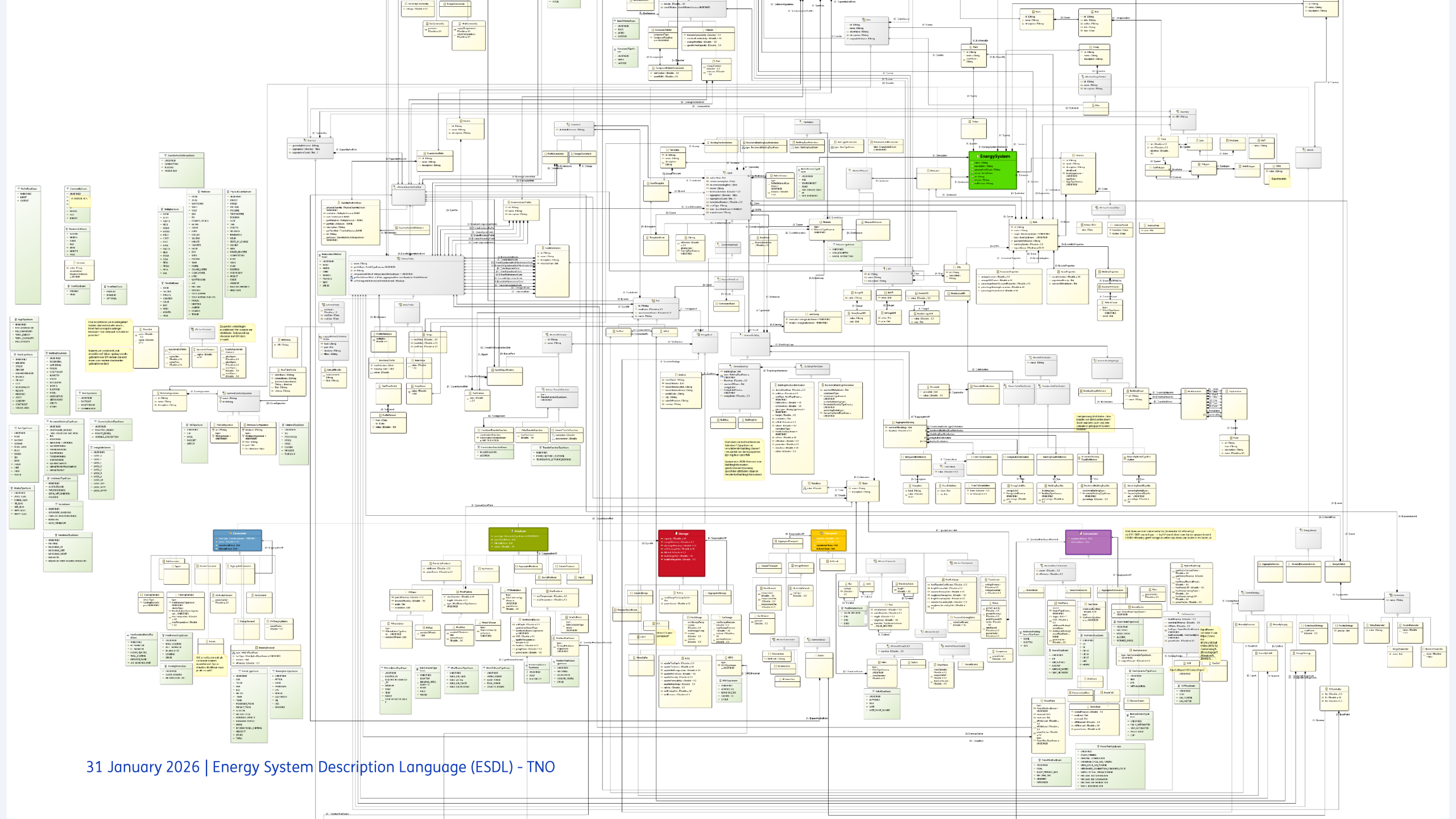
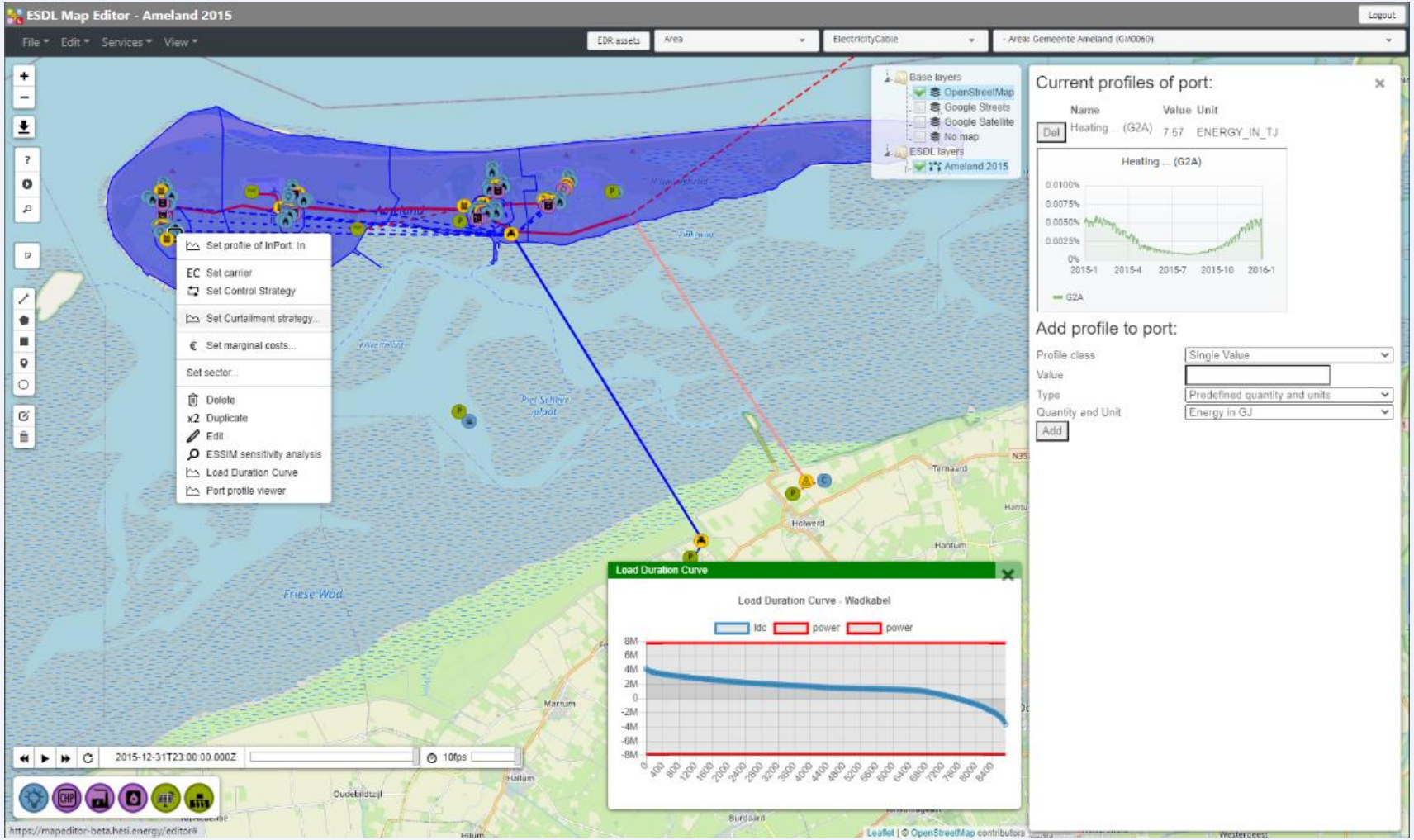

EnergySystem
Consumer
Producer
Storage
Conversion

The ESDL MapEditor, the human interface



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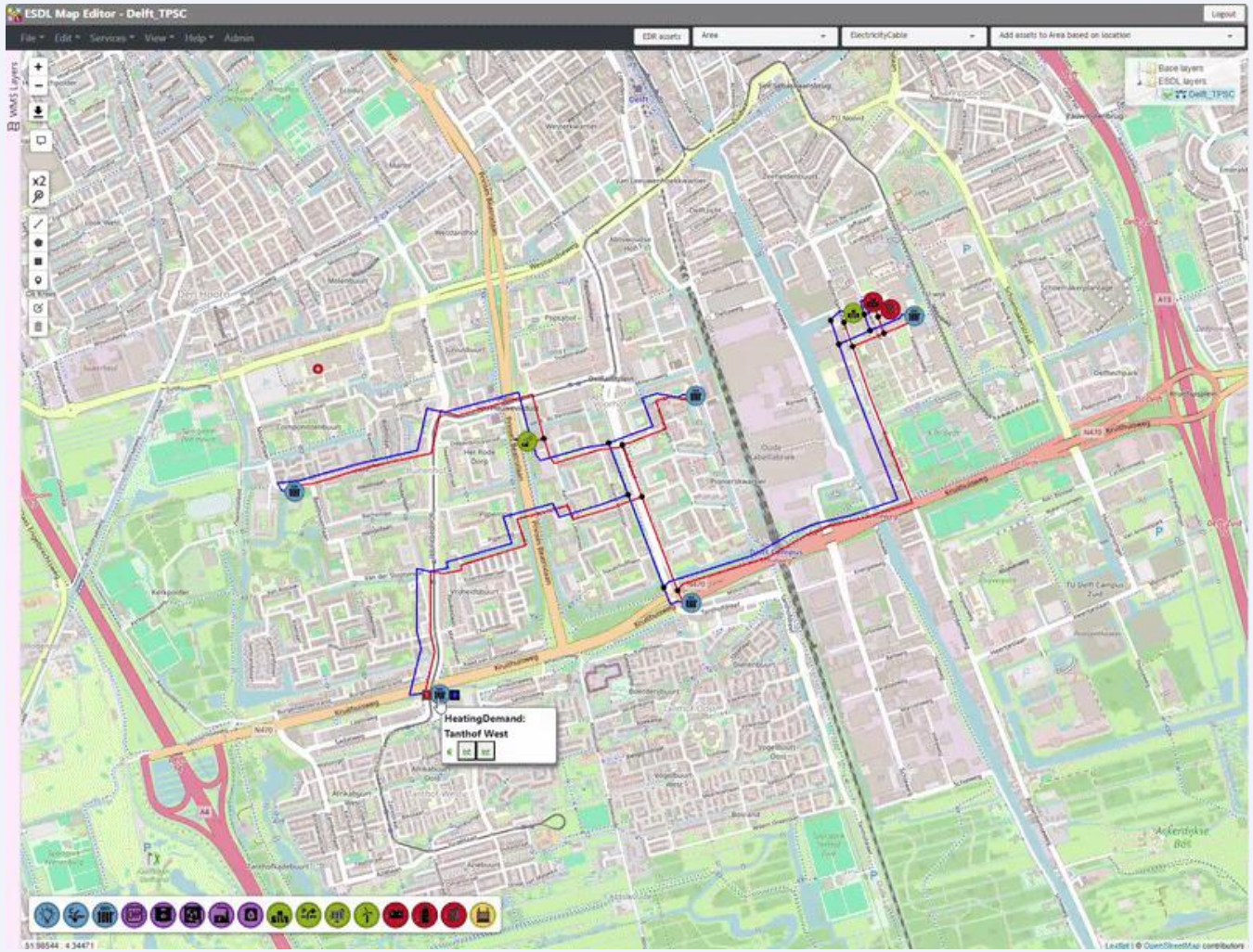
Profile inspection



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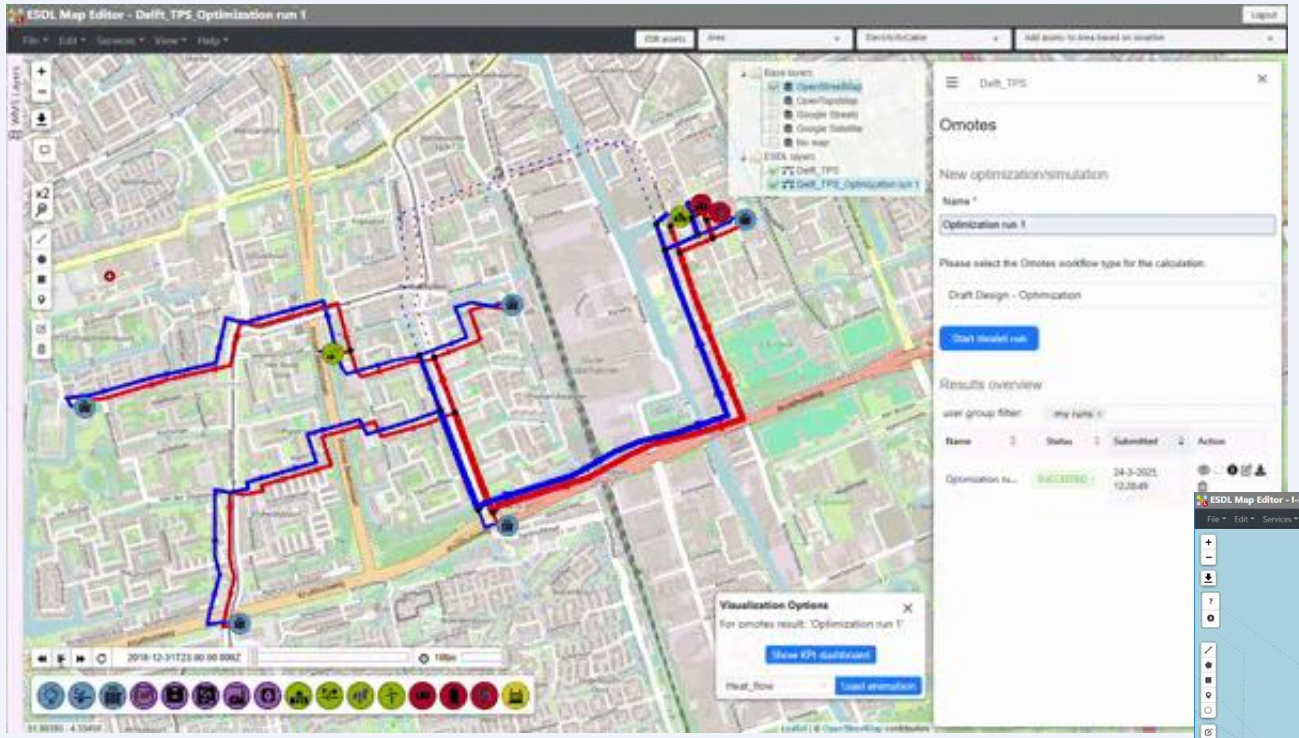
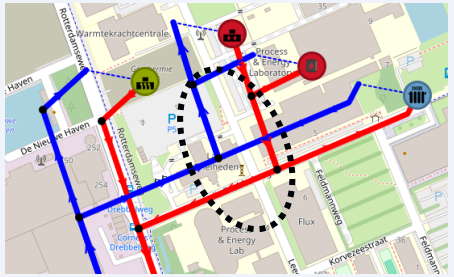
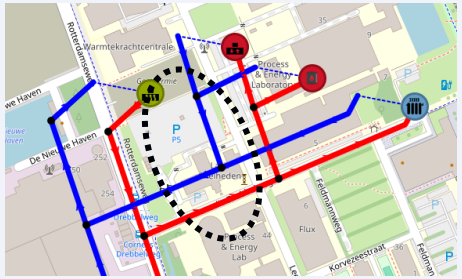
Time series animation

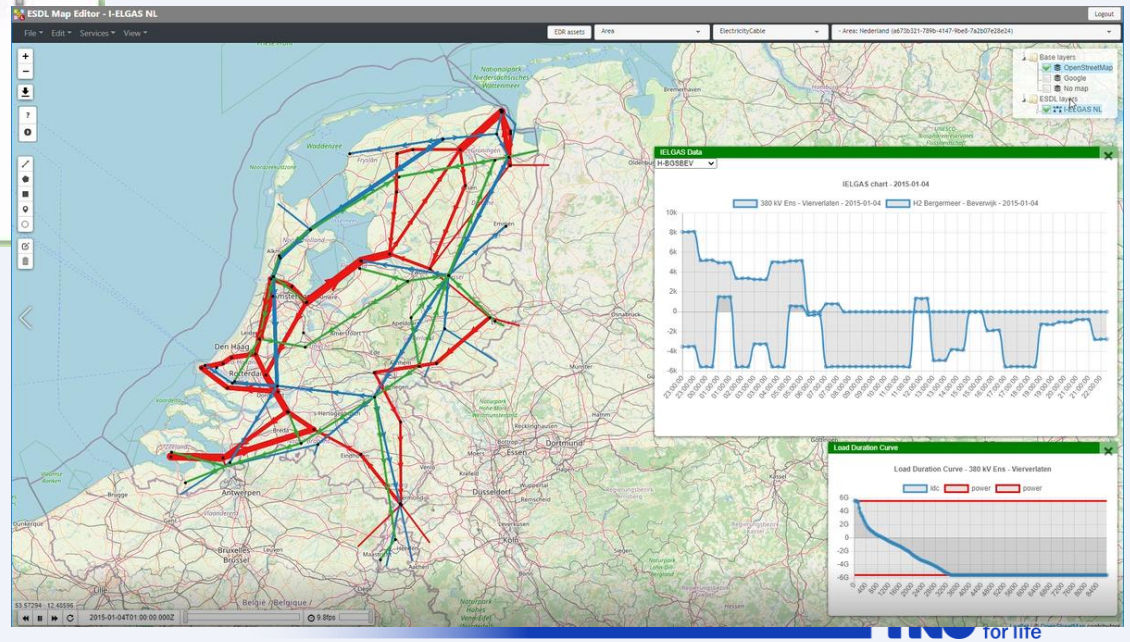


Use of seasonal storage in winter



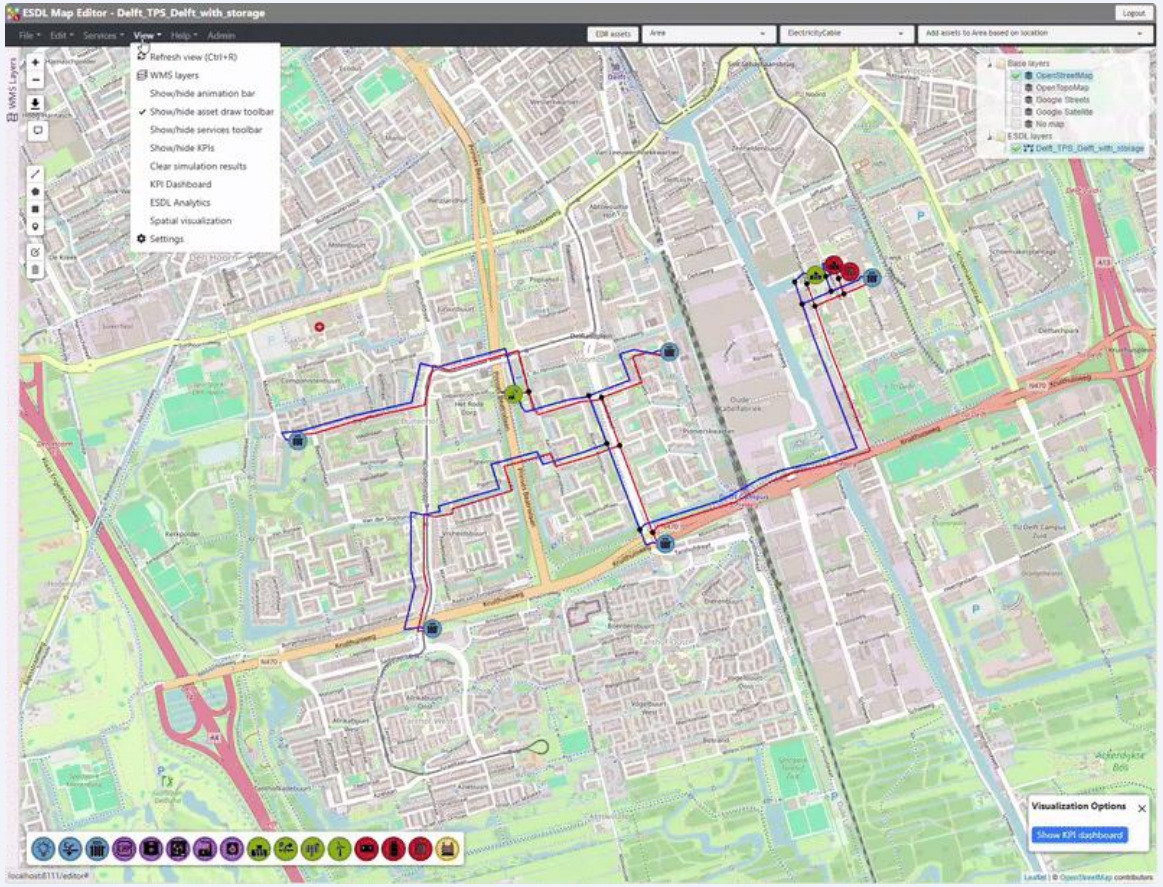
Charging of seasonal storage in summer

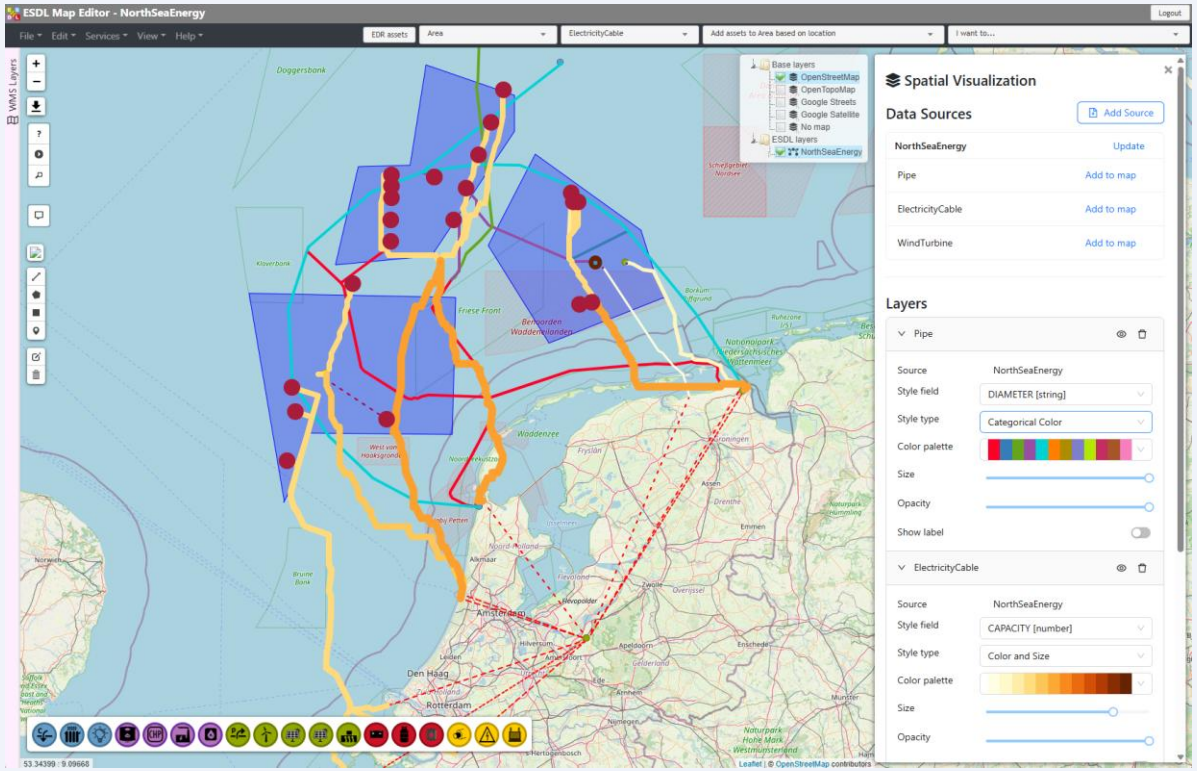




Play, Pause, change speed, scroll through time, ...

Spatial visualization – generate pictures for reports





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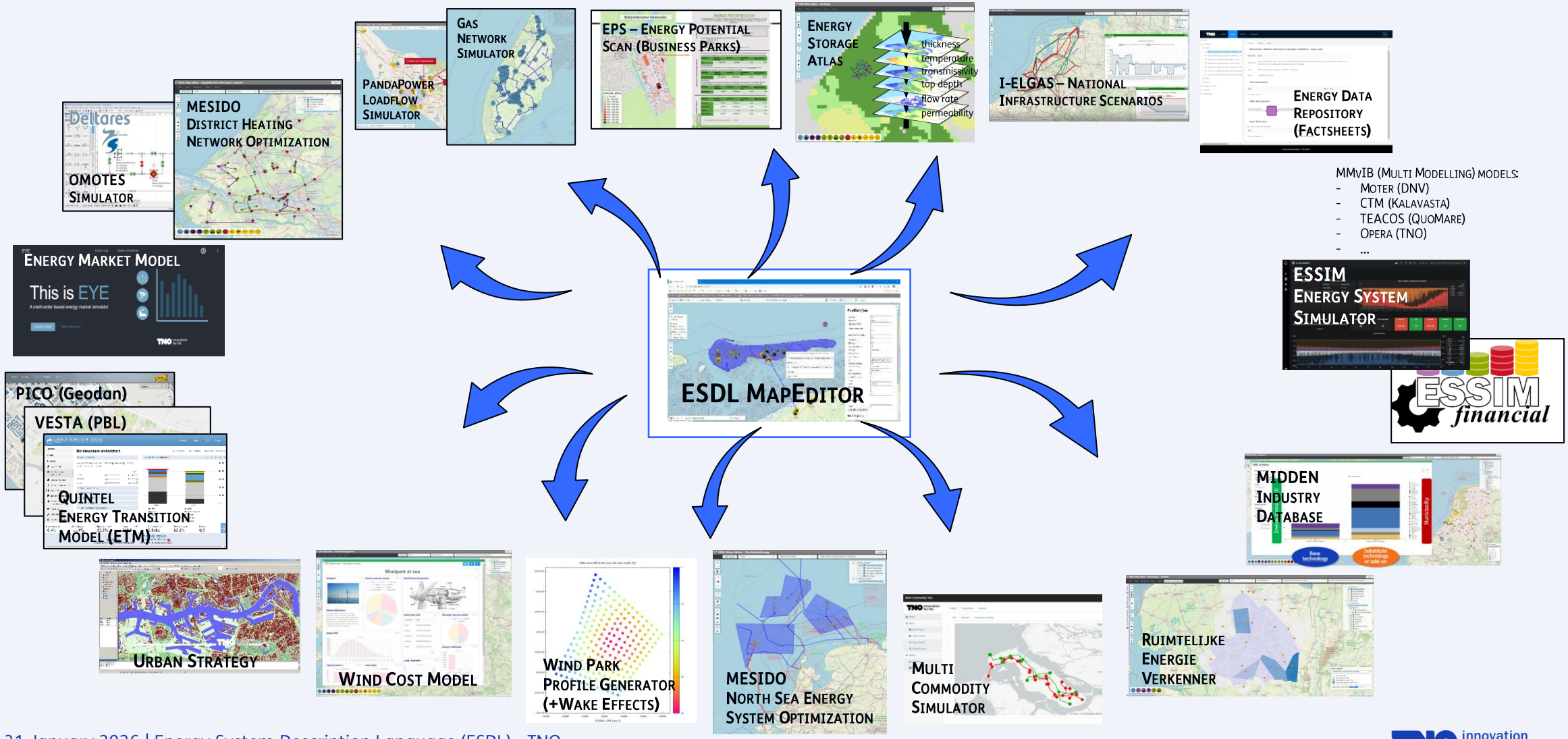
Growing ecosystem of models and data available



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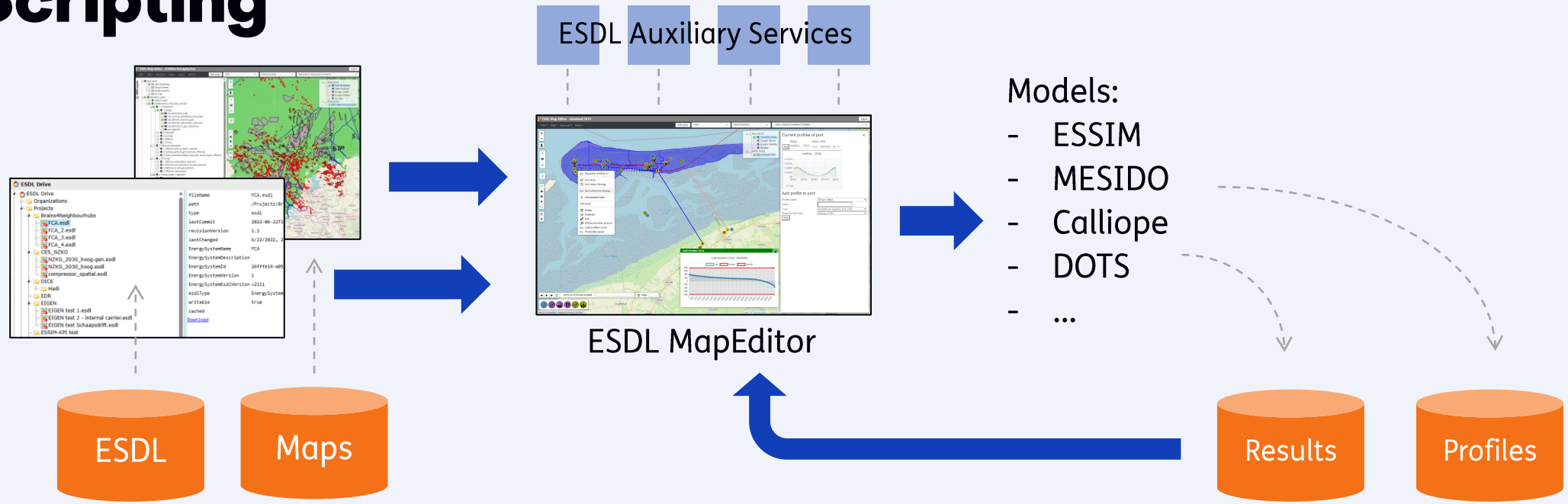
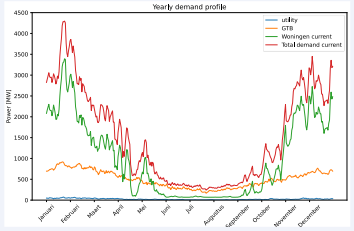
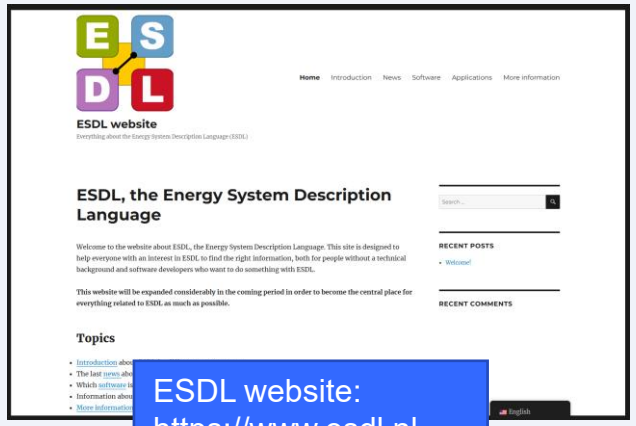
Scripting


ESDL Auxiliary Services
ESDL MapEditor
Models:
- ESSIM
- MESIDO
- Calliope
- DOTS
- ...
ESDL
Maps
Results
Profiles

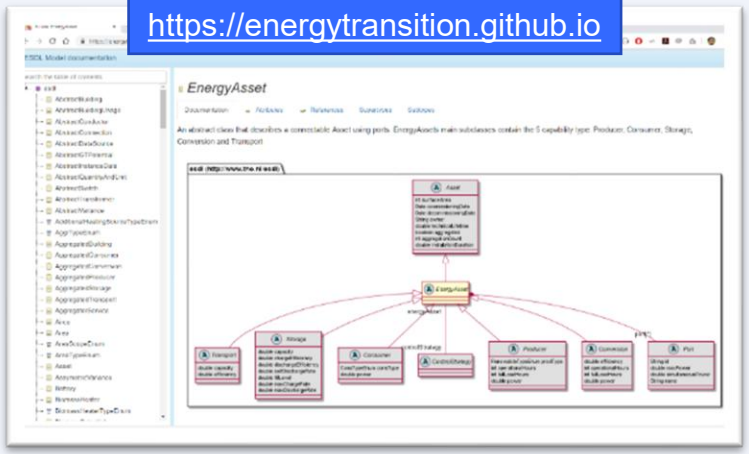

Yearly demand profile

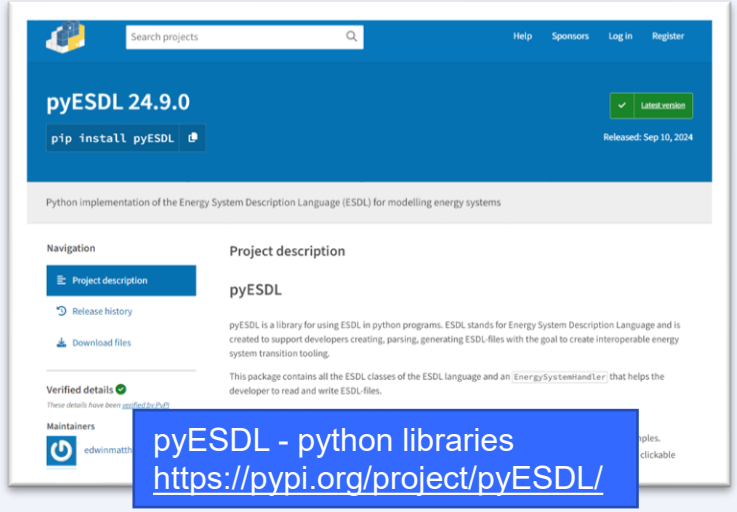
Open source



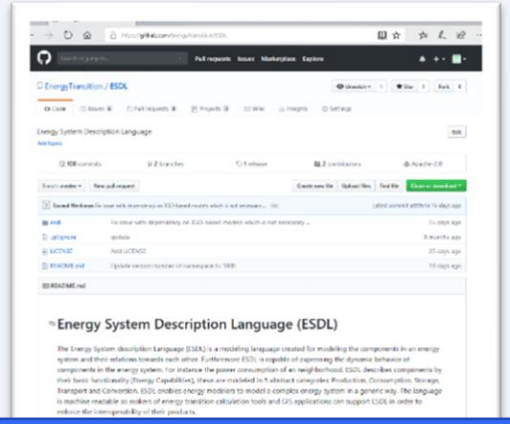
ESDL website:
https://www.esdl.nl

Class documentation:
https://energytransition.github.io



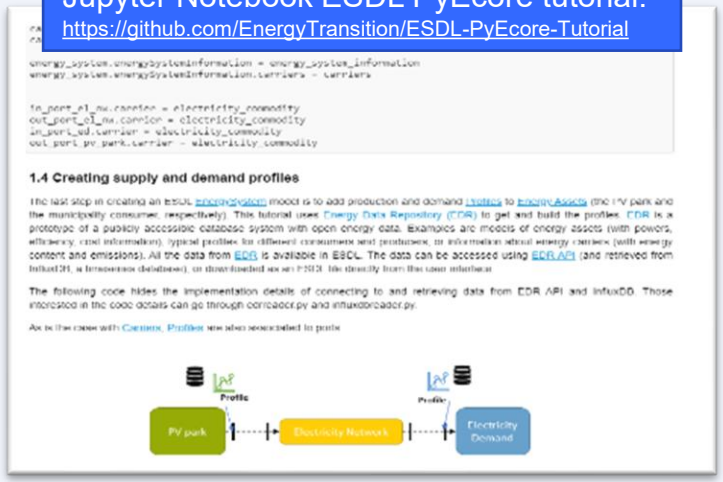


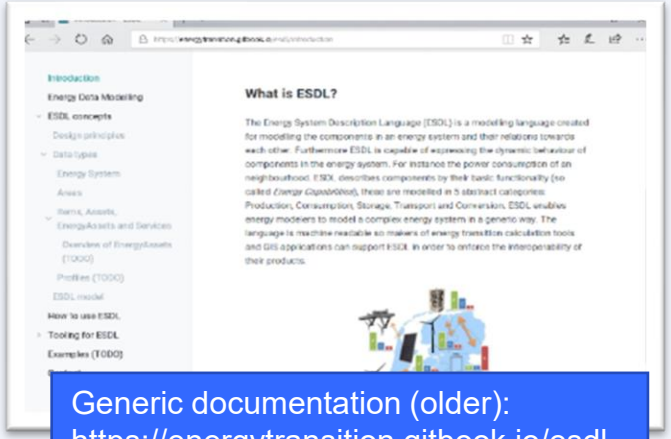
pyESDL - python libraries
https://pypi.org/project/pyESDL/



ESDL model itself published on Github:
https://github.com/EnergyTransition/ESDL

Jupyter Notebook ESDL PyEcore tutorial:
https://github.com/EnergyTransition/ESDL-PyEcore-Tutorial





Generic documentation (older):
https://energytransition.gitbook.io/esdl

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ESDL Ecosystem

Application Domains

Available Models

Current Partners

ESDL

Quintel, Deltares, TPG, NEC, DoingTheMath, TUe/TUD, ...

MMvIB (2021-2023, QuoMare, Kalavasta, DNV GL, Quintel)

(2025 ,RH DHV , warmtetooling)...

Gridmaster(2018, Siemens)
ObjectVision, Geodan

ESDL MapEditor

TPG UI

ESRI ArcGis

District Heating Networks	OMOTES, MESIDO, EDR, TPG GSD, GeoESDLService, ...	W+B, Greenvis, Antea Group, RH DHV, Rotterdam Engineering, Saxion, ... Capturam, Vattenfall, Quirion, EnNatuurlijk, Eneco
Business Parks / Communities	EPS, ESSIM, Flexscan, BC Module, ...	TNO, Saxion, DEP, CCS, ...
Spatial planning (local/regional governments)	ETM, EDR, Connect-Nearest-Infra, Infra-Impact, ...	*Min KGG, IPO, VNG, NBNL, WIP, provinces, RES regions, municipalities, ...* W+B, Quintel
System Integration on the North Sea	ESSIM, MESIDO, EDR, DOWA service, BC Module, ...	TNO, NEC, Van Oord, Deme Group, RWE, ...
Regional Energy Transition	High level: ESSIM, EDR, ... Dynamics: DOTS	Equans, Common Futures, Bax Company, Blueconomy EKwadraat, MUG, Ecorys, Stedin, Hanze, ...
Market Modelling	EYE, I-ELGAS, Calliope, ...	Power2X, TUD, TUe
Education [...]	ESSIM, EDR, ...	Hanze, Saxion, TUD, TUe, UU, ...

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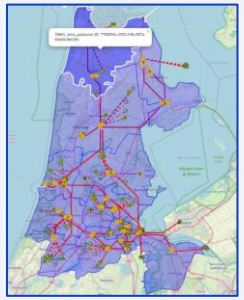
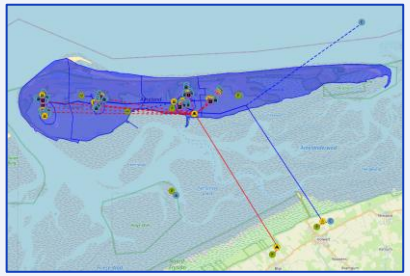
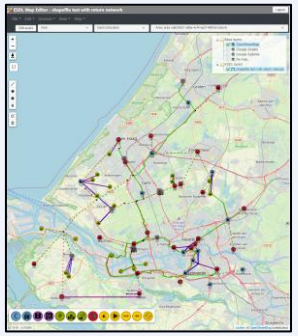
Application Domains

Regional Energy Transition

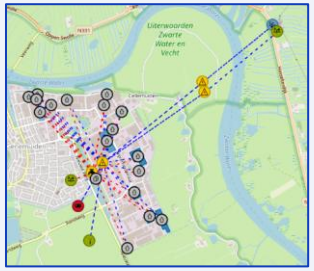




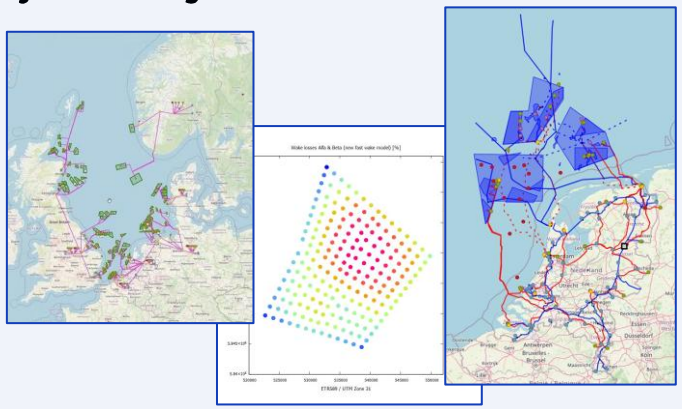
District Heating and Cooling Network



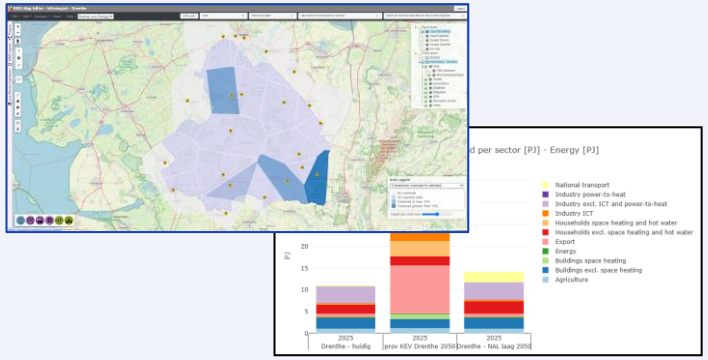
Business Parks



System Integration on the Norh Sea



Spatial Planning



Market modelling

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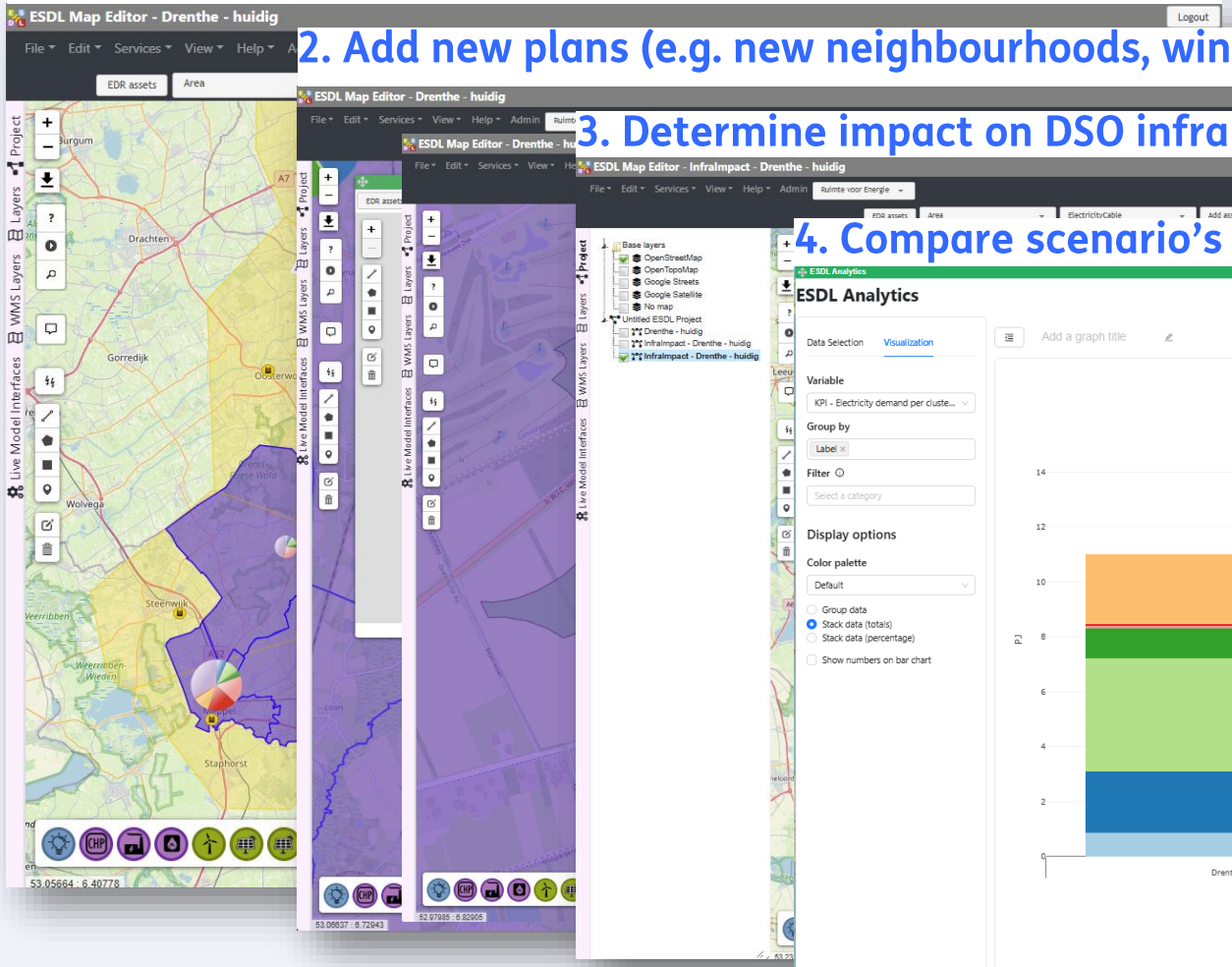
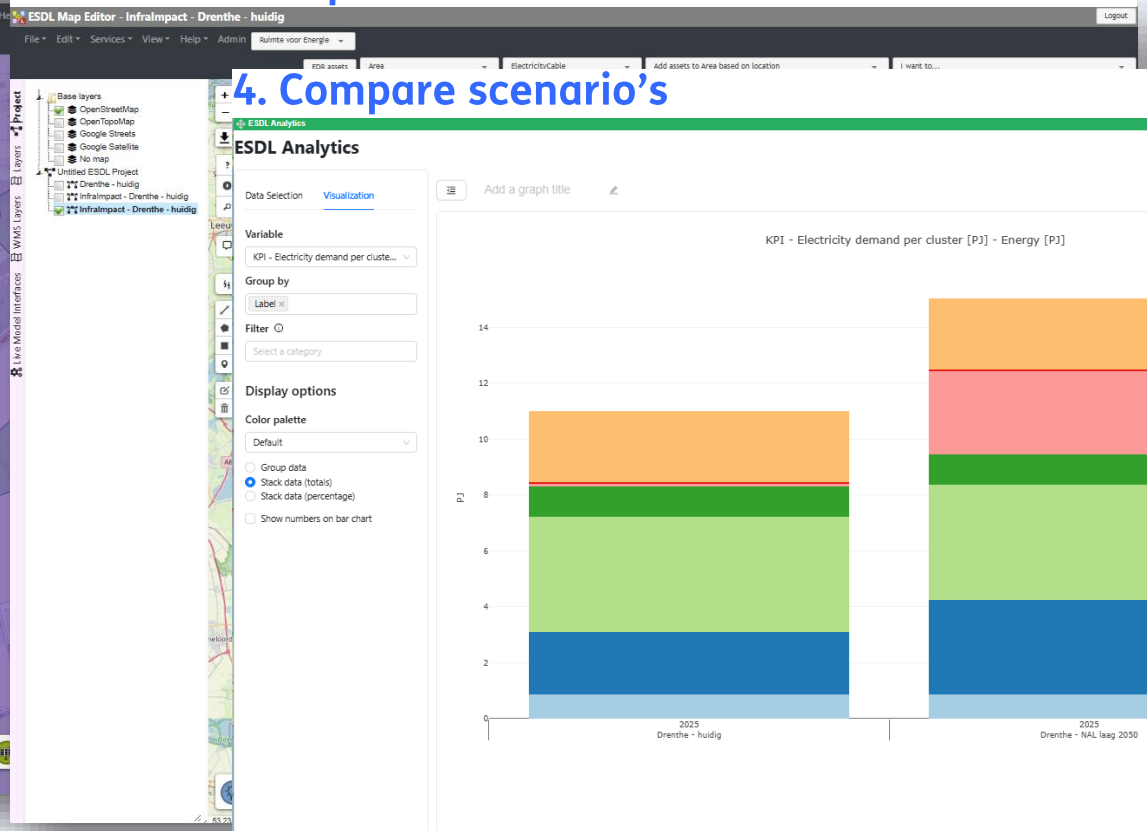
Spatial energy explorer

1. Map Current Situation



2. Add new plans (e.g. new neighbourhoods, windmills)

3. Determine impact on DSO infra



4. Compare scenario's

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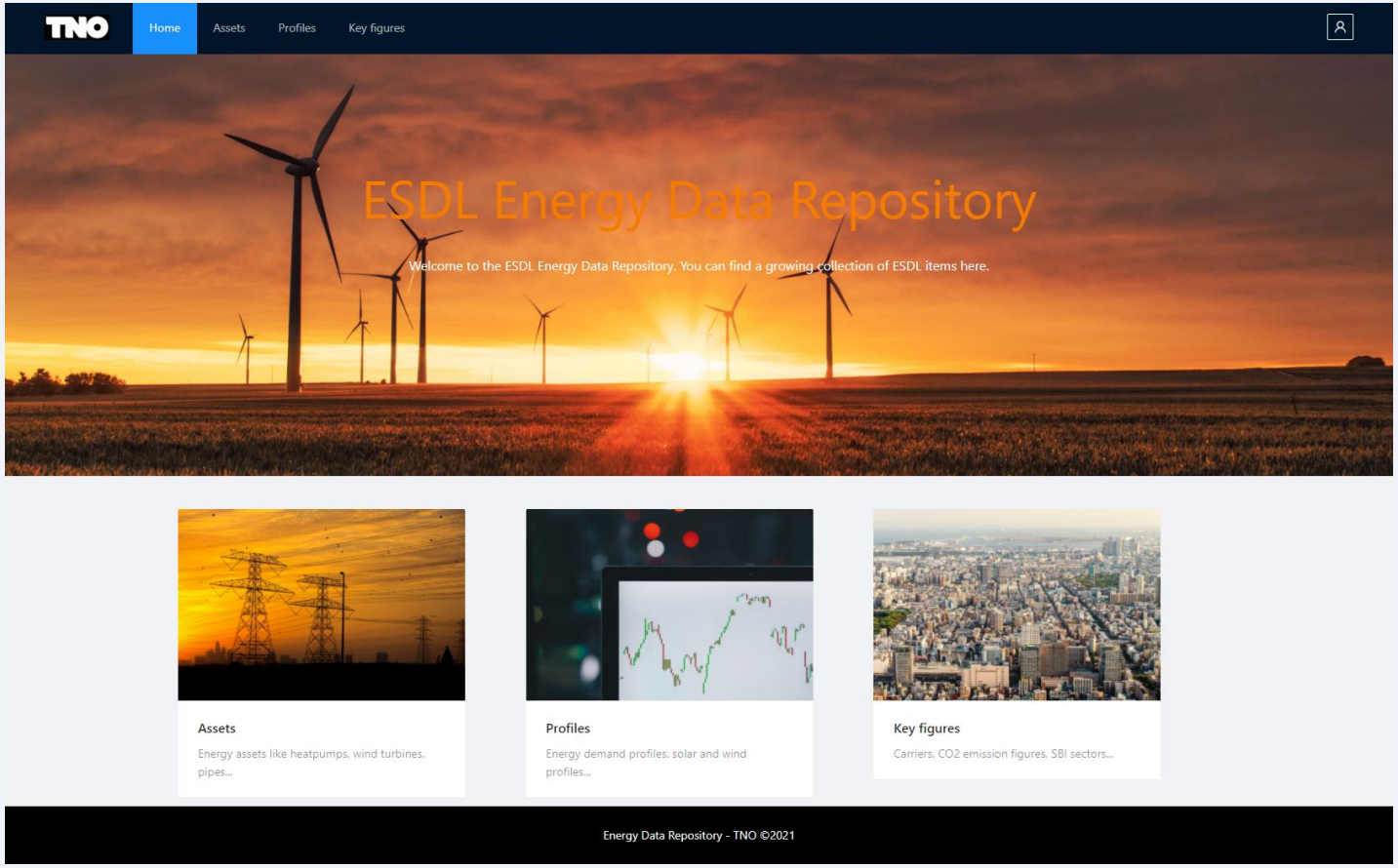
Energy Data Repository (EDR)



Website:

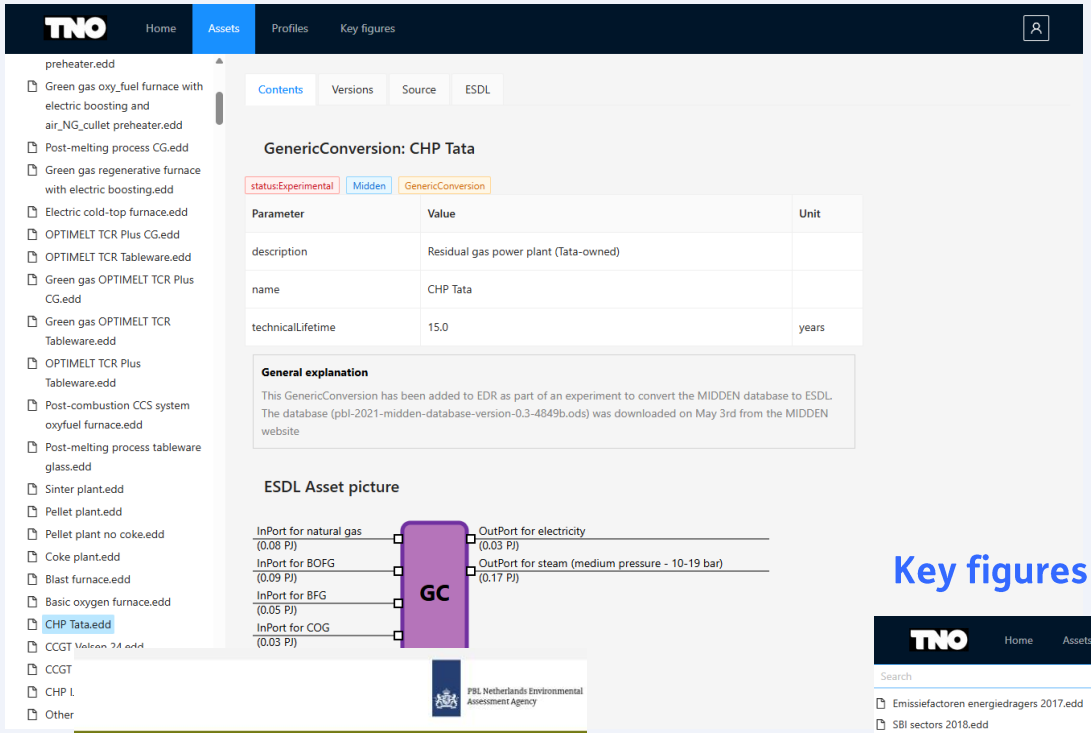
https://edr.hesi.energy

API:

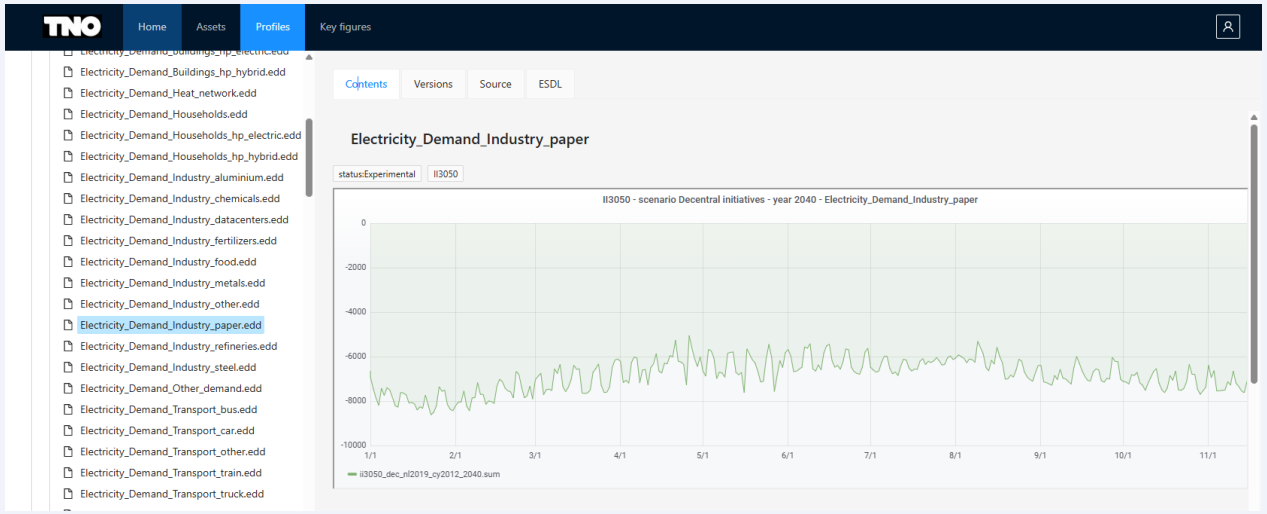
https://drive.esdl.hesi.energy/openapi/ui

What kind of data can be shared?

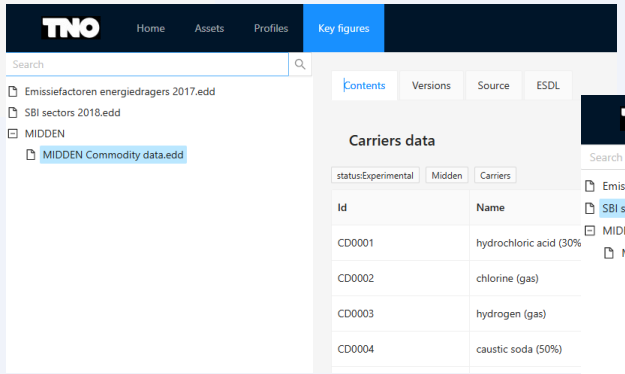
Technology & asset data (efficiency, costs): CHP Tata

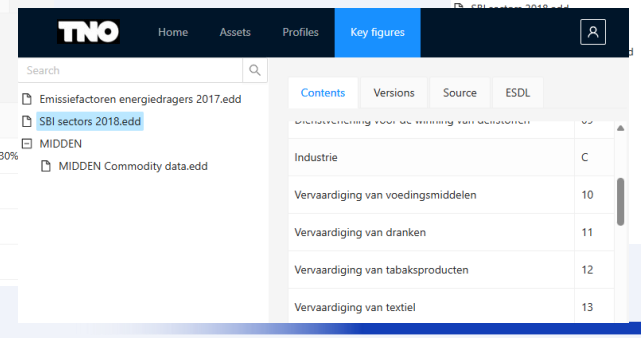


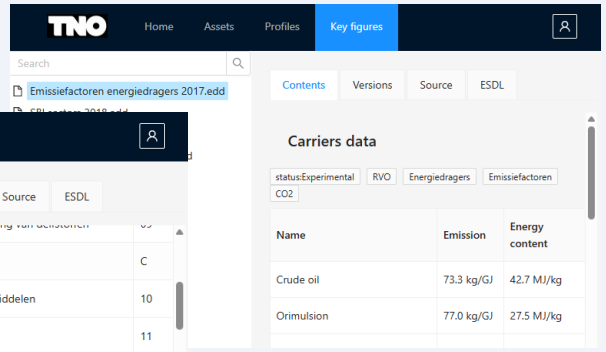
Profile data: II3050 Dec.Init. 2040 – Electricity demand paper industry



Key figures data: Carriers, SBI sectors, Emission figures







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Energy Hubs

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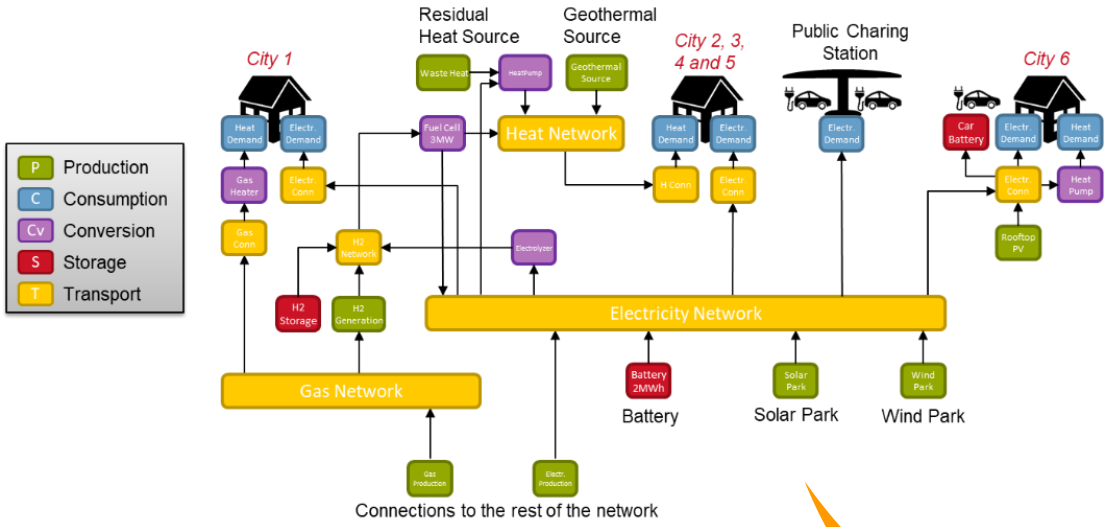
Energy System Simulator (ESSIM)

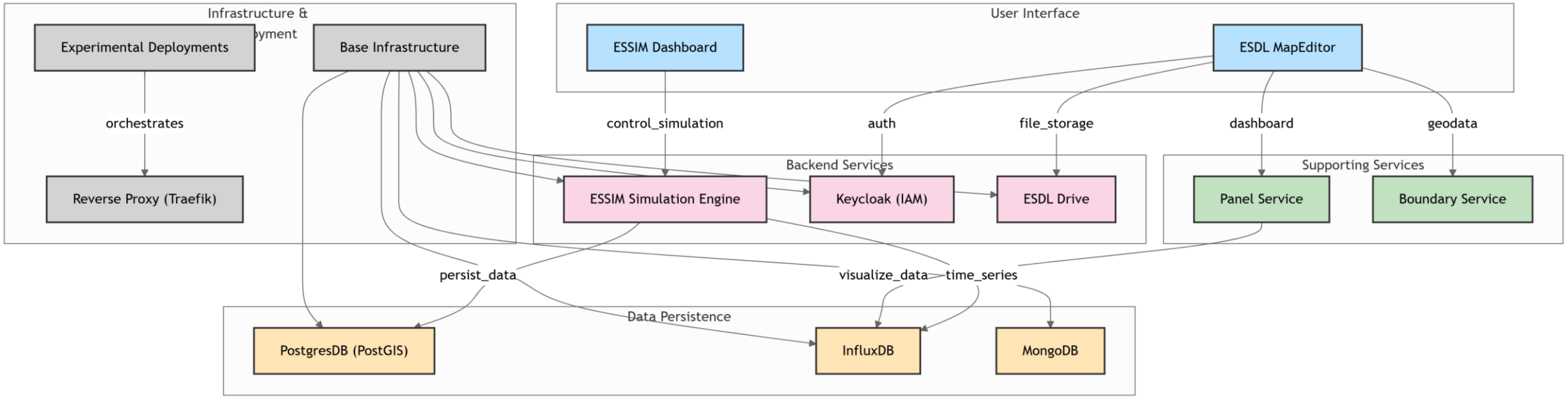


- Flexible and fully configurable in ESDL
- Profiles for demand and inflexible production
- Conversion: Power, efficiency
- Storage: Capacity, (dis)charge rate
- Transport: Capacities for the infrastructure

Typical questions:

- Is my energy system well dimensioned?
- Are all energy carriers in balance at all times?
  How do different energy carriers interact?
- (Over)load of the distribution or transport infrastructure?
- What are the effects of adding storage in the system?

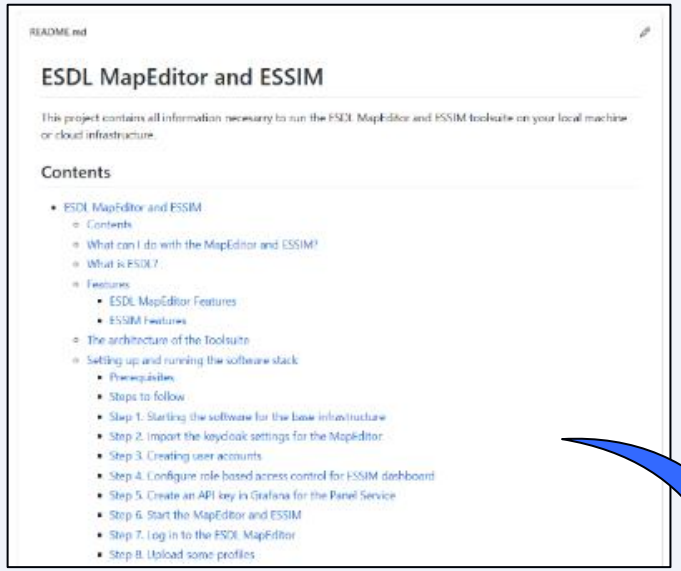
GitDiagram

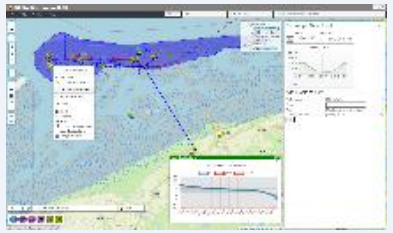

Infrastructure &
yment
Experimental Deployments
Base Infrastructure
orchestrates
Reverse Proxy (Traefik)
User Interface
ESSIM Dashboard
ESDL MapEditor
control_simulation
auth
file_storage
dashboard
geodata
Backend Services
ESSIM Simulation Engine
Keycloak (IAM)
ESDL Drive
Supporting Services
Panel Service
Boundary Service
persist_data
visualize_data
time_series
Data Persistence
PostgresDB (PostGIS)
InfluxDB
MongoDB

ESSIM simulation software

Installation instructions:
https://github.com/ESDLMapEditorESSIM/docker-toolsuite

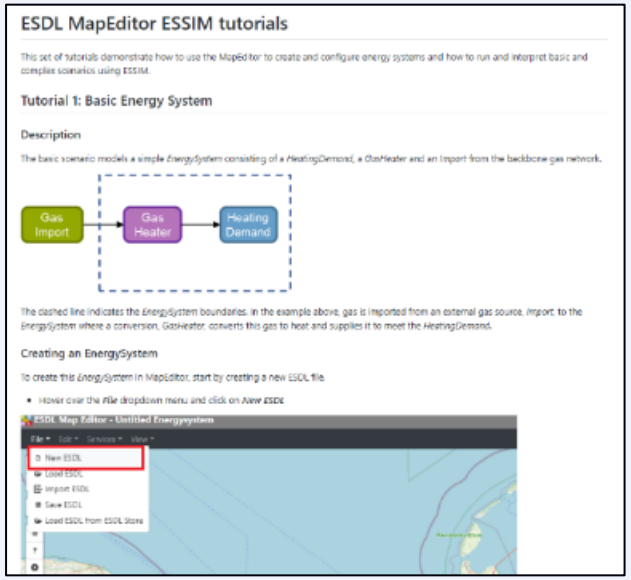
ESSIM and MapEditor Tutorials
https://github.com/ESDLMapEditorESSIM/essim-tutorials

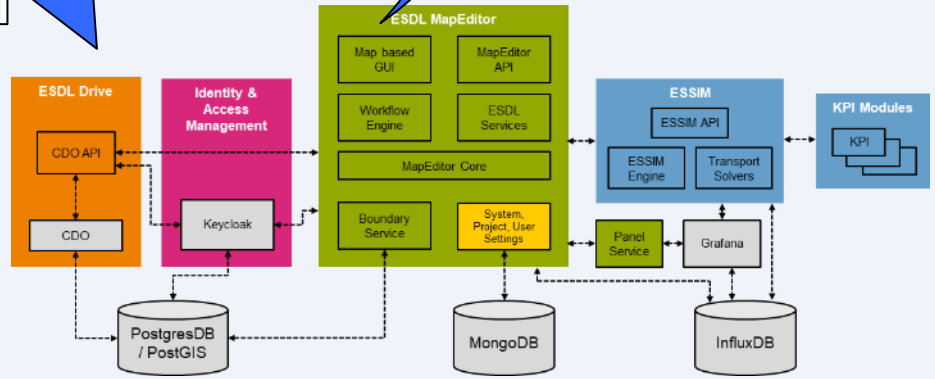




ESDL MAPEDITOR

ESSIM





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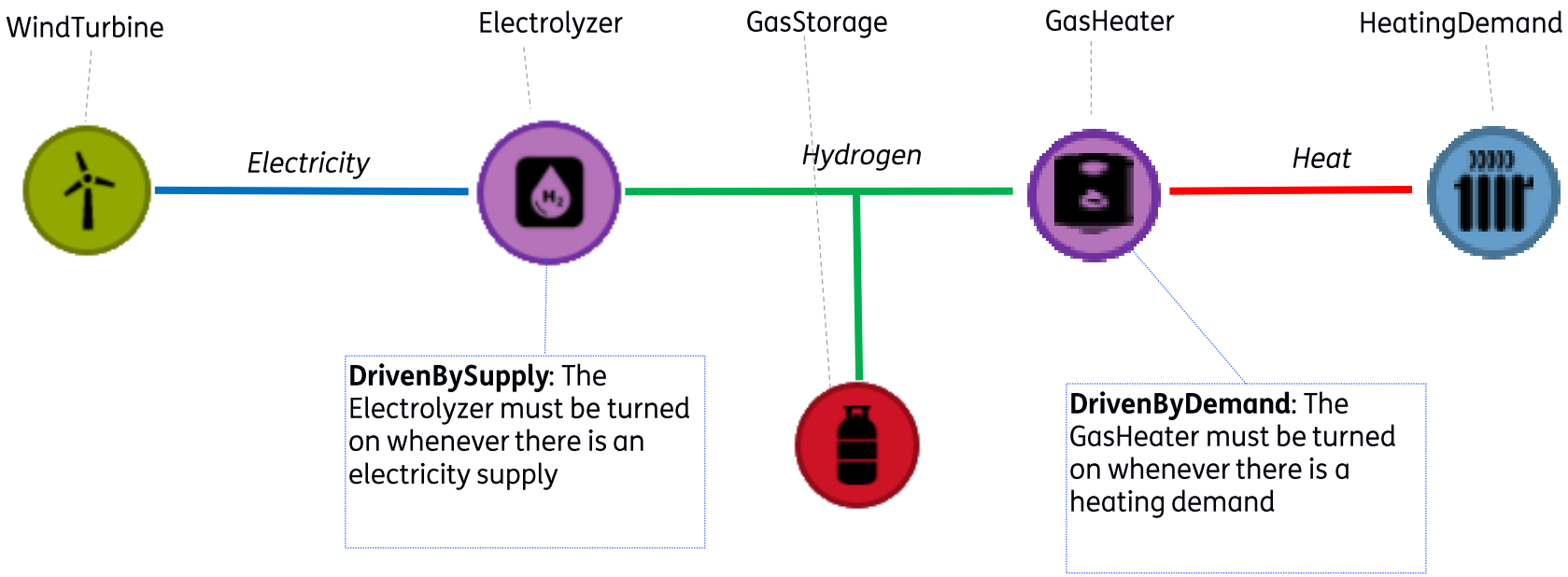
ESSIM: Behind the curtains



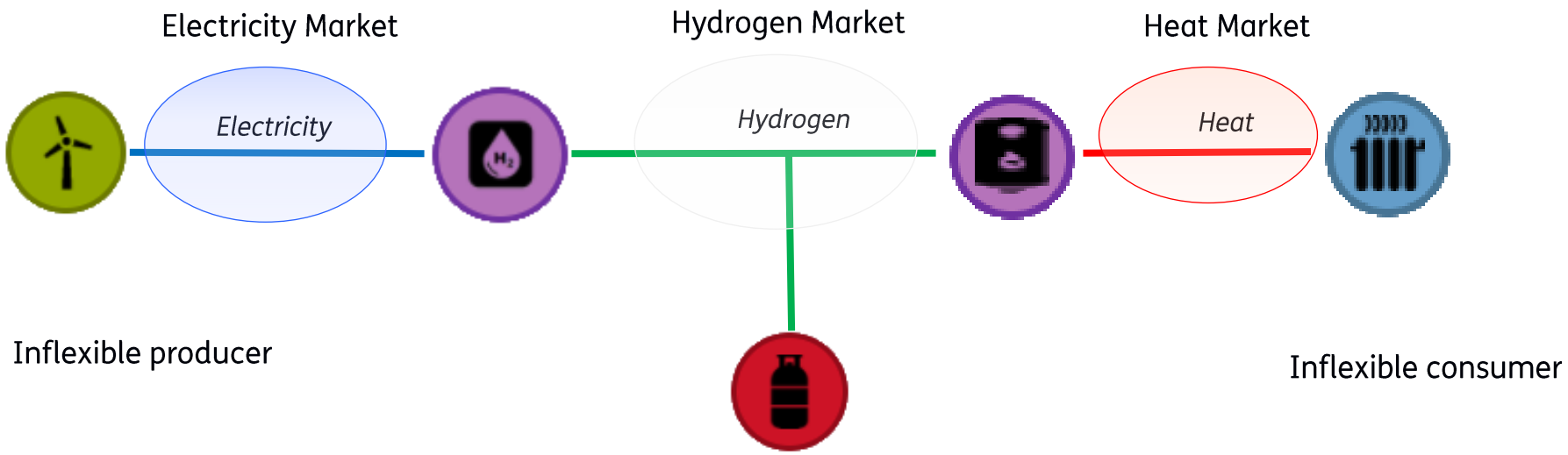
Control strategies (dictate asset behavior)

- DrivenByDemand
- DrivenBySupply
- DrivenByProfile
- StorageStrategy
- CurtailmentStrategy
- (PIDController)

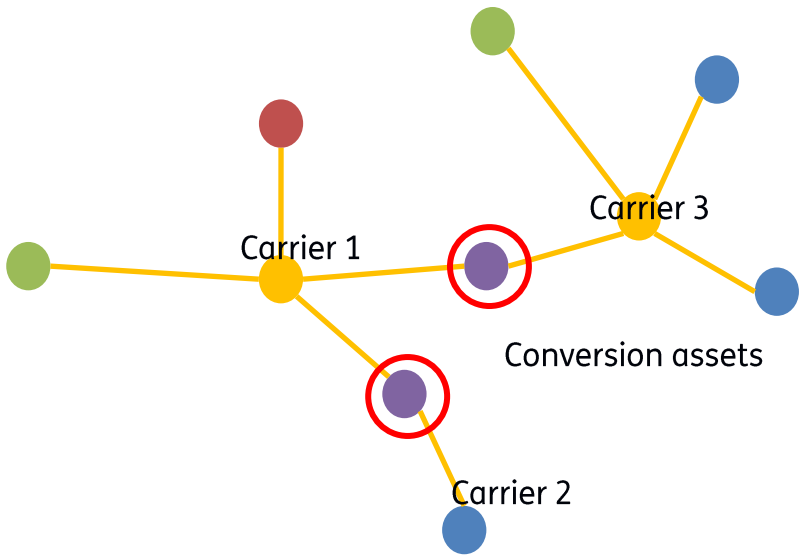
Profiles (flexible and inflexible assets)

Marginal costs (who is willing to pay more/who charges more)

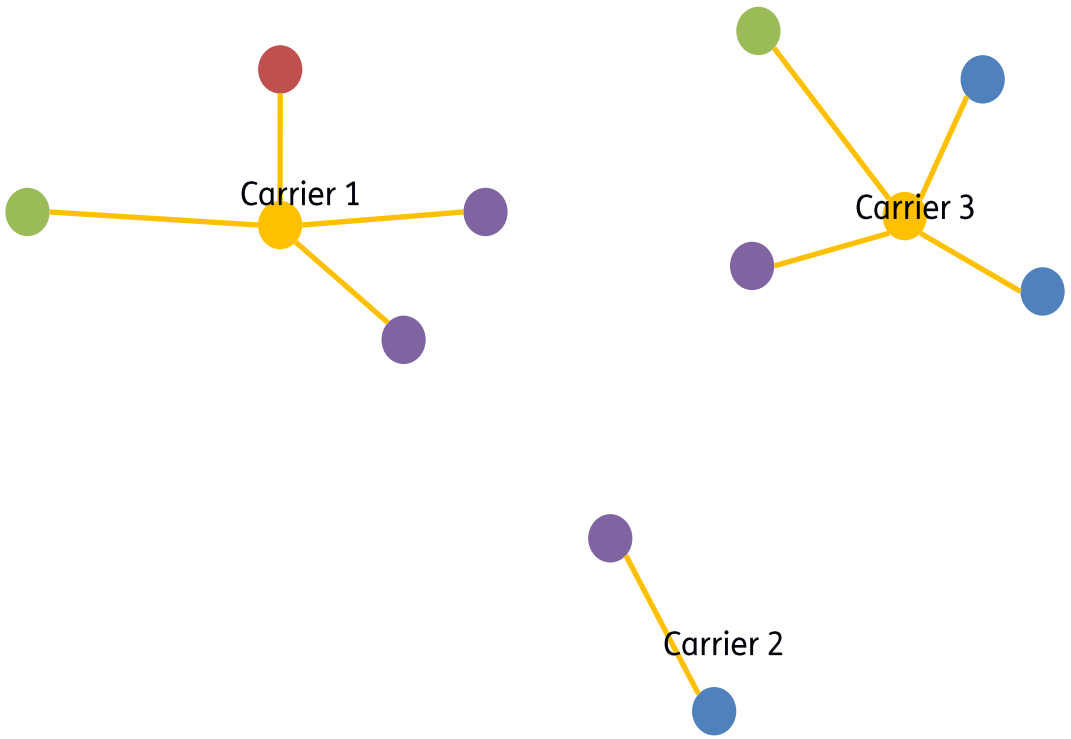
ESSIM: Behind the curtains

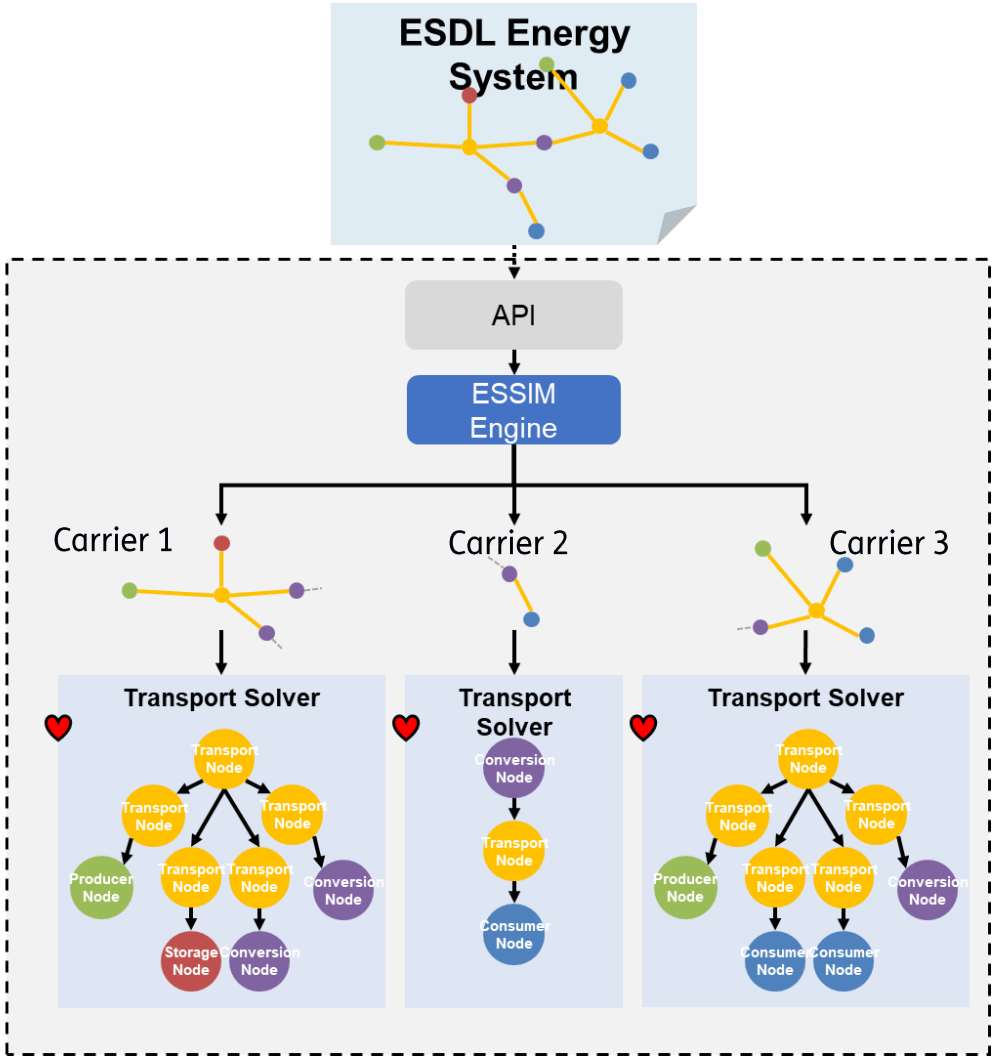


ESSIM: Behind the curtains

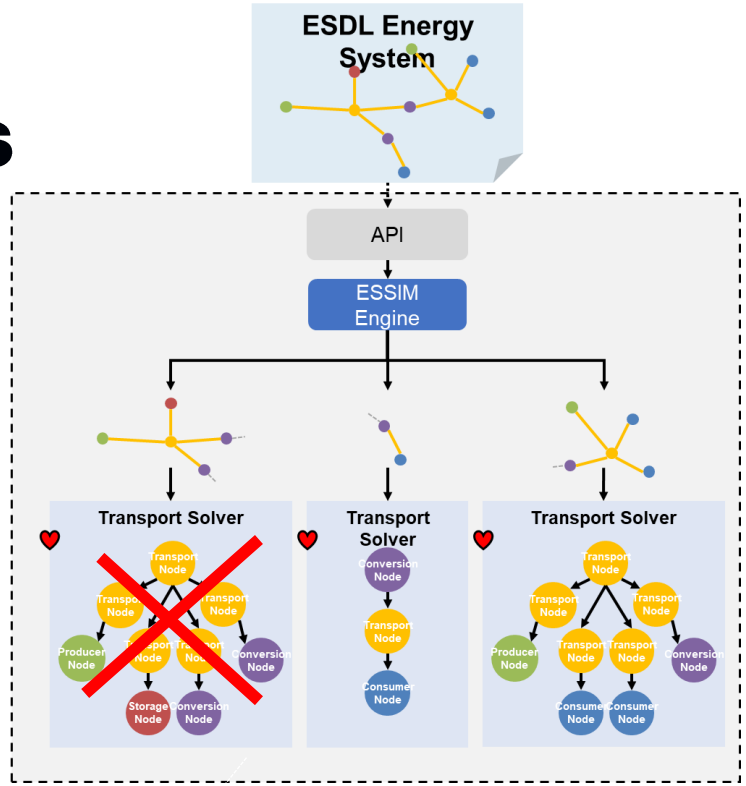


ESSIM: Behind the curtains





ESSIM With load flows



pandapower

LFENERGY POWSYBL

LFENERGY POWER GRID MODEL

ESSIM: Connecting external modules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            "startDate": "2019-01-01T00:00:00+0100",
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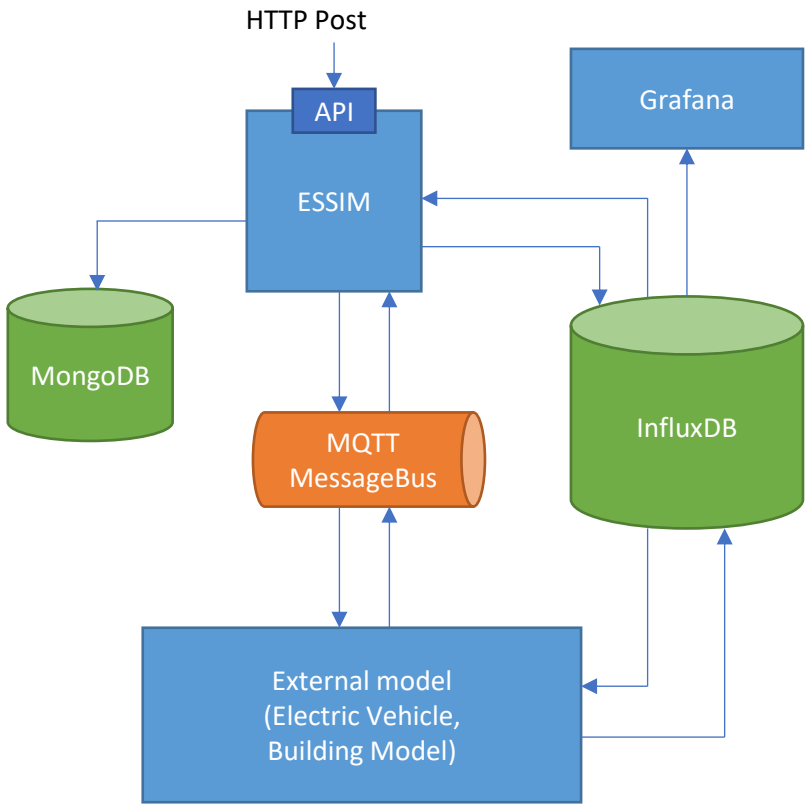
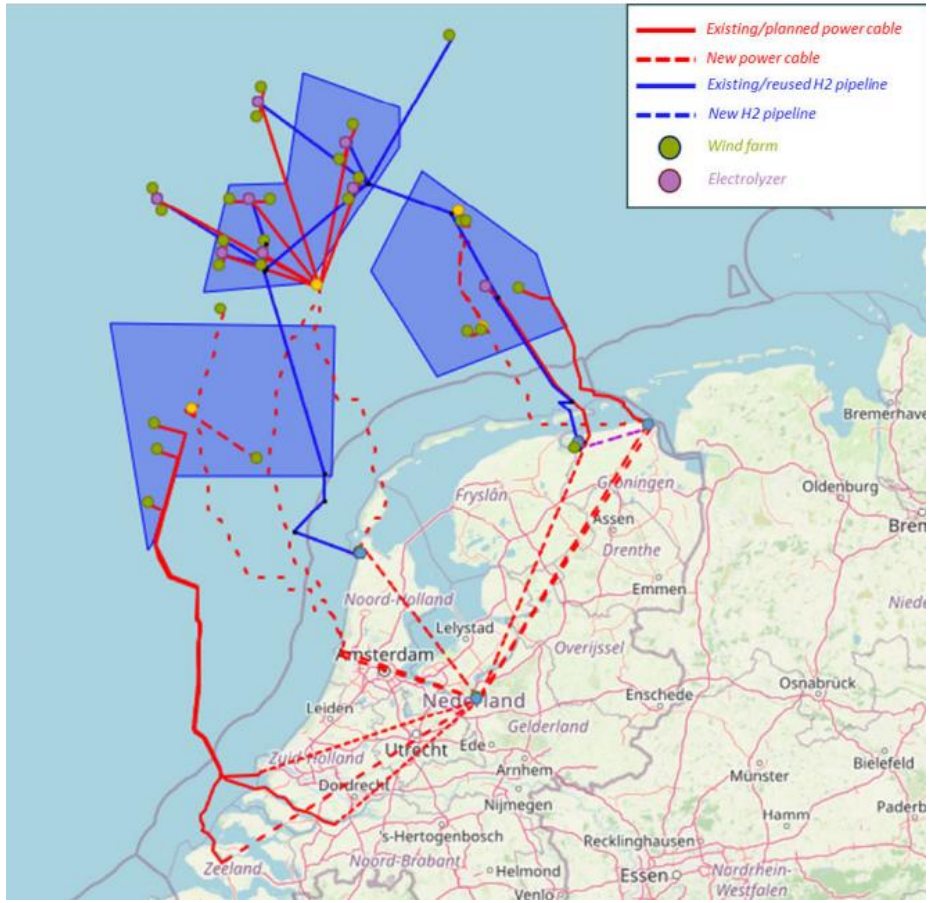
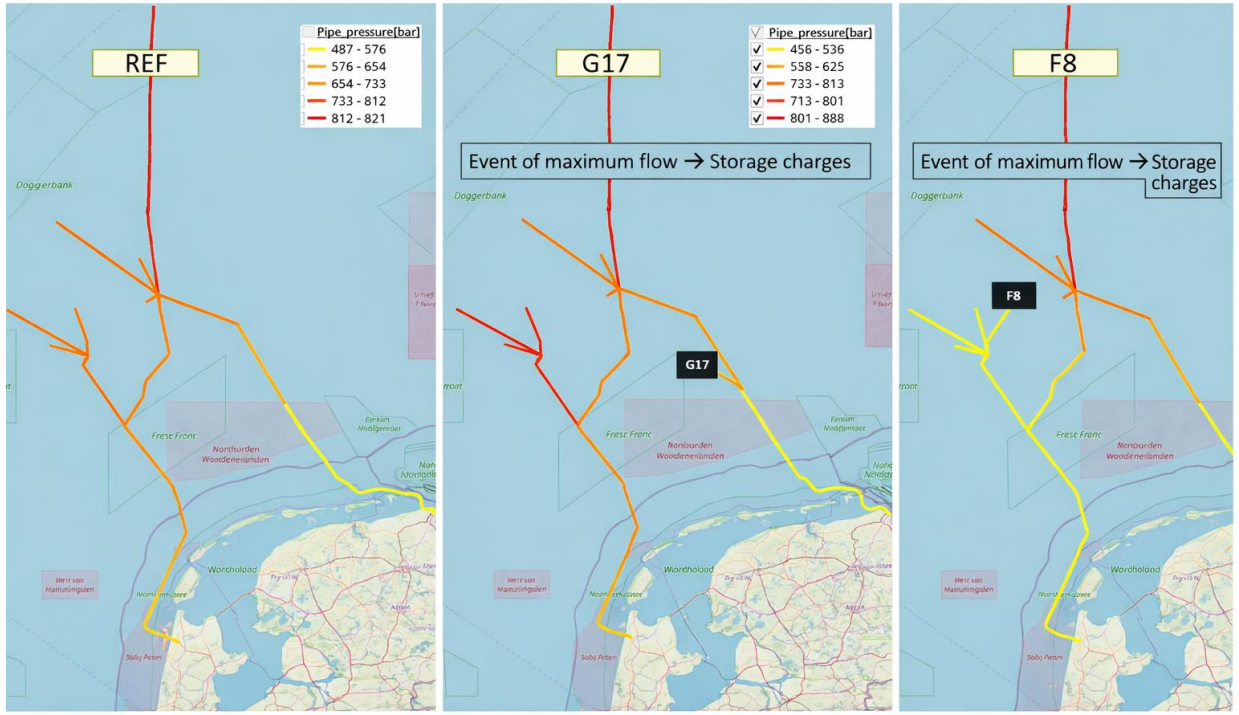


North Sea Energy

offshore
system
integration

Modelling hydrogen gas flow with MESIDO





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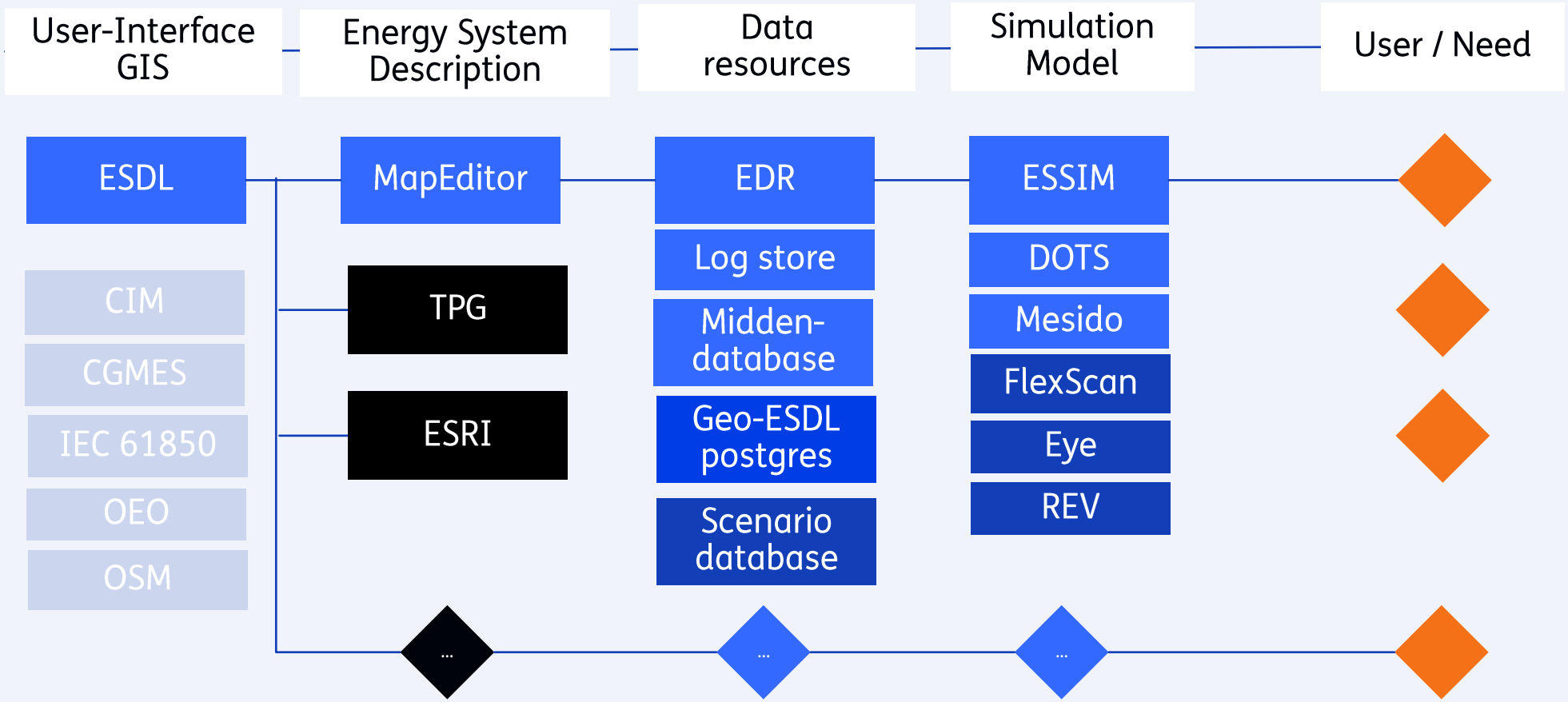
Open-source

Inner-source

Proprietary

Ontology – UI - Data – Simulations – Users



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Future AI Energy Agents

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Towards a future with AI

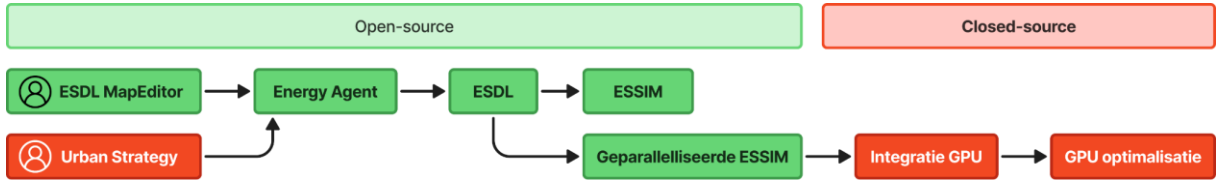
"Success in creating effective AI could be the biggest event in the history of our civilisation.

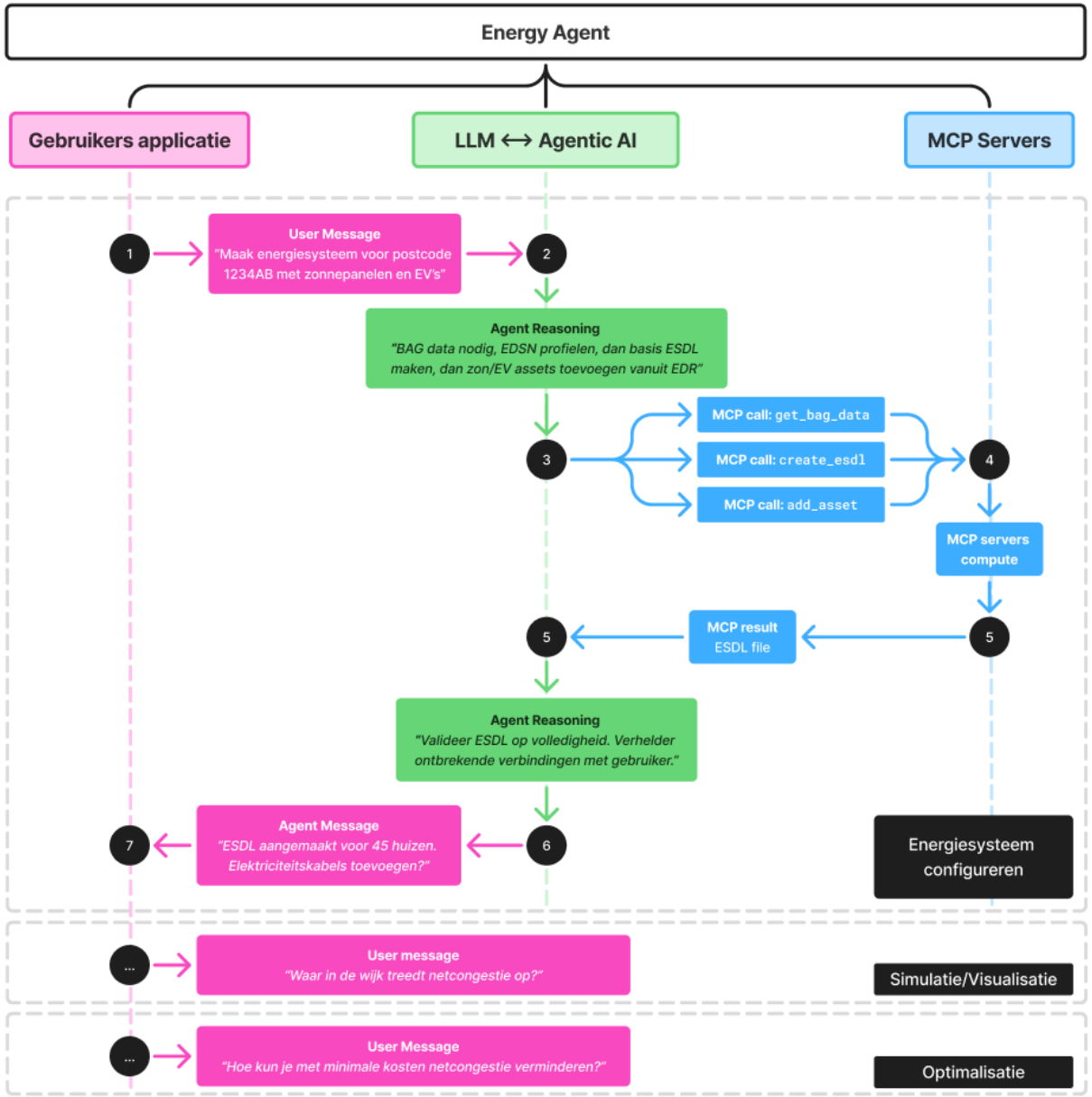
Or the worst.

We just don't know."

- Stephen Hawking

Energy AI Agents





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