



› **WELKOM!**  
HAAL GERUST NOG EEN KOPJE KOFFIE, DE MEETING START OM  
14:30 UUR

- **Huisregels: graag camera en geluid uitzetten!**
- **Graag in de chat de vragen en opmerkingen of reacties plaatsen (we zullen tussentijds geen vragen beantwoorden)**
- **In het programma hebben we na de pauze tijd voor feedback op de chat. We zullen dan actief aanwezigen betrekken bij de bijeenkomst**
- **De sheets worden na afloop geplaatst evenals de belangrijkste ‘opbrengsten’ van de discussie**
- **Voor overige vragen [essim@tno.nl](mailto:essim@tno.nl)**



› **ESSIM COMMUNITY DAG**  
| 14 OKTOBER 2021

25-10-2021



# Agenda 14 oktober

OPZETTEN MAPEDITOR ESSIM COMMUNITY – WAAROM?

ESSIM BASICS & VERDIEPING

PAUZE

FEEDBACK & VRAGEN

INTERACTIEVE SESSIE - TOEKOMSTIGE ONTWIKKELAGENDA

AFRONDING

## › **WELKOM / EVEN VOORSTELLEN** **TNO TEAM WERKZAAM AAN ESSIM/MAPEDITOR**



Edwin Matthijssen



Arun Subramanian



Ewoud Werkman



Selma Causevic



Richard Westerga



Elodie Jegu



Joram Nauta



Sebastiaan la Fleur

*TNO Team: Pathways towards a sustainable regional energy system*

25-10-2021

[essim@tno.nl](mailto:essim@tno.nl)

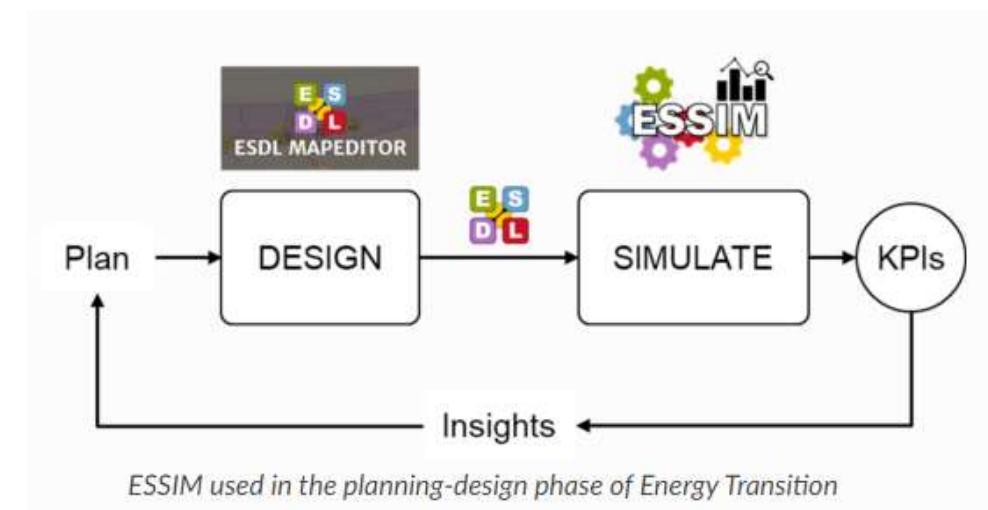
## › REAGEREN/VRAGEN OF OPMERKINGEN

- Huisregels: graag camera en geluid uitzetten!
- Graag in de chat de vragen en opmerkingen of reacties plaatsen (we zullen tussentijds geen vragen beantwoorden)
- In het programma hebben we na de pauze tijd voor feedback op de chat. We zullen dan actief aanwezigen betrekken bij de bijeenkomst
- De sheets worden na afloop geplaatst evenals de belangrijkste ‘opbrengsten’ van de discussie
- Voor overige vragen [essim@tno.nl](mailto:essim@tno.nl)

## WAAROM

Deze Community is bedoeld om de combinatie [ESSIM \(Rekenmodule\) in combinatie met de MapEditor \(GUI\)](#) als tool breed inzetbaar -te maken voor het modelleren van lokale/regionale energietransitievraagstukken.

Hiermee kan door de gebruikersgroep (lokale /regionale) simulatiestudies worden uitgevoerd om verschillende varianten te verkennen en de resultaten te gebruiken in besluitvormingsprocessen.



### Status:

- › Open Source software sinds aug 2020
- › Groeiende (diverse) gebruikersgroep
- › Los van TNO gepositioneerd (github)
- › Voorzien van installatieinstructies, gebruikersinstructies (Engelstalig), uitleg, tutorials
- › Gebruik in eigen projecten, samen met anderen (consultancy, onderzoek) en zonder TNO's medeweten.

## › AMBITIE ESSIM COMMUNITY

### Korte termijn (2021):

Start van de ESSIM/Mapeditor-community

- Er is een actieve groep ESSIM/Mapeditor gebruikers
- Die ELKAAR ook helpen bij de vraagstukken waar je ESSIM voor in kunt zetten



### Lange Termijn (>2021):

IMPACT: Verhogen kwaliteit van analyses over de energietransitie in NL.

IMPACT: Een ‘standaard’ worden voor regionale energie transitie studies en analyses

We willen graag een concrete route hebben met 1 of meer universiteiten of hogescholen voor het gebruik van de tooling door studenten.

# Voorlopige interesse

**TNO** innovation  
for life



**SIEMENS**



# AGENDA 14 OKTOBER

OPZETTEN MAPEDITOR ESSIM COMMUNITY – WAAROM?

**ESSIM BASICS & VERDIEPING**

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FEEDBACK & VRAGEN

INTERACTIEVE SESSIE - TOEKOMSTIGE ONTWIKKELAGENDA

AFRONDING



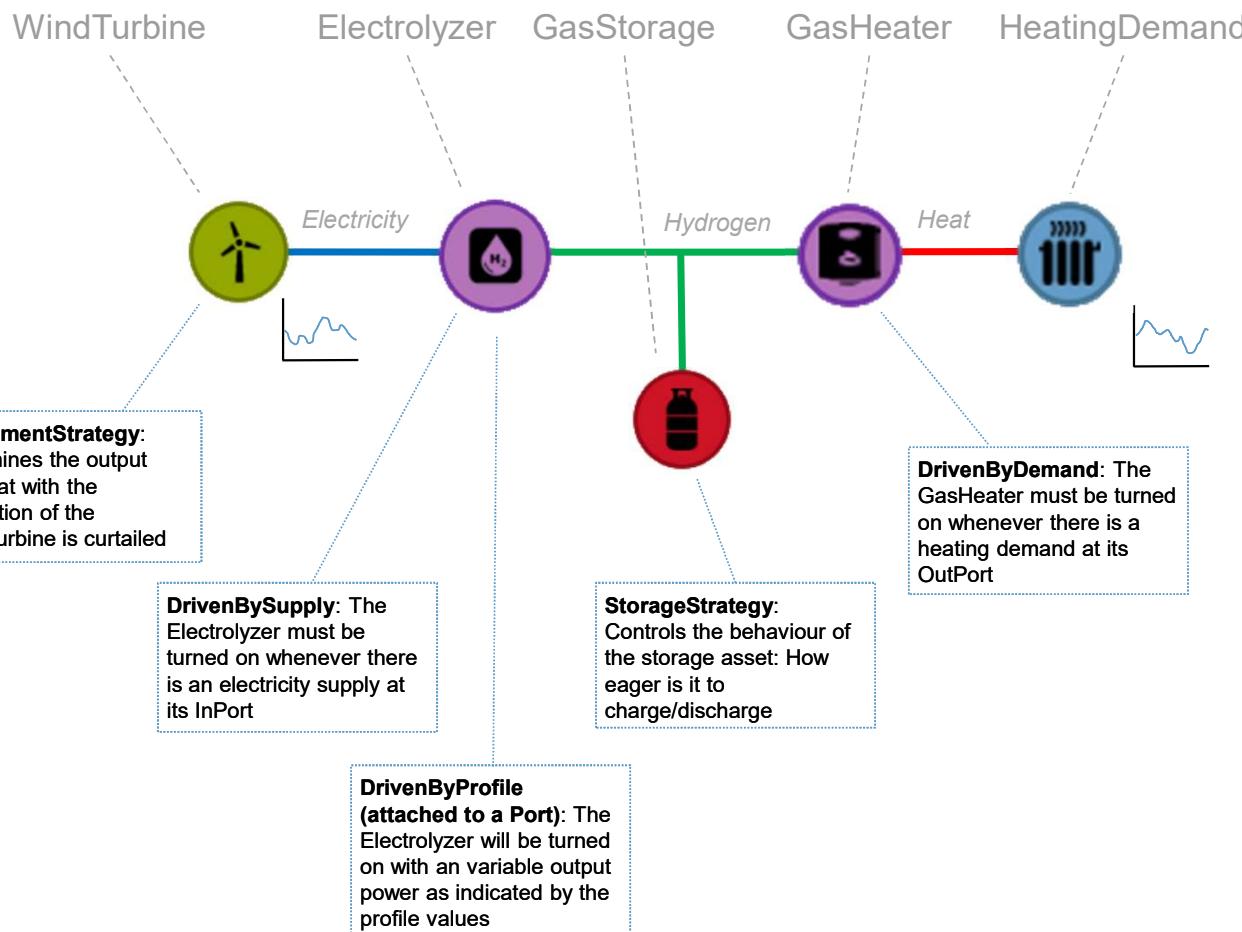
# ESSIM COMMUNITY PRESENTATION

Edwin Matthijssen

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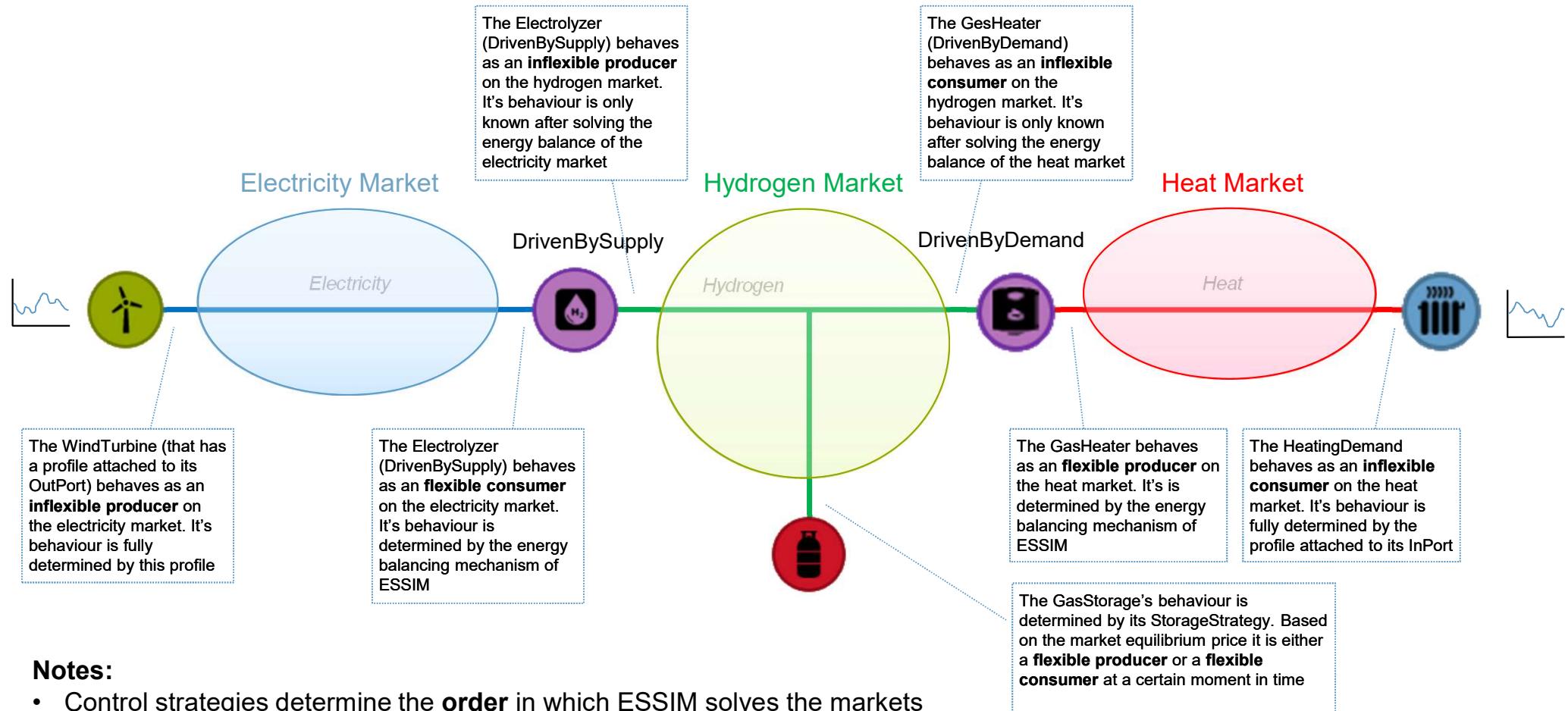
## › ESSIM “BASICS”

# CONTROL STRATEGIES



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

# ENERGY BALANCING

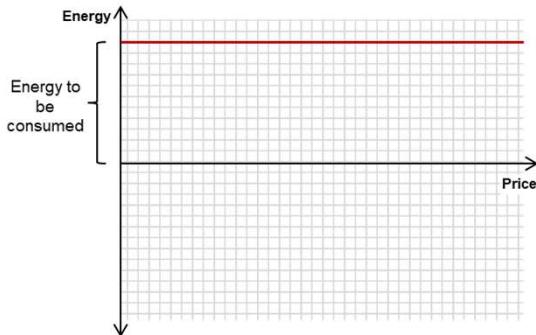


## Notes:

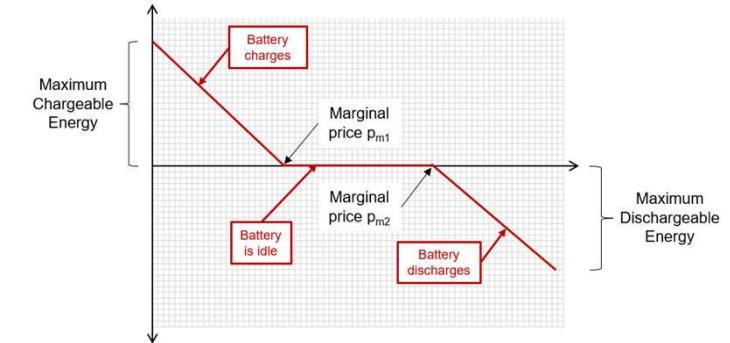
- Control strategies determine the **order** in which ESSIM solves the markets
- Assets behave (at every timestep) either as a producer or as a consumer of energy

# BID CURVES

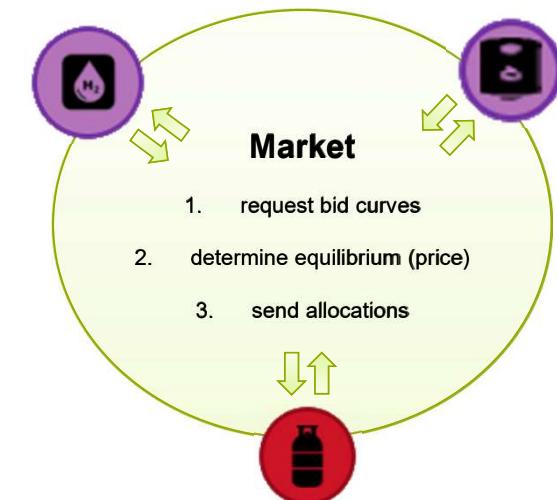
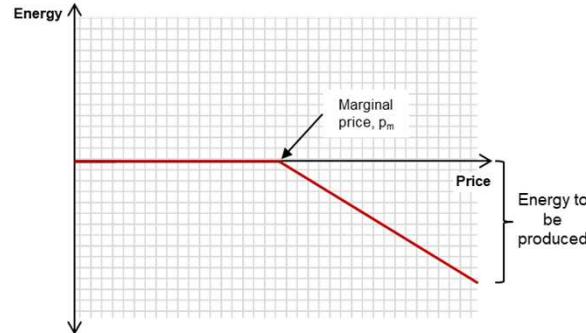
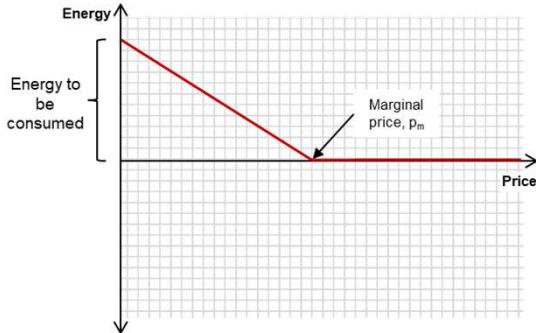
Inflexible consumer or producer



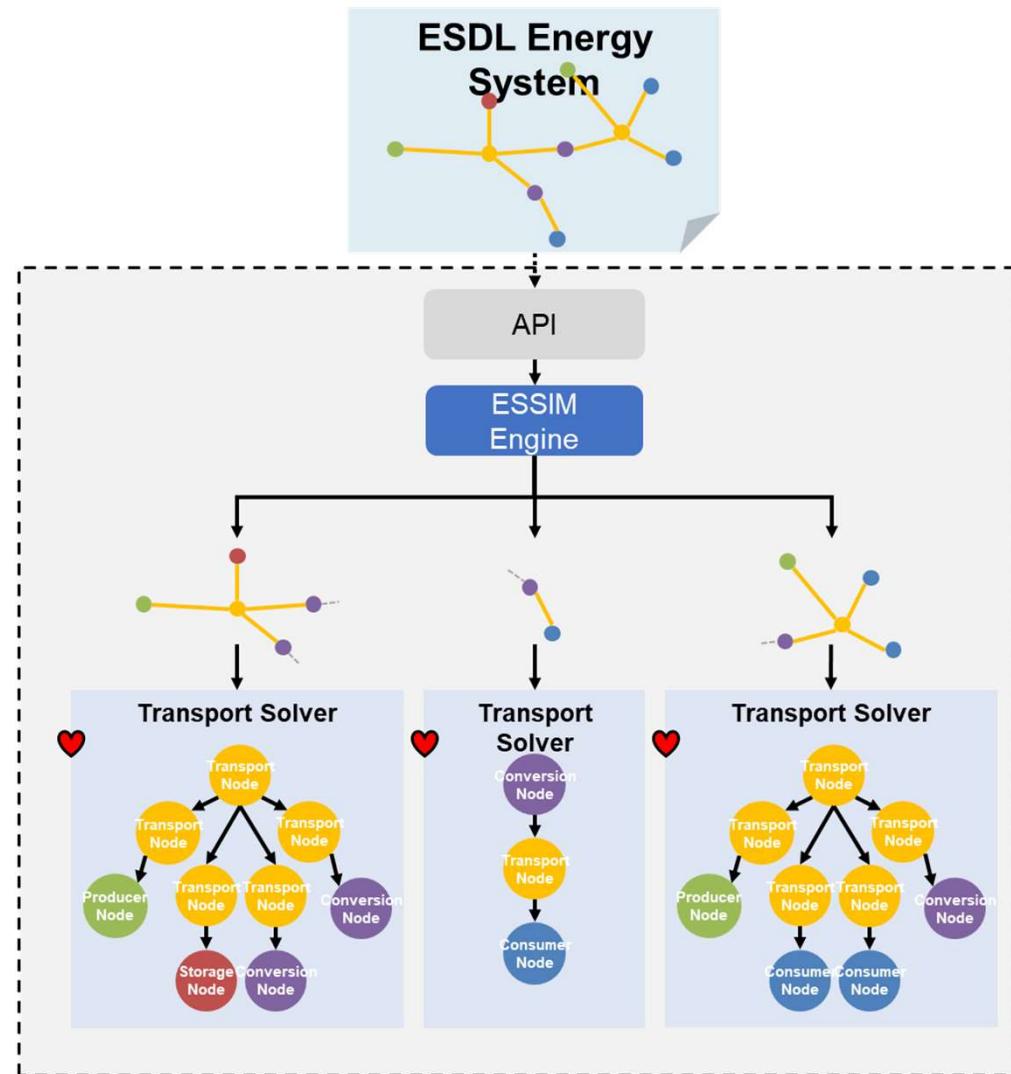
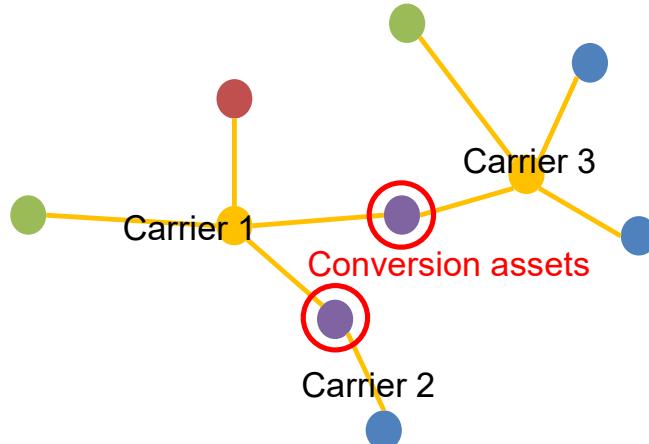
**Storage asset**



Flexible consumer or producer



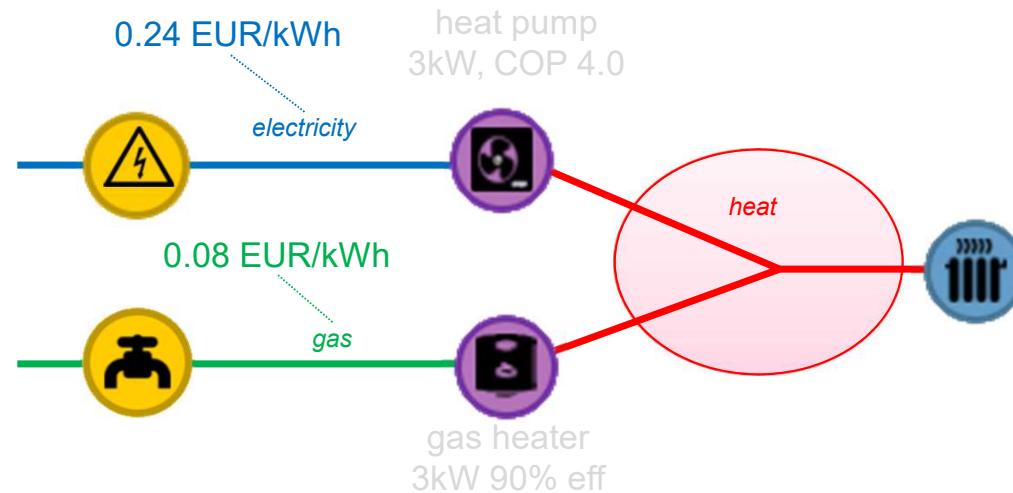
# TRANSPORT SOLVERS



# › ESSIM SELECTED TOPICS

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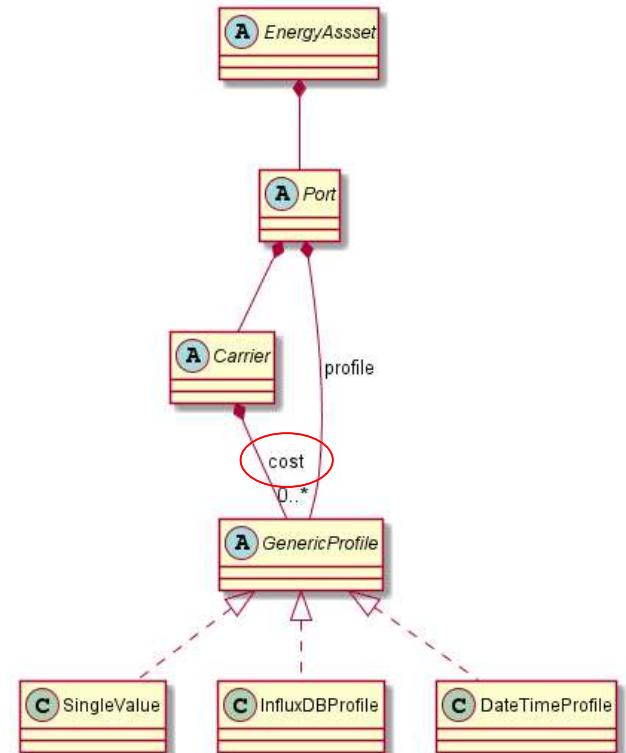
# USING PRICE PROFILES



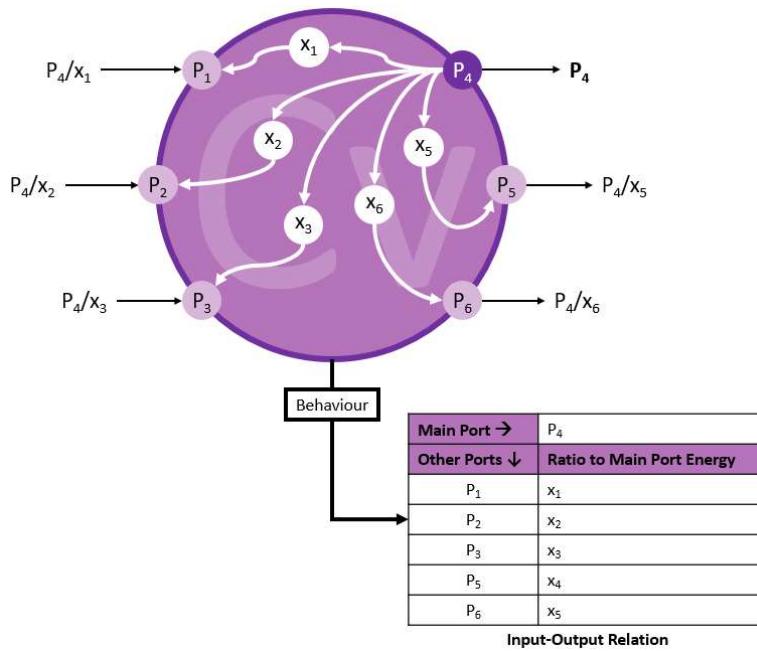
```

<esdl:EnergySystem
    xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xmlns:esdl="http://www.tno.nl/esdl"
    id="9f0f2530-d534-4faf-82cd-4bdf4b0f7a0c" name="ESSIM test price profiles" description="" esdlVersion="v2109" version="4">
    <energySystemInformation xsi:type="esdl:EnergySystemInformation" id="88517162-866e-4fee-af4c-1dc17de45803">
        <carriers xsi:type="esdl:Carriers" id="0f8922c7-96ac-4b9e-903b-d4a83c68057d">
            <carrier xsi:type="esdl:EnergyCarrier" id="50a6a2f6-a27d-4a41-843c-1cf63e98d74f" name="Electr">
                <cost
                    xsi:type="esdl:InfluxDBProfile"
                    host="http://localhost" port="8086"
                    database="price_profiles"
                    startDate="2019-01-01T00:00:00.000000+0100" endDate="2020-01-01T00:00:00.000000+0100"
                    measurement="elec_price_2019"
                    field="price"
                    id="a3add39-5fe1-4b75-a57d-4e8cb051259c">
                </cost>
            <carrier xsi:type="esdl:EnergyCarrier" id="1c09dec7-e237-4880-b250-4127b39235c8" name="Gas">
                <cost xsi:type="esdl:SingleValue" id="92d55836-f4c5-4693-96ca-cc7fae0eab7d" value="0.08" profileType="MONEY IN EUR" name="Gas price"/>
            <carrier xsi:type="esdl:HeatCommodity" id="12fc87a7-7d11-49d4-bb29-9ba9bad6ccb0" name="Heat"/>
        </carriers>
    </energySystemInformation>
    <instance xsi:type="esdl:Instance" id="1a665a09-ba19-4fb7-a369-ff031525f460" name="Untitled instance">
        <area xsi:type="esdl:Area" id="52532989-74d0-4092-8106-936f50c4c9db" name="Untitled area">
            <asset xsi:type="esdl:HeatingDemand" id="b129d663-7ff1-4ac2-a324-32902904ad47" name="HeatingDemand_b129">

```



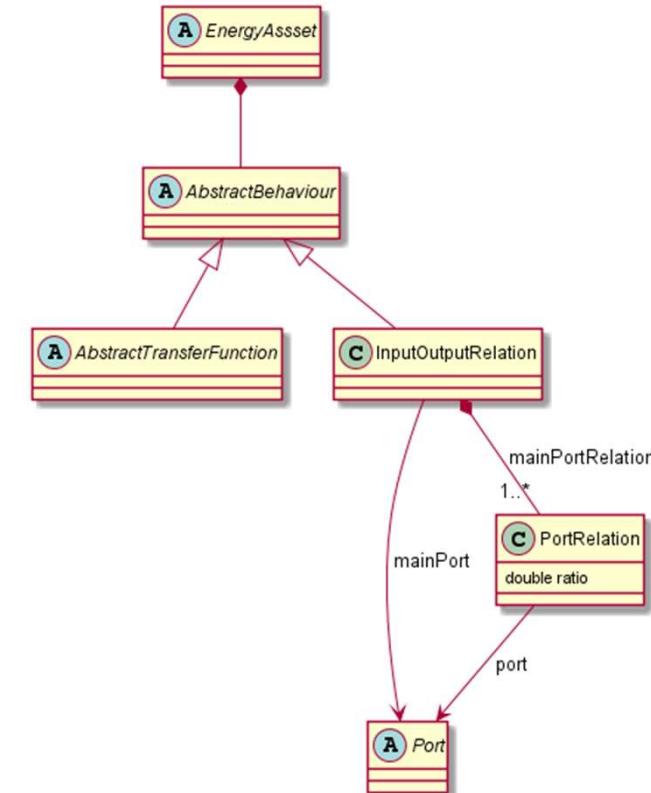
# MULTI-INPUT MULTI-OUTPUT ASSETS



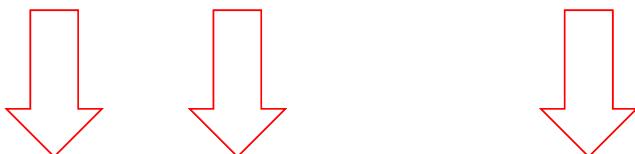
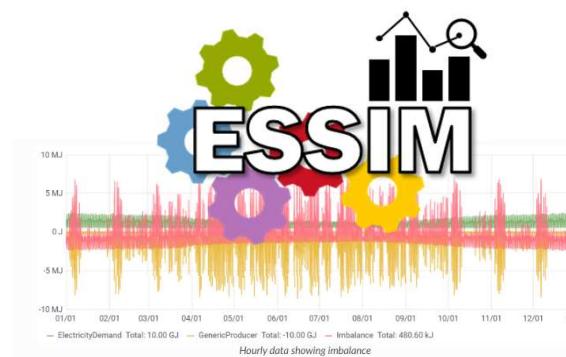
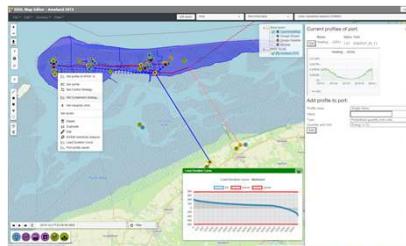
```

<asset xsi:type="esdl:PowerPlant" id="..." name="PowerPlant_Maasvlakte">
  <port xsi:type="esdl:InPort" id="GasIn" name="Gas InPort"/>
  <port xsi:type="esdl:InPort" id="BiomassIn" name="Biomass InPort"/>
  <port xsi:type="esdl:OutPort" id="ElectricityOut" name="Electricity OutPort"/>
  <port xsi:type="esdl:OutPort" id="ResidualHeatOut" name="ResidualHeat OutPort"/>
  <behaviour xsi:type="esdl:InputOutputRelation" name="InputOutputRelation" id="..." mainPort="ElectricityOut">
    <mainPortRelation xsi:type="esdl:PortRelation" port="GasIn" ratio="0.45"/>
    <mainPortRelation xsi:type="esdl:PortRelation" port="ResidualHeatOut" ratio="4.0"/>
    <mainPortRelation xsi:type="esdl:PortRelation" port="BiomassIn" ratio="0.3"/>
  </behaviour>
</asset>

```



# ESSIM KPI MODULES



Run ESSIM simulation

Please enter a description for this simulation. This description will be shown in the simulation results.

The following settings should only be changed if you know exactly what you're doing

Year 2015  
 Year 2019  
 Custom year

Start datetime   
End datetime

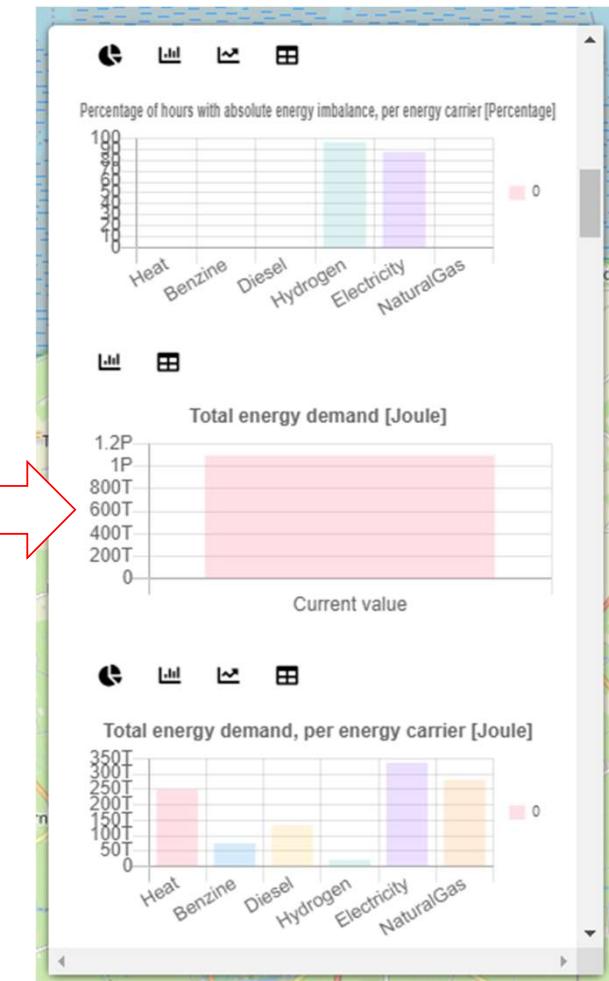
Please select the KPIs that you want to be calculated after the simulation

Total Absolute Energy Imbalance  
 Total Energy Demand  
 Total Energy Production  
 Total Excess Production  
 Total Imported Energy  
 Total Exported Energy  
 Total Renewable Production  
 Total Shortage Production

Use ESSIM with loadflow engine

Favorite ESSIM simulations

Date	Description	Action
2021-02-15 20:14:25	Curacao met KPIs	
2020-06-01 19:44:40	GM_S3	

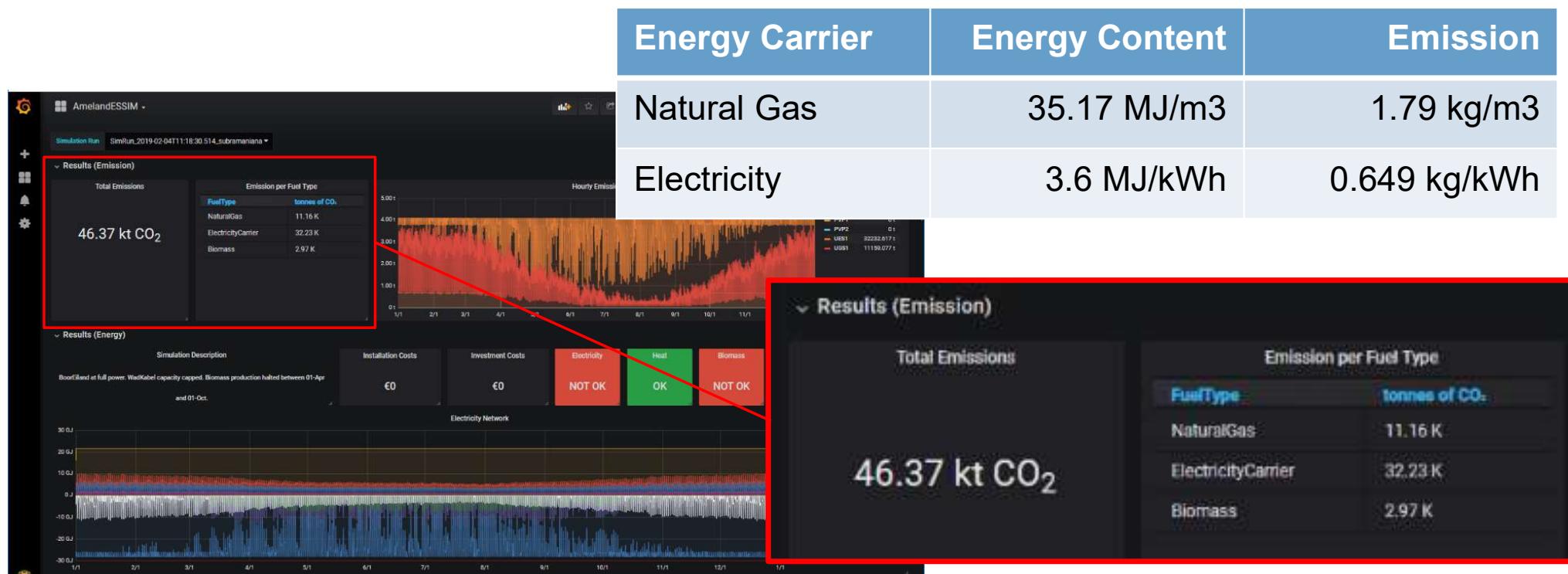


# CO2 CALCULATIONS

```

<carriers xsi:type="esdl:Carriers" id="6cf4541d-b1fe-4bf1-b160-0fb0977e5d43">
  <carrier xsi:type="esdl:EnergyCarrier" id="NaturalGas" name="NaturalGas" energyCarrierType="FOSSIL" emission="1.79139" energyContent="35.17">
    <emissionUnit xsi:type="esdl:QuantityAndUnitType" multiplier="KILO" perUnit="CUBIC_METRE" unit="GRAM" physicalQuantity="EMISSION"/>
    <energyContentUnit xsi:type="esdl:QuantityAndUnitType" multiplier="MEGA" perUnit="CUBIC_METRE" unit="JOULE" physicalQuantity="ENERGY"/>
  </carrier>
  <carrier xsi:type="esdl:EnergyCarrier" id="Electricity" name="Electricity" energyCarrierType="FOSSIL" emission="0.649" energyContent="3.6">
    <emissionUnit xsi:type="esdl:QuantityAndUnitType" perMultiplier="KILO" unit="GRAM" multiplier="KILO" physicalQuantity="EMISSION" perUnit="WATTHOUR"/>
    <energyContentUnit xsi:type="esdl:QuantityAndUnitType" perMultiplier="KILO" unit="JOULE" multiplier="MEGA" physicalQuantity="ENERGY" perUnit="WATTHOUR"/>
  </carrier>

```



# USING THE ESSIM API

## API description, example code in Python

[https://essim-documentation.readthedocs.io/en/latest/essim\\_api/index.html](https://essim-documentation.readthedocs.io/en/latest/essim_api/index.html)

The screenshot shows the ESSIM API documentation. On the left, there's a sidebar with 'CONTENTS' and 'ESSIM API' sections. Under 'ESSIM API', it lists 'Sequence', 'APIs', 'Code Example', and 'Example use cases'. A DigitalOcean advertisement is at the bottom.

**APIs:**

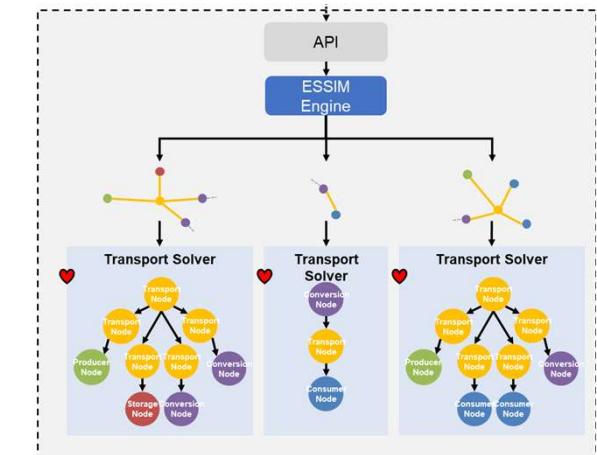
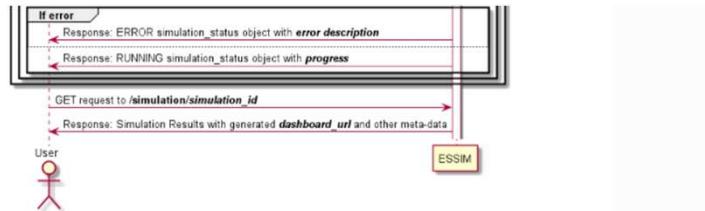
**/simulation**

- HTTP Method: POST
- Description: Create a new simulation
- Request Body:
  - endDate: End date of simulation in ISO-8601 format ( YYYY-MM-DDTHH:mm:sshh:mm )
  - esdlContents: 64-bit encoded ESDL string
  - influxURL: URL of InfluxDB instance to store simulation results in
  - scenarioID: String ID representing the scenario being simulated. This ID is used to name the database in InfluxDB.
  - simulationDescription: Human-readable description of the simulation visible in the dashboard
  - startDate: Start date of simulation in ISO-8601 format ( YYYY-MM-DDTHH:mm:sshh:mm )
  - user: Name of the user running the simulation. Used to tag the name of the Grafana dashboard

Example:

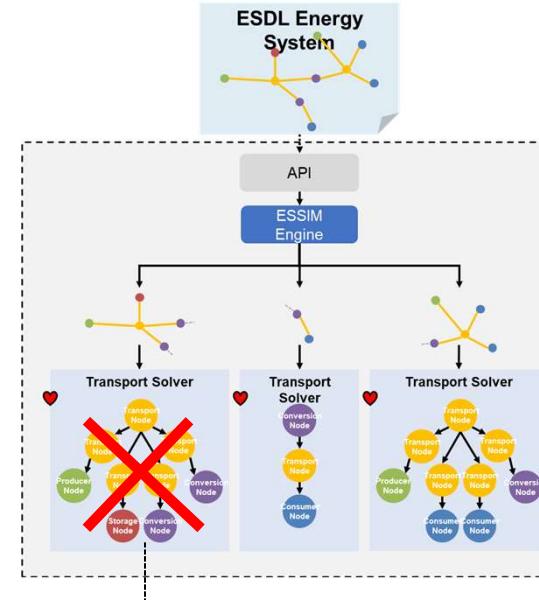
```
{
  "user": "john doe",
  "scenarioID": "essim",
  "simulationDescription": "A simple ES with one geothermal source and a heat demand",
  "startDate": "2019-01-01T00:00:00+0100",
  "endDate": "2020-01-01T00:00:00+0100",
  "influxURL": "http://influxdb:8086",
  "esdlContents": "P094Bnwgdmvyc2lvbj0MS4wJyBlbmNvZGluZz0nvVRGLTgnPz4KPGVzZGw6Rw6lcmdsU3lzdGvtIHtbG5zonhzTeiaHR0cDovL3"
}
```

- Response:
  - CREATED (HTTP status code - 201)



# ESSIM WITH LOADFLOWS

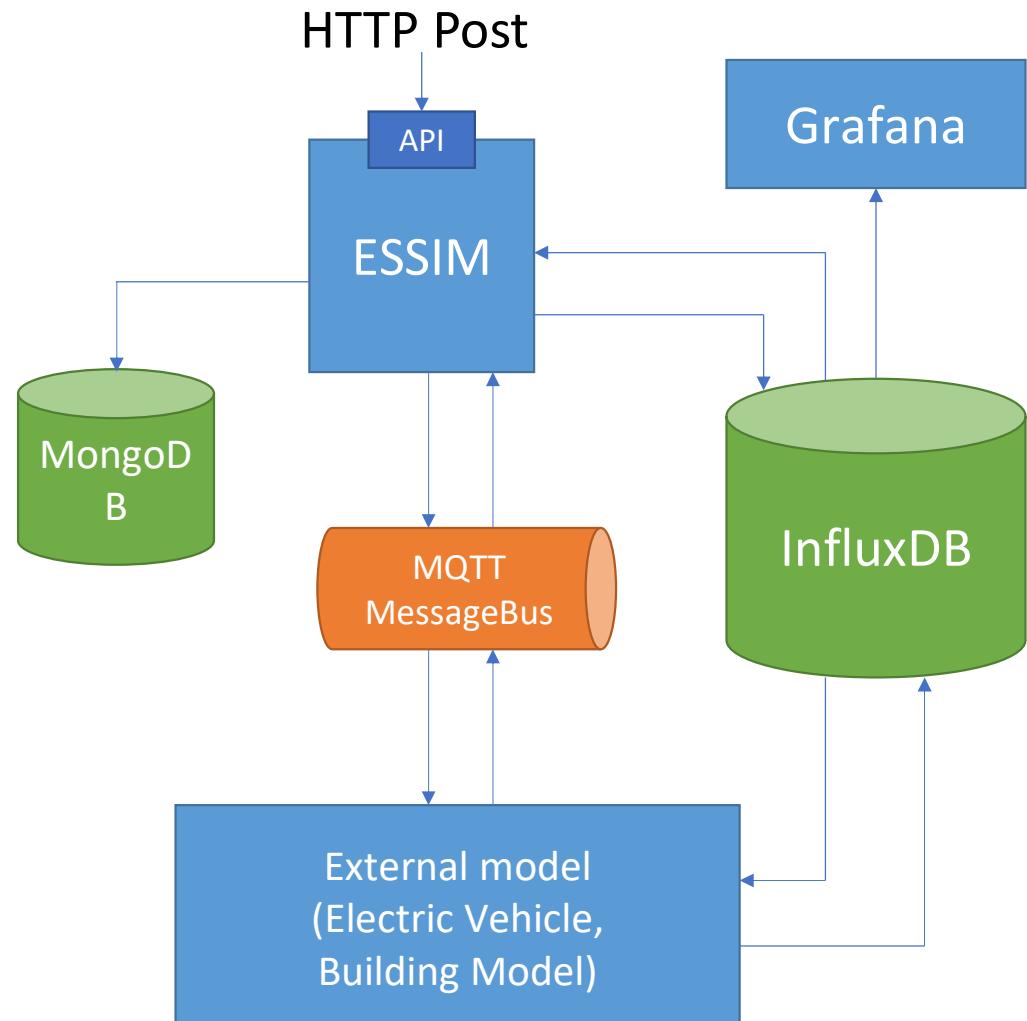
```
{  
    "user": "essim",  
    "scenarioID": "multi-sim",  
    "simulationDescription": "Demo Zuid Holland",  
    "startDate": "2019-01-01T00:00:00+0000",  
    "endDate": "2019-01-01T23:00:00+0000",  
    "influxURL": "http://localhost:8086",  
    "controllerConfiguration": {  
        "name": "PySuperController",  
        "controllerHost": "localhost",  
        "controllerPort": "5000"  
    },  
    "solverConfiguration": [  
        {  
            "name": "PandaPower",  
            "type": "PandaPower",  
            "carrierId": "Electricity",  
            "supervisory": true,  
            "config": {  
                "solverHost": "localhost",  
                "solverPort": 5000  
            }  
        },  
    ],  
},  
}
```



# CONNECTING EXTERNAL MODELS

## ESSIM API call

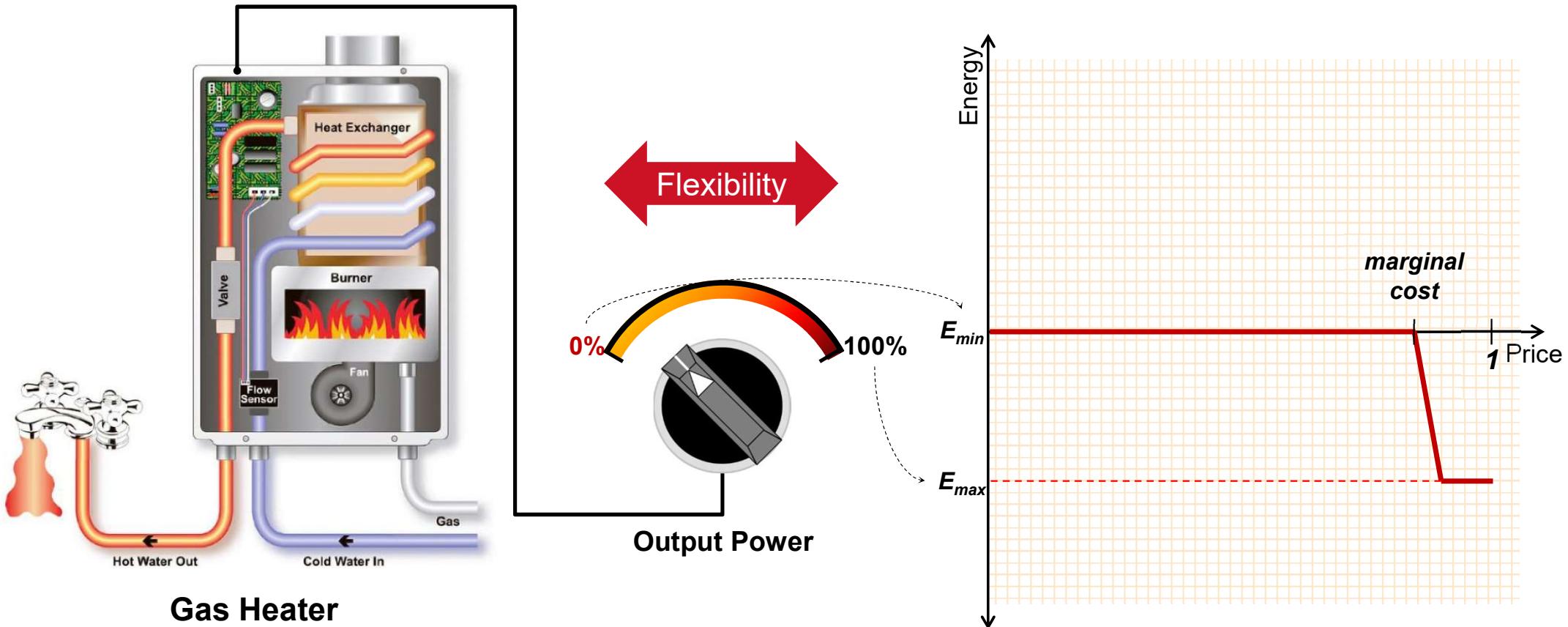
```
1  {
2      "user": "essim",
3      "scenarioID": "essim_hlc",
4      "simulationDescription": "External model",
5      "startDate": "2019-01-01T00:00:00+0100",
6      "endDate": "2019-01-30T23:00:00+0100",
7      "influxURL": "http://influxdb:8086",
8      "grafanaURL": "http://grafana:3000",
9      "nodeConfig": [
10          {
11              "esdlNodeId": "eHP1",
12              "config": {
13                  "influxUrl": "http://localhost:8086",
14                  "scenarioID": "essim_hlc",
15                  "strategy": "EAGER",
16                  "startDate": "2019-01-01T00:00:00+0100",
17                  "endDate": "2019-01-30T23:00:00+0100"
18              },
19              "mqttHost": "mqtt",
20              "mqttPort": 1883,
21              "mqttTopic": "essim"
22          ],
23      "esdlContents": "PD94bWwgdmVyc2lvbj0nMS4wJyB1bmNvZGlubz0nVVRGLTgGxWZXJzaW9uPSJ2MjEwMiIgdmVyc2lvbj0iOCIgaWQ9IjNhY
```



# › FLEXIBILITY MODELLING

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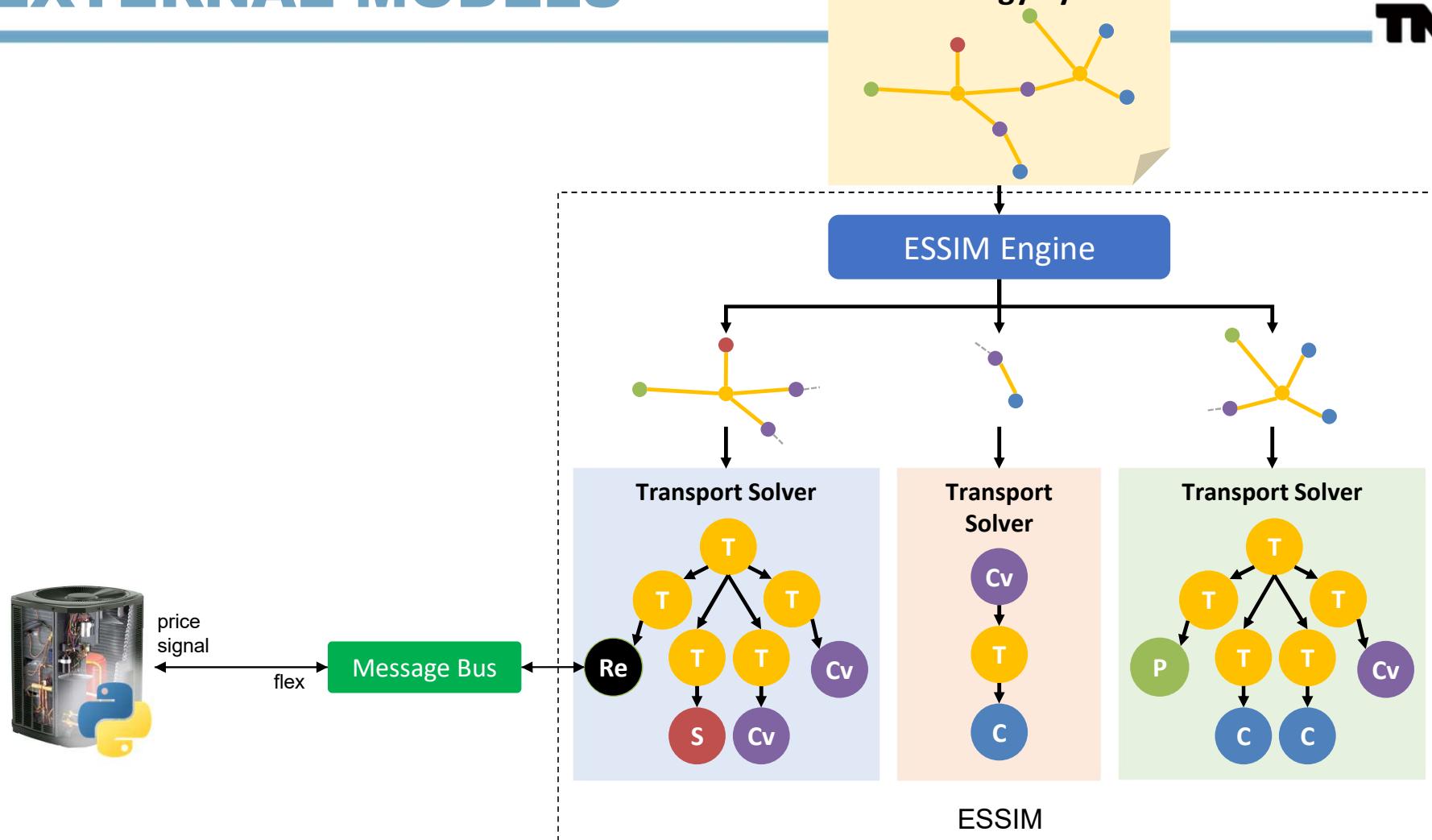
# ESSIM'S INTERNAL FLEX ASSET MODELS



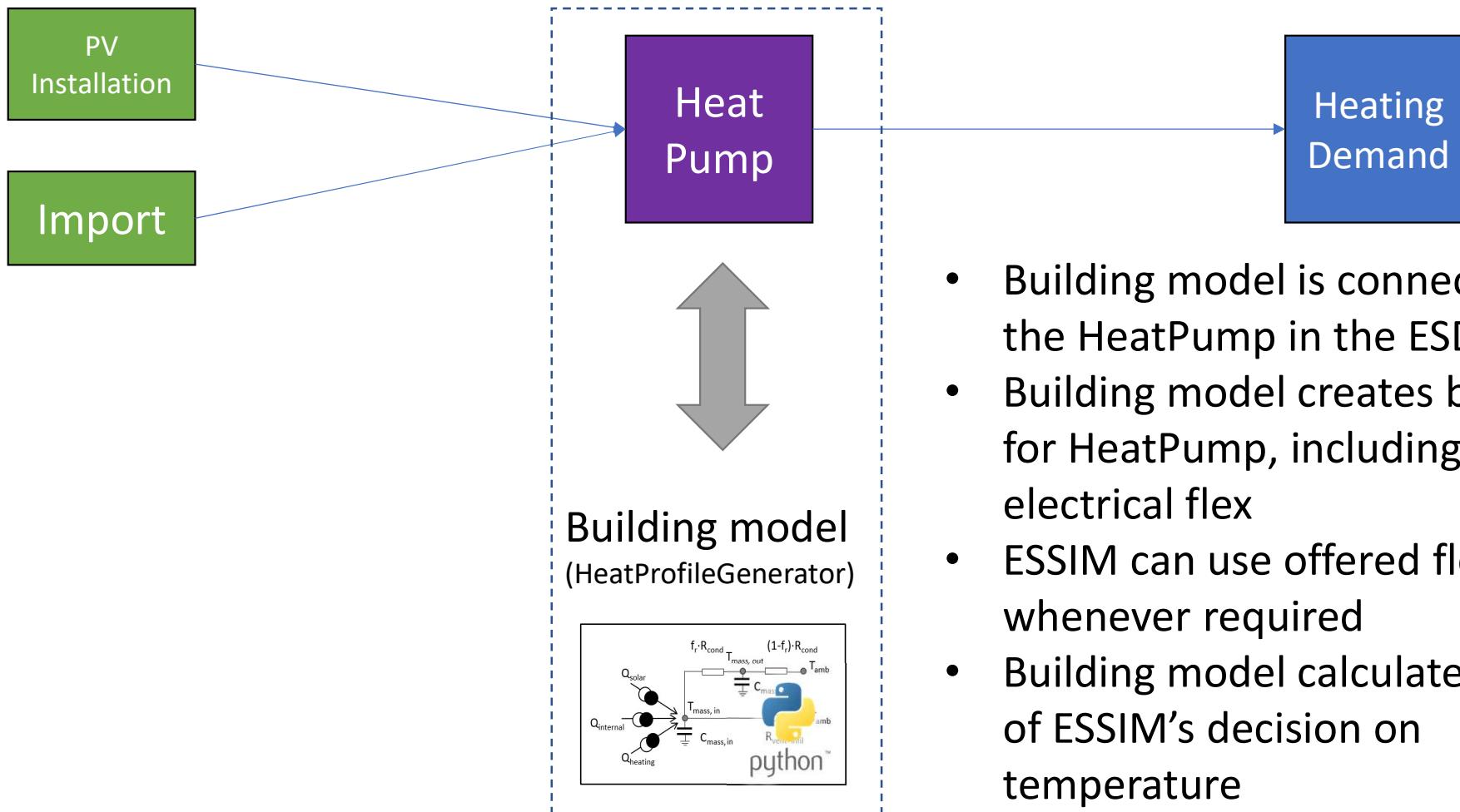
# EXTERNAL MODELS

ESDL Energy System

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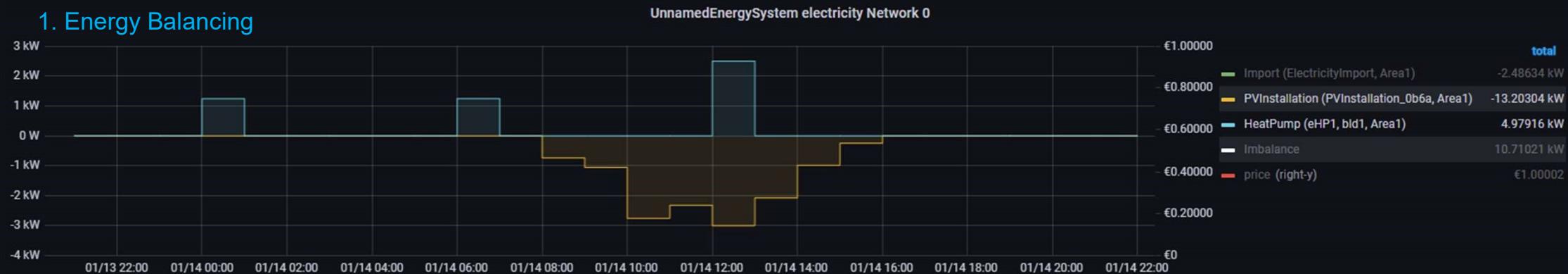


# USING FLEXIBILITY OF THERMAL MASS



- Building model is connected to the HeatPump in the ESDL
- Building model creates bidcurve for HeatPump, including available electrical flex
- ESSIM can use offered flex whenever required
- Building model calculates effect of ESSIM's decision on temperature

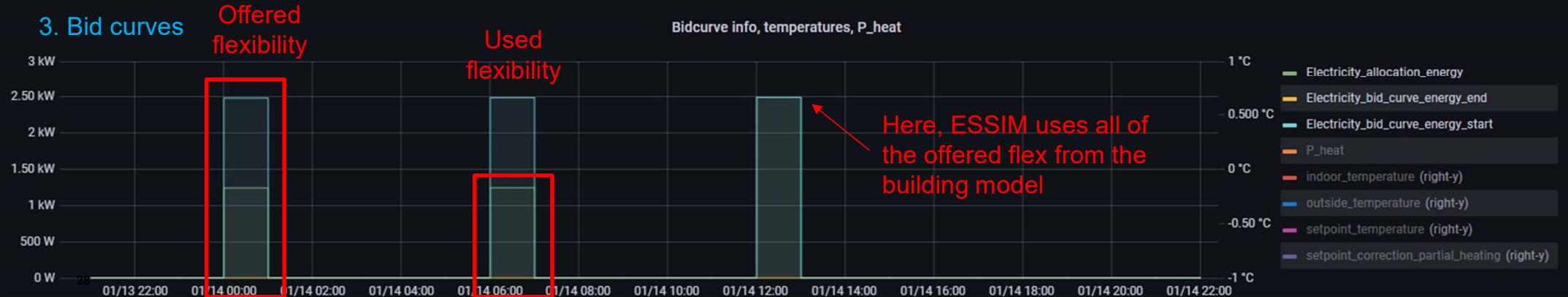
## 1. Energy Balancing



## 2. Comfort / Temperatures

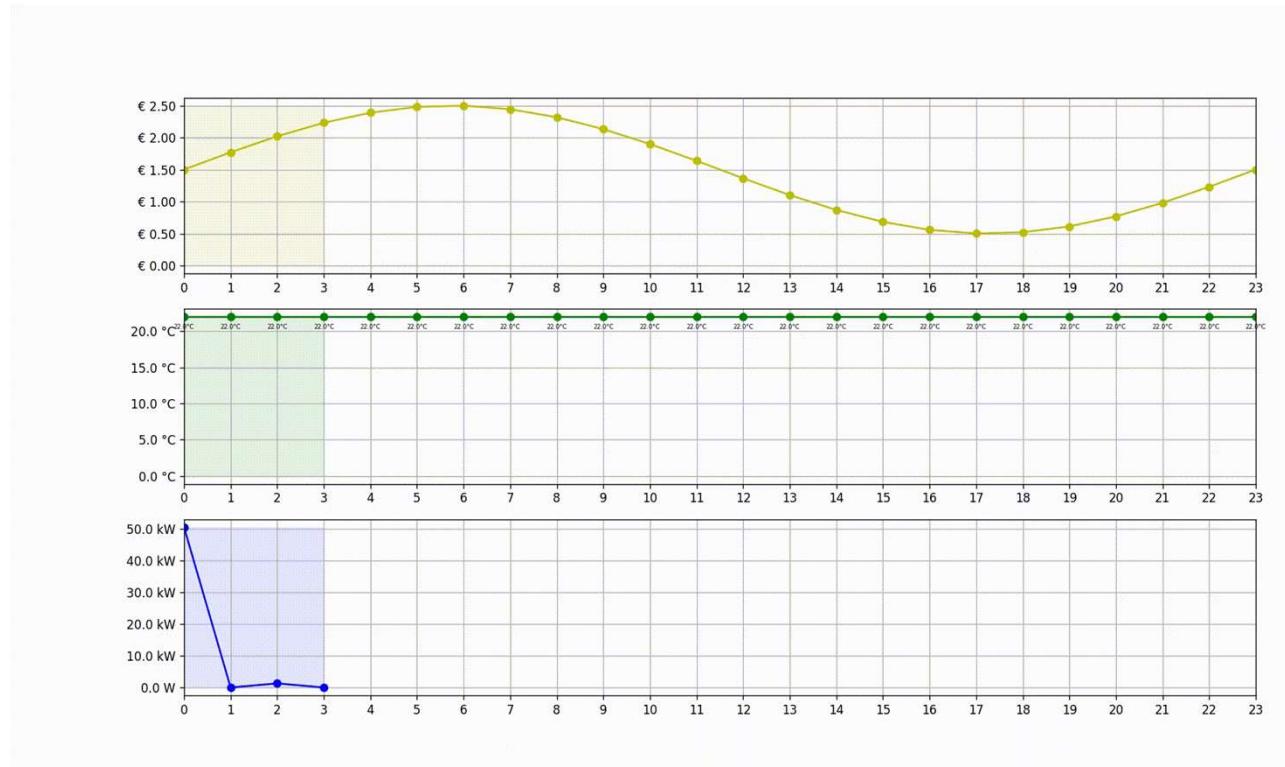


## 3. Bid curves

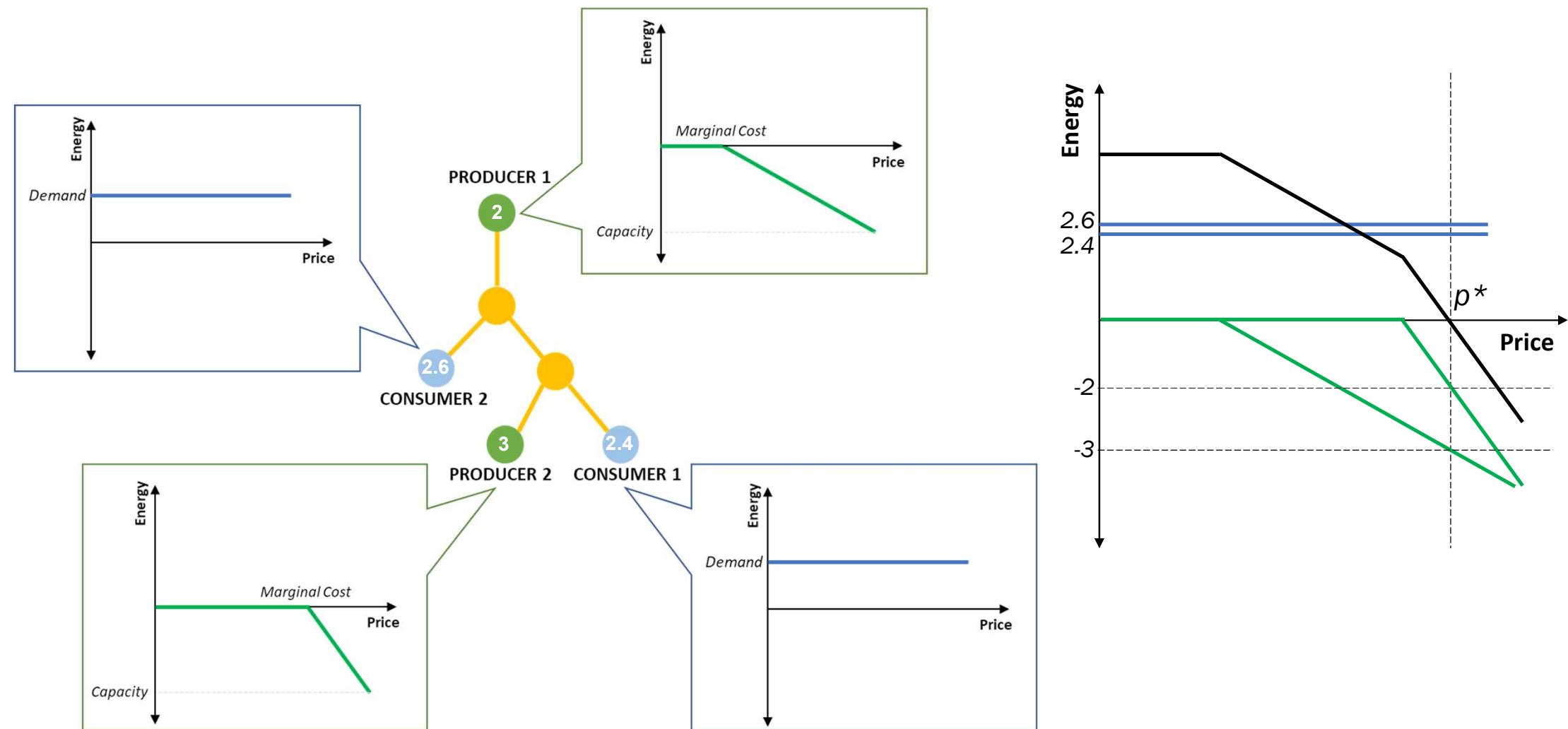


# CURRENT WORK

- › More intelligent controller that:
  - › Takes energy prices **and** comfort into account
  - › Looks 4 (or more) hours ahead (moving horizon)
- › Plans to experiment with EV model

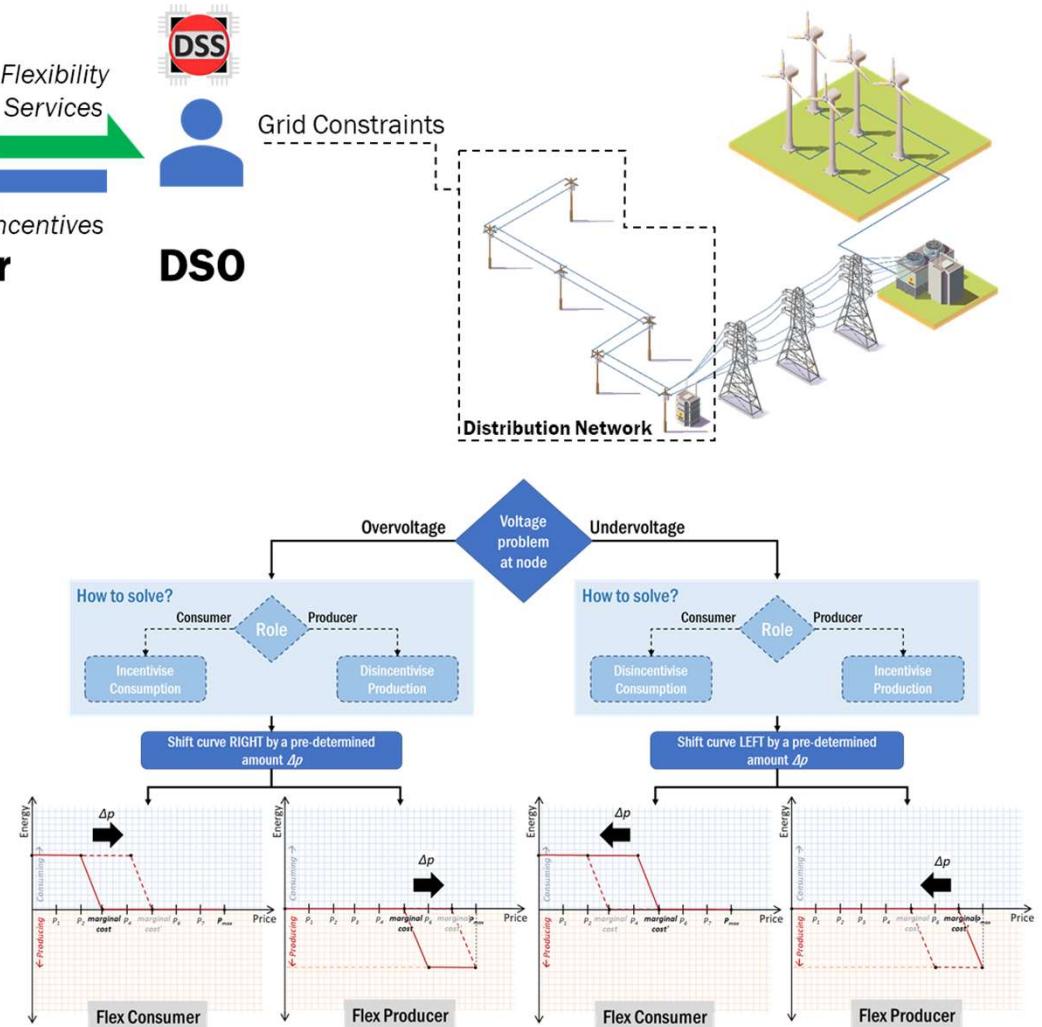
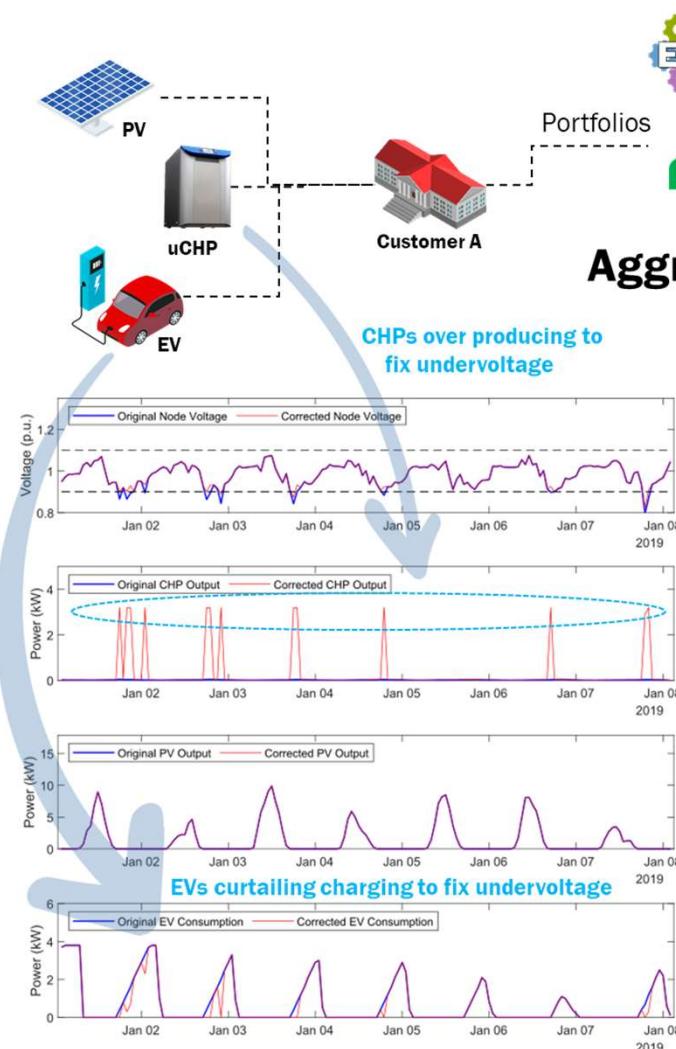


# USING FLEXIBILITY FOR BALANCING



# FLEXIBILITY AS A SERVICE

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› PAUZE

**HAAL GERUST EEN KOPJE KOFFIE, WE GAAN ZO VERDER**

25-10-2021



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AFRONING

# FEEDBACK & VRAGEN



- › Chat als basis voor de vragen & opmerkingen
- › Moderator nodigt vragensteller uit – leuk om je camera/geluid aan te zetten

## › AGENDA 14 OKTOBER

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**INTERACTIEVE SESSIE - TOEKOMSTIGE ONTWIKKELAGENDA**

AFRONING

## › **TOEKOMSTIGE ONTWIKKELAGENDA** **INTERACTIEVE DISCUSSIE**

TNO is gecommitteerd om ESSIM/Mapeditor te blijven gebruiken en te ontwikkelen als open source software.

Het liefst zo, dat het ook gebruikt wordt:

voor de uitdagingen van vandaag & morgen  
op een wijze die intuitief / makkelijk/eenvoudig is  
in samenhang met andere software (input-output)

(actuele functionaliteit)  
(gebruiksgemak)  
(interactie)

**Wat is jullie advies voor vervolgstappen?**

doel: bepalen ontwikkelagenda ESSIM/ Mapeditor (open source)

- Gebruik de chat voor commentaar/suggesties en ideeen
- Moderator zal je uitnodigen om toe te lichten

## ANDERE ONDERWERPEN: ENERGIE EN RUIMTE



De uitdaging: in het fysieke domein is het plaatsen van assets o.m. afhankelijk van:

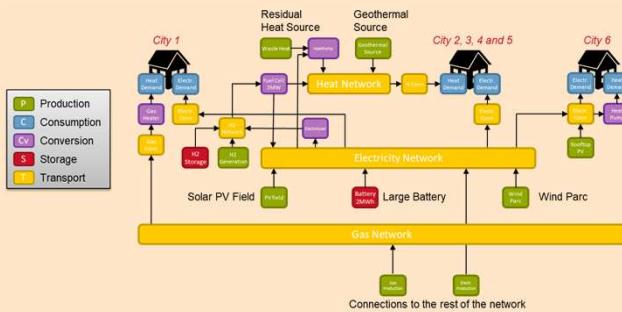
- is er plaats (fysiek, milieu, veiligheid)?
- is het (kosten) efficient?

› **IS ER PLAATS (FYSIEK, MILIEU,  
VEILIGHEID)?**



# PLAATSEN VAN ASSETS: IS ER RUIMTE?

## Abstracte modellering



Abstracte weergave van de assets

Knooppunten, Kabels, Leidingen, Vraag, Aanbod, Conversie en Opslag.

Alles kan en alles mag

## De echte wereld



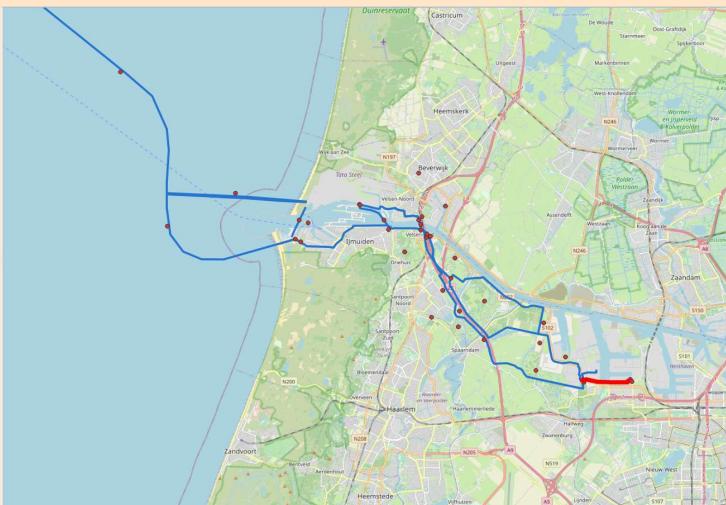
van ruimteclaim  
naar  
beschikbare ruimte

Bestemmingsplannen (Omgevingsplannen)  
Landschappelijke kwaliteit  
Draagvlak

Transitie heeft ruimte nodig. Duurzaam meer dan fossiel

# VAN RUIMTECLAIM NAAR INPASBAARHEID

**TNO** innovation  
for life

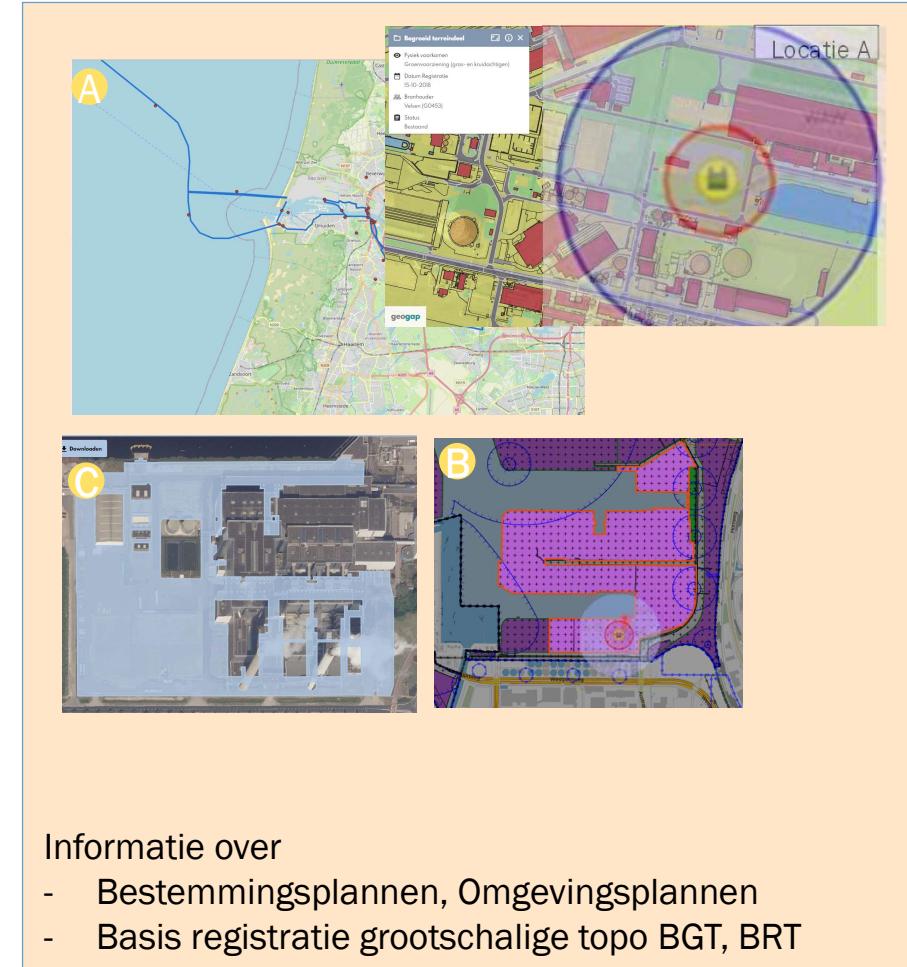


Geografische lokalisatie van assets

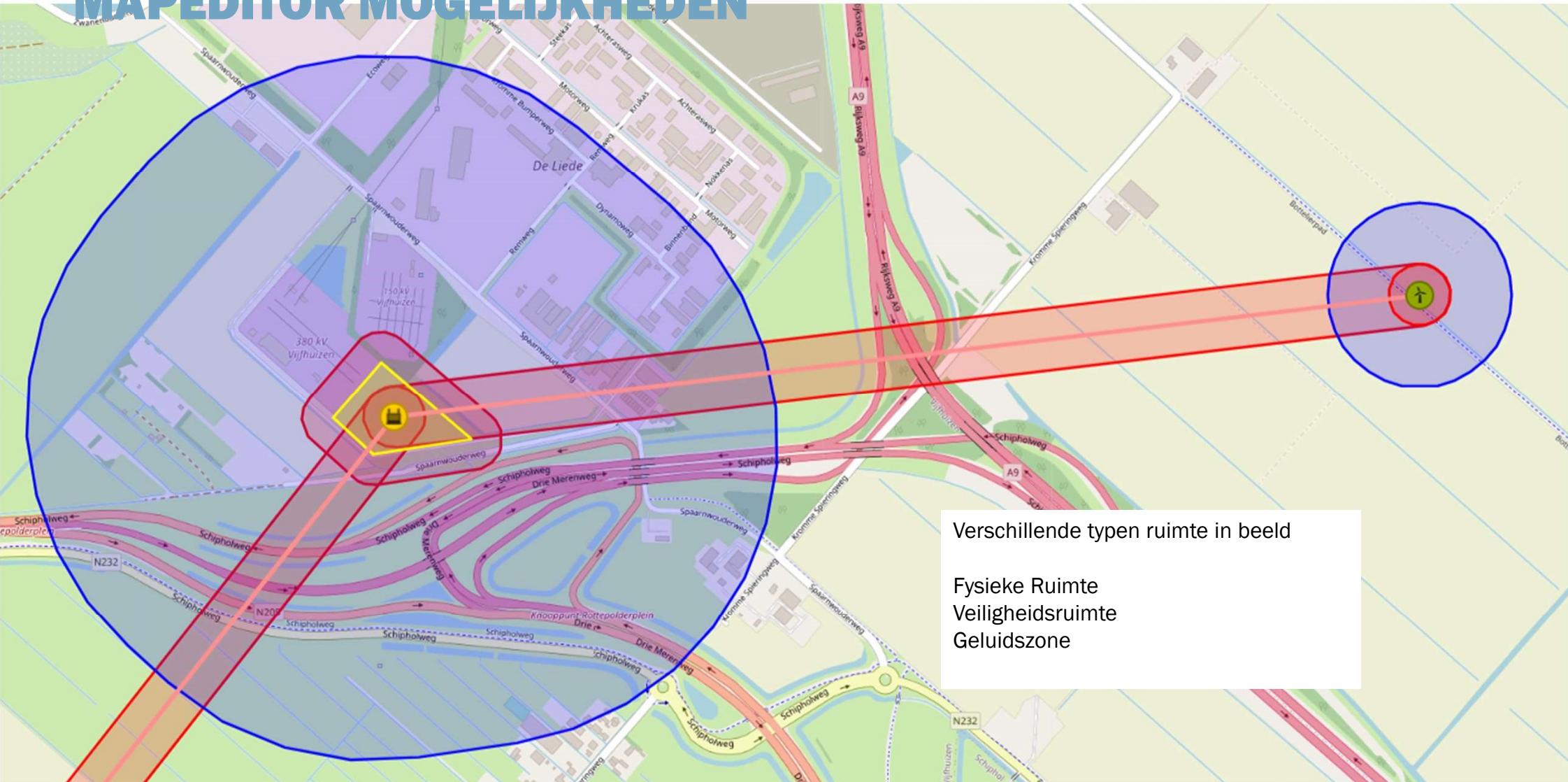
Enigzins representatief

Alles kan en mag

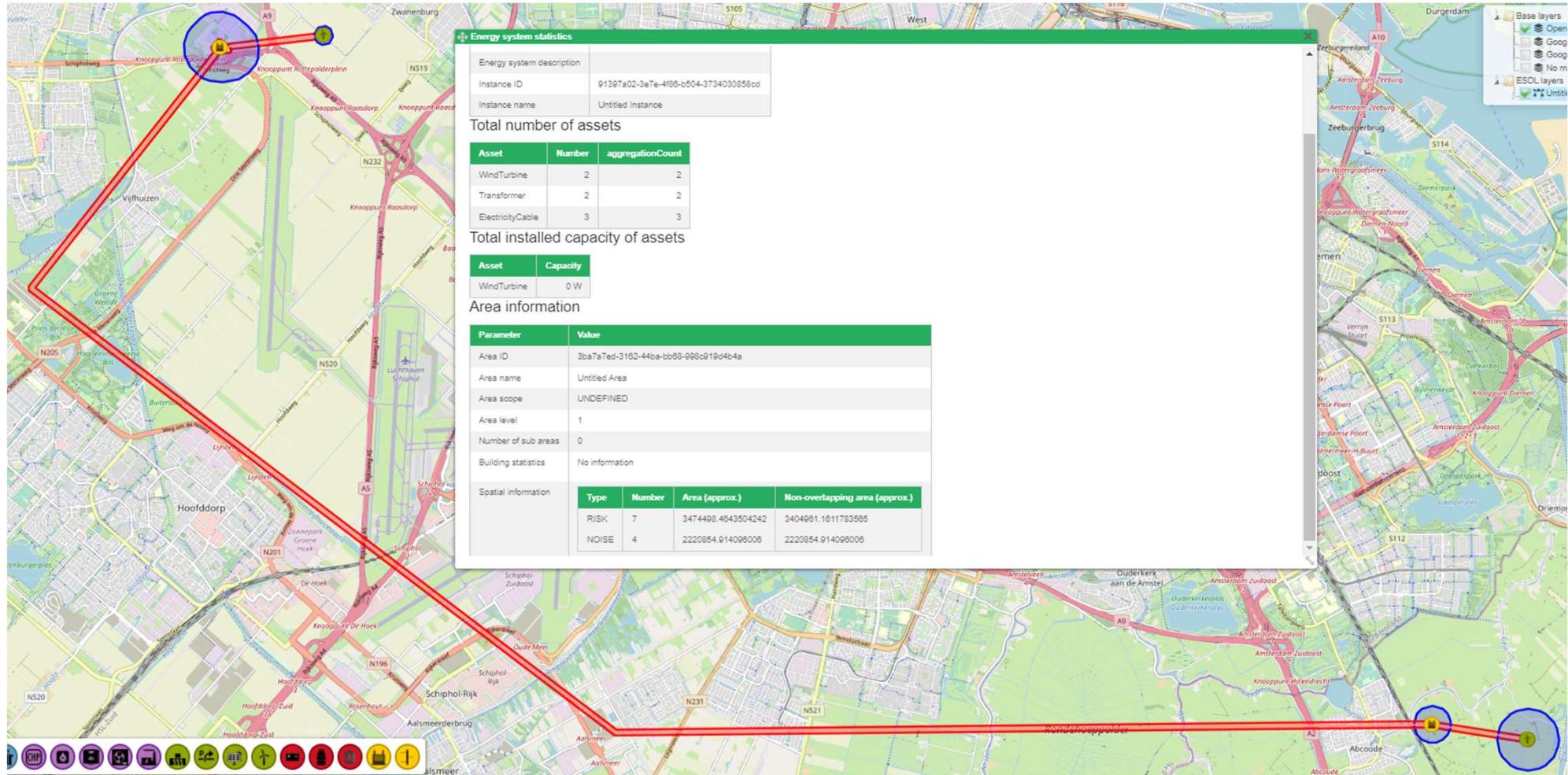
Welke locatie  
Welke tracés  
Hoeveel m<sup>2</sup> nodig



# MAPEDITOR MOGELIJKHEDEN



# INZICHT IN TOTALEN RUIMTECLAIM



# › IS HET (KOSTEN) EFFICIENT?

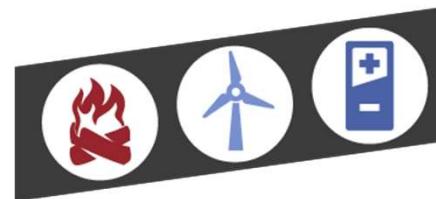
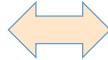


# PLAATSEN ASSETS: IS HET (KOSTEN) EFFICIENT?

for life

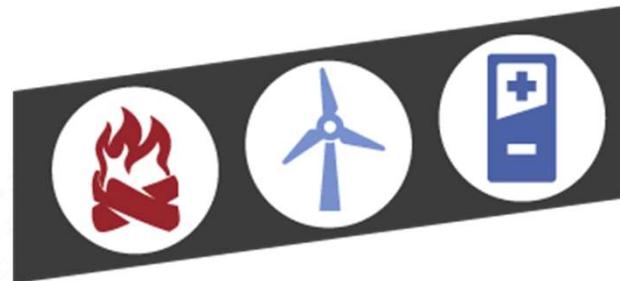
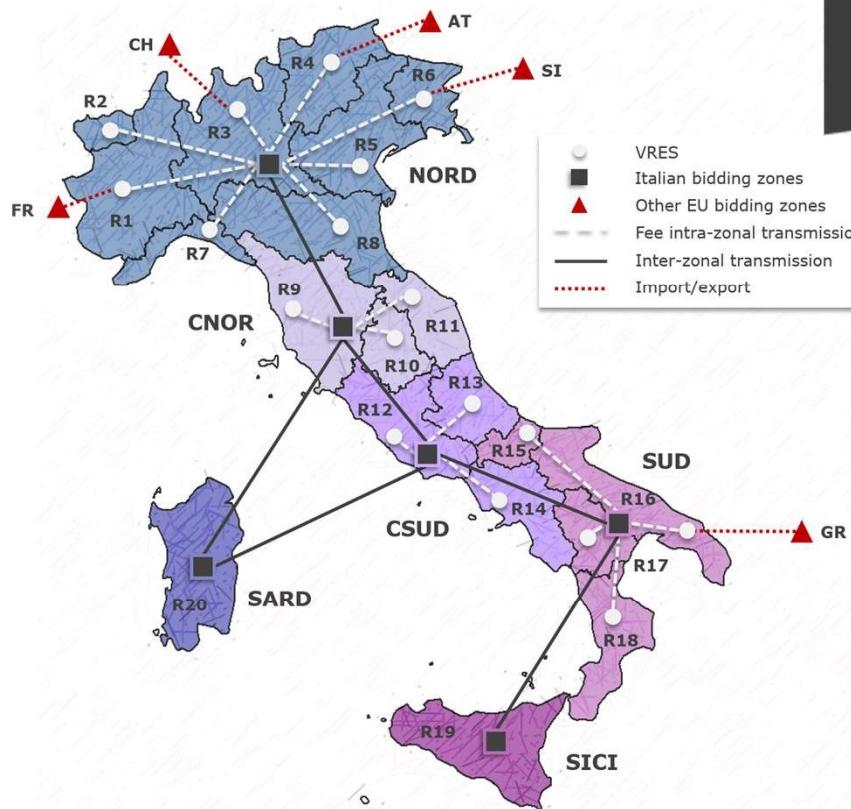
› De volgende situatie

- › Er is een bestaande transport infrastructuur met vraag op meerdere knooppunten
- › Nieuwe bronnen moeten worden gekoppeld
- › Er is keuze voor de locaties van deze bronnen
- › Er is keuze voor de uitbreiding van de transport infrastructuur



Calliope

# RUIMTELIJKE ANALYSES MET CALLIOPE



# Calliope

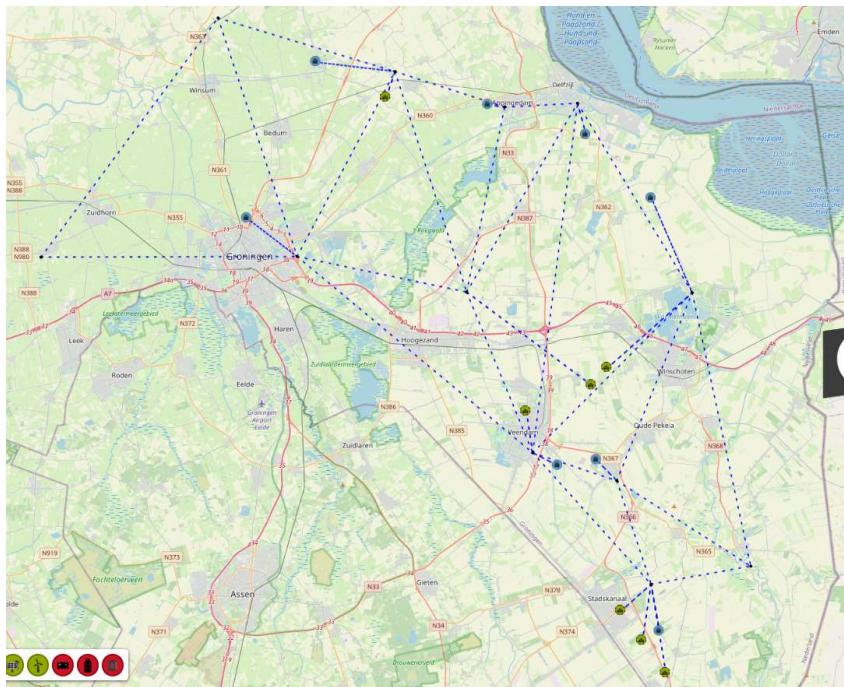
A multi-scale energy systems modelling framework  
(also the muse of epic poetry in Greek mythology)

Model Gallery

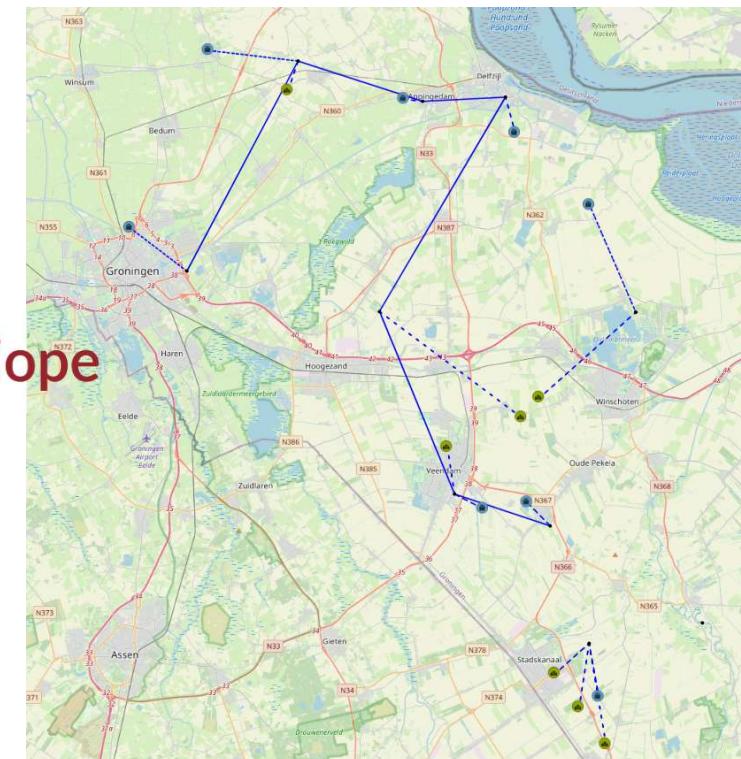


# VOORBEELD: GRONINGEN GEOTHERMIE

Potentiele transport infra en locaties van opwek (gestippeld)  
Vraag is vooraf gedefinieerd



Calliope



## › AGENDA 14 OKTOBER

OPZETTEN MAPEDITOR ESSIM COMMUNITY – WAAROM?

ESSIM BASICS & VERDIEPING

PAUZE

FEEDBACK & VRAGEN

INTERACTIEVE SESSIE - TOEKOMSTIGE ONTWIKKELAGENDA

AFRONDING

## › **AFRONDING & VERVOLG HOE VERDER?**

Open vraag: moet dit een vervolg krijgen?

Wat is dan een vorm die hier bij past? (maar ook duur, evt frequentie)?

› **DANK VOOR UW AANWEZIGHEID**

**TOT DE VOLGENDE KEER!**



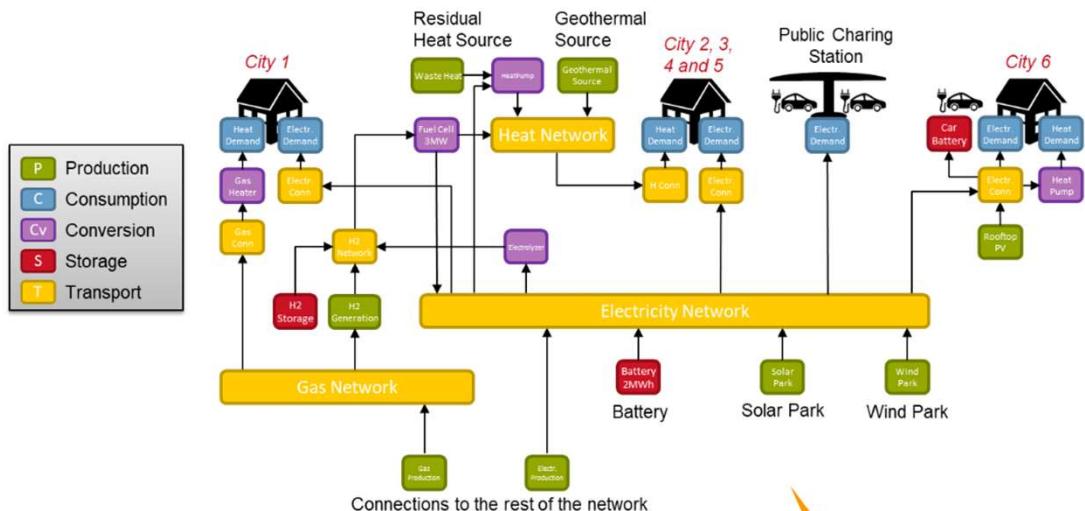
## > BACKUP SLIDES

Take a look:

**TNO.NL/TNO-INSIGHTS**

**TNO** innovation  
for life

# ENERGY SYSTEM SIMULATOR (ESSIM)



*“... translation of (integral) technical scenarios to support decision making, formulation of strategies or policies”*

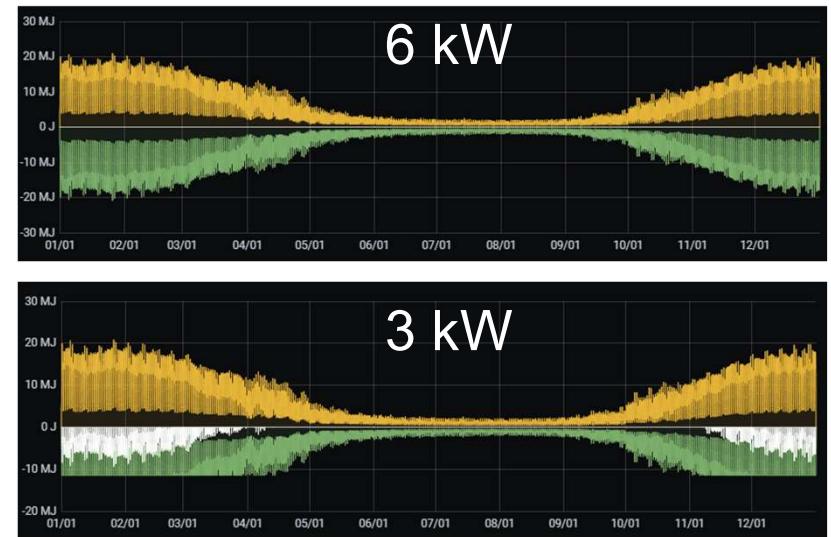
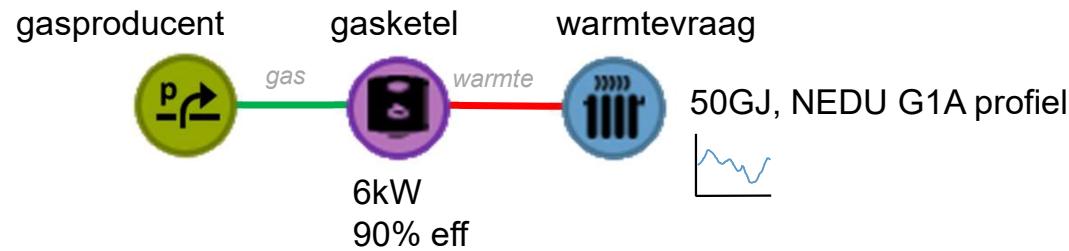
## Typical questions:

- 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 CO<sub>2</sub> emissions per scenario?
- What are the effects of adding storage in the system?

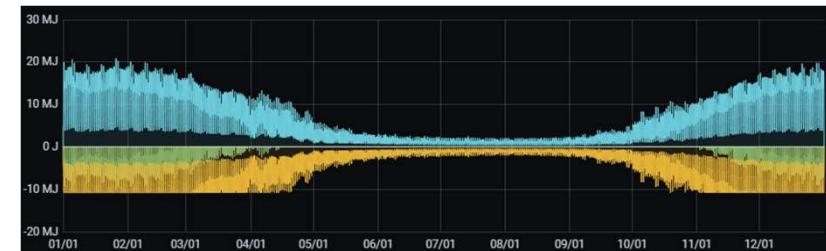
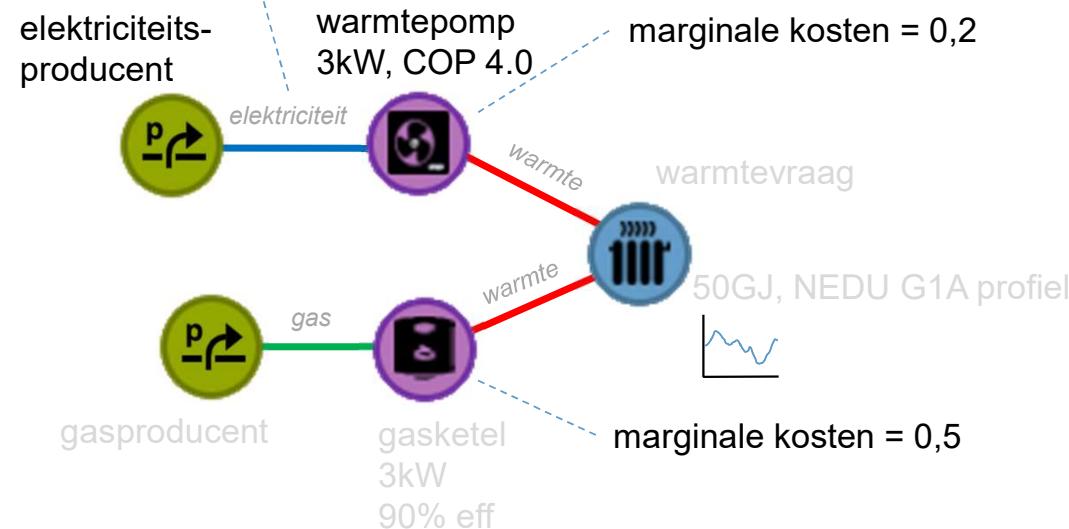
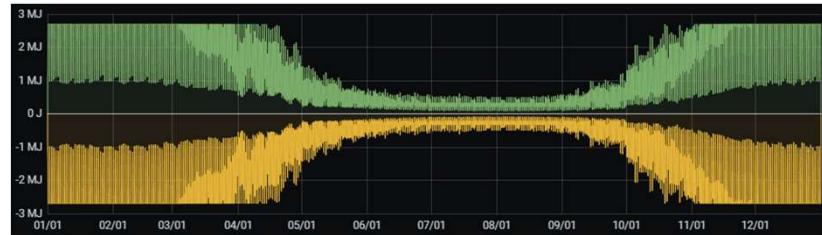


- Flexible** and fully **configurable** in ESDL:
- Profiles for demand and inflexible production
  - Conversion: Power, efficiency
  - Storage: Capacity, (dis)charge speed
  - Transport: Capacities for the infrastructure

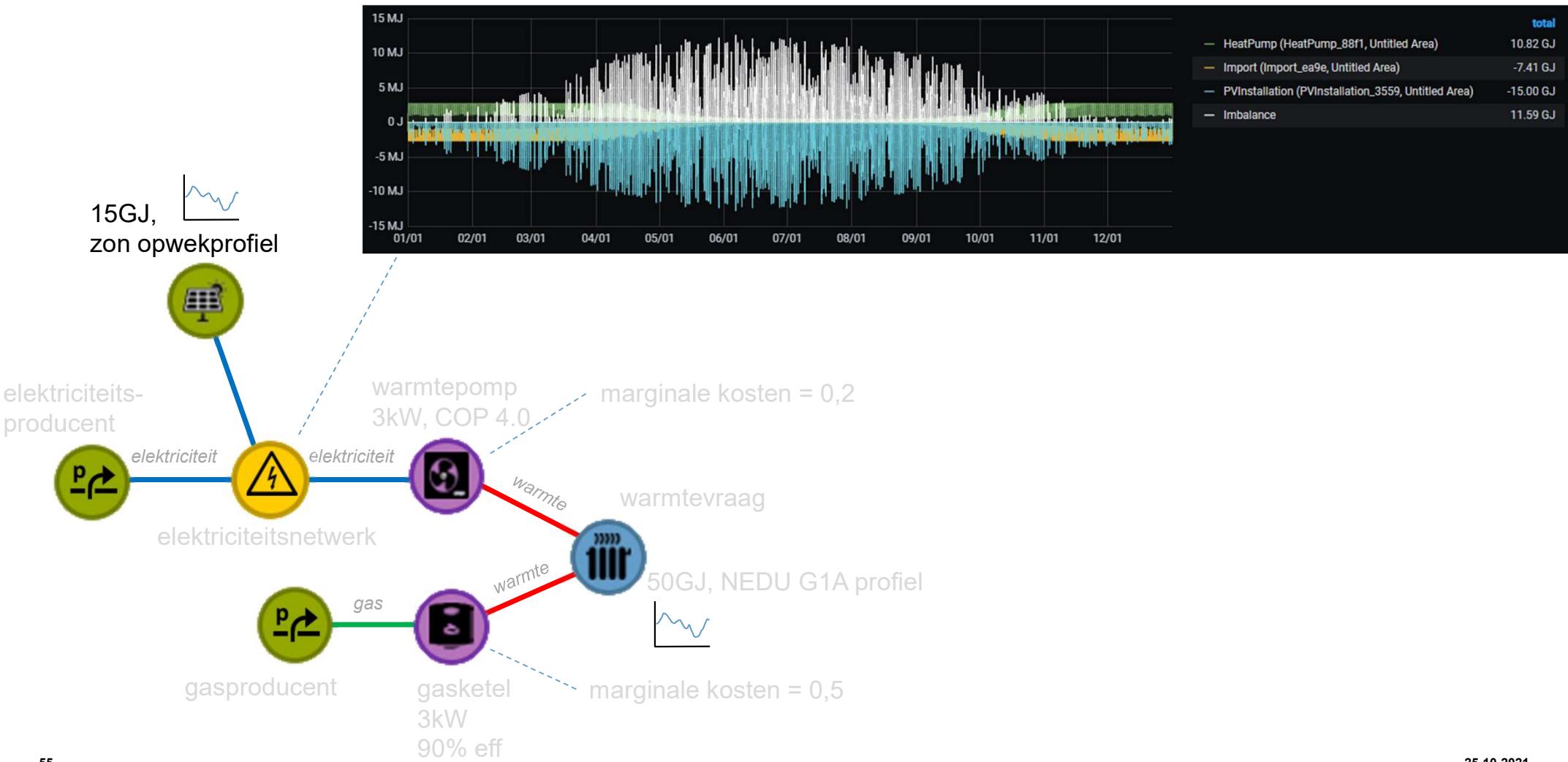
# ESSIM BASIC PRINCIPLES (1/4)



# ESSIM BASIC PRINCIPLES (2/4)



# ESSIM BASIC PRINCIPLES (3/4)



# ESSIM BASIC PRINCIPLES (4/4)

15GJ,  
zon opwekprofiel

