

# Multi-model.nl

Naar een Nationale multi-model infrastructuur voor integrale besluitvorming in de energie transitie

## Project vision and overview

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# Goals for this talk

- Introduce
  - notion of multi-model ecosystems
  - the multi-model.nl project
- Identify
  - Multi-modelling potential within e-Refinery
- Explore
  - Possible synergies

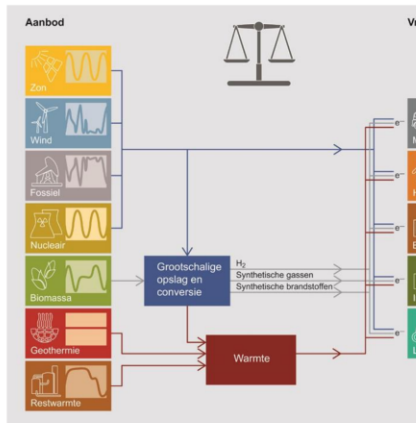
# Sciatal context: Topsector Energy / System Integration program / MMIP13

Missiegedreven Meerjarig InnovatieProgramma Een robuust en Maatschappelijk gedragen Energiesysteem



Missiegedreven Meerjarig  
InnovatieProgramma 13

## Een robuust en maatschappelijk gedragen energiesysteem MMIP



1	<b>Kennis voor integrale besluitvorming</b>	Kennisontw. besluiten or
2	<b>Inclusieve energietransitie</b>	Kennisontw. rechtvaardig inpassing.
3	<b>Geïntegreerde energie-infrastructuur</b>	Onderzoek ontwerp en voor veranc
4	<b>Flexibele energiemarkten</b>	Onderzoek van de ener lage maatsc
5	<b>Opslag en conversie</b>	Onderzoek grootschalig
6	<b>Operationeel management en digitalisatie</b>	Onderzoek energiesyst onderliggen

Dit MMIP 13 is overkoepelend en verbindt daarbij enkele specifieke onderwerpen.

Dit leidt voor dit onderdeel onder andere tot de volgende kennisvragen en innovatiethema's:

- Wat zijn de technische, economische en maatschappelijke gegevens die de bouwstenen vormen van het toekomstig energiesysteem en het transitiepad? Welke informatieproducten zijn nodig voor analyses en besluitvorming en hoe kunnen deze op een gestandaardiseerde en betekenisvolle manier worden gerealiseerd en ontsloten door het combineren, verrijken en (semantische en syntactisch) uniformeren van (ruwe) data? Wat zijn adequate standaarden, architecturen en datamodellen om de informatie benodigd voor de energietransitie transparant en uitwisselbaar te houden.
- Hoe zorgen we ervoor dat de informatiebasis geborgd wordt? Waar wordt dit belegd en hoe dient de governance hiervoor ingericht te worden?
- Welke innovatieve oplossingen zijn er om deze energie-informatie, die commercieel of anderszins gevoelig is (bijvoorbeeld van de industrie), op een geaccepteerde manier te delen ten behoeve van besluitvorming over de ontwikkeling van het energiesysteem?
- Welke verbeterde en nieuwe rekenmodellen en ontwerptools zijn nodig voor de (bij)sturing van de energietransitie? Integratie van economische, gedragsmatige en technische kennis in geïntegreerde modellen en een samenhangende set van deelmodellen.
- Welke werkwijzen en aannames moeten worden gehanteerd om duidbare en betrouwbare resultaten uit rekenmodellen en ontwerptools te krijgen? Hoe ziet "good modelling practice" eruit?
- Hoe kunnen modellen gecombineerd en geïntegreerd worden opdat er integrale beelden, op verschillende schaalniveaus en vanuit verschillende perspectieven ontstaan? Hoe en welke data uitwisseling zijn noodzakelijk voor integrale analyse en sectorkoppeling en hoe kunnen visualisaties helpen om deze integrale inzichten bruikbaar(der) te maken?

# Guide for Good Modelling Practice in policy support

White-paper TSE7190007

17 July 2019

DOI: 10.4233/uuid:1aa3d16c-2acd-40ce-b6b8-0712fd947840

# Principles, challenges and guidelines for a multi-model ecology

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Energietransitie modelleren

## Energietransitie modelleren

*Jouw gids in de wereld van energiemodellen*

Nederland werkt aan de energietransitie. Om beslissingen te ondersteunen worden steeds vaker modellen gebruikt. Overheden en belanghebbenden hebben niet altijd voldoende achtergrond in de modelleerwereld. Deze website biedt deze achtergrond in een notendop.

**Ben je ambtenaar, bestuurder of andere belanghebbende?**  
Deze website helpt jou modellen te begrijpen en goed te gebruiken. Zo kan je betere beslissingen maken. Elk vraagstuk is uniek en vraagt om maatwerk. Deze website belooft daarom geen kant-en-klare oplossingen, maar geeft je de nodige houvast om in gesprek met een modelleur de maatwerkoplossing voor jouw vraagstuk te vinden.

**Ben je modelleur?**  
Deze website vat op een compacte manier de "good modelling practices" samen. Je kan het gebruiken om na te gaan of je alle principes scherp hebt en goed toepast. De website biedt jou en gebruikers van modellen een gemeenschappelijke basis om elkaar beter te begrijpen. Zo kan je betere maatwerkoplossingen aanbieden.

[Wegwijs op de website](#)

Infographics

# Principles, challenges and guidelines for a multi-model ecology

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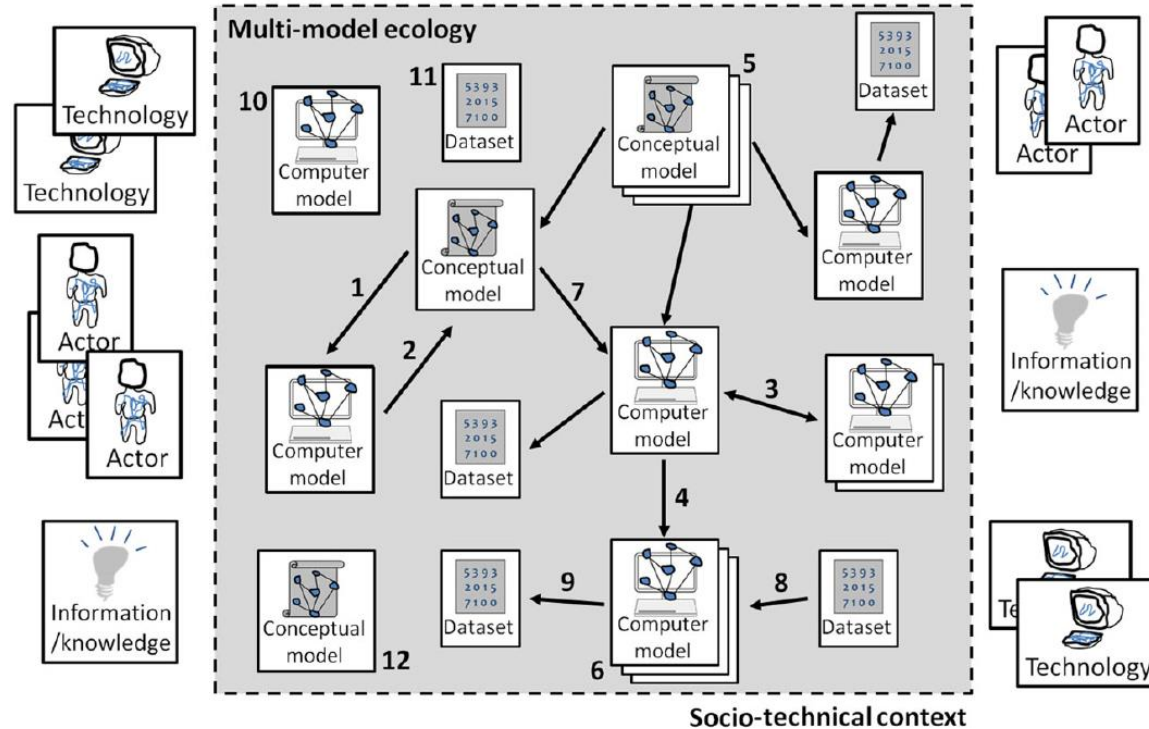
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# Moonshot:

## Multi-model ecosystem for the energy transition modelling



# Energy transition modelling in NL policy

Klik op de naam van het door u gewenste rekenmodel om de flyer te downloaden.

## ENERGIETRANSITIE REKENMODELLEN

**GEOGRAFISCHE SCOPE**

**PLANFASE DIE VAN TOEPASSING IS**

**FOCUS VAN HET MODEL**

**WARMTE**

- CHES
- COMSOF HEAT
- ETA
- GREENVIS
- VESTA

**ELEKTRICITEIT**

- CEGRID
- COMPTES
- POWERVIS
- PIVOPSLAG
- WINDPLANNER

**MEERDERE ENERGIE DRAGERS**

- ARTIS
- CEGOIA
- DSSH
- ENERGEYES
- ETS
- ENERGIEPOTENTIEKAART
- ENERGIETRANSITIEMODEL
- ES-IT
- GEBIEDSMODEL
- LEAP
- MOTER
- OPERA
- PIEN
- PICO
- S-TOP CO2
- TRANSFORM
- WARMTEVRAAGPROFIELEN
- WIND
- WOODCONNECT

**INTER-NATIONAAL** **NATIONAAL** **REGIO** **STAD** **STAD/ WILK** **WONING**

**VISIE** **MAKEL-PLAN** **STEDEN-BOLING-PLANNING** **INRICHTING** **UITVOERING** **GEbruik/ BEHEER** **ENER-GETISCH** **ENERGIE-MARKT-SIMULATIE** **BELEIDS-MAATREGEEL** **RUIMTELIJK VERGAAFE**

Source : EG-ETRM / Netbeheer Nederland

# Why build multi-models?

- Theoretical
  - All models are wrong, some are useful. P.E. Box
  - All models are biased, therefore we need more of them! S.E. Page
  - Separation of concerns
  - Multi/transdisciplinary perspective possible
- Societal
  - Model authoritativeness
  - Decentralised expertise/data
  - Shared stake in outcome
- Practical
  - Reuse of existing models
  - Maintainability and transparency of mega-models
  - Rapid reconfiguration and modularity

# Main theoretical challenges

- Incompatible ontologies
- Multi-formalism alignment
- Conflicting rationalities & abstractions
- Scaling
- Model fidelity, resolution, accuracy and precision
- Variability, uncertainty and noise (propagation)
- Communicating and retaining meaning and intention
- Analysis and Interpretation

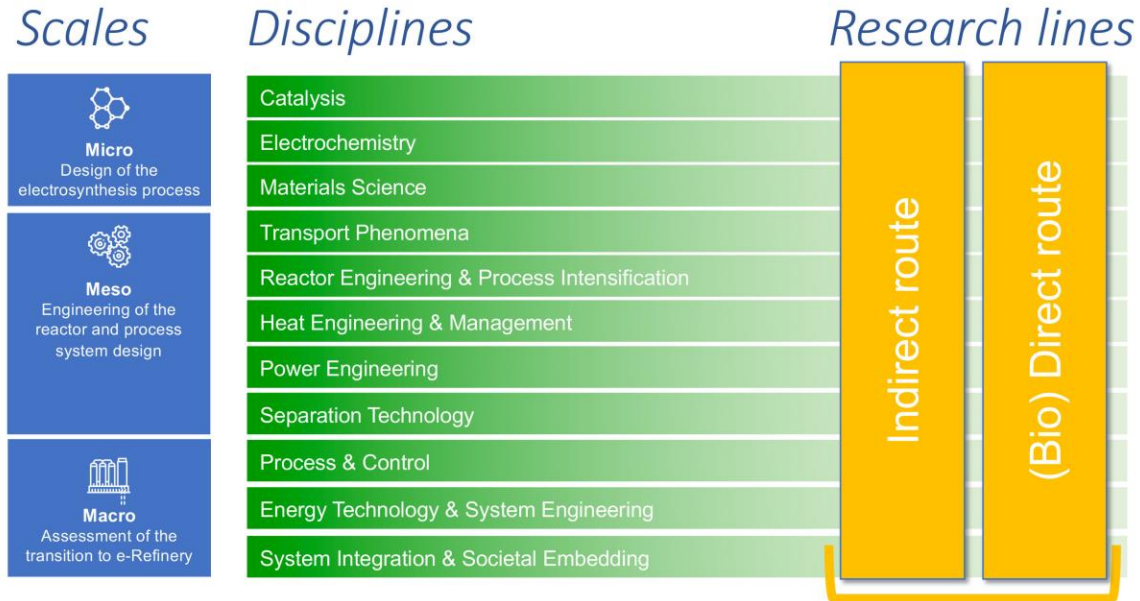


# Main practical challenges

- Transparency and access
  - Models are proprietary
  - Data is secret
  - Assumptions are unclear
- Use and reuse
  - Built for one purpose, (ab)(re)used for others
  - Manual operation
  - Tension between pretty / easy to use and correct
- Limited attention to
  - Social process
  - Methodological aspects (uncertainty, scaling, ontological alignment, etc)
  - Model/data provenance, verification, repeatability,

# Why should e-Refinery care?

Because you are already doing it !



*Parallel and Synergetic Development*

Base Chemicals & Fuels  
CO, HCOOH, C<sub>2</sub>H<sub>4</sub>, NH<sub>3</sub>, CH<sub>4</sub>,  
CH<sub>3</sub>OH, CH<sub>5</sub>OH, C<sub>4</sub>, C<sub>6</sub>.....

# Why should e-Refinery care?

- Highly heterogeneous problem across scales and domains
  - Micro: electrodes, electrolytes and membranes...
  - Meso: Transport Phenomena, Reactor Engineering & Process Intensification ...
  - Macro: Process-, Energy- and System-Integration and Societal Embedding .
- Bottom up : Impact on future scenarios
  - Which technology might exist when and how does it perform
- Top-Down : Requirements for technology
  - Dominant future developments might be X, therefore this type of tech is needed, available energy infra could be Y,...

# Project in a nutshell

- 2 years, start 1 sept 2021
  - Spring 2022 : hello world
  - Summer 2022 : first operational version
  - Autumn 2023 : 3rd iteration MVP
- Practice, R&D and academia in close collaboration
- Case driven, agile, learning by doing
- Focus on methods, tooling and community
- Main goal :  
making your life as a modeller  
easier and your models more  
powerful

gasunie

Hanzehogeschool  
Groningen  
University of Applied Sciences

TNO

TU Delft

Universiteit  
Leiden

Kalavasta  
Energy System Strategy

QUINTEL  
TECHNOLOGIES

QuO Mare  
Ocean Energy Hub

STEDIN™

DNV·GL

alliander

enduris

# Goals of multi-model.nl

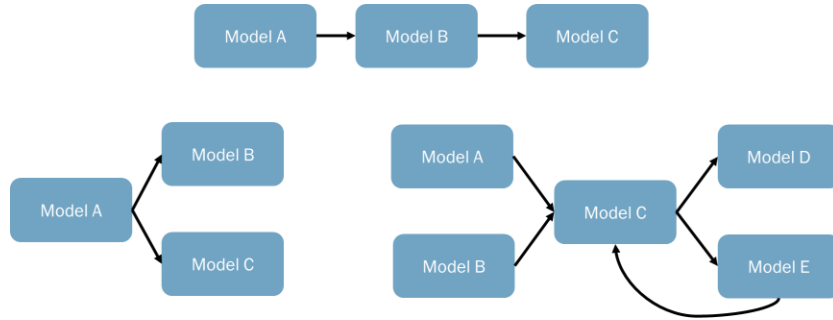
- Researches, designs and implements a "minimum viable product" multi-model infrastructure for integral decision making in the energy transition
- Coupling of models within a technical platform and methodological framework
- Allows for model interactions that are
  - Transparent
  - Traceable
  - Testable
- Design, support and understanding supported by a Community Of Practice
  - Modelers
  - Decision makers
  - Researchers
- **Current status**
  - First version of software platform operational and methodological aspects clear

# Core ideas behind the multi-model infrastructure

- Socio-technical process
  - Social: Purpose, design, alignment and interpretation
  - Technical: execution, verification, analysis, provenance
- Model as service
  - Model has no idea it is part of a multi-model
  - Model adaptor/daemon receives messages and "pushes buttons" of the model
  - Common language available, but not compulsory
- Centralised and decentralised
  - Dedicated orchestrator and/or self-orchestration
  - Centralised infra / within organisation / single machine
- Open source / open access
  - Low barrier to entry
  - Anybody can speak, nobody has to listen
  - All infra code is open source

# WHY IS IT DIFFICULT?

## COMBINING



### Problem:

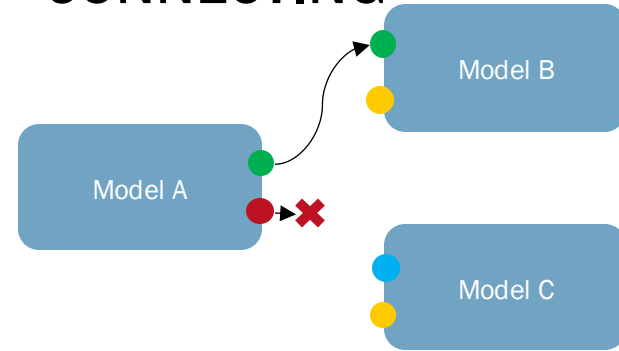
- Many different combinations of models are needed
- Investment is too high to implement this again for each new situation.

### Challenge:

- Only *describe* which models to combine and *automate* the data flow through these models

&

## CONNECTING



### Problem:

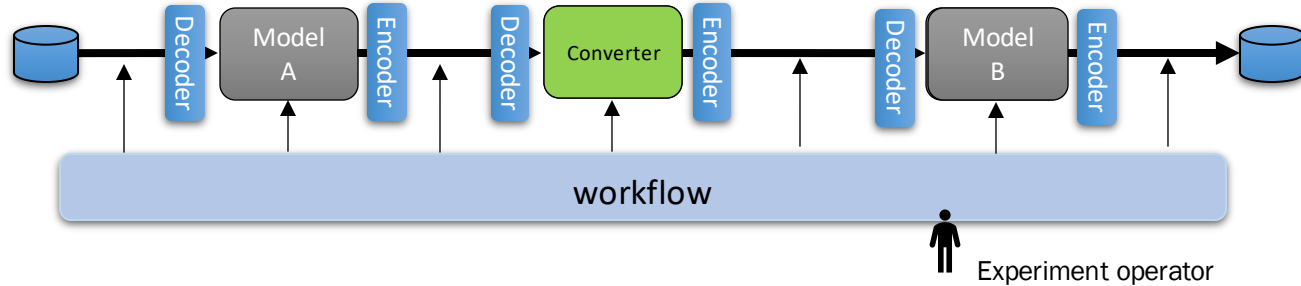
- models don't take each other into account
- Many different combinations of models are needed

### Challenge:

- Models should *not be aware* if they are part of a multi model or not
- *Lower* the number of *data formats* to connect models

## › SOLUTION

# IMPLEMENT ONCE AND REUSE MANY



### Combining models

- **Multi model == workflow** of data from model to model
- Use an **orchestrator** to control this data flow from model to model
- A **model does not need to be aware it is part of a multi-model**

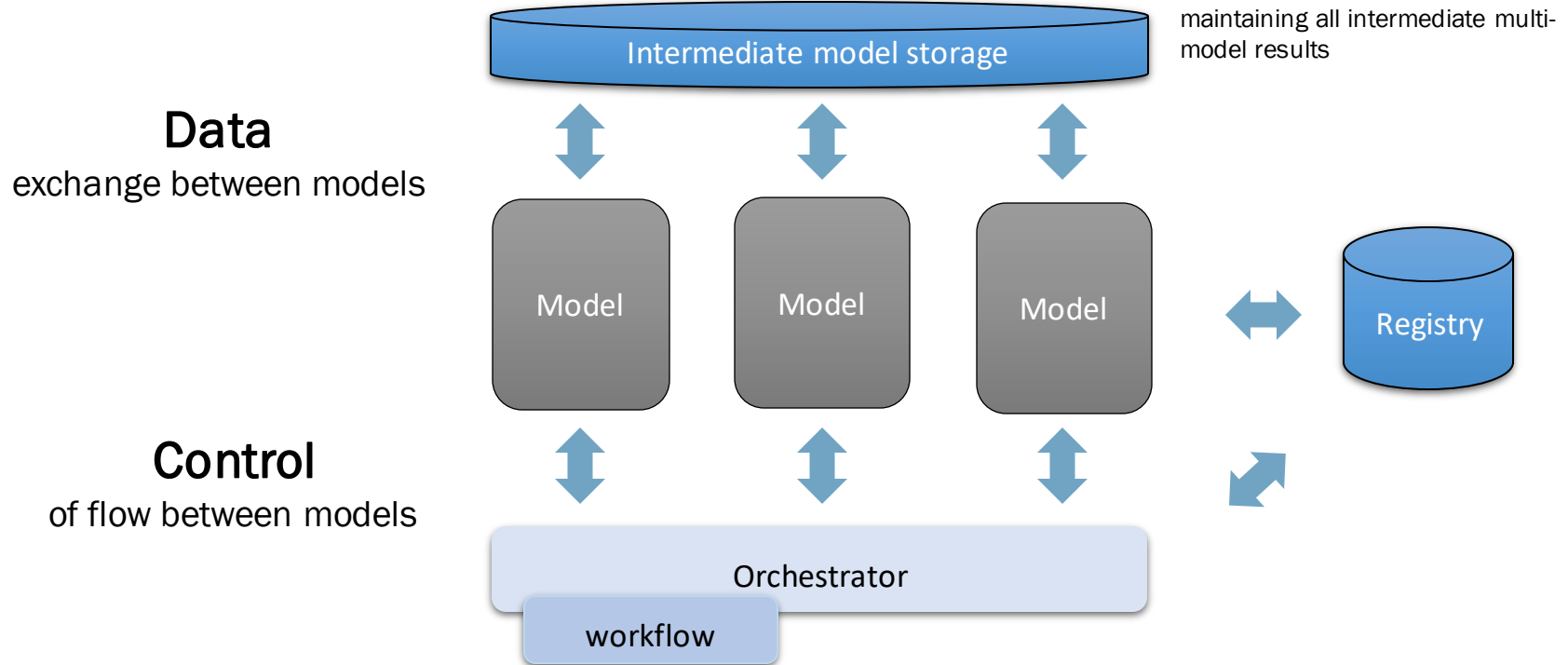
### Connecting models

- Choose a **limited number of data formats** for the input & output of models.
  - **Add en- & decoders**
- **Add converters** for basic transformations
  - Street level → city level, hourly → daily, ...

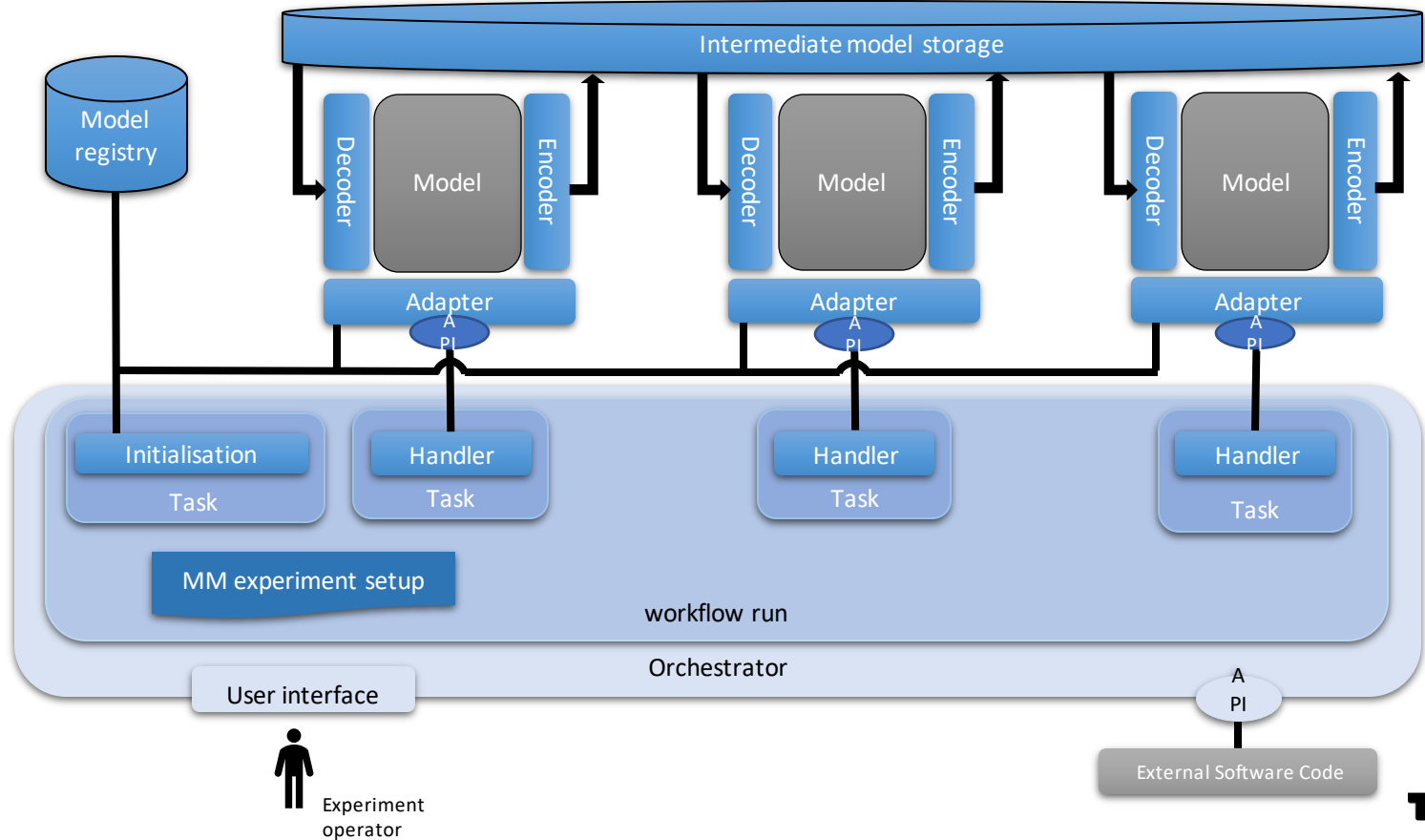


# IT ARCHITECTURE MMVIB PLATFORM

## SEPERATION OF DATA EXCHANGE AND MODEL CONTROL



# IT ARCHITECTURE MMVIB PLATFORM



# › MMVIB PLATFORM

## THE SOFTWARE COMPONENTS

› Core of the platform is the orchestrator

› Apache Airflow



› Intermediate model storage

› Minio

› InfluxDB

**MINIO**



› Everything runs on Docker



# Practically this means :

- Internet service for inter-model communication and coordination
- Specification of communication language
  - Model identity and control
  - Information payload
  - Scenario space description
- Methods for identifying and dealing with:
  - Uncertainty propagation
  - Scaling in time and space
  - Combination of different model operational principles
- Community of practice : creating and sharing knowledge on
  - Multi-model development, conceptual and practical
  - Use of multi-models in decision making
  - Future development of models and projects

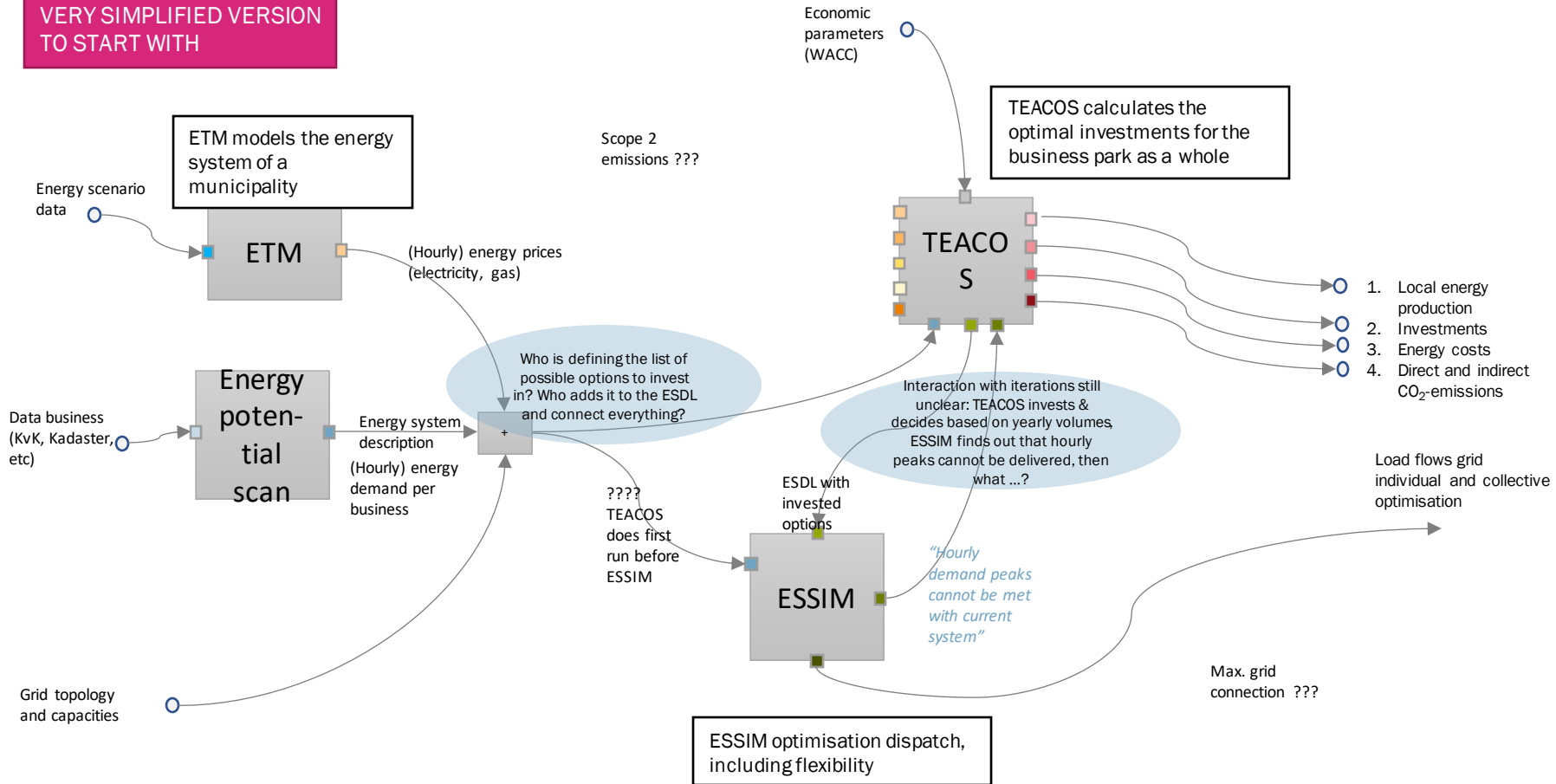
# Cases

- Macro scale : Il3050 as a multi-model
- Meso scale : RES
- Micro scale : Transitievisie Warmte



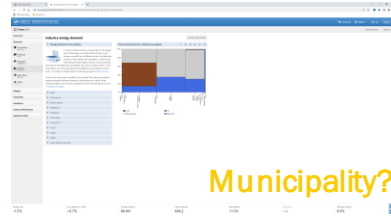
**MMVIB PROJECT**  
**WP4 – MICRO USE CASE ACTION POINTS**

VERY SIMPLIFIED VERSION TO START WITH



# MMVIB BUSINESS PARK USER WORKFLOW

1. Build model representation of current energy system



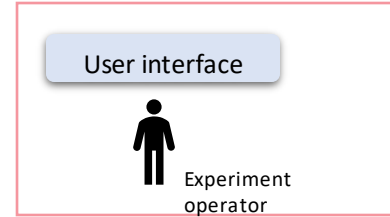
2. Configure optional + planned assets & measures



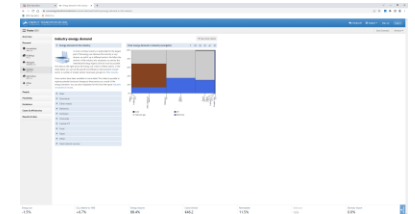
3. Select technology cost & energy price scenario's



4. Press "start"



5. Interpret results





# Industrial cluster Zeeland

## Problem owner + outcomes

Outcomes should be 'useful' for the industry cluster Zeeland to:

1. understand possible investment paths in the future *Investment pathways*
2. foundation for communication with regional/national government. *KPI's (?)*

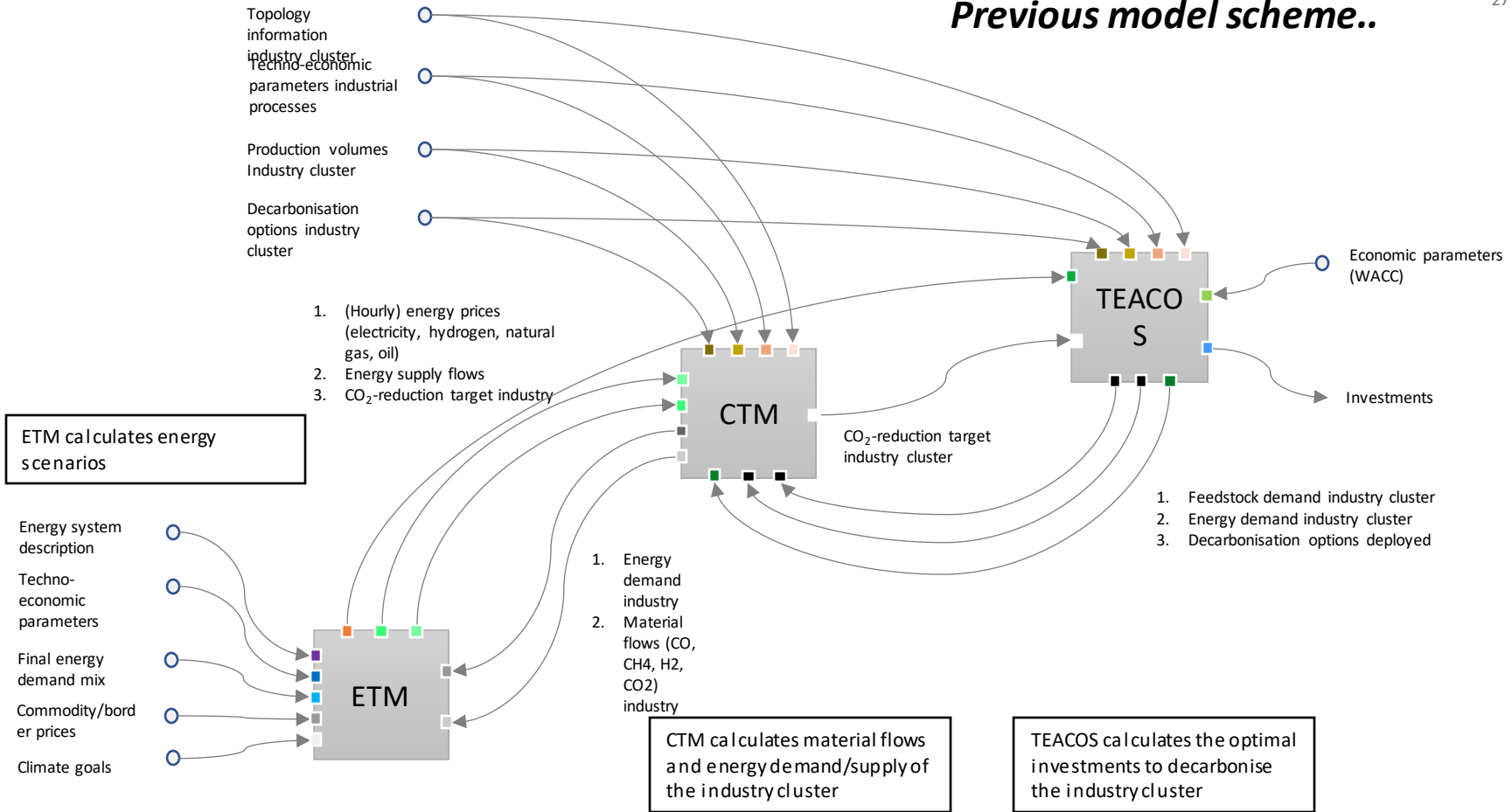


## Method: Multi-model structure

To be able to answer all research questions and deliver valuable output we use the following models:

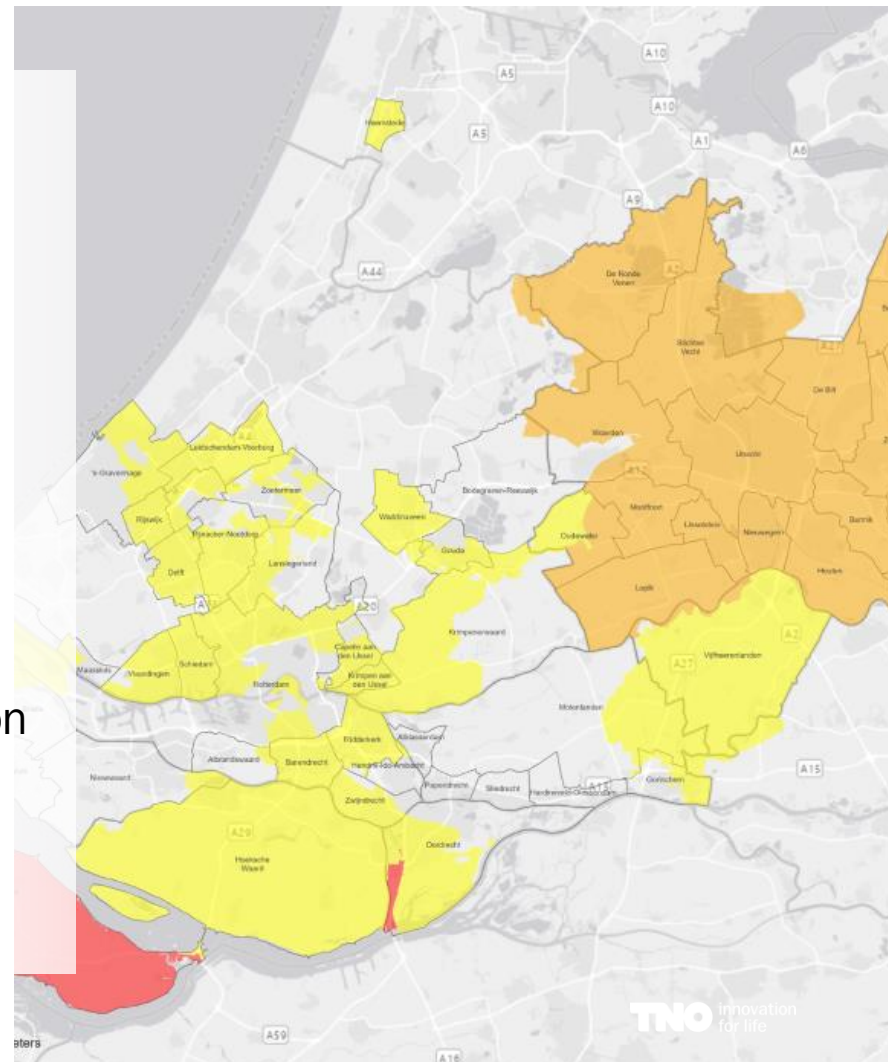
- **Teacos** optimizes possible investment choices for industry cluster Zeeland
- **CTM** describes the industrial sites present in industry cluster Zeeland and delivers input & output data to understand the impact on industries
- **ETM** describes the national context and delivers input & output data to understand national conditions and impact

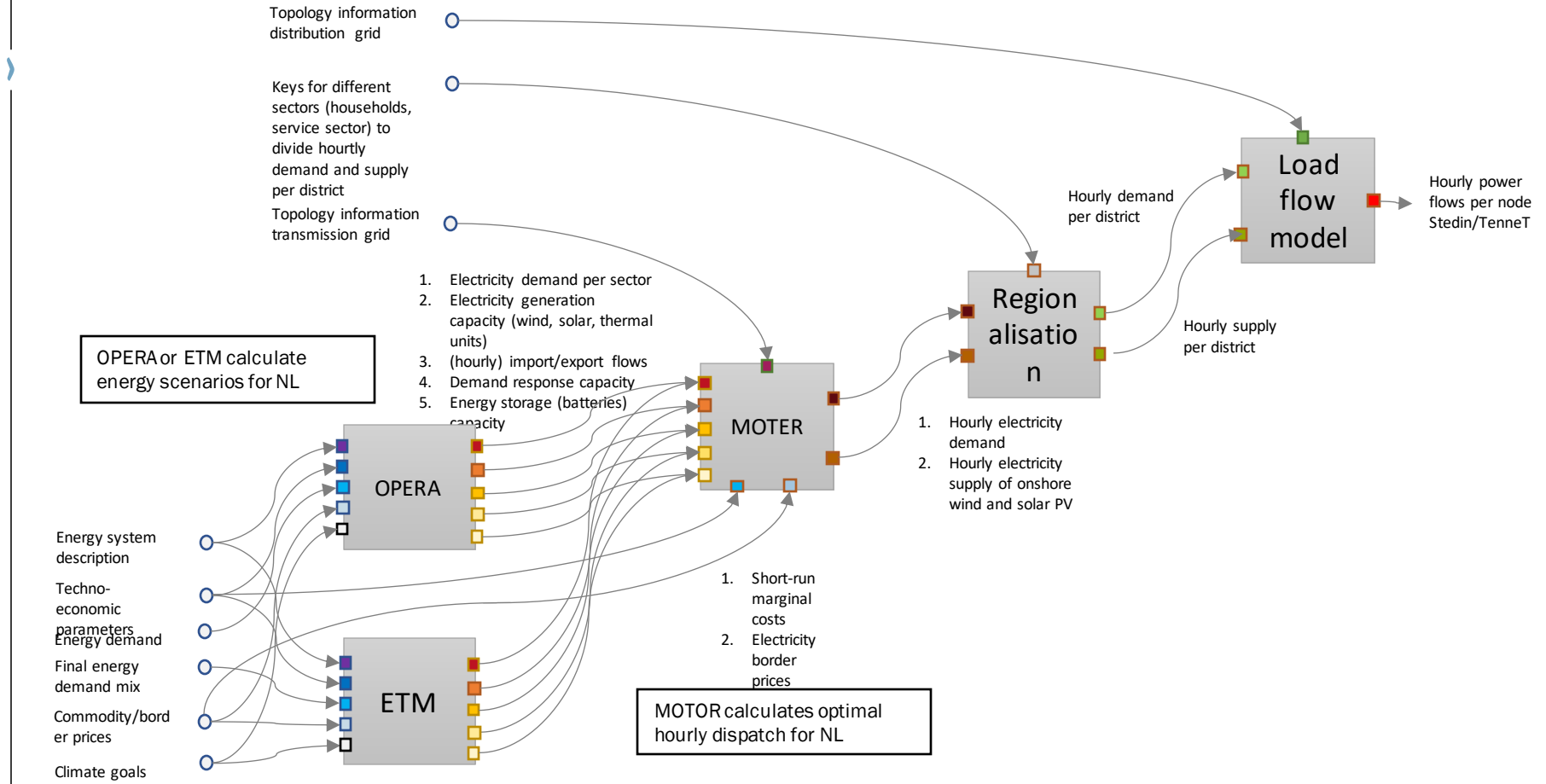
# Previous model scheme..



## › MACRO USE CASE

- › Energy system:
  - › Stedin electricity distribution network with connections to transmission network (Tennet)
- › Problem to analyse:
  - › What is the impact of different scenarios on the grid capacity, in particular at coupling nodes with the transmission network (25 kV stations)?





# We need you !

- Share your multi-model challenges
- Connect your models
- Use the infrastructure in your projects
- Accelerate and improve the energy transition!