Uncertainty and modelling: lessons learned and gaps

EMP-E 2020

8th October, 2020
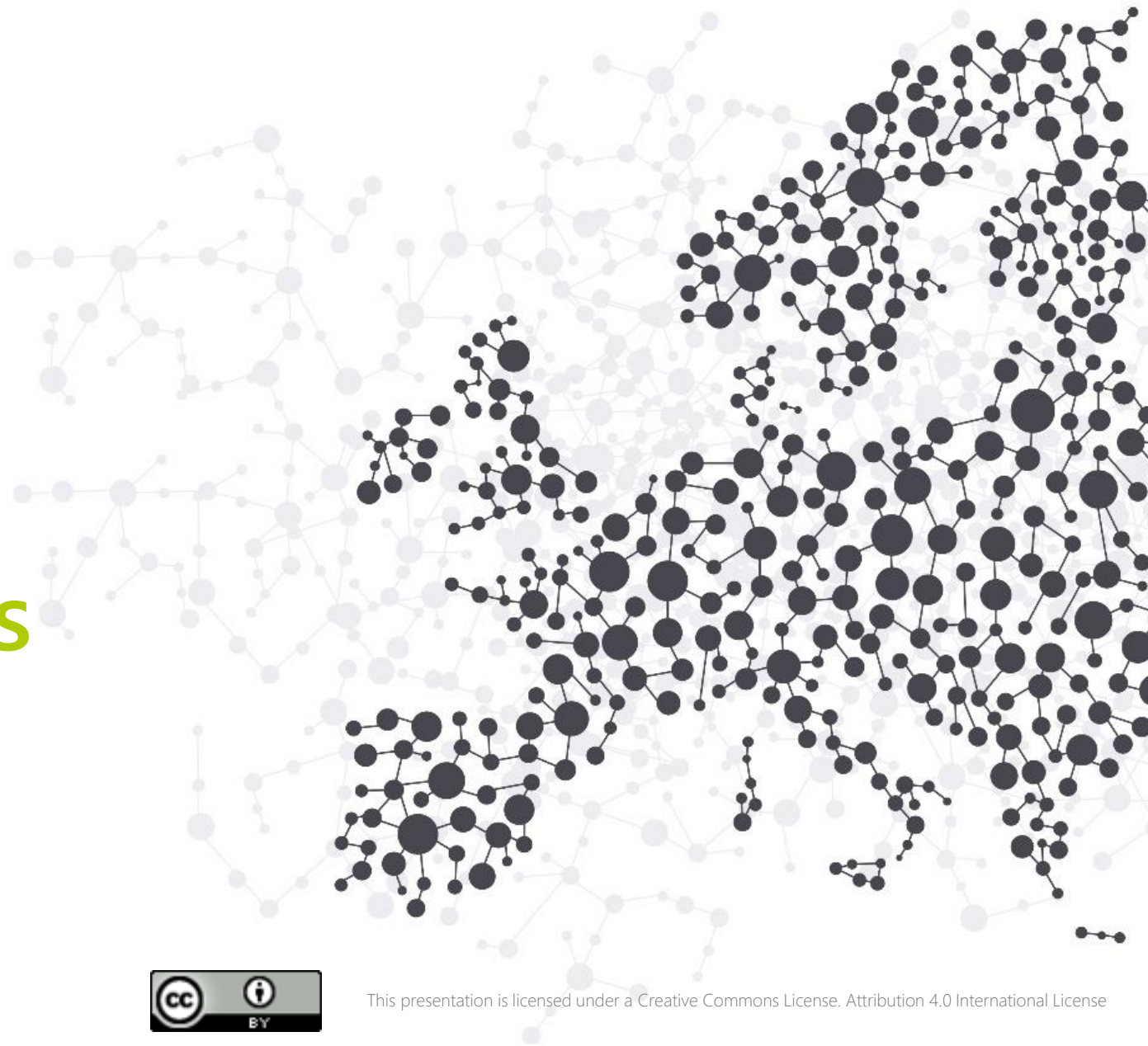
Agenda

1. Welcome and results of the survey (10 min)

2. Asgeir Tomasgaard- *Uncertainty in Energy Planning: State of the Art* (20 min)

3. Sara Lumbreras - *Uncertainty in Transmission Expansion Planning: A Bird's Eye View Through Three European Projects* (10 min)

4. Paula Falugi – *Transmission Investments Under Long-Term Uncertainty in the European Electricity System* (10 min)

5. Thomas Heggarty – *Accounting for Uncertainty in Power System Planning: The OSMOSE approach (10 min)*

6. Q&A + Discussion (30 min)

The importance of uncertainty

- Uncertainty in energy modelling is key in the current context:

- It is necessary to consider very different long-term (30 years) scenarios/storylines w.r.t. preferred generation technologies and/or market integration.

- High renewable penetration forces us to consider short-term scenarios/uncertainties for different resource availabilities.

- This is compounded by the time coupling introduced by storage.

- Regional markets and long-range transmission introduce higher complexity.

- To face these challenges, we have more resources available in terms of computation capacity and algorithms.

- We will cover all these topics from the perspective of European projects.

Modeling challenges to deal with

- Consider long-term (30 years) and short-term (hours) stochasticity simultaneously

- Coordination between GEP and TEP decisions

- Solvability (reasonable computing time)

- Replicability (open data + model)

open ENTRANCE

Responses to the survey

Link to updated google form:

https://docs.google.com/forms/d/1WuLcEowwKpNjES9NHFnZMPW-owlPzO4vmiQQyhLl0Ns/edit?gxids=7757#responses

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Uncertainty in Transmission Expansion Planning:
A Bird's Eye View Through Three European Projects

We will review how uncertainty was incorporated into the planning process along several European projects:

- e-Highway2050 (2012-2015)

- SET-Nav (2016-2019)

- openENTRANCE (2019-2023)
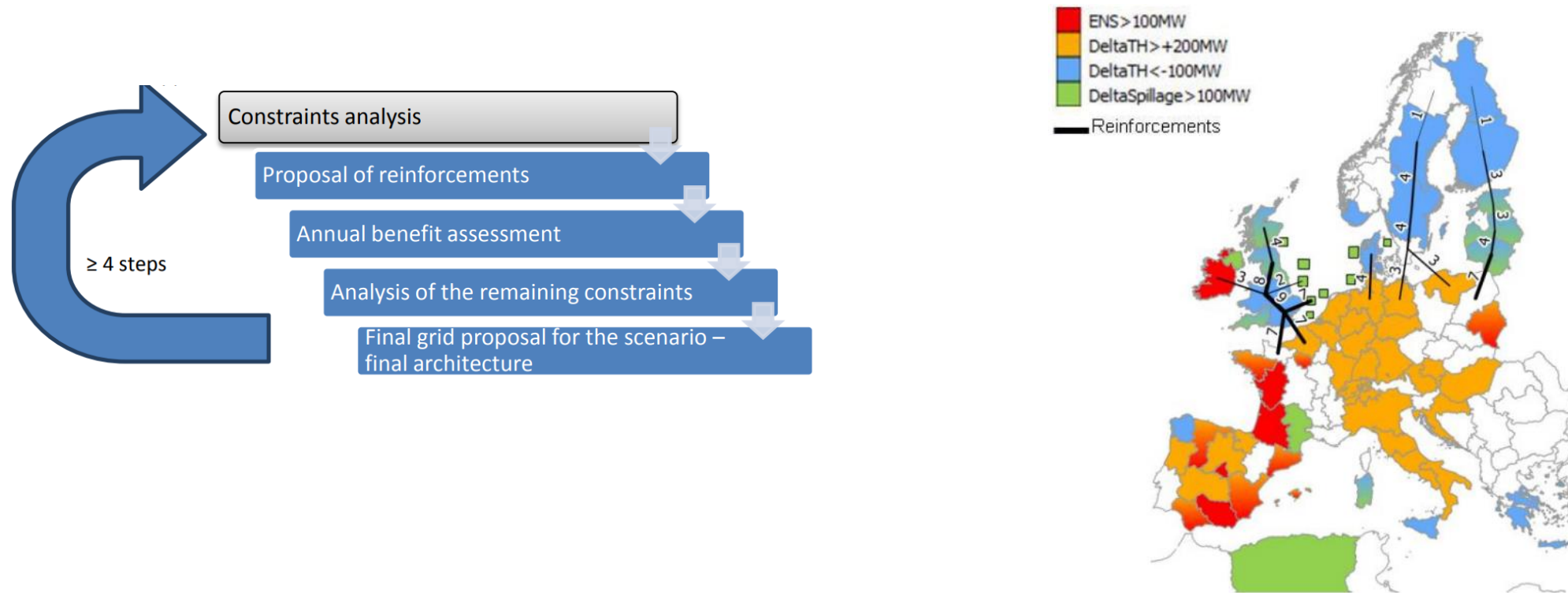
e-Highway: Scenarios/Storyline

A scenario/storyline is a combination of a strategy (we have control) with a future (no control). The combinations gave 30 possible scenarios, and 5 were selected as the most challenging.

Strategies		Strategy 1	Strategy 2	Strategy 3	Strategy 4	Strategy 5	Strategy 6
Futures		MARKET LED	LARGE SCALE RES SOLUTIONS	LOCAL SOLUTIONS	100% RES	NUCLEAR & CCS	WITHOUT NUCLEAR
Future 1	Green Globe	NUC	X-1	X-2	X-3	NUC	X-4
Future 2	Green EU	CCS	X5 Large scale RES	X-6	X7 100% RES el.	CCS	CCS
Future 3	EU- Market	X-8	No Policy	X-9	No Policy	No Policy	No Policy
Future 4	Big is beautiful	X10 Big and market	CCS	Non-Logical	X-12	X13 large fossil fuel	X-14
Future 5	Small things matter	NUC/CCS	Non-Logical	X16 small and local	X-17	NUC	CCS

e-Highway v1: Determination of network reinforcements for each scenario

Iterative manual process based on the analysis of weekly constraints, the proposal of reinforcement and the cost-benefit analysis (CBA).

≥ 4 steps

Constraints analysis

Proposal of reinforcements

Annual benefit assessment

Analysis of the remaining constraints

Final grid proposal for the scenario – final architecture

ENS > 100MW
DeltaTH > +200MW
DeltaTH < -100MW
DeltaSpillage > 100MW
— Reinforcements

e-Highway v1: Common Corridors

Iterative manual process based on the analysis of weekly constraints, the proposal of network reinforcement and the CBA.
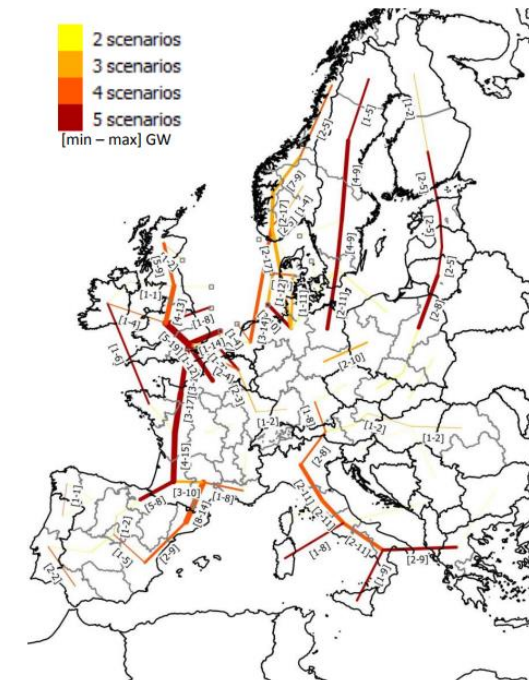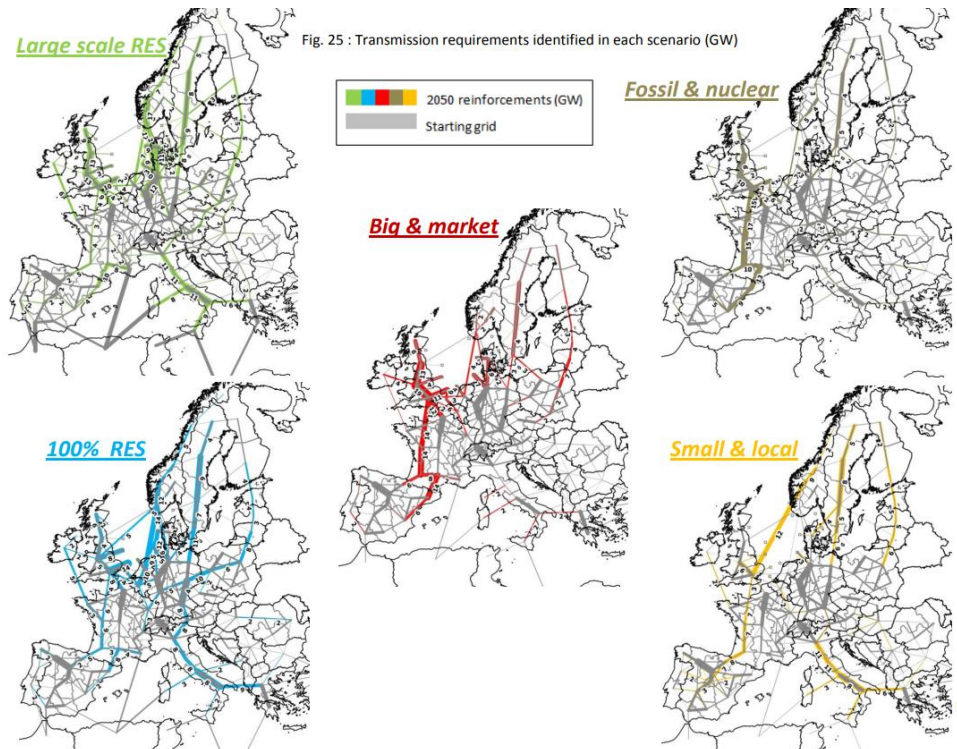
e-Highway v2: Alternative methodology

Based on stochastic optimization for network expansion based on zones

New mechanisms for network reduction and snapshot selection

- From lines to corridors, and from nodes to zones

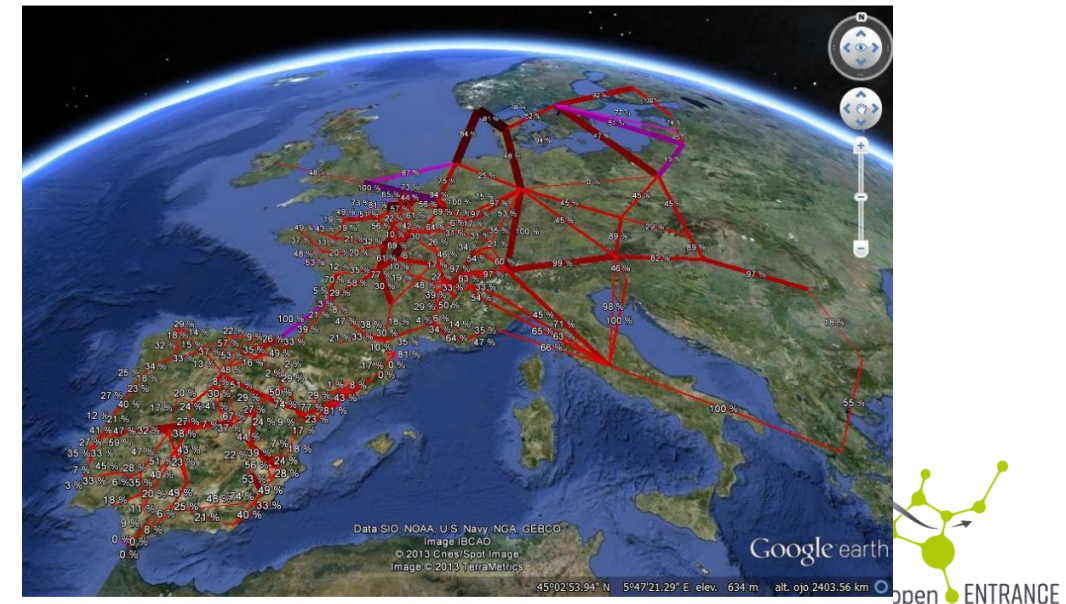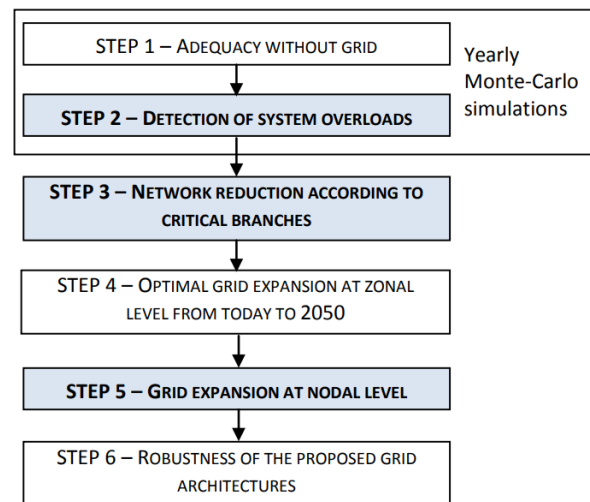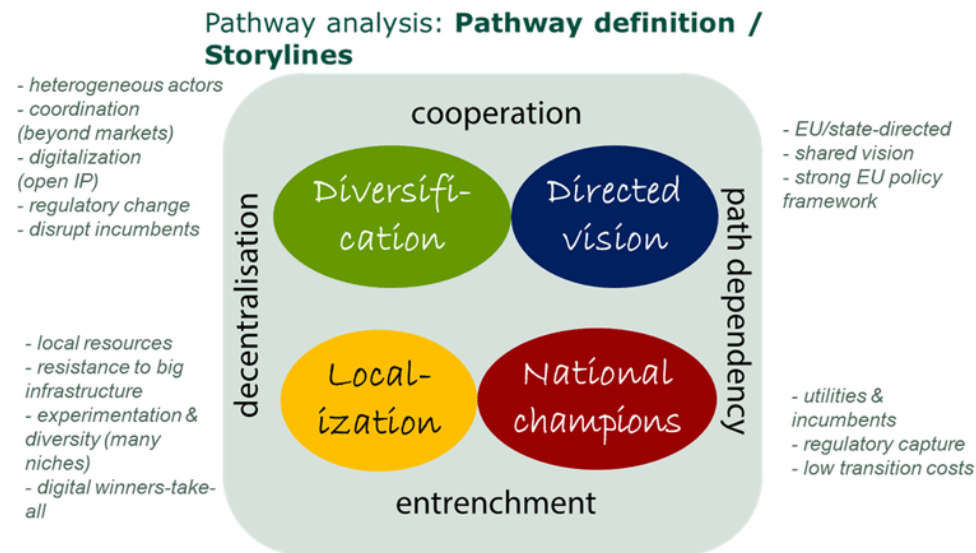From zonal results to a nodal expansion plan

STEP 1 – Adequacy without grid

STEP 2 – Detection of system overloads

Yearly Monte-Carlo simulations

STEP 3 – Network reduction according to critical branches

STEP 4 – Optimal grid expansion at zonal level from today to 2050

STEP 5 – Grid expansion at nodal level

STEP 6 – Robustness of the proposed grid architectures

Figure 20. Representation of an example expansion plan obtained with TEPES

SET-Nav: Defining storylines for the energy transition

Four storylines towards the future energy system and many case studies to highlight specific issues.


Pathway analysis: **Pathway definition / Storylines**

- heterogeneous actors
- coordination (beyond markets)
- digitalization (open IP)
- regulatory change
- disrupt incumbents

- local resources
- resistance to big infrastructure
- experimentation & diversity (many niches)
- digital winners-take-all

cooperation

decentralisation

Diversifi-cation

Directed vision

Local-ization

National champions

entrenchment

path dependency

- EU/state-directed
- shared vision
- strong EU policy framework

- utilities & incumbents
- regulatory capture
- low transition costs

- Centralized vs. decentralized.
- PCI and gas pricing.
- Role of CCTS
- ...

SET-Nav: Stochastic optimization

Stochastic optimization applied to coordinated GEP+TEP

Snapshot selection is used to be more efficient with computational resources.
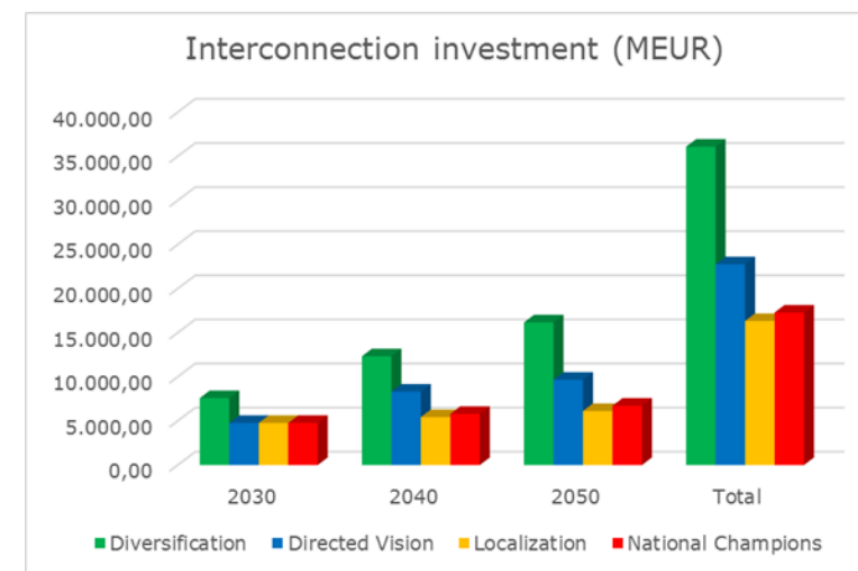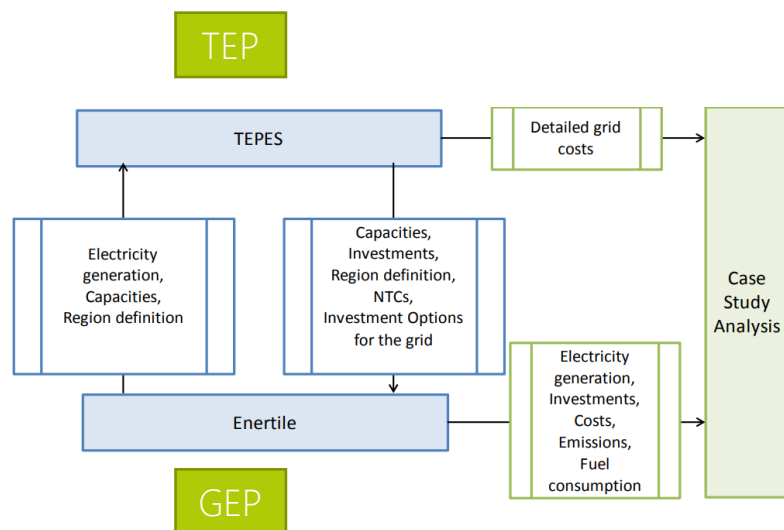
openENTRANCE: New Challenges

- Focus on open data (+open models).

- TEP still as stochastic optimization, but with a larger number of snapshots.

- Need to coordinate with system operation: The focus on storage leads to the need of combining:

    - Representative periods that capture intertemporal links

    - Representative snapshots

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A bird's eye view

Optimization is now the main approach

Uncertainty is key – stochastic optimization seems to be the king.

Larger numbers of snapshots, larger problems.

Coordination GEP + TEP, GEP + short-term operation.
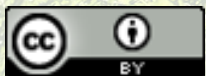
Open data.

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Q&A

Please input your questions and comments to the chat window

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Thanks

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