This project has received funding from the European Union's Horizon2020 research and innovation programme under grant agreement N° 863819

FlexPlan

ENLIT2020 | 20th April 2021

The FlexPlan project

Gianluigi Migliavacca
RSE S.p.A.

Agenda

- Motivation of the FlexPlan project
- FlexPlan partnership
- Goals and structure of the project
- The FlexPlan approach: a simple example
- The FlexPlan web

- Agenda of the session

Motivation of the FlexPlan project

FlexPlan

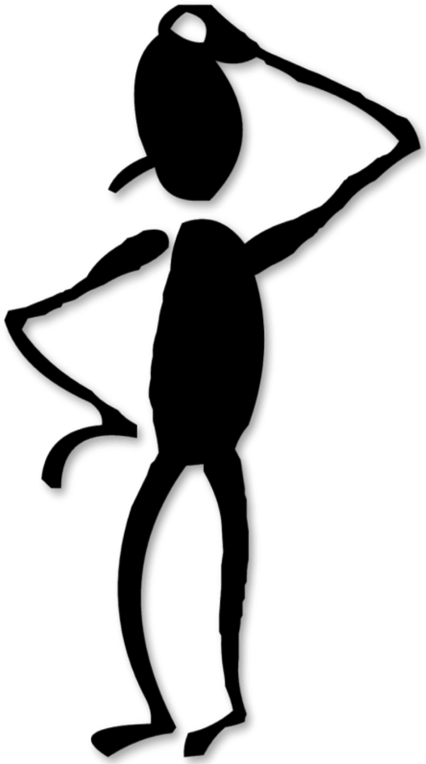
- High-speed deployment of RES (challenging European target: 32% at 2030) is making T&D planning more and more complex and affected by a high level of uncertainty

- Grid investments are capital intensive and the lifetime of transmission infrastructure spans several decades: when a new line is commissioned it might be already partially regarded as a stranded cost

- Building new lines meets more and more hostility from the public opinion, which makes planning activities even longer and affected by uncertainties

- Variable flows from RES are generating a new type of intermittent congestion which can sometimes be well compensated with system flexibility: investments in a new line would not be justified.

- There is an on-going debate on the employment of storage technologies and system flexibility to make the RES grid injection more predictable ("virtual power plant")



The FlexPlan project

FlexPlan

- **Start date: 01.10.2019**
- **End date: 30.09.2022**

… aims at establishing a new grid planning methodology considering the opportunity to introduce new storage and flexibility resources in electricity transmission and distribution grids as an alternative to building new grid elements.

FlexPlan: partnership

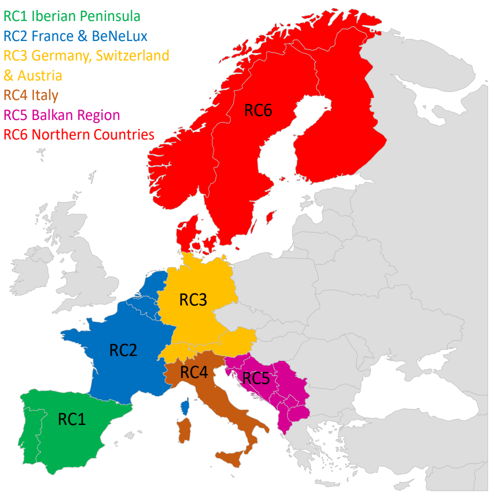
- ## Research Partners:
  - **RSE**, Italy (Project Coordinator, WP7 and WP8 leader)
  - **EKC**, Serbia
  - **KU-Leuven**, Belgium (WP1 leader)
  - **N-SIDE**, Belgium (WP3 leader)
  - **R&D NESTER** Portugal (WP5 leader)
  - **SINTEF**, Norway (WP6 leader)
  - **TECNALIA**, Spain (WP2 leader)
  - **TU-Dortmund**, Germany (WP4 leader)
  - **VITO**, Belgium

- ## Transmission System Operators:
  - **TERNA**, Italy
    - **Terna Rete Italia** as Linked third Party
  - **REN**, Portugal
  - **ELES**, Slovenia

- ## Distribution System Operators
  - **ENEL** Global Infrastructure and Networks
    - **e-distribuzione** as Linked third Party

What FlexPlan will achieve

1 – New planning methodology - Creation of a **new tool for optimizing T&D grid planning**, considering the **placement of flexibility elements** located both in transmission and distribution networks **as an alternative to traditional grid planning**: in particular, storage, PEV, demand response)

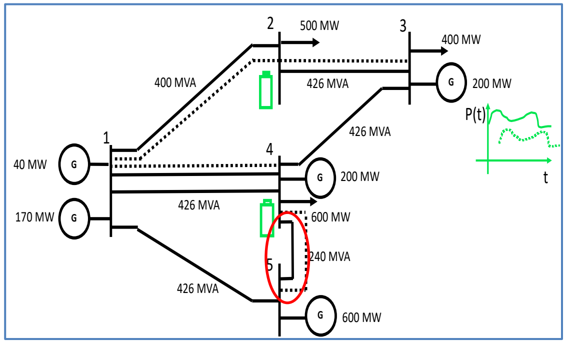


2 – Scenario analysis 2030-40-50 - New methodology applied to analyse **six regional grid planning scenarios at 2030-2040-2050.** A **pan-European scenario** will deliver border conditions to initialize in a coherent way the 6 regional cases.

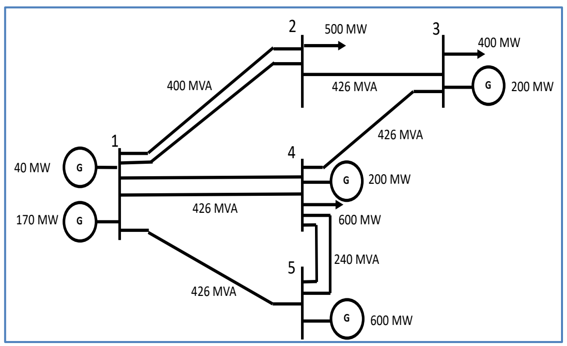
3 – Regulatory guidelines – FlexPlan goal is to provide:

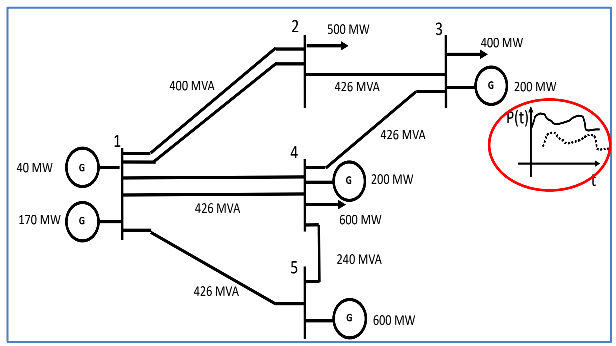
- an optimized planning methodology for the future usage of TSOs and DSOs
- indications on the potential role of flexibility and storage as a support of T&D planning
- guidelines for NRA for the adoption of opportune regulation.

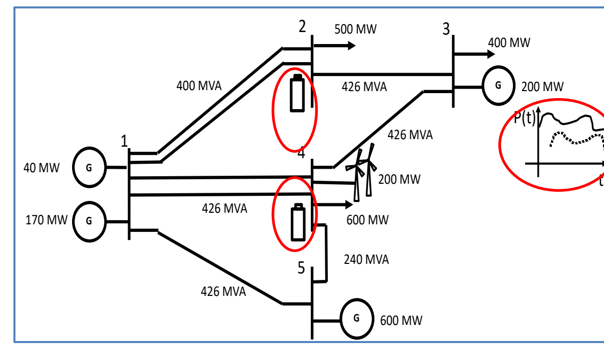
The FlexPlan approach: a simple example



Power transfer capacity of line 4 - 5 limited to 240 MVA, the generation resources connected to bus 5 cannot be utilized to fully supply the demand on bus 3. Investments are needed.
Candidates: four lines (dashed), two storage systems (in green) one flexible demand (in green).







Solution 1 - Classic transmission expansion planning (transmission lines), by designing the system for peak load conditions. If peak load conditions only occur for a limited number of hours this is not economically optimal.

Solution 2 – Omitting investments into line 4-5, as the existing line is sufficient to supply the demand for most of the time, and activate demand flexibility (shifting and/or reduction) whenever needed.

Solution 3 - Conventional generators have been replaced by wind farms, then storage could allow to supply demand in hours of low wind generation and high demand.

The FlexPlan web

- The official web site of the FlexPlan project is: https://flexplan-project.eu/
  All project news and other information are posted there
- Project brochure can be downloaded from: https://flexplan-project.eu/wp-content/uploads/2020/02/FlexPlan_brochure.pdf
- All project publications (deliverables, papers, important presentations) are publicly downloadable from: https://flexplan-project.eu/publications/

Agenda of the session

- Introduction

  Gianluigi Migliavacca (RSE)

- **Next generation flexible system planning models**

  Hakan Ergun (KULeuven/EnergyVille)

- **Characterization and potential of flexibility in the power system**

  Raul Rodriguez (TECNALIA)

- **An ambitious set of energy and grid scenarios at 2030-40-50**

  Björn Matthes (TU Dortmund)

- **Regulation Framework and attention points for the future**

  Andrei Morch (SINTEF Energi)

- **Panel: Present and future needs for the European Grid: how to enforce a future role for flexibility**

Thank you…

Gianluigi Migliavacca

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FlexPlan

FlexPlan-Project.eu

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research and innovation programme under grant agreement N° 863819

FlexPlan

ENLIT2020 | 20th April 2021

Next generation flexible system planning models

Hakan Ergun
KU Leuven / EnergyVille

Agenda

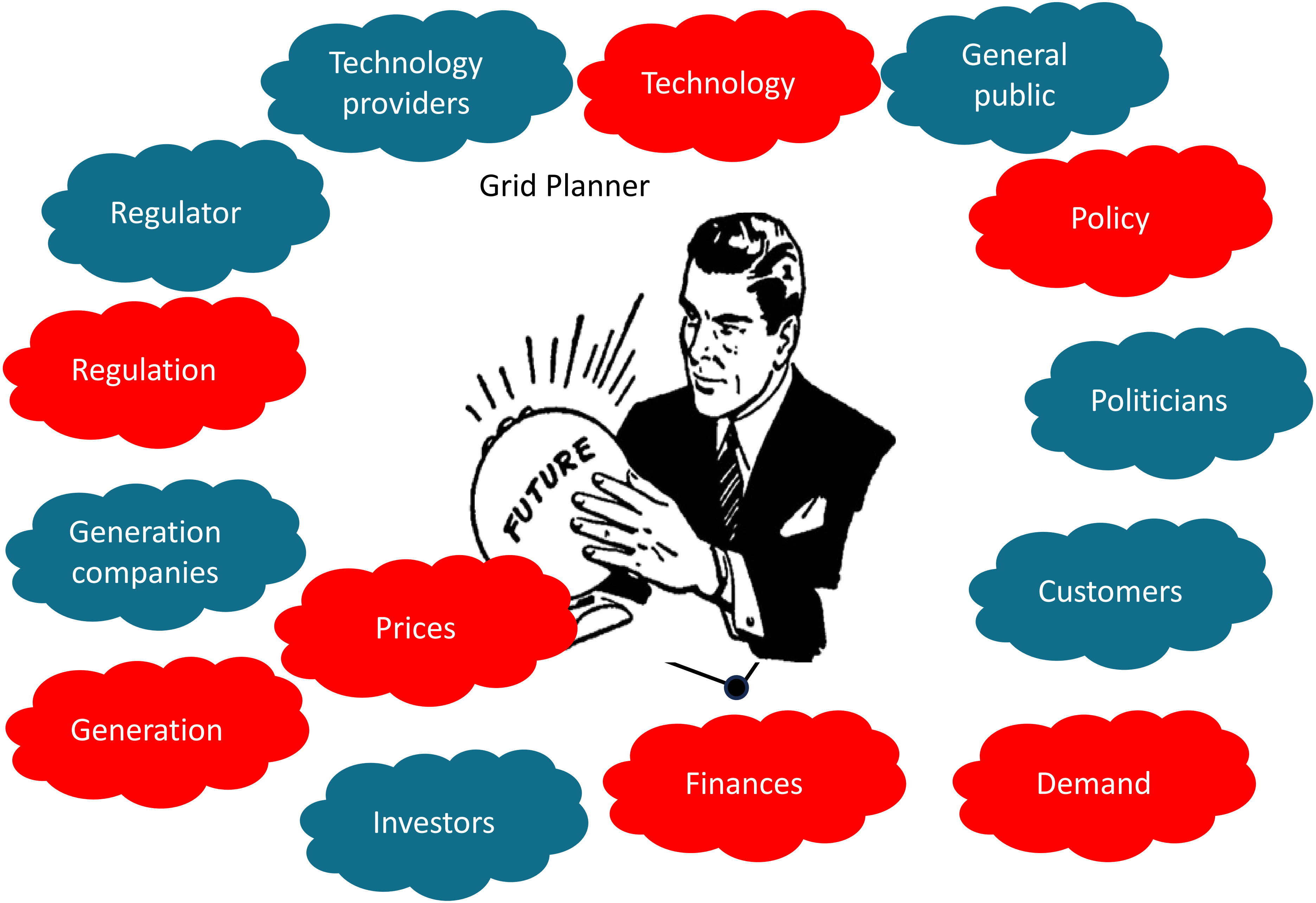
- Introduction into transmission and distribution system planning
- Actors, uncertainties and challenges
- The FlexPlan approach for system planning
- Model implementation, validation & testing
- Summary / conclusions

The four 'W's of transmission system planning

- **W**here to invest?
  - Identification of specific corridors and grid nodes for system expansion
- **W**hat type of investment?
  - Identification of optimal investments, e.g., lines, storage, ac / dc technology, ….
- **W**hen to invest?
  - Identification of optimal moment of investments in a planning sequence
- **W**ho pays for the investment?
  - Incentivizing investment with highest social benefit through cost allocation and remuneration

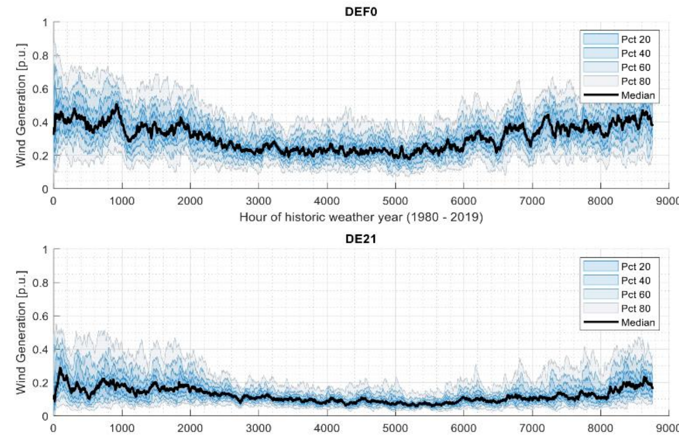
Where, What, When and Who depend on each other!

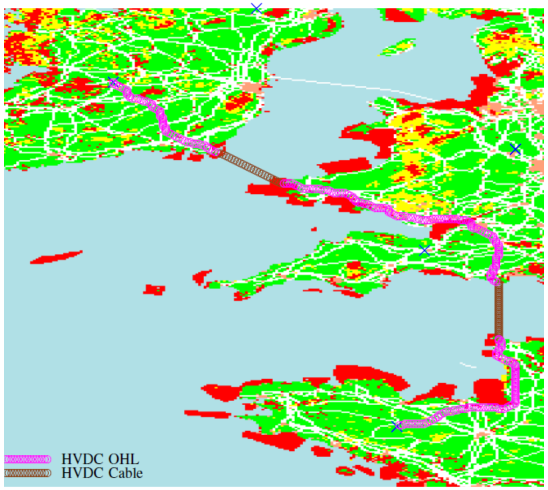
Actors and uncertainties



Main challenges

- How to deal with uncertainty?
- How to model environmental impact?
- How to ensure a holistic system design?
- How to find trade-offs between flexibility /storage and “classical” line investments?
- Computationally challenging!





The FlexPlan approach

Candidate transmission lines & cables, HVDC connections, PSTs, storage, demand flexibility

Quantify landscape impact costs

Carbon footprint analysis using LCA

Generation and demand time series for 2030, 2040, 2050

T & D grid data based on ENTSO –e TYNDP

Optimization model

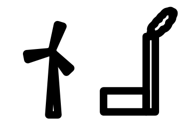
Objective: Maximum social welfare consisting of investment costs, power plant operational costs, environmental impact, system security impact

Decision variables: Investment decision (binary), hourly generator dispatch, flexibility activation, storage usage, PST & HVDC set points

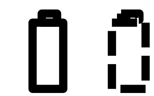
Constraints: T&D grid constraints, T&D security constraints, flexibility characteristics, storage constraints

Scope of the optimisation

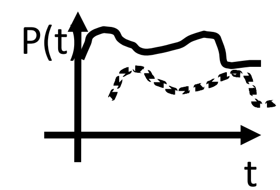
- Generators
  - Operational costs
  - Generator emission impact costs



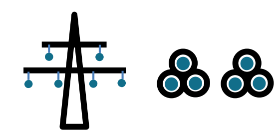
- Storage
  - Operational costs, e.g., storage losses (existing and new)
  - Storage CAPEX (new), storage carbon footprint impact cost (new)



- Demand flexibility
  - Cost of voluntary demand reduction
  - Cost of involuntary demand reduction
  - Cost of voluntary demand shifting
  - CAPEX and carbon footprint cost

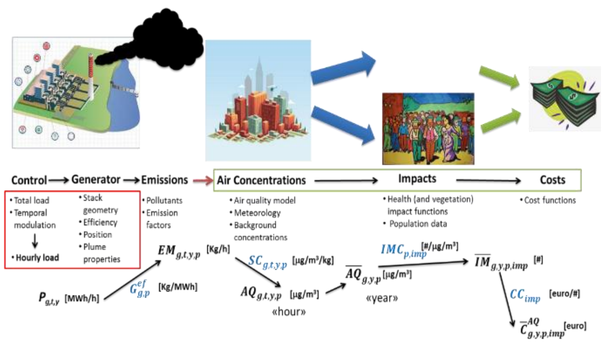


- Grid elements
  - AC line CAPEX and carbon footprint cost (new)
  - PST CAPEX and carbon footprint cost (new)
  - HVDC line and converter CAPEX and carbon footprint cost (new)
  - Expected redispatch / load shedding cost due to outages



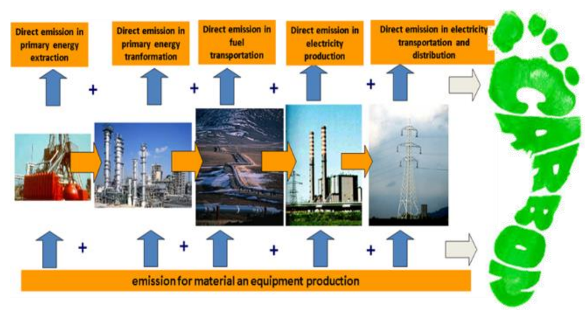
Environmental impact modelling

Air quality impact modelling



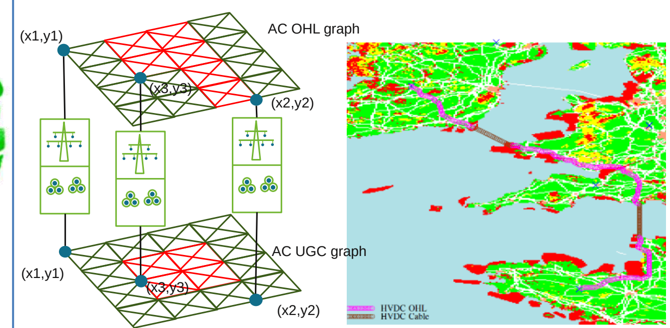
Linearized model quantifying air quality impact related costs in dependence of generation

Carbon foot print modelling



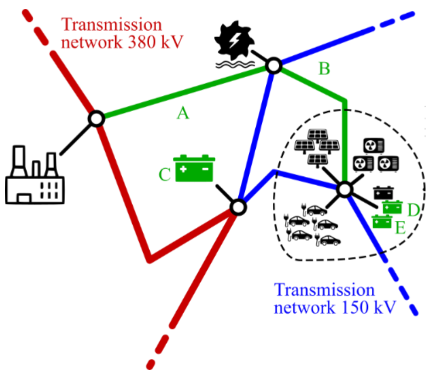
CO_2 emission cost of power generation as direct input, CO_2 impact of new grid investments using LCA

Landscape impact modelling

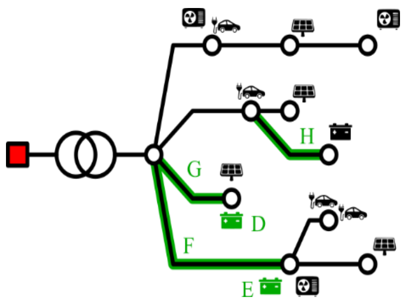


Using optimal routing routing algorithm quantifying landscape impact cost for OHL and cable investments

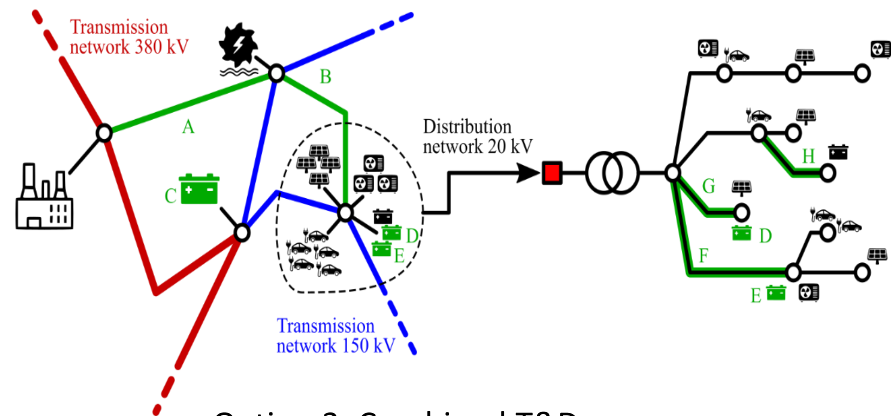
Enhancing computational tractability



Option 1: Transmission only



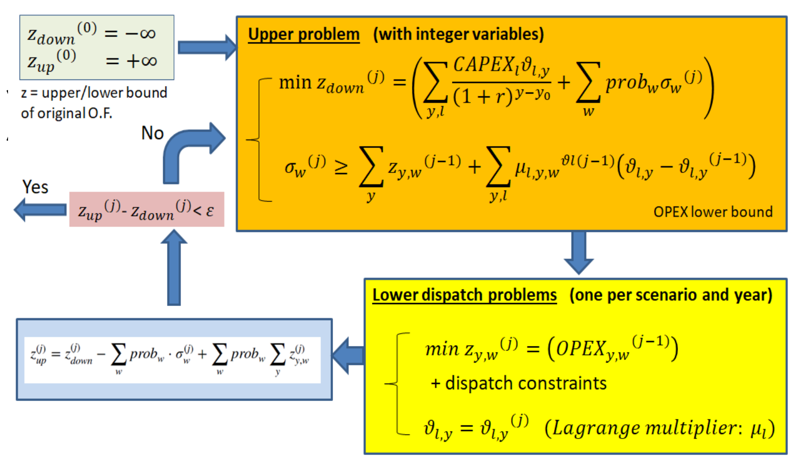
Option 2: Distribution only



Option 3: Combined T&D

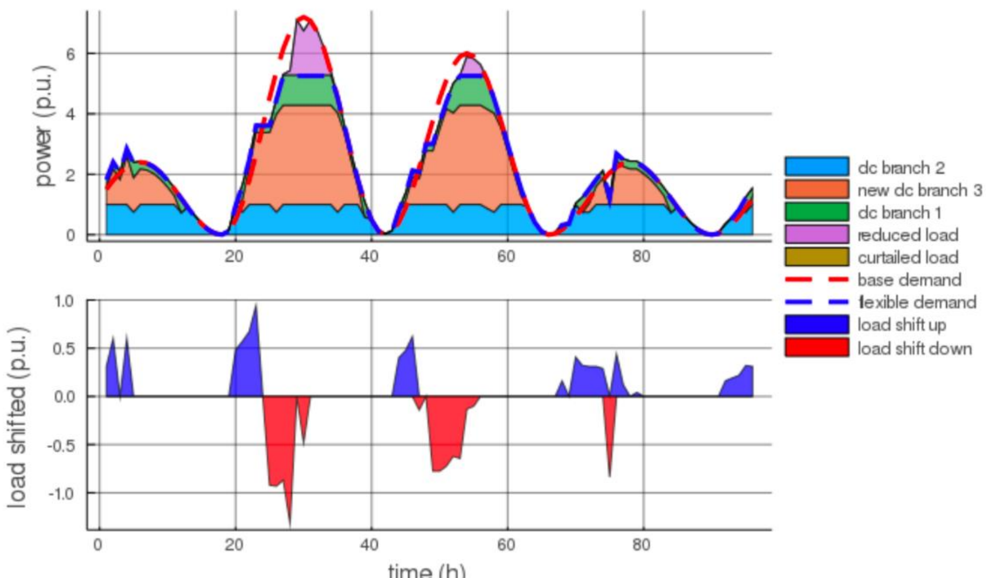
- Generic model formulation to support T&D expansion options
- Model decomposition for combined T&D modelling
  - *Distribution system expansion as transmission planning candidate*

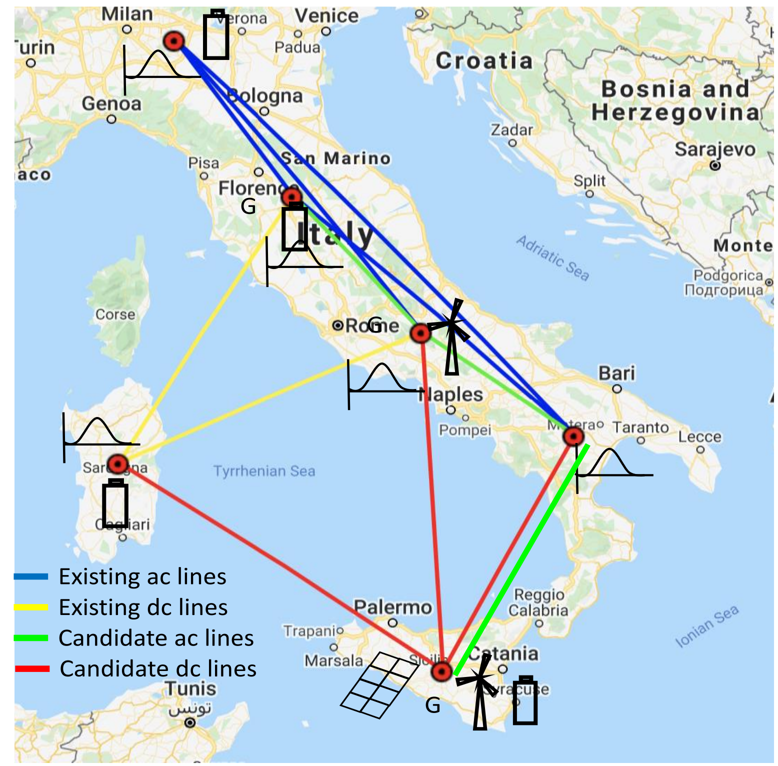
- Decomposition into higher level (investment) and lower level (operational) problem to increase tractability
- Allows also to preserve the stochastic nature of the planning problem over the planning horizon



Implementation, validation & testing

- The model is implemented and validated as a proof-of-concept software tool *"FlexPlan.jl"*
  - *To be open sourced soon*





Further references:

- FlexPlan Consortium, D1.1 Monte Carlo scenario generation and reduction, 2020
  - https://flexplan-project.eu/wp-content/uploads/2020/12/D1.1_20201210_V1.0.pdf
- FlexPlan Consortium, D1.2 Probabilistic optimization of T&D systems planning with high grid flexibility and its scalability, 2021
  - https://flexplan-project.eu/wp-content/uploads/2021/03/D1.2_20210325_V1.0.pdf

Conclusions

- Transmission and distribution system planning is a complex task due to many uncertainties and interactions
- Computationally tractable models are needed for optimal system design
- Within FlexPlan we have developed a proof-of-concept model allowing different decomposition techniques to achieve a tractable and versatile planning model

Thank you…

Hakan Ergun

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FlexPlan

ENLIT2020 | 22nd April 2021

Characterization and potential of flexibility in the power system

Raúl Rodríguez

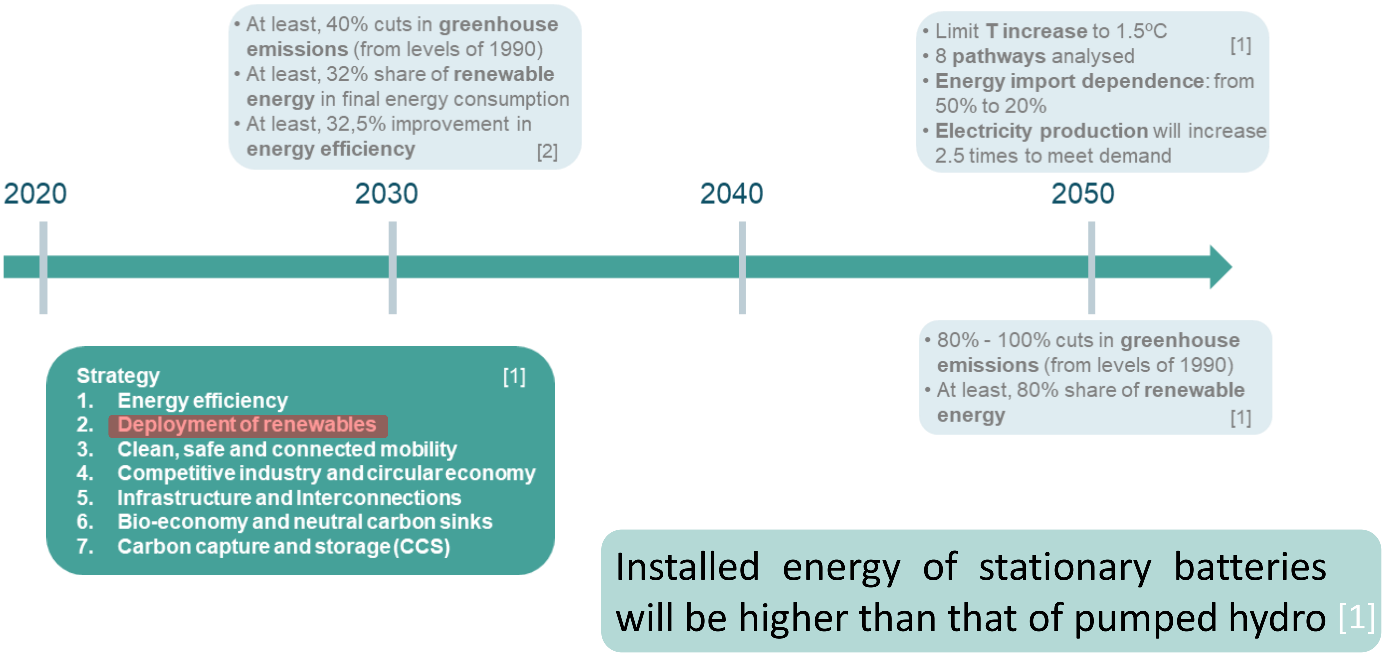
tecnalia Inspiring Business

Agenda

- Introduction
- Storage and Demand Response strategies
- Characterization of flexibility resources
- Pre-selection of flexibility resources as part of a network planning methodology
- Summary / conclusions

Introduction

- The **increasing integration** of variable wind and solar generation in the power system requires flexibility from other resources, such as storage and demand [1].



- Storage, other than pumped-storage hydropower, and DR have not been considered in traditional **network planning:** it is the aim of FlexPlan to revert this.

[1] European Commission, *A Clean Planet for all A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy*, COM(2018) 773 final, Brussels, 28.11.2018
[2] European Commission, *A policy framework for climate and energy in the period from 2020 to 2030*, COM(2014) 15 final, Brussels, 22.1.2014

Storage and Demand Response strategies

D2.1 Topics https://flexplan-project.eu/publications/

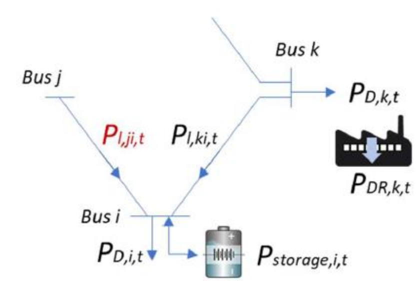
1. Storage related services definition and characterization.
2. DR strategies characterization.
3. Service specifics at regional level.
4. Flexibility resources mapping to services.
5. Service selection for flexibility resource candidates.
6. Congestion support in the network by flexibility resources.
7. LMP, LM, PTDF concept basics.

Generation/Bulk Services	Ancillary Services	Transmission Infrastructure Services	Distribution Infrastructure Services	Customer Energy Management Services
Arbitrage	Primary frequency control	Transmission investment deferral	Capacity support	End-user peak shaving
Electric supply capacity	Secondary frequency control	Angular stability	Contingency grid support	Time-of-use energy cost management
Support to conventional generation	Tertiary frequency control	Transmission support	Distribution investment deferral	Particular requirements in power quality
Ancillary services RES support	Frequency stability of the system		Distribution power quality	Maximising self-production & self-consumption of electricity
Capacity firming	Black start		Dynamic, local voltage control	Demand charge management
Curtailment minimisation	Voltage support		Intentional islanding	Continuity of energy supply
Limitation of disturbances	New ancillary services		Limitation of disturbances	Limitation of upstream disturbances
			Reactive power compensation	Reactive power compensation
				EV integration

[3]

Not considered in FlexPlan:
- Service not related to CM and/or with time scales lower than an hour
- Voltage control related service

Suitable for FlexPlan:
- DR strategy supporting CM
- Generation side application supporting CM
- CM support related application



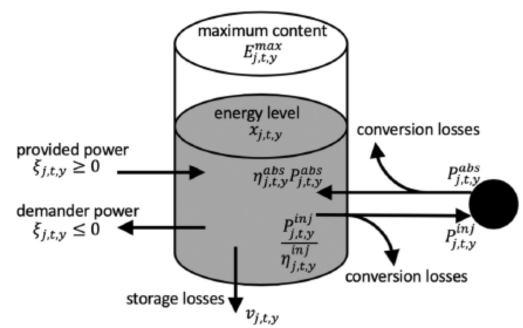
[3] EASE/EERA, *European energy storage technology development roadmap - update*, 2017

Characterization of flexibility resources

D2.2 Topics https://flexplan-project.eu/publications/

1. Flexibility technology listing and selection.
2. Characterization of flexibility resources.
3. Modelling of flexibility resources.
4. Link between flexibility characteristics and model parameters.
5. Qualitative mapping of flexibility solutions to selected services.

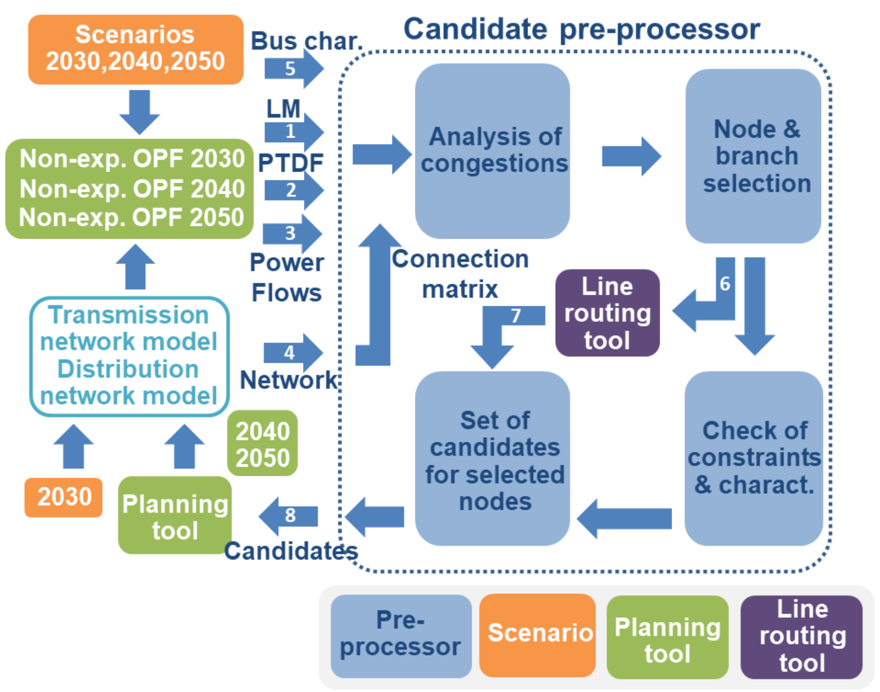
Flexibility resource		CAPEX (€/kW(h))		
		2020	2030	2050
Battery energy storage system [16], [11], [33]		278 - 1475	95 - 505	67 - 226
Demand Response [18]	Domestic	54/year	29/year*	15/year*
	Industrial	54/year	29/year*	15/year*
Electric vehicles [18]		54/year	29/year*	15/year*
Hydrogen [19], [20]	Alkaline	0.5 k – 1.5 k	0.3 k - 0.7 k	0.2 k- 0.6 k
	PEM	1.2 k – 1.8 k	0.6 k – 1.4 k	0.2 k – 0.8 k
	SOEC	2.5 k - 5 k	0.7 – 2.5 k	0.5 k – 0.9 k
Pumped hydro		40 -150	21.5-80.8*	16-43.5*
Thermal loads [21]	Space heating /cooling	54/year	29/year*	15/year*
	Cold storage	54/year	29/year*	15/year*
Combined heat and power [34]		0.88 k – 2.244 k	0.88 k – 2.155 k	0.88 k – 2.068 k
Compressed air storage [16], [2]		40-80	40-80	40-80
Liquid-Air Electricity Storage systems [26]		60 - 600	32.3-323*	17.4-174*
Thermo electric storages				



FlexPlan

Pre-selection of flexibility resources as part of a network planning methodology

- To help the planning tool with the candidate selection process, a **pre-processor** tool has been developed (currently, first version).



Inputs
- Optimal Power Flow (OPF) results (LM)
- Network model and scenario
- Characterization for network nodes
- Pre-defined network candidates

Outputs
- Congestion location
- Proposal of set of candidate technologies for network expansion
- Provide size of cost for candidates

Next steps

- **Validation** of the current version of the pre-processor through the analysis of Regional Use Cases.
- **Integration** between the pre-processor and both the planning tool and a line routing software, which will provide line technology and cost inputs to evaluate AC and DC branches as network expansion options.
- First complete version by 30/06/2021.

FlexPlan

Summary/conclusions

- A **characterization** of flexibility resources for the power system has been accomplished, considering both operation strategies and technical aspects.
- A software tool has been developed for **network extension candidate pre-selection**, which interacts with the planning tool developed in FlexPlan in the frame of a common methodology.
- This tool identifies congestion locations and proposes a **set of candidates** for each of them taking into account local **restrictions** and congestion characteristics.

Thank you…

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FlexPlan

ENLIT2020 | 20th April 2021

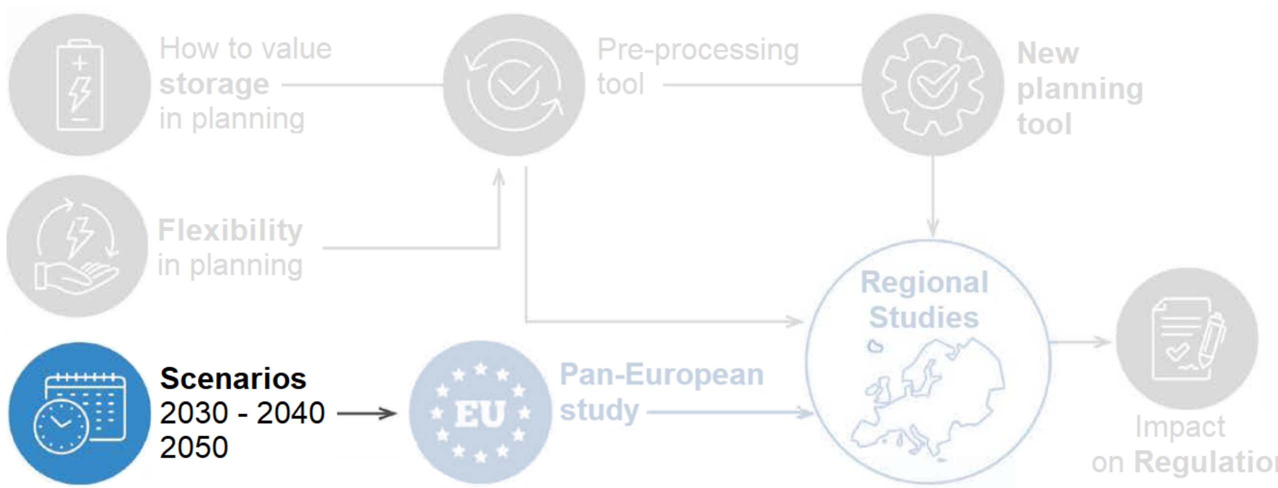
An ambitious set of energy and grid scenarios at 2030-40-50

Björn Matthes
Institute of Energy Systems, Energy Efficiency and Energy Economics (ie³)
TU Dortmund University

Energy and grid scenarios in the FlexPlan project

Characterization and potential of flexibility in the power system
Raul Rodriguez (TECNALIA)

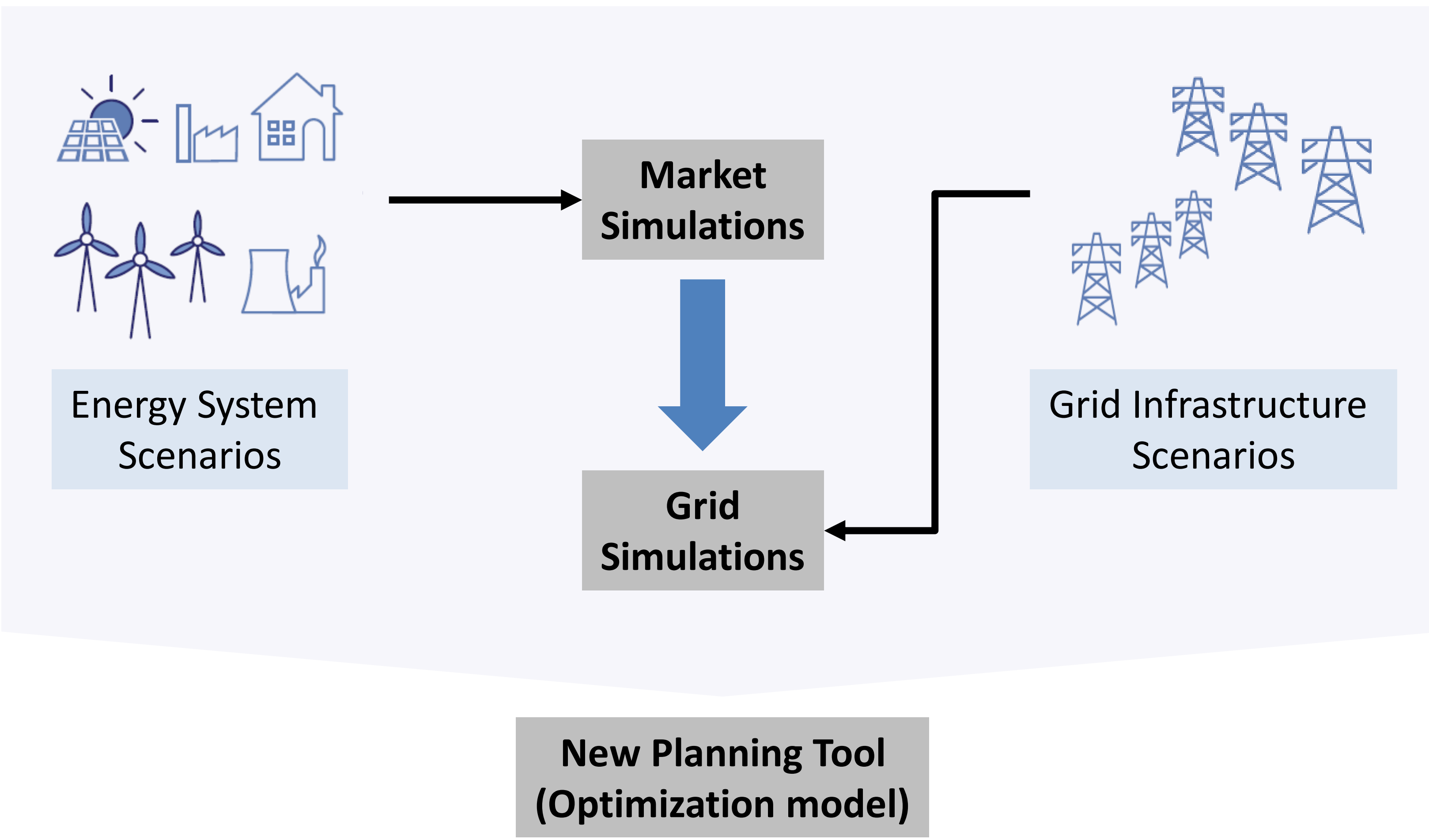
Next generation flexible system planning models
Hakan Ergun (KULeuven/EnergyVille)



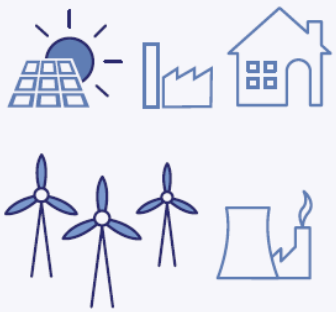
An ambitious set of energy and grid scenarios at 2030-40-50
Björn Matthes (TU Dortmund)

Regulation Framework and attention points for the future
Andrei Morch (SINTEF Energi)

On the role of energy and grid scenarios in the planning process



Differences between market and grid scenarios / simulations



Energy System Scenarios

- Installed **generation capacity** by type per country in EU
- (Annual mean) **capacity factors** for renewables
- Annual **electricity consumption** and peak load
- Net Transfer Capacities (**NTC**) and fossil fuel **prices**

- Generation and load time series (on zonal level)
- Net exchange positions (per zone)
- Commercial cross-border exchanges between zones

- Reference transmission & distribution grid **topology**
- **Electrical parameters** of reference grid's components
- **Locations** (lat./lon.) of nodes / bus bars in ref. grid
- List of planned and permitted **investment projects**

- Generation and load time series (on nodal level)
- Net power injection / consumption (per node)
- Physical power flows between nodes

Grid Infrastructure Scenarios

Main Challenges in Market and Grid Scenario Creation

Energy System Scenarios

- No one can reliably predict the future
- Scenarios are always driven by assumption
- Level of uncertainty increases over time

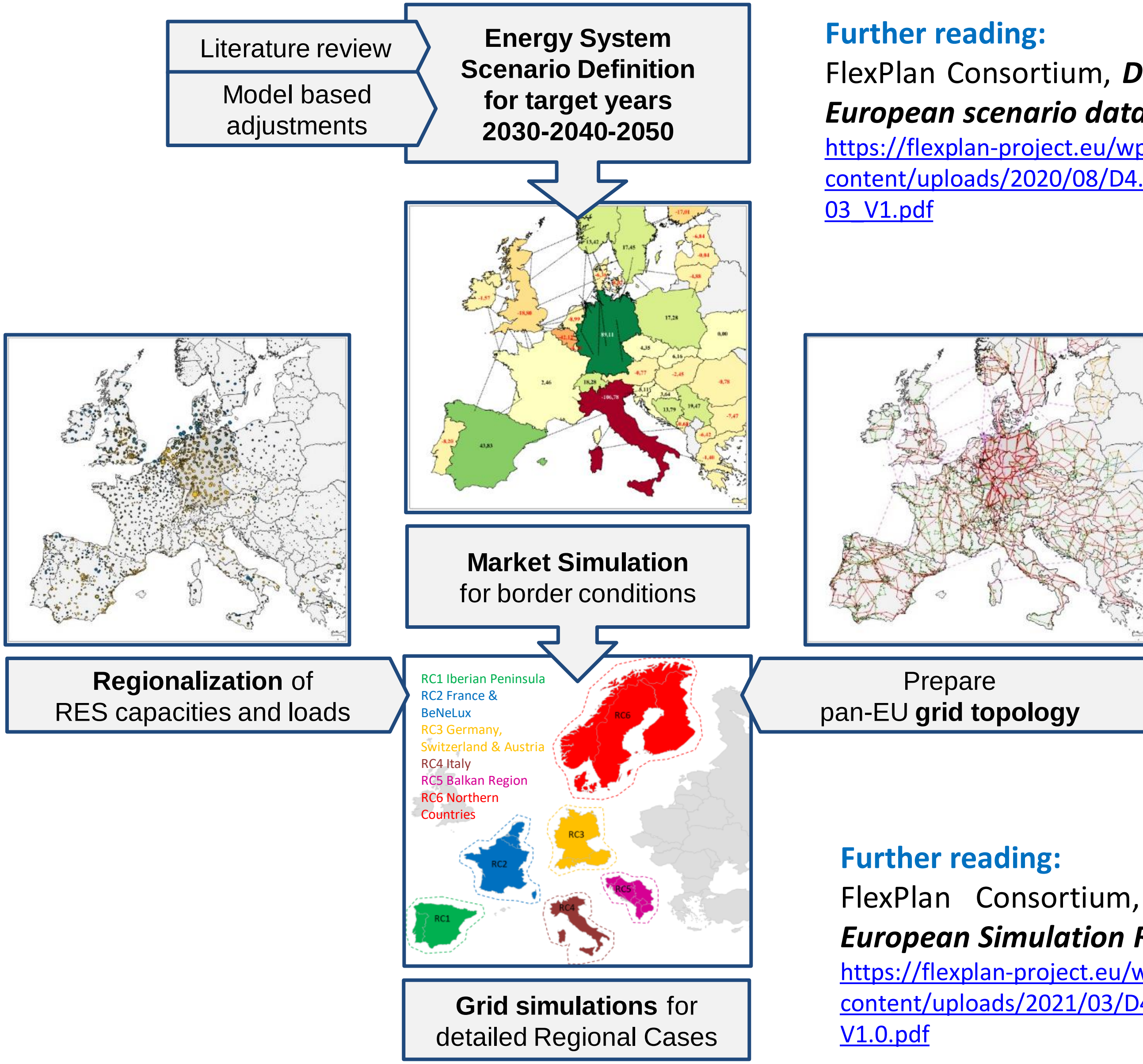
- Quite a few **diverse scenarios** publicly available
    - EU Ref. Scenarios, ENTSO-e TYNDP, IRENA REmap, etc.
- **Main drivers vary** or weighted differently
- **Changing** political and regulatory **environment**

- Transmission grid is considered as **critical infrastructure**
- Validated detailed **information are <u>not</u> publicly** available
- Grid **topology changes continuously** due to expansion and operational measures

- **Some** pan-EU transmission grid models **are publicly available**, mostly rely on **parameters from literature**
- Modelling pan-EU T&D grid is quite a **data heavy task**

Grid Infrastructure Scenarios

FlexPlan's approach to create consistent market and grid scenarios



Further reading:

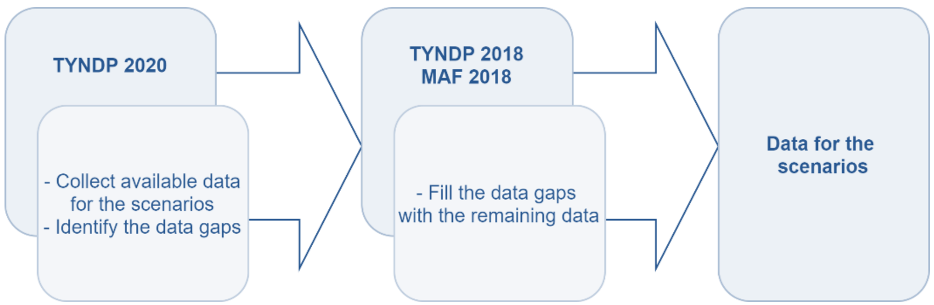
FlexPlan Consortium, ***D4.1 Pan-European scenario data***, 2020
https://flexplan-project.eu/wp-content/uploads/2020/08/D4.1_20200803_V1.pdf

Further reading:

FlexPlan Consortium, ***D4.2 Pan-European Simulation Results***, 2020
https://flexplan-project.eu/wp-content/uploads/2021/03/D4.2_20210326_V1.0.pdf

On the creation of market scenarios

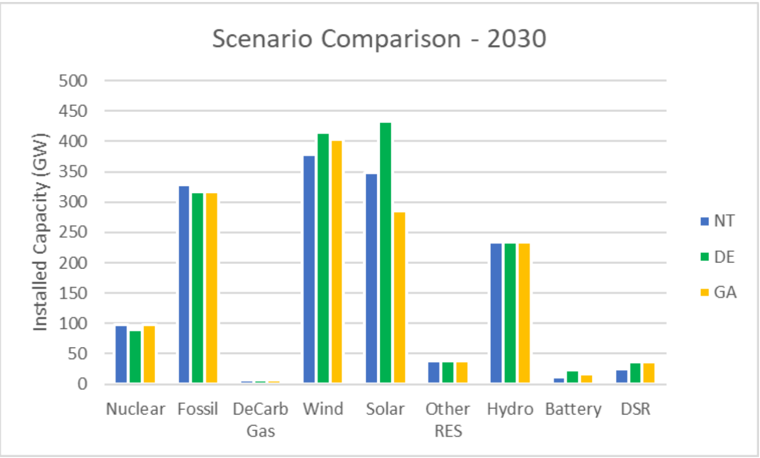
- **TYNDP 2020** scenarios as a starting point

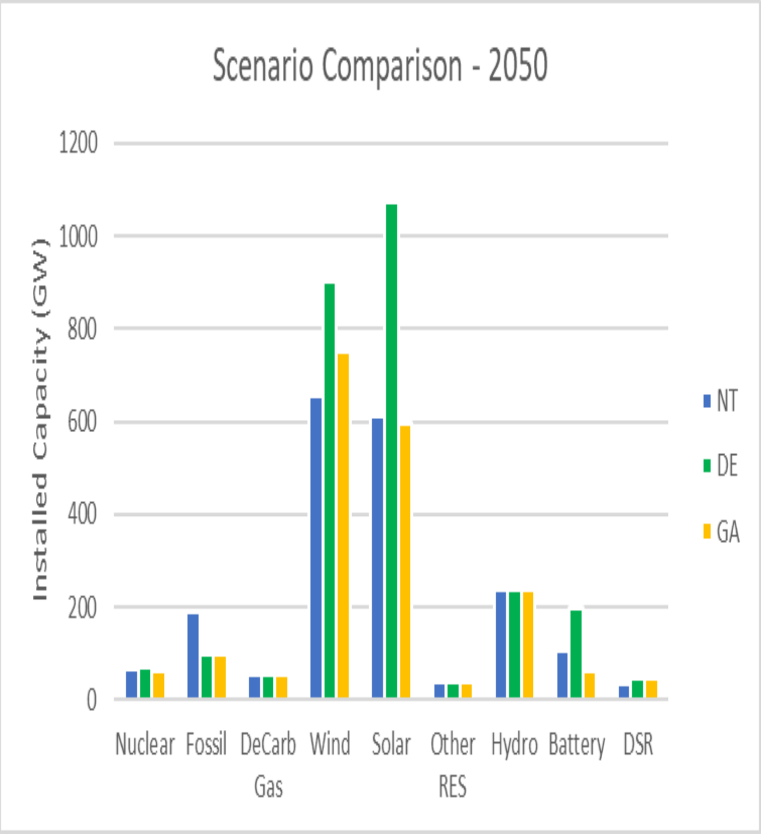


- Three **diverse storylines** were adapted
  - National Trends (NT)
  - Distributed Energy (DE)
  - Global Ambition (GA)

- 2050 scenarios based on EU Commission's *"A Clean Planet for all"* strategy

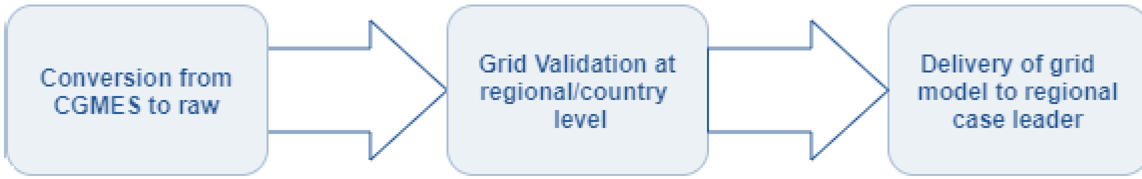
- Scenarios checked against EU-28 target of net zero emissions by 2050 (decarbonization trajectory)



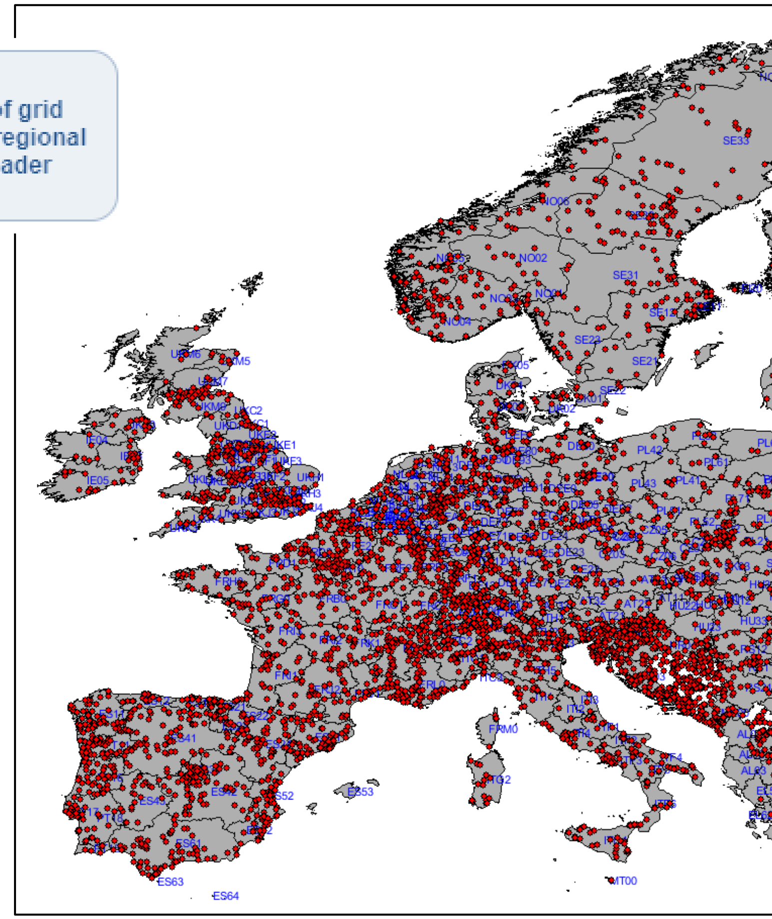


On the creation of the reference grid model

- **ENTSO-E Study Model** (STUM) as a starting point
  - Available with Non-Disclosure Agreement (NDA)



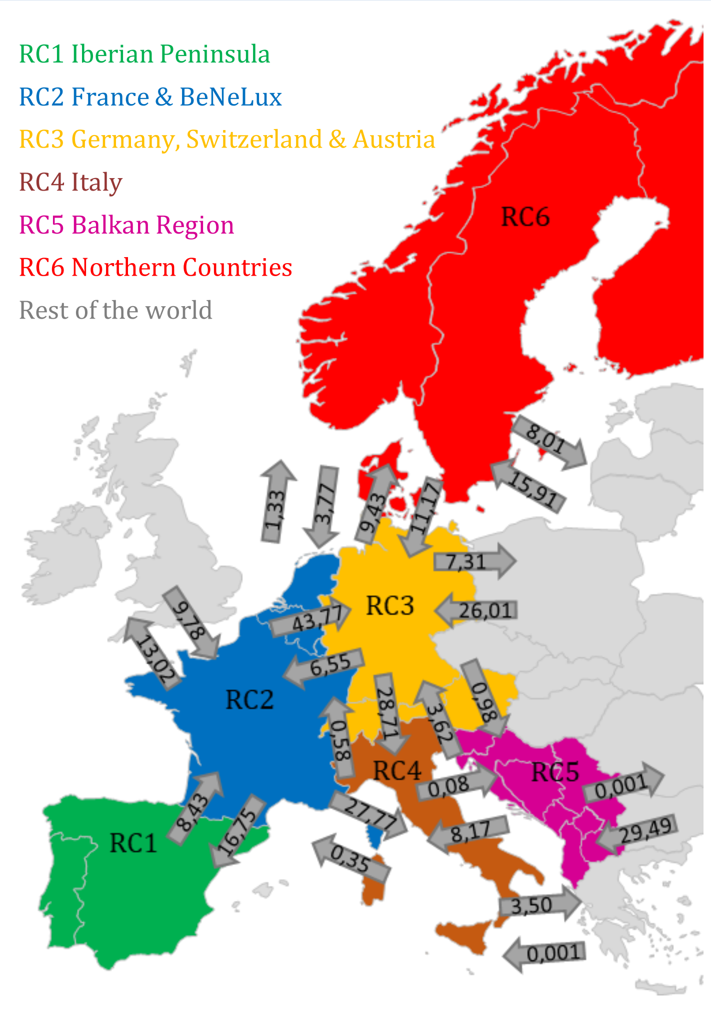
- Model of transmission grid in **continental Europe**
  - Only components above 110 kV, below aggregated in ENTSO-E STUM
- Information (line/node names) are **partly anonymized** or have TSO internal labels
  - Decrypted with the help of project partners
- Locations of substations are **<u>not</u> georeferenced**
  - Coordinates of substations were added
- Transmission grid of **Nordic countries** was added from public sources (PyPSA-Eur)
- Added **sub-transmission** data from public sources where available or synthetic distribution grids



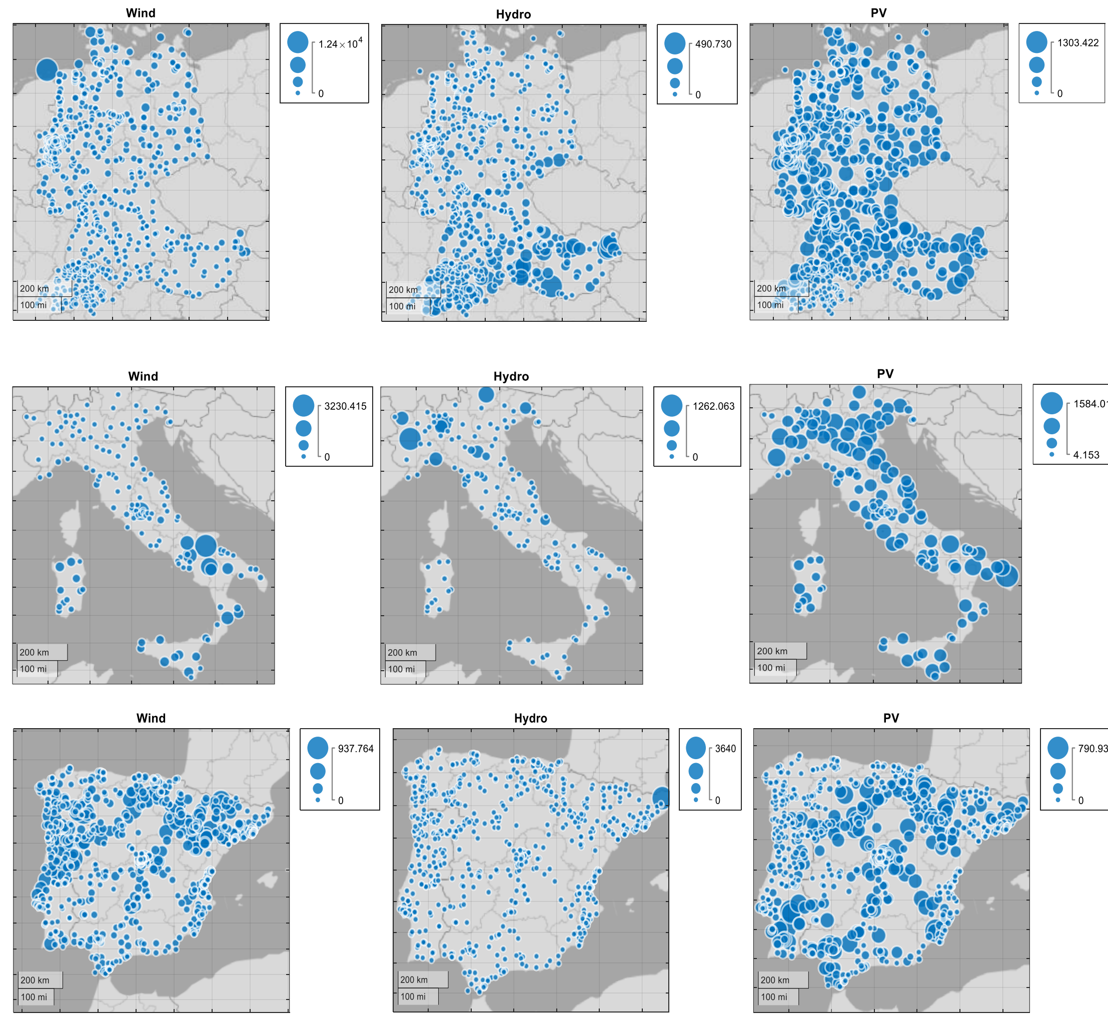
Nodes of FlexPlan's reference grid

Exemplary results of market simulations and regionalization

Cross-border exchanges between RCs [TWh/a]



Spatial distribution of national capacities to ref. grid nodes [MW]



→ **Border conditions** for grid simulations

→ Reference **generation and demand** for grid simulations

Conclusion

- 3 **diverse storylines** to consider **fundamental uncertainties** in scenarios
  - Additionally various **meteorological variants** for variability in RES generation

- Created energy system scenarios checked against **EU climate targets**
  - Energy pathways in line with **decarbonization trajectory**

- **High consistency** between market and grid scenarios due to **integrated creation**
  - Regionalization of capacities **interlinked** with ref. grid topology

- Integrated T&D grid planning is a **highly complex and data heavy process**
  - Pan-EU **system** has to be **divided** by smart approaches
  - Ensure computational **traceability** as well as overall **consistency**
  - **Shared** border **conditions** between regional cases to **reduce complexity**

Further reading on FlexPlan web:

FlexPlan Consortium, D4.1 Pan-European scenario data, 2020
https://flexplan-project.eu/wp-content/uploads/2020/08/D4.1_20200803_V1.pdf

FlexPlan Consortium, D4.2 Pan-European Simulation Results, 2020
https://flexplan-project.eu/wp-content/uploads/2021/03/D4.2_20210326_V1.0.pdf

FlexPlan Consortium, D1.1 Monte Carlo scenario generation and reduction, 2020
https://flexplan-project.eu/wp-content/uploads/2020/12/D1.1_20201210_V1.0.pdf

Thank you …

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Regulatory framework and attention points for the future

Andrei Morch
SINTEF Energi AS

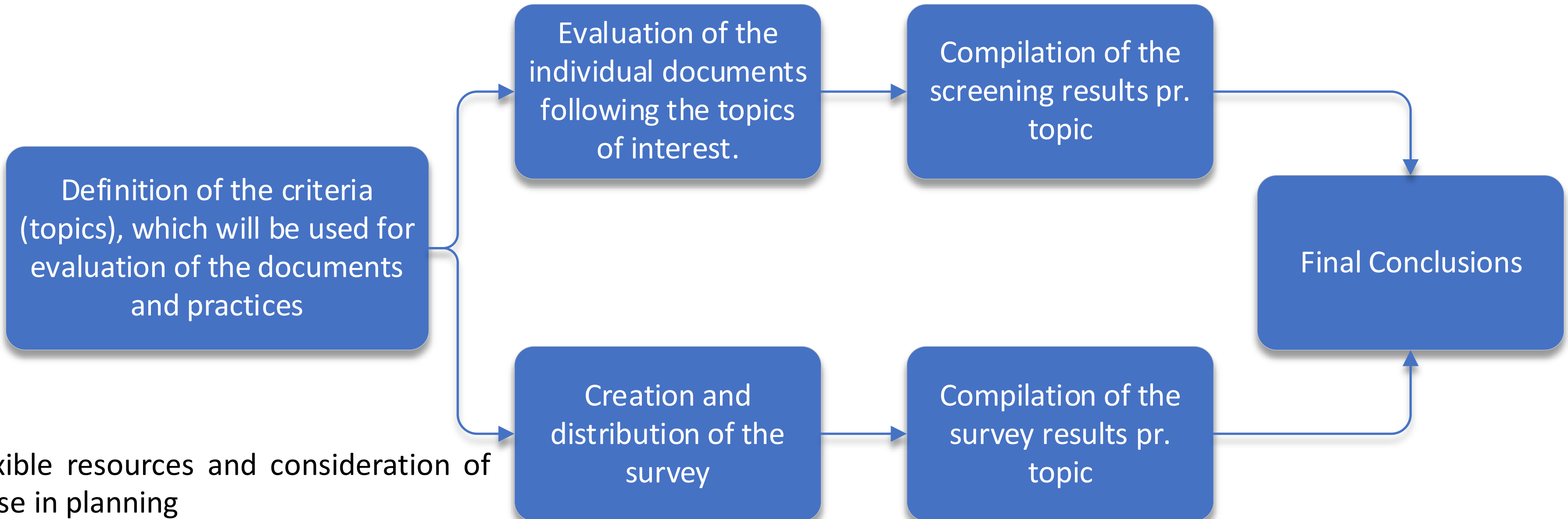
Agenda

- Objectives and methodology for the analysis of present regulation in Europe on grid development
- Gaps and barriers to valorize the role of flexibility
- Summary / conclusions and preliminary ideas of a regulatory development

- Screening study "Compliance of FlexPlan tool with EU regulation and TSO-DSO practice"
- Objective of the study was to get a picture of the present overall pan-European regulation and political targets to ensure that the subsequent FlexPlan project activities and development of FlexPlan tool are correctly oriented
- Additional objective is to analyse the existing regulation, identify possible regulatory gaps and raise the need for the consideration of additional topics in future regulation (by the end of the project)

The applied methodology

- The European Commission (EC): Directives and Regulations, including Network Codes (NCs)/Guidelines
- ENTSO-E: NCs/Guidelines, including standard methods for cost-benefit analysis
- Interest organisations and associations as Eurelectric, E.DSO, GEODE and CEDEC



- Flexible resources and consideration of these in planning
- Cost-benefit analysis (CBAs), allocation of costs, criteria for evaluation of new projects
- Interaction between TSOs and DSOs, including planning, sharing of resources, roles and responsibilities
- Other subjects, including incentive mechanisms, criteria for development of scenarios, reliability criteria, etc.

- Three TSOs
- Four DSOs

Requirements related to consideration of flexible resources in planning

- Internal Electricity Market (IEM) Directive (2019/944):
  - Requires that distribution network development plan shall also **consider demand response, energy efficiency, energy storage facilities or other resources** that the DSO has to use as an alternative to system expansion
  - TSOs shall fully take into account the potential for the use of demand response, energy storage facilities or other resources as alternatives to system expansion when elaborating 10-year Network Development Plan (TYNDP)
- The IEM Regulation (2019/943) requires that for integration of the growing share of renewable energy, the future electricity system should make use of **all available sources of flexibility**, particularly demand side solutions and energy storage
- The ENTSO-E's 3rd Guideline for Cost Benefit Analysis (CBA) of Grid Development Projects: **flexibility of demand** is considered as a consistent part of the estimation of the socio-economic welfare
- None of the survey responding System Operators (SOs) consider flexible resources in their current planning practices.

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Ownership and operation of energy storage*

- The most recent recast of the IEM Directive reaffirms the position stated before, not allowing System Operators (SOs) to own, develop, manage or operate energy storage facilities
- However, SOs are allowed to own, operate or manage such devices, among other conditions, if these devices are "*are fully integrated network components and the regulatory authority has granted its approval*", which can pave the way for many exceptions
- The most recent version of recasts has been partially modified, taking into account input coming from some stakeholders, expending the possible terms of derogation for SOs for operational purposes

* *the project does not aim at taking any specific position on this subject*

Rules for TSO/DSO allocation of costs and incomes in new common investment projects

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- There is a clear message from the EC that socio-economic welfare should be taken as the main indicator for the prioritization of investments in new grid projects
- ENTSO-E has developed a CBA of Grid Development Projects, ensuring a common framework for multi-criteria CBA for TYNDP projects (ref. EU Regulation 347/2013)
- There are no commonly agreed rules for allocation of costs between TSOs and DSOs in common investment projects. Two different views presented in common "Data Management Report" (Use Case "Balancing")

DSO view: Balancing services based on assets connected on the DSO level should, for economic reasons, not lead to any additional constraints in DSO networks. If this is the case, TSO and the market actor interested in using this asset connected to the DSO network on the balancing market **should cover the full costs of any grid enforcement** according to the national regulations on the allocation of network expansion costs.)

TSO view: In case of additional constraints in DSO's networks, a regulatory framework should be established in which the **compromise** between the additional value of the flexibility not available to the balancing markets due to these constraints and the network expansion that resolves those congestions is evaluated and, in any case, ensures a proper allocation of the corresponding additional costs.

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Sharing of resources between TSO and DSO: what are the priorities?

- The IEM Directive defines that DSOs shall cooperate with TSOs for the effective involvement of market participants connected to their grid in retail, wholesale and balancing markets. Delivery of balancing services stemming from resources located in the distribution system shall be **agreed with the relevant TSO**.
- Further screening and survey of the present practice indicated that at present **there is no common regulatory or practice** background allowing to draw clear conclusions on this topic. The necessity of defining this is clearly highlighted both at the institutional level and by the stakeholders.

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Conclusions

- The EC strongly emphasises the need for efficiency in different activities of the power system, including a technological scope and social-welfare among others e.g. utilisation of already existing resources, such as demand response, which might have the potential to reduce the necessity for new grid investments.
- The EC proposes to consider the existing flexibility resources as a consistent part of network expansion planning and considering demand response and storage with the same priority as generation in dispatching and re-dispatching procedures.
- Difficult to see any common well-established practice in Europe, meaning that the process is still under development.
- Use of market-based mechanisms whenever possible is underlined in several regulatory documents with reference to many network operative aspects, e.g. for the procurement of resources for ancillary services or even for system defense and restoration services.
- EC shows a very pragmatic approach on several critical issues, as for example ownership and operation of energy storage.

Conclusions

- Investments in storage and flexibility will remain mostly in the hands of private investors. Consequently, national regulatory authorities (NRAs) should translate the suitability of deploying new storage or flexibility in strategic network locations into opportune incentivisation schemes.
- There are several unresolved issues related to interaction between TSOs and DSOs, which have to be addressed. Otherwise, these disagreements may potentially become show-stoppers in the future common projects.
- The introduction of new actors e.g. CECs could change the landscape and roles/procedures applied both in the planning and in the operation phases.
- There are strong regulatory signals prompting European system operators to consider flexible resources as a new important active subject in the grid expansion planning process formulation. Despite strong efforts from ENTSO-E to develop common methodologic principles, there are still several missing elements in the puzzle.

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