CONTENT

Offshore Wind Farm Clusters

Interconnection optimization and Power Plant Services

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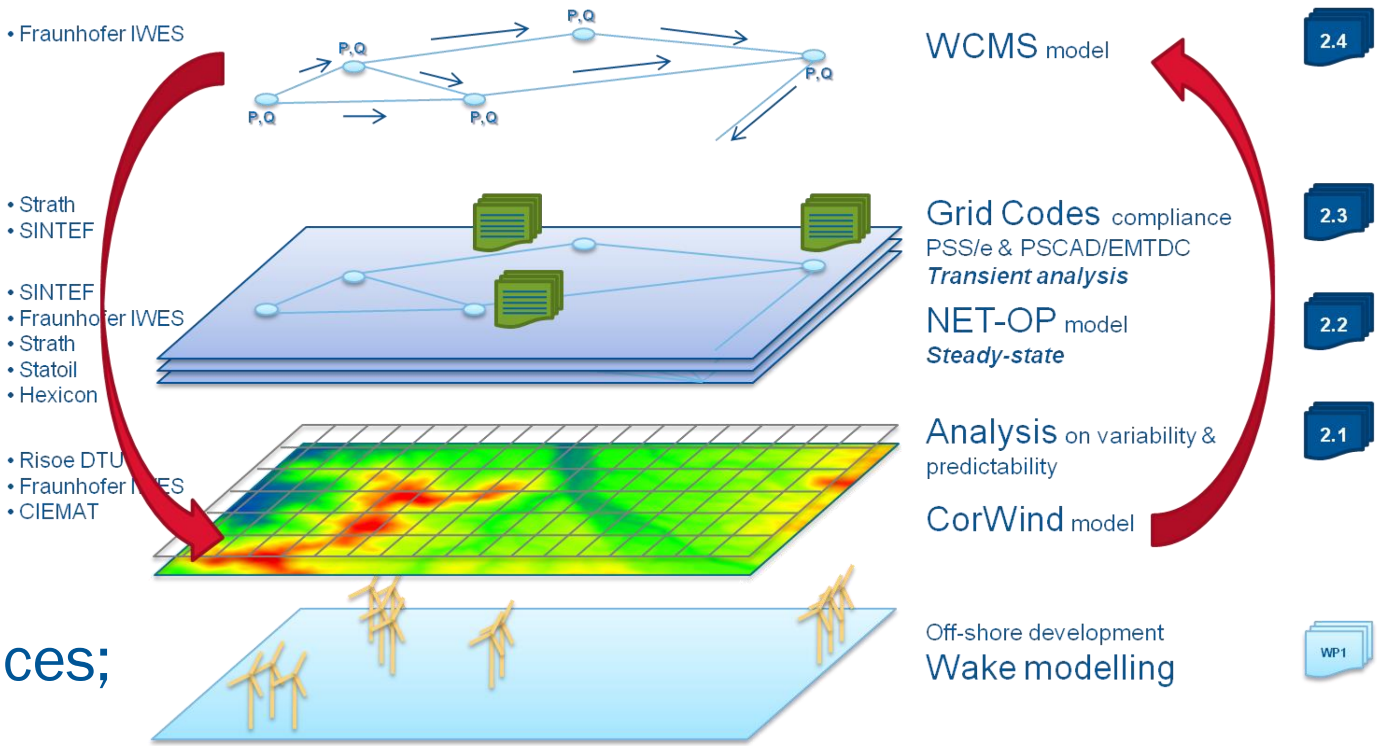
THE EUROPEAN ENERGY RESEARCH ALLIANCE
DESIGN TOOLS FOR OFFSHORE WIND FARM CLUSTER

Support by

SEVENTH FRAMEWORK PROGRAMME

1. Aims > Grid Layout Optimization

- Design tool and procedure assisting the optimization of the electrical design;
- Clustering;
- Grid code compliance;
- Power plant ancillary services;

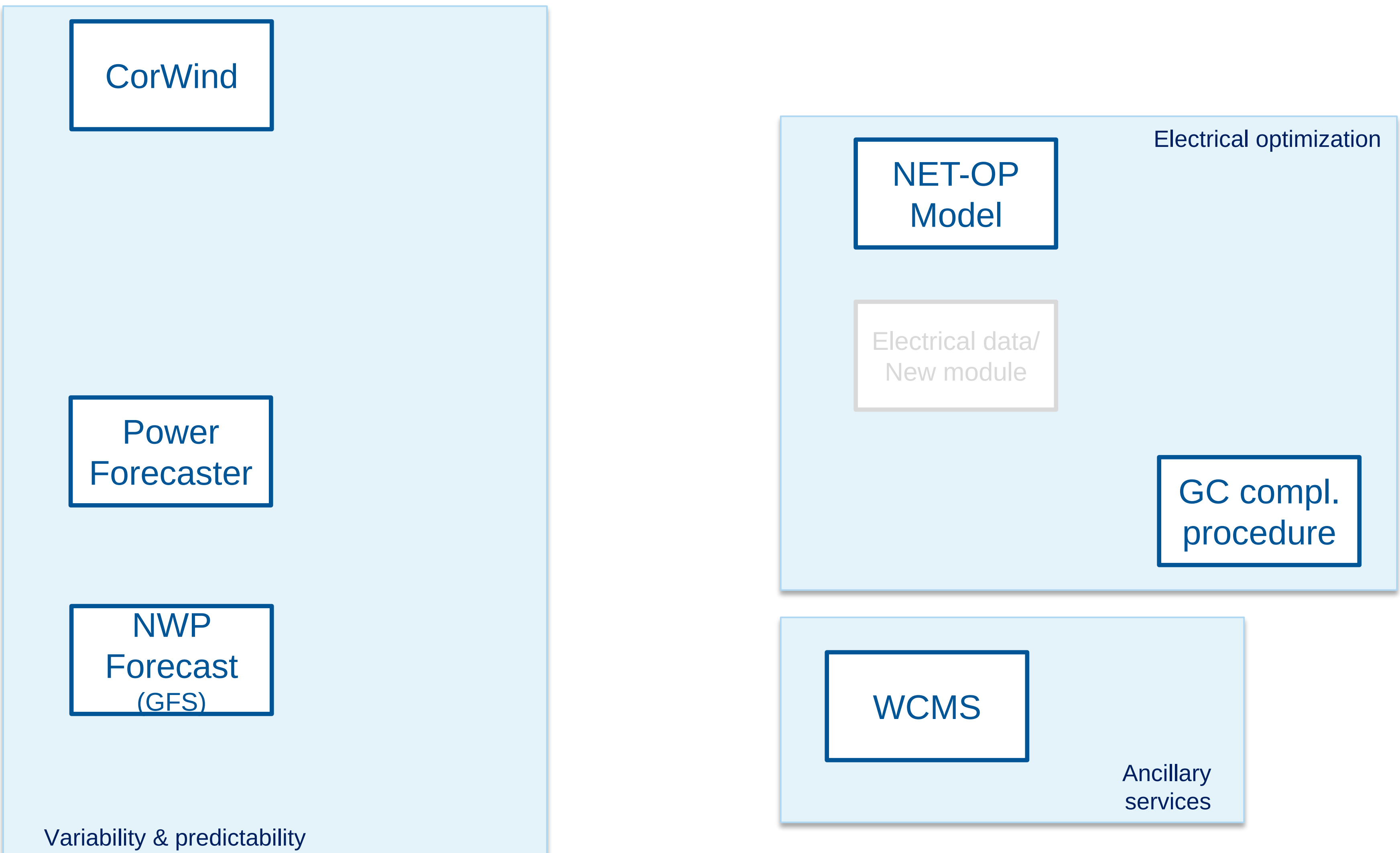


- Evaluate impact of the variability and the predictability.

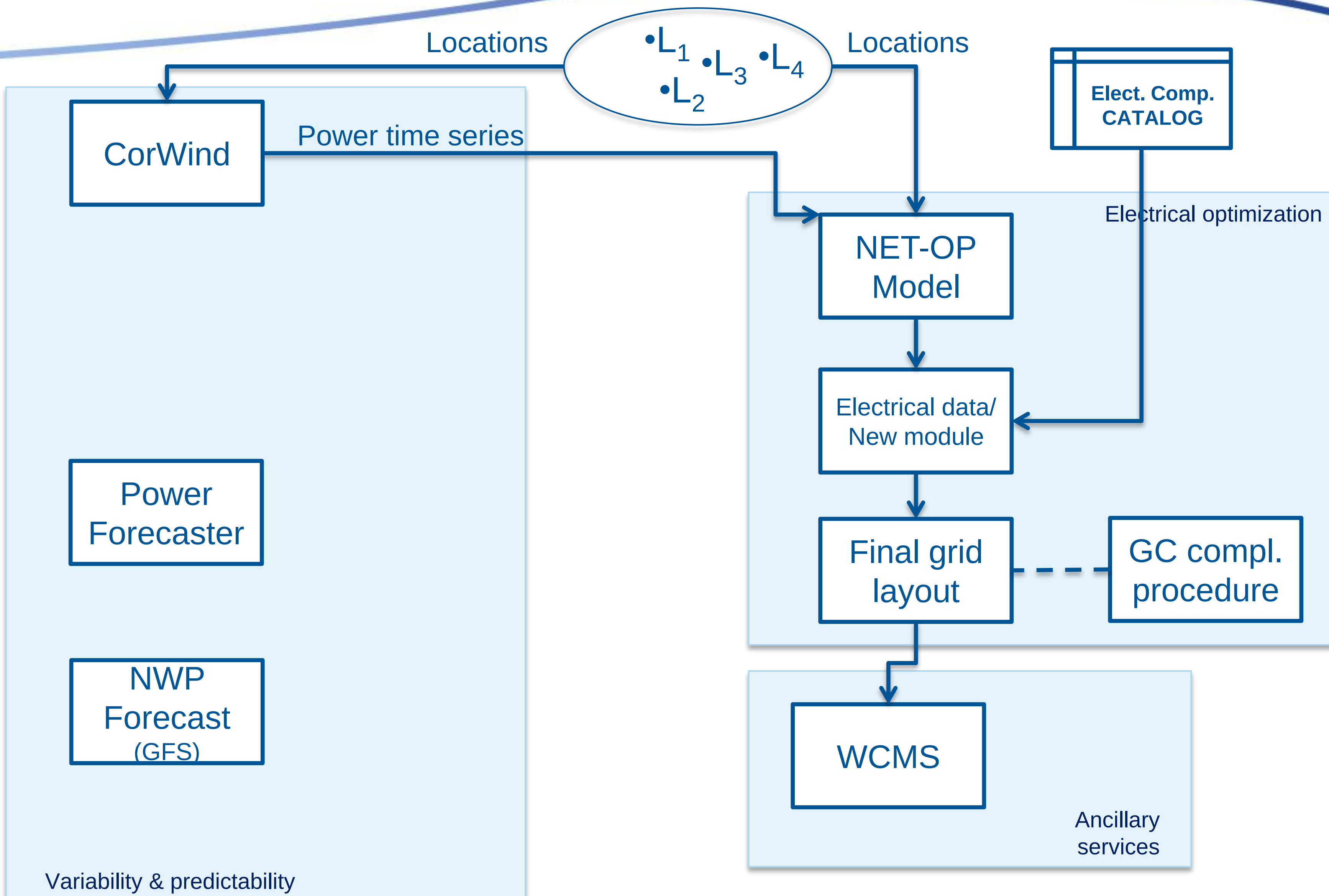
2. Methodology

1. Determine the models chain, interactions, I/O;
2. Establish the data flow/ data gaps according to the user cases;
3. Procedure to fill overcome gaps was investigated:
   1. Automatic electrical data generation
   2. User intervention providing accurate data.
   3. Implementation of a new module
4. Dry runs (based on scenarios)
5. Assessment/ convenience evaluation

2. Methodology



2. Methodology



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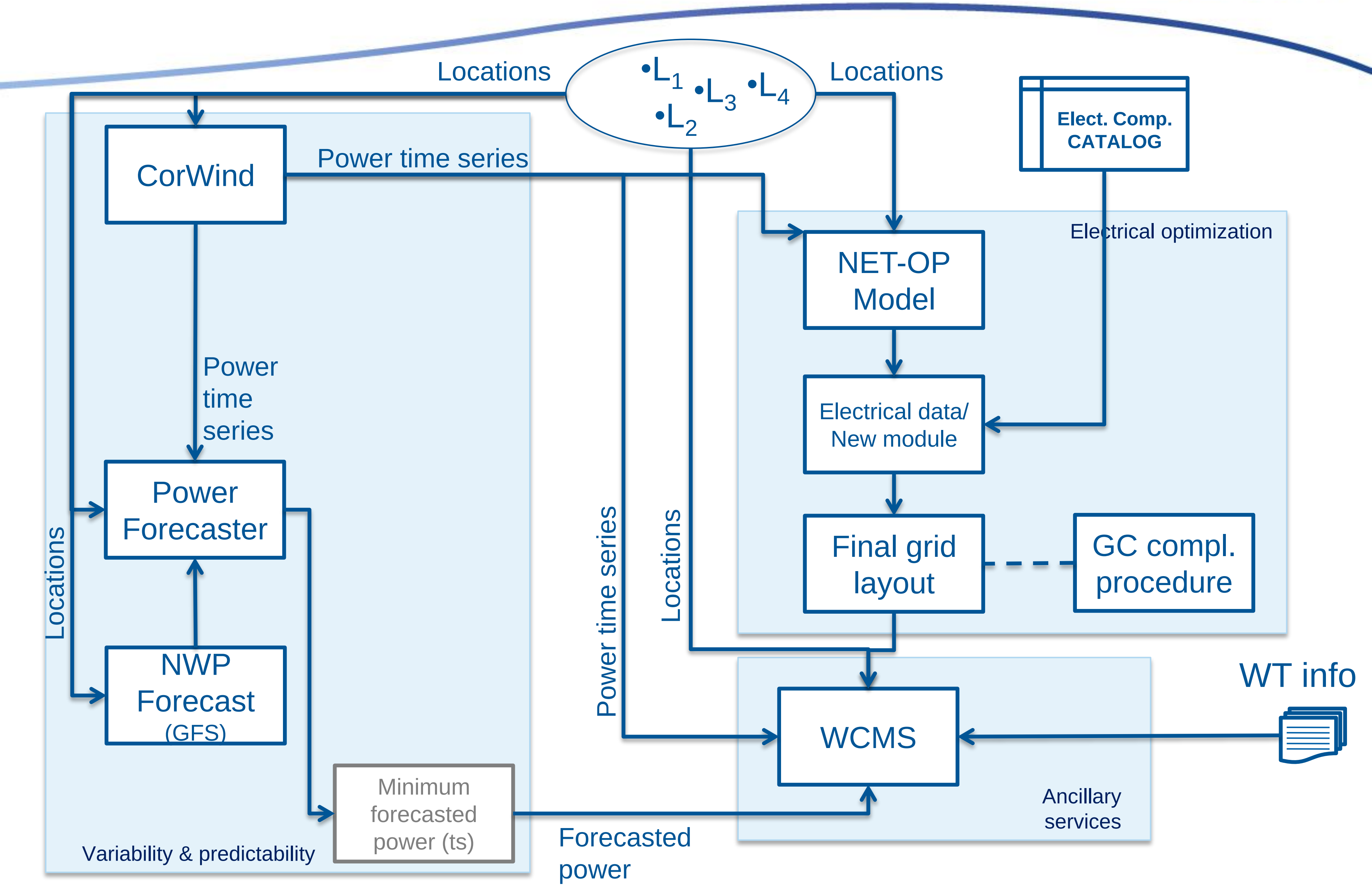

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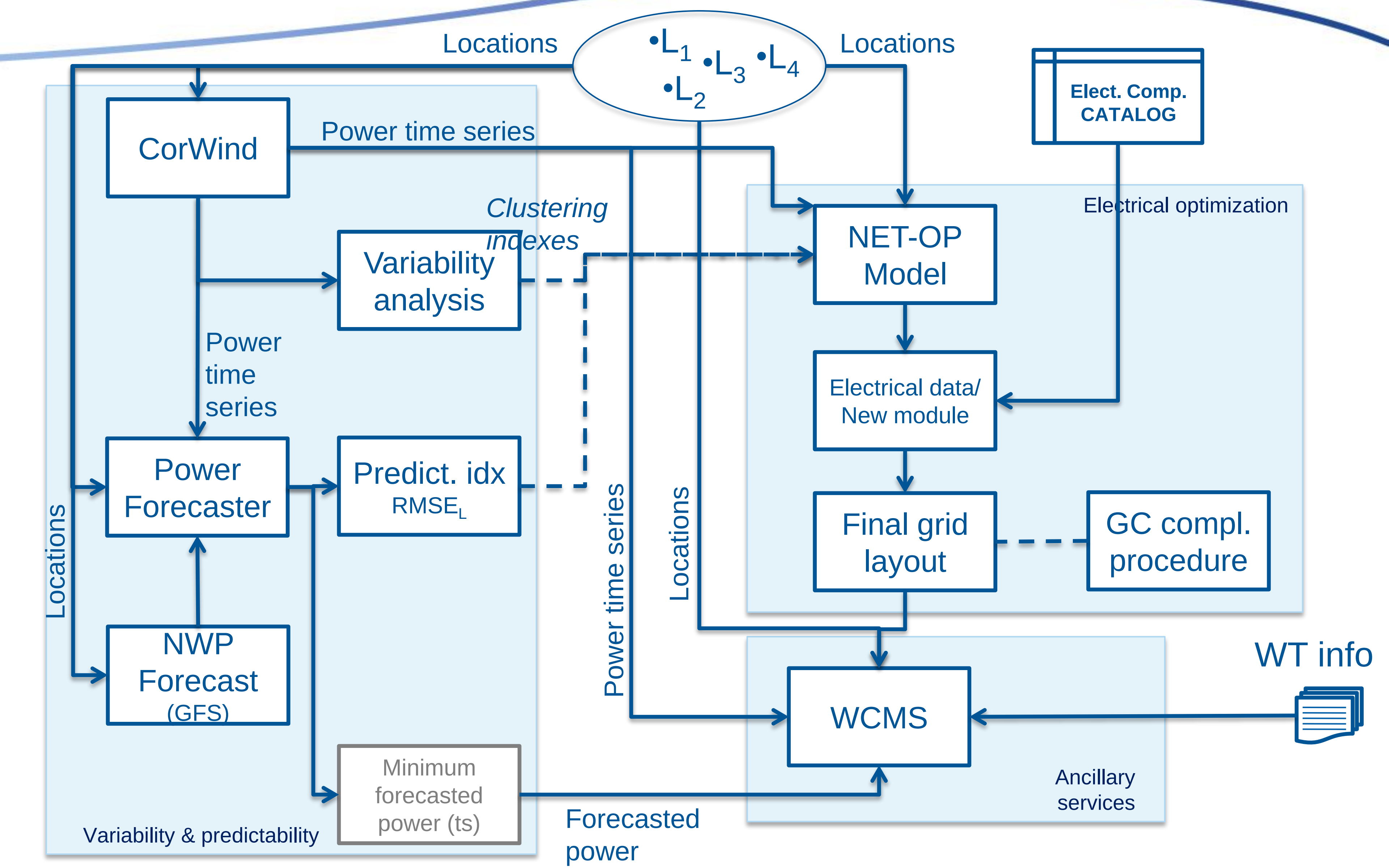
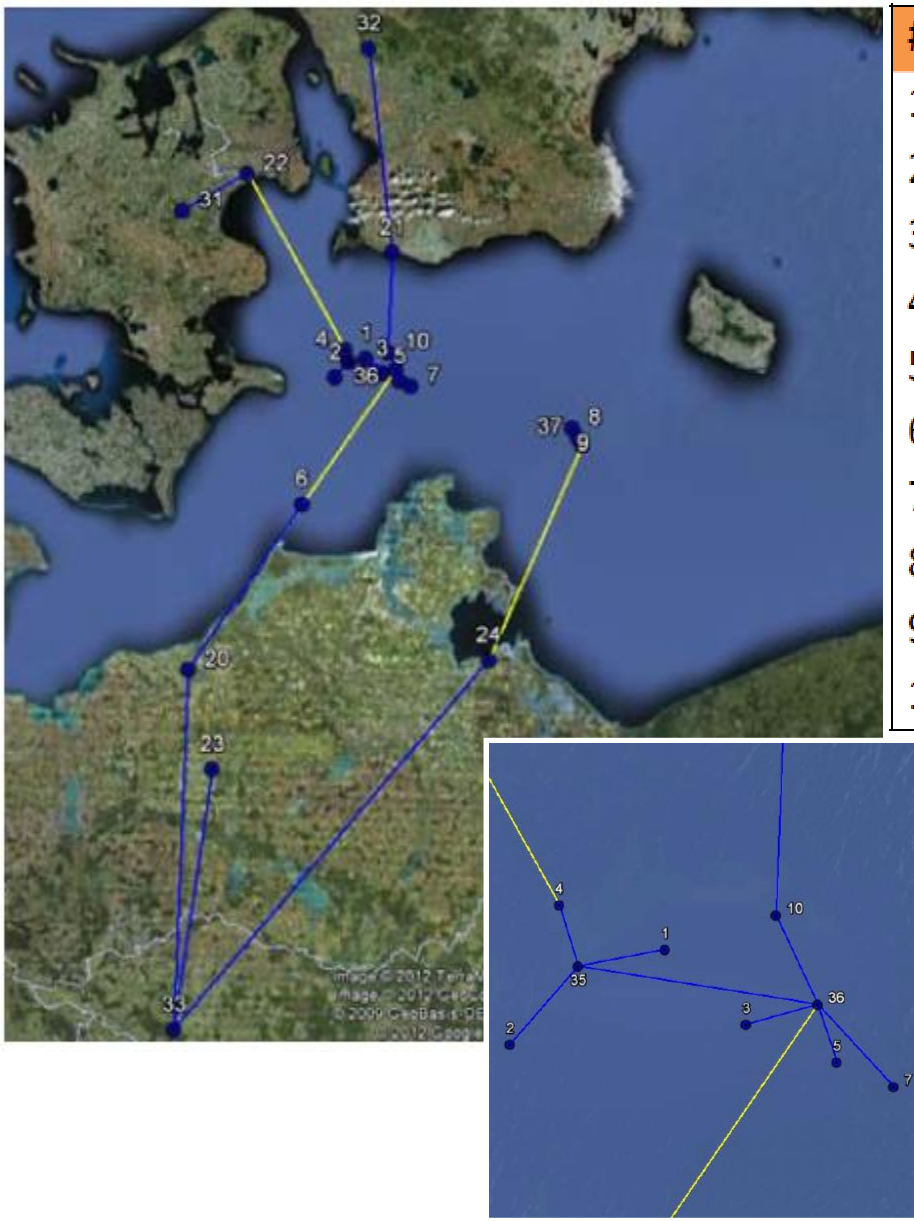


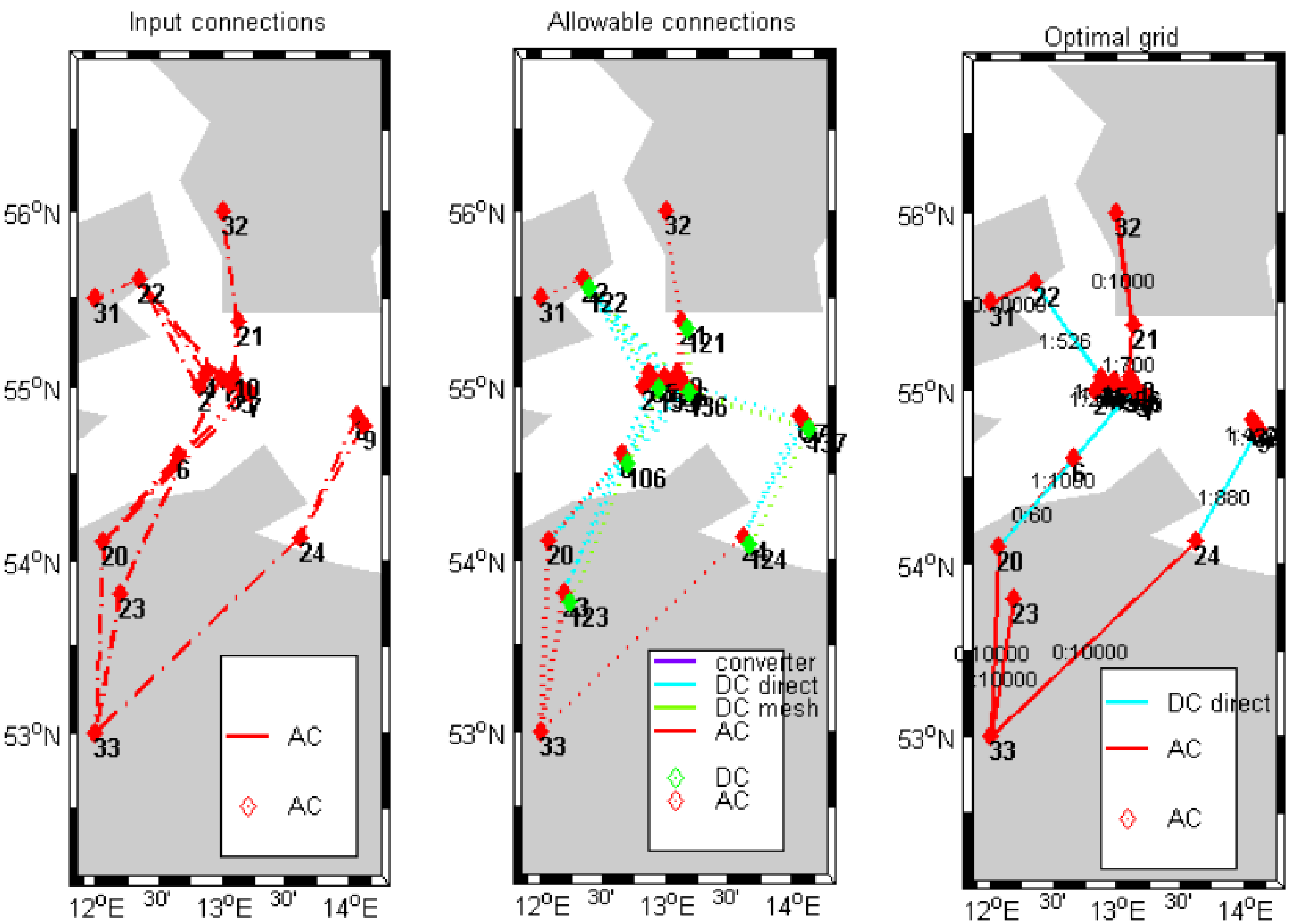
3. Scenarios > Kriegers Flak case study



#	Country	Wind farm	Capacity
1	DK	Kriegers Flak A K2	200
2	DK	Kriegers Flak A K3	200
3	DK	Kriegers Flak A K4	200
4	DK	Kriegers Flak B K1	200
5	DE	EnBW Baltic 2	288
6	DE	EnBW Baltic 1	48
7	DE	Baltic Power	500
8	DE	Wikinger	400
9	DE	Arkona Becken Südost	480
10	SE	Kriegers Flak	640

Branch type	max distance	max power
AC	65 km	700 MW
DC-direct		1000 MW
DC-mesh		1000 MW
converter		1000 MW

3. Scenarios > Kriegers Flak case study



3. Scenarios > Clustering

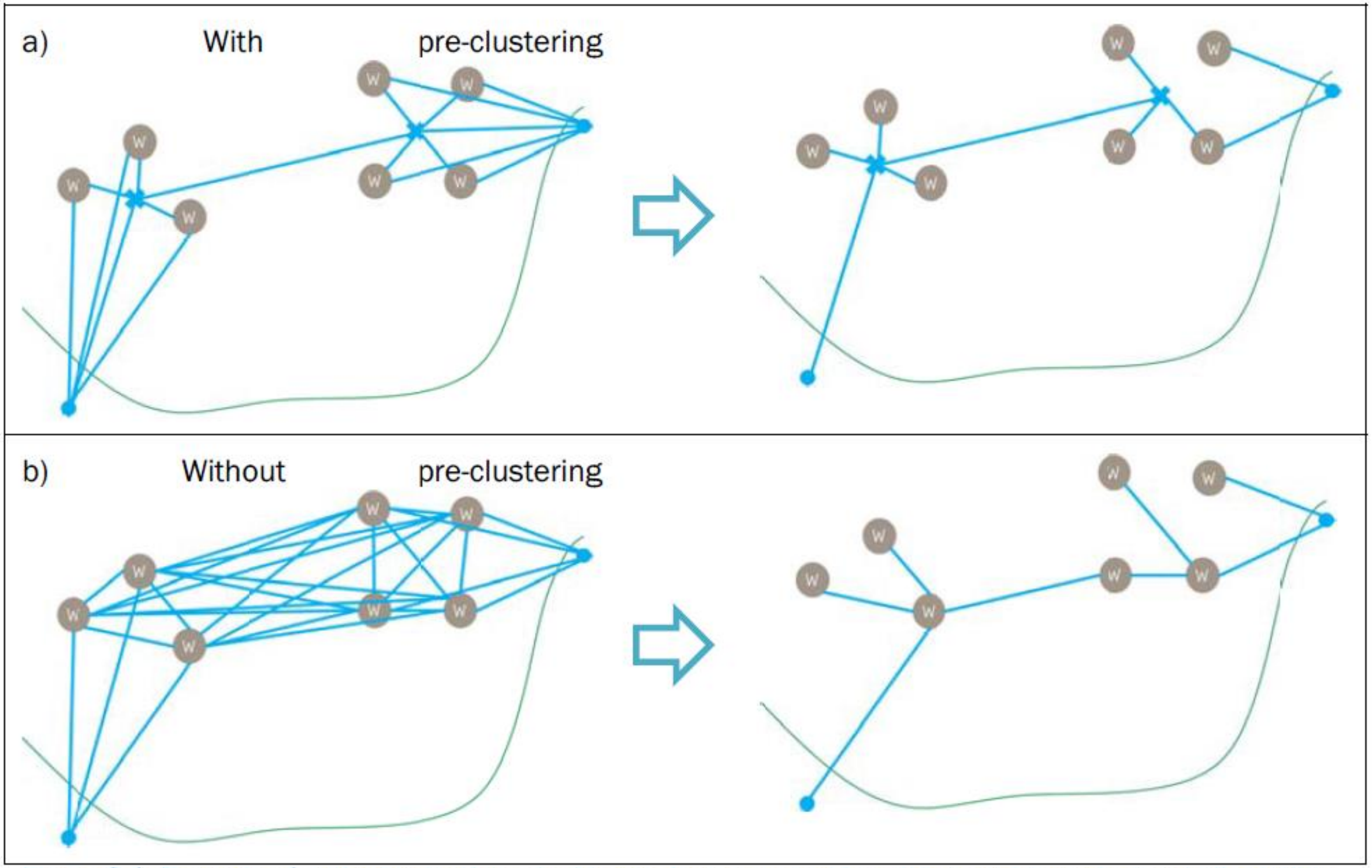


Figure 2-1: Example of grid optimisation; a) with pre-clustering; and b) without pre-clustering and all possible offshore branches included. The indicated solutions to the right are just for illustration and not based on any actual optimisation.

4. Expected Achievements

- Strategic Planners requirements:
  - Optimum strategic infrastructure.

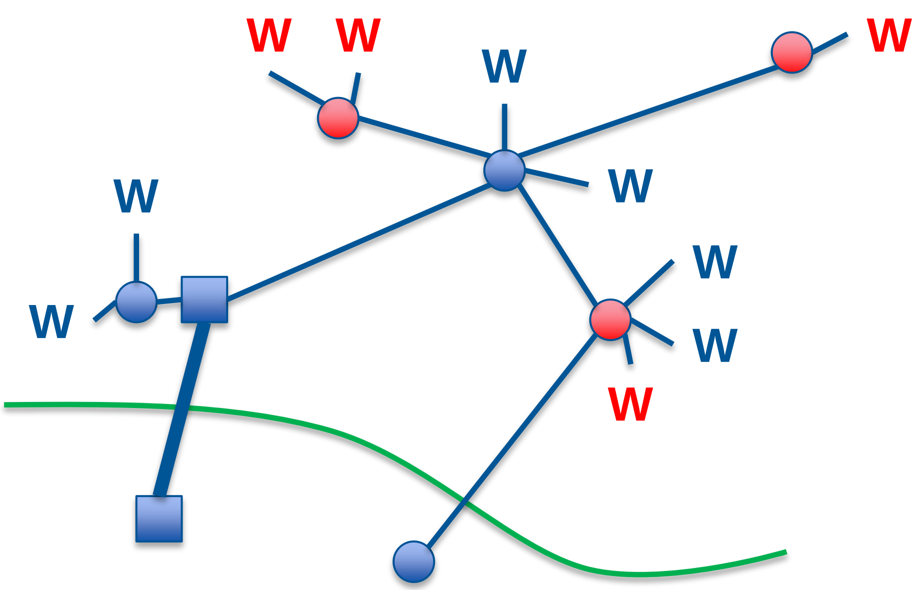
- Developers requirement, to assist the user finding:
  - optimum cable layout
  - optimum number of substations → clustering.
  - Optimum installed capacity within a site boundary.
  - Optimum transmission technology (e.g. HVDC or HVAC).
  - Test design according to grid code.

4. Expected Achievements

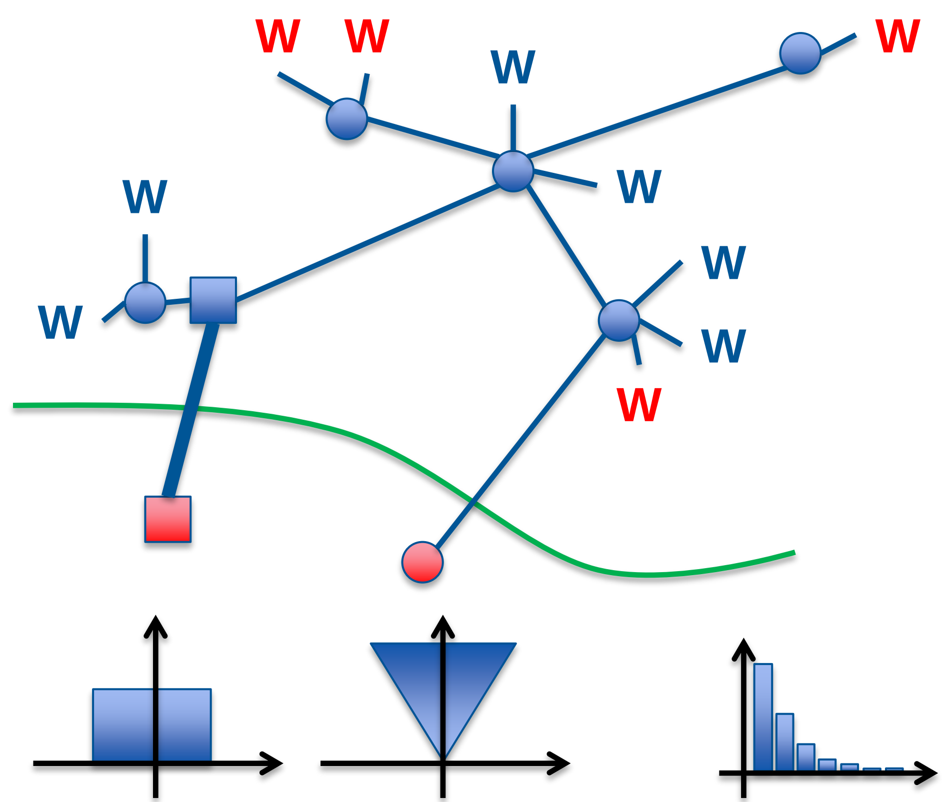
- Checking planned grid:
  - Fulfillment of full load flows → calculate component utilization factors.
  - Fulfillment of certain average load flows situations.
  - Checking congestions and voltages.
  - Control power:
    - Power reserve
    - Balancing power
  - Voltage Control
  - Enabling market/ transport

4. Expected Achievements > Voltage Control

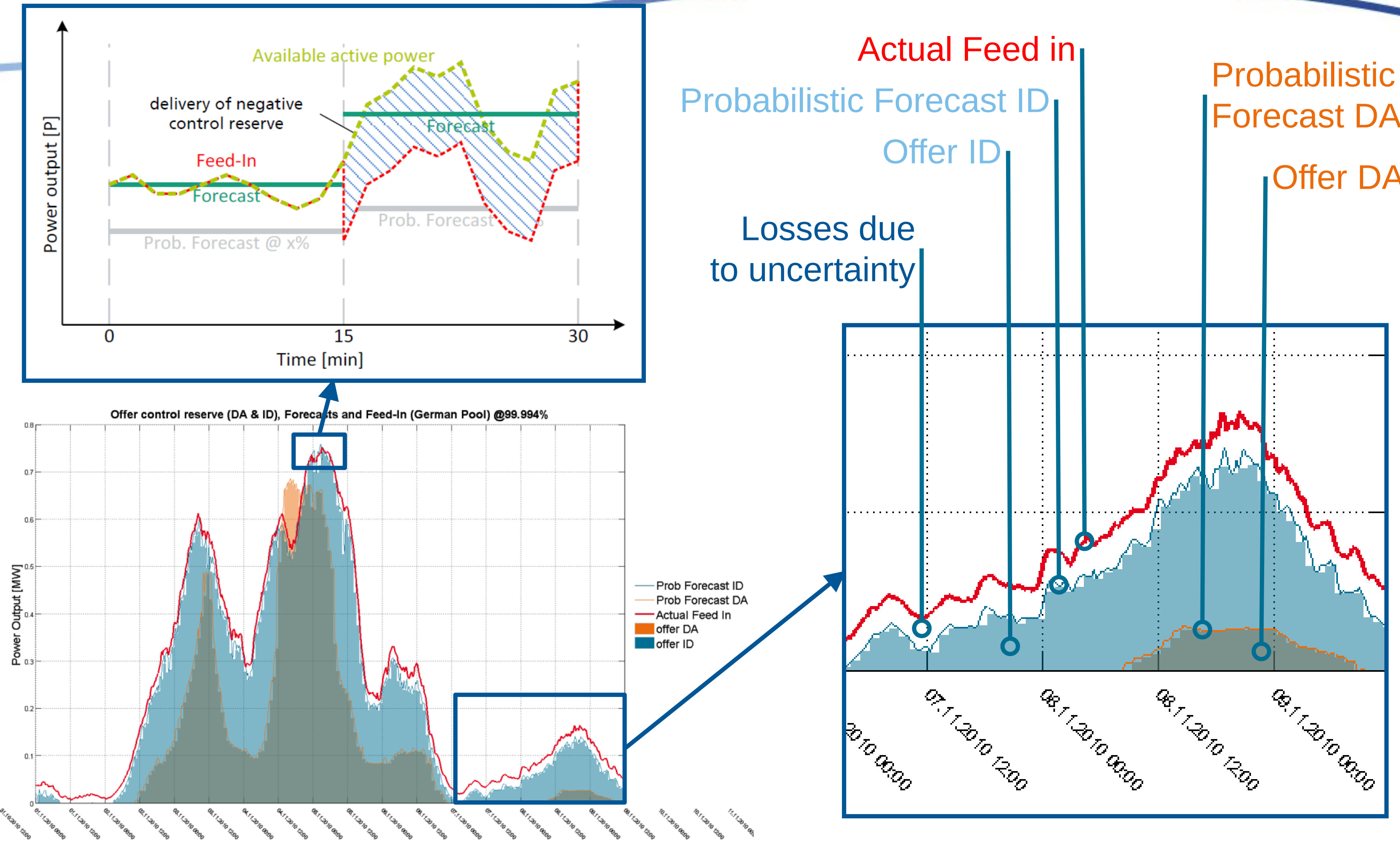
1. Offshore nodes U control



2. Onshore Q contribution



4. Expected Achievements > Frequency Support



Source: Malte Jansen – Fraunhofer IWES

5. Challenges

1. Provide the right features for the user
2. Gap between the different modules/ addition of new electrical data and components
3. Lack of precise information required for electrical calculations in future scenarios (cables, trafos, voltage levels) in 2020/2030/2050? (only assumptions)
4. The availability of updated cost information and validation data for the study cases, essential to correctly parameterize the optimization process.

Thank you very much for your attention

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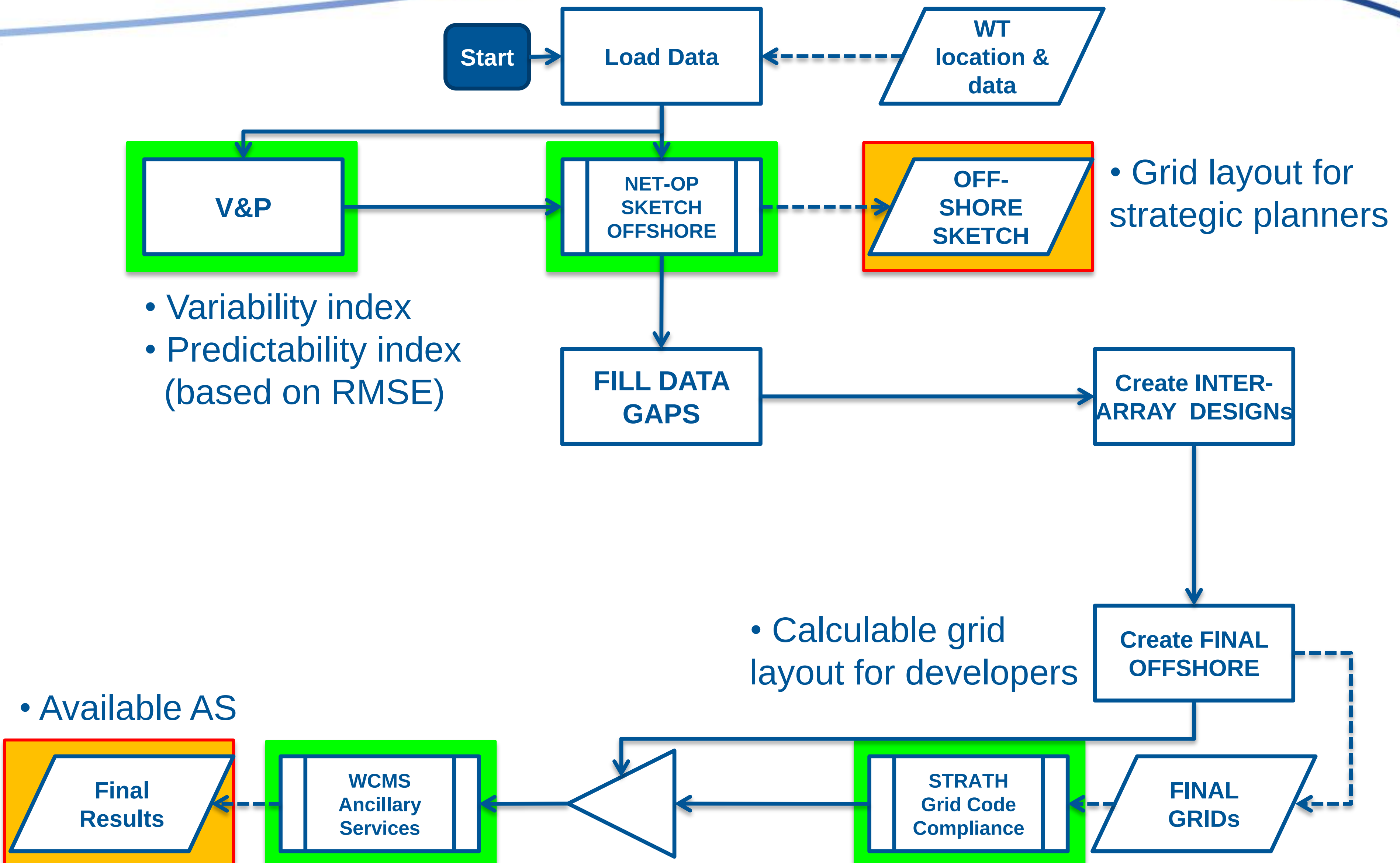
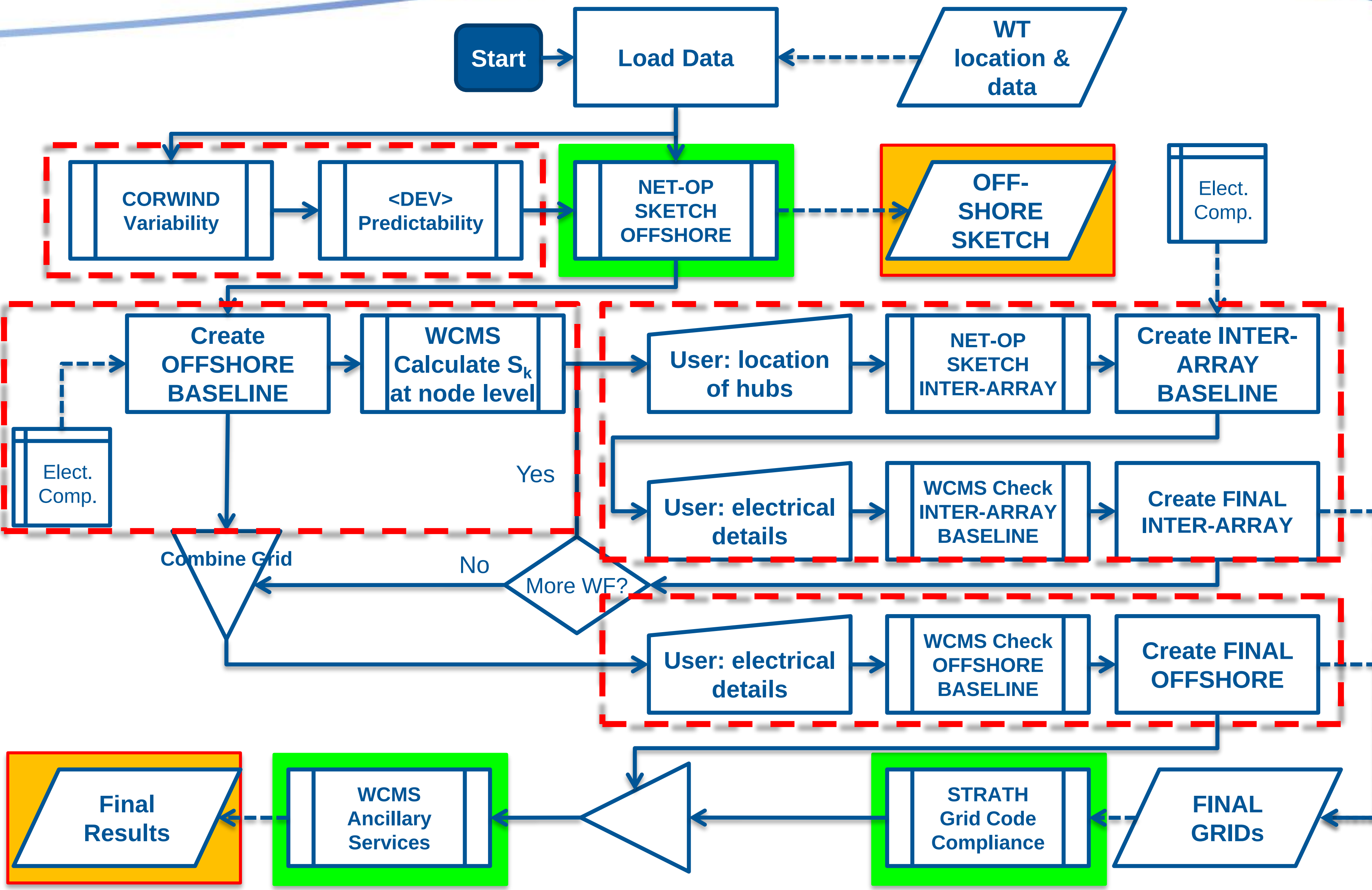
SEVENTH FRAMEWORK PROGRAMME

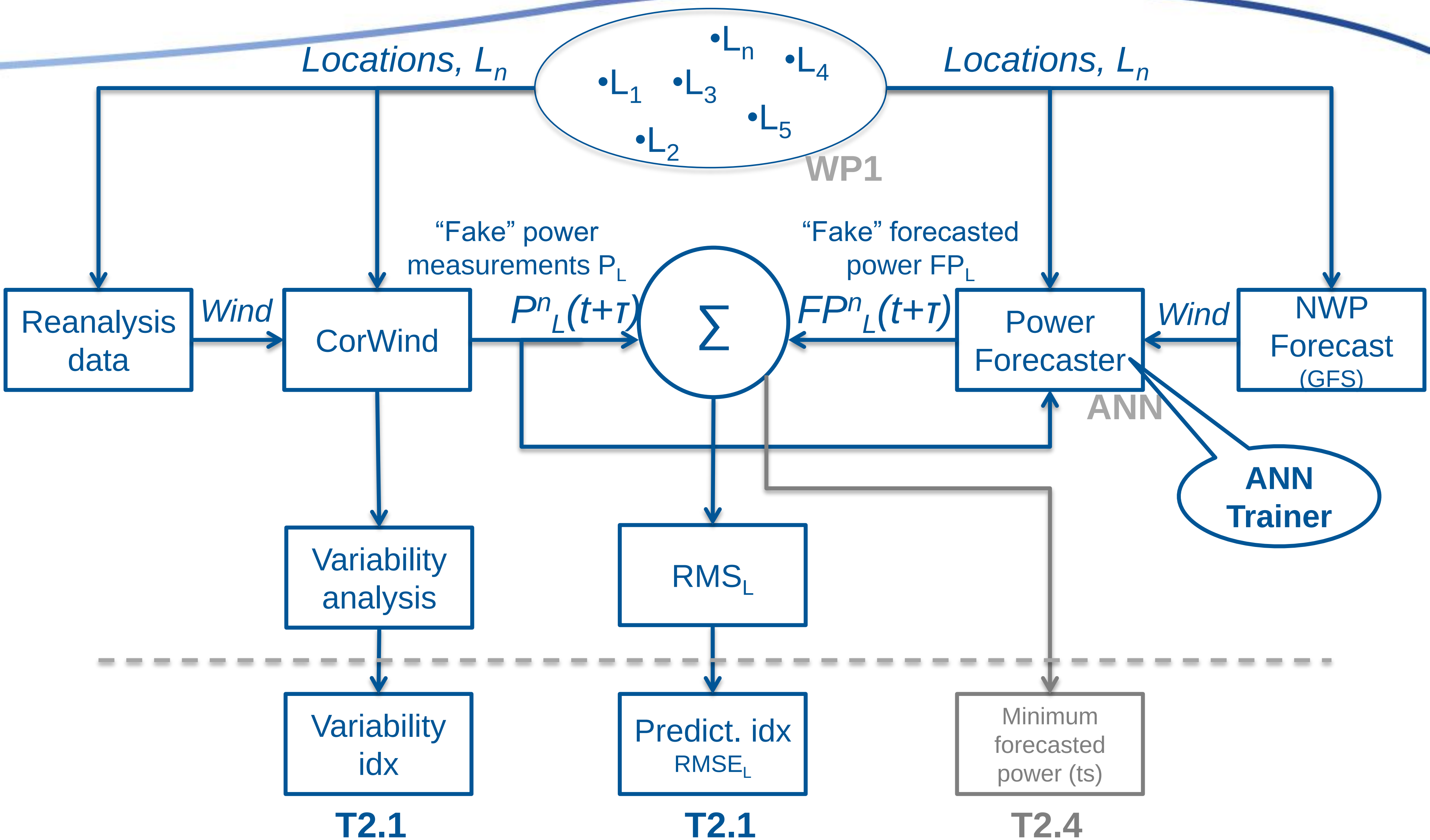
1. Achievements > How to overtake info gaps



1. Achievements > How to overtake info gaps



2. Expected Achievements > V&P



$$FP^n{}_L(t_p+\tau)=f(NWP(t_p+\tau,t_p))$$