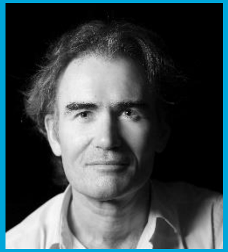
Le réseau
de transport
d'électricité

New Adaptive Zonal Automaton



Guillaume Giraud
RTE – R&D

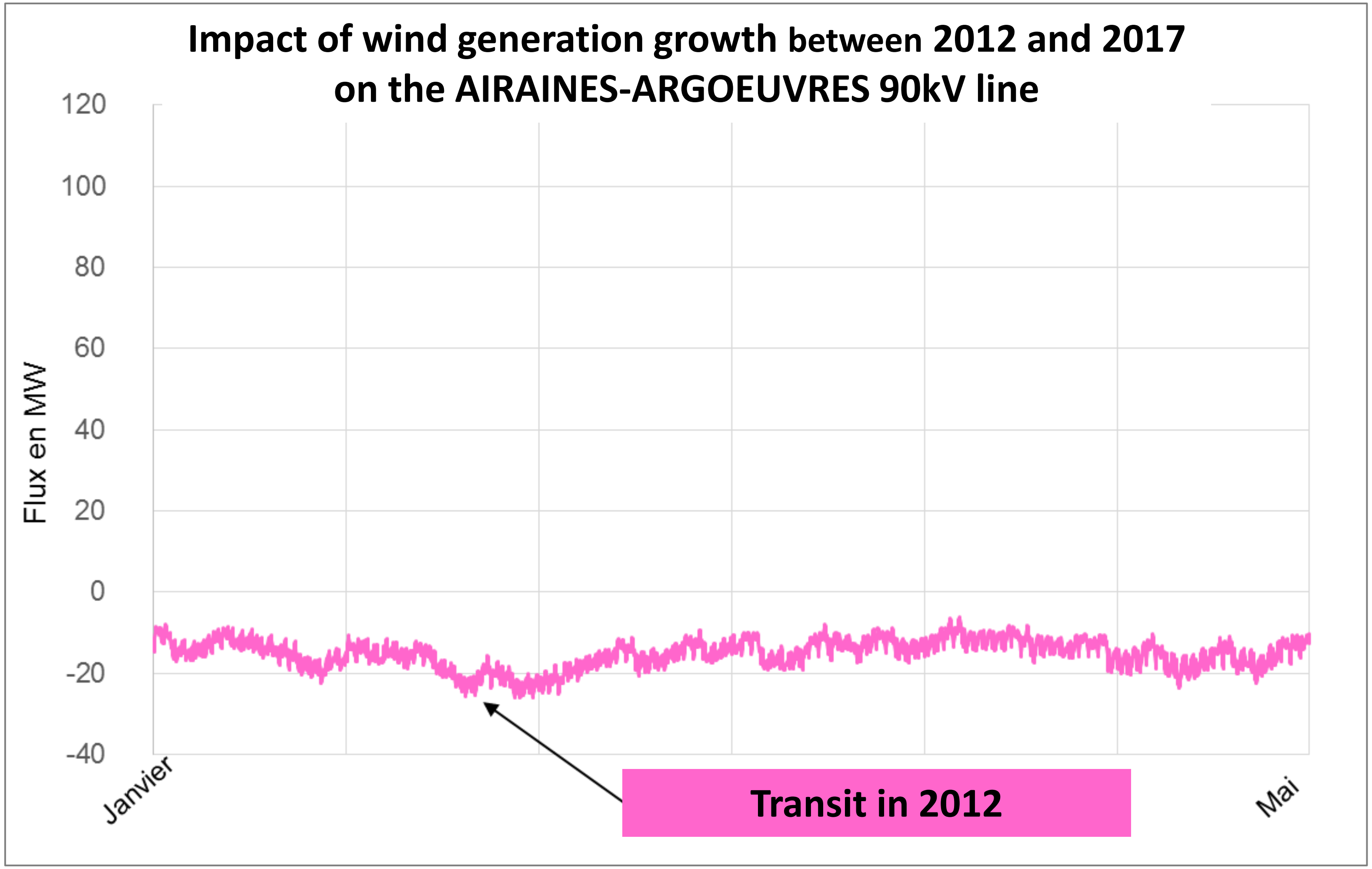
SOMMAIRE

1 Why do RTE need NAZA ?

The photovoltaic and wind energy sectors have been growing sharply for the past 5 years and the trend is expected to continue.

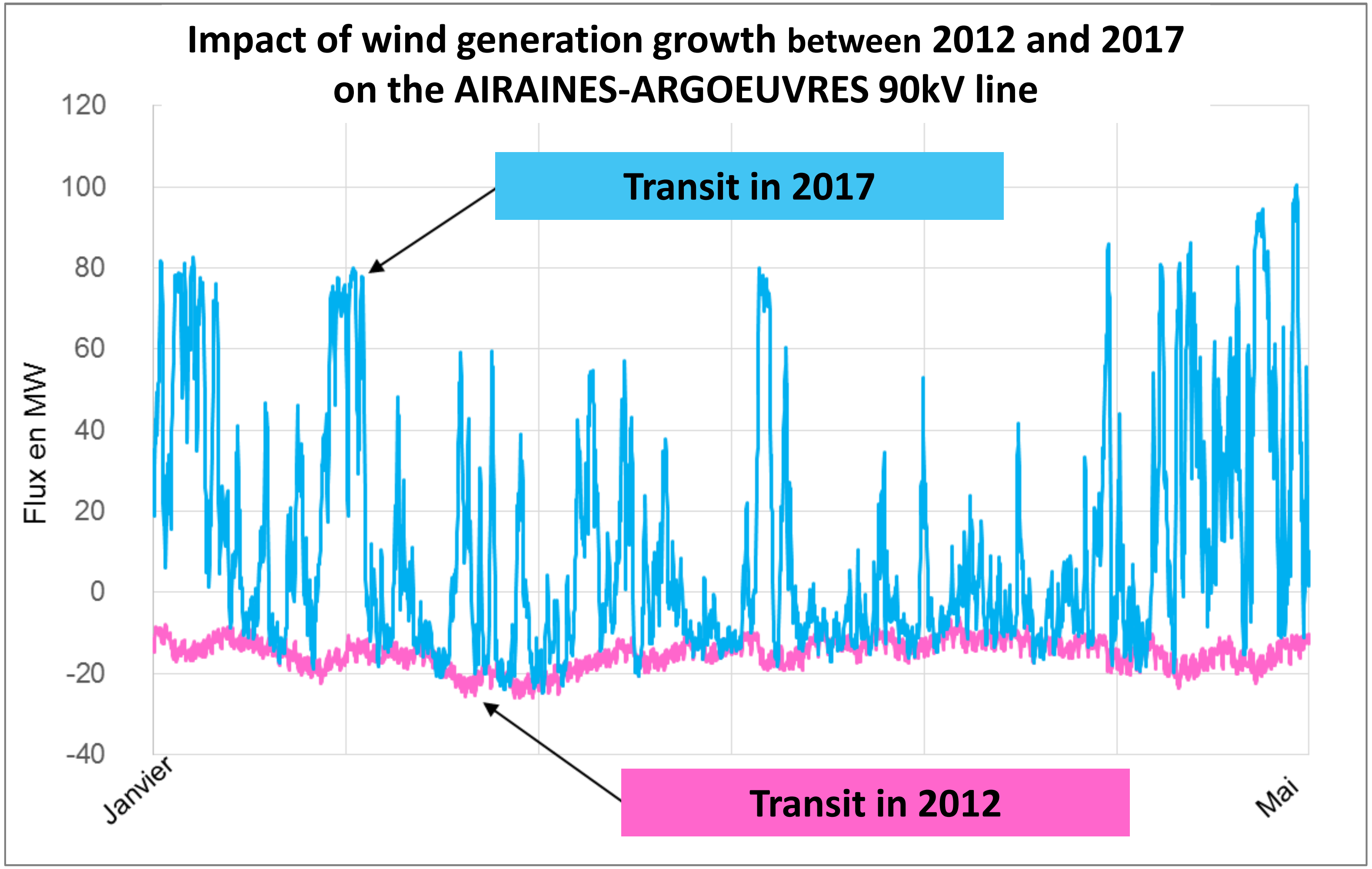
93% of the installed capacity of renewable energies is connected to the distribution grid

Illustration of a sharp increase in wind generation



Renewable energies increase the variability and uncertainty of flows

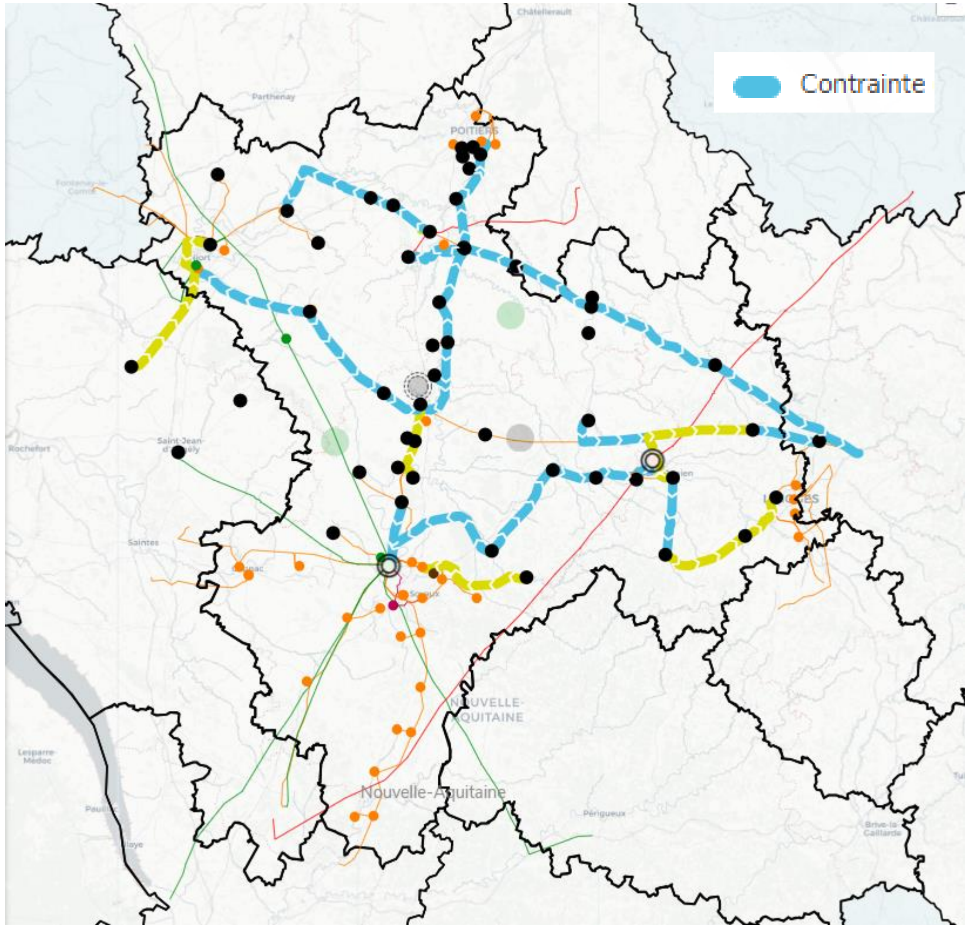
Illustration of a sharp increase in wind generation



Renewable energies increase the variability and uncertainty of flows

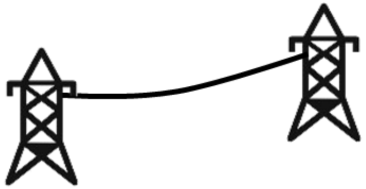
How can we support the rapid arrival of renewable energies?

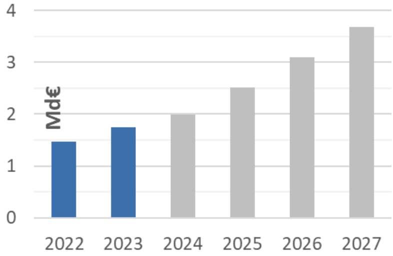
Area Centre EX-Poitou, Sud Charente et Ouest Limousin 1



Source https://www.contraintes-reseau-s3renr-rte.com/

RTE aims for an optimum cost/quality for the community
Optimal sizing





Strengthening the network

About 1/3 of RTE's investments concern the HTB1 network (less than or equal to 90kV)

Occasional curtailment of renewable energy production a few hours a year

The network needs generated by the arrival of renewable energies are concentrated on the HTB1 network (< 90 kV)

Different deadlines for deciding on limitations

Anticipate what is predictable by managing real-time uncertainty by automatons

Y-1 | M-4 | D-15 | Real time

Limitation requests for scheduled work

Seasonal limitation requests (valid for one season)

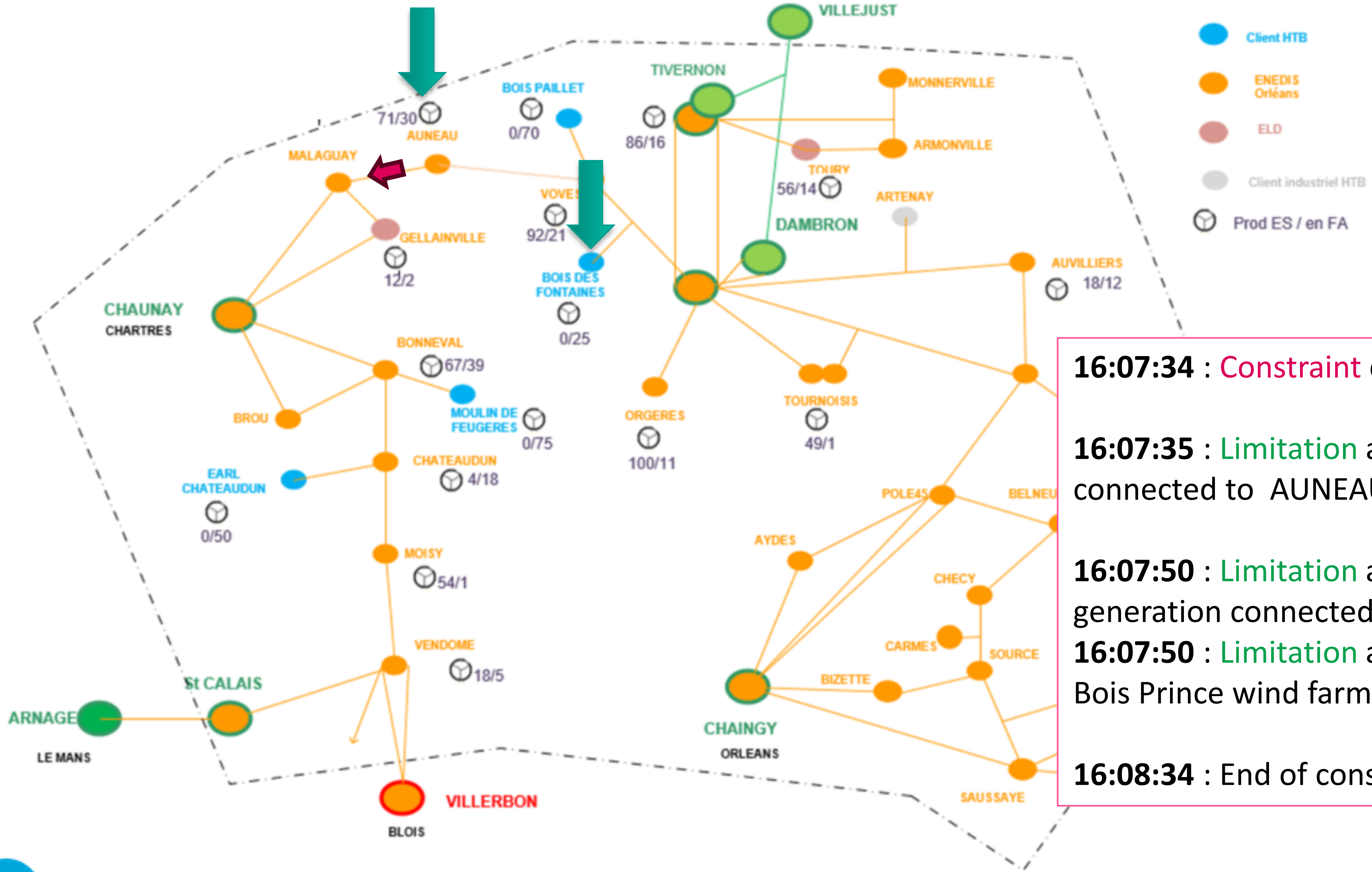
RTE ⟷ Interaction ⟷ DSO ⟷ Interaction ⟷ DSO parks

RTE ⟵ Interaction ⟶ TSO parks

2

Real world example

Example – BEAUCE area, 23rd of March 2024



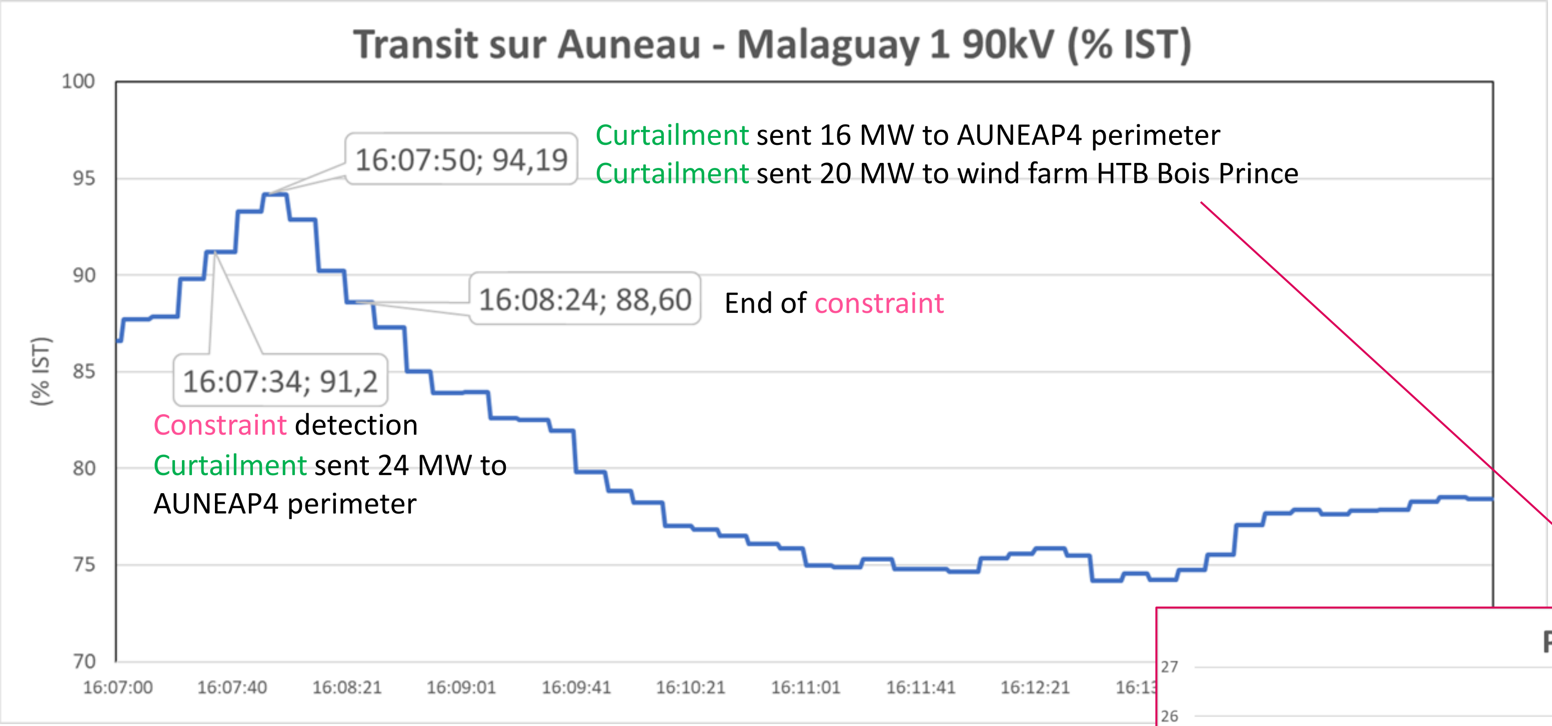
16:07:34 : Constraint detection on Auneau-Malaguay line

16:07:35 : Limitation at 24 MW sent for DSO generation connected to AUNEAU substation

16:07:50 : Limitation at 16 MW sent sent for DSO generation connected to AUNEAU substation
16:07:50 : Limitation at 20 MW sent to TSO connected Bois Prince wind farm

16:08:34 : End of constraint on Auneau-Malaguay

Example – BEAUCE area, 23rd of March 2024

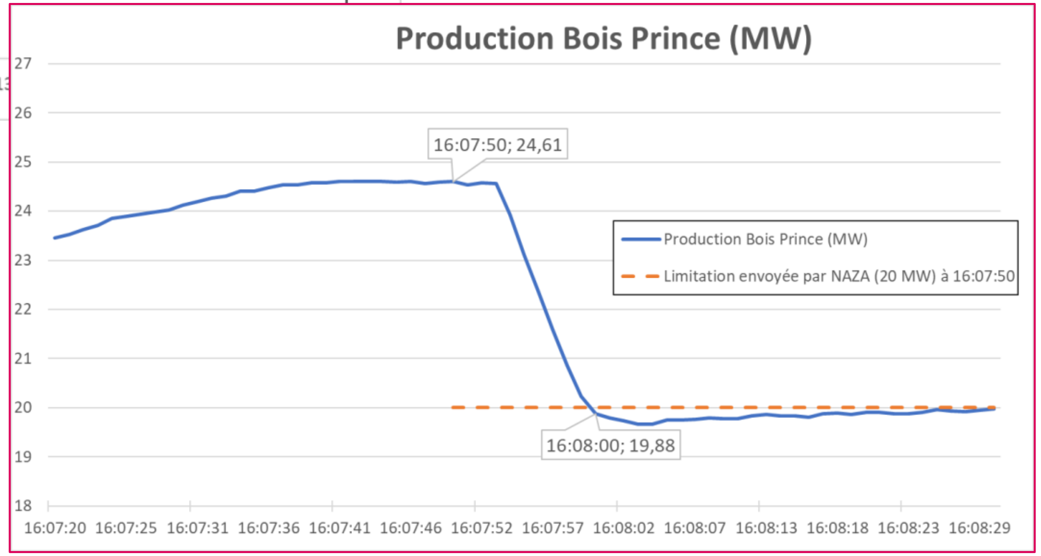


Auneau HTA
P_{max} curtailable 40 MW
$P_{estimated}$ before curtailment 27 MW

Bois Prince (HTB)
P_{max} 25 MW
P before curtailment 24,6 MW

The two **DSO level** curtailments were completed in **less than a minute**

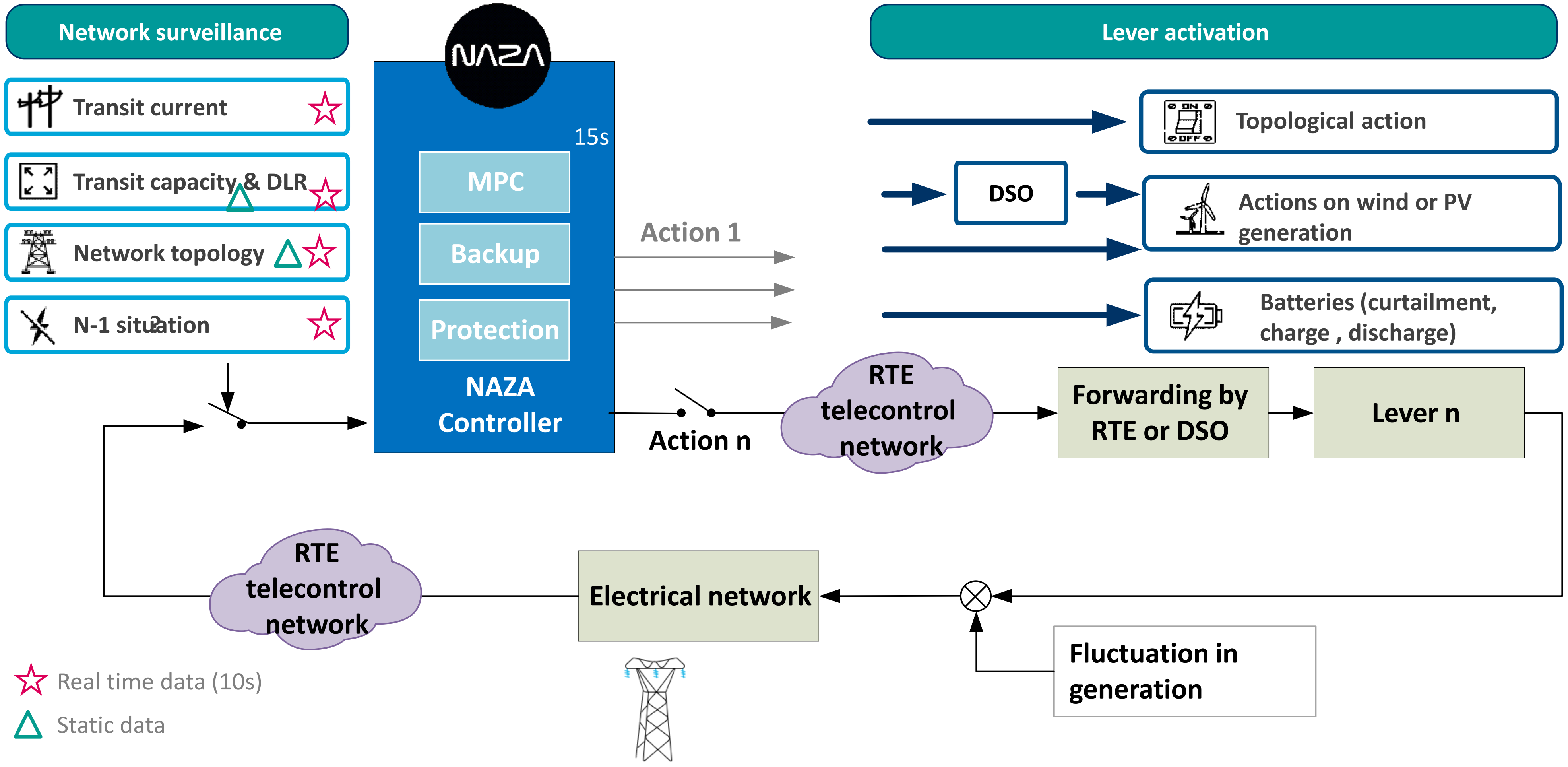
The **TSO** level curtailment was completed in less than **15 seconds**



3 NAZA Technical Solution

NAZA – A closed loop controller

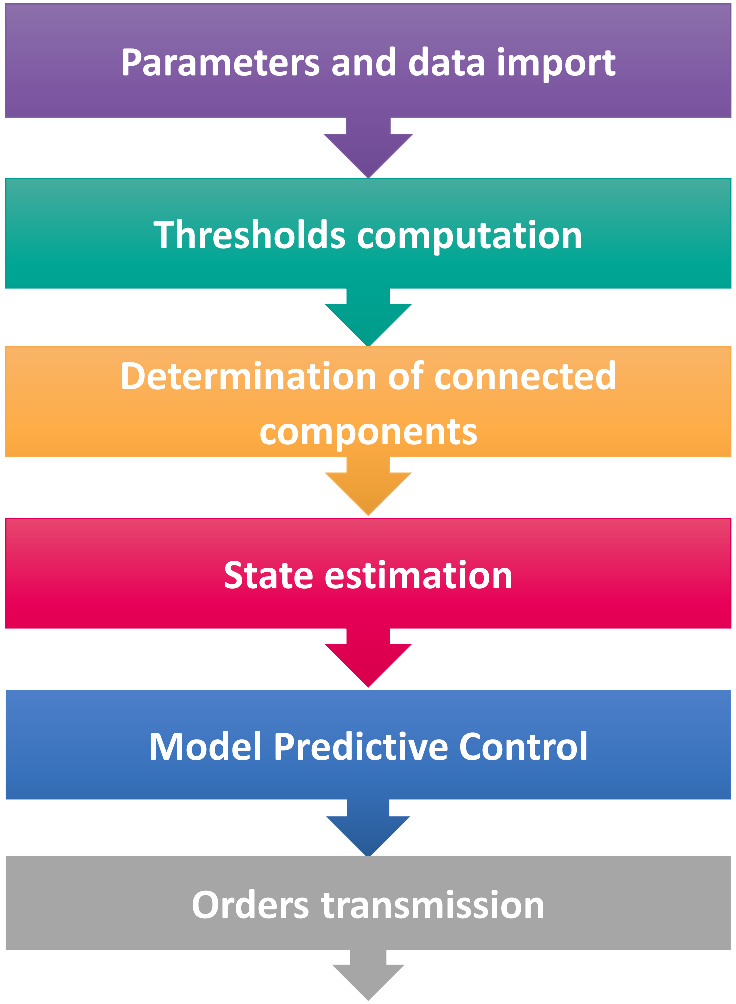
NAZA is an innovative software platform with an optimization algorithm (Model Predictive Control) to detect and process transit constraints in a specific zone



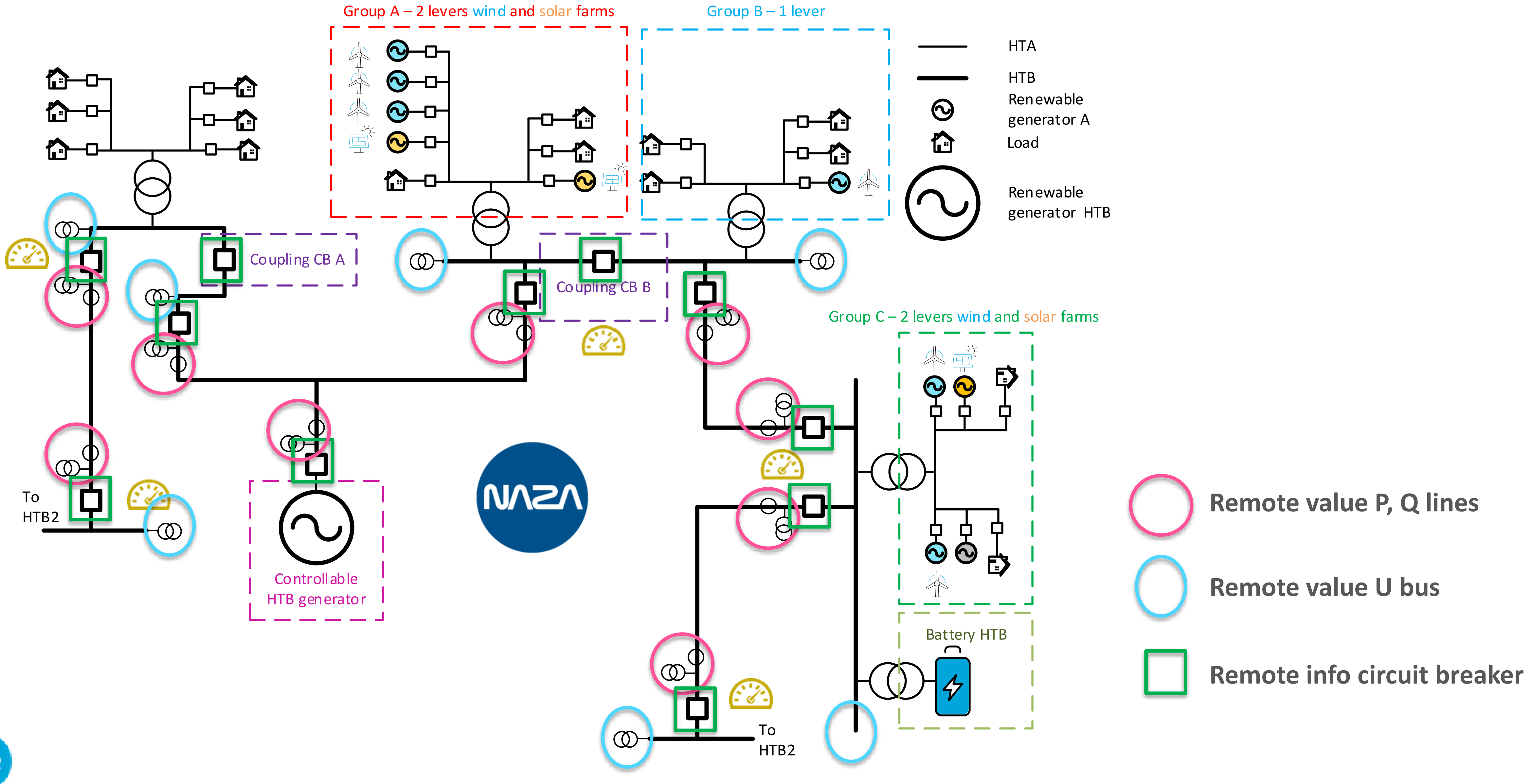
At the heart of NAZA is the **Model Predictive Control** algorithm

An innovative approach that introduces **predictive control** for real-time network management.

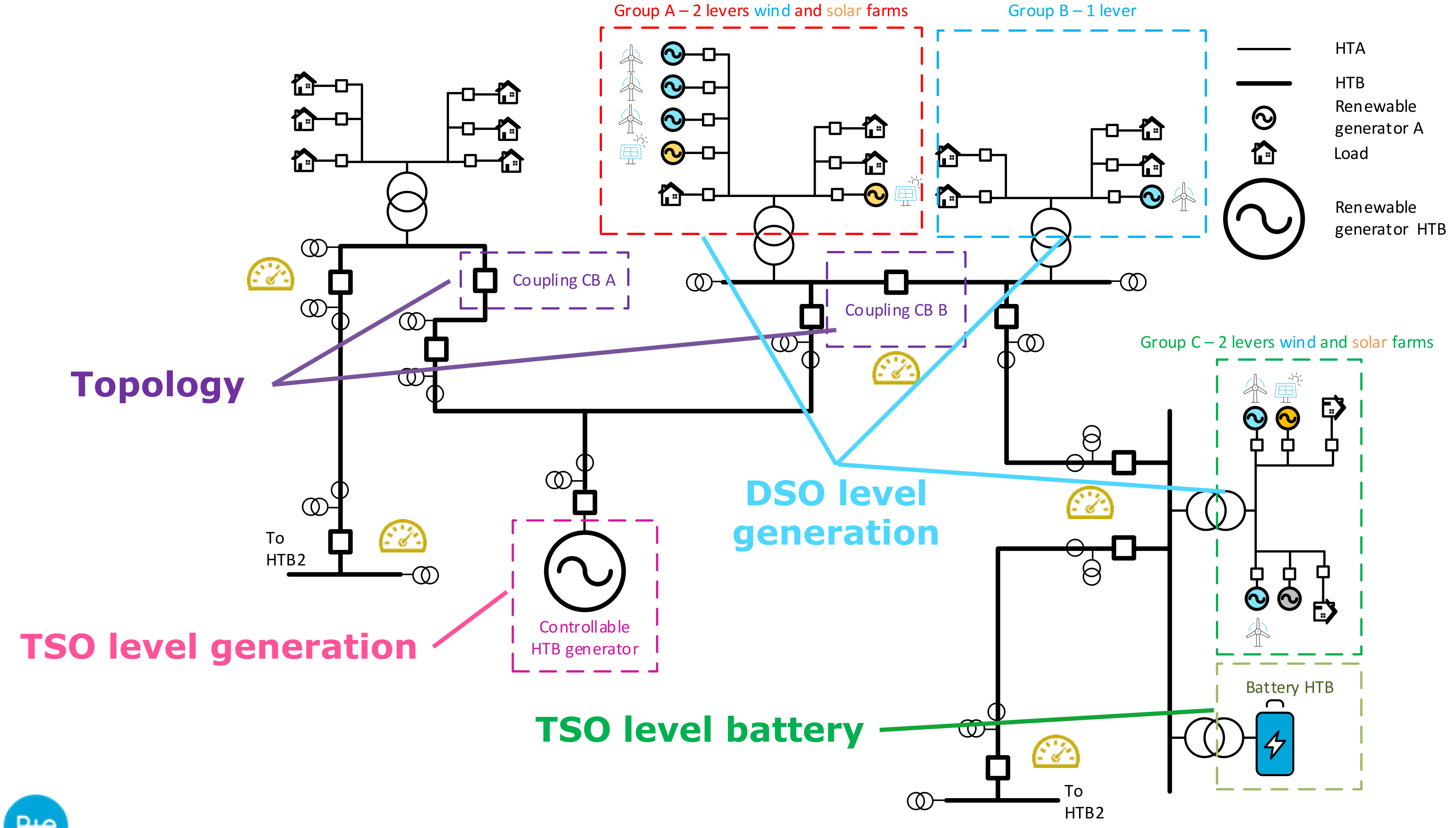
- Supervision line by line is replaced by management by zone.
- The meshed network, the changes in topology and the multiplicity of levers do not allow effective remedial actions (flowchart like) to be defined in advance: a **network model** and an **optimization algorithm** are necessary.
- To minimize **margins**, it is necessary to decide at the last moment, depending on the **dynamics of the flows** and **how long** it takes to activate the **levers**.
- Taking these deadlines into account corresponds to the framework of **predictive control**, with a **closed-loop** operation to manage errors.



Focus on real time data

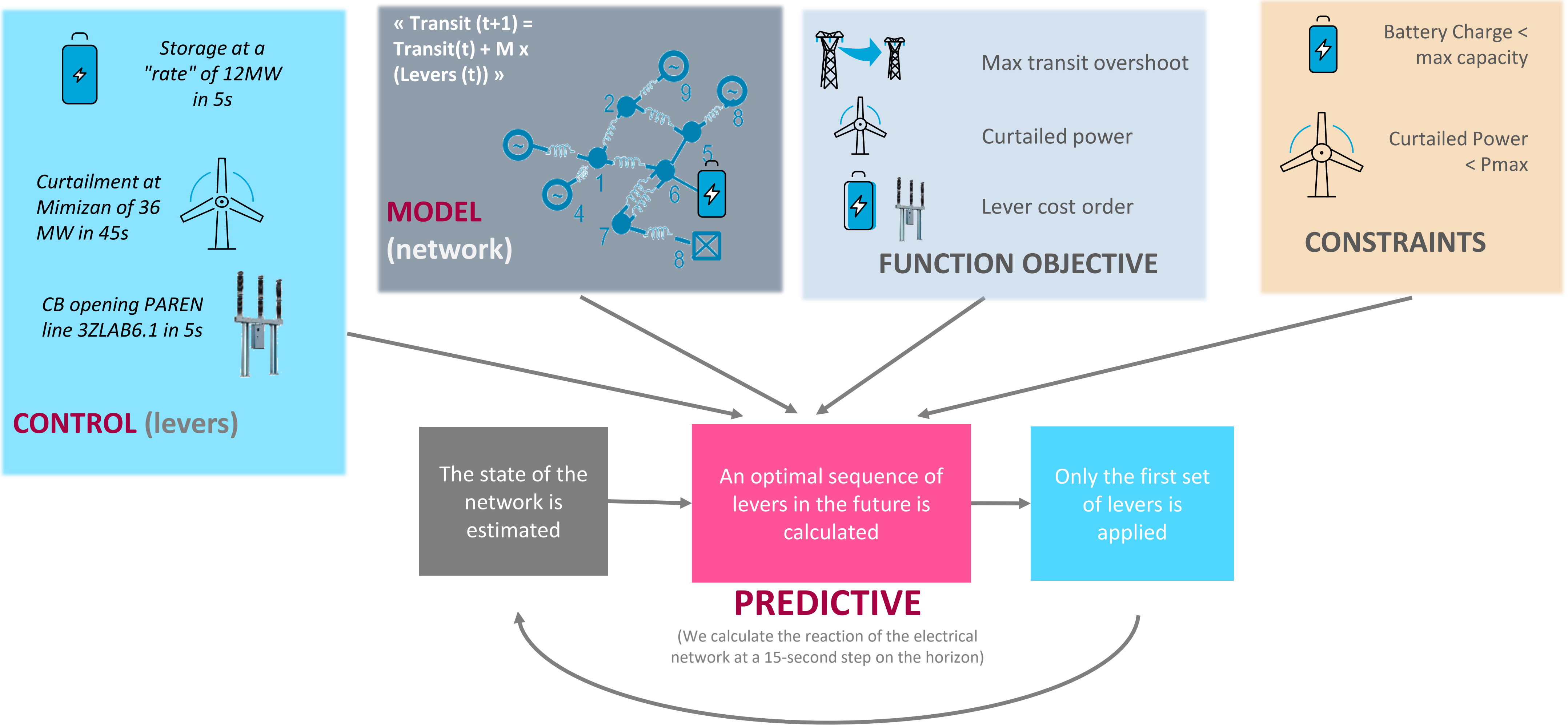


Focus on the levers



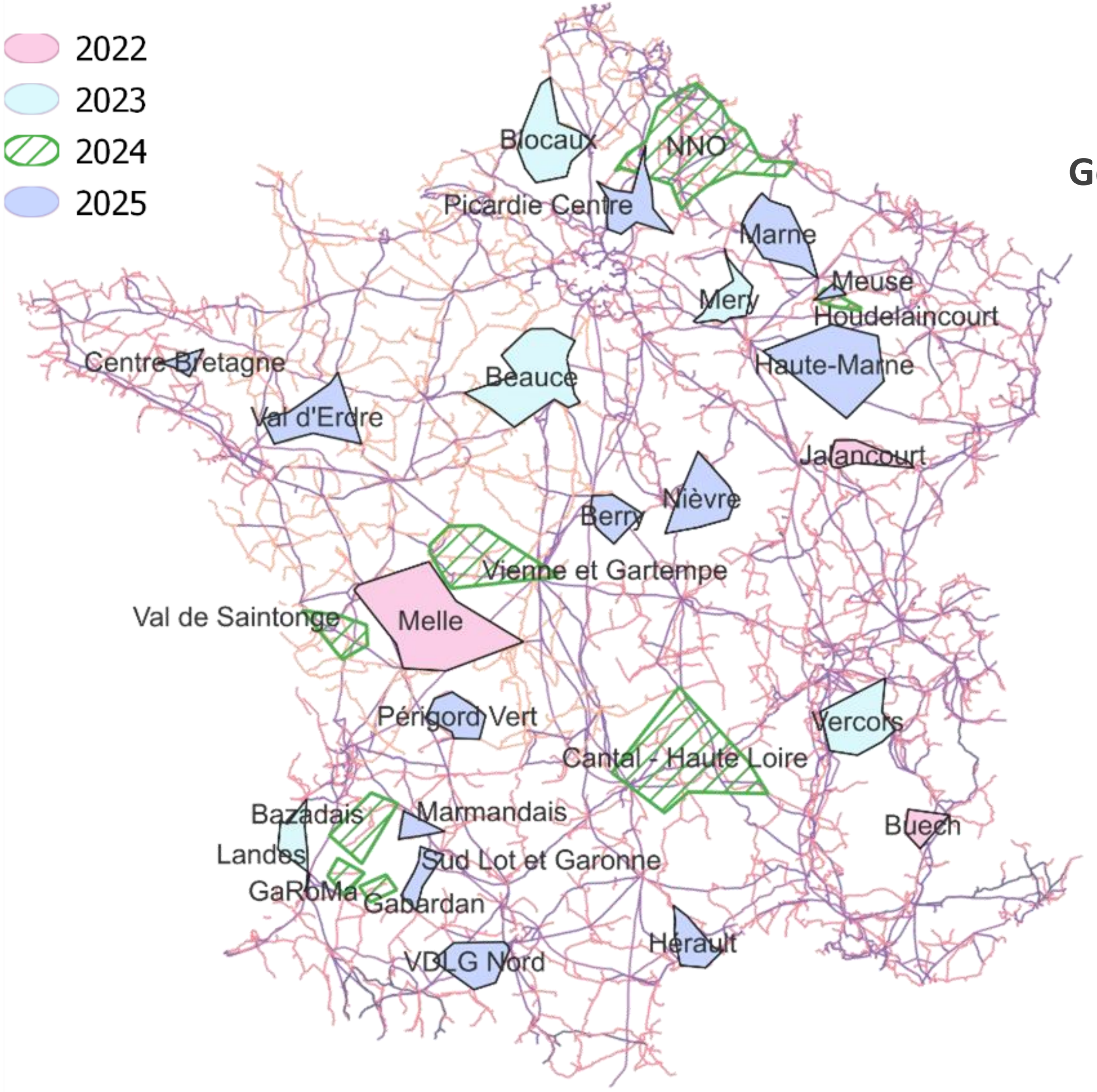
Mathematical model of the decision algorithm: Model Predictive Control

The problem is described as an optimization to be is solved every 15 seconds over a horizon that corresponds to the delays of the slowest levers



4 NAZA Deployment

NAZA already deployed and programmed (May 2025)



Generation connected to NAZA in February 2025

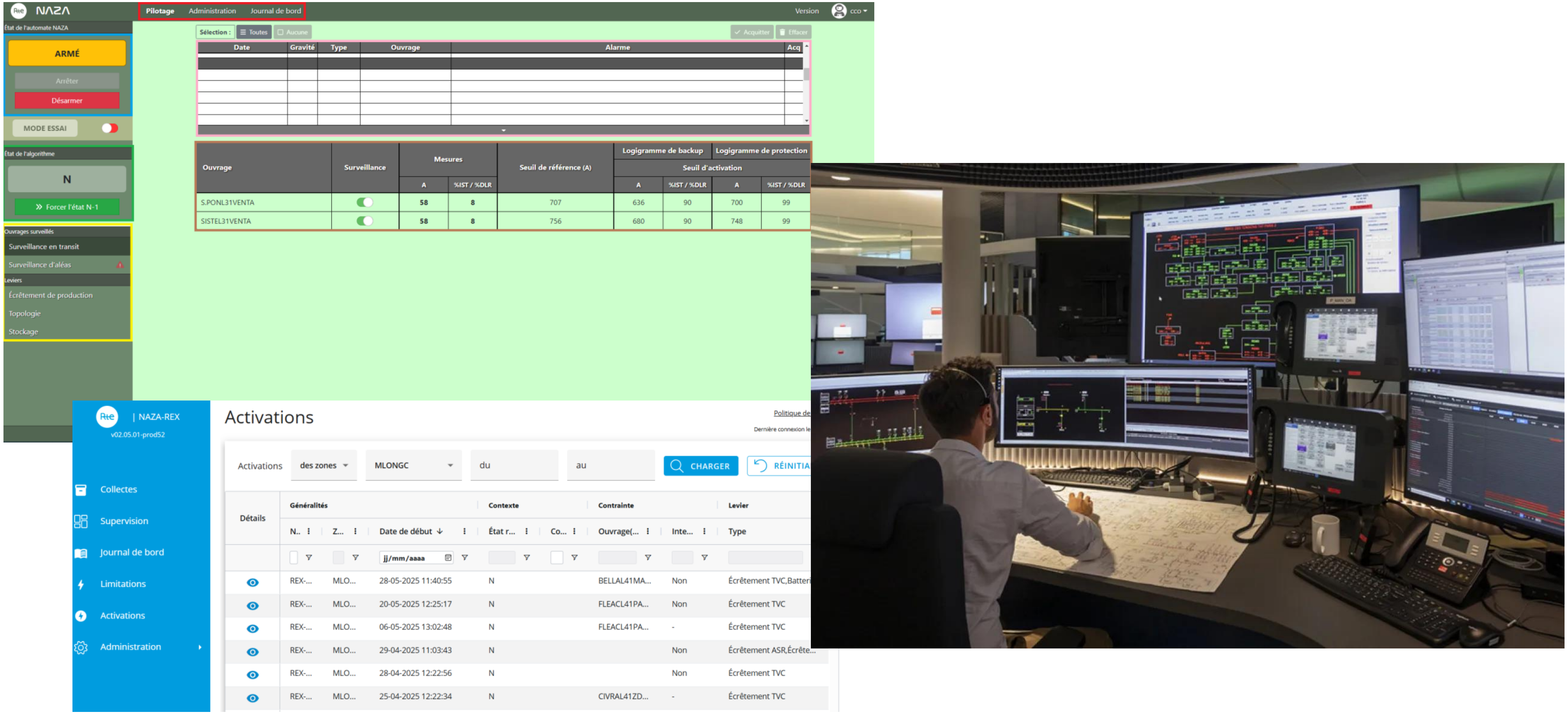
Nb of NAZA zones	Nb of lines in the areas	Nb of sub-stations in the areas	Total RES generation in the areas (MW)	Total RES generation connected to NAZA (MW)
19	324	513	8 849	4 535

Energy Regulation Commission targets

2025	2026	2027	2028
10	10	15	15

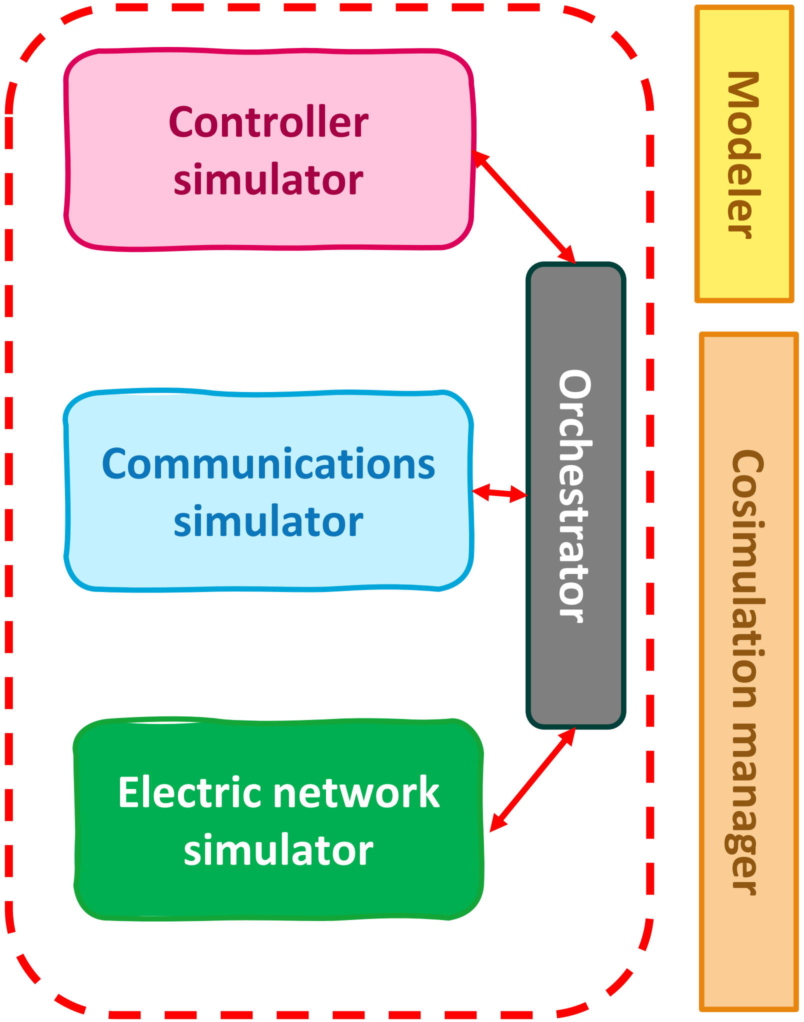
From the operator point of view

IHM



5 New cosimulation needs

We need several cosimulation tools



From conception.... NACRE

New Architectures for Control and Resilience of the Electrical grid

Which digital infrastructure architectures are best suited to my future control system ?

RESYST ...to validation

Does my control system behave correctly in the presence of disturbances?

REal-time **SYS**tem **T**esting

New Architectures for Control and Resilience of the Electrical grid

Test the behavior of my algorithm on multiple digital infrastructures during its design phase.

NACRE

MODELLING

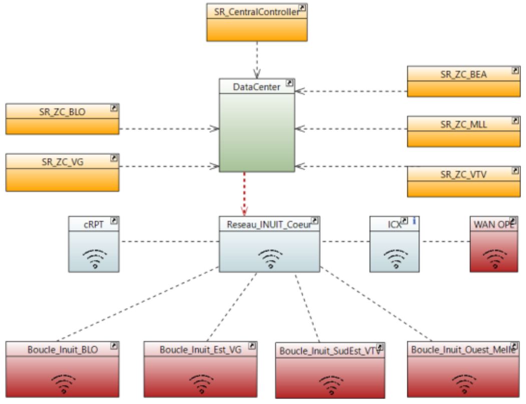
- FUNCTIONNAL ARCHITECTURE EDITOR
- RESOURCES ARCHITECTURE EDITOR
- COMMUNICATION HAZARDS EDITOR

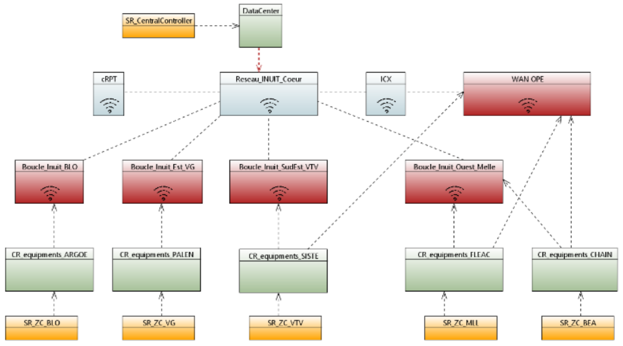
SIMULATION MANAGEMENT

- CAMPAIGN MANAGER
- SIMULATION MANAGER

SIMULATION

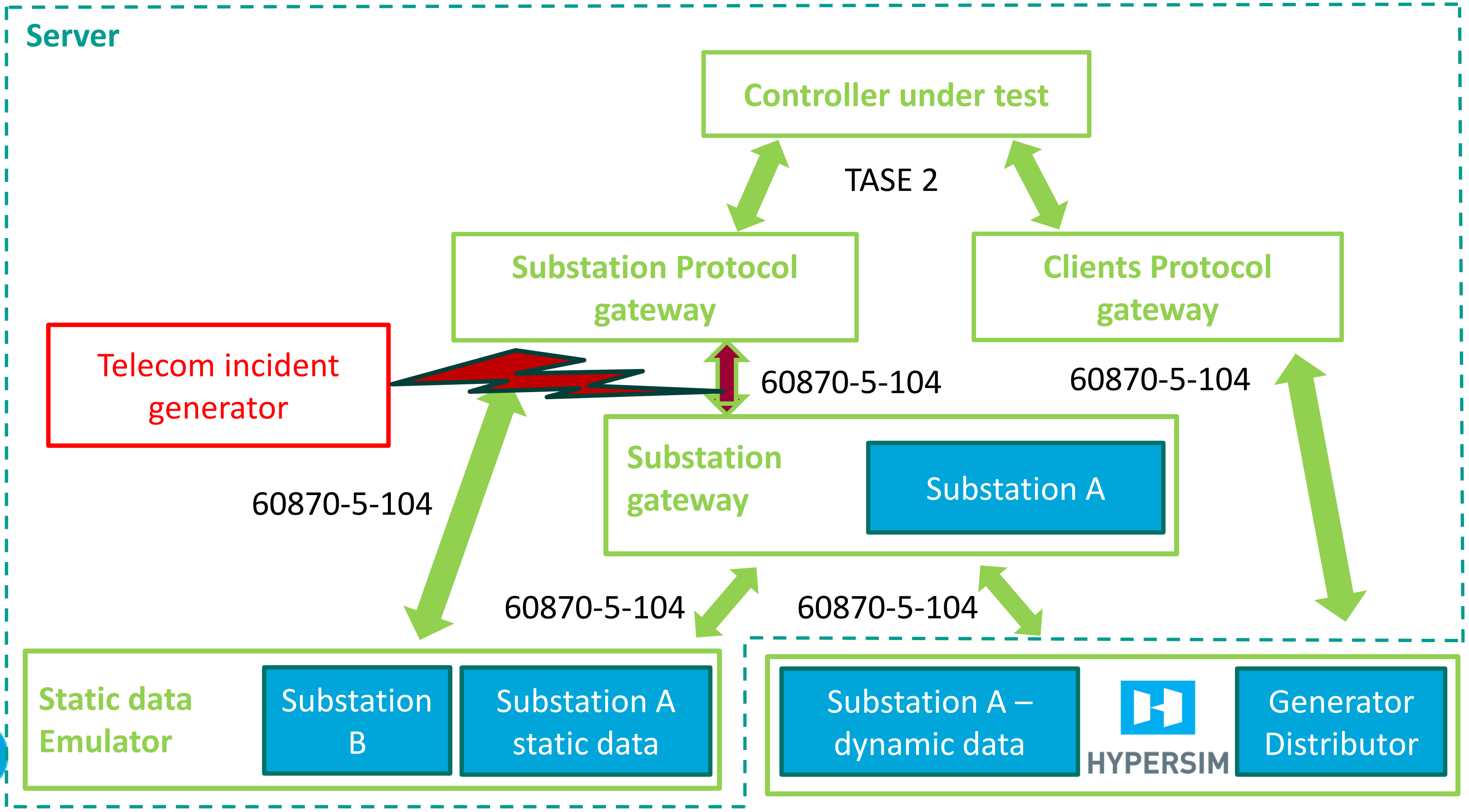
- ORCHESTRATOR
- CONTROLLERS SIMULATOR
- COMMUNICATION SIMULATOR
- CONTROL ALGORITMS LIBRARY
- PHYSICS SIMULATOR





REal-time SYStem Testing

Validate a controller in the presence of telecom disturbances on a platform close to the real system.



- Virtual machines containing the real production software
- Real remote control application protocols
- Emulated IP
- Real-time power grid simulator

6 Takeaways

Takeaways

Success story **…**

- This is the **first time** a **TSO** has used an **optimization-based controller** for **real-time** management of network congestion.
- Effective **industrial deployment** at cruising speed.
- Good overall operational performance.

…. And a space for **improvement**

- Harden the internal state estimator regarding aberrant or missing data.
- Understand and manage the interactions between the NAZA controllers.
- Industrialize the cosimulation tools necessary for testing.
- Integrate new flexibilities.
- Prepare to implement the new operational interface with Enédis.

Thanks for your attention !