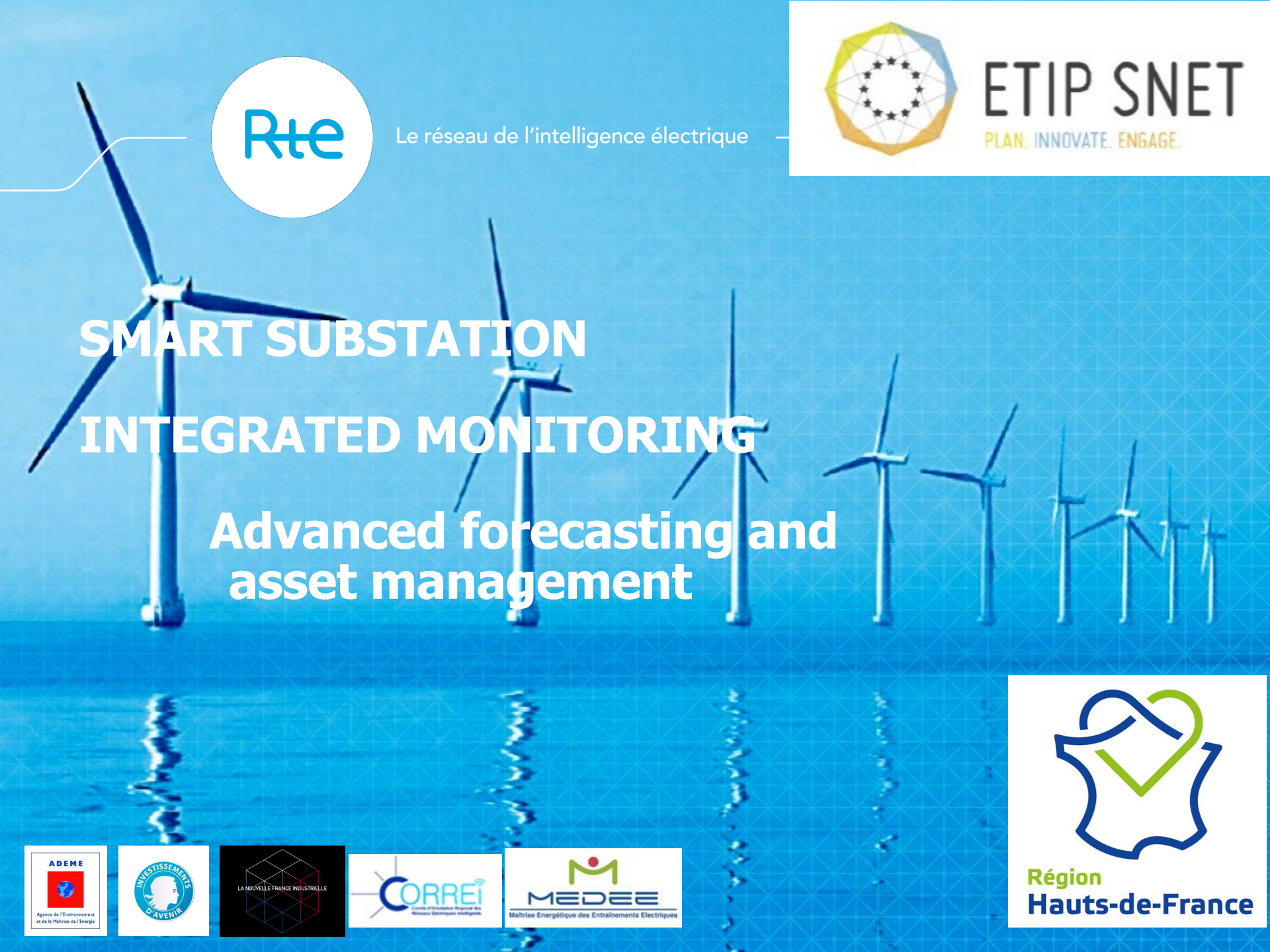


Le réseau de l'intelligence électrique

ETIP SNET
PLAN. INNOVATE. ENGAGE.

SMART SUBSTATION

INTEGRATED MONITORING

Advanced forecasting and asset management

ADEME
Agence de l'Environnement et de la Maîtrise de l'Energie

INVESTISSEMENTS D'AVENIR

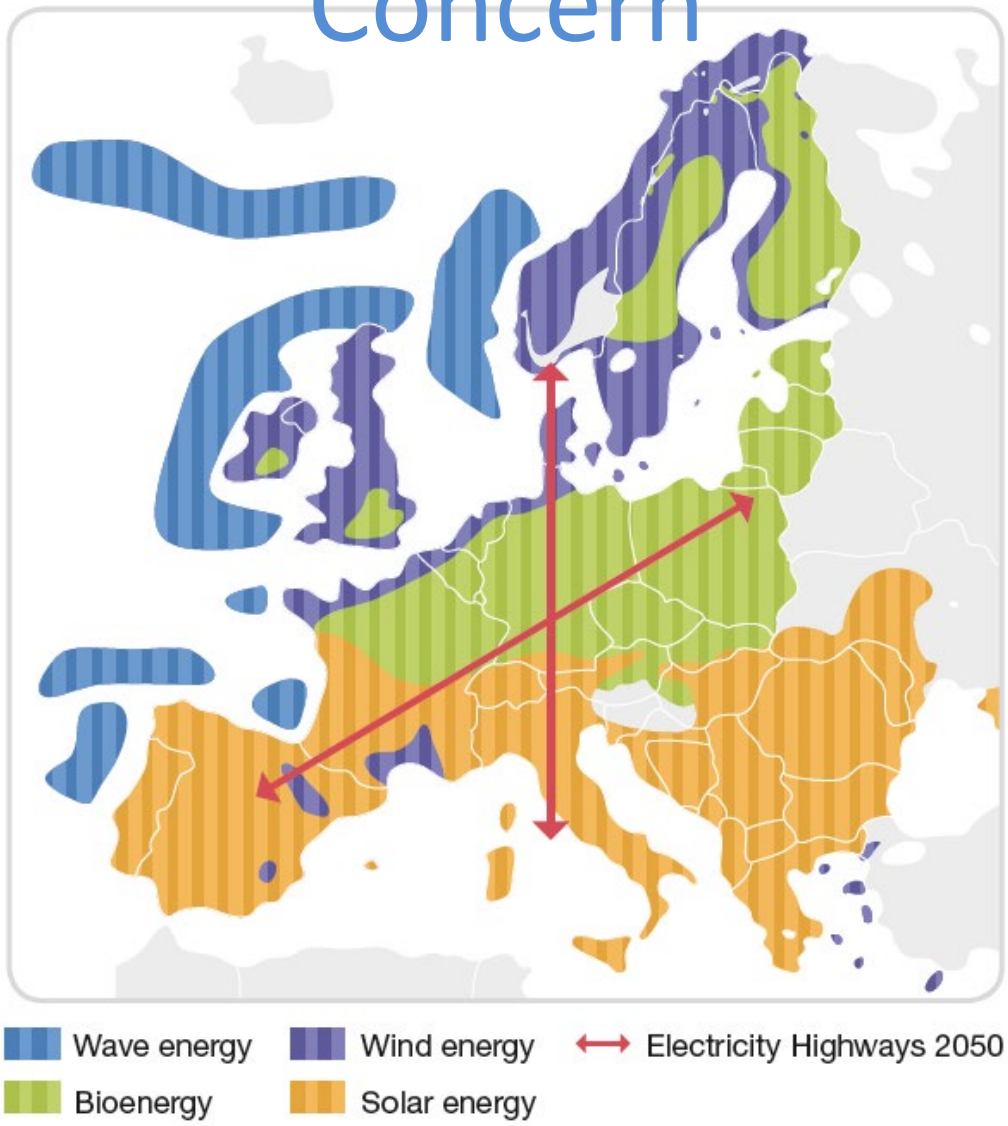
LA NOUVELLE FRANCE INDUSTRIELLE

CORREI

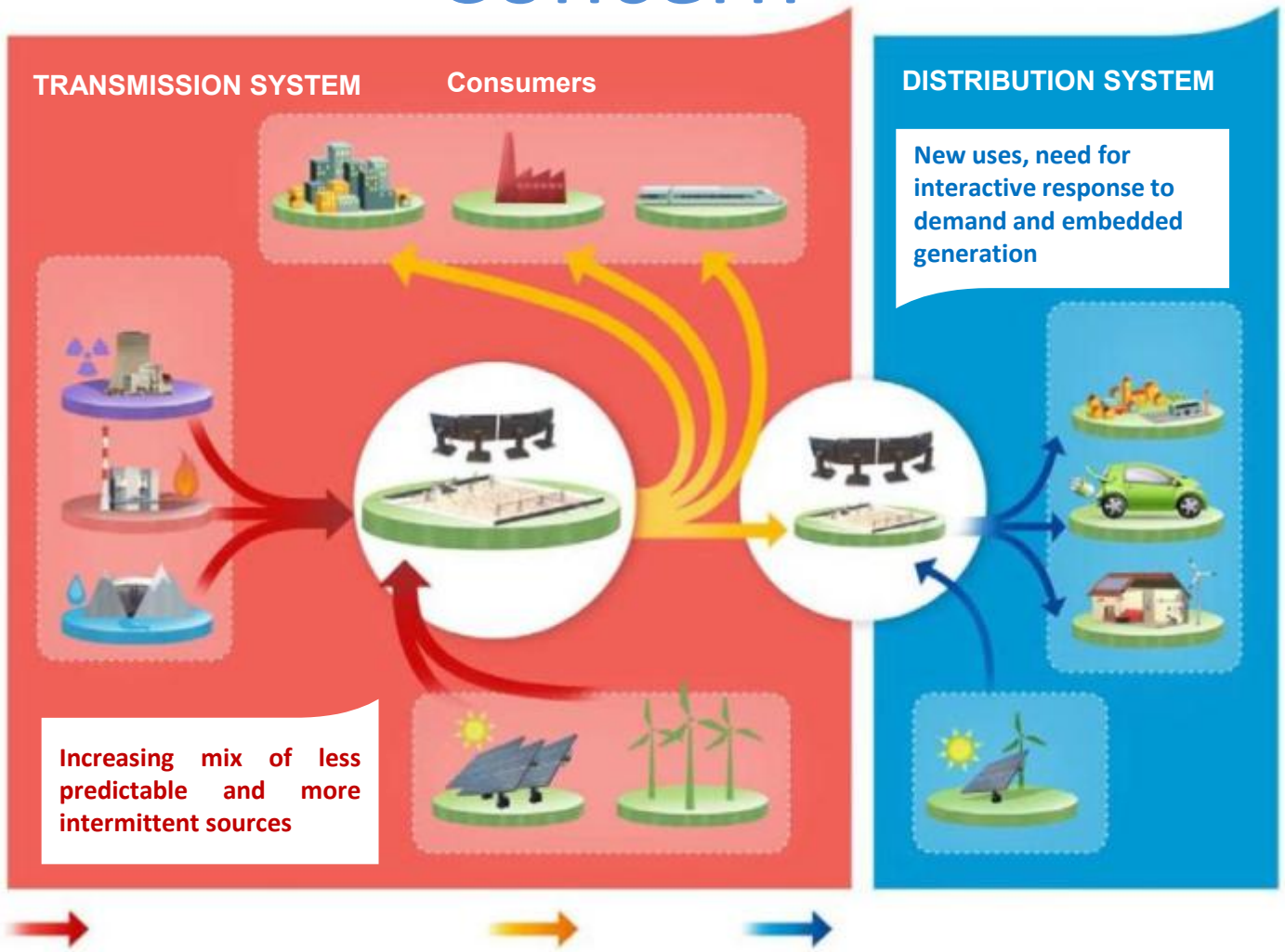
MEDEE
Maîtrise Energétique des Entraînements Electriques

Région Hauts-de-France

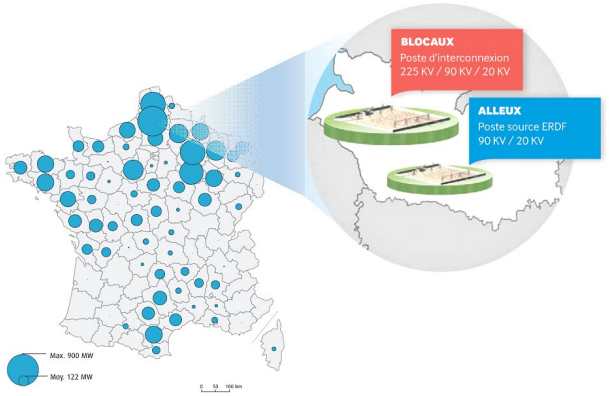
The Flow of Energy: a European Concern



The Flow of Energy – also a Local Concern

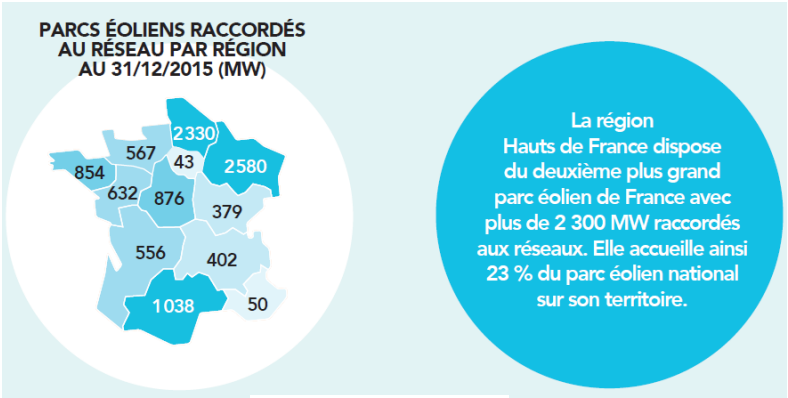


The BLOCAUX substation in the heart of the french energetic transition

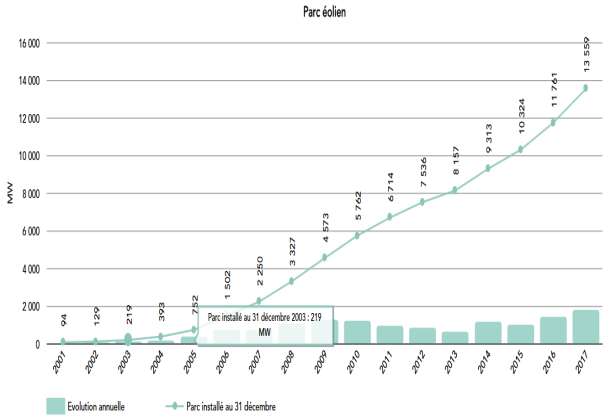


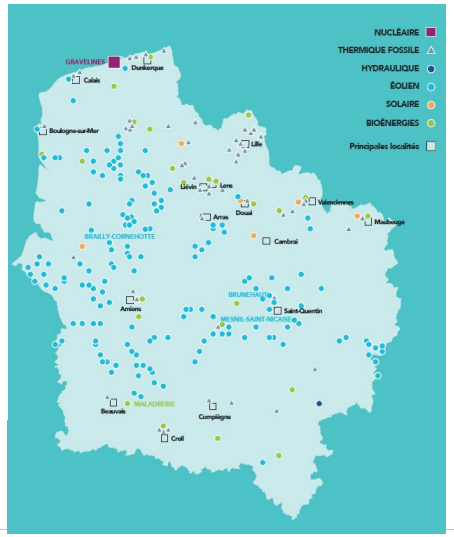
Source : SOeS d'après ERDF, RTE, EDF-SEI, CRE et les principales ELD

Localisation des installations de production d'électricité en Hauts de France

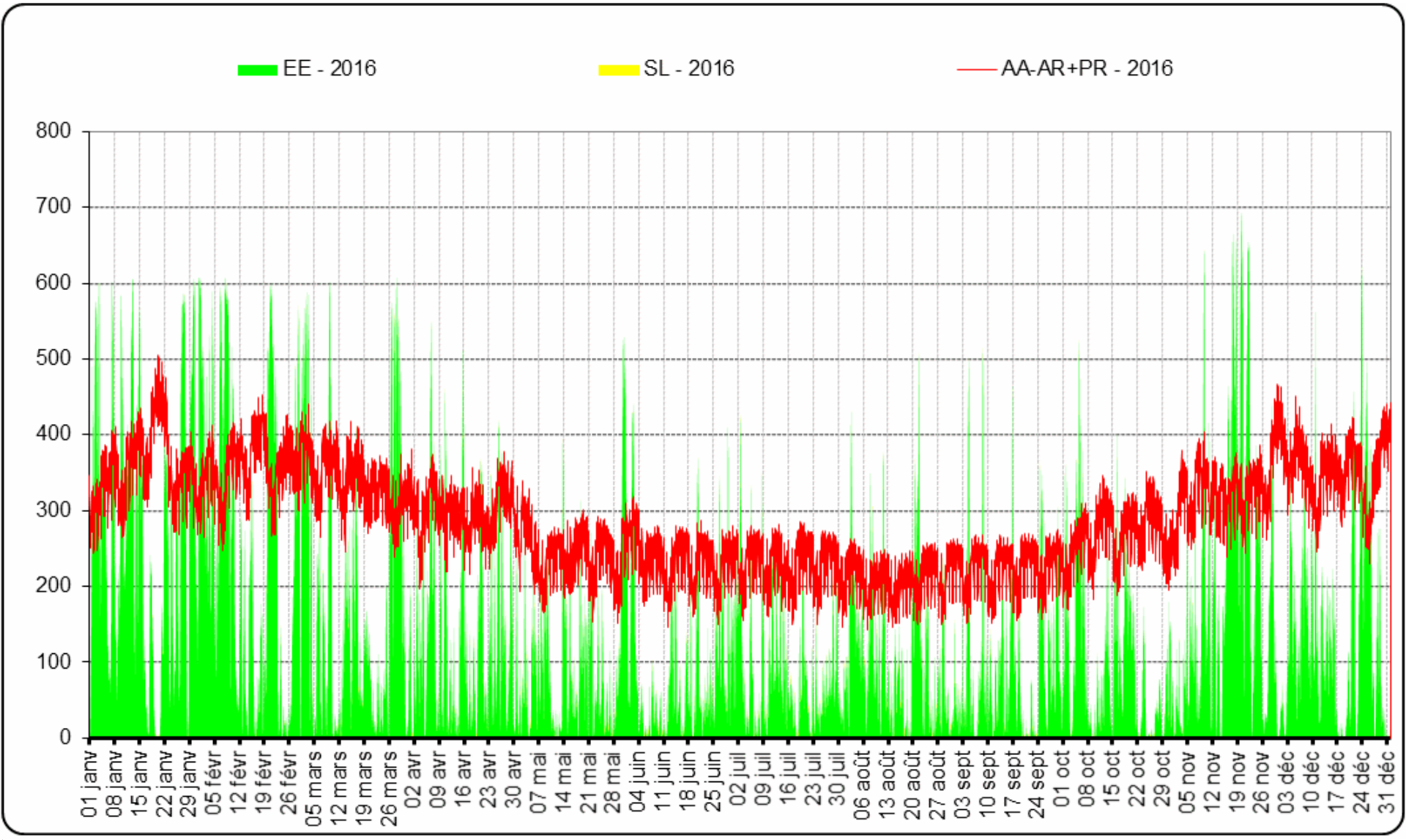


>= 50 KW au km²





Local P/C (MW) 2016



The BLOCAUX substation : The first full digital substation in France

No plan B, No backup, No compromise, Digital or nothing…

Key drivers for TSO

- Operational performance
- Safety
- Availability
- Global CAPEX/OPEX
- Assets management

Iteration

1950

Electromécanical

1975

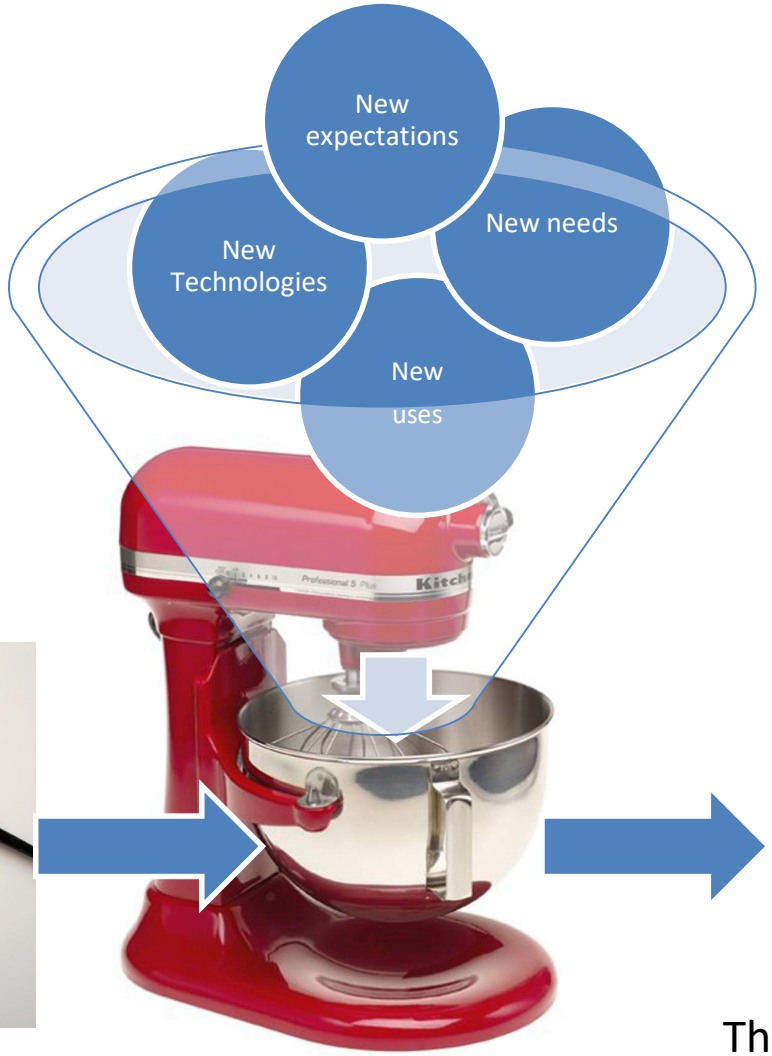
Electronic

2000

First steps in semi digital substation

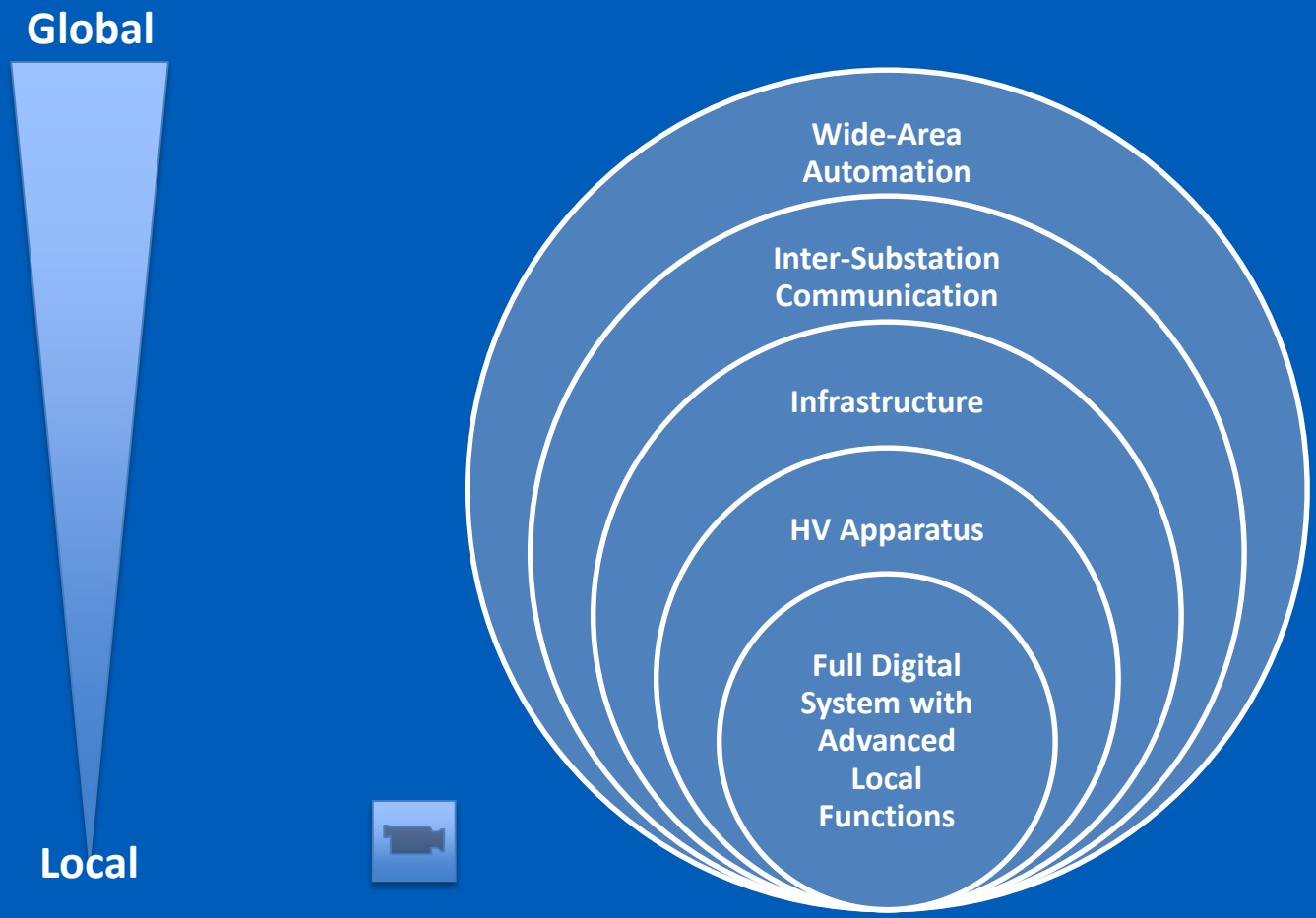
3 technologies for faster an more reliable solution, decreasing cost but similar architecture and same limits.

Digital = Disruption

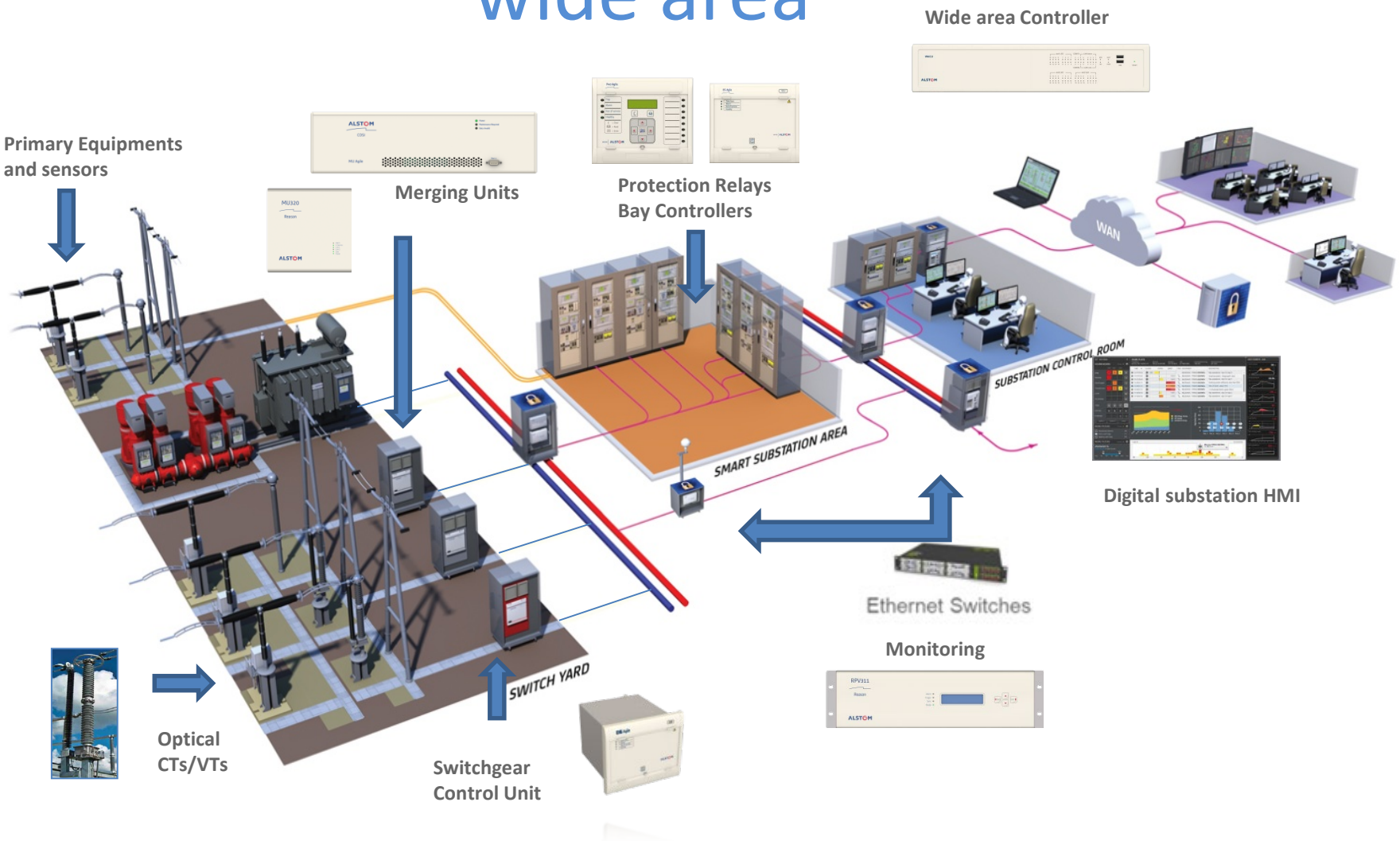


The first prototype for the next generation substation

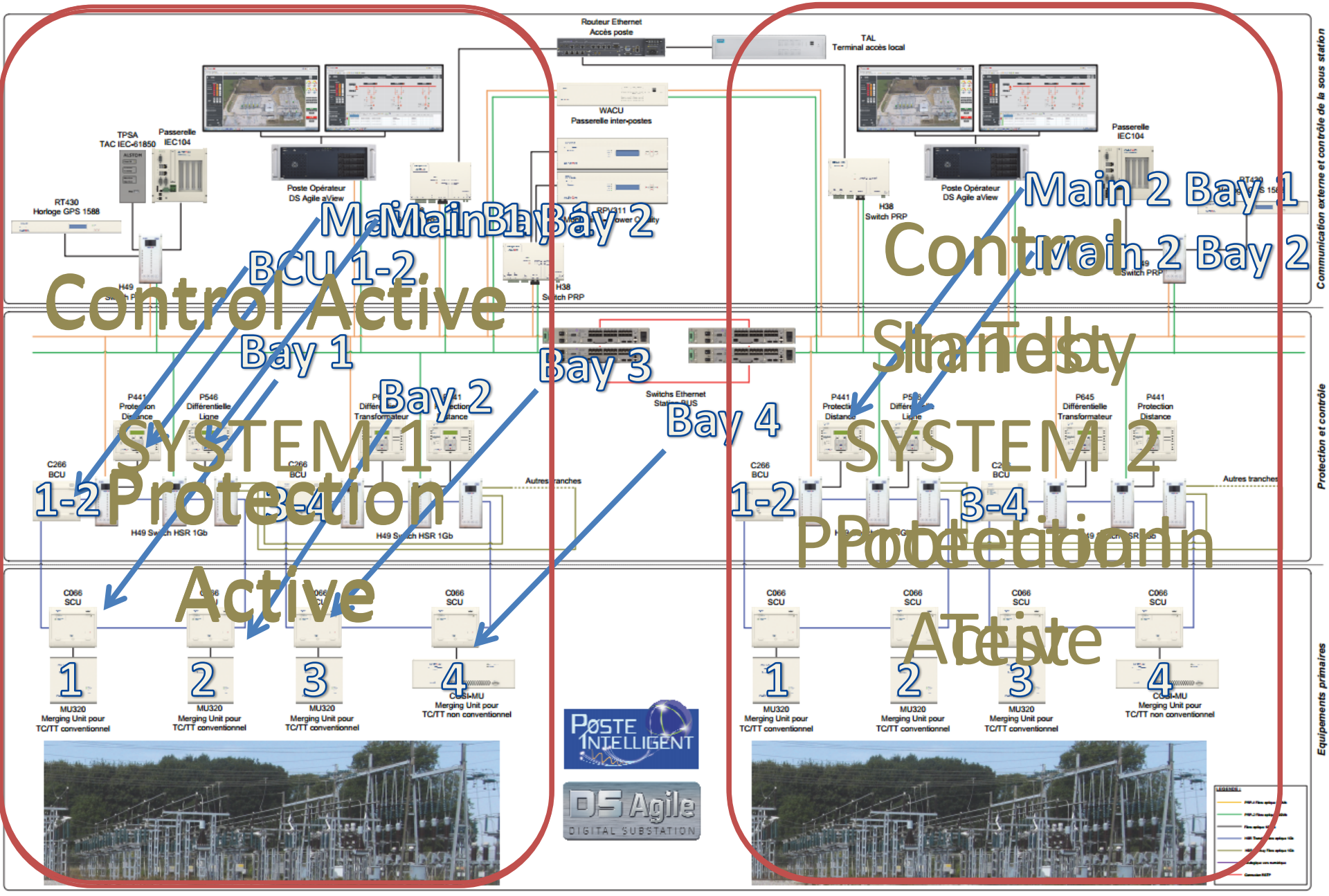
Introducing the Technologies



Digital integration from process to wide area

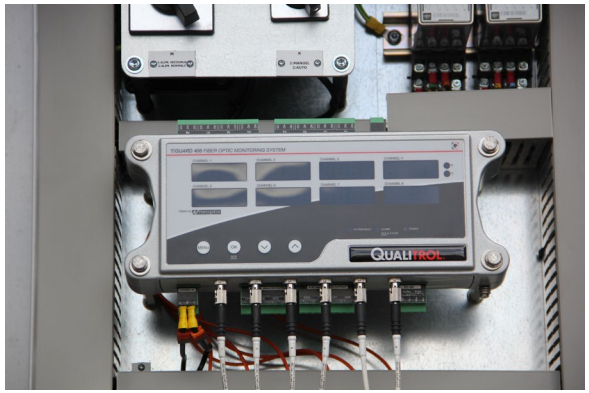


Full redundant architecture



RTE Smart Substation

Sensors on Power Transformer



Power transformer control & monitoring

Buchholz relay (*)
- fault gas accumulation
- increase rate trend & alarms

Temperature sensors (*)
- oil temperature
- head-mount signal converter
- fast process coupler

Bushings monitoring (BMT300)
- Power dissipation (tgdelta)
- Power factor
- Capacitance
- Partial discharge

LV currents tore (*)
- Cooling fans and pumps supervision

Multigas DGA (TRANSFIX)
- photo-acoustic method
- 9 faults gases analysis
- moisture-in-oil (%RH & ppm)

LV Smart breaker (*)
- Remote open/close control
- Integrated protection
- Integrated measurements

IEC61850

Digital Control cubicle (ACN)

Bay Control Unit

Merging Units (HV-MV)

control
protection
monitoring

Cooling system control cubicle

Manual Automatic

control
protection
monitoring

Tap Changer control cubicle

low raise

Note * : monitoring functions realized by 3rd party devices, able to communicate with DS Agile system (dry contacts, 4-20mA, legacy protocols, IEC ...).

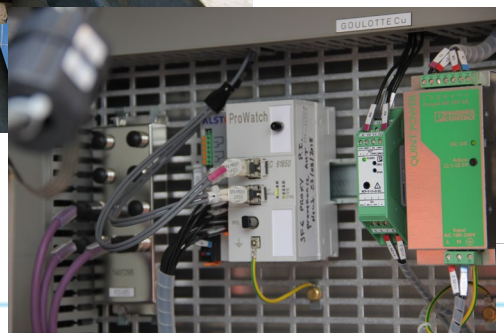
Digital twin

The Smart Cooling Control

- Controlling each individual fan
- Optimize fan life time, cooling, and power consumption
- Optimize maintenance by using lower fan first
- Limit ageing of transformers by anticipating the cooling stage
- Dynamic Overload capacity calculation using :
  - Rated current, Load factor K
  - Transformer losses (HV/MV, HV/LV, MV/LV)
  - Thermal transfer times
- Predictive values (Hot spot and top oil temperature)
- Advanced alarms (Cooling system alarm, Top oil alarm, hot-spot alarm)
- Oil level & Cooling group temperature discrepancy

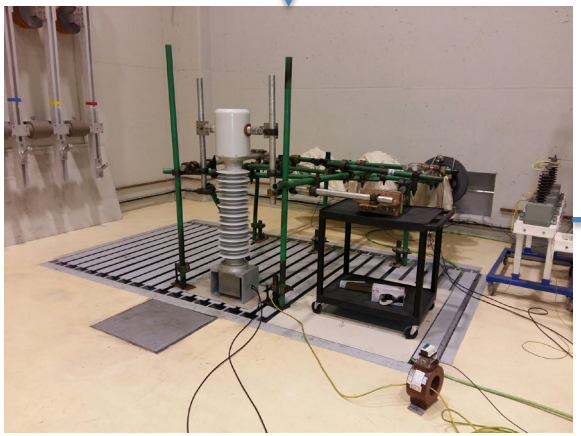
CB control and monitoring

- Open close contact
- Real time current
- Motor/pump start information
- SF6 information

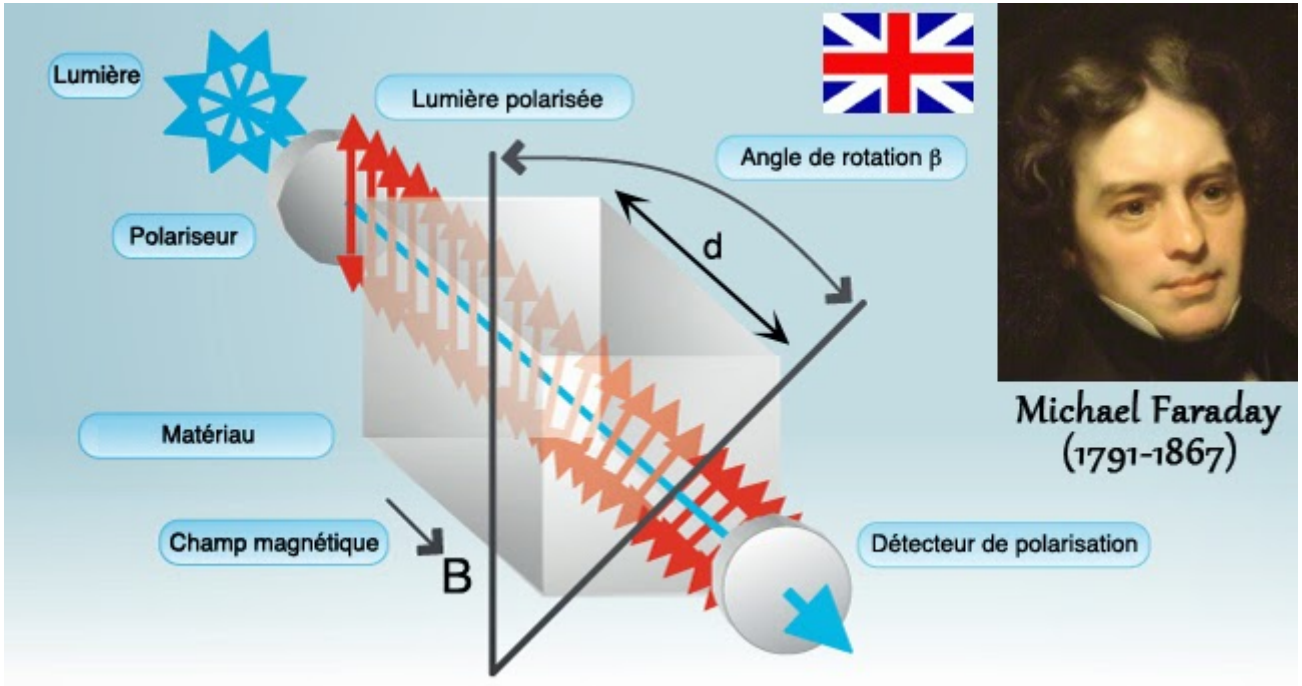


World first
61850 Disconnector
With Torque control

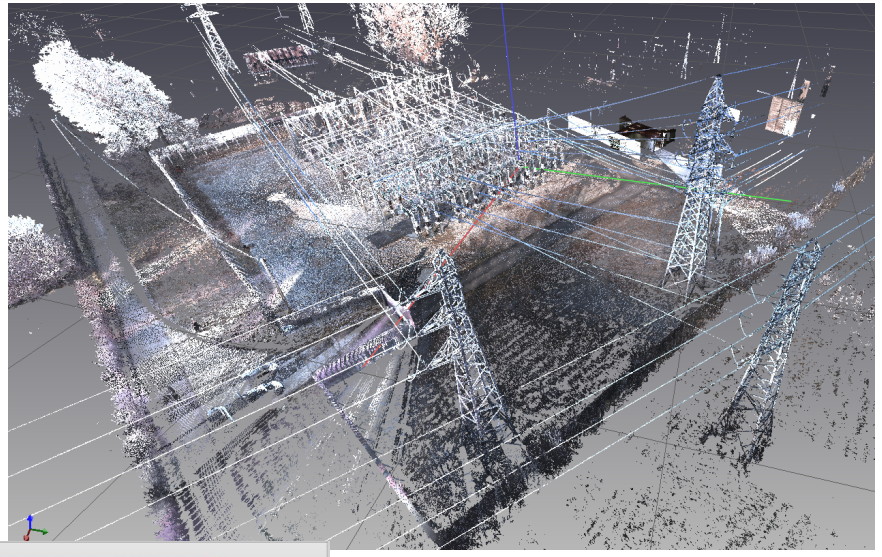
Optical CT → World first Optical CT/VT

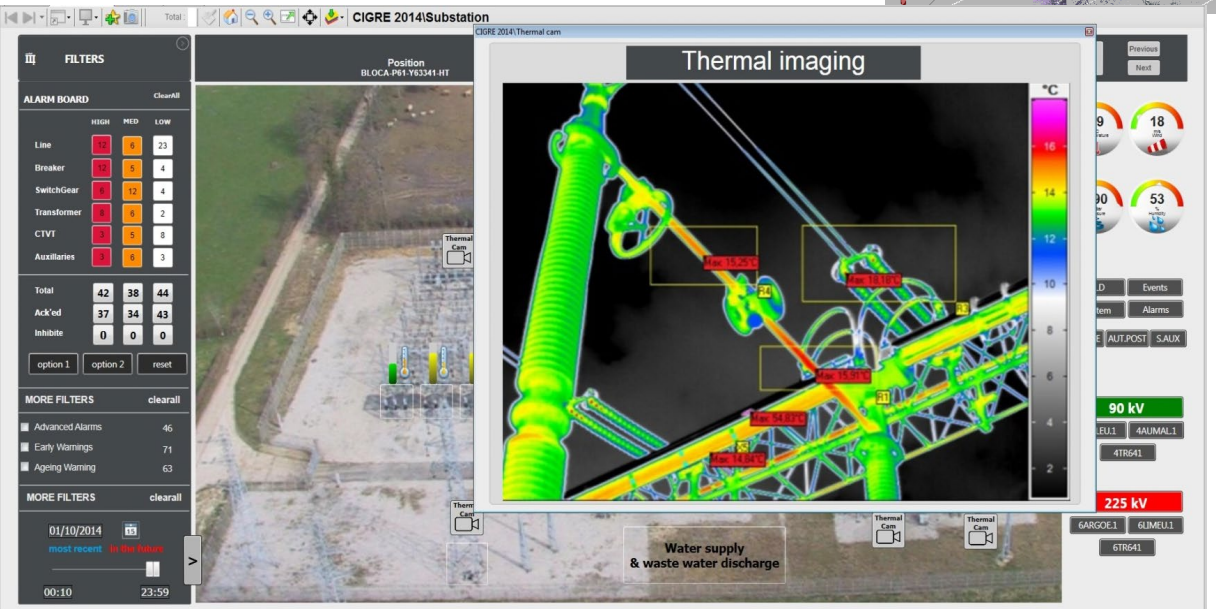


Effet FARADAY



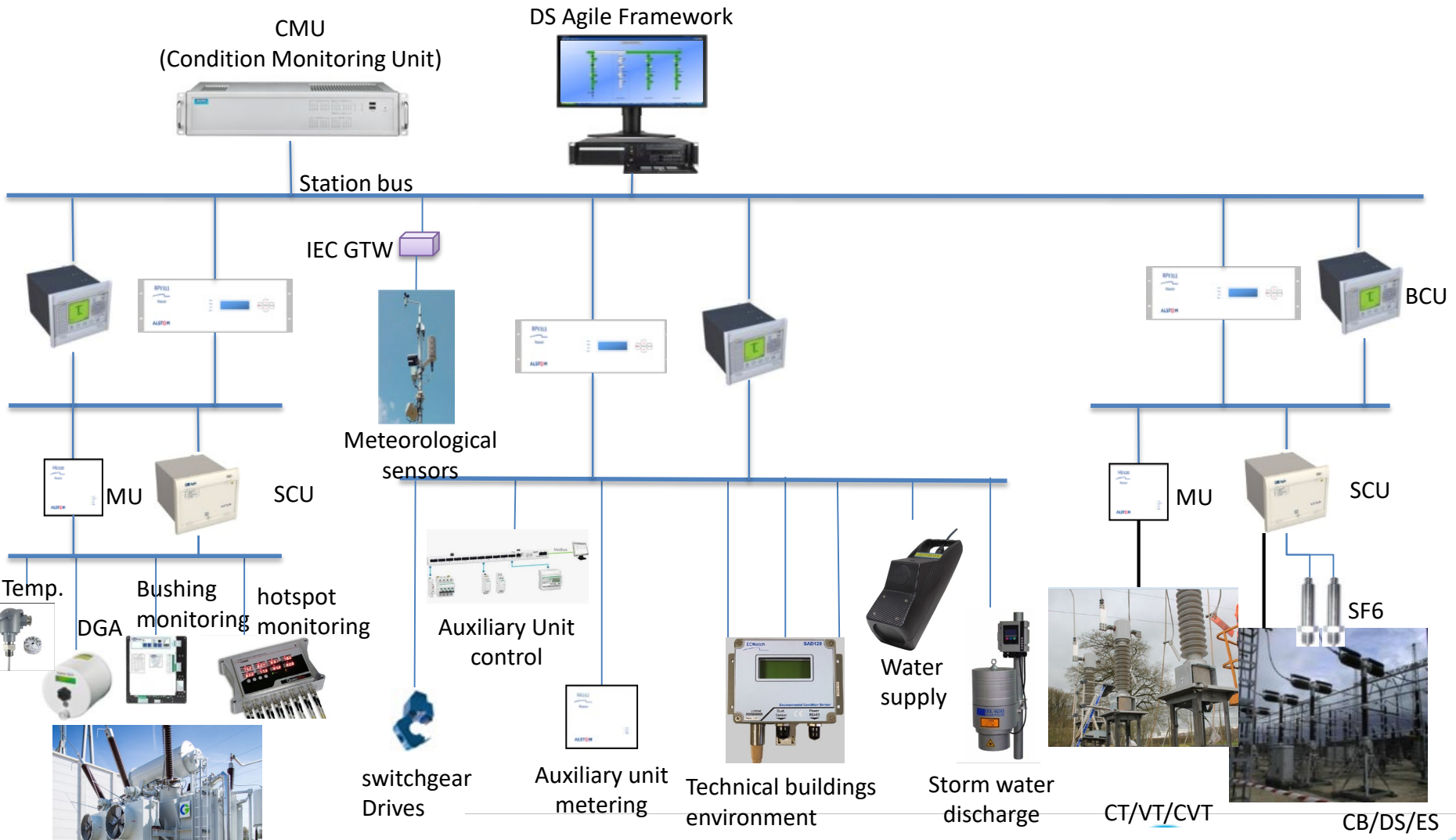
IR Hot Spot Detection



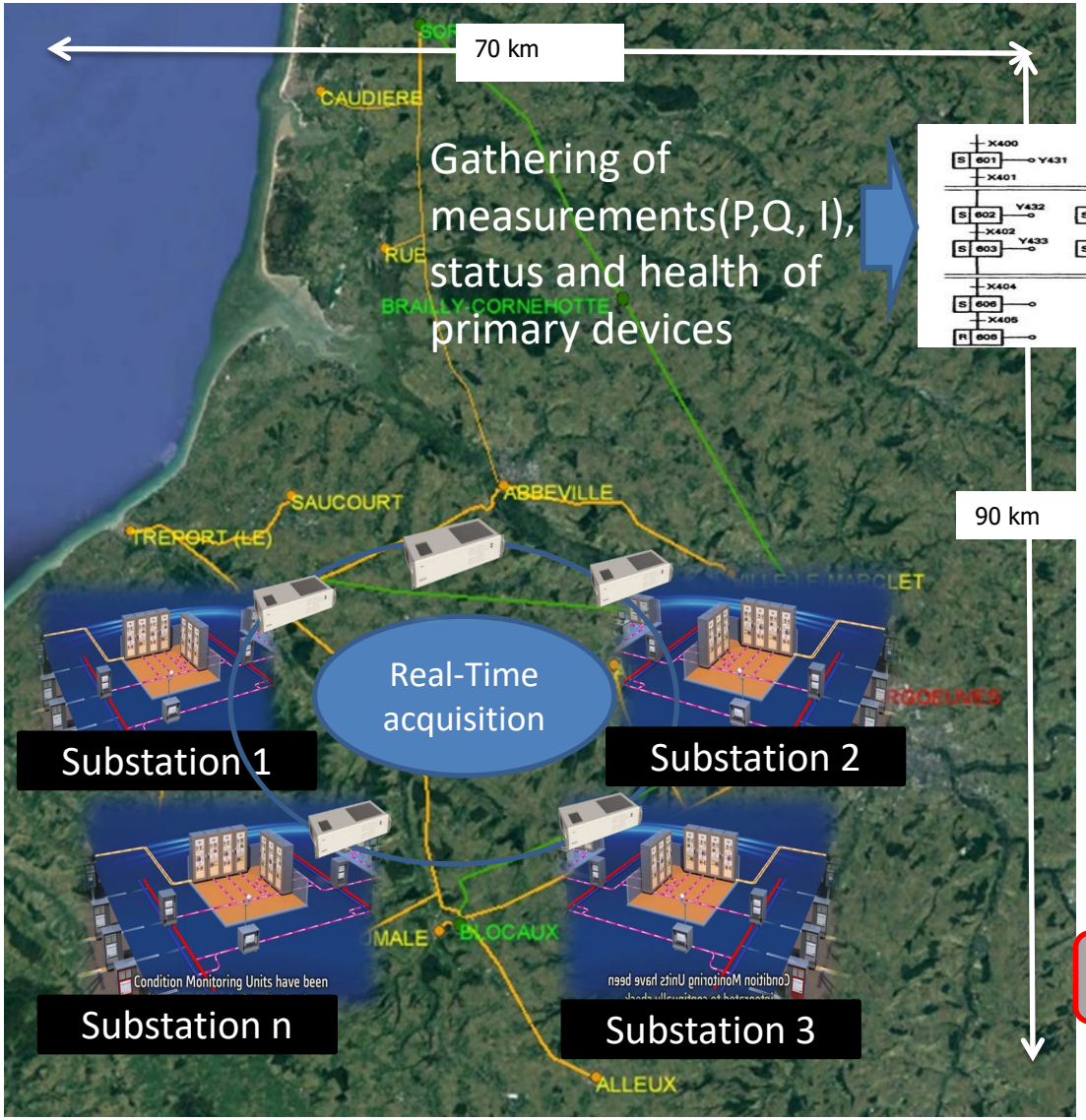


2 TIR camera sets
Range 100 m
1000 thermal points

Condition Monitoring



DLR Weather Based

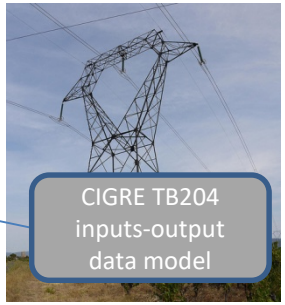


Wide area controller process real-time algorithms for wide area Control

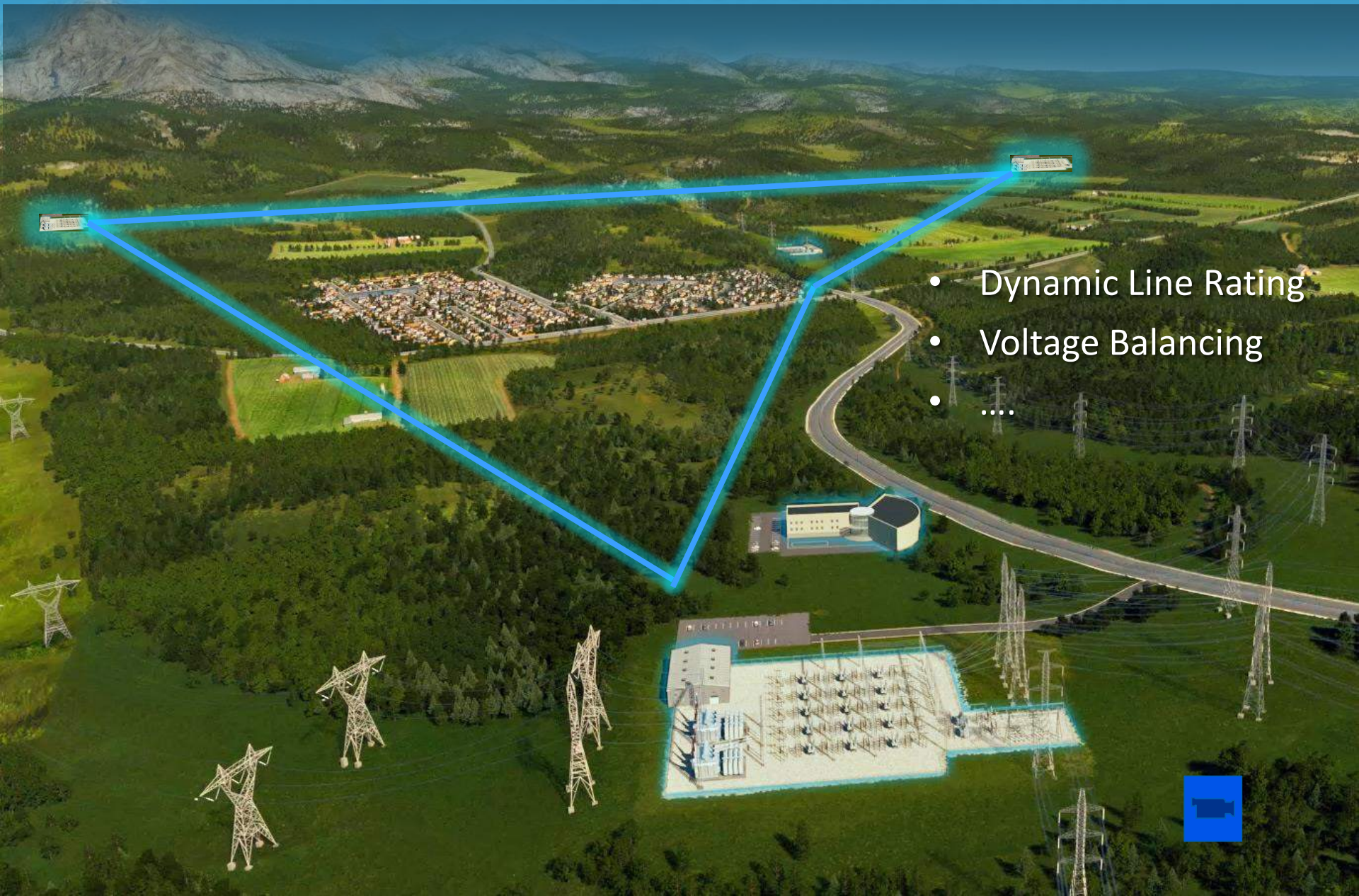
1000 MW
15 substation
500 km OHL

DLR

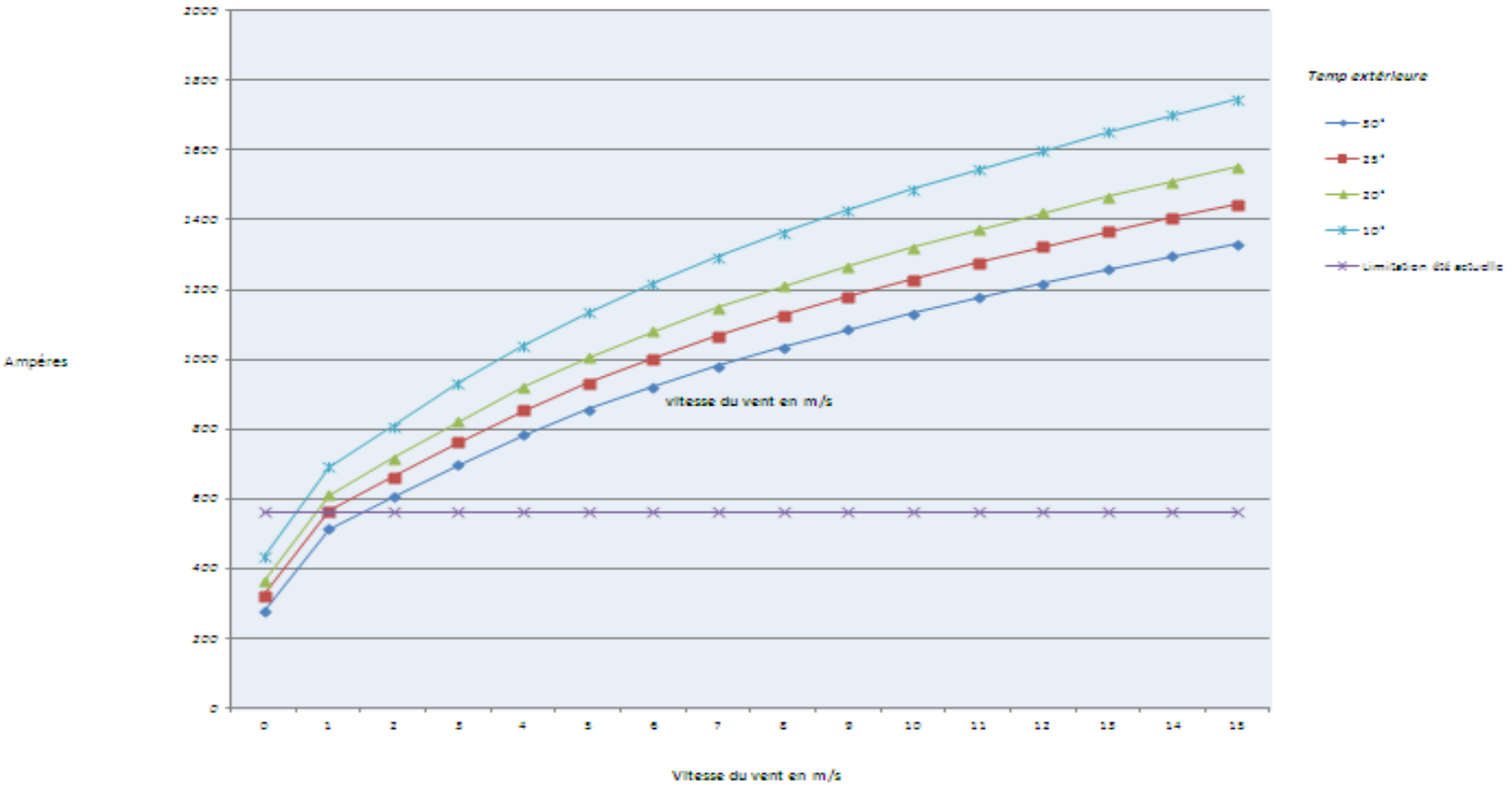
- Ampacity computation
- Ambient temperature
- Wind speed
- Wind direction
- Solar emission
- Relative humidity

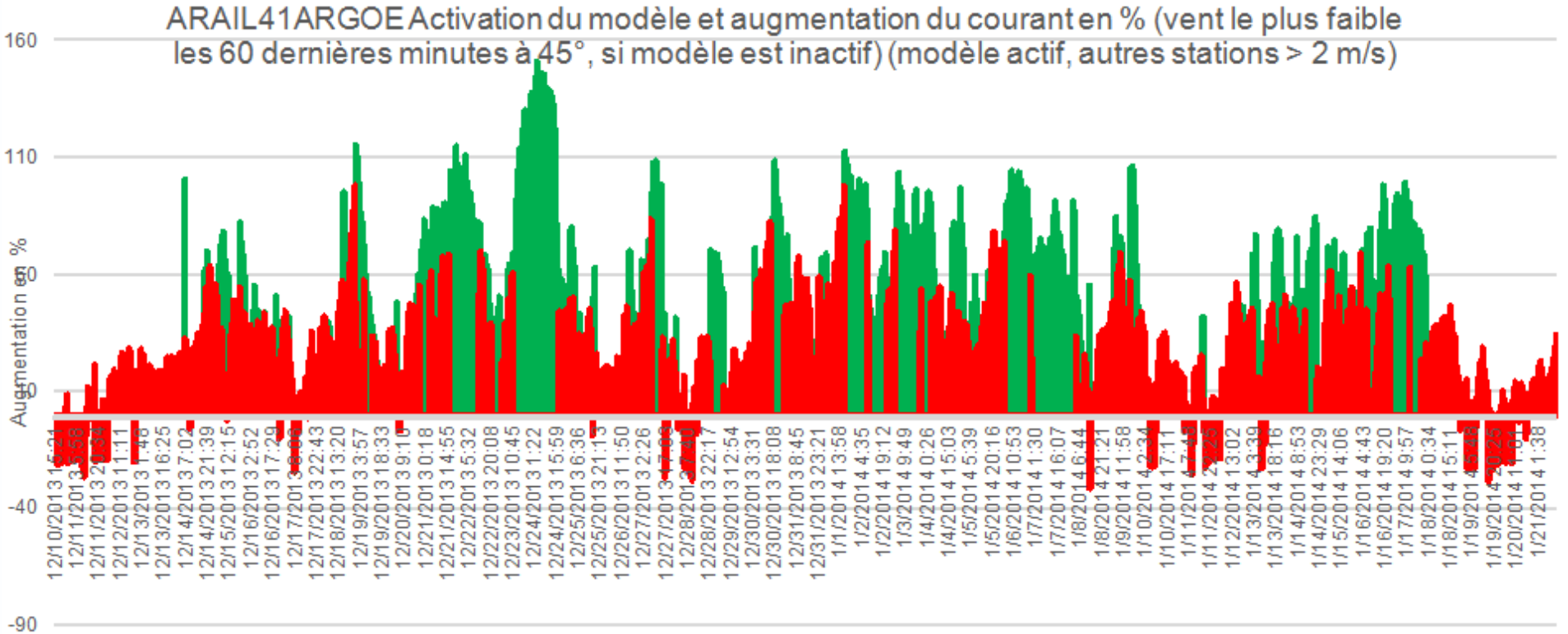


…Wide area **interconnections and controls**



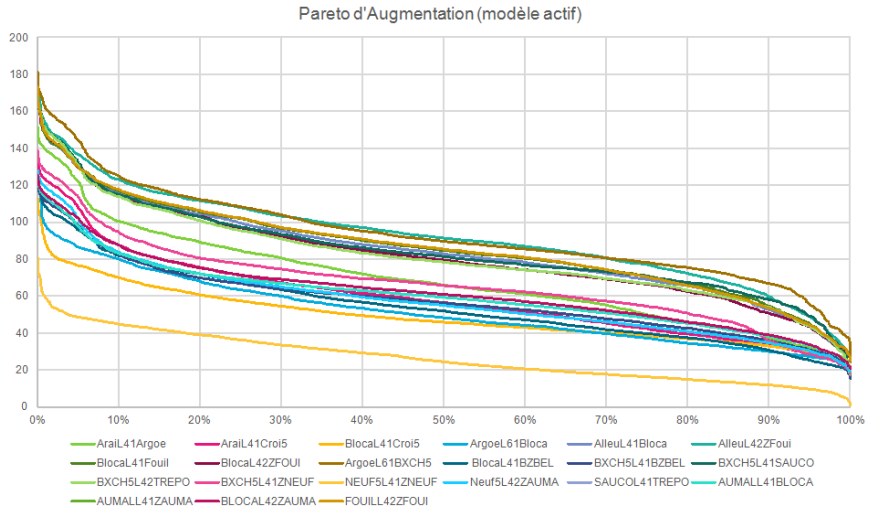
Capacités de transport d'un câble 90 kV en fonction de la vitesse du vent et de la température extérieure
Vent à 90 ° par rapport au conducteur
Rayonnement solaire maximum à 900 W/m2



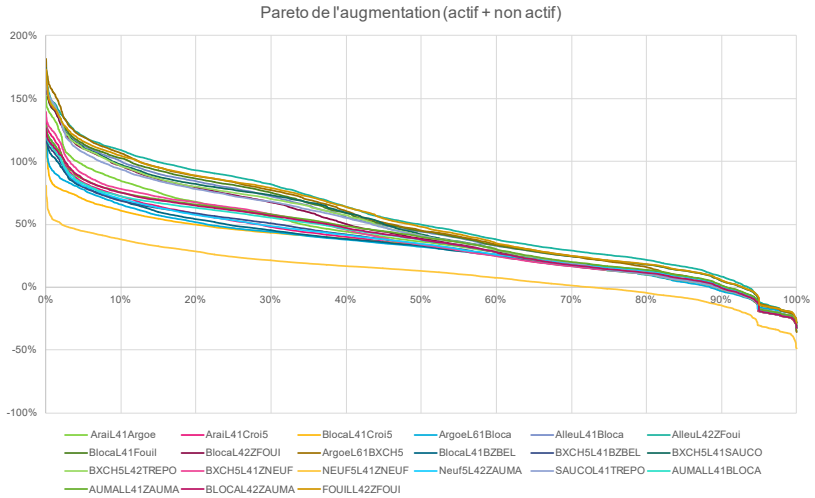

ARAIL41ARGOE Activation du modèle et augmentation du courant en % (vent le plus faible les 60 dernières minutes à 45°, si modèle est inactif) (modèle actif, autres stations > 2 m/s)
160
110
60
10
-40
-90
Augmentation en %

SIMULATION 40 jours sur zone de BLOCAUX

- MODELE ACTIF SEUL



- MODELE TOUT TEMPS



Digital Substation : 3 main phases

Smart substation learnings

The global concept

- First full digital substation in France
- Smart extends from the SCADA to the substation in a distributed way
- First step toward an optimisation of IEDs
- Powerful real time response to DER integration challenges
- Total remote control
- Concept for the secondary equipment: maintenance free

Local integrated monitoring

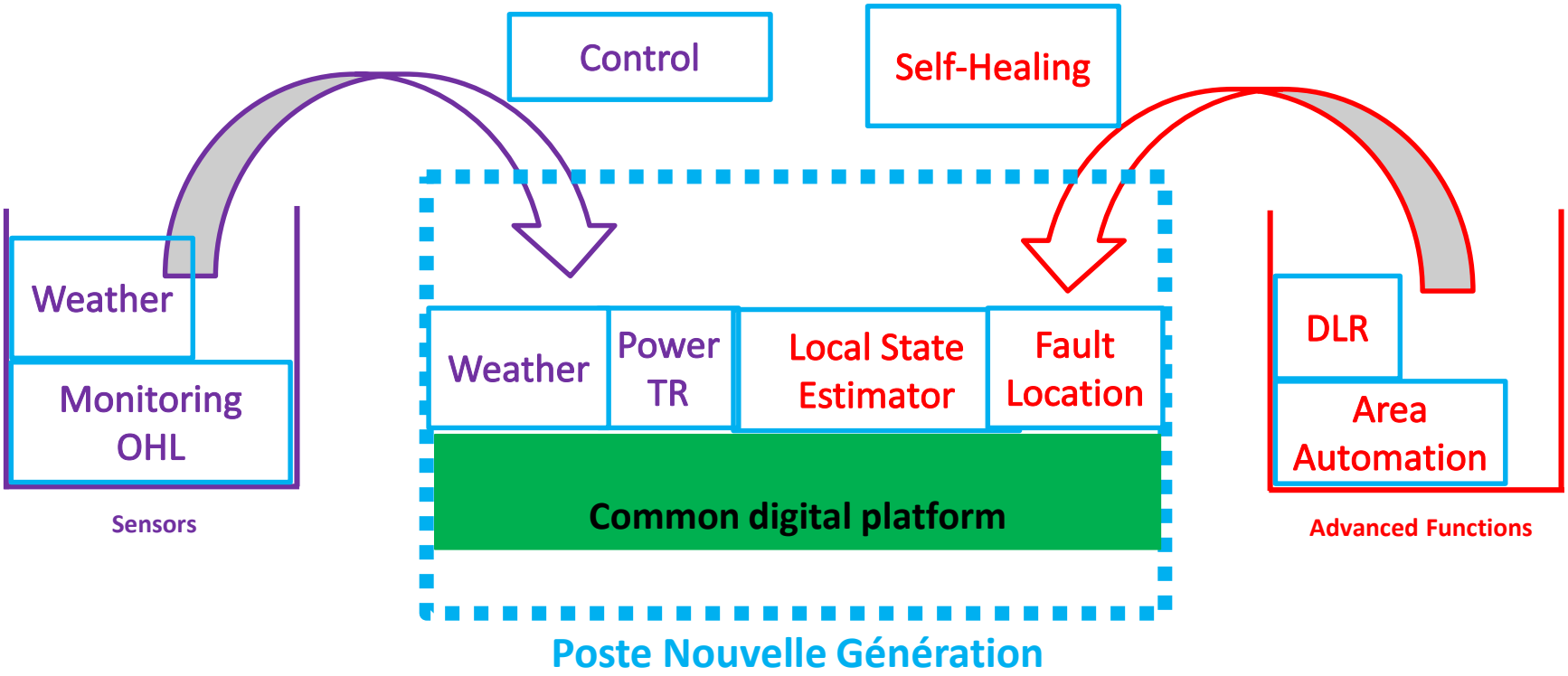
- Clustered approach
- Enhanced operational capabilities
- Scalable solutions
- Early warnings
- Trend analysis
- Conditional maintenance
- Custom asset management
- Extended life

Corporate vision

- Data lake
- Ready for Edge to cloud
- Ready for Machine Learning and Analytics

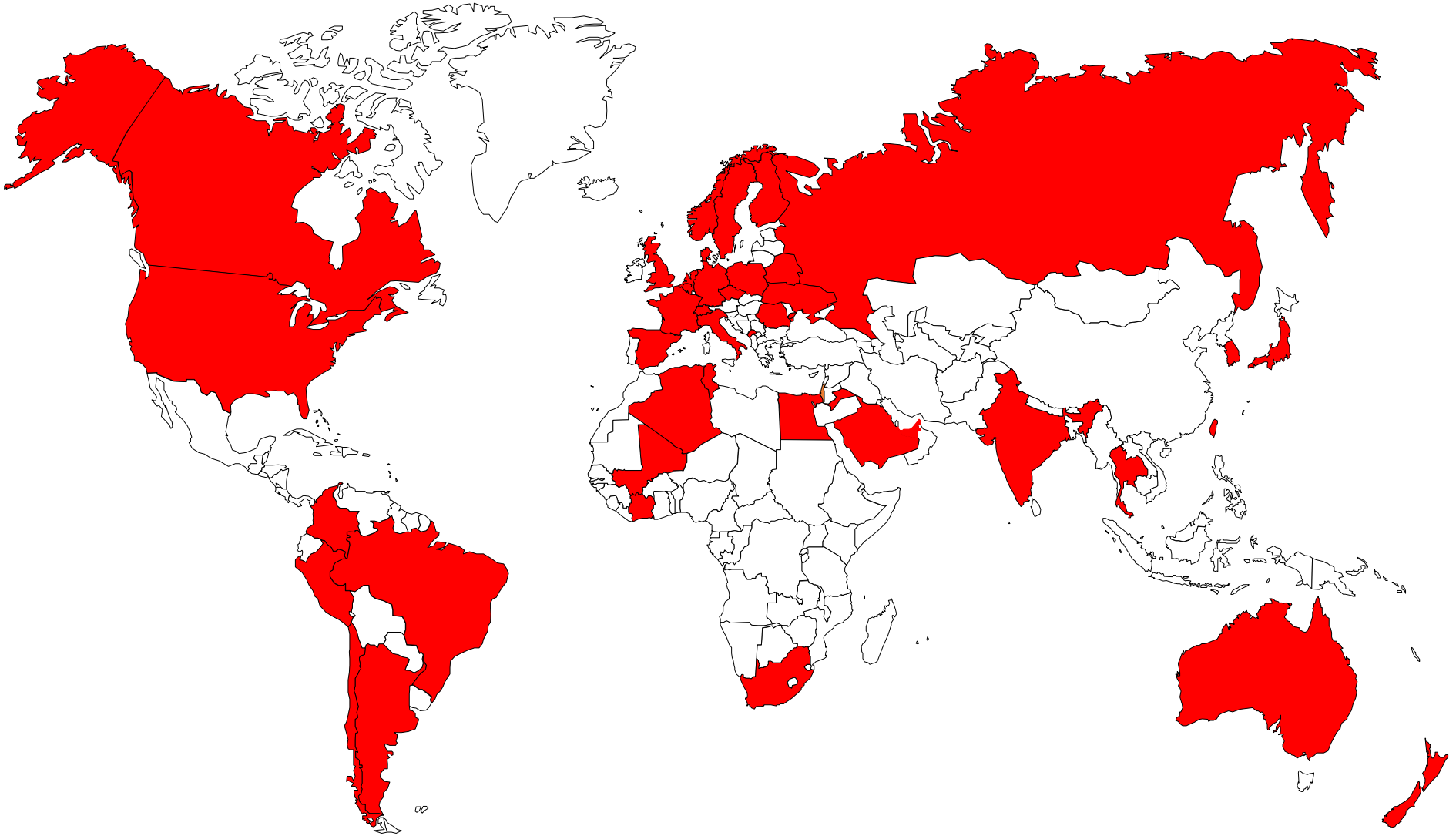
Next generation substation : Toolbox for Industrial Modular Solution

2800 digital substations in France in 2030
3 Billions Euros investment program



https://www.rte-france.com/fr/document/controle-commande-des-postes-rte-modelisation-iec-61850

Blocaux substation visits

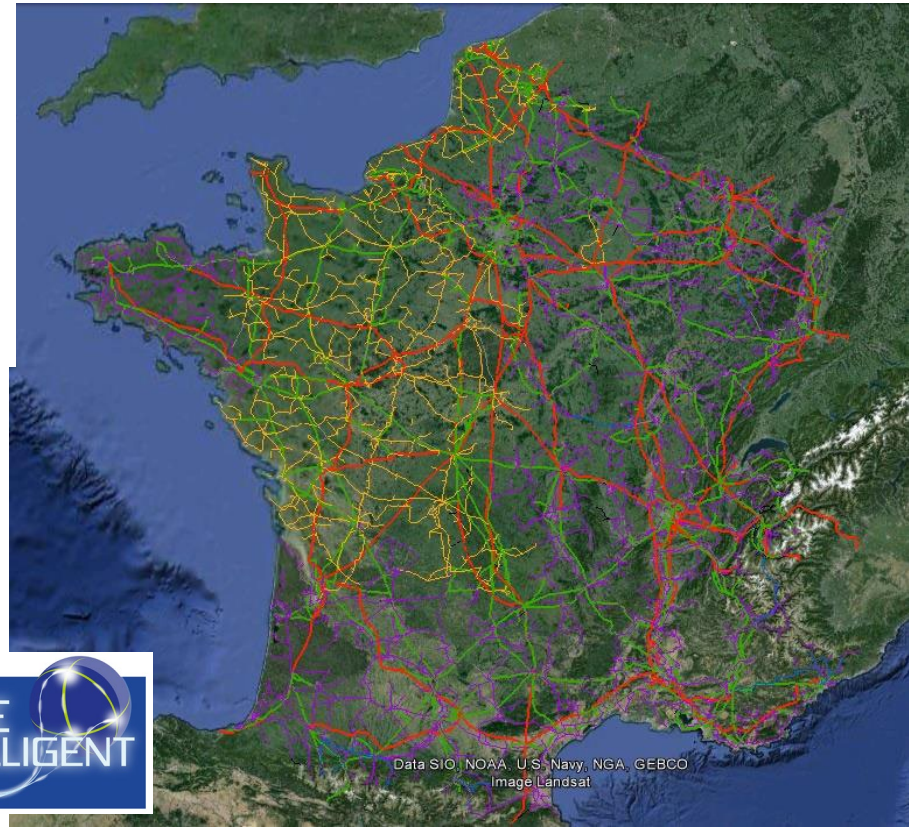


Thank you for your attention !

Your sharing of experiences

and questions

are welcome



https://www.rte-france.com/

thierry.buhagiar@rte-france.com