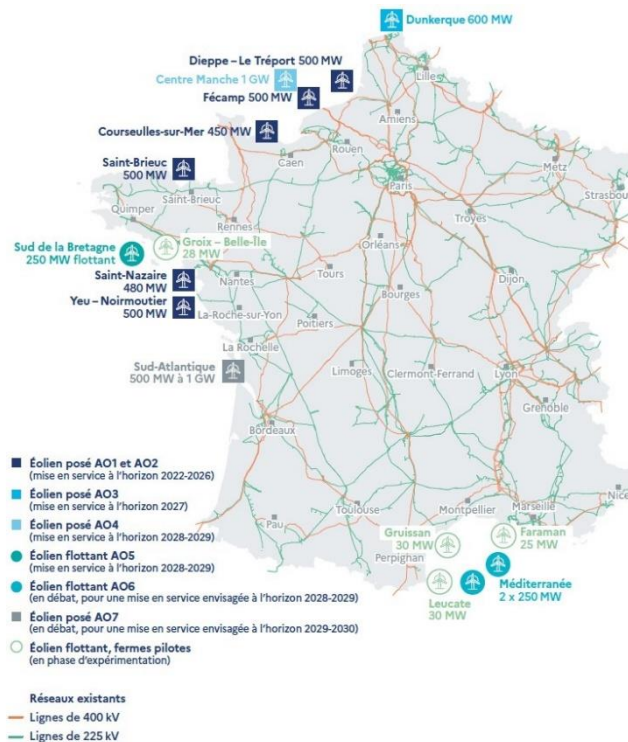


## EMT Model validation process implemented by RTE for connection of IBR

### Context

As experienced in many countries France is facing large integration of Inverter Based Ressources. They are composed of Wind generation connected in AC or in DC, Battery Energy Storage System (BESS), Photovoltaic generation, HVDC and FACTS. For offshore wind projects, 18GW generation are expected to be connected by 2030 and 40 GW in 2050. Offshore wind projects are shown in Figure 1.



*Figure 1 – Offshore Wind projects in France*

Events showing unexpected behavior of IBR with major impact on the transmission grids have been reported in several countries. A well-known example is the Odessa disturbance documented in the report [1] provided by NERC. 1-ph to ground fault occurred on the transmission grid, the fault was correctly cleared within 3 cycles. Voltage in the area recovered very quickly after fault clearance. Several PV and wind generations exhibited active power reduction (loss of 1.1GW) during this event. None of the affected installation were tripped consequentially to the fault itself. A significant number of solar PV resources responded to the fault in an abnormal manner. A post event analysis showed the main reasons of converter trip: PLL loss of synchronism was the largest contributor to the reduction of solar PV output in this even. The inverters should recover back to predisturbance output relatively quickly when voltage recovers but they failed. It is clearly established in this report that it would have been able to analyse these phenomena and prevent trip with EMT studies rather than phasor domain simulation. But EMT studies require detailed and accurate models

This is why recommendation of the grid operator in Texas (ERCOT) is to improve quality of the EMT models provided by vendors. This is a crucial aspect that needs to be addressed to improve reliability of large-scale converter based systems. Therefore validation of EMT models provided by suppliers is an important step of the connection process.

### Grid code EMT model requirement in France

Requirements for the EMT model are available in [2]. EMT model are delivered to RTE for all Power Parc Module (PPM as described in Figure 2) above 18MW (Type C and D). The power equipment cannot be black boxed. The main protections shall be included in the model.

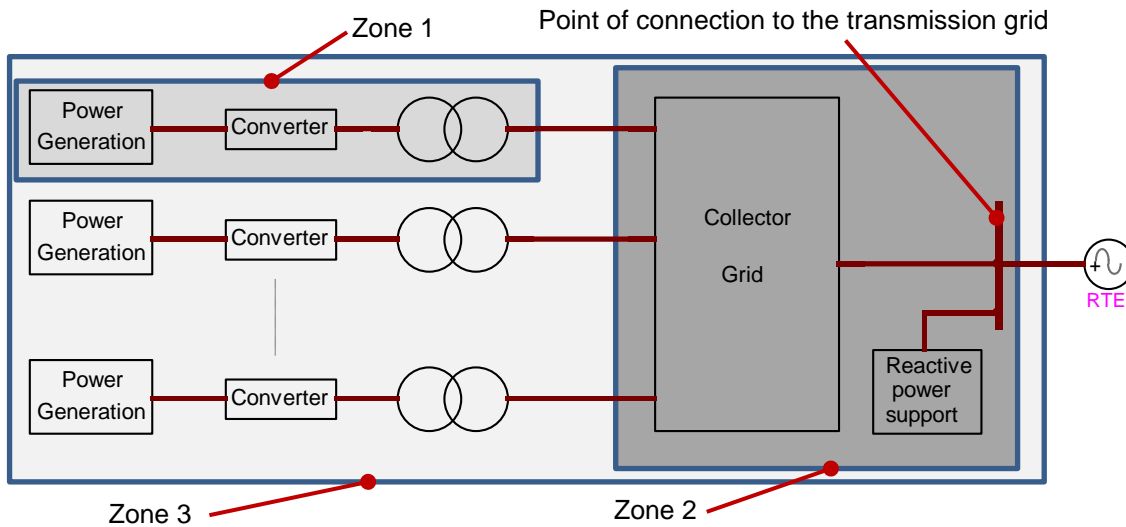


Figure 2 - PPM high level description

Validation of EMT models is described in French grid code. It is a process organized in 4 steps:

- 1<sup>st</sup> step: Validation of 1 single power generation unit

This step corresponds to the comparison between the EMT model delivered to RTE against the EMT model used by the developer to perform its dynamic studies. The simplified description of the test circuit is presented in Figure 3.

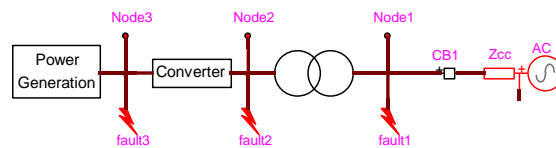


Figure 3 – Test circuit for validation step 1

- 2<sup>nd</sup> step: Validation of the collector grid

This step corresponds to the comparison between the EMT model delivered to RTE against the frequency domain model used by the developer to perform harmonic studies. The simplified description of the test circuit is presented in Figure 4.

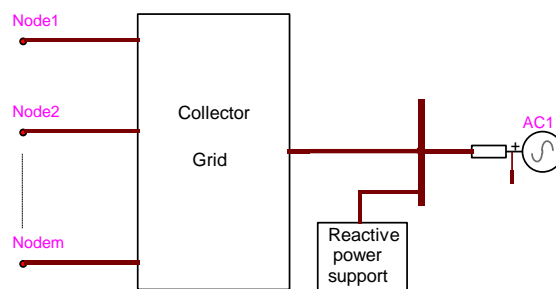


Figure 4 – Test circuit for validation step 2

- 3<sup>rd</sup> step: Comparison of the entire EMTP system with RMS model

This step corresponds to the comparison between the EMT model delivered to RTE against the phasor domain model used by the developer to perform its dynamic studies.

- 4<sup>th</sup> step: Validation of the EMT model of the entire system

Comparison between the EMT model delivered to RTE against field measurement done during site commissioning (set point change, energization and startup sequence...)

## References

- [1] [https://www.nerc.com/pa/rrm/ea/Documents/Odessa\\_Disturbance\\_Report.pdf](https://www.nerc.com/pa/rrm/ea/Documents/Odessa_Disturbance_Report.pdf)
- [2] Rte service