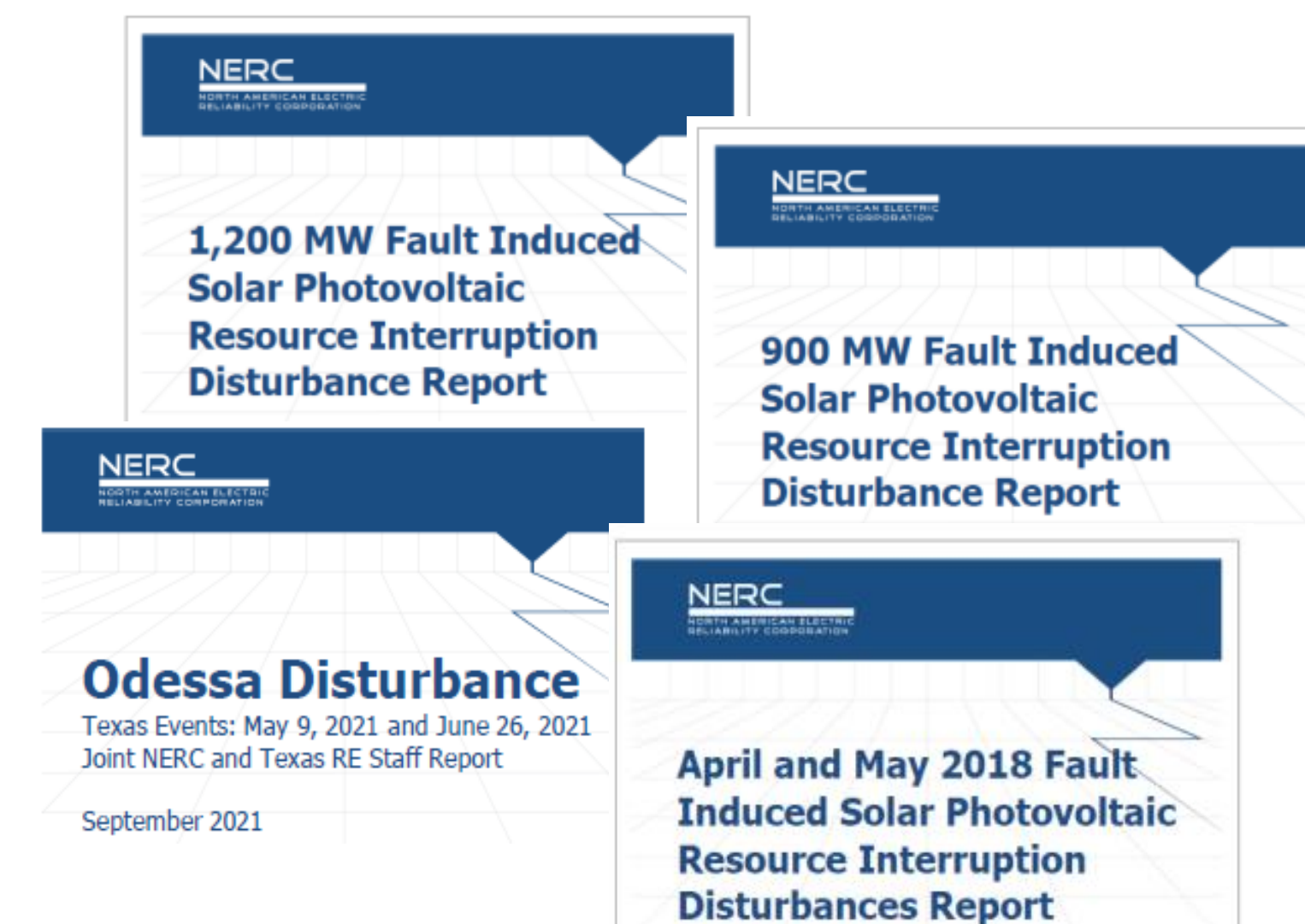


EMT Modeling for Offshore Wind: Motivations and Challenges

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Arup

Reliability Gaps in Renewables Interconnection

- Numerous IBR-related reliability disturbances have been reported and investigated by NERC in recent years.
- At the heart of the problem is **inadequate** modelling, simulation and assessment of the operation and control strategies of the Inverter-Based Resources (IBRs).



Proactive Approach for EMT Modelling

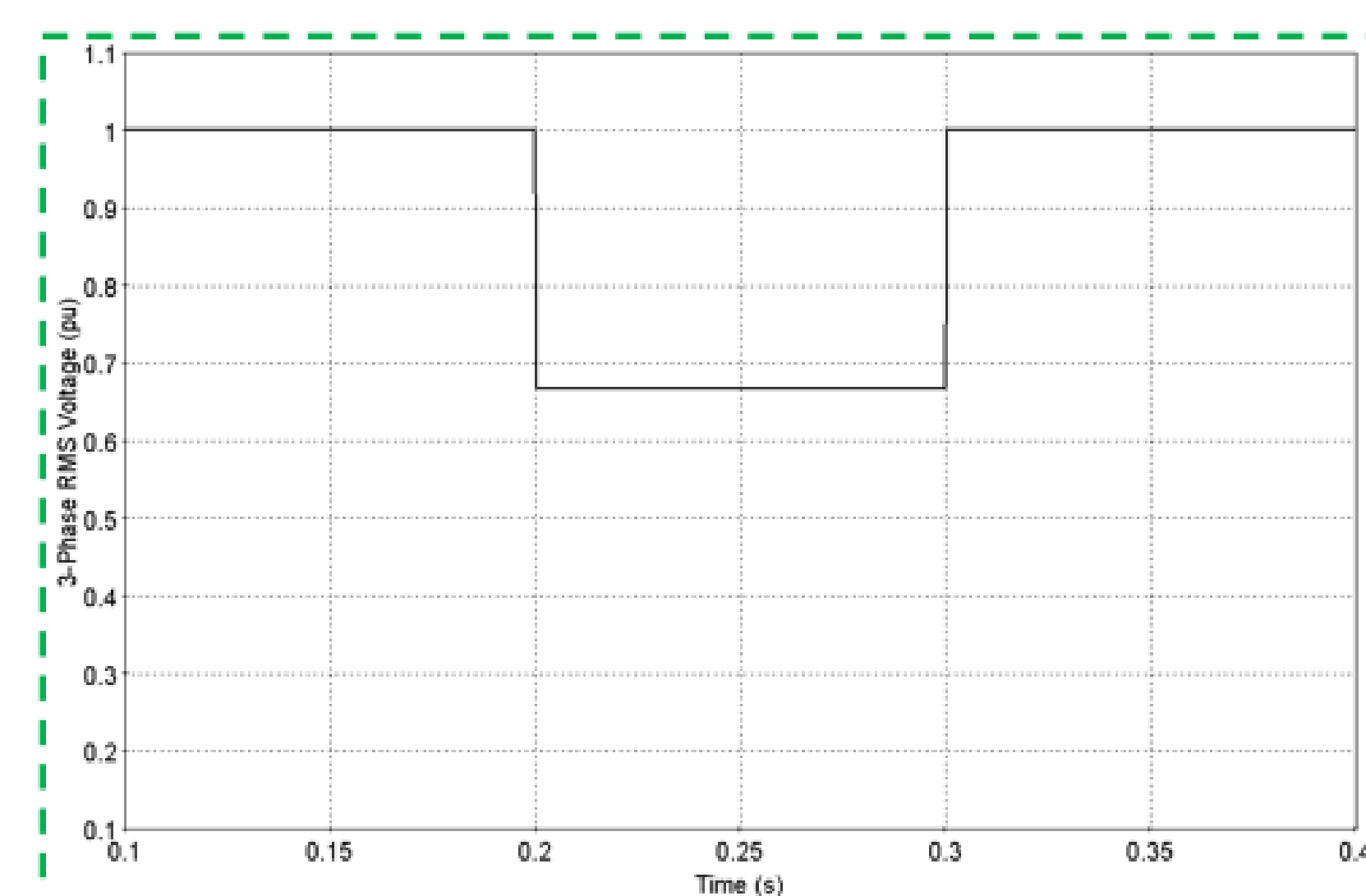
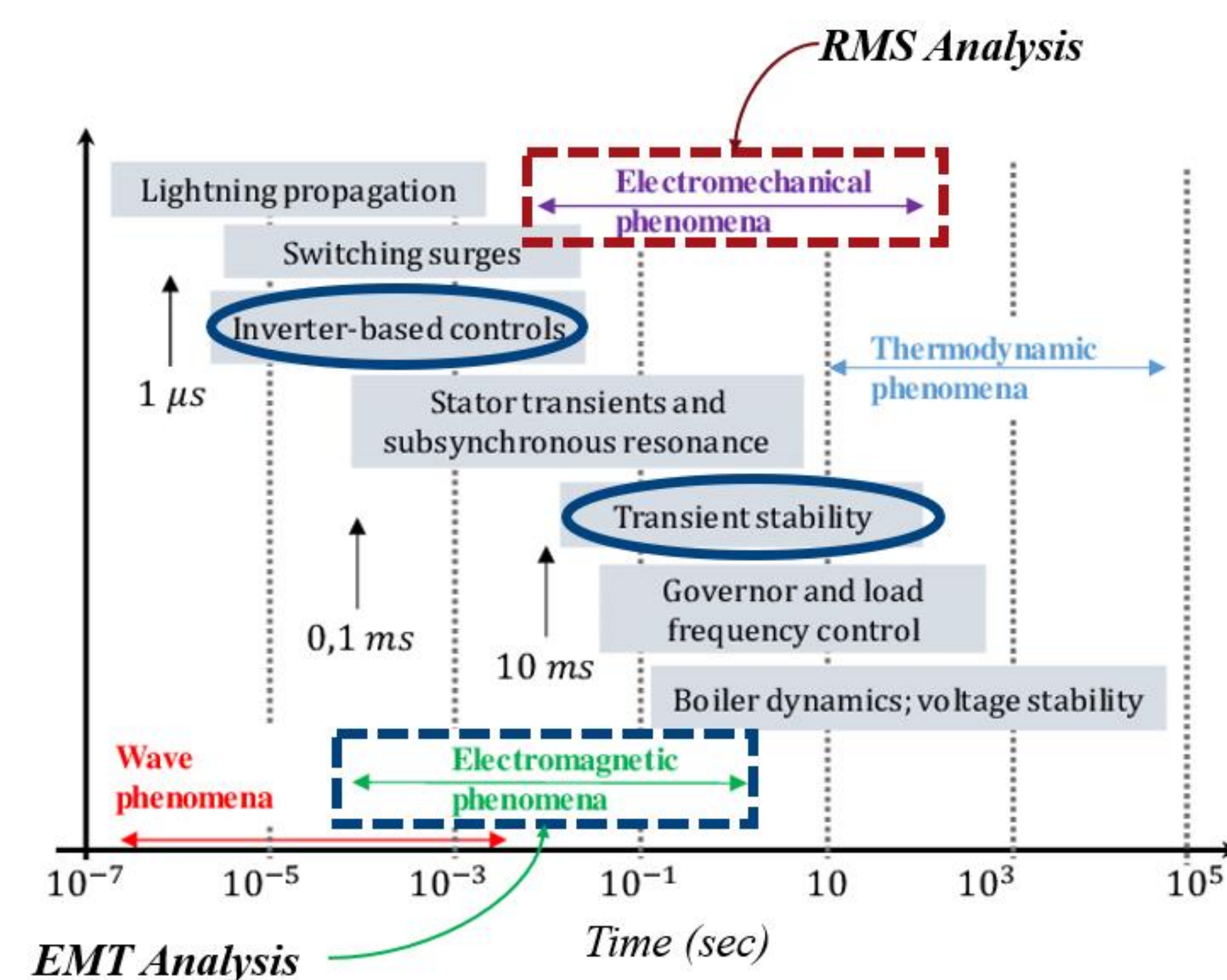
- Developers should adopt a **proactive** approach to obtain and maintain **complete** and **validated** EMT models for their projects all the way from the energy source (WTG, PV, etc.) to the POI.
- At minimum, all **Fault-ride through (FRT)** modelling, tuning and assessment for IBRs should be performed using validated EMT models.
- RMS models should be **benchmarked** against validated EMT models.

EMT Modelling Challenges

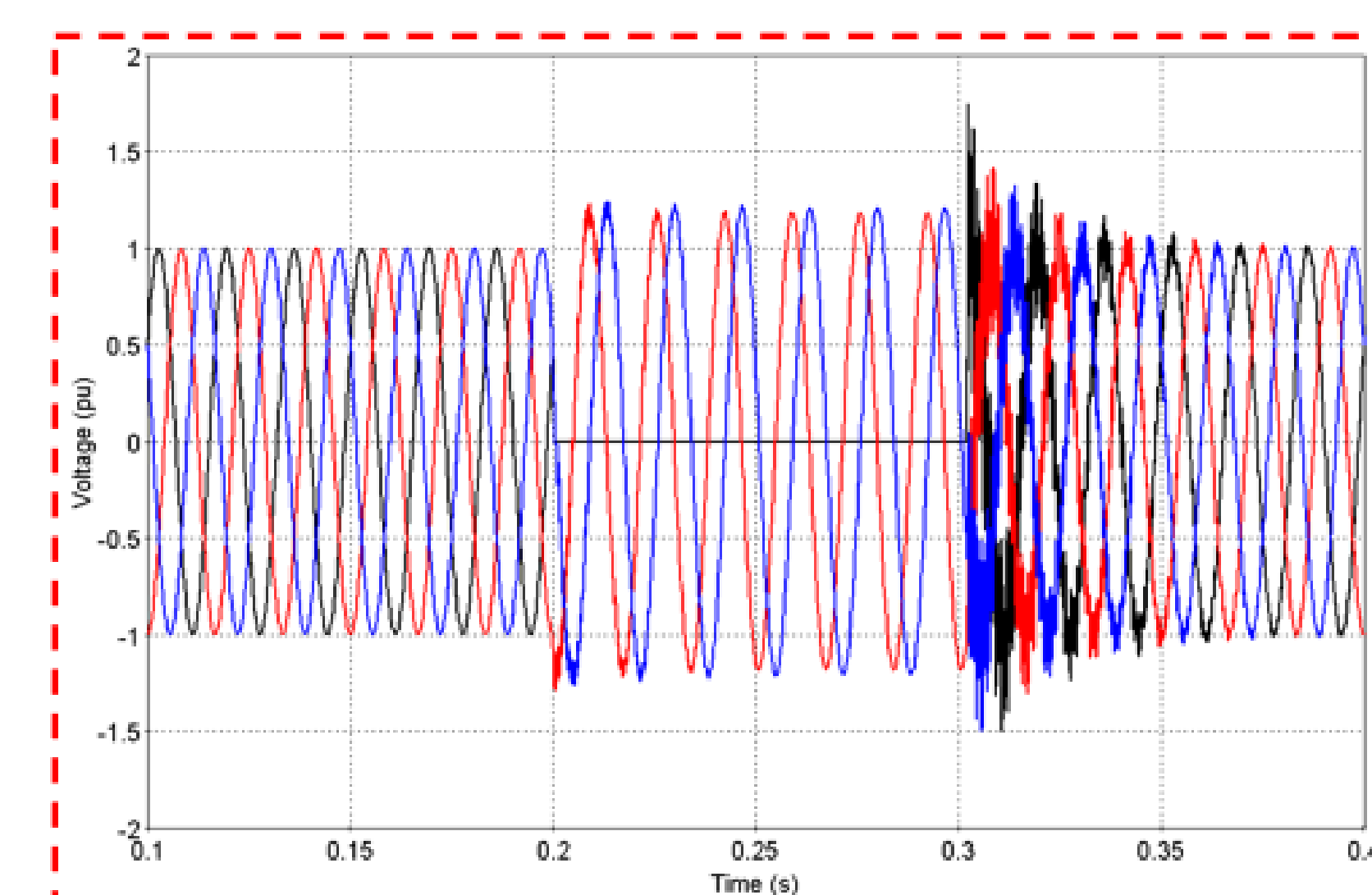
- Equipment EMT models are normally black-boxed to protect vendor's IP.
- EMT models require more effort to gather parameters and ensure the models are validated.
- EMT simulations are computationally intensive and therefore large-scale EMT simulations are very challenging.
- Utilities and transmission planning entities are not familiar with EMT for use in typical planning studies.

Impact of IBRs on Power System Transients

- Power system transient stability have traditionally been dominated by the **electromechanical** transients of synchronous machine rotor.
- With significant increase in IBRs (such as OSW), the power system dominant transient is shifting to the **electromagnetic** domain.
- RMS Analysis cannot truly capture the performance of IBRs and all its controls and protection systems.



RMS Analysis



EMT Analysis

Modelling of IBRs Control and Protection Systems

- Regulatory requirements related to EMT modelling of IBRs are under development by FERC and NERC.
- IEEE P2800 has been published recently and will likely form the basis for IBR performance requirements in the near future.
- IBRs, specially HVDC-connected OSW, have intricate tripping mechanisms, protection systems, controls that can only be modelled in EMT simulations:
 - PLL loss of synchronism
 - Instantaneous AC overvoltage and overcurrent
 - DC reverse current
 - DC low voltage
 - Control systems interactions
 - Sub-synchronous resonance
 - Performance under unbalanced system or unbalanced faults
 - Performance under weak grid situations

329. Specifically, we propose to revise Attachment A to Appendix 1 of the *pro forma* LGIP, and Attachment 2 of the *pro forma* SGIP to require each interconnection customer requesting to interconnect a non-synchronous generating facility to submit to the transmission provider: (1) a validated user-defined root mean square (RMS) positive sequence dynamics model; (2) an appropriately parameterized, generic library RMS positive sequence dynamics model, including a model block diagram of the inverter control system and plant control system, that corresponds to a model listed in a new table of acceptable models or a model otherwise approved by WECC; and (3) a validated EMT model, if the transmission provider performs an EMT study as part of the interconnection study process.

FERC NOPR on Generation Interconnection Reform

Conclusions

- IBR resources, including Offshore wind, can provide great benefits to the reliability of the power grid by utilizing their control capabilities.
- Conventional RMS modelling and simulations are tailored to study transient stability of synchronous machines and cannot truly model IBRs in great details.
- Adopting EMT modelling and simulations can ensure the reliability of IBRs and unlock the full potential of utilizing IBRs to support the wider grid reliability.

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