

Netherlands-France



Cross-Border Guardians: Control Room of the Future

Digital Twins for cyber-physical grid resilience and stability



Dutch Demo



Concept

Digital Twin that mirrors real-time power system operation and communication dynamics to enable proactive cybersecurity and stability assessment. It aims to enhance cyber-physical grid resilience and ensure a stable and secure operation under diverse attack and disturbance scenarios.

Key outcomes

- Realistic replication of cyberattack propagation and its physical consequences, enabling cyber attack detection, impact and cascading failure analysis.
- Realistic emulation of power system dynamic behaviour under renewable-dominated conditions, enabling stability assessment, disturbance analysis, and evaluation of mitigation strategies.

Impact/added value

- Provides a safe experimental environment where operators can simulate, anticipate, and mitigate cyber-physical disturbances before they affect the real grid, thereby strengthening grid resilience without risking live infrastructure.
- Improves situational awareness of cyber and stability risks under evolving operating conditions and high renewable penetration.

Time for deployment

Integrated Dutch grid will be tested in the final year of the project and deployed in full operation in two years after project completion

Potential users

- TSOs/DSOs
- Control Room Operators
- Cybersecurity Engineers
- Power System Stability Engineers

Lessons learnt

- Cyber disturbances should be evaluated within an integrated cyber-physical framework, as network-level anomalies can propagate into significant physical consequences.
- Digital Twin provides a safe and controlled platform for assessing such impacts without exposing operational infrastructure to risk.
- Stability assessment is essential in renewable-dominated systems, where disturbances and control interactions may rapidly affect grid security.

Technology Readiness Level

1 2 3 4 5 6 7 8 9



French Demo





enhanced
observability and
controllability

advanced
forecasting for
optimized market
actions

smart
coordinated
planning

improved
physical and
cyber grid
resilience

Concept

Develop DT of Control Room to both train operators and to test new decision –support assistants using existing state –of-the-art tools and frameworks. The simulator integrates cyber-physical components, a game master for scenario generation, SCADA emulation and communication network modelling.

Key outcomes

- Reviewed existing training solutions and defined the overall system architecture
- Developed core components, including:
 - Game Master for scenario generation
 - Orchestrator coordinating real-time simulation across components
 - SCADA Emulator
 - Grid Simulator based on Dynawo
 - Information Flow Model – to model the telecommunication grid

Impact/added value

- Enable R&D teams to design, validate, and deploy decision-support tools for the operations in control room of the future
- Supports simulation of realistic and complex operational scenarios
- Allows testing and validation of automation strategies and control systems
- Promotes transparency, reproducibility, and collaboration through an open-source framework, particularly the development of a SCADA emulator (in the absence of suitable open-source solutions)

Time for deployment

One Year

Potential users

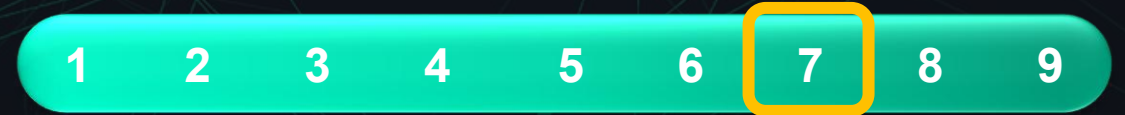
- TSO
- DSO
- Operators in the control room

Lesson learnt

„Defining the system architecture was initially complex, which led to a slow start. However, a strong collaboration between partners helped resolve these challenges. The use of open-source tools such as Dynawo and PowSybl, along with standardized data, improved integration and interoperability.”

Lucas Saludjian, RTE –French demo leader

Technology Readiness Level



The Netherlands:

France

Demo leader:



Demo partners:



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