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Energy Session

Digital Twins, Energy Data Spaces and Interoperability for the Sustainable Energy Transition

May 6th 2026, Oslo (Norway)

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Session Outline

- Welcome and introduction on Policy Context & Digitalisation Challenges – 10 min, Dr. Massimo Bertoncini, Engineering, Digital Energy R&D Opportunities Senior Manager & Energy BDVA TF7 Task Force Lead
- Digital Twin Methodologies & Frameworks, INTEREST and ORION projects Digital Twin approaches. Balram Panjwani (SINTEF); Scott Young (AUGM), **20** min
- Real-World Digital Twin Use Case Demonstration, Fengshuo Hao (RWTH), 10 min
- Integrating Energy Digital Twins with Energy Data Space through the OneNet Energy DataSpace Connector– An Innovation Trajectory from TwinEU and AVANT projects, Massimo Bertoncini, Engineering, (10 min)
- Collaborating Digital Twins: A Data Space Mini-Energy-Grid Use Case for Sovereign Data Exchange, Gøran Brekke Svaland (SINTEF), (10 min)
- Local partner experience using Data Space and Digital Twins, Petter Kvalvik (IFE), (10 min.)
- Discussion & Future Collaboration (10 min) , All partners (chaired by Massimo Bertoncini)
- Q&A from Audience & Conclusions (10 min)

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Integrating Energy Digital Twins with Energy Data Space through the OneNet Energy DataSpace Connector- *An Innovation Trajectory from TwinEU and AVANT projects*

Massimo Bertoncini, Engineering, Digital Energy R&D Opportunities Senior Manager & Energy BDVA TF7 Task Force Lead

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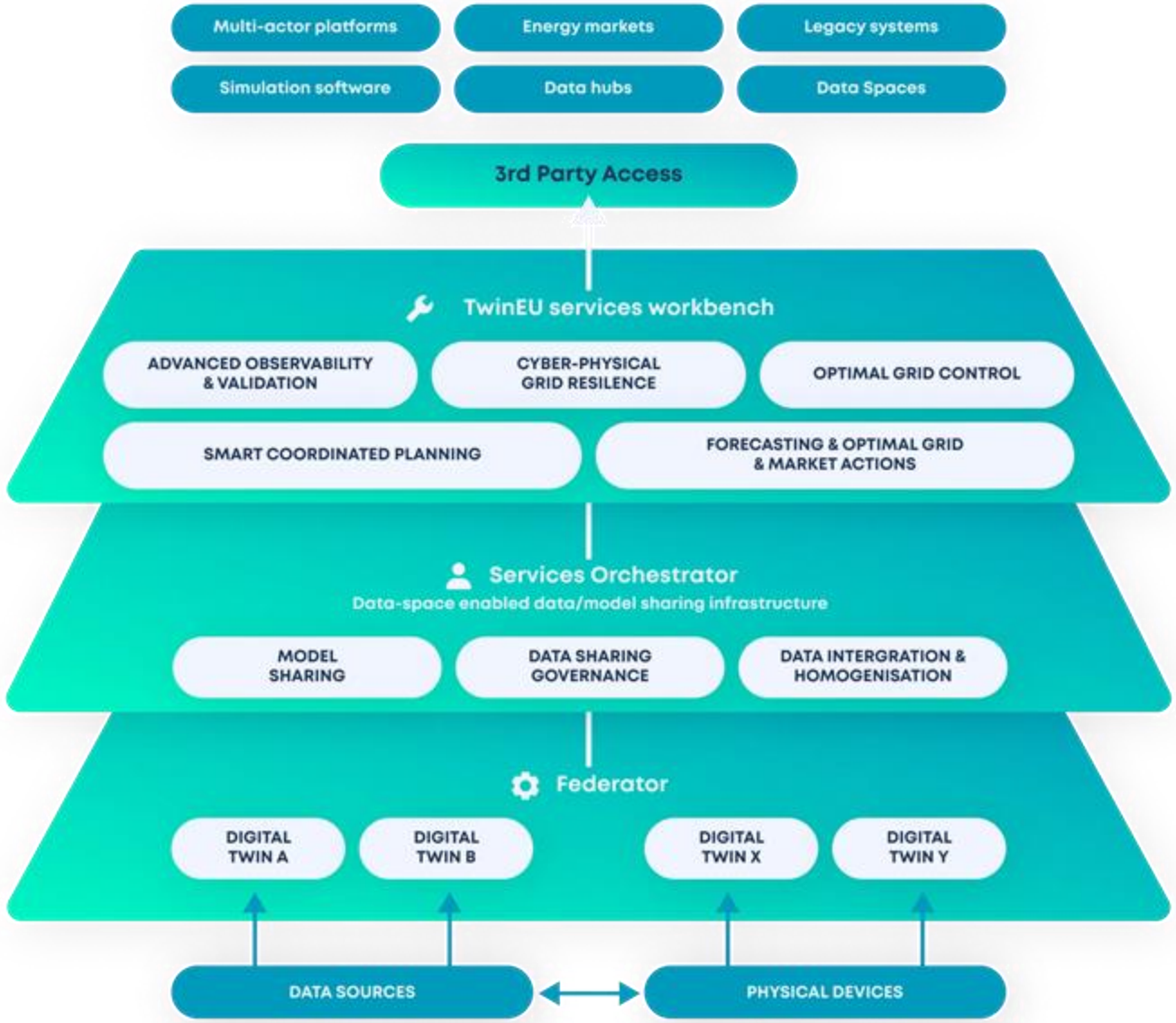
TwinEU – Key Facts

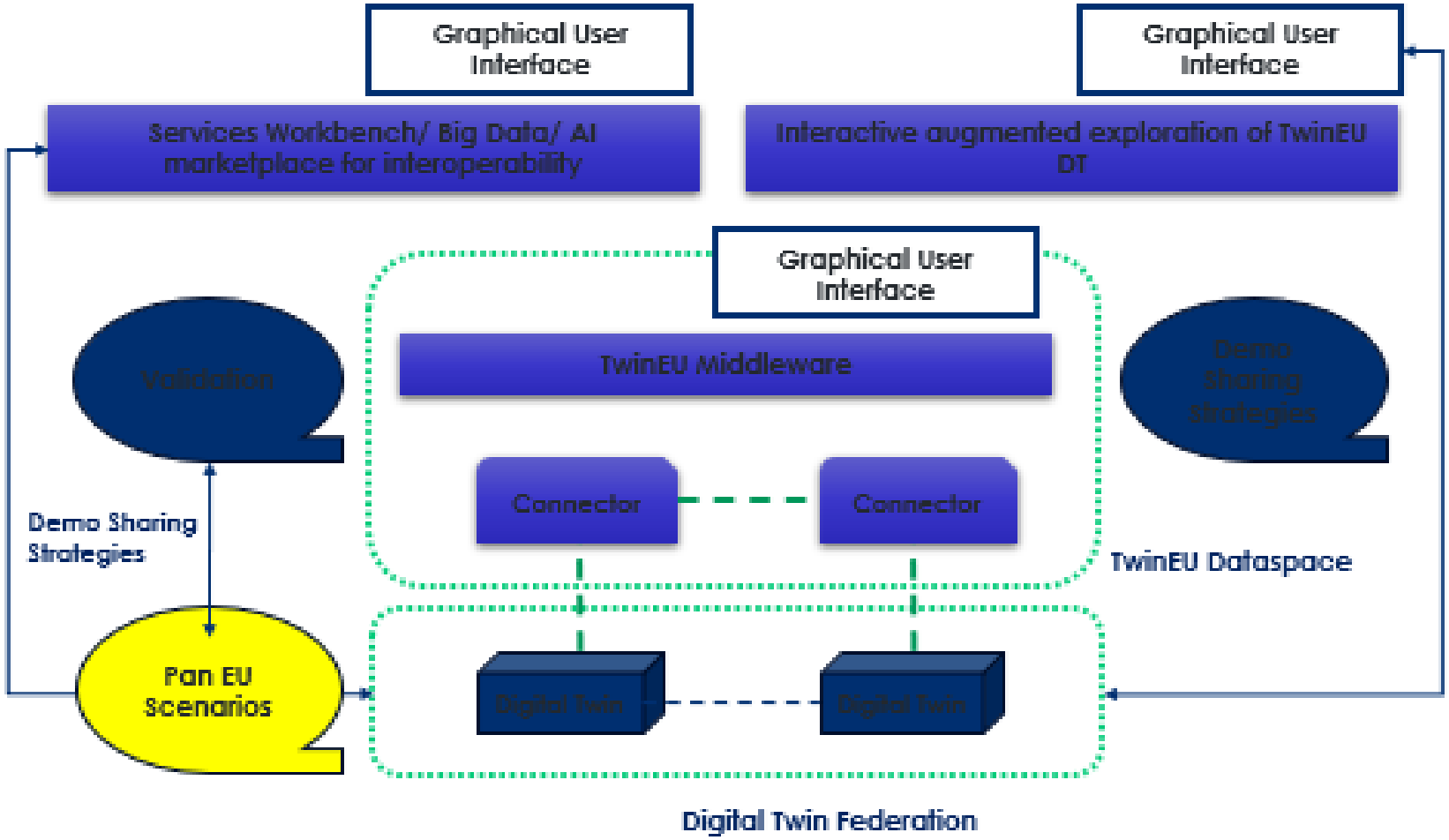
- **Programme**: Horizon Europe Innovation Action
- **Topic**: HORIZON-CL5-2023-D3-01-10 - Supporting the development of a digital twin to improve management, operations and resilience of the EU Electricity System in support to REPowerEU
- **Start**: Jan 2024
- **Duration**: 36 Months
- **Budget**:
  Estimated Project Cost: €25,216,061.25
  Requested EU Contribution: €19,999,999.50
- **Number of partners**: 71 beneficiaries,
  4 associated partners, 7 affiliated entities

Main Objectives- Federation of Digital Twins

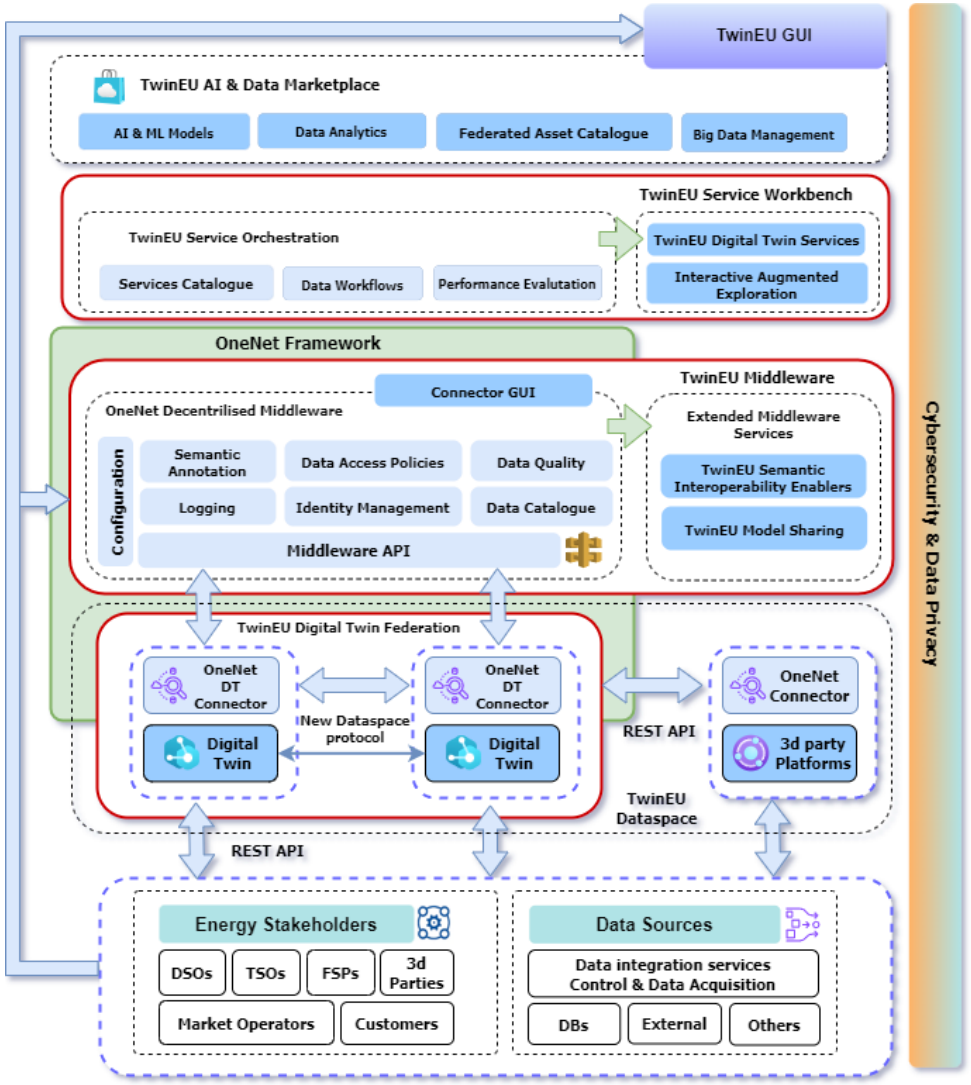
- **31 different digital twins** within the 8 demos
- A **reference architecture** will ensure the interoperability
- **Local twins** & use cases will build up **pan-EU solutions**
- Ensuring connection with the **European Data Spaces**



Simplified Reference Architecture



TwinEU Architecture



AI & Data Marketplace AI/ML Models, Data Analytics and Big Data Mgmt supporting DT development

Service Workbench AI/ML Models, Data Analytics and Big Data Mgmt supporting DT development

Federation Layer **DT Connector** embedded in each Digital Twin **Middleware** providing Data Quality, Data Access Policies, IDM, Semantic Interoperability, Data/Model sharing and Data catalogue

DT Layer External DTs managed by energy stakeholders (TSO, DSO, etc.), outside the TwinEU platform

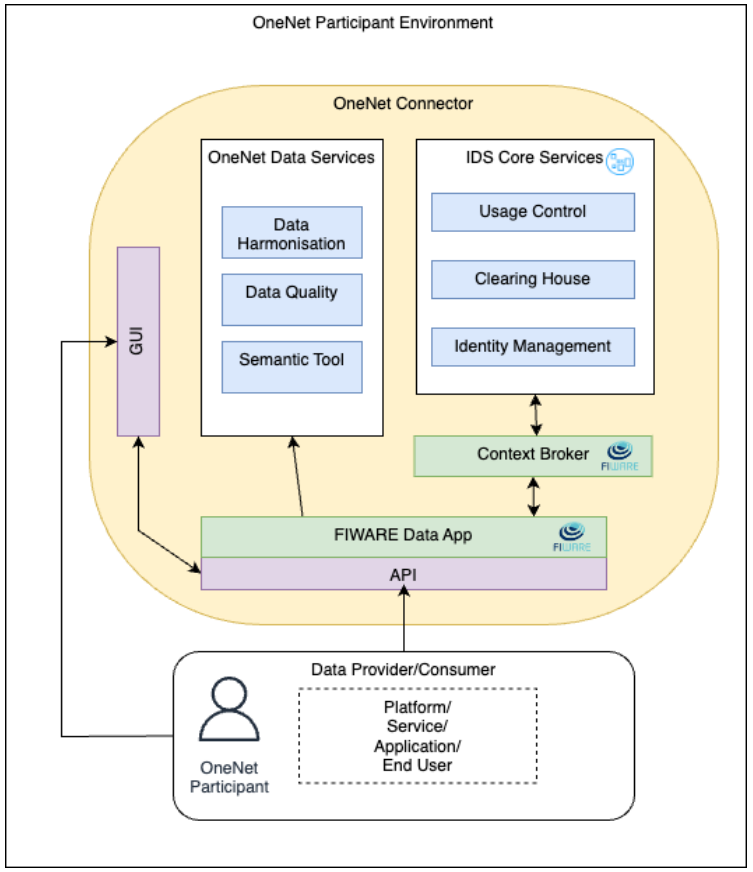
TwinEU

TwinEU Reference Architecture Main Aspects

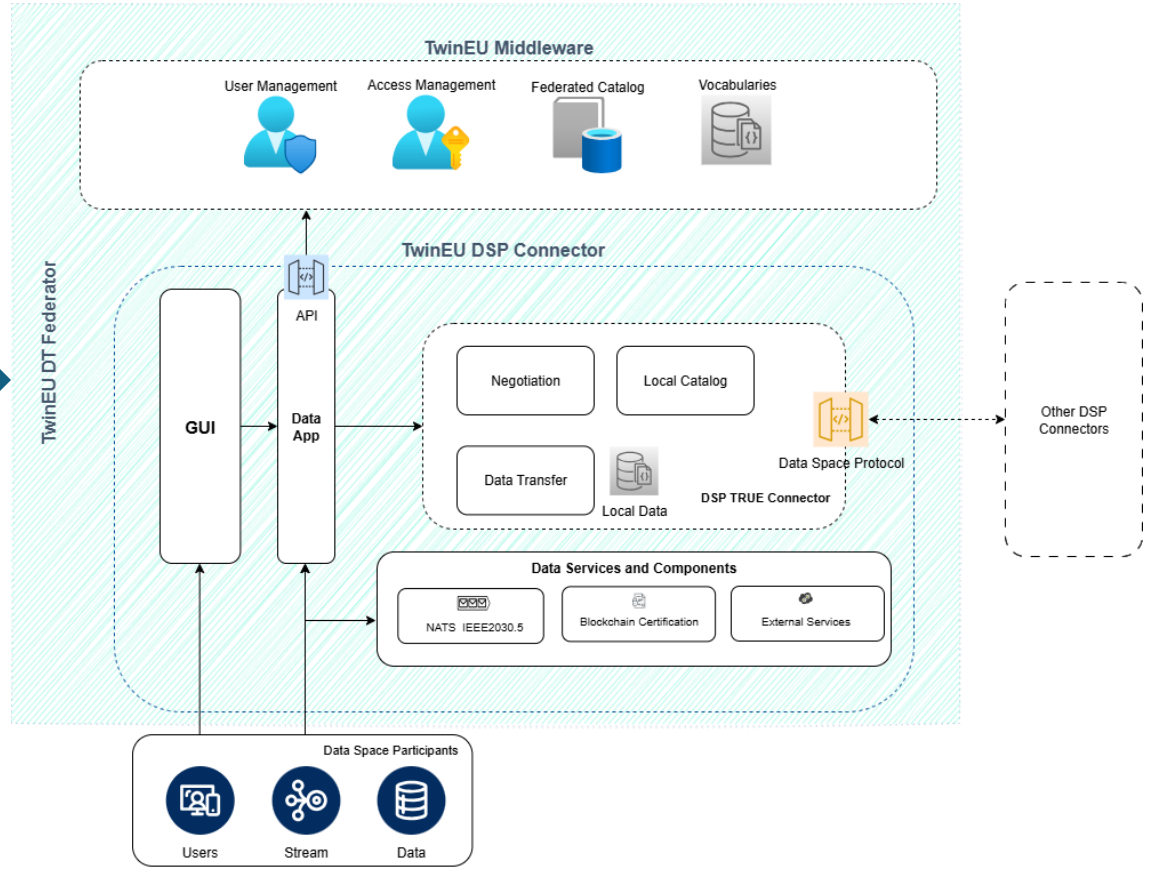
Federation of Digital Twins	Data Spaces Integration	Model Sharing and Reusability	Semantic Interoperability
Enable **secure, decentralized collaboration among energy stakeholders** by orchestrating interoperability between their Digital Twin systems	Implement the core principles of European Data Spaces, ensuring **secure, sovereign, and policy-driven data exchange** between energy stakeholders.	Facilitate the reuse and exchange of **Digital Twin models** across domains and applications through standardized interfaces	Ensure semantic alignment of exchanged data by adopting **common vocabularies, ontologies, and data models**

TwinEU Connector Evolution

From OneNet & ENERSHARE Connectors...



...to TwinEU DSP Connector



Additional Features

- **Integration of external services (Push Mechanism)**
  - Provide data to external service in a (near) real-time way, maintaining the features related to the Data Space
- **Blockchain Transaction Notarization**
  - Logging and Certification of data transaction in an immutable and secure way
- **New Standards (IEEE2030.5) and real-time communication protocols (NATS)**
  - Integration of new standards and protocols for a wider support

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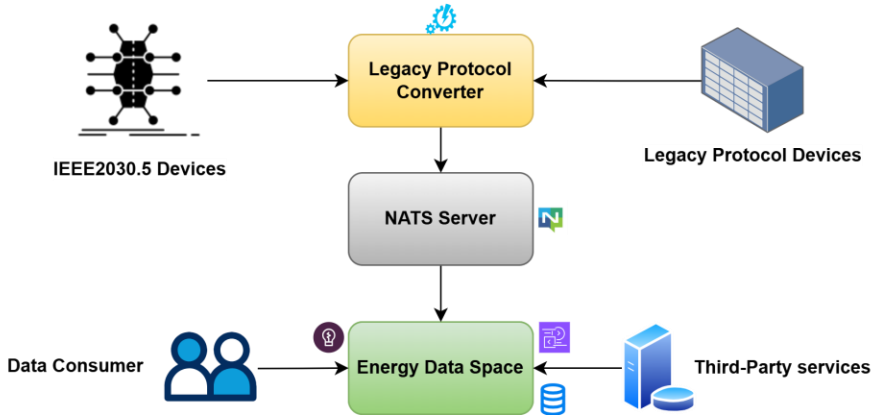

OSS for an AI-powered Edge-IoT Innovation

- **Trends like edge technologies and Artificial Intelligence** will reshape the IoT landscape,
- **Open Architecture for a vibrant IoT ecosystem** is key in support of the AI-edge-IoT platform
- **Re-usable modular Building blocks** require open APIs and standards

- **A SW Maintainer** to track releases
  - **HW Development Kit or SW Toolbox**
  - Support emerging standards

- **Open Source** for
  - *Accelerating standards adoption*
  - *Deploying AI models*

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AI.grids
Building the First Pan-European AI Foundation Model for Power Grid Operations

Leveraging DataSpaces and TwinEU building blocks to develop GenAI-based Digital Twins - AVANT project

- Development of a Digital Twin with an edge-to-cloud infrastructure for **predictive maintenance of a Floating storage and regasification units FSRU/LNG regasification plant,** which combines
- Interactive 2D and 3D Digital Twin for energy multisector scenarios.
- ***Integration of LLMs for maintenance, AI explainability, and Conversational interaction in natural language with the system.***
- Advanced algorithms for forecasting and classification, enabling accurate predictions, optimized operations, and deeper insights into system behavior.
- Main outcome: immersive, secure, and scalable ecosystem that brings together 2D dashboards, advanced 3D visualizations, AI/ML and data traceability and GenAI/LLM integration
- It enables real-time visual monitoring of the operational status of critical components, anomaly detection, risk classification, historical data visualization, and large-scale ML model training.

GenAI-based DT for optimizing maintenance of a floating storage and regasification unit

- *Off-the-shelf Large Language Models (LLM) has been integrated into the Digital Twin for a gas regasification plant (FSRU), for LNG storage control, in practical and complementary ways with respect to the already implemented physical simulation and AI prediction modules.*
- For the proposed use cases, **Mistral** has been identified as the reference LLM thanks to its efficiency, open-source ecosystem, and strong performance in reasoning tasks.
- Mistral is an **Open-source LLM** with high performance, efficient inference, suitable for on-premise or edge deployment https://mistral.ai/

Mistral AI

Gen-AI enabled DTs delivered

Predictive Maintenance & AI Explainability
The LLM interprets anomalies (XGBoost/LSTM), translates them into natural language with probable causes and recommended actions, and converts SHAP values into clear explanations.
Acts as a Technical Copilot, automates documentation, increases trust in AI, enables faster decision-making.

Interactive Technical Knowledge Base (RAG)
The LLM queries manuals, logs, and regulations using RAG and provides Conversational system for Targeted answers in natural language.
Immediate and contextualized access, supports continuous training, leverages corporate documents to enrich model knowledge.

Operational Scenario Verification
The LLM compares Digital Twin simulations with real data, highlights deviations and trends, and generates "what-if" scenarios explained in natural language.
Improves operator understanding, reduces risk of human error, supports preventive decision-making.

Automated Reporting & Documentation
The LLM automatically generates daily, monthly, or incident reports based on telemetry data and events, aligned with corporate templates and standards.
Saves reporting time, ensures consistency and traceability, supports compliance and audit processes.

Synthetic Data Generation

- **Synthetic data generation** (statistical, ML, deep learning, generative AI) is essential for training, validating, and handling rare or critical scenarios.
- Synthetic data generation enables the creation of controlled, scalable datasets for training, validation, and testing, without exposing sensitive or operationally critical systems to risk. It provides a safe and flexible environment for experimentation, predictive model development, and scenario analysis.
- GAN/TimeGAN comparison
  - **GAN** is a promising approach to time series data augmentation, as they can generate synthetic sequences that preserve the structure and dependencies of real data, a particularly relevant feature for the EC dataset, although training can be complex, with risks of low variety, amplification of biases, and a strong need for validation, while architectures specifically designed for time series
  - **TimeGAN**, offer a more solid compromise; as for traditional machine learning, we successfully applied the SMOTE technique to balance the dataset and improve the performance of the classification model based on XGBoost.

THANK YOU!