TW Insider Session #1

March 6th 2025

TwinEU

TW Insider Session #1

6 March | Online

Part I - Challenges of adopting Digital Twins

Welcome & intro	10.00-10.05	**Lóránt Dékány** | TwinEU
Digital Twins & the Digitalization EU Action Plan	10.05-10.15	**George Paunescu** | DG ENER
Standards and new policies for AI and DTs	10.15-10.25	**Svet Mihaylov** | DG CNECT
TwinEU sneak-peak: challenges & barriers	10.25-10.35	**Ilias Zafeiropoulos** | TwinEU
Digital Twins for TSOs & DSOs	10.35-10.45	**Stephan Gross** | DSO Entity **Siddhesh Gandhi** | ENTSO-E
Panel discussion + Q&A with the speakers	10.45-11.00	Moderator: **István Vokony** | TwinEU

Part II - Opportunities of Digital Twins for electricity systems

TwinEU vision & European use cases	11.00-11.10	**Antonello Monti** | TwinEU
Digital Twins & Standards	11.10-11.20	**Dune Sebilleau** | BRIDGE WG Data management
Digital Twins & buildings	11.20-11.30	**Diego Arnone** | DEDALUS project
Digital Twins for end-consumers	11.30-11.40	**Stratis Kanarachos** | DECODIT project
Panel discussion + Q&A with the speakers	11.40-12.00	Moderator: **Selene Liverani** | TwinEU

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TwinEU

George Paunescu

Policy Officer | DG ENER

Svet Mihaylov

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TwinEU

Ilias Zafeiropoulos

Technical Coordinator | TwinEU – UBITECH Energy

Digitalisation challenges and opportunities in the system planning, operation, and energy markets

TwInsider Session #1,

6 March 2025

Presenter: Ilias Zafeiropoulos,

Ubitech Energy, TwinEU Technical Manager

TwinEU

TwinEU at a glance

- TwinEU creates a concept of **Pan-European digital twin** based on the **federation of local twins** so to enable a reliable, resilient, and safe operation of the infrastructure while facilitating new business models that can accelerate the deployment of renewable energy sources in Europe.
- TwinEU consortium is leveraging a unique set of competences coming from grid and market operators, technology providers and research centers and will carry out **8 pilots** of the developed DT technologies in **11 European countries**.
- During the first phase of the project, the digitalization challenges and system needs have been explored, and the respective use cases have been described in detail.
- During this period, the approach followed was **two-folded**, i.e. desktop analysis of past and on-going Horizon **projects** and **stakeholders**’ feedback.

Analysis of projects

- The projects have been grouped in focus areas, based on their objectives and outcomes :
  - Providing enhanced **flexibility and market** participation through integrated **platforms**
  - **Data sharing** platforms and interoperability
  - Strengthening **cybersecurity** and **resilience** of energy systems
  - Advancing **grid operations**, **asset management** and **infrastructure** resilience
  - Promoting **decarbonization** and enhanced **RES** integration
  - Development of innovative tools for **energy services** and markets

Challenges (project analysis)

- Data privacy and security: Well identified in several projects and specific technologies i.e. Homomorphic encryption, intrusion detection, privacy-by-design.
- Technological complexity: apparent in several projects where there is a need to integrate legacy and modern systems
- Interoperability and standardization: data models and ontologies are proposed in projects to cope with various vendors and technologies

Challenges (projects)

- Regulatory and policy barriers: low incentives for grid modernization (capex-based approach), difficulty for sandboxes, different maturity level of markets across Europe.
- Market acceptance and stakeholder/user engagement: consumers/stakeholders are sometimes unaware and reluctant to adopt smart technologies for various reasons i.e. not obvious/measurable benefits, show 'inertia' to change habits/disrupt practices.
- Investment costs: High upfront costs, no subsidies and unclear estimations on ROI.

Opportunities (projects)

- Advanced technologies for achieving decarbonization: Smart technology innovations go with a fast pace, so once adapted they can provide excellent results in various grid business processes
- Data exchange and interoperability: relevant standards and technologies can ensure these merits and result in the integration of significant flexibility resources and new services.
- Real time monitoring and control: sensor-based devices with high granularity of data collection, high computation efficiency of big data can achieve grid stability and predictability for fluctuations.

Opportunities (projects)

- Developing cybersecurity and data privacy solutions for the energy sector: As proposed in several projects, cybersecurity technology advancements can certainly support the resilient transition of grid into the digitalization era.
- Leverage flexibility services and demand response: Digitalization and data analytics unleash the potential to use the DERs flexibility to balance the grid and implement demand response mechanisms in order to decarbonize the energy mix while mitigating RES volatility.

Opportunities (projects)

- <u>Enhance market mechanisms promote new business models:</u> The digitalization and sector integration priorities have opened opportunities for new business models and market mechanisms that can mobilize new revenue streams and businesses.
- <u>Promoting collaboration and consumer engagement</u>: Coping with new challenges requires coordination of System Operators and market participants to achieve optimization of energy resources management, as well as the engagement of consumers, turning them into active consumers / prosumers / prosumagers.

Stakeholders-Current DTs

- In TwinEU, a questionnaire for the current state and expectations from DTs has been developed and circulated among partners and stakeholders
- Regarding the current implementations of DTs, the respondents highlighted the existing applications in grid analysis, asset management, system operations, market modelling, interoperability with legacy systems.
- Regarding the expected functionalities of DTs, the respondents prioritized the merits of high performance, accuracy, scalability, user interfaces and visualization.

Stakeholders-Expectations for DTs

- Enhanced data integration, real-time data processing,
- Interoperability and standardization
- Cybersecurity and data governance
- Modelling, AI/ML integration, observability, controllability,
- Automation, visualization, federation of DTs,
- Scalability, cloud-based solutions, HPC
- Model validation, verification and auditability
- Sustainability and environmental considerations

Recommendations for DTs roll-out

- Data management and interoperability: Prioritize the establishment of common protocols, standardized data formats, interoperability in the energy sector, that will facilitate Data Spaces and DTs, in energy and other sectors as well, leveraging big data to ensure efficiency and resilience of critical infrastructures
- Stakeholder coordination and engagement: The decarbonization targets, bidirectional flows, electrification of sectors and the digitalization of the energy sector, necessitate the coordination of all energy stakeholders for efficient operation of the energy system. The DTs can attract the participation of stakeholders and public into the energy balancing challenge.

Recommendations for DTs roll-out

- Cybersecurity: Digitalization of the energy sector requires robust data protection measures and cybershielding of critical IT/OT infrastructure. Developing a robust smart grid cybersecurity framework can enable the acceptance and roll-out of DTs in the operational practices of the energy stakeholders and consumers.
- Future development of EU grids: Infrastructure upgrades of the grids can be accelerated, whereas the DTs can provide an efficient testbed for facilitating scenario studies, contingencies mitigation, efficient training and several other opportunities in a secure, and cost-efficient way.
- Regulation&market incentives: The modernization of the electricity grid can be accompanied with targeted incentives to favor digital innovations, that can improve significantly grid management and related business processes with low cost comparing to CAPEX-based grid upgrades.

TwinEU

Stephan Gross

Senior Coordinator | DSO Entity

Siddhesh Gandhi

Senior Innovation Specialist | ENTSO-E

DSO ENTITY
DSOs FOR EUROPE

entsoe

JTF DESAP

TSO-DSO Challenges & Opportunities for the Digital EU Electricity System

Siddhesh Gandhi
Stephan Gross

DESAP - Work package structure and timeframes

Year 1					Year 2			
M1	M3	M6	M9	M12	M15	M18	M21	M24

T 2.1: TSO-DSO Challenges identification

Task 2.2: Stakeholder analysis

Task 2.3: State of the Art & Gap analysis

WP2 CHALLENGES & REQUIREMENTS

D2.1 – TSO-DSO challenges and opportunities

T 3.1: Priority Use Cases

T 3.2: Digital Twin Solutions

T 3.3: Smart Indicators

WP3 USE CASES, DT SOLUTIONS & SMART INDICATORS

D3.1 – Use Cases & Digital Twin Solutions

D3.2 – Common definition of smart indicators

Today

Task 4.1: Roadmap

WP4 ROADMAP & WORKSTREAM DEFINITION

D4.1 Roadmap

Addressing flexibility, resilience and security with Digital Twins

Customers, Business, Market, Data & Info. Exchange

Consumer-centric activation of flexibility for scalable grid-solutions

The DT strengthens consumer-centric flexibility, enhances grid observability across all voltage levels. DT combines reference solutions for dissemination and scaling up flexibility.

System Planning, Future Flexibility & Assets Lifecycle

Coordinated management of system resilience

The DT employs granular, high-resolution data analysis to assess impact on grid. Supports critical business processes by enhancing operational efficiency and strengthening the overall resilience of the grid infrastructure.

System Operations, Dynamics & Control Rooms of the Future

Coordinated security analysis to optimize system operations

The DT aims a macro-level data utilization / aggregation / post-processing for informed decision making at control rooms

Mapping of ongoing Digital Twin initiatives and maturity stages

Average maturity stages (in green) determined for different application areas

Application area \ Maturity stage	A	B	C	D	E	F
(Advanced) Grid and market modelling (7)	36 %	23 %	29 %	0 %	14 %	0 %
System operation and operational planning (9)	0 %	16 %	6 %	34 %	22 %	11 %
BIM and 3D modelling (6)	38 %	28 %	0 %	33 %	0 %	0 %
Real-time monitoring and control (12)	8 %	25 %	34 %	25 %	8 %	0 %
Grid Flexibility and Customer Interaction (5)	20 %	26 %	46 %	6 %	0 %	0 %
Centralised Data Platforms and Data exchange (4)	0 %	58 %	33 %	8 %	0 %	0 %
Grid Optimisation and Asset Health (7)	14 %	14 %	7 %	43 %	22 %	0 %

A – Conceptualization, B – Development / Descriptive, C – Integration, D – Diagnostic, E – Predictive Analysis, F – Predictive / Autonomous Optimization

Number of projects in parenthesis

Conclusions

Main barriers

- Forecasting accuracy
- Extensive grid modelling and prediction
- Data integration (basis for interoperability)
  - Limited data and process harmonisation
  - Lack of standardisation between SOs and in internal data systems within SOs
- Scaling and processes
  - Priorities for advancing data platforms and reducing organizational data silos
  - Mapping processes to align digital capabilities
- Stable and supportive regulatory framework
  - Covering of cost for digitalisation efforts
  - Targeted funding for deployment of essential tools, such as smart metering
- Resource capacity
  - High capital and operational costs
  - Shortage of expertise

Opportunities implementing DT

- Electrification to reach zero carbon emissions
- Integration of more renewable energy sources
- Flexible consumers can cash in their flexibility value
- Utilize new technology, such as DLR
- Safeguarding society well-being with a cyber-secure power system

Solution: Common use cases and common roadmap / strategy (part of DESAP WP3 and WP4)

DSO Entity's Engagement is Increasing

[Access the DSO4DT Webinar recording here]

DSO Entity/ENTSO-E Joint Task Force on Digital Twins

Joint effort towards Digital Twins

DSO Entity and DSO4DT

Top-Down Approach

Bottom-Up Approach

DSO4DT
DSOs FOR DIGITAL TWINS

- **January 2025:** DSO4DT launched and will allow **DSO Entity to intensify its engagement to support the development of Digital Twins** for the energy sector.
- DSO4DT project will continue to **closely collaborate with ENTSO-E** on the topic of Digital Twins.

The project's core Objectives

1. Mobilize DSO Entity's members to support the European Digital Twin Activities
2. Boost the uptake of Digital Twins, smart grid, and innovative grid technologies
3. Enhance DSO Entity's digital, operational and technical expertise to mobilize its members

Interlinked Objectives

Funded by the European Union
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TwinEU

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Smart Grid & Interoperability Expert | BRIDGE Data Management WG - Trialog

TwinEU webinar

DTw standardisation

06/03/2025
Dune Sebilleau

BRIDGE initiative & Data Management WG

Launch date	N° of countries involved	N° of participating organisations
2016	39	1458

N° of projects	Accumulated EU funding	Time frame of the calls
98 / 155 SINCE 2016	€1.23bn	2014-2023

Smart Grids

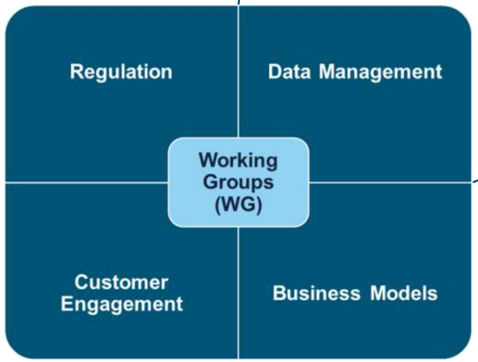
Energy Storage

Islands

Digitalisation

6 action groups:

Repository of use-casesq
Data Exchange Reference Architecture
Reference framework
Bridge standards user group
Interoperability of home appliances
AI



Digital twin standardisation

- *Several perspectives*
  - **Horizontal standards: ISO/IEC JTC1/SC41 “IoT and Digital Twin”**
    - Created in 2018
    - Renamed to include Digital Twin in 2021
    - First standard developments started in 2021, published in 2023
    - Several on-going projects
    - Cooperation with other committees and organisations
      - ISO/IEC JTC1/SC7 on Reference Architecture and interoperability
      - ISO/IEC JTC1/SC27 on Security and privacy
  - **Energy vertical: IEC SyC Smart Energy**
    - System Committee = system perspective (cross TCs)
    - Contributing to ISO/IEC JTC1/SC41 with Energy/grid use-cases
    - Cooperation with IEC Technical Committees (TCs)
      - Workshop on digital twins for the electrical energy system (Sept 2024)
      - Leveraging existing Digital Twins applications in the energy domain
        - » System application, e.g. IEC TC57 / Grid automation, IEC TC8/SC8A = Power system modeling
        - » Product application, e.g. IEC TC17 / HV switchgear

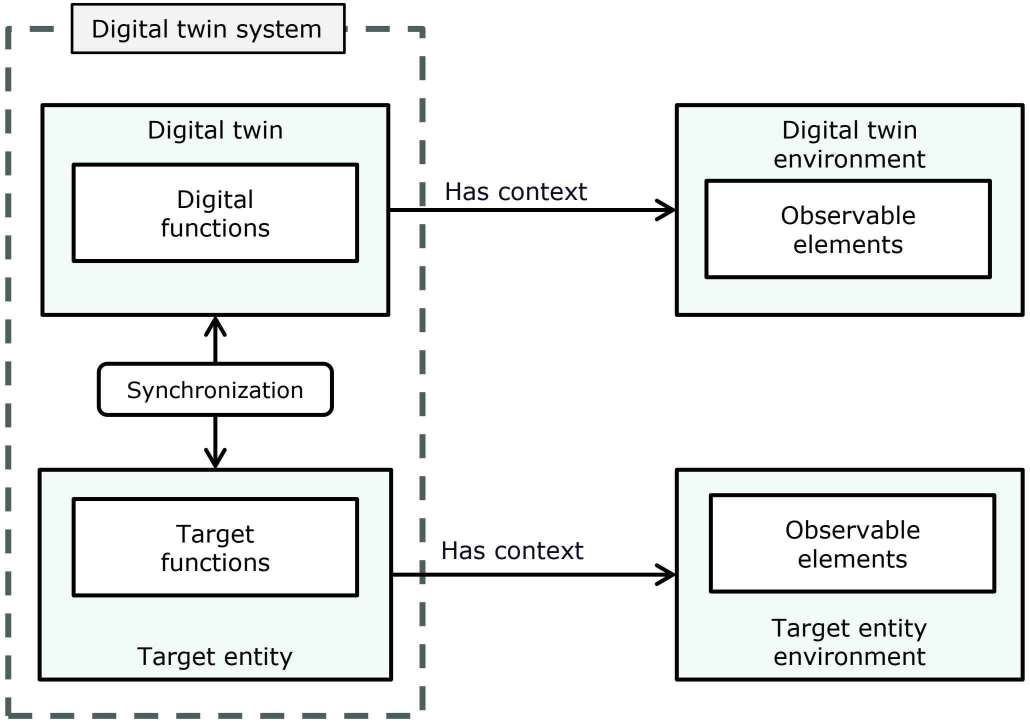
Horizontal standards

Status
Published
Committee Draft available
Preliminary work

- *ISO/IEC JTC1/SC41 « Internet of Things and Digital Twin »*
  - Published standards on digital twin
    - 30173 Digital twin concepts and terminology (2023)
    - 30172 Digital twin use-cases (2023)
    - 20924 Ed3 IoT and digital twin – Vocabulary (2024)
  - Published standards on interoperability
    - 20183-1 Interoperability framework (2019)
    - 20183-3 Semantic interoperability (2021)
  - On-going projects on digital twin
    - 30188 Digital twin Reference Architecture
    - 30186 Digital twin maturity model & guidance for assessmt
    - TR 30138 Fidelity metric of digital twin system
    - 30151 Digital Twin extraction & transaction of data products
    - 30152 IoT & DTw guidance on connection to data spaces
    - PWI 19 (30153) Digital twin guidelines for digital entity modelling
    - 20183-5 Behavior and policy interoperability
  - Liaison with AIOTI
- *ISO/IEC JTC1/SC27 on Security and privacy of DTw*
  - On-going projects
    - 27568 Security and Privacy of digital twin

Horizontal standards

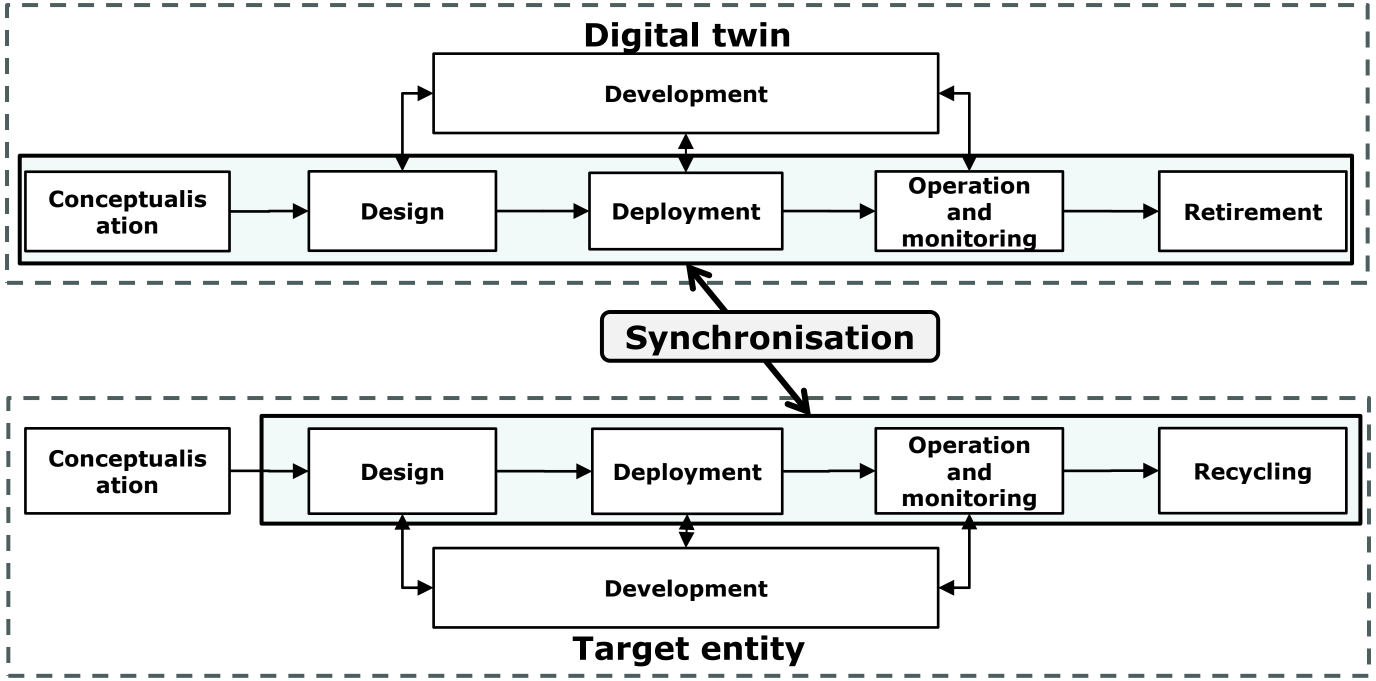
- *ISO/IEC 30188 Digital Twin Reference Architecture*
  - **Conceptual model**



Horizontal standards

ISO/IEC 30188 Digital Twin Reference Architecture

Lifecycle model



Energy vertical

- *IEC SyC Smart Energy*
  - **Topic: Digital twins for the electrical energy system**
    - Scope: Digital twins for the electrical energy system
    - Objective: Target the electrical domain and address the needs of the digital twins during their lifecycle
    - Topics identified:
      - Definitions & scope of application
      - Expected functions
      - Needed building blocks and processes
      - Data model considerations
      - Lifecycle challenges
      - Interplay with other committees
      - IEC tools & processes used
      - Other relevant considerations
    - Workshop / TC/SCs Forum carried out 3rd September
      - 120+ online participants (200+ registered)
      - Recording & presentations available
        - » https://www.iec.ch/academy/webinars/workshop-digital-twins-electrical-energy-system
        - » Blog: https://iec.ch/blog/digital-twins-electrical-energy-systems

Energy vertical

- *IEC SyC Smart Energy*
  - **Topic: Digital twins for the electrical energy system**
    - Main learnings
      - Several digital twins were identified, but with several differences
        - » Data models, tools
        - » Lifecycle moments
        - » Construction methods
      - Almost no data reuse between TCs
        - » E.g. between grid DTw and HV switchgear DTw data
      - Alsmost no formal shared governance on the data lifecycle
    - ⇒ 4 topics to address
      - Data model harmonization
      - Tools
      - Education & awareness (de-silo)
      - Governance
    - Open questions: How much harmonization/commonality is required? For which benefits? At which cost?

Conclusion

- *Complementary standardisation work*
  - Interplay horizontal standard – Energy standards
    - From SC41 architecture standard to Energy architecture patterns for digital twin
    - From SC41 semantic interoperaiblity standard to Energy information models including SAREF for digital twin
  - Application-oriented in vertical committees
    - E.g. energy in IEC… but various TCs (product / system)

- *Connection to the EU R&I ecosystem*
  - AIOTI Standardisation WG
  - BDVA Standardisation Task force
  - BRIDGE Standards User Group
    - Via liaison with CEN/CLC/ETSI Coordination Group on Smart Grids

Thank you!

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Diego Arnone/Luca Vitale

Project Coordinator | DEDALUS - Engineering dedalus

Data-driven Residential Energy Carrier-agnostic
Demand Response Tools and Multi-value Services

Development of Digital Twins in the DEDALUS Project

06/03/2025 → Remote

This project has received funding from European Union's Horizon Europe Research and Innovation programme under the Grant Agreement No 101103998

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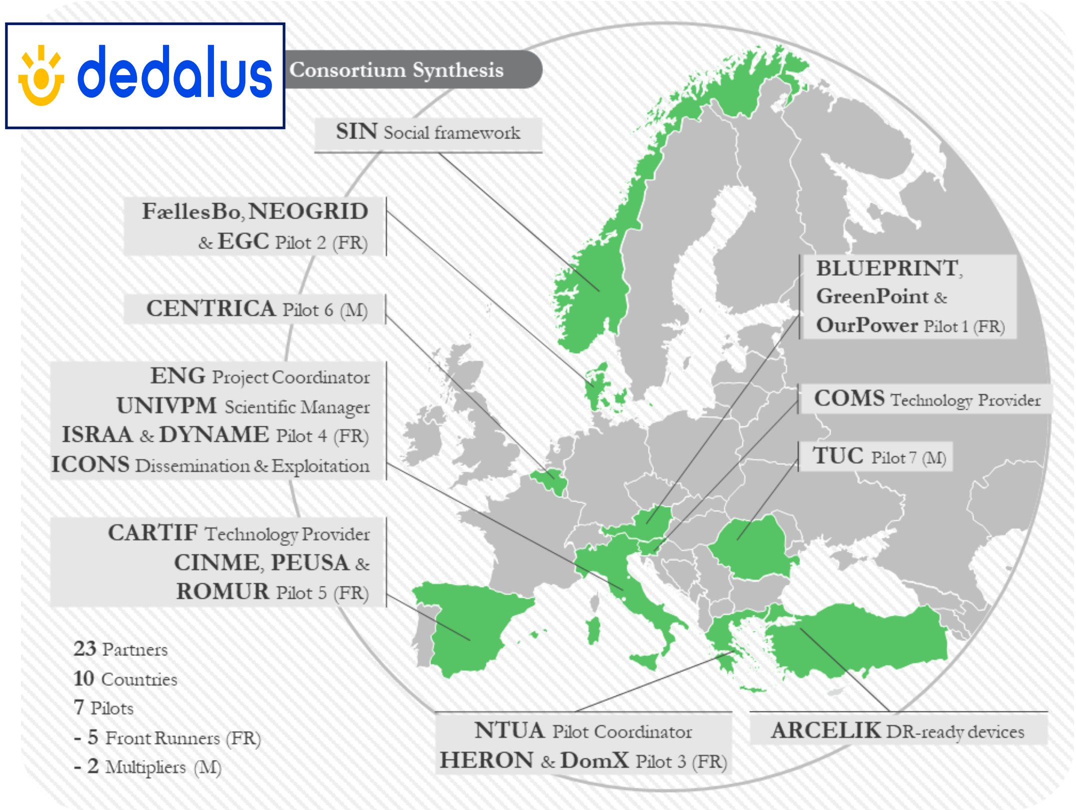
Introduction to DEDALUS

Data-driven Residential Energy Carrier-agnostic Demand Response Tools and Multi-value Services

Funded by the European Union

Project Identity Card

- **H2020 Call:** HORIZON-CL5-2022-D4-01 /HORIZON-CL5-2022-D4-01-01
- **Starting Date:** 1st May 2023 – Duration: 36 months
- **Total Costs:** 7.359.075,00 Euro
- **EU contribution:** 5,999,801.25 Euro (Innovation Action)
- **Partners:** 23 (21 Full beneficiaries + 2 Affiliated Entities)
- **Country Coverage:** 10 Countries (8 member States + 2 Associated Countries)
  - Italy, Slovenia, Greece, Spain, Austria, Romania, Denmark, Belgium, Norway, Turkey



7 Real Life Pilots, across 7 countries

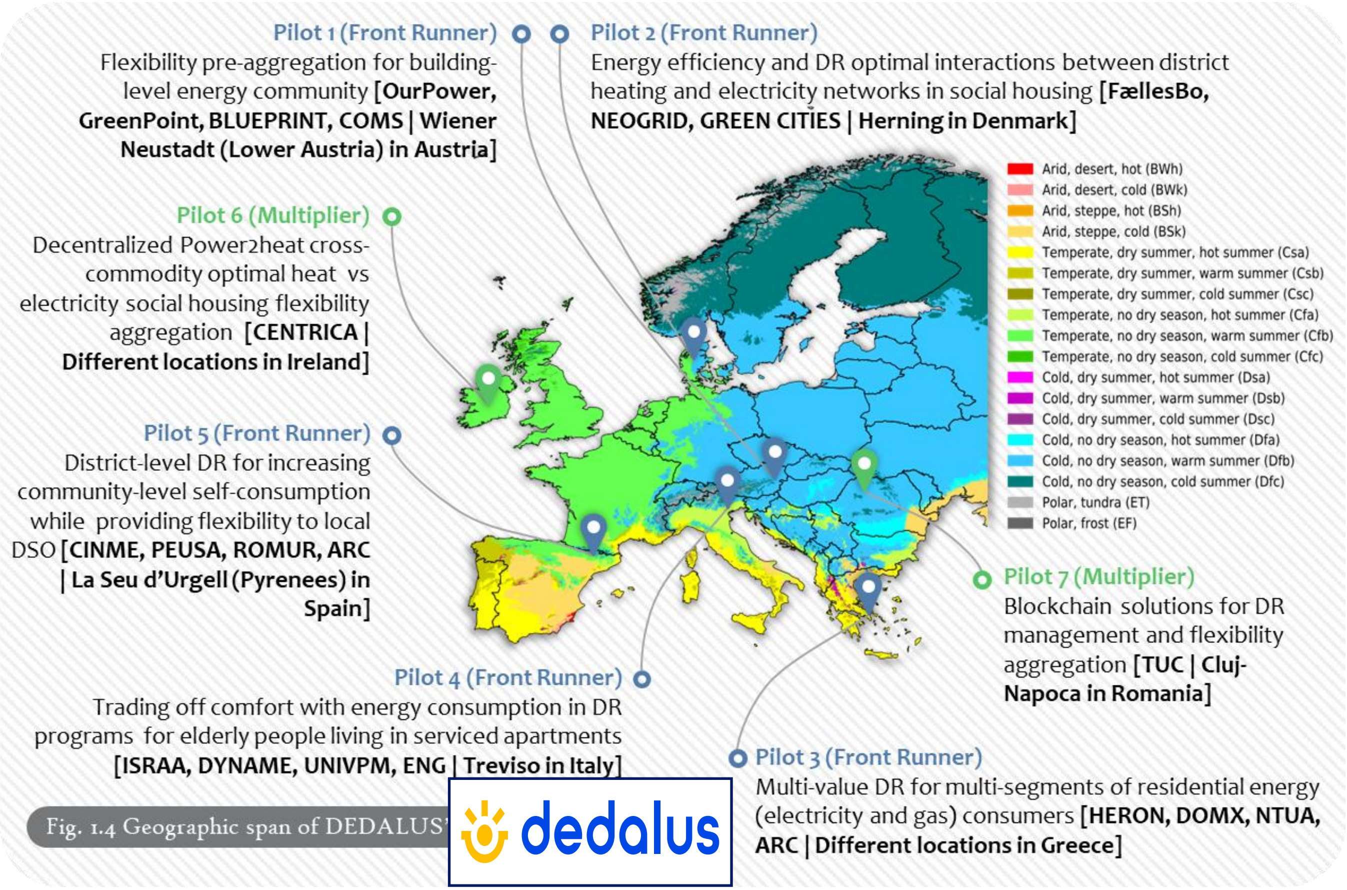


Fig. 1.4 Geographic span of DEDALUS'

The DEDALUS framework is being validated in 7 Real-life Pilots whose

- 5 Front Runners
- 2 Multipliers
- across 7 countries

- We are covering to the largest possible extent the electricity and energy value chains, while considering also other non-energy sectors, such as buildings, mobility, storage, financial, comfort/wellness/health, older people

Digital Twin Overview

Digital Twin

A digital representation of a target entity, integrating data connections that enable synchronization between the physical and digital states, facilitating analysis, simulation, optimization, and lifecycle management.

- **Key features:**
  - AI-driven predictive analytics.
  - Integration with IoT devices and smart grids.

- **Applications in DEDALUS:**
  - Consumer flexibility planning.
  - Demand Response optimization.
  - Energy efficiency monitoring.

3D Building Visualization in Digital Twins

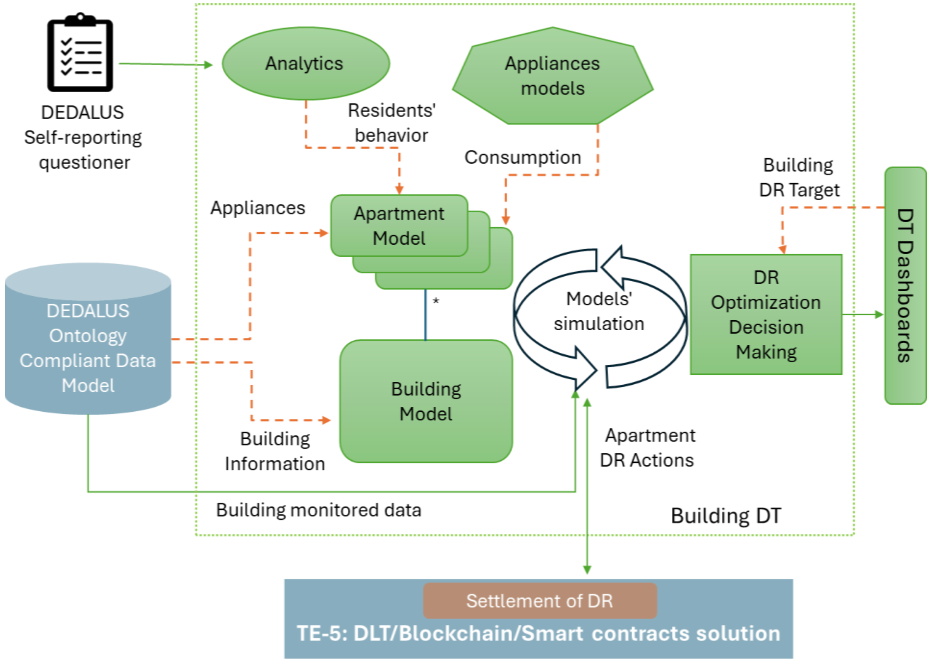
- **Technology Stack:**
  - Frontend: React with TypeScript & Bootstrap 5.
  - 3D Library: Three.js integrated with BIM tools and ThatOpen 3D Library.

- **Challenges & Solutions:**
  - Large model size optimization through segmentation.
  - Interactive 3D models for intuitive navigation.
  - Integration with near real-time sensor data.

Digital Twins for blockchain integration

Combining DT models with blockchain and smart contracts to simulate DR actions regarding appliance activation within the context of DR settlement smart contracts.

- **Key features:**
  - Clustering algorithms for self-reports on appliance usage to detect patterns of energy related behaviors.
  - Simulation engine for energy consumption profiling based on appliances models, and residents' behaviors.
  - DR optimization decision making through bio-inspired meta-heuristics, e.g. Harris Hawks Optimisation (HHO) algorithm.
- **Blockchain integration:**
  - Profiles injection into DR settlement smart contracts.
  - Blockchain-based distributed ledger is set up at the building level to store and digitally fingerprint energy data.
  - Smart contracts are defined to manage flexibility using decentralized market trading mechanisms.



Building DT and its integration with blockchain

AI-Driven Simulation in Digital Twins

- Machine Learning Models Used:
  - Gradient Boost Regressor.
  - Multi-Layer Perceptron.
  - Clustering Algorithms.

- Purpose:
  - Predictive energy consumption modelling.
  - Optimized demand response decision-making.
  - Improved user comfort and efficiency recommendations.
  - Detect patterns of energy related behaviours.

User Trust and Behavioural Impact

- **User-Centric Design & Transparency:**
  - Intuitive, visual interfaces enhance trust.
  - Actionable insights empower users without overwhelming them.

- **Concrete Benefits for Users:**
  - **Better Decision-Making & Comfort Optimization:** Personalized recommendations balance energy efficiency and comfort.
  - **Cost Savings & Energy Efficiency:** Reduced energy waste lowers bills and incentivizes efficiency.
  - **Active Participation in the Energy Transition:** Users contribute to a more sustainable and resilient energy grid.

Key Takeaways

- Digital Twins are essential for optimizing Demand Response and energy flexibility.
- 3D building visualization enhances monitoring and user interaction.
- Blockchain enables secure, automated transactions.
- AI-driven models improve prediction accuracy and energy efficiency.
- User-centric design and engagement enhance trust and adoption.

dedalus

Data-driven Residential Energy Carrier-agnostic
Demand Response Tools and Multi-value Services

Thank you!

DEDALUS-HORIZON.EU @DEDALUS_EU @DEDALUS_EU INFO@DEDALUS-HORIZON.EU

This project has received funding from European Union's Horizon Europe Research
and Innovation programme under the Grant Agreement No 101103998

TwinEU

Stratis Kanarachos

Project Coordinator | DECODIT – European Dynamics

< Digital twins for households >

Presentation by **Stratis Kanarachos**
DECODIT project coordinator

Prepared for **TwInsider Session, 6/03/2025**

Funded by the European Union

< DECODIT project >

< Summary>

1. Addresses the challenges of home energy transitions by developing digital tools that provide **personalized, data-driven solutions for citizens**.
2. It aims to **simplify decision-making** through **accessible natural language interfaces and innovative financing**, while also reducing costs for professionals.
3. **Pilot programs across 4 countries** will demonstrate the project's effectiveness in creating smarter, more **collaborative energy services aligned with citizen energy practices.**

Facts

Topic: HORIZON-CL5-2023-D3-03-04
Start date: 1 June 2024
End date: 30 November 2027
18 partners, 11 countries

Funded by the European Union

DECODIT

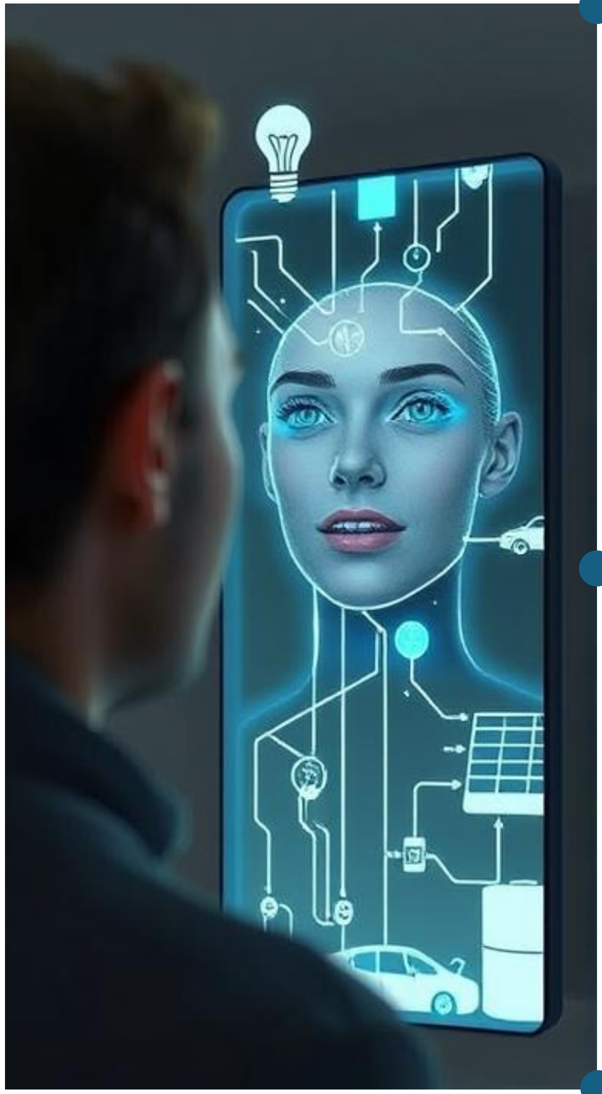
< Consumer Digital Twin >

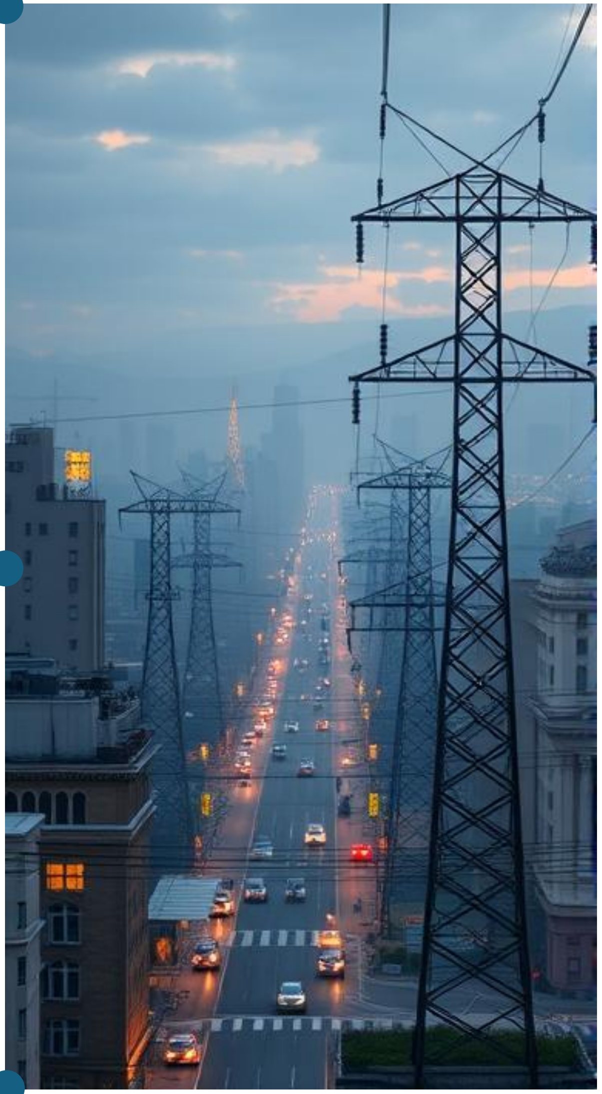
The problem

Electricity and gas prices have surged.

The volatility in energy markets exposes consumers to price fluctuations.

The citizens don’t understand how to utilize the very complex energy services landscape.





The solution

Create a digital twin of the consumer/citizen.

Use the data to offer personalized services.

Use the data to interact optimally with the consumer.

Funded by the European Union

DECODIT

< DECODIT data driven services >

<Energy management>

<Rennovation Support>

<Home upgrade financing>

Energy management
Flexibility management

Green retrofiting
Building assessment
Energy Efficiency Renovations

Loan underwriting
Project bundling

Consumer Digital Twin

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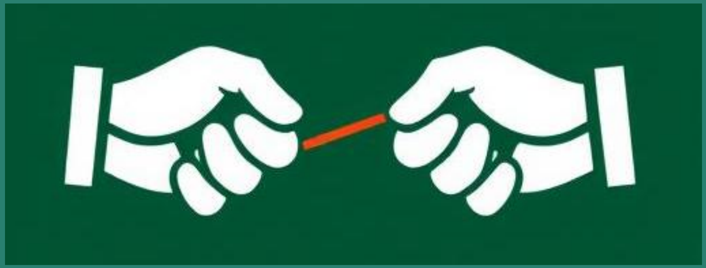
DECODIT

< Tug of war >

Lack of incentives
Data privacy
Services fragmentation
Lack of interoperability
Low digital literacy
No user centric design
Lack of trust
Fragmented financing framework

It takes a village to raise a child ☺

Benefits of future proofing Homes



Obstacles in future proofing Homes

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DECODIT

< Digitally empowering citizens >

Funded by
the European Union

TwinEU

Moderator:

Selene Liverani

TwinEU – E.DSO

Dune Sebilleau
BRIDGE WG Data - Trialog

Diego Arnone
DEDALUS – Engineering

Stratis Kanarachos
DECODIT – European Dynamics

Stephan Gross
DSO Entity

Antonello Monti
TwinEU – Fraunhofer FIT/RWTH Aachen

Thank you for joining us!

Follow TwinEU and

take part in the upcoming sessions too

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement N°101136119

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