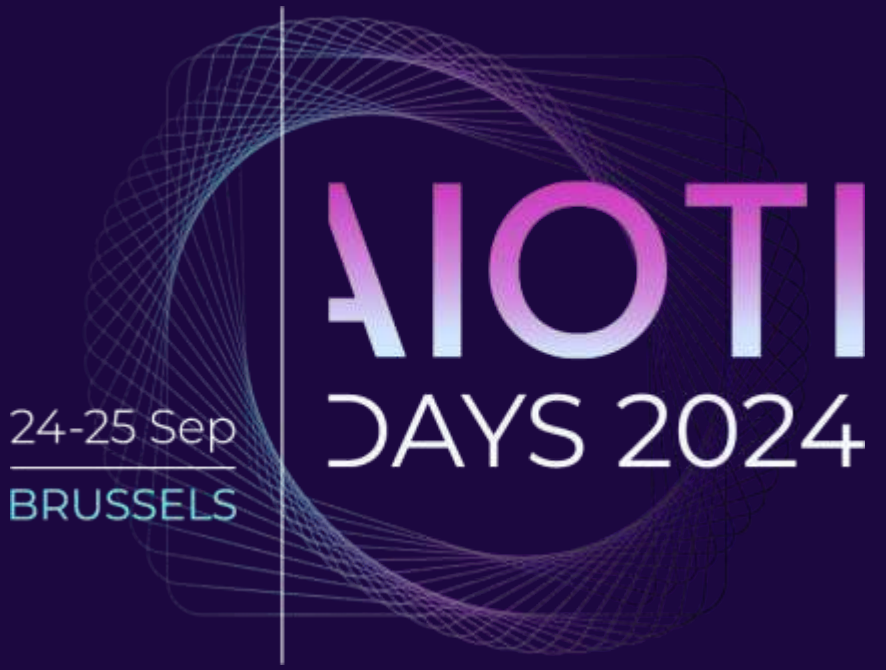
Alliance for IoT
and Edge Computing
Innovation

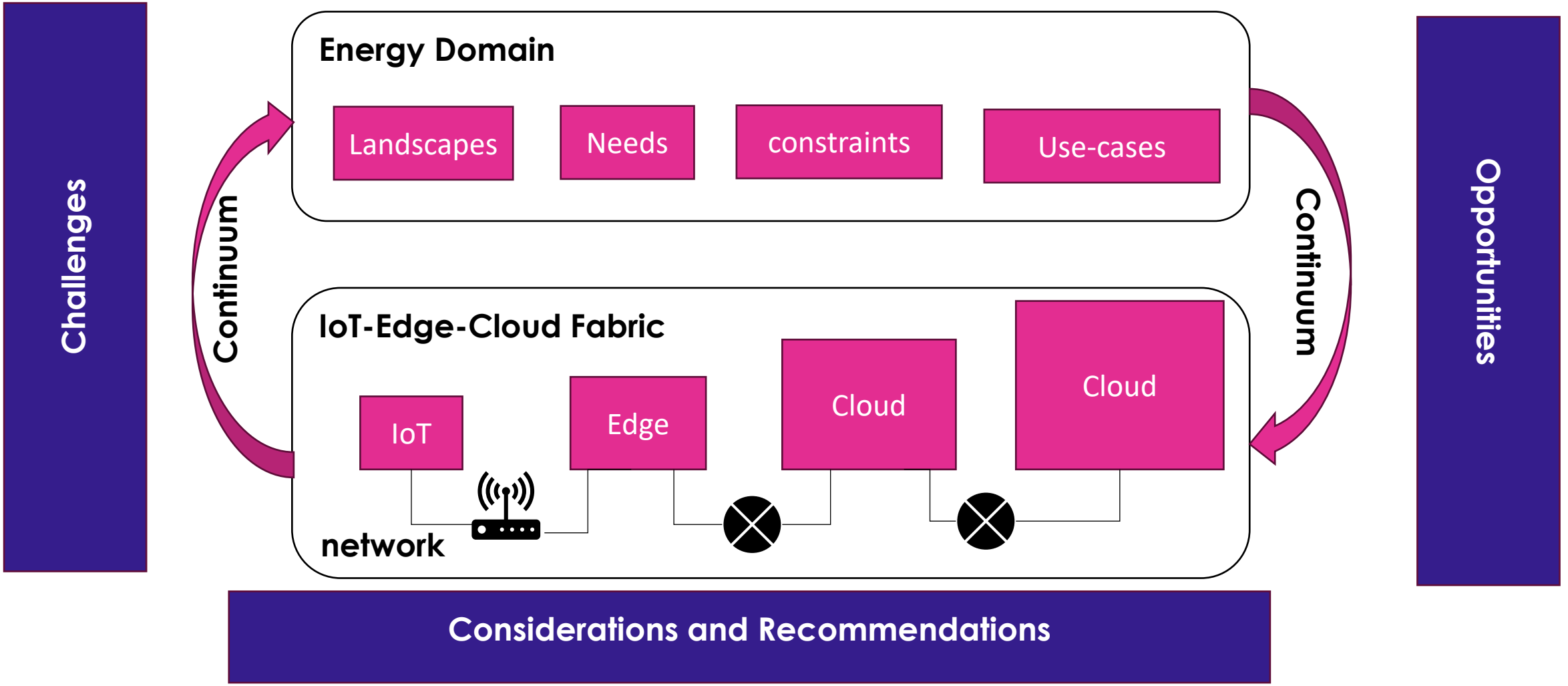


Session: Virtual World of Energy - Digital Twins as building blocks

Mays AL-Naday, University of Essex, Senior Lecturer

Event Sponsors

AIOTI Building Block: Digital Twin paper



EDGE in ENERGY

EDGE in Energy - Evolving?

Edge Intelligence for energy efficiency

Edge analytics for predictive maintenance

Edge computing for smart grids

Edge driven models process time-sensitive data, while Cloud computing focuses on more asynchronous processes based on data

Edge computing is used to process time-sensitive data, while cloud computing is used to process data that is not time-driven

Edge devices for worker safety and enablement

Demand Response Flexibility of Demand, VPPs

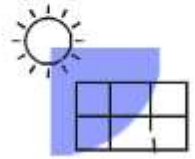
Digital Twins and advances analytics towards Data Spaces

SMART ENERGY COMPONENTS
EDGE infrastructure layer

Smart Meters

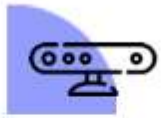
Thermostats

Drones



Solar panels inverters

Battery storage control systems



Smart appliances other sensors

Electric Vehicles Charging systems and V2G

Challenges and opportunities of Edge Computing and Digital Twins in distributed energy sector

Challenges	Technical maturity of digital twin technology	Lack of plug and play deployment tools
Shortage of digital skills in the energy sector	Regulatory issues	Data privacy and security concerns
Requiring innovative policies and regulatory experimentation (TEF, regulatory sandboxes)	Opportunities for future growth	AI and Digital Twins within the distributed scalability
Federated Digital Twins models	Linkage to the European Data Space	Optimisation and needs for determining useful data for collection

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Digital twins in distributed energy systems

RES, electrification

Edge computing

Digitalisation

Energy democratisation

Digital twins

- Real-time data
- More information points
- Heterogenous applications
- Standardised data
- Standardised communication interfaces/APIs
- Open-access, data ownership governance

Enhanced grid observability

Enabling flexibility, congestion management

Improved asset management

Efficient planning & investments

Value generation for other sectors

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Use cases (from our paper)

FinSESCo
Fintech for Smart Energy System Contracting

→ Fintech platform solution for sustainable energy system

GIFT

→ Harbour Energy Flexibility Monitoring Service

riot-es

→ Increased performance in IoT systems

BD4NRG
Big Data for Next Generation Energy

→ Digital Twin for edge driven smart buildings and buildings clusters

EDDIE
EUROPEAN DISTRIBUTED DATA INFRASTRUCTURE FOR ENERGY

→ Digital Twin for real-time residential flexibility market participation

PREDICTRICITY

→ artificial intelligence for demand response market participation

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Considerations of digital twins in edge-cloud

Energy footprint

- Diverse services (particularly AI) , demand, connectivity
- Diverse edge-to-cloud infrastructure
- Addon resources and dependencies (e.g. data Ops)
- Not only consumption, but prices and source-type

Comprehensive Modelling

- Joint problems and their interplay
- Multiple objectives (possibly conflicting) and trade-offs
- Large number of parameters and constraints

Multiple Stakeholders

- Co-existence and dependency (e.g. cloud-network providers)
- Autonomy of connected systems and variant information sharing

Edge-cloud: Priority metrics

Infrastructure Energy

- Power Utilization Efficiency (PUE) of edge-cloud DCs in similar climate
- Energy Proportional computing (per cloud job)
- energy price, brown-green split, CO_2 emissions

Digital services

- Characteristics (e.g. inter-service dependency), resource intensity
- Restrictions on movability, QoS/QoE, and induced load on continuum resources

Data

- Volume and complexity of data produced by energy systems
- Features' heterogeneity across different energy systems and interoperability
- Restrictions on data sharing across autonomous systems and stakeholders

Skills Gap

- Technical and digital literacy in the energy sector (common practices)
- DevOps increasingly integrating data and AI Ops

Recommendations: enabling factors

Regulation

- Flexible regulation including supportive instruments (sandboxes etc)
- Implementation on national level

EU cooperation

- Coordinated implementation of digital twins
- Important role of standardisation
- Sharing best practices

Digital skills

- Developing capabilities in industry
- Enhancing competences and understanding of policy makers and regulators

Recommendations

Support further research

- Advancing the maturity of the technology
- Support cross-EU collaboration
- Deliver best practices and learnings from implementation

Regulatory flexibility

- Regulatory sandboxes and other instruments for testing impacts of digital twins
- Enable the required investments

Enhance stakeholders' capabilities

- All actors should be included (industry, consumers, policy makers)

Enhance data standards

- To cover the new used cases connected to grid edge and digital twins
- Ensure interoperability, security and privacy of the shared data

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