INTERNATIONAL

INVITED SESSION SUMMARY

Title of Session:

Advancing Smart Building Energy Management: Practical AI and ML Solutions for Real-World Applications

Name, Title and Affiliation of Chair:

Marco Savino Piscitelli, Asst. Professor at Politecnico di Torino
Alfonso Capozzoli, Full professor at Politecnico di Torino
Cristian Pozza, Senior Researcher at EURAC Research
Daniele Antonucci, Senior Reseacher at EURAC Research

Details of Session:

The building sector is undergoing a profound transformation, driven by both energy and digital transitions. Digitalization is playing a pivotal role in enabling low-carbon, energy-efficient buildings by harnessing advanced technologies to optimize performance. The vast volume of operational data collected from buildings offers a unique opportunity to make smarter, more informed decisions across the entire building lifecycle — from design and construction to ongoing operations and retrofitting.

By integrating artificial intelligence (AI), machine learning (ML), and data-driven approaches into real-world energy management platforms and Building Management Systems (BMS), stakeholders can achieve actionable insights, improve energy performance, and implement scalable energy conservation measures. These systems promise not only operational efficiency but also seamless interaction with broader energy grids and smart city infrastructure.

This invited session focuses on the intersection of digitalization, AI, and advanced energy management in buildings. It highlights practical implementation pathways for ML pipelines and data-driven solutions, showcasing their integration into energy management platforms and BMS. Through case studies, real-world demonstrations, and recent developments, the session emphasizes turning concepts into deployable solutions that drive widespread adoption.
Key topics for contributions include but are not limited to:

- Energy Flexibility and Grid Interactions: Analyzing the role of buildings in energy networks, focusing on demand-side management, renewable energy integration, and energy flexibility quantification.
- Fault Detection and Diagnosis (FDD): Developing hybrid AI approaches, including semi-supervised learning and transfer learning, to enhance fault detection, diagnosis, and system reliability in HVAC and energy subsystems.
- Predictive and Adaptive Control: Designing AI-driven algorithms for short-term energy prediction, predictive maintenance, and adaptive control strategies tailored to integrated energy systems.
- Practical Solutions Addressing Data Challenges: Identifying solutions for handling data sparsity, ensuring data quality, and integrating multi-source data also considering the role of generative AI.
- Scalable and Reliable Technologies: Demonstrating scalable AI-based diagnostic and control technologies through case studies and field implementations in residential, commercial, and community-scale settings.
- Smart Communities and Districts: Exploring the extension of data-driven technologies to community and district-level systems for achieving energy-efficient, low-carbon smart cities.
- Building Digital Twins: Developing real-time, high-fidelity digital twins for predictive analysis, system optimization, and strategic retrofitting planning.
- Cross-Domain Integration and Metadata Enrichment: Expanding the concept of digital twins fostering cross-domain interaction, exploring methodologies and approaches to enhance

metadata connections and enable innovative data-driven applications.

- Automated Energy Modeling: Leveraging large language models (LLMs) and other AI tools to automate building energy modeling and reduce the time and effort required for simulation and analysis.

Through the collective efforts of researchers, this invited session seeks to advance the state of smart, data-driven technologies in the building sector, enabling a deeper understanding of their current capabilities and identifying pathways for future innovation.

Main Contributing Researchers / Research Centres (tentative, if known at this stage):

Politecnico di Torino – Energy Department – BAEDA Lab
EURAC Research

Website URL of Call for Papers (if any):

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