Capacity building in Smart and Innovative eNERGY management

WP5

Organization of Joint SINERGY Events for Expertise Exchange and Hands-on Experience

D5.4 International SINERGY Conference on Smart Energy Management

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Executive Summary

The SINERGY work package 5 focuses on the organisation of joint project events that enable know-how exchange and provide with a "hands-on" experience in the domain of smart energy management. Deliverable 5.4 reports about the **SINERGY International Conference on Smart and Innovative eNERGY management** that was organised at the Institute Mihajlo Pupin premises from 26th to 28th of September 2023. The event gathered over 40 experts from the field, while one third of them were from abroad and two third from Serbia and the Region. Altogether 27 presentations were given, two of them being company presentations (AIT and NUIG) and two keynotes as follows

- Dr. Stergios Vakalis (University of the Aegean, Greece) held a lecture on "The role of bioenergy on the increased penetration of RES – the green transition of Lesvos island"Professor; and
- Dr. Maria-Esther Vidal (TIB, Germany), held a lecture on "Knowledge Graphs in the Energy Sector: Challenges to Enhance Transparency and Trustability in Energy Data Ecosystems".

Figure 1. SINERGY Conference – Group photo (Day 1)

The SINERGY partners (the Institute Mihajlo Pupin as a Coordinator and the two leading partners – the AIT Austrian Institute of Technology GmbH and University of Galway (NUIG) were main organisers of the Conference. The submitted papers (via EasyChair platform) were reviewed by 18 international experts, members of the SINERGY Conference Programme Committee.

Papers were grouped into four sessions as follows

- Smart Grids;
- Energy Management Systems;
- Building Energy Management Systems;
- Knowledge Management and ICT Tools.

Panel discussion was organised as part of the opening of the event.

The event was an opportunity to present SINERGY results as well as results of ongoing (e.g. OMEGA-X, NEON) and recently finished projects (e.g. REACT, GEOFIT).

Especially important for the objectives of the SINERGY project is the success of inclusion of young researchers in the research activities of the project partners (IMP, AIT and NUIG). Twelve (12) out of twenty three (23) papers were presented by young researchers being the SINERGY conference the first one in their career.

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Abbreviations and Acronyms

AIT Austrian Institute of Technology
CA Consortium Agreement
CO Coordinator
DSO Distribution System Operator
EMS Energy Management System
ERDF European Regional Development Fund
EU European Union
IEEE Institute of Electrical and Electronics Engineers
ICT Information and Communications Technology
IMP Institute Mihajlo Pupin
INT Electrical Engineering Institute Nikola Tesla
NUIG University of Galway
R&D Research and Development
TIB Leibniz Information Centre for Science and Technology and University Library
WP Work Package
UWE University of the West of England

1 Introduction

The primary objective of SINERGY is to strengthen the research capacity and further unlock the innovation potential of IMP, transforming it into a regional Centre of Excellence in smart energy management. To that aim, a set of actions that range from (1) exploring the synergies between the partners; via (2) exchange of personnel and early-stage researchers' involvement in joint research and development; to (3) organising joint events for knowledge transfer, expertise exchange, awareness raising and stakeholders networking; have been started.

1.1 Main Objectives and Deliverable Scope

Workshops and conferences are seen as the most efficient way to get an insight into the state-of-the-art in selected research topics. Therefore, work package 5 focuses on the organisation of joint project events that enable know-how exchange and provide with a "hands-on" experience in the domain of smart energy management. In the first two years of the project, three workshops as combination of training courses and lectures, hands-on experience, social and networking activities have been organised:

- 1st Workshop coordinated by AIT, November 2021, https://project-sinergy.org/Events/1st-Workshop;
- 2nd Workshop, coordinated by NUIG, May/June 2022, https://project-sinergy.org/2nd-Workshop;
- 3rd Workshop, coordinated by IMP, November 2022, https://project-sinergy.org/3rd-Workshop.

This deliverable focuses on the organisational aspects and specific sessions of the SINERGY International Conference (Task 5.4), organised by SINERGY partners and hosted by IMP (Belgrade, Serbia) from November 26th to November 28th 2023.

Figure 2. SINERGY Conference – Announcement

1.2 Conference Announcement and Promotion

The Conference was announced and promoted via different channels including the SINERGY web page, IMP Web site, LinkedIn and Twitter accounts, see Figure 2 (announcement at the SINERGY webpage) and Figure 3 (information shared via LinkedIn).

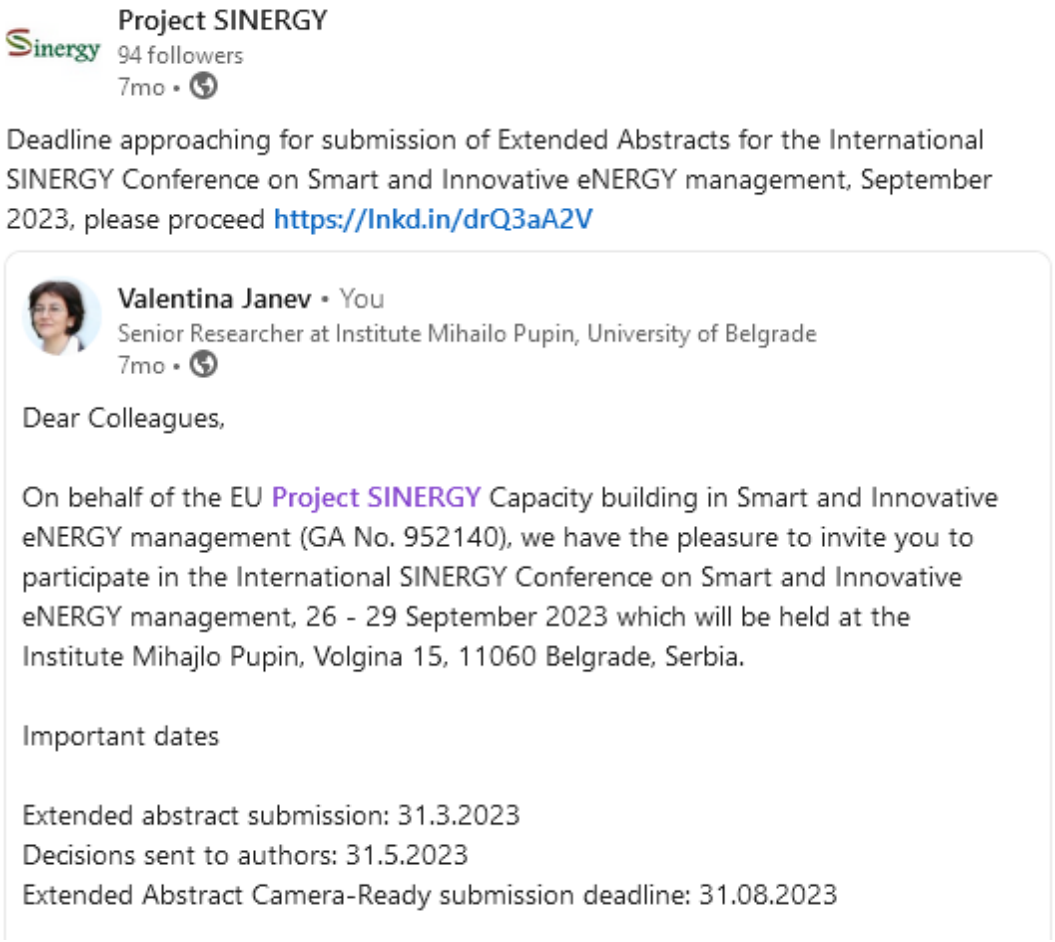


Figure 3. SINERGY Conference - Reminder about the Conference on LinkedIn

1.3 Structure of the Deliverable

This deliverable is structured as follows:

- Section 1 provides with an overview of the objectives of WP5 and the Task 5.4;
- Section 2 describes the organisational aspect of the Conference;
- Section 3, Section 4 and Section 5 gives an overview of activities (Day 1, Day 2 and Day 3) and presents the Abstracts of the papers presented; and
- Section 6 briefly summarises the plans for future activities.

Annex I includes the Conference Information Pack, while Annex II contains the abstracts of research papers.

2 Organization of the International Conference

2.1 Programme Committee

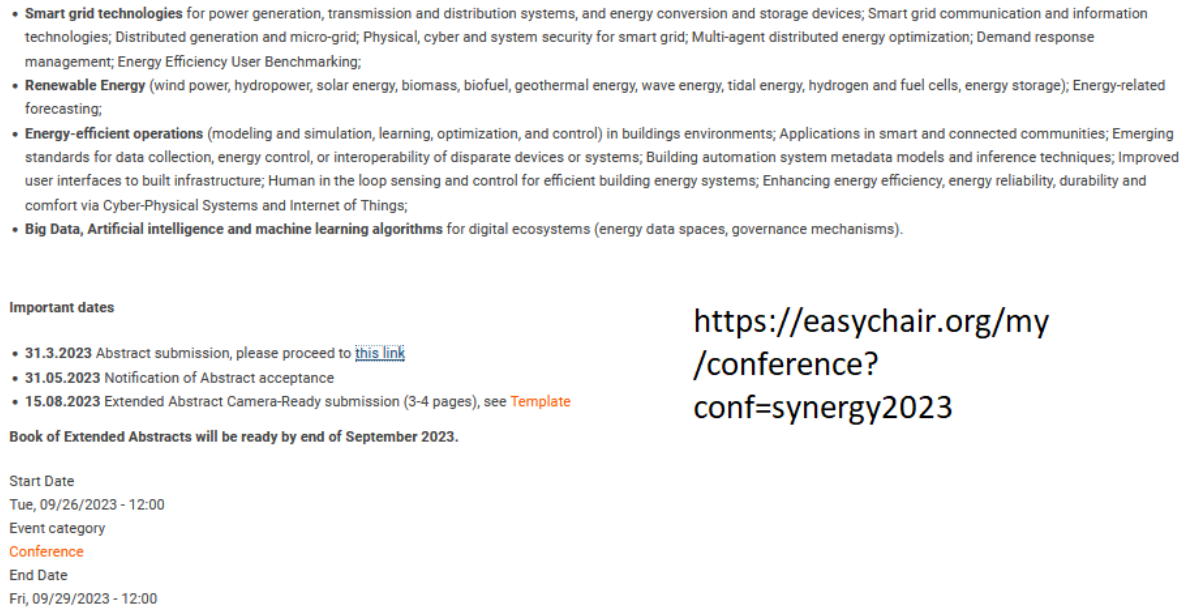
Besides the representatives of the SINERGY consortium, relevant international experts were invited to be part of the Program Committee. International experts were asked to disseminate the SINERGY Call for papers to their communities.

Table 1. Members of the Program Committee

Program Committee		
Institution	**Name, Surname**	**Country**
Institute Mihailo Pupin	Valentina Janev Slavica Bostjančič Rakas Valentina Timčenko Lazar Berbakov Marko Batić	Serbia
Electrical Engineering Institute Nikola Tesla (INT)	Jasna Dragosavac	Serbia
Austrian Institute of Technology	Johannes Stöckl	Austria
University of Galway	Luis Miguel Blanes Restoy Dayanne Peretti Correa	Ireland
University of the West of England (UWE)	Francisco Sierra	UK
Universitat Politècnica de Catalunya	Mònica Aragüés-Peñalba	Spain
ComSensus d.o.o.	Andrej Čampa	Slovenia
National Institute of Technology, Kurukshetra	Sarika Jain	India
TIB	Maria-Esther Vidal	Germany
ENGIE LAB CRIGEN	Lilia Bouchendouka Sarra Ben Abbes	France
Ss. Cyril and Methodius University in Skopje	Aleksandra Krkoleva Mateska	North Macedonia
University of Tuzla	Vedad Pašić	Bosna and Herzegovina

2.2 Paper Submission and Conference Proceedings Publication

In the announcement, instructions were provided for paper submission, see Figure 4.



- **Smart grid technologies** for power generation, transmission and distribution systems, and energy conversion and storage devices; Smart grid communication and information technologies; Distributed generation and micro-grid; Physical, cyber and system security for smart grid; Multi-agent distributed energy optimization; Demand response management; Energy Efficiency User Benchmarking;
- **Renewable Energy** (wind power, hydropower, solar energy, biomass, biofuel, geothermal energy, wave energy, tidal energy, hydrogen and fuel cells, energy storage); Energy-related forecasting;
- **Energy-efficient operations** (modeling and simulation, learning, optimization, and control) in buildings environments; Applications in smart and connected communities; Emerging standards for data collection, energy control, or interoperability of disparate devices or systems; Building automation system metadata models and inference techniques; Improved user interfaces to built infrastructure; Human in the loop sensing and control for efficient building energy systems; Enhancing energy efficiency, energy reliability, durability and comfort via Cyber-Physical Systems and Internet of Things;
- **Big Data, Artificial intelligence and machine learning algorithms** for digital ecosystems (energy data spaces, governance mechanisms).

Important dates

- **31.3.2023** Abstract submission, please proceed to this link
- **31.05.2023** Notification of Abstract acceptance
- **15.08.2023** Extended Abstract Camera-Ready submission (3-4 pages), see Template

Book of Extended Abstracts will be ready by end of September 2023.

Start Date
Tue, 09/26/2023 - 12:00
Event category
Conference
End Date
Fri, 09/29/2023 - 12:00

https://easychair.org/my/conference?conf=synergy2023

Figure 4. SINERGY Conference – Instructions for submission

Papers were reviewed by at least one member of the Program Committee. The camera ready versions of the papers were collected before the Conference.

After the conference, a questionnaire was sent to (68) authors of the papers in order to get their feedback about the Conference materials (papers, PPTs).

Table 2. Feedback Questionnaire

Questionnaire		
#	Name, Surname	Options
1.	I agree with the proposal of SINERGY Conference Organizers to publish the Abstract of my/our paper on the SINERGY web page	yes-no
2.	I agree with the proposal of SINERGY Conference Organizers to share the material we provided (PPT) with other participants at the Conference	yes-no
3.	I agree with the proposal of SINERGY Conference Organizers to share the material we provided (paper) with other participants at the Conference	yes-no
4.	The final version of the paper (submitted via EasyChair) can be included in the SINERGY Proceedings (not available online)	yes-no

So far, all the collected answers are YES. Hence, currently, the Consortium considers the different options for publishing the Proceedings of the Conference.

2.3 Conference Materials (Program)

The Conference Information Pack[1] that included the Program of the Conference was prepared and distributed to the participants at the registration, see Figure below.

Figure 5. SINERGY Conference – Registration desk

[1] https://project-sinergy.org/sites/default/files/2023-09/SINERGY_Conference_Information_Pack.pdf

Figure 6. SINERGY Conference - Program and leaflets

2.4 Keynote Speakers

Two keynotes were invited for the event

- Dr. Stergios Vakalis (University of the Aegean, Greece) with a lecture on "The role of bioenergy on the increased penetration of RES – the green transition of Lesvos island"Professor (see Figure 7); and
- Dr. Maria-Esther Vidal (TIB, Germany), held a lecture on "Knowledge Graphs in the Energy Sector: Challenges to Enhance Transparency and Trustability in Energy Data Ecosystems" (see Figure 8).

Figure 7. SINERGY Conference – Keynote 1 (Stergios Vakalis, University of the Aegean, Greece)

Figure 8. SINERGY Conference – Keynote 2 (Dr. Maria-Esther Vidal, TIB, Germany)

2.5 Session Chairs

Papers were grouped into four sessions as follows

- Smart Grids;
- Energy Management Systems;
- Building Energy Management Systems;
- Knowledge Management and ICT Tools.

Table 3. List of Sessions Chairs

Sessions and Session Chairs		
#	Name of the Session	Chairs
1.	Smart Grids	Dr. Jasna Dragosavac, ITN Dr. Rao Bharath-Varsh, AIT
2.	Energy Management Systems	Dr. Slavica Boštjančič Rakas, IMP Dr. Francisco Sierra, UWE
3.	Building Energy Management Systems	Dr. Marcus Keane, NUIG Dr. Francisco Sierra, UWE
4.	Knowledge Management and ICT Tools	Dr. Marija Radmilović, IMP Dr. Valentina Janev, IMP

2.6 Venue

The Conference was organised in the Big Lecturing Hall of the Institute Mihajlo Pupin, Volgina 15, Belgrade, Serbia.

3 Conference - Day 1

3.1 Opening

The Conference was opened by the IMP General Director, Dr. Nikola Tomašević, Dr. Valentina Janev, SINERGY Project Manager and Coordinator and Dr. Valentina Timčenko as a Local Conference Organizer.

Dr. Nikola Tomašević welcomed the guests to the Institute Mihajlo Pupin and presented some basic facts about the Institute.

Dr. Valentina Timčenko explained the Conference logistics, registration procedure and the social networking events.

Dr. Valentina Janev presented the Conference program.

3.2 Keynote I: The role of bioenergy on the increased penetration of RES – the green transition of Lesvos island by prof. Stergios Vakalis, University of the Aegean

Abstract: The green transformation of the energy sector on islands has perpetually presented a formidable challenge. Establishing a reliable connection between these islands and the mainland grid on the mainland can prove problematic, particularly when substantial distances are involved. In such scenarios, independent electrical grids have been developed on islands, with utilized fuel sources being primarily diesel or fuel oil. A transition towards sustainable energy is currently in progress, with renewable energy systems progressively augmenting their share in the overall energy mix. Notably, wind and solar power, characterized as variable renewable energy (VRE) systems, are witnessing the most substantial capacity expansions. It is important to acknowledge that integrating VRE systems into isolated grids raises stability concerns. From a technical standpoint in the transition of the electricity sector, a key consideration for isolated grids is that as the capacity of variable renewable energy sources like photovoltaic and wind increases, a subsequent need arises for additional capacity from a stable and readily available source. This supplementary capacity is essential for meeting peak demand hours or addressing periods when solar PV and wind power alone are unable to fulfill the island's electricity requirements. This study presents several applications on islands in Greece that undergo green transition in respect of VRE installations (Ag. Efstratios) and e-mobility (Astypalaia) and highlights the drawbacks of RES penetration. The interesting case of Lesvos Island is presented, and this study explores the potential for biomass and biowaste utilization in the context of the green energy transition. Lesvos has 11 million olive trees and more than 40.000 tonnes of pruning are readily available every year that can support a 5 MW biomass gasification facility. In addition, for every hour of operation of olive mills on Lesvos, 100 tonnes of olive mill wastewater are produced. Liquid biowaste can undergo anaerobic digestion to produce biogas. Leveraging biomass and biowaste for energy production can contribute to the grid stability during the transition to higher VRE utilization, effectively serving as a "gas-battery" to address any supply shortfalls. Therefore, we introduce the concept of "μgas-to-grid," wherein various biomass sources are converted into gaseous fuels and injected into a small-scale natural gas grid. This μgas design entails localized, small-scale conversion of biomass and biowaste into gaseous fuels, with centralized upgrades to the gases before injection into a small natural gas grid. This concept can support the second stage of the energy transition, as isolated island grids become integrated with central grids while also meeting the demand for greener heating fuels in buildings and the transportation sector. This study delves into the pivotal role that biomass can play in both stages of the energy transition.

3.3 Panel discussion

Figure 9. SINERGY Conference – Panel discussion

Dr. Rao Bharath-Varsh (AIT) organised a panel discussion with the following guests

- Dr. Johannes Stöckl, AIT,
- Dr. Marcus Keane, NUIG, and
- Dr. Stergios Vakalis, University of the Aegean.

3.4 Session I: Smart Grids

Session I was devoted to **Smart grid technologies** (power generation, transmission and distribution systems, and energy conversion and storage devices; Smart grid communication and information technologies; Distributed generation and micro-grid; Physical, cyber and system security for smart grid; Multi-agent distributed energy optimization; Demand response management; Energy Efficiency User Benchmarking).

The session was moderated by senior researchers from the Austrian Institute of Technology (Austria) and the Institute Nikola Tesla (Serbia), while young researchers presented results of their work.

Figure 10. AIT presentation by Johannes Stöckl

Figure 11. ITN presentation (Jovana Gluščević, young researcher)

In the OMEGA-X project, IMP researchers collaborate with Spanish research centre Tecnalia on decarbonisation scenarios for the IMP campus. The work was presented in the Session I framework.

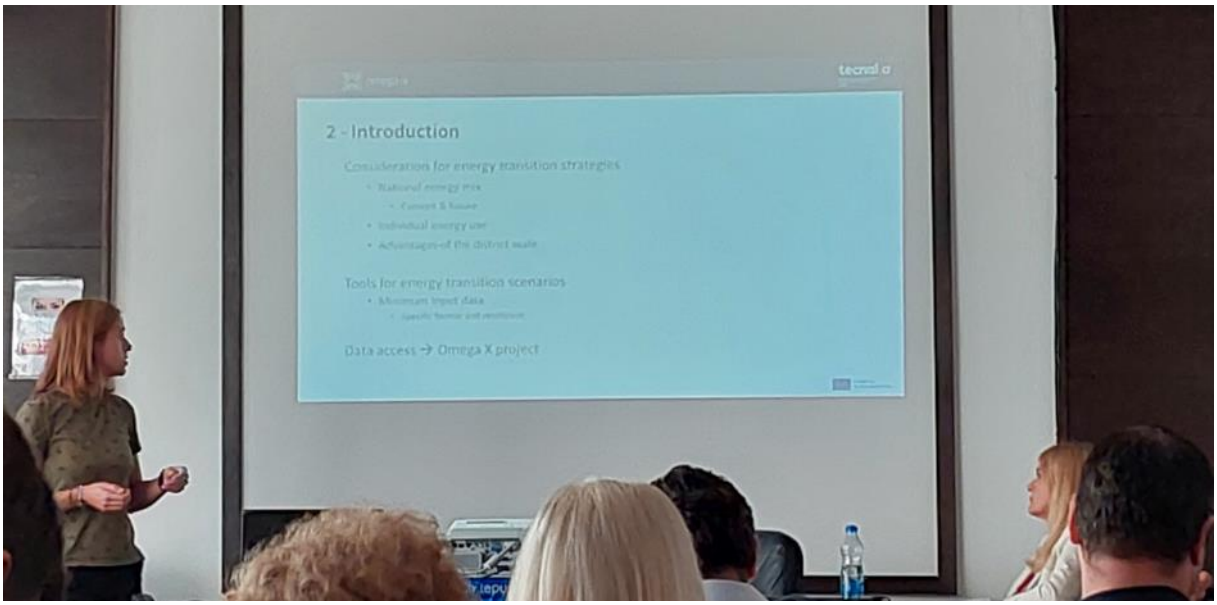


Figure 12. Development of Energy Transition Scenarios for IMP R/D Campus (Nekane Hermoso, Tecnalia young researcher)

Table 4. Session I: Smart Grids (Agenda)

Session I: Smart Grids	
I-1	Johannes Stöckl **Introduction to the Session with a Presentation of the Austrian Institute of Technology**
I-2	Jovana Gluščević, Žarko Janda and Jasna Dragosavac **Comparison of the response of grid forming and grid following inverters connected to a real grid**
I-3	Florian Strebl and Bharath-Varsh Rao **Impact of large-scale Deployment of Energy Communities on Distribution Grids**
I-4	Dayanne Peretti Correa, Luis Miguel Blanes Restoy, Paulo Lissa and Marcus Keane **Clustering Analysis to Support Demand Response Programs**
I-5	Patxi Hernandez, Nekane Hermoso and Valentina Janev **Towards Positive Energy Districts: Data Requirements and Use of Tools for Development of Energy Transition Scenarios**
I-6	Luka Ivanović, Djordje Stojić, Slavko Veinović, Dušan Joksimović, Jasna Dragosavac and Ilija Klasnić **Voltage Stability of Microgrid with Grid-Connected Wind Farm**
I-7	Valentina Timčenko and Slavica Boštjančič Rakas **Cyber Security Issues of Cloud-based Dynamic Line Rating**
16:30 End of Session I	

Session I was concluded with a presentation from the caber security domain by senior researchers from IMP, Dr. Valentina Timčenko and Dr. Slavica Boštjančič Rakas. Young researchers who had an opportunity to present for the first time at an international conference are highlighted in yellow.

4 Conference - Day 2

On the second day of the Conference, the sessions were moderated by Dr. Francisco Sierra (UWE) and Dr. Slavica Boštjančič Rakas (IMP).

4.1 Session II: Energy Management Systems

In Session II, mainly results from SINERGY and other IMP projects were presented. The Session started with a presentation from a SME from Serbia, presented by Mr. Branislav Dobrosavljević.

Figure 13. Cyber Security in the Supply Chain (SME from Serbia)

Young researchers from IMP presented their results, see figures 14 and 15.

Figure 14. Energy Monitoring at IMP R&D Campus (Anđela Marković, IMP young researcher)

Figure 15. Multi Objective Energy Management System and Sizing Optimization with Load Shifting (Igor Jovanović, IMP young researcher)

Table 5. Session II: Energy Management Systems (Agenda)

Session II: Energy Management Systems	
II-1	Branislav Dobrosavljević **How to Ensure Cyber Security Deep in Your Supply Chain**
II-2	Željko V. Despotović, Ilija R. Stevanović, Jovan Šumarac and Aleksandar Rodic **Hybrid and Uninterruptible Power for Irrigation on Agriculture Smart Land**
II-3	Marija Radmilović, Uroš Ilić, Željko Despotović, Jelena Kljajić, Jovan Šumarac, Aleksandar Pavlović, Predrag Đešnić **Sustainable and Automated Production Process of Seedlings Using Robotic Systems**
II-4	Gavin Larkin, Luis Miguel Blanes Restoy and Marcus M. Keane **Simulation-based Evaluation of Air-source Heat Pump Retrofit to Phase-out Condensing Gas Boilers. Case Study of Campus Building In Ireland**
II-5	Anđela Marković, Valentina Janev, Nikola Tomašević and Marko Batić **Approach to Energy System Modelling for Supporting Decarbonization Scenarios in Energy Communities**
II-6	Igor Jovanović, Marko Jelić and Nikola Tomašević **Multi Objective Energy Management System and Sizing Optimization with Load Shifting**
13:00 End of Session II	

4.2 Session III: Building Energy Management Systems

Session III was devoted to Building Energy Management Systems and hosted by NUIG. The goal was to discuss **Energy-efficient operations** (modeling and simulation, learning,

optimization, and control) in buildings environments; Applications in smart and connected communities; Emerging standards for data collection, energy control, or interoperability of disparate devices or systems; Building automation system metadata models and inference techniques; Improved user interfaces to build infrastructure; Human in the loop sensing and control for efficient building energy systems; Enhancing energy efficiency, energy reliability, durability and comfort via Cyber-Physical Systems and Internet of Things.

In this Session case studied of R&D campus (IMP), University campus buildings (NUIG) and Higher Education Institutions Buildings (UWE) were discussed. Additionally, a Local Energy Communities case study from Austria was presented.

Similarly as in previous sessions, young researchers were encouraged to present their work.

Figure 16. NUIG presentation (results of MSc thesis presented by Marcus M. Keane)

Figure 17. UWE presentation (results of MSc thesis presented Francisco Sierra)

Figure 18. Energy Flexibility Assessment for Buildings in Ireland (Mariya Chukkiriyan Joy, NUIG MSc student)

Figure 19. Energy Efficiency for Local Energy Communities in Austria (Thi Kim Bich Pham, AIT MSc student)

Table 6. Session III: Building Energy Management Systems (Agenda)

Session III: Building Energy Management Systems	
III-1	Marcus M. Keane **Introduction to the Session with a Presentation of the University of Galway**
III-2	Luis Miguel Blanes Restoy, Dayanne Peretti Correa and Marcus M. Keane **Simulation-based Commissioning of Control Loops for Heat Pump Integration and High Temperature Systems**
III-3	Mariya Chukkiriyan Joy and Marcus Keane **Energy Flexibility Assessment for Buildings in Ireland**
III-4	Thi Kim Bich Pham, Bharath Varsh Rao and Wilhelm Süßenbacher **Peer-to-peer Energy Market Incentivizing Energy Efficiency for Local Energy Communities in Austria**
III-5	Mojgan Sami and Francisco Sierra **The Evolution of Heat Transfer Coefficient (HTC) Calculation Methods: A Critical Analysis**
III-6	Zhuoqun Sun, Francisco Sierra and Colin Booth **Real-time Occupancy Estimation Using Carbon Dioxide Concentration in Higher Education Institutions Buildings**
III-7	Spiros Chadoulos, Sotirios Athanasoulias, Stelios Kalogridis, Nikolaos Ipiotis, Odyssefs Diamantopoulos Pantaleon, Iordanis Koutsopoulos and George C. Polyzos **Energy Optimization of Building IoT Infrastructures in A Stratified Way**
16:30 End of Session III	

5 Conference - Day 3

Conference Day 3 started with the second keynote by prof. Maria-Esther Vidal.

Figure 20. Keynote II introduced by Dr. Marija Radmilović (IMP young researcher)

Figure 21. Keynote II - Discussion of EU strategies by prof. Maria-Esther Vidal

Relevant EU strategies were also discussed.

5.1 Keynote II: Knowledge Graphs in the Energy Sector by prof. Maria-Esther Vidal, Leibniz University of Hannover and TIB-Leibniz Information Centre for Science and Technology, Hannover, Germany

Abstract: Knowledge graphs (KGs) have momentum as expressive data structures to represent the convergence of data and knowledge spread across various data sources. Although coined by the research community for several decades, KGs are increasingly relevant in scientific and industrial

areas. In particular, the rich amount of encyclopedic knowledge in KGs like DBpedia and Wikidata, or domain-specific KGs (e.g., Transparent Energy Knowledge Graph and the PLATOON Knowledge Graph) demonstrate the feasibility of integrating factual domain-specific knowledge following the Linked Data principles.

Energy data integrated into existing KGs are collected in heterogeneous formats or physically distributed over multiple sites (e.g., wind power systems, solar power systems, conventional power plants, cooling, heating, lighting systems, and smart grids). Years of research on semantic data management and knowledge engineering have led to merging heterogeneous data as factual statements into a KG. Despite accepting data management systems as crucial data processing tools for industrial and scientific database applications, the scenario differs for KG-driven solutions. Real-world applications require a complete understanding of all the decisions made during data management. Unfortunately, the absence of algorithmic methods to account for KG transparency considerably affects trustability and prevents their full acceptance as reliable solutions for decision-making.

This talk will present the challenges faced at data integration, query processing, and knowledge engineering levels to empower the pipelines of KG creation with transparency. Solutions for query processing and data management over data integration systems represent the baselines. Moreover, we will explain the role of knowledge extraction, mapping languages, integrity constraints, and provenance towards data transparency and traceability. We will further discuss knowledge-driven data ecosystems as reference architectures to provide the foundations for transparent KG-driven frameworks to enhance trustability. We will illustrate our proposed approach with existing KGs in the energy sector, where data transparency is crucial for building trustable solutions to support decision-making.

5.2 Session IV: Knowledge Management and ICT Tools

The third day of the conference was dedicated to analysis of services; Big Data, Artificial intelligence and machine learning algorithms for digital ecosystems (energy data spaces, governance mechanisms).

Similar as at the previous sessions, IMP young researchers and colleagues from Spain and Croatia presented their work for the first time (outside of their universities).

Figure 22. APIs and Knowledge Graphs for Efficient Data Access and Interoperability (Miloš Jovanović, young researcher)

Figure 23. Medium-term Electrical Demand Forecasting of Residential Activity SINERGY Conference - Group photo (Day 1) young researcher)

Figure 24. Prediction Of Carbon Dioxide Emissions In Building Sector (Saša Mitrović, young researcher)

Table 7. Session IV: Knowledge Management and ICT Tools (Agenda)

Session IV: Knowledge Management and ICT Tools	
IV-1	Enrique Iglesias, Ahmad Sakor, Philipp D. Rohde, Maria-Esther Vidal and Valentina Janev **KatanaG: Fragmenting Data Strategies to Enhance Knowledge Graph Creation from Large Datasets**
IV-2	Miloš Nenadović **Leveraging APIs and Knowledge Graphs for Efficient Data Access and Interoperability in the Energy Domain**
IV-3	Óscar Cabrera Redondo, Mónica Aragüés Peñalba and Sara Barja-Martinez **Medium-term Electrical Demand Forecasting of Residential Activity**
IV-4	Saša Mitrović and Neven Vrček **Automated Machine Learning Methods for Efficient Prediction Of Carbon Dioxide Emissions In Building Sector**
IV-5	Lazar Berbakov, Valentina Janev, Marko Jelić, Dea Pujić and Nikola Tomašević **Towards a SGAM-Compliant Platform for NextGeneration Integrated Energy Services**
13:30 End of Session IV	

6 Conclusion

From September 26 till 28th 2023, the Institute "Mihajlo Pupin" had an honour to host the International SINERGY Conference on Smart and Innovative eNERGY management.

During the three days of the conference we gathered 27 papers, and 68 authors from a large number of countries. The conference presenters raised a number of questions in the field of smart networks, energy efficiency, big data processing, while also discussing the application of different artificial intelligence and machine learning approaches for big data analysis, combined with a number of other relevant topics.

Especially important for the objectives of the SINERGY project is the success of inclusion of young researchers in the research activities of the project partners (IMP, AIT and NUIG). Twelve (12) out of twenty three (23) papers were presented by young researchers with the SINERGY Conference being the first one in their career.

At the moment the SINERGY consortium is studying the opportunities for publishing a Proceedings of the Conference. The authors of the papers expressed their willingness to share the conference materials (papers, PPTs) with conference attendees, while they still have the rights to further extend the papers and submit to journals.

7 Annex I: Conference Information Pack

8 Annex II: Book of Abstracts

International Conference on Smart and Innovative eNERGY management

26 – 28 September 2023

Institute Mihajlo Pupin, Belgrade, Serbia

Capacity building in Smart and Innovative eNERGY management

This project has received funding from
the H2020 programme of the European Union under GA No. 952140

Programme Overview

26/09/2023 at 11:00	Opening Welcome to the Institute Mihajlo Pupin
26/09/2023 at 11:20	Keynote I (prof. Stergios Vakalis)
26/09/2023 at 11:50	Panel Discussion I
26/09/2023 at 14:00	Session I
27/09/2023 at 11:00	Session II
27/09/2023 at 14:00	Session III
28/09/2023 at 11:00	Keynote II (prof. Maria-Esther Vidal)
28/09/2023 at 11:30	Session IV

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the H2020 programme of the European Union under GA No. 952140

Programme Day 1

26/09/2023 at 11:00	Opening Welcome to the Institute Mihajlo Pupin
26/09/2023 at 11:20	Keynote I (prof. Stergios Vakalis)
26/09/2023 at 11:50	Panel Discussion I

Session I: Smart Grids	
I-1	Johannes Stöckl **Introduction to the Session with a Presentation of the Austrian Institute of Technology**
I-2	Jovana Gluščević, Žarko Janda and Jasna Dragosavac **Comparison of the response of grid forming and grid following inverters connected to a real grid**
I-3	Florian Strebl and Bharath-Varsh Rao **Impact of large-scale Deployment of Energy Communities on Distribution Grids**
I-4	Dayanne Peretti Correa, Luis Miguel Blanes Restoy, Paulo Lissa and Marcus Keane **Clustering Analysis to Support Demand Response Programs**
I-5	Patxi Hernandez, Nekane Hermoso and Valentina Janev **Towards Positive Energy Districts: Data Requirements and Use of Tools for Development of Energy Transition Scenarios**
I-6	Luka Ivanović, Djordje Stojić, Slavko Veinović, Dušan Joksimović, Jasna Dragosavac and Ilija Klasnić **Voltage Stability of Microgrid with Grid-Connected Wind Farm**
I-7	Valentina Timčenko and Slavica Boštjančič Rakas **Cyber Security Issues of Cloud-based Dynamic Line Rating**
16:30 End of Session I	

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Programme Day 2

Session II: Energy Management Systems	
II-1	Branislav Dobrosavljević **How to Ensure Cyber Security Deep in Your Supply Chain**
II-2	Željko V. Despotović, Ilija R. Stevanović, Jovan Šumarac and Aleksandar Rodic **Hybrid and Uninterruptible Power for Irrigation on Agriculture Smart Land**
II-3	Marija Radmilović, Uroš Ilić, Željko Despotović, Jelena Kljajić, Jovan Šumarac, Aleksandar Pavlović, Predrag Đešnić **Sustainable and Automated Production Process of Seedlings Using Robotic Systems**
II-4	Gavin Larkin, Luis Miguel Blanes Restoy and Marcus M. Keane **Simulation-based Evaluation of Air-source Heat Pump Retrofit to Phase-out Condensing Gas Boilers. Case Study of Campus Building In Ireland**
II-5	Anđela Marković, Valentina Janev, Nikola Tomašević and Marko Batić **Approach to Energy System Modelling for Supporting Decarbonization Scenarios in Energy Communities**
II-6	Igor Jovanović, Marko Jelić and Nikola Tomašević **Multi Objective Energy Management System and Sizing Optimization with Load Shifting**
13:00 End of Session II	

Session III: Building Energy Management Systems	
III-1	Marcus M. Keane **Introduction to the Session with a Presentation of the University of Galway**
III-2	Luis Miguel Blanes Restoy, Dayanne Peretti Correa and Marcus M. Keane **Simulation-based Commissioning of Control Loops for Heat Pump Integration and High Temperature Systems**
III-3	Mariya Chukkiriyan Joy and Marcus Keane **Energy Flexibility Assessment for Buildings in Ireland**
III-4	Thi Kim Bich Pham, Bharath Varsh Rao and Wilhelm Süßenbacher **Peer-to-peer Energy Market Incentivizing Energy Efficiency for Local Energy Communities in Austria**

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III-5	Mojgan Sami and Francisco Sierra **The Evolution of Heat Transfer Coefficient (HTC) Calculation Methods: A Critical Analysis**
III-6	Zhuoqun Sun, Francisco Sierra and Colin Booth **Real-time Occupancy Estimation Using Carbon Dioxide Concentration in Higher Education Institutions Buildings**
III-7	Spiros Chadoulos, Sotirios Athanasoulias, Stelios Kalogridis, Nikolaos Ipiotis, Odyssefs Diamantopoulos Pantaleon, Iordanis Koutsopoulos and George C. Polyzos **Energy Optimization of Building IoT Infrastructures in A Stratified Way**
16:30 End of Session III	

This project has received funding from
the H2020 programme of the European Union under GA No. 952140

Programme Day 3

28/09/2023 at 11:00	Keynote II (prof. Maria-Esther Vidal)
28/09/2023 at 11:30	Session IV

Session IV: Knowledge Management and ICT Tools	
IV-1	Enrique Iglesias, Ahmad Sakor, Philipp D. Rohde, Maria-Esther Vidal and Valentina Janev **KatanaG: Fragmenting Data Strategies to Enhance Knowledge Graph Creation from Large Datasets**
IV-2	Miloš Nenadović **Leveraging APIs and Knowledge Graphs for Efficient Data Access and Interoperability in the Energy Domain**
IV-3	Óscar Cabrera Redondo, Mónica Aragüés Peñalba and Sara Barja-Martinez **Medium-term Electrical Demand Forecasting of Residential Activity**
IV-4	Saša Mitrović and Neven Vrček **Automated Machine Learning Methods for Efficient Prediction Of Carbon Dioxide Emissions In Building Sector**
IV-5	Lazar Berbakov, Valentina Janev, Marko Jelić, Dea Pujić and Nikola Tomašević **Towards a SGAM-Compliant Platform for NextGeneration Integrated Energy Services**
13:30 End of Session IV	

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From/To Airport

Taxi: http://www.beg.aero/en/strana/8871/from-belgrade-airport

It is strongly recommended to contact the city service *TAXI INFO* desk, located in the baggage claim area in order to get a voucher which will enable you the fixed rate from airport to the city center (~€30). The same price will hold for the hotels in the city center and for the Institute Mihajlo Pupin.

Public transport:

http://www.beg.aero/en/strana/8811/bus

There are regular buses going from the airport to the city center. However, due to reconstruction work at the airport, we strongly recommend booking your transfer in advance via your accommodation/hotel.

Recommended Hotels

- Holiday Inn Express Belgrade, https://www.hiexpress.com

From/To Institute

The Institute can be reached form the city center:

- By public transportation: Use the bus **line 65**, in the direction **Zvezdara** and take off at station **"Institut Mihajlo Pupin"** which is at the Institute doorstep. https://www.planplus.rs/gradski-prevoz/beograd/autobus/65/A/213

Price: (around €1)

- By taxi: From the city center, using the taxi stand near **Terazije Square** (close to the hotel Moskva).

Price: (~€7-€10)

From Holiday Inn Express Belgrade/To Institute

- By public transportation: Use the bus **line 65**, in the direction **Zvezdara** and take off at station **"Institut Mihajlo Pupin"** which is at the Institute doorstep.

  https://www.planplus.rs/gradski-prevoz/beograd/autobus/65/A/213

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Internet access

Eduroam is available. For those without Eduroam account, another WiFi network will also be accessible.

For sightseeing

For useful information regarding Belgrade cultural/entertainment offer please visit: http://www.tob.rs/en/index.php

Or download **Android App** which will provide you some interesting sightseeing information (available in English): https://play.google.com/store/apps/details?id=com.hub.bgtalking

Climate

For more details please visit http://www.serbia.climatemps.com/

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Visa requirements

Serbia is an EU candidate and visas are not required for EU citizens. All travelers are advised to have a passport to enter Serbia, although EU citizens can enter Serbia with an ID card. Some citizens may need an appropriate visa to visit Serbia. For more information on the visa regime for entering Serbia please check the information at the Ministry of Foreign Affairs of the Republic of Serbia's website: http://www.mfa.gov.rs/en/consular-affairs/entry-serbia/visa-regime.

Other

The Republic of Serbia is not using the Euro currency, but there are many exchange offices (approved by the Central Bank of Serbia) throughout the city. To check the current exchange rates please visit the official site of the National Bank of Serbia: http://www.nbs.rs/internet/english/index.html. Local currency (Serbian dinar – RSD) can be withdrawn from ATMs.

VISA/Master/AMEX cards are generally accepted everywhere, except in small shops.

International phone code for Serbia: +381

International call prefix: 00 (+ sign is also usually supported)

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Book of Abstracts

Session I: Smart Grids	
I-1	Johannes Stöckl **Introduction to the Session with a Presentation of the Austrian Institute of Technology**
I-2	Jovana Gluščević, Žarko Janda and Jasna Dragosavac **Comparison of the Response of Grid Forming and Grid Following Inverters Connected to a Real Grid** **Abstract:** The increasing penetration of wind and solar power sources in power networks has led to the need for advanced inverter technologies to support the integration of these renewable energy sources into the grid. Inverters play a critical role in power networks, and understanding the benefits and limitations of different inverter types can facilitate the effective management of renewable energy sources and contribute to a more stable and sustainable power system. New types of power grid instabilities are field recorded as it is resonance instability. Several inverters connected to grid can have multiple resonances (range from low-medium high). The main goal of this paper is to explore the differences between grid-following and grid-forming inverters in power networks with high penetration of wind and solar power sources. These inverters have the main difference in output voltage electrical angle control circuit design. The paper aims to provide insights into the advantages and disadvantages of each type of inverter control and their impact on grid stability and the management of intermittency in renewable energy sources. Additionally, the paper aims to discuss the challenges associated with integrating grid-forming inverters into existing power networks and the potential for future developments in inverter technology to address these challenges. The research methodology of this paper involves a comprehensive literature review and analysis of existing literature on grid-following and grid-forming inverters. The literature review examines the benefits and limitations of each type of inverter, including their impact on grid stability, power quality, and management of

	intermittency. Additionally, the literature review explores the challenges associated with integrating grid-forming inverters into existing power networks and the potential for future developments in inverter technology. These differences and features of each inverter are compared by simulations results using Matlab/Simulink environment. The control is realized with varying the virtual moment of inertia and the damping factor for the purpose of achieving a better response to network disturbances. The output variables that change according to control actions are active and reactive power. Several scenarios were tested to compare the response of grid forming and grid following inverters: grid disturbance, change of reference value and change in grid load. The obtained results were compared. Additionally, the results of the paper discuss the challenges associated with integrating grid-forming inverters into existing power networks and the potential for future developments in inverter technology to address these challenges. In conclusion of the paper, means to mitigate the discussed problems are highlighted and coordinated control of inverters proposed.
I-3	Florian Strebl and Bharath-Varsh Rao **Impact of large-scale Deployment of Energy Communities on Distribution Grids** **Abstract:** The presented work shows a master thesis aimed to investigate the impact of a large-scale deployment of Renewable Energy Communities (REC) on low voltage (LV) as well as medium voltage (MV) distribution grids. A REC represents a citizen-driven, economic and legal entity, destined to enforce the further installation of renewable energy sources (RES) by, first of all, enhancing acceptance of the broader public. This shall be accomplished by letting citizens benefit from local RES production which then increases the attractiveness of local RES investments leading to further RES rollout, letting citizens benefit from it even more [3]. While RECs have been legally introduced within the "Clean Energy for all Europeans" package back in 2019 [4, 2], large-scale real world implementations are still the missing piece. In general, the intrinsic behaviour of RECs regarding optimal capacity management and integration of RES as well as market design have been well researched within the past years [5]. Due to the mentioned lack of real-world implementations and therefore the negligible overall capacity of RECs, the impact of these communities on the outer LV/MV grid has not been well researched so far. The aim of this work is to address the gap between RECs and distribution grids. Questions to be researched are if there is a way to locally operate RECs in a matter so they support the outer LV/MV grid, at which point in time or installed REC capacity they have to be accounted for from a grid operation viewpoint and if there is a conflict of interest between local, economic optimization and overall grid stability and capacity management. Expected results are a certain REC capacity value in respect to the observed outer grid at which theyr behaviour has to be accounted for. Also, a sensitivity analysis regarding local optimization versus global grid operation parameters is wished. Finally, recommendations on REC design and control, so that it aids the grid, will be given.
I-4	Dayanne Peretti Correa, Luis Miguel Blanes Restoy, Paulo Lissa and Marcus Keane **Clustering Analysis to Support Demand Response Programs** **Abstract:** Demand side management applied in the residential sector has a high

	potential in assisting the achievement of the balance between generation and demand in the electricity grid. For instance, increasing the self-consumption of local renewable energy sources using demand response techniques can avoid the need of importing electrical energy from the grid during peak consumption hours. One of the challenges in balancing demand and energy consumption in the grid, which is also one of the main issues faced nowadays by the grid stakeholders, is that residential energy consumption is hard to predict in terms of human behaviour and renewable energy sources. In this regard, there are characteristics of this type of energy user that may help the grid management stakeholders to understand the best type of demand response technique to be applied. These users may be classified based on the type and quality of the data that is being collected in the residence, for example. This paper aims to create an objective way to analyse the demand response capability of a group of buildings by classifying them using clustering techniques. A study about the most common techniques for clustering residential consumers will be performed with the objective of assessing the best one for this application. The state of the art will be studied, and a benchmark to understand the work already done in this field will be performed. These techniques will be applied in a database of the residential participants of the REACT H2020 project - an Irish pilot located in the Aran Islands. Preliminary analysis identified that the most common clustering technique applied nowadays is K-means. However, other solutions may achieve a more accurate result depending on the data distribution. As an example, a technique that is based on density known as DBSCAN can be more suitable compared to K-means when the dataset does not have spherical clusters. The test case analysis should demonstrate categories that will enable a more accurate applicability of demand response techniques. For instance, if there is no equipment suitable for autonomous or remote control of loads, implicit demand response would be a good option for these buildings. On the other hand, if a database with high accuracy is available and also remotely controllable devices, buildings may be categorized into a group where more advanced explicit demand response techniques can be applied, and this way automated actions would be a suitable solution.
I-5	Patxi Hernandez, Nekane Hermoso and Valentina Janev **Towards Positive Energy Districts: Data Requirements and Use of Tools for Development of Energy Transition Scenarios** **Abstract:** This paper presents a case study of development of energy transition scenarios for a small area in Belgrade, where Institute Pupin buildings are located. The data requirements for undertaking this type of model include detail accounting of hourly electricity and heat loads in the current situation. An understanding of the Serbian electricity system, and of its future planned evolution, is needed to understand the potential benefits of the interaction of the buildings with the national electricity grid. The paper presents an example of a preliminary scenario that can be used as part of a scenario-based prospective evaluation of transition solutions. This approach uses available monitored data, together with future projections of the buildings' demands, and a prospective evaluation of the electricity mix. The use of this type of model should serve to support decision-making towards a Positive Energy District, and for devising optimum management strategies.
I-6	Luka Ivanović, Djordje Stojić, Slavko Veinović, Dušan Joksimović, Jasna Dragosavac and Ilija Klasnić **Voltage Stability of Microgrid With Grid-Connected Wind Farm** **Abstract:** In this paper, we present a robust algorithm for tuning the parameters of

	a PID controller for automatic voltage regulator (AVR) of synchronous generator (SG). Our motivation for this work originate from the increased penetration of intermittent renewable energy sources (RES), which can cause voltage disturbances in the grid to which they are connected. Our goal is to develop a regulator that can mitigate disturbances in the grid resulting from renewable sources fluctuations while also remaining robust to errors in system modeling. The objective is to minimize the integral absolute error index (IAE) while taking into account predetermined values for Ms and Mp. Ms represents the maximum sensitivity function modulus, which is the transfer function of the coupled system from the output disturbance to the output. Mp represents the maximum complementary sensitivity function modulus, which is the closed-loop transfer function from the reference to the output. This guarantees sufficient reserves of stability for the entire system while also facilitating effective response to reference changes, as will be demonstrated and explained in the paper. The problem is analyzed and its solution is implemented using Matlab Simulink model.
I-7	Valentina Timčenko and Slavica Boštjančič Rakas **Cyber Security Issues of Cloud-based Dynamic Line Rating** **Abstract:** The introduction of the Dynamic Line Rating (DLR) is crucial for the implementation of the smart grids. It represents continuous assessment of the thermal and other operating conditions of the overhead transmission line in real-time to estimate maximum transmission line's load. In this paper we have addressed private, public and hybrid cloud services and cyber security concerns of cloud-based DLR systems. We have also proposed a secure DLR architecture based on a hybrid cloud.

Session II: Energy Management Systems	
II-1	Branislav Dobrosavljević **How to Ensure Cyber Security Deep in Your Supply Chain** **Abstract:** In this paper, we presented one of the possible solutions how to provide a comprehensive, flexible, high-quality Cyber security solution not only for large systems in the public and private sectors, but also for small and medium-sized enterprises (SMEs). This solution, based on open software and completely developed in Serbia, includes the use of the unique combination of the ARMADA integrated Cyber security platform and various services based on it. It is shown how this approach allows Cyber security risks to be addressed throughout the entire supply chain in the Smart grid, including its smallest elements. It is shown how this approach makes it possible to respond to cyber security risks throughout the entire supply chain in the Smart grid, including its smallest elements.
II-2	Željko V. Despotović, Ilija R. Stevanović, Jovan Šumarac and Aleksandar Rodić **Hybrid and Uninterruptible Power for Irrigation on Agriculture Smart Land** **Abstract:** The paper presents the realization of a hybrid and uninterruptible power system (HUPS) based on renewable energy sources (solar and wind) which is used for irrigation of vegetable crops on the "smart land" at the location of the village "Belegiš". Within the power system are realized the solar power plant with an output power of 8 kW, the wind generator system with a power of 0.5 kW and battery bank of 48V/720Ah, as primary power sources and a diesel electric generator (DEG) with a power of 7.5 kW as an auxiliary power source. In addition to this hybrid power, a system for remote management of irrigation and smart management of land has been implemented. At the end of the paper will be present the experimental results obtained during the exploitation tests on the smart land.
II-3	Marija Radmilović, Uroš Ilić, Željko Despotović, Jelena Kljajić, Jovan Šumarac, Aleksandar Pavlović, Predrag Đešnić **Sustainable and Automated Production Process of Seedlings Using Robotic Systems** **Abstract:** The aim of this paper is to present the sustainable and automated process of growing any kind of seedling using the collaborative robot UR5 without human involvement. The automation process is presented within one work cell where the robot, using additional devices, performs all the necessary steps of plant care and cultivation, following the cycle of its development from seed to seedling. Custom robot gripper components were developed to enable the robot to manipulate devices for watering, feeding, and spraying the plant and detecting parasites on plant leaves. The key advantages of this approach are sustainable production of any type of plant and food without human involvement.

II-4	Gavin Larkin, Luis Miguel Blanes Restoy and Marcus M. Keane **Simulation-based Evaluation of Air-Source Heat Pump Retrofit to Phase-out Condensing Gas Boilers. Case Study of Campus Building in Ireland** **Abstract:** The Áras DeBrún building, situated on the University of Galway campus, underwent energy retrofit works financed by the Energy Efficiency and Decarbonisation Pathfinder Programme, a government retrofit grant towards 2030 climate targets. A key focus of the retrofit works was the replacement of the condensing gas boilers with an air-source heat pump. To assess the performance of the retrofitted building, a significant quantity of data and measurements were collected to evaluate indoor environmental characteristics and the operational profiles of the installed energy systems. Using a systematically developed whole building energy model that was calibrated using IPMVP option D hourly energy consumption assessment and ASHRAE 140 criteria, this paper draws contrasts between the pre-retrofit and post-retrofit building performance, from the perspective of occupant comfort and energy usage. The primary goal of this whole building energy model is to optimise energy consumption associated with the operation of the building. The building energy model was implemented to analyse the building operation at a high-resolution time step, specifically at quarter-hour intervals, and conduct scenario analysis to propose methods of improving building operation. The investigation revealed significant scope for improvements in building energy consumption and occupant comfort with the implementation of the operation strategies developed. This study presents proposals for improved building operation and the development of optimal operation strategies under various scenarios investigated.
II-5	Anđela Marković, Valentina Janev, Nikola Tomašević and Marko Batić **Approach to Energy System Modelling for Supporting Decarbonization Scenarios in Energy Communities** **Abstract:** This research paper explores the approach to energy system modelling for supporting decarbonization scenarios in energy communities. Energy communities, comprising small-scale distributed energy systems, are increasingly being considered as a viable solution to achieve decarbonization goals. The paper discusses the steps involved in the energy system modelling process, including data collection, model development, and scenario analysis. The paper emphasizes the importance of energy system modelling in designing and implementing energy communities and highlights its potential to reduce carbon emissions, lower energy costs, and improve energy security. The paper concludes by emphasizing the critical role of energy communities in the transition towards a sustainable energy future.
II-6	Igor Jovanovic, Marko Jelic and Nikola Tomasevic **Multi Objective Energy Management System and Sizing Optimization with Load Shifting** **Abstract:** One of the steps towards the modern world of technology refers to the field of energy, especially when it comes to smart homes. With an increasing rate of

	digitalization, the need for efficient use of electricity as well as a controlled environmental impact is becoming greater. This leads to development of multi-criteria systems that takes into account several optimization types. Accordingly, a key problem to consider is implementing a model that receives the amount of energy produced data as an input, considering solar panels and wind turbines as energy sources, as well as the energy demand profile. Where the desired system outputs are the optimal energy dispatched to various energy assets with an assumed resolution of one hour, as well as determining the energy assets size. Consequently, two optimization aspects are of importance. The optimal amount of energy withdrawn from the grid, sold to the grid, stored in batteries or withdrawn from them is the first of two mentioned aspects. This optimization becomes multi-objective by considering the environmental impact through CO2 emissions. The second aspect is the sizing optimization, which refers to the optimal system configuration and design. Finally, demand-side management and the overall optimization process at the community level is analyzed in this paper. Moreover, the obtained results contribute to substantial electricity savings, which is directly correlated with financial aspects, as well as the recommendation to users towards the optimal use of appliances.

Session III: Building Energy Management Systems	
III-1	Marcus M. Keane **Introduction to the Session with a Presentation of the University of Galway**
III-2	Luis Miguel Blanes Restoy, Dayanne Peretti Correa and Marcus M. Keane **Simulation-based commissioning of Control Loops for Heat Pump Integration and High Temperature Systems** **Abstract:** Integration of heat pumps with existing heating systems brings challenges for its design and operation. In these situations, concurrent heat sources are available and is important to carefully consider the different source temperatures and load response times to maximise the use of renewable sources and heat pumps in retrofitting projects. Different hydronic integrations are possible and it is crucial to understand their implication, in terms of responsiveness and performance, of the control loops associated. Orchestrating this operation is usually not possible without understanding the associated load profiles and thermal inertia also on the consumption side of the system, hence the use of simulation-based techniques as helpful resource to plan the commissioning and to optimise the operation of the BMS controllers. In this paper we present the approach followed to address this problem during the commission of a a heat pump retrofit as part of a EU H2020 project GEOFIT. A dual source air-ground heat pump was installed that provides process water heating to a campus swimming pool. The approach described in this paper aims to use simulation to assess the tuning of two concurrent PID controllers and their corresponding setpoints by using systems identification techniques and simplified resistance-capacitance models (RC models) within the MATLAB environment as a quick shortcut to provide commissioning guidelines to the engineering teams involved. The expected optimised results will be tested and further assessed during the operational stage of the project using real monitoring data.
III-3	Mariya Chukkiriyan Joy and Marcus Keane **Energy Flexibility Assessment for Buildings in Ireland** **Abstract:** Globally, the energy sector is going through several shifts. The most important development is the uptake of renewable energy sources becomes near to primary electricity generation and the introduction of the smart grid provides the facility for demand response. Unconventional sources have traditionally been a major factor, but the impact these sources have on the ecosystem and people has been a hot topic of discussion. The advantages of green energy sources also encouraged people to research them. As a result, electricity is now produced using renewable energy sources like solar, wind, and others. This change in energy networks has made the topic of energy flexibility more crucial than ever. Because the building industry consumes more energy than other industries, energy flexibility in buildings is more crucial. Therefore, the benefits make continue to be the subject of research. To evaluate a building's implementation flexibility, a four-step approach is suggested.

	This has opened a new avenue for buildings to become more energy efficient. Additionally, flexible structures have the advantages of penetration of renewable sources and grid stability. By using more cleaner energy in buildings, the carbon footprint is consequently decreased. Future energy grids powered solely by renewable energy may benefit from the energy flexibility provided by buildings. The building's performance will be enhanced in the future by an ICT platform that has access to real-time data. Moreover, a designed load dispatch Centre and an energy storage facility will provide buildings with a wide range of alternatives for acting intelligently and flexibly. According to the research, energy flexibility in a building will undoubtedly lower energy expenses and emissions. In Addition, it will Provide support will for the uptake of renewable energy sources. As a result, this type of building helps the grid to maintain stability. Additionally, it provides an opportunity to meet EU goals to produce electricity from renewable sources.
III-4	Thi Kim Bich Pham, Bharath Varsh Rao and Wilhelm Süßenbacher Peer-to-peer **Energy Market Incentivizing Energy Efficiency for Local Energy Communities in Austria** **Abstract:** Local communities are increasingly embracing peer-to-peer energy trading as a workable approach to facilitating direct energy trade, advancing renewable energy integration, and democratizing the energy market. An overview of previous studies' findings on performance enhancement, the impact on the physical energy network, and the development of energy-exchange systems has been made available. However, there is little discussion of pricing competence and energy efficiency in peer-to-peer trading in local energy communities, which this paper aims to do. The implementation requirements of Austrian rules for peer-to-peer energy accounting are especially examined in this article. It investigates the effects of adopting peer-to-peer trade in local communities on the grid parameters and offers analysis and insights into this effect. The need of efficient trading algorithms for maximizing the potential of peer-to-peer energy trading is also highlighted in the article.
III-5	Mojgan Sami and Francisco Sierra **The Evolution of Heat Transfer Coefficient (HTC) Calculation Methods: A Critical Analysis** **Abstract:** The Heat Transfer Coefficient (HTC) is a vital parameter used to assess heat transfer efficiency of the fabric of the buildings. HTC is a key parameter to understand what the right measures are to enhance and control heating demand. The use of inaccurate HTC values of the fabric often leads to wrong decisions during the analysis of solutions to improve the fabric to reduce heating demand. Over the years, researchers have developed various methods to calculate HTC, leading to significant advancements in the field. However, these methods have limitations, necessitating their effectiveness evaluation. This paper explores recent methods used to calculate HTC, including analytical, experimental, numerical, and machine learning techniques. Analytical methods such as the LMTD and effectiveness-NTU are commonly used but have limited

	accuracy in complex heat transfer systems. Experimental methods such as heat flux and temperature gradient methods provide accurate results but are time-consuming and costly. Numerical methods such as Finite Element Method (FEM) and Computational Fluid Dynamics (CFD) can analyse complex systems but require substantial computational resources. Recent advances in machine learning techniques, such as Artificial Neural Networks (ANNs), have demonstrated efficiency and accuracy in HTC prediction. This article critically evaluates recent HTC calculation methods, analysing their effectiveness in different applications, their limitations, and main findings from recent studies. It provides insights into the evolution of HTC calculation methods and highlights areas for further research and development.

III-6	Zhuoqun Sun, Francisco Sierra and Colin Booth **Real-time Occupancy Estimation Using Carbon Dioxide Concentration in Higher Education Institutions Buildings** **Abstract:** In 2011, most HEIs failed to meet the carbon reduction target of 43% set by the Higher Education Funding Council for England by 2020. To help HEIs to meet the target, this research presents the concept of an algorithm for estimating real-time indoor occupancy. The information provided by this algorithm will allow the HVAC configuration to be updated with accurate live occupancy data. Thus, improving the operational and energy efficiency of HEI buildings and the comfort of their occupants. This tool applied a variation of the Extreme Learning Machine algorithm to estimate indoor occupancy using existing carbon dioxide (CO2) sensor data. By adding an additional feature such as room area in a layer between the input and hidden layer in a standard Extreme Learning Machine, this algorithm resolves the issue of CO2 detection delay caused by larger indoor space addressed in the previous research. The proposed algorithm was tested in a lecture room with 32 open seats. The result shows an accuracy of 94.3%.
III-7	Spiros Chadoulos, Sotirios Athanasoulias, Stelios Kalogridis, Nikolaos Ipiotis, Odyssefs Diamantopoulos Pantaleon, Iordanis Koutsopoulos and George C. Polyzos **Energy Optimization of Building IoT infrastructures in a Stratified Way** **Abstract:** According to EU sources, three out of four buildings in Europe do not consume electricity in an efficient manner, leading to energy waste and significant carbon emissions. Hence, Energy Management Systems (EMS) constitute a prominent tool for optimizing the energy consumption of building facilities. Such systems provide insights regarding energy usage in buildings, however, simple monitoring does not suffice to increase energy efficiency. The project "energy oPtimization of building Internet Of Things Infrastructures in a Stratified way" presented a holistic approach for an AI-enabled EMS for building-level energy management and maximizing the available renewable energy sources utilization. The project's scope was to develop and extend the data analytics tools and the interoperability layer of the PLATOON reference architecture by offering a holistic EMS for stratified energy optimization, from the asset level (e.g. HVAC), up to the building and district level. Specifically, the solution integrated a PV generation

forecasting module, a building energy demand forecasting module, and an energy task scheduling and optimization component. This paper presents the methodology and preliminary results regarding the PV generation forecasting and energy task scheduling modules tested both for the premises of Institute Mihajlo Pupin and several buildings managed by Plegma Labs. Namely, the PV generation forecasting module utilizes a neural network to conduct hourly solar irradiance predictions based on hourly weather forecasts. Then, the forecasted solar irradiance for a specific location is utilized to calculate the energy generation of any PV plant, based on its characteristics (e.g. panel efficiency, number of panels, etc.) regardless of its type and size. In addition, the energy task scheduling module incorporates the PV forecasts to maximize the utilization of solar generation by providing the optimal device activation schedule based on user preferences.
Experiment results showed that the proposed methodology outperforms other approaches in terms of forecasting error, while the utilization of the available PV generation is maximized.

Session IV: Knowledge Management and ICT Tools	
IV-1	Enrique Iglesias, Ahmad Sakor, Philipp D. Rohde, Maria-Esther Vidal and Valentina Janev **KatanaG: Fragmenting Data Strategies to Enhance Knowledge Graph Creation from Large Datasets** **Abstract:** In recent years, the amount of data being generated has increased exponentially. Thus, a unified schema is needed to bring multiple data sources under a single format. For that reason, the use of knowledge graphs (KGs) has become commonplace. However, the problem of generating KGs efficiently has become a new problem. When creating a KG, multiple factors affect the creation process, like the size and heterogeneity of the input data and the complexity of the input mapping. When managing large data sources, a new problem arises: how much memory will be needed? We propose $\mathcal{K}$atana$\mathcal{G}$, a framework that encloses partition techniques to scale up the process of KG creation to complex scenarios, i.e., large data sources and complex mapping assertions. As a result, memory usage and execution time are optimized. It is used alongside different knowledge graph creation engines to demonstrate that data source partitioning improves the knowledge graph creation process. The results indicate savings in execution time of one order of magnitude.
IV-2	Miloš Nenadović **Leveraging APIs and Knowledge Graphs for Efficient Data Access and Interoperability in the Energy Domain** **Abstract:** Efficient data access and interoperability are critical factors in the energy domain with the orchestration of many different services requiring seamless communication. Streamlining data access and manipulation requires the presence of an interface that facilitates interaction between the various services on one side and energy-related data on the other. In this case, standardization is achieved by reusing standardized vocabularies, which are deployed in a centralized repository of knowledge. The creation of an ontology is the first of the two main aspects of this paper, involving use-case analysis, conceptualization, instantiation of the knowledge graph, and integration. The second aspect focuses on the design and implementation of an API serving as a bridge between services/users and the energydomain ontology, highlighting its role in improving data interoperability and enabling efficient data retrieval. Real-world use cases demonstrate the benefits of the API and the ontology, showcasing enhanced integration, data sharing, and simplified data management processes. Furthermore, challenges and future developments are discussed, paving the way for future research in optimizing API functionality and extending support to additional services or data sources.
IV-3	Óscar Cabrera Redondo, ~~and~~ Mónica Aragüés Peñalba and Sara Barja-Martinez **Medium-term Electrical Demand Forecasting of Residential Activity** **Abstract:** Electrical power generation and demand forecasting are essential for guiding power systems operations which are facing uncertainties due to the increasing participation of prosumers and the larger number of flexible loads installed, among others. Because of the change in the demand profiles and the increase in uncertainty, forecasting the demand becomes a bigger challenge. The

	present study focuses on medium-term forecasting of aggregated residential consumption. Machine learning models will be developed and compared to derive the most significant variables to predict aggregated residential demand.
IV-4	Sasa Mitrovic and Neven Vrcek **Automated M achine Learning Methods for Efficient Prediction of Carbon Dioxide Emissions in Building Sector** **Abstract:** The research carries out the usage of automated machine learning methods for development of a methodological framework for predicting carbon dioxide (CO2) emissions in buildings using intelligent methods for data analysis. Research purpose is to conduct an intelligent analysis of data on the building sector in Croatia and offer automated machine learning methods for a methodological framework for intelligent data analysis on carbon dioxide emissions in buildings and offer models that would enable a high rate of forecasting of CO2 emissions annually in buildings and thus reduce the consumption of human time in the decision-making process and provide decision support for effective management of carbon dioxide emissions for public building managers. Research results are of global importance because from a problematic and practical point of view they may serve as a tool to reach binding targets for CO2 reduction in the world.
IV-5	Lazar Berbakov, Valentina Janev, Marko Jelić, Dea Pujić and Nikola Tomašević **Towards a SGAM-Compliant Platform for Next-Generation Integrated Energy Services** **Abstract:** This paper describes a SGAM (Smart Grid Architecture Model) compliant collaborative platform including its logical components in terms of functionalities and interfaces and their relationships. It aims to facilitate the service deployments, establishment and management of a Citizen Energy Community (CEC) by stakeholders along the energy value chain (consumers, energy managers, grid operators, service providers). Its foundation is based on standard-enabling technologies and practices and recommendations from EU projects (NEON and SINERGY). Unified Modeling Language (UML) is used to illustrate potential scenarios of CEC pilots.