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Smart Grid Interoperability Laboratory

Annual Report 2020

von Estorff, U., Covrig, F.,
Georgiopoulos, S., Kotsakis, E.,
Lucas, A., Marinopoulos, A., Masera, M.,
Papaioannou, I., Seldis, T., Tarantola, S.,
Wilkening, H.

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Contact information
Name: Ulrik von Estorff
Address: European Commission, Joint Research Centre (JRC), Westerduinweg 3, 1755 ZG - Petten, The Netherlands
E-mail: jrc-ptt-interoperability@ec.europa.eu
Tel.: +31.224.565325

EU Science Hub
https://ec.europa.eu/jrc

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Abstract

The Smart Grid Interoperability Laboratory in Petten was inaugurated on 29 November 2018. It is designed to foster a common European approach to interoperable digital energy, focussing on the smart home, community and city levels. The facility in Petten is part of a larger activity of the JRC, the science and knowledge service of the European Commission, encompassing electric vehicles, smart grids and batteries. The activities in 2020 are highlighted in this report.

Acknowledgements

The authors would like to thank the project leader Harald Scholz for his forward-looking view on integrating interoperability activities from the electric automotive sector. A special thanks goes as well to Philip Minnebo, who has played a significant role in the laboratory's quality and safety related issues. Last but not least nothing would have worked without a strong administrative support from the Unit, i.e. Virginie Petitjean and Dima Petrova.

Authors

von Estorff, U., Covrig, F., Georgiopoulos, S., Kotsakis, E., Lucas, A., Marinopoulos, A., Masera, M.,

Papaioannou, I., Seldis, T., Tarantola, S., Wilkening, H.

Executive summary

Smart homes are growing into smart communities and smart regions – even smart cities. In the future, we will live in an intelligent digital eco-system, where virtual power plants connect up sustainable energy systems, where electric cars behave as intelligent batteries, and where citizens produce energy as well as consuming it.

In order to achieve an intelligent digital eco-system, all systems need to be able to communicate with each other. They need to be interoperable. After the opening of the House of the Future as part of the JRC Smart Grid Interoperability Laboratory (SGIL) in Petten, NL, at the end of 2018, scientific activities started. With that scope the first test series had been undertaken in 2019. The continuation in 2020 is reported under chapter 4.

As a continuous activity the Laboratory is updated with new innovative digital products when needed. The tailor-made energy management system software is also further developed on a continuous base.

Policy context

The Energy Union in 2015 set the scene for an ambitious EU's positioning concerning energy, climate and clean mobility. Key objectives are the strengthening of the position of citizens while paving the way for innovative business. This approach is necessary to achieve the commitments of the Paris Agreement and the 2030 Energy Strategy, but also to enable the EU e-industry to be at the forefront of the global market. It recognizes the need for an integrated, coordinated and streamlined approach of EU policy and industrial R&D and business development with a global reach.

From the technological viewpoint, one major change is the massive introduction of ICT solutions in the energy field. This process of digitalization will result in an energy system characterised by extensive interconnections and exchanges of data between stakeholders, systems and devices. In this context, the potential of the market cannot be effectively realised if interoperability is not a cornerstone of efforts. Proprietary solutions, mainly if imposed by foreign companies, can greatly hamper the prospects for EU companies, and the empowerment of consumers.

The Tallinn e-Energy declaration ([1]) of 2017, signed by all Member States, asserted the vast potential for digital solutions in the energy sector and the requirement to ensure full interoperability between systems. The European Commission services are currently preparing both policy initiatives (DG CONNECT and DG ENER) in support of the 'Digitising European Industry' (DEI) strategy ([2]) and of the Clean Energy for All Europeans package (CEP) ([3]), and support to interoperability standardisation and testing with a hub of dedicated laboratories by JRC.

More recently, in 2019 the Green Deal ([4]) was launched by President Ursula von der Leyen, It is about making Europe climate-neutral and protecting our natural habitat, which will be good for people, planet and economy. The related initiatives are decarbonisation of the energy sector and renovation of building to cut energy bills and use.

In 2020, the New European Bauhaus ([5]) initiative was launched, which connects the European Green Deal to our living spaces. It intends to look at our green and digital challenges as opportunities and an approach to finding innovative solutions to complex societal problems. In line with these aims the JRC SGIL is prepared to contribute to the interoperability testing of digital solutions for the energy sector.

([1]) https://www.eu2017.ee/tallinn-e-energy-declaration
([2]) https://ec.europa.eu/digital-single-market/en/policies/digitising-european-industry
([3]) https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/clean-energy-all-europeans
([4]) https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
([5]) https://ec.europa.eu/commission/presscorner/detail/en/AC_20_1916

From e-mobility, to resilience of the energy grid passing via smart homes and grid integration, the SGIL is able to independently assess and support industry developments with respect to interoperability.

Key conclusions

Since the SGIL inauguration more and more interoperability use cases are and will be developed based on co-operation with industry, academia and research. The need for a common European interoperability testing methodology had been recognized and was taken on board by the SGIL, backed and recognized more and more by industry. The test results are described in detailed use-case testing descriptions.

The SGIL developed and published a tool kit on smart energy management for its Energy Management System.

The SGIL developed and tested for its Energy Management System a prediction model of the electrical power generated by the photovoltaic installation.

The SGIL validated the basic models for the residential electricity load simulation (resLoadSim) of households and developed an improved e-vehicle charging method. The SGIL initiated a collaboration with AIT on reducing grid load due to pv-generation at low voltage level by battery storage management. The SGIL could show, that with such battery management we can reduce peak grid load by almost 50% most of the time. Next to that, a paper on "Bottom-up Modelling Approach for Household Profiles" was published.

Related and future JRC work

In fact, the new JRC lab in Petten is part of a broader set of interoperability labs. It is connected with many other research facilities, including the Battery Energy Storage Testing facility on the same premises and the European Interoperability Centre for Electric Vehicles and Smart Grids in Ispra. Interoperability testing is carried out following an in-house developed European interoperability testing methodology. A common European repository for dissemination and open access is envisaged. The SGIL aims to attract external researchers with their use case, in order to build up the repository. For a better dissemination a peer-reviewed article is foreseen on the European interoperability testing methodology with use case examples. In that context also the SGIL will draft a Manual for the European interoperability testing methodology, as well as a module in the repository where public use cases can be reviewed externally. On top of this two new documents are in discussion: Interoperability standards following a new approach and a benchmarking process for defining the maturity in interoperability of devices, processes and services.

Further plans are to intensify our collaboration with EEBus with the objective to validate the EEBus interface against our interoperability testing methodology, which will require real hardware testing experiment. For this purpose, an experimental setup was designed jointly which will be delivered in 2021.

The already started process to define Living Lab activities at the JRC's Petten (NL) site will continue with dedicated staff awareness workshops and implementation plans.

Quick guide to this report

Chapter 1 gives a short introduction to the theme.
Chapter 2 describes the EC policy relevance, the motivations and the benefits for all stakeholders.
Chapter 3 describes the laboratory.
Chapter 4 reports about the activities related to the laboratory
Finally, conclusions are drawn in Chapter 5.
Annex

1 Introduction

Smart homes and communities are benefiting EU citizens mainly by optimized energy consumption and therefore energy bill reduction. Our houses are quickly becoming smart homes, with smart thermostats, domestic appliances and security systems activated by apps on our smartphones. However, this is just the beginning. Smart homes are growing into smart communities and smart regions – even smart cities. In the future, we will live in an intelligent digital eco-system, where virtual power plants connect sustainable energy systems, where electric cars behave as intelligent batteries, and where citizens produce energy along with consuming it.

In order to achieve an intelligent digital eco-system, all systems need to be able to communicate with each other. They need to be interoperable. But as citizens, how do we know if the appliances we buy are compatible; as investors and producers, what gives us the confidence to invest in specific products and to design new components?

The European Commission has launched several initiatives for making interoperability a reality, such as:

- Mandate to the European Standardization bodies on standards for smart grids and smart meters ([6]);
- Energy Union and Clean Energy for All Europeans policy packages ([7]);
- High level Meeting "Interoperability to create the Internet of Energy ([8]);"
- Calls in Horizon 2020 in the Pillar of Industrial Leadership ([9]);
- Common international smart grid standards initiatives within the Transatlantic Economic Council (TEC) ([10])

Developing common standards, test procedures and tools to promote universal compatibility and interoperability between electric vehicles, e-vehicles supply equipment, and the electric power supply infrastructure. The successful bilateral working relationship has led to an expansion of collaboration to include smart energy management;

Advancing work towards international standards on interoperability of patient health summaries, creating a common education programmes to support jobs in the health-IT workforce, and fostering transatlantic partnerships with regions/cities to solve similar health IT challenges and identify potential trade and commercial opportunities; and

Promoting opportunities for small and medium enterprises (SMEs) to increase exports. At JRC-Petten, we offer to stakeholders a laboratory facility to evaluate interoperability in smart homes and communities, fostering the adoption of a common testing methodology. The work is carried out in conjunction with other JRC facilities supporting the interoperability of smart grids and electric vehicles. With these actions, JRC will contribute to the implementation of EU policies aiming at the clear energy transition and the digitalisation of energy.

In 2020, we specifically investigated the application of the European Interoperability Testing Methodology in use cases and developed further our modelling and programming activities.

([6]) https://ec.europa.eu/energy/sites/ener/files/documents/2011_03_01_mandate_m490_en.pdf
([7]) https://ec.europa.eu/energy/topics/energy-strategy/clean-energy-all-europeans_en
([8]) https://ec.europa.eu/digital-single-market/en/news/high-level-meeting-interoperability-create-internet-energy
([9]) https://ec.europa.eu/programmes/horizon2020/en/h2020-section/industrial-leadership
([10]) https://trade.ec.europa.eu/doclib/press/index.cfm?id=1591

Figure 1. JRC Petten site from the air

Source: JRC, 2021

2 Policy background

The Energy Union set the scene in 2015 for an ambitious EU's positioning concerning energy, climate and clean mobility. Key objectives are the strengthening of the position of citizens while paving the way for innovative business. This approach is necessary to achieve the commitments of the Paris Agreement and the 2030 Energy Strategy, but also to enable the EU e-industry to be at the forefront of the global market. It recognises the need for an integrated, coordinated and streamlined approach of EU policy and industrial R&D and business development with a global reach.

From the technological viewpoint, one major change is the massive introduction of ICT solutions in the energy field. This process of digitalization will result in an energy system characterised by extensive interconnections and exchanges of data between stakeholders, systems and devices. In this context, the potential of the market cannot be effectively realised if interoperability is not a cornerstone of efforts. Proprietary solutions, mainly if imposed by foreign companies, can greatly hamper the prospects for EU companies, and the empowerment of consumers.

The Tallinn e-Energy declaration of 2017, signed by all Member States, asserted the vast potential for digital solutions in the energy sector and the requirement to ensure full interoperability between systems. The European Commission services are currently preparing both policy initiatives (DG CONNECT and DG ENER) in support of the 'Digitising European Industry' (DEI) strategy and of the Clean Energy for All Europeans package, and support to interoperability standardisation and testing with a hub of dedicated laboratories by JRC.

More recently, in 2019 the Green Deal ([11]) was launched by President Ursula von der Leyen, It is about making Europe climate-neutral and protecting our natural habitat, which will be good for people, planet and economy. The related initiatives are decarbonisation of the energy sector and renovation of building to cut energy bills and use.

In 2020, the New European Bauhaus ([12]) initiative was launched, which connects the European Green Deal to our living spaces. It intends to look at our green and digital challenges as opportunities and an approach to finding innovative solutions to complex societal problems.

In line with these aims the JRC SGIL is prepared to contribute to the interoperability testing of digital solutions for the energy sector.

From e-mobility, to resilience of the energy grid passing via smart homes and ~~transmission~~ grid integration, the SGIL is able to independently assess and support industry developments with respect to interoperability.

2.1 Why is interoperability important?

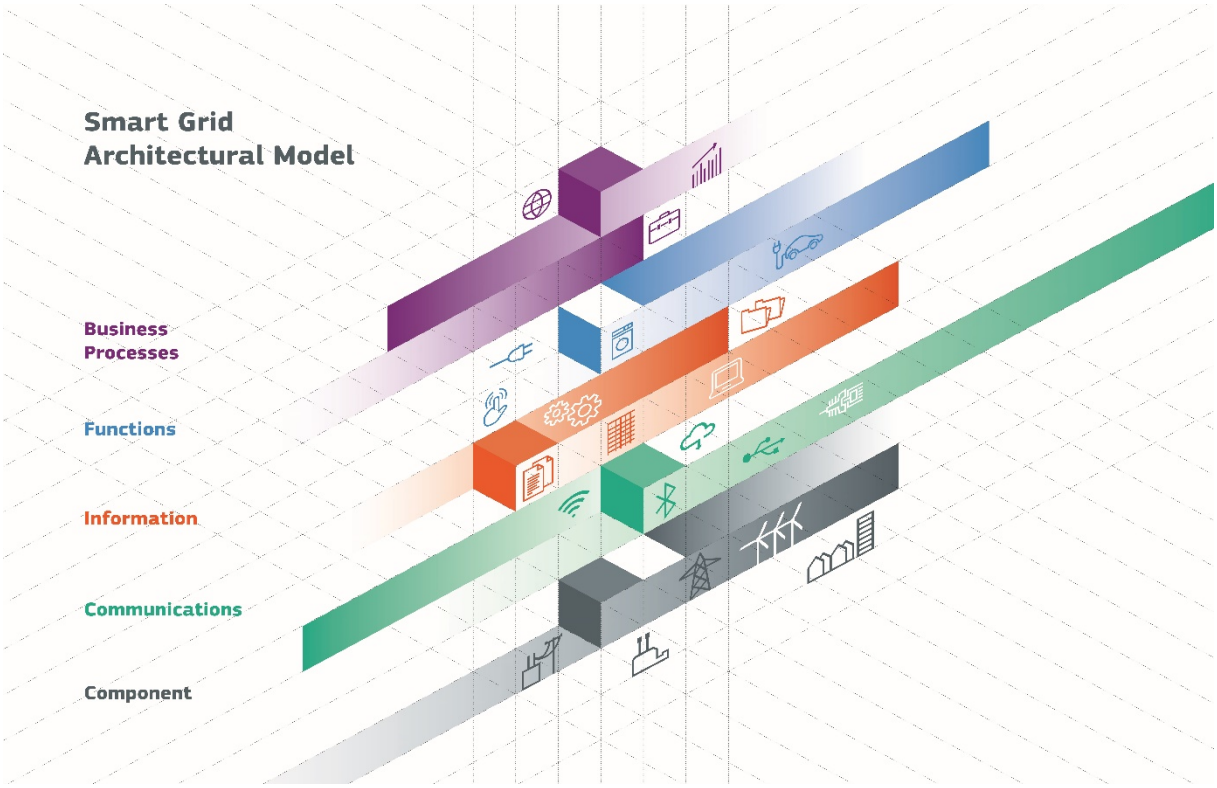
The digital transformation of the energy sector is already changing the way energy is produced, distributed and consumed, affecting not just industry, but also consumers and local communities. This revolution is characterised by the conjunction of renewable sources, smart grids, smart houses and electric vehicles, and is enabled by widespread application of information and communication technologies. The introduction of "internet of things" solutions in homes and buildings, for example, can interconnect appliances and devices to achieve energy efficiency.

([11]) https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en
([12]) https://ec.europa.eu/commission/presscorner/detail/en/AC_20_1916

A key challenge for digital energy, especially from the consumer's point of view, is the interoperability of all the components, systems, applications and information involved. Interoperability is the ability of two or more items to work together, which is key to the creation of a single digital energy ecosystem. But digital energy results from the convergence of many different industrial sectors – electricity, power electronics, home appliances, telecoms and internet – all with their own standards, cultures and technical backgrounds.

Interoperability will not happen spontaneously and needs to be supported with dedicated policy, standardisation and technical instruments.

Figure 2. The different interoperability layers based on the Smart Grid Architectural Model (SGAM)



Source: JRC, 2018

2.2 What is the issue for the EU consumer?

Consumers (at all levels: citizens, private companies, public organisations) would benefit substantially from the certainty that the goods they purchase can be integrated without major inconvenience and that they are not locked-in by vendors. This is particularly significant in the case of smart houses, where commercial offers can hide the perils and shortcomings of proprietary solutions. Lack of interoperability will fragment markets and damage consumers.

2.3 What is the EU doing about interoperability?

The European Commission has identified interoperability, based on open standards, as an essential requirement for the fostering of markets for innovative energy products and services. The European standardisation bodies (CEN-CENELEC and ETSI) have been working to develop an approach that can guarantee the interoperability of solutions. This work is complicated by the vast range of standards used and the lack of a common methodology to demonstrate interoperability (annex 1).

It is in this context that the JRC SGIL was conceived to contribute to the interoperability testing of digital solutions for the energy sector.

2.4 Why a laboratory for the interoperability of smart homes?

The above mentioned policy decisions made it the right moment to launch the Smart Grid Interoperability Lab and to demonstrate the House of the Future in JRC's Petten site. Smart Homes and communities are central to the energy transition. They set the pace for the connection of renewable energy sources (RES), the promotion of energy efficiency, the smooth management of distributed generation and the charging of electric vehicles, as well as the adoption of new services based on local storage solutions, smart appliances and Internet-of-Things (IoT).

Interoperability is the crucial element, not just enabling the overall integration of energy and ICT components, but unblocking open and fair markets based on seamless access to data and communication interfaces. Interoperability, building on existing standards, paves the way to an innovative digitalisation of energy.

This demonstrates the political emphasis placed on interoperability for Europe and provides the impetus to translate political goals into workable solutions.

Indeed it is now timely for the work of the European Commission towards interoperability of solutions and standardisation for smart energy grids, smart homes and smart meters to benefit consumers and industry. The "Clean Energy for All Europeans" package presented in November 2016 clearly stated that the development of more interoperable systems was required "in order to stimulate the further development and uptake of low-carbon, energy-efficient solutions across all sectors."

Additionally, the High-Level meeting organised by DG CONNECT and ENERGY in 2017 highlighted the need for aligning the standards regarding smart homes and smart grids, as a way for promoting the broad introduction of smart technologies and appliances. The link with public policies is clear: there is the collective interest of not fragmenting the internal market, of promoting European solutions worldwide, of sustaining public procurement and of empowering the end-users.

Nevertheless, policies, technologies and standards by themselves cannot secure the flourishing of the digital energy market. Policymakers, market players and consumers require a solid basis upon which to build up trust. Interoperability needs evidence and only systematic tests can provide it.

The work to be accomplished in the JRC Interoperability lab represents an important novelty: it will propose and disseminate the first complete and actionable interoperability testing methodology for digital energy and

smart homes ([13]). The approach to this issue has to be pan-European. A common approach to testing and reporting will facilitate the openness of information and the development of markets.

The creation of the lab thus represents a substantive step towards a more thorough European approach to interoperability. The future use and implementation of the common testing methodology by other laboratories and industry in Europe will secure a homogeneous and consistent reporting of the state-of-the-art of interoperable solutions.

Moreover, access to open and trustworthy information will reinforce the engagement of citizens. The vision is that of Interoperable digital energy systems for All Europeans, where each citizen can benefit with new products and services.

This is also an opportunity for Europe to play a leading role in the global scene. By unlocking the potential of interoperability and demonstrating its application, Europe's standards, technologies, solutions and industrial actors can gain markets and pioneer the worldwide adoption of clean and smart energy.

2.5 Smart Grid Interoperability Laboratory (SGIL) at JRC Petten: What do we do and for whom?

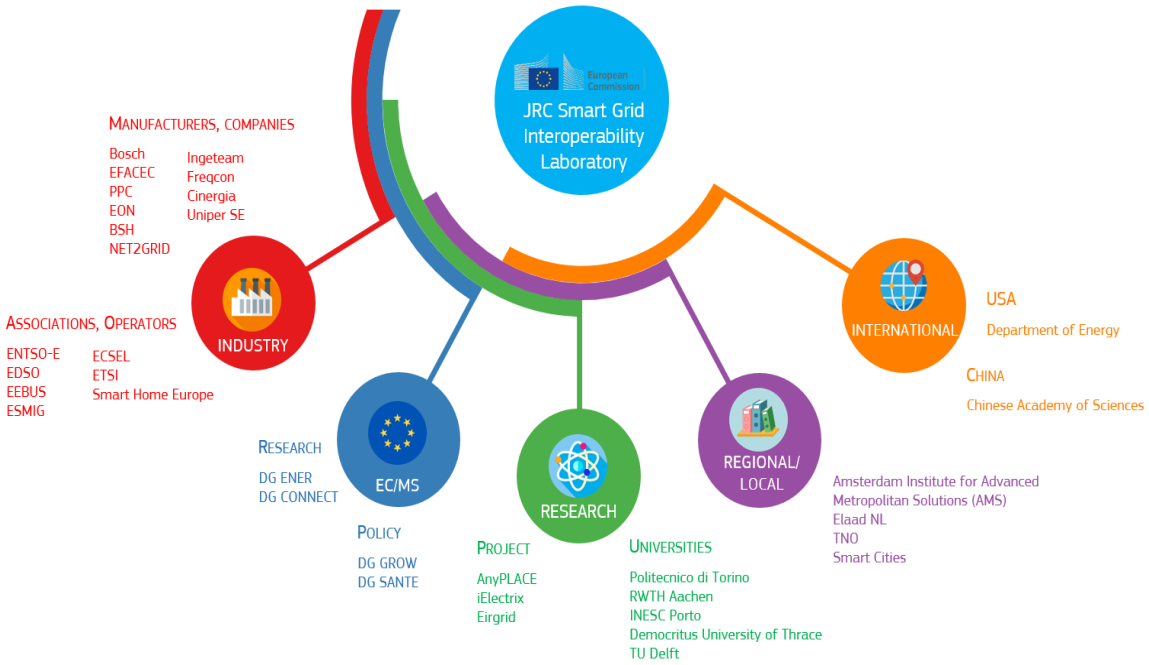
The SGIL at Petten has a clear objective: to promote the interoperability of digital energy in the interface between smart homes and smart grids. In order to do this, SGIL does:

- Test the interoperability of solutions, from the market and from research projects.
- Promote the use of a common interoperability testing methodology based on the CEN-CENELEC-ETSI framework.
- Network with other European laboratories and research centres for common initiatives.
- Network with European industrial actors in various sectors.
- Disseminate the results of testing campaigns.

Figure 3 shows an overview of stakeholders addressed by the SGIL.

([13]) Papaioannou I., Tarantola S., Lucas A., Kotsakis E., Marinopoulos A., Ginocchi M., Olariaga Guardiola M., Masera M., Smart grid interoperability testing methodology, EUR 29416 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-96855-6, doi:10.2760/08049, JRC110455

Figure 3. Stakeholders beyond the EU citizen addressed by the SGIL



Source: JRC, 2019

2.6 What is demonstrated in the SGIL?

- The implementation of a House of the Future platform, which examines the integration of solutions for white goods, home functions and other consumer electronics and their interconnection through smart meters to local grids.
- Some use cases taken from recent European projects.
- Integration with other JRC labs and facilities in European research centres.

Box 1. Some concrete examples of problems to solve for consumers or businesses

a) Carla wants to make her home in Italy smarter. She is looking for products to buy, but feels lost in the jungle of EU products and standards.
By making use of the results of the JRC lab, Carla will be able to speedily select among products with demonstrable interoperability.

b) George works in a retail company and would like to offer smart services, but finds the wide range of standards confusing.
Taking advantage of the database of use cases and testing results carried out at JRC's and other European facilities, George will be able to select interoperable services and the related products.

c) Pat and Ken are young entrepreneurs with an idea for a start-up, but the market is blocked by proprietary solutions.
Pat and Ken can benefit from the Interoperability labs in several ways: by testing their idea for qualifying their solution and accelerating the innovation cycle; by browsing the database of testing cases for examining the technical state of the art; and by being part of an ecosystem that defends open standards vs monopolies.

2.7 Who is benefitting from SGIL activities?

Consumers

- Access to reliable information on interoperable energy-related products and services.
- More certainty about plug-and-play digital energy solutions.
- Proof that applications can enable energy efficiency and participation in the energy market.

Manufacturers

- Less market fragmentation, opening up global market opportunities.
- Lower production costs due to economies of scale.
- Benefits of using open standards.

Operators

- Better integration of distributed energy resources.
- Opportunity for new business models and services.
- More consistent approach to a comprehensive digital energy framework.

Standardisation

- Identification of gaps and misalignments in current standards.
- Recommendations for further global harmonisation.

3 Layout and equipment of the SGIL

Accommodated in a new tailor-made building, the lab features a testing space for the future components of smart homes – where apps can regulate the fridge temperature according to your energy saving preferences for example, or the energy left over in the electric vehicle battery can be used to power your washing machine at a time of your choosing.

On one floor, simulators and technical apparatus set the testing environment. They are used to analyse the electricity and data flows between the grid and the smart home components.

Figure 4. SGIL from the air

Source: JRC, 2019

Figure 5. Smart kitchen SGIL, first floor

Source: JRC, 2018

Figure 6. Control room SGIL, first floor

Source: JRC, 2018

Figure 7. SGIL, ground floor

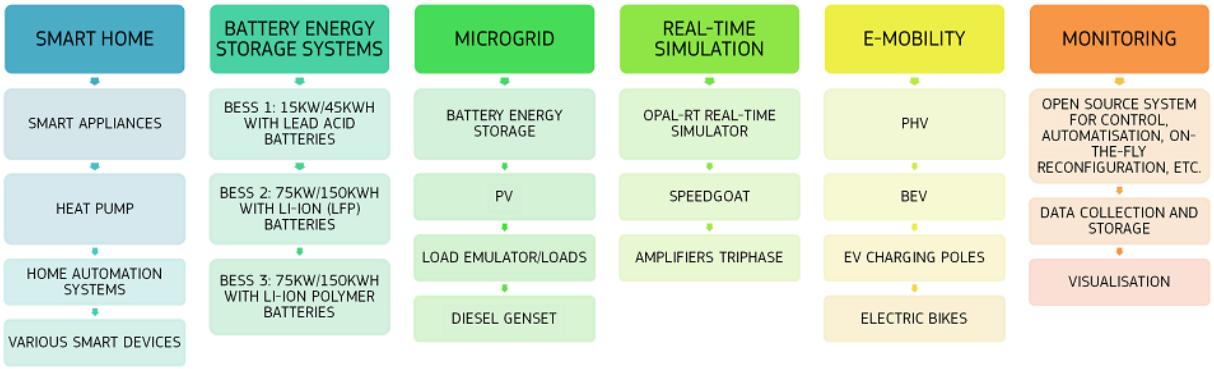
Source: JRC, 2018

Figure 8. Battery containers SGIL

Source: JRC, 2018

The SGIL is structured and composed according to figure 9.

Figure 9. Structure SGIL



Source: JRC, 2018

Some examples are shown hereunder.

Figure 10. 3 Large energy storage units (batteries)

Source: JRC, 2018

Figure 11.. Microgrid SGIL

Source: JRC, 2018

Figure 12. Electric vehicles SGIL

Source: JRC, 2019

Figure 13. Real time simulation SGIL

Source: JRC, 2018

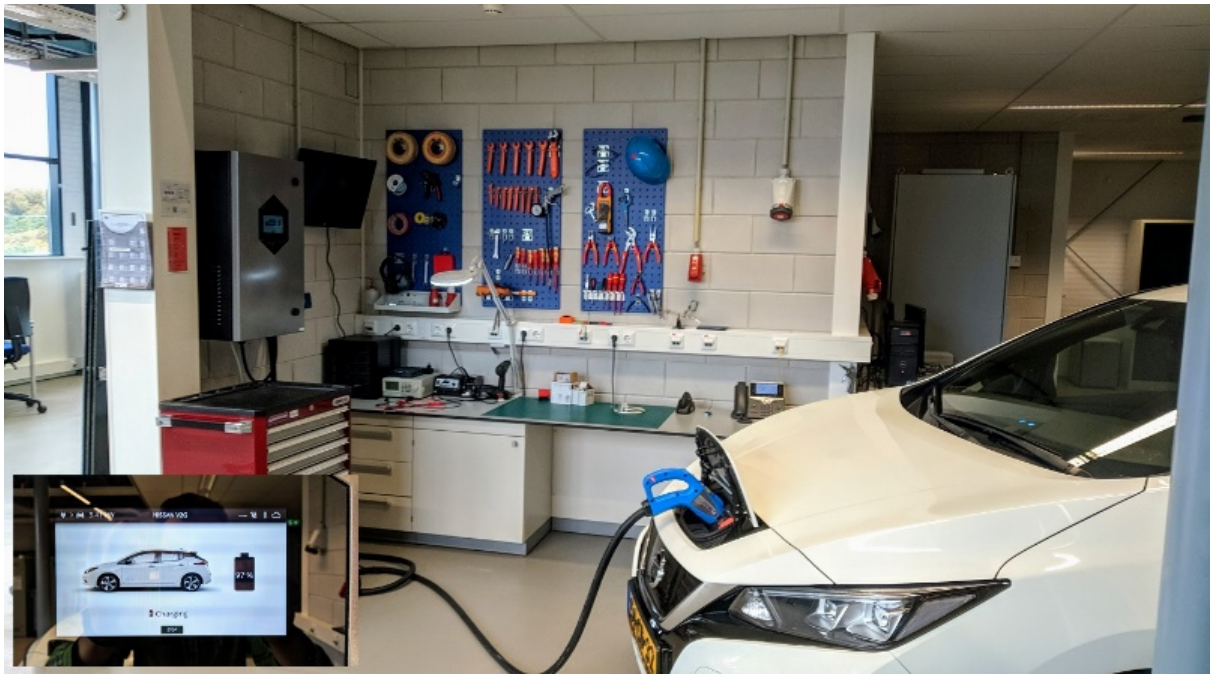
Figure 14. Smart Home appliances SGIL, first floor

Source: JRC, 2018

Figure 15. Diesel generator for uninterruptable power supply in the SGIL

Source: JRC, 2018

Figure 16. Vehicle to Grid (V2G) Charger, bidirectional flow of energy possible



Source: JRC, 2019

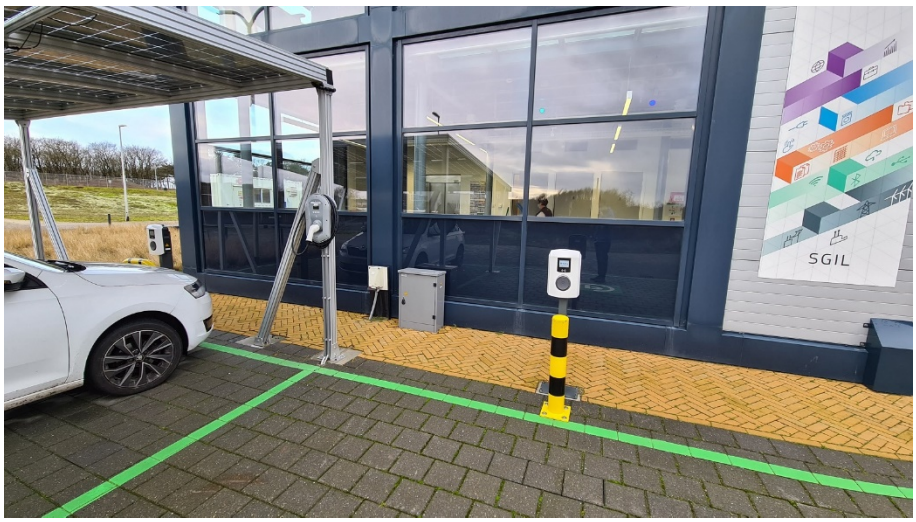
Figure 17. Prototype of Dutch Solar Design solar panels

Source: JRC, 2019

Figure 18. Revised extended electro cabinet

Source: JRC, 2020

Figure 19. New car charging infrastructure:



Source: JRC, 2020

Figure 20. Home battery and a hybrid solar inverter

Source: JRC, 2020

4 Scientific and experimental achievements in 2020 and planned activities in 2021

4.1 European Research Infrastructure supporting Smart Grid and Smart Energy Systems Research, Technology Development, Validation and Roll Out (ERIGrid 2.0)

Authors: Antonios Marinopoulos, Evangelos Kostakis

Since April 2020, the team of the JRC Smart Grid Interoperability Laboratory is taking part in a new Horizon 2020 EU project, ERIGrid 2.0 (https://erigrid2.eu/). The project runs from April 2020 until September 2024, comprises 20 partner organisations from 13 countries, including Universities, Research Institutes, and a Grid Operator, and has a total budget of 10 million Euros.

ERIGrid 2.0 will further expand the research services and tools of research infrastructures, previously developed in ERIGrid project (2015-2020), for validating smart energy networks with the electric power grid as the main backbone. Committed to the holistic and cyber-physical systems-based validation approach, ERIGrid 2.0 will foster system-level support and education for industrial and academic researchers in power and energy systems research and technology development.

The JRC SGIL team participates in most of the ERIGrid 2.0 Network activities and the Joint Research Activities of the project, as well as in the Transnational Access Activity for Facilities for Smart Energy Systems Integration and Validation.

In 2020 our team actively participated in three ERIGrid 2.0 work packages leading to the definition of a set of Functional Scenarios and Test Cases for further exploration during the project. We are also participating in the Joint Research Activities, where we lead a sub-task to define a benchmark (reference setup) for simulation of Electrical only test cases (excluding ICT or other energy sources), and contribute to developing common methods and approaches for Real-Time coupling and Hardware-in-the-loop.

For the Transnational Access Activities, JRC opens its Smart Grid facilities in Petten (NL) and Ispra (IT) to engineers and researchers from all over Europe in the domains of power system testing, smart grids and distributed energy, through periodic open calls ([14]) for project proposals (3-4 per year). After a rigorous selection process from a selection panel of experts, the selected researchers will receive free funding to access the lab facilities (including travelling, accommodation, and lab access) and perform their own experimental research. The first lab access call in the framework of the ERIGrid2.0 project was open for three months until the end of 2020. Two project proposals indicated our Smart Grid Interoperability Laboratory in Petten as their first preference to conduct their experiments. Due to COVID-19, the number of proposals was rather low, as at the time of writing this report, it is very difficult for most labs to accept external researchers and/or for researchers to travel around Europe. The second call will be published in February 2021 and will remain open for transmissions for three months.

The dedicated webpage for the SGIL in the frame of the project is found here: https://erigrid2.eu/jrc-petten/

The SGIL team actively participates in ERIGrid2.0 activities and expands its pool of collaboration partners. Through ERIGrid2.0 we have the possibility to co-create scenarios, use cases and test cases that can be used in the coming years as a reference for simulation and testing in the field of smart energy in European

([14]) https://erigrid2.eu/lab-access/

research facilities. We continue our work and we further plan to attract researchers to perform their tests in our lab.

4.2 Conference Paper on bottom-up Modelling Approach for Household Profiles

Authors: Antonios Marinopoulos

A conference paper from the collaboration with Democritus University of Thrace in Greece was presented in UPEC2020 ([15]):

G. C. Kryonidis et al., "A Bottom-up Modelling Approach for Household Power Profiles Using Time-series Measurements," 2020 55th International Universities Power Engineering Conference (UPEC), Torino, Italy, 2020, pp. 1-6, doi: 10.1109/UPEC49904.2020.9209849. (https://ieeexplore.ieee.org/document/9209849).

The paper proposed a bottom-up modelling approach of households equipped with appliances, photovoltaic and battery energy storage system (BESS). We created a high-resolution dataset of appliances (from real-life data and laboratory measurements) to simulate the daily household power profiles. The household model was applied to both single- and three-phase installations and incorporated a technique to optimize the BESS operation. The effectiveness of the model parameters and the performance of the model, in terms of power consumption, was positively evaluated using indicative simulation examples.

The work for this paper was based on the results of the 2019 project "Data-driven simulation modelling for smart neighborhoods", performed together with a team from the Power Systems Laboratory of Democritus University of Thrace, Greece. The result of the project was a software tool that modelled smart homes using daily time-series of power demand resulting from the combination of load consumption, a photovoltaic (PV) roof-top system and a battery energy storage system (BESS) that operates using self-consumption strategy.

The paper has been well received by the conference attendees and the dataset has been made publicly available in the IEEE Dataport ([16]): "Theofilos Papadopoulos, Georgios Barzegkar-Ntovom, Georgios Kryonidis, Dimitrios Doukas, Antonios Marinopoulos, Catalin-Felix Covrig, Eleftherios Kontis. (2020). High resolution profiles of residential appliances. IEEE Dataport. https://dx.doi.org/10.21227/yz3w-ca81". We are currently preparing a journal article in collaboration with the University, where an update of the model and the tool will be presented along with a few interesting study cases. The updated version will include among others weekly simulations and the possibility to run unbalanced power flow.

4.3 European Interoperability Testing Methodology

Authors: Ioulia Papaioannou, Evangelos Kotsakis, Sotirios Moustakidis

A systematic approach for developing smart grid interoperability tests may facilitate the dissemination of innovative solutions, the stability and resilience of the smart grid.

([15]) http://upec2020.polito.it/
([16]) https://www.ieee.org/

The European Interoperability Testing Methodology had been published as a report ([17]). This report provides an analysis of the methods applicable to smart grid interoperability tests. It comprises the body of methods and principles associated with smart grid interoperability and it proposes a methodology offering theoretical underpinning to the necessary set of methods and best practices for developing successfully smart grid interoperability testing specifications.

Based on the above, it had been decided that a scientific paper should be prepared, for a better dissemination. In the paper, an example of a use case, basic application profile and basic application interoperability profile of a real application will be added. The paper was not yet released in 2020, but will become a peer-reviewed article for the European Interoperability methodology in 2021.

A full application of the European Interoperability Testing Methodology was carried out for the H2020 project: Interflex https://interflex-h2020.com/. The project had 20 partners and is finalized by now. In WP3 they were carrying out Interoperability testing and using the JRC methodology and all the templates.

The SGIL is designing and setting up a database which will reflect and facilitate the implementation of the European Interoperability Testing Methodology. The database is basically a system which guides the user to create the Use Cases (UC), Basic Application Profile (BAP) and Basic Application Interoperability Profile (BAIOP). The system helps the user with drop down menus and options that the user can select to create his elements. Once, an interoperability object (UC, BAP or BAIOP) is finalized, the user can make this public and call reviewers to review and give their expert feedback.

Apart from continuous work on dissemination of the European Interoperability Methodology, the SGIL database on use cases is further developed, presently in a beta version for testing and using it. A manual is also being drafted to help the user.

Based on the European Interoperability Testing Methodology, two new ideas have been conceived and from these ideas, two new documents are already in process. The one involves the Introduction of Interoperability standards in the New Approach (The New Approach is a group of Directives, namely Essential Requirements and Harmonised Standards that are applicable in the European Economic Area.). In this document we are proposing an extension of the New Approach to accommodate the Interoperability standards as a result of the coupling of the information technologies with other sectors. Interoperability standards due to the necessity of designing interoperable devices that are able to be connected and communicate with the system shall be placed in the New Approach. They should be not obligatory but being used in the design of a device, product or a process should be able to give confidence to the end user that he/she has bought an accredited product ready to be used as integrated in his/her ecosystem. The way the Interoperability standards should be considered is similar to the Harmonised Requirements (https://ec.europa.eu/growth/single-market/european-standards/harmonised-standards_en) . They should not be obligatory but they should give the manufacturer/ designer an option to design the product/ process that can be accredited as interoperable.

The second idea involves a benchmarking process for defining the maturity in interoperability of devices, processes or services. The document will propose a Smart Grid Interoperability Maturity Model (SGIMM) and it describes the tools for applying the model to analyse the maturity of interfaces that support interacting entities and as well as defining practices that they can help organisations to achieve their smart grid interoperability goals. It provides also the metrics to define the levels of interoperability maturity and establishes a framework of methods to prepare an entity to move readily to connect and interact with the smart grid system of interest. Maturity model is a quality assurance process, which identifies five maturity levels using a staged representation. This staged representation provides a structured way to improve processes one stage at a time

([17]) http://publications.jrc.ec.europa.eu/repository/bitstream/JRC110455/kjna29416enn_final.pdf

The JRC-developed European Interoperability Testing Methodology had been used already by some stakeholders to describe their use cases. It is further disseminated, with the goal to enter use cases in a comparable manner in a common database.

4.4 Living Laboratory Project at JRC

Authors: Felix Covrig, Ioulia Papaioannou, Stefano Tarantola, Antonios Marinopoulos, Federico Maniaci, Georgios Tentzos, Roeland van Elsen, Ulrik von Estorff

The development and implementation of the Living Laboratory Project (DES-Lab) at the JRC's site in Petten, NL, followed the same scheme carried out at JRC's site in Ispra (I) though later in time. The project faces similar challenges but aims to test different use cases. The Petten site is much smaller than the Ispra site both in terms of area and number of personnel, which means that other use cases may find more applicability and practicality, compared to the pilots designed for JRC Ispra.

Furthermore, the implementation of the DES-Lab in Petten needs to be in line with the Petten Site Development plan8 and as such, it aims at making the site an attractive, smart, sustainable, functional, and person-centric working environment. In the spirit of the Living Lab approach, JRC staff members and equipment will serve as elements of real-life experiments. The JRC technological and social systems, with their daily activities (people working, moving across the site, eating, meeting, socialising, communicating and using the services of the site) will be part of specific investigations, producing scientific data through well-defined test and trials.

The goal of the first workshop organised in Petten in June 2019 was in fact to gather preliminary thoughts, concerns and ideas around the concept of a Living Lab specifically for the JRC Petten site. This ideation workshop allowed the identification of three use cases to be further discussed, with the objective of developing and – later - implementing pilot projects onsite with the participation and engagement of (identified) key stakeholders.

- Use Case 1. Commuting Efficiency

Several issues were raised regarding commuting from, to and during work. The suggestions made included the use of an e-bike fleet for commuting, more solar chargers for e-bikes, bike sheds, shuttle bus info app, carpooling app, data collection on the means of transport used and their impact on behaviour, commuting patterns to the canteen, and the development of a JRC "Uber" service.

Future discussions will address the main barriers and benefits for the installation of some of the proposals mentioned above.

- Use Case 2. Environmental Efficiency (Eco-Management and Audit Scheme) and Health

The JRC uses the Eco-Management and Audit Scheme (EMAS) on site. The system is developed by the European Commission for companies and other organisations to evaluate, report, and improve their environmental performance.

EMAS's last recommendations for the Petten site in view of their improvement possibilities through a Living Lab activity will need to be discussed. Recommendations included, for example, taking steps to reduce the

site's CO2 footprint, implementing energy saving measures with a payback time of 5 years, making a site-wide exchange of cold and heat (using the onsite thermal well) and monitoring air emission resources for a better insight. Discussions on the barriers and solutions for increasing the site's energy efficiency and reducing the CO2 footprint are needed.

- Use Case 3. In-house Research Testing

In the frame of its scientific portfolio various tests are carried out in the different JRC laboratories and different types of data are collected every day on the Petten site, from different fields and serving different purposes. Smart home energy management prototypes and car charging stations are only two examples, but there is certainly more that is being tested in Petten.

Discussions on the types of testing and/of data to be shared, and the main barriers which could prevent data access will be required.

The use cases will be the subject of a co-design workshop planned for 2021.

Link: https://publications.jrc.ec.europa.eu/repository/bitstream/JRC120368/jrc120368_living_labs_co-design_workshop_proceedings_final.pdf

4.5 Residential Electric Load Simulation

Authors: Heinz Wilkening

resLoadSim ([18])([19]) is a tool for residential electric load simulation developed within the Smart Electricity Systems and Interoperability project. The tool allows prediction of residential electric loads with a time resolution of 1 minute. It uses a probabilistic approach based on statistics to predict the electric load profiles of individual households by summing up the consumption of individual household appliances. Besides using the tool for load prediction, it is also possible to study the potential for load shifting in private households by implementing different control mechanisms, for example, based on variable pricing. The objective is not to develop a specific technology in detail than rather to evaluate the potential of certain technologies and concepts for the energy transition such as demand side management.

In 2020 we performed an extensive validation for the basic models within resLoadSIM against Hannover Rehre Zero-Energy-Park. A problem occurred, as there was no pvgis data available for the validation period, thus we had to use other data taken from an enercity pv reference station. This required extra modelling.

Furthermore we developed an improved e-vehicles charging method, which allows to study more realistically future loads in the distribution grid, which could even cause severe overloads in the grid if no management measures for charging are applied. Nevertheless simulation show, that with controlled charging these overloads can be reduces drastically or even fully avoided.

In addition in 2020, we initiated a collaboration with AIT on reducing grid load due to pv-generation at low voltage level by battery storage management. Also here we could show, that with such battery management we can reduce peak grid load by almost 50% most of the time.

Finally resLoadSIM has been made public-domain available under the GNU licence in 2020.

([18]) https://ses.jrc.ec.europa.eu/power-system-modelling;
([19]) http://files.messe.de/abstracts/85152_GB_2404_1620_Wilkening_Heinz.pdf

4.6 Energy Management System Tool Kit

Authors: Felix Covrig, Miguel Angel Munoz Diaz, Stavros Georgiopoulos, Antonios Marinopoulos, Thomas Seldis

The demanding environmental challenges our society is facing, appeal for greener and more efficient energy usage in our homes and buildings. Renewable energy (e.g. solar, wind) paves the way to solve these issues. The intermittent availability of renewable energy due to factors like lack or excess of sun or wind, could be addressed with the introduction of grid storage that will help in balancing the grid by providing or capturing the missing/excess power.

In this context, the implementation of smart systems in our buildings is a necessary task with a threefold outcome, namely: an enhanced energy management, a reduction of interoperability conflicts and an improvement in user comfort level. Home Automation and Energy Management Systems are called to play this role in the houses and buildings of the future.

In the technical report (Smart Grid Interoperability Laboratory - A toolkit for smart energy management), we introduced a Python based toolkit intended to act as an Energy Management System (EMS) for Smart Buildings. EMS play an important role in the buildings of the future by addressing interoperability problems, improving energy efficiency and user comfort. The package presented in this report provides the mathematical and data pre-processing tools to leverage existent Home Automation software into fully-fledged EMS. It makes use of optimization techniques take decisions in a coordinated way on device operation of the building or system considered (like the state of charge of batteries). Furthermore, the package eases data collection and pre-processing by automatically issuing forecasts of energy production and consumption based on past and present information and future predictions.

The Smart Grid Interoperability Laboratory (SGIL) of the JRC in Petten, the Netherlands has developed the tool, where it has been also tested.

Link: https://publications.jrc.ec.europa.eu/repository/handle/JRC120540

4.7 Energy Management System: Prediction of the electrical power generated by the photovoltaic installation - Programming Work

Authors: Thomas Seldis

The announcement to create a new "European Bauhaus" ([20]) by the European Commission was followed by the publication of a new strategy "A Renovation Wave for Europe" ([21]). The new strategy's main aim is to improve the energy performance of buildings. The intention is to double the annual energy renovation rate of residential and non-residential buildings in the next ten years and to foster deep energy renovations. Mobilising forces at all levels towards these goals will result in 35 million building units renovated by 2030. The increased rate and depth of renovation will have to be maintained also post-2030 in order to reach EU-wide climate neutrality by 2050.

According to the new strategy, the renovation wave should speed up the integration of renewables such as photovoltaics (PV) and its use at house, district or city level. Combined with smart energy distribution systems, they will enable highly efficient and zero-emission buildings. The Commission will map challenges

([20]) https://ec.europa.eu/jrc/en/news/new-european-bauhaus-commission-launches-design-phase
([21]) https://ec.europa.eu/commission/presscorner/detail/en/IP_20_1835

encountered by these products on the single market and consider ways to remove identified barriers, including via mutual recognition. With the installation of new solar systems, the number of Energy Management Systems (EMS) in smart buildings will also rise in the coming years. In general, a EMS is a device comprised of hardware and software to monitor, log, control, and manage the generation, storage, and consumption of electricity in a building.

A lot of research has been done so far to make the EMS a demand response tool that shifts and curtails demand to improve the energy efficiency and reduce electricity cost based on the real-time electricity price and consumer comfort. What has been less explored so far, however, is the possibility of integrating an algorithm to predict the electrical power generated by the PV installation over the next, say, 24 hours as a feature in the EMS. Ideally, the prediction is generated on the spot based on the logged power data of the PV system as well as local conditions such as irradiation, inclination/orientation angle and ageing of the solar panels, shadowing, etc. An accurate building-by-building prediction of the PV generated power would have a number of advantages: I) Higher rate of self-consumption per building, II) Smoother exchange of electricity surplus among buildings, III) Providing more accurate data aggregated from the per installation level to balance the grid.

A first prototype was developed and implemented in the Smart Grid Interoperability Laboratory (SGIL) in Petten. The system was built on Prophet, an open source tool provided by Facebook to forecast time series. The code was reviewed and tested and it has been shown that the accuracy of the predicted PV generated power is robust. The computational cost, however, i.e. the computation power required to make a forecast for the next 24 hours is relatively high. An integration of such a solution into a commercial EMS would not be possible, because the computing power of these systems are limited. Therefore, in a next step, a benchmark model was developed and implemented to test the performance of a computational low cost algorithm. The tests showed that it took only a fraction of time to compute the forecast with the benchmark model, while the accuracy of the predictions outperformed the Prophet model.

At this point, a more fundamental research was kicked off to answer the question: Which model/algorithm gives the most accurate forecast of the PV generated power at the lowest computational cost? A number of classical time series models have been implemented, tested, and compared with both the benchmark and Prophet model so far. More advanced machine learning models will be also tested to ultimately find the most suitable algorithm for the problem at hand. A Proof-of-Concept (PoC) project will demonstrate that it is feasible to host the best high performing PV power generation forecast algorithm on a low budget mini-computer (Raspberry Pi).

If successful, we can use the demo to:

- Enhance the performance of the EMS prototype in the lab
- Use it as a showcase in the lab
- Integrate/link it with the EEBUS demonstrator?
- Build a living lab application
- Study and identify interoperability issues (for retrofitted solutions)
- Define minimum requirements for commercial EMS (standards)

4.8 Collaboration with the EEBus Initiative

Authors: Ioulia Papaioannou**,** Heinz Wilkening

The EEBus ([22]) Initiative e.V. is a non-profit association with leading manufacturers from the sectors of networked building technology, electromobility and energy. EEBus is communication interface for typical smart home devices based on standards and norms. Although the main application of EEBus is the energy demand management, it also can be used for Home automation in general. As such, EEBus is a ideal test case for use to apply our interoperability testing methodology to it. This is even facilitated as already many use cases have been already defined within EEBus. Therefore, we decided to intensify our collaboration with EEBus with the objective to validate the EEBus interface against our interoperability testing methodology, which will require real hardware testing experiment. For this purpose, an experimental setup was designed jointly and an order for construction was placed and will be delivered in 2021.

([22]) https://www.eebus.org/what-is-eebus/

5 Conclusions

The construction of the Smart Grid Interoperability Laboratory at the JRC in Petten (NL) is an additional piece in the JRC support to EC policy in the area of Digital Energy. Interoperability has received a high level of attention. JRC developed a widely accepted European Interoperability Testing Methodology based on the Smart Grid Architectural Model, which serves as a basis for testing use cases of interoperability in future smart homes. Next to the enlargement of the laboratory testing capabilities, new use cases will be continuously defined and carried out. These use cases are of interest for or result directly from networking with European industry and research consortia. First tests were carried out in 2019 and mentioned in the 2019 Annual Report of the SGIL. Activities carried out in 2020 are reported here. In parallel, a database is close to finalization for the collection and dissemination of the use cases examined. In parallel, the SGIL has further developed its Energy Management System and its modelling and programming capabilities.

References

Papaioannou I., Tarantola S., Lucas A., Kotsakis E., Marinopoulos A., Ginocchi M., Olariaga Guardiola M., Masera M., 'Smart grid interoperability testing methodology', EUR 29416 EN, Publications, Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-96855-6, doi:10.2760/08049, JRC11045531-34.

List of abbreviations

ANL	Argonne National Laboratory
BAP	Basic Application Profile
BAIOP	Basic Application Interoperability Profile
BESS	Battery Energy Storage System
BMS	Battery Management System
CEN	European Standardisation Committee
CENELEC	European Committee for Electrotechnical Standardization
CEP	Clean Energy for all Europeans Package
DEI	Digitising European Industry
DES Lab	Digital Energy Solutions Laboratory
DoE	Department of Energy (USA)
DUTH	Democritus University Thrace
EMS	Energy Management System
ETSI	European Telecommunications Standards Institute
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
GGIP	Global Grid Integration Project
HA	Home Automation
IoT	Internet of Things
LED	Light-emitting Diode
OCPP	Open Charge Point Protocol
OpenDSS	Open Distribution System Simulator
PQ	Power Quality
PV	Photovoltaic
PyEMS	Python based Energy Management System
RCD	Residual Current Device
RES	Renewable Energy Sources
SGAM	Smart Grid Architecture Model
SGIL	Smart Grid Interoperability Laboratory
SOC	State Of Charge
SOH	State of Health
TEC	Transatlantic Economic Council
UC	Use Case
V2G	Vehicle to Grid

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Annexes

Annex 1. Developing Interoperability for Europe

The digitalisation of energy integrates components from different sectors: electricity, heating and cooling, information, communications, business processes and home appliances. The interconnection of those different systems, designed and developed according to different standards, brings about the problem of their interoperability. All those elements have to work together in order to have workable solutions in the market.

The lack of interoperability obstructs and delays the implementation of the digital energy solutions, affecting also the deployment of –among others– distributed renewable energy sources, smart homes and electric vehicles.

For tackling this conundrum, the European Commission set up the ***Smart Grids Task Force*** in 2009 for receiving advice on relevant issues regarding the deployment and development of Smart Grids. Based on the work of this expert group, the European Commission issued mandates in 2011 to European Standardisation Organisations (ESOs) –CEN, CENELEC and ETSI– to develop and update technical standards: M/441 'Standardization Mandate of Smart Meters', M/468 'Standardization Mandate concerning the charging of electric vehicles' and M/490 'Standardization Mandate for Smart Grids'.

The ***Mandate M/490*** had the precise goal of accelerating the standardisation process required for the deployment of Smart Grids in Europe. The Mandate 490 explicitly stated:

> *The objective of this mandate is to develop or update a set of consistent standards within a common European framework that integrating a variety of digital computing and communication technologies and electrical architectures, and associated processes and services, that will achieve* ***interoperability*** *and will enable or facilitate the implementation in Europe of the different high level Smart Grid services and functionalities as defined by the Smart Grid Task Force that will be flexible enough to accommodate future developments.*

To work on mandate M/490, the ***Smart Grid Coordination Group (SG-CG)*** was set-up in July 2011. After work on standards, in 2014 the group produced a report on Smart Grid Interoperability, highlighting the urgent need for a shared European approach to its testing. The report[23] sketched a first set of methodologies for including interoperability requirements during system design, and then ascertaining them through testing. The report states:

> *As more and more ICT components are connected to the physical electrical infrastructure, interoperability is a key requirement for a robust, reliable and secure Smart Grid infrastructure. The way to achieve Smart Grid system interoperability is through detailed system specification, through use of standards, and through* ***testing****.*
>
> *…*
>
> *Although the majority of Smart Grid equipment is based on (inter)national standards, this does not automatically result in an interoperable Smart Grid infrastructure. This is partly due to misunderstanding of what interoperability means, what can be expected from it and what should be done to realize it.*

In 2015 the European Commission set up a ***Smart Grid standards expert group*** with the aim of supporting the work on interoperability, standards and functionalities applied in the large scale roll-outs of smart

[23] ftp://ftp.cencenelec.eu/EN/EuropeanStandardization/HotTopics/SmartGrids/SGCG_Interoperability_Report.pdf.

metering in EU Member States. The work included an extensive survey,[24] and responses by the Member States.[25]

An important aspect has been the link between the European Union and USA. In successive dialogues in the context of the Trans-Atlantic Economic Council (TEC), and ratified by the EU-US Energy Council, both parties ratified the importance of cooperation in interoperability. A TEC Joint Statement in November 2011[26] called for "*working jointly towards the objective of common or compatible* standards" and launched a cooperation pilot project, agreeing on the establishment of two Electric Vehicle/Smart Grid Interoperability Centres, one at Argonne National Laboratories and one at JRC. This was complemented with a Letter of Intent (LoI) between JRC and the US Department of Energy (DOE) declaring the interest on closer co-operation on interoperability matters. This cooperation was later confirmed during the inauguration of the Argonne National Lab interoperability facilities for electric vehicles in 2013.

In parallel, the Trans-Atlantic Business Council identified e-mobility and smart grids as a key growth sector in both USA and EU where collaboration in standards, regulation and interoperability could be of great value.

In 2015, the TEC meeting reiterated the shared interests for EU-US cooperation on e-vehicles and smart grids, highlighting that the work on interoperability and the joint work between the labs in DOE and JRC was a priority. This demonstrated the high political support to the initiative. One relevant phrase of the TEC facilitators says (27 March 2015):

> *In view of this success in the field of charging devices, facilitators encouraged Argonne National Laboratory and DG JRC to continue their active cooperation towards implementation of the Letter of Intent between the DG JRC and the DOE to test and verify equipment, connectivity technologies, communication protocols, and standards.*

Other relevant activities in Europe

⇒ DG CNECT/ENER - High level Meeting "Interoperability to create the Internet of Energy"

On 11 May 2017 DG ENER and DG CNECT organised a high-level meeting on how interoperability of communication and data exchange can ensure that Europe will benefit from the new opportunities that the IoT will create in the energy transition. The main questions were around interoperability, such as: What can public authorities do to ensure interoperability? What interoperability is needed to develop the smart home of the future that is for the benefit of consumers? What interoperability is needed for an efficient smart grid that fosters innovative energy services.[27]

⇒ DG ENER - Smart Grids Task Force Expert Group 1 Electricity and Gas Data Format and Procedures

Following the decision of the Smart Grids Task Force on 17/02/2017, a Working Group on Energy Data Format and Procedures was formed with the overall task to collect information and investigate the potential for setting up a common format and procedure for energy data exchange in the EU-28. There have been some first reflections on this issue captured in a recent study on "My Energy Data"[28] drafted as an interim report by an ad-hoc group of the Expert Group 1 (EG1) of the Smart Grids Task Force.

The main objective of this Group is to work towards a common interoperable energy data format and procedures at European level, achieve consensus among key stakeholders on best practice, and propose what

[24] https://ec.europa.eu/energy/sites/ener/files/documents/Annex%20C_Survey%20Result_for%20EG1%20Report.xls
[25] https://ec.europa.eu/energy/sites/ener/files/documents/Annex%20%20D_%20to%20EG1%20Report.pdf
[26] https://www.state.gov/p/eur/rls/or/178419.htm
[27] https://ec.europa.eu/energy/en/events/high-level-meeting-interoperability-create-internet-energy

should be the scope and coverage of further and more specific secondary EU legislation (i.e. implementing act) to set such common arrangements.

Uniting the existing various arrangements into a common data format and procedure at EU level will bring together diverging national practices, facilitate interoperability and uptake of new services, boost internal market competition and keep administrative costs under control.

The tasks were divided into four ad-hoc working teams (subgroups) dealing respectively with three processes – change of supplier, billing, emerging services – and the horizontal issue of interoperability. JRC takes part in the latter.

The final aim is to achieve consensus among key stakeholders on best practices, and finally frame recommendations to propose what should be the scope and coverage of a secondary EU legislation to set-up such common arrangements ensuring interoperability. The outcome of this work will also facilitate the discussions of the Council with the Parliament for the Article 24 "Interoperability requirements and procedures for access data" of the Recast of the Electricity Directive, and will directly feed into testing requirements.

⇒ DG CNECT/ENER - H2020 Call Interoperable and smart homes and grids

Within H2020 a Call is dedicated to the topic 'Interoperable and smart homes and grids,'[29] where the aim is to exploit the Internet of Things (IoT) architectures models that allow for combining services for home or building comfort and energy management, based on platforms, that enable the integration of relevant digital technologies. With deadline on 14 November 2018, the project is planned to begin in the 2Q 2019.

The envisaged architecture should allow for third-party contributions that may lead to new value-added services both in energy and the home/building domain. This shall be done by developing interoperability and seamless data sharing, through aligning existing standards from the utility and ICT domains, across the devices and systems to enable innovative building energy management services, with the aim to save costs to consumers, to facilitate the integration of renewable energy from distributed intermittent sources and to support energy efficiency.

The JRC SGIL in Petten, in agreement with DG ENER/CNECT, intends to provide technical support to the selected project consortium.

⇒ DG CNECT/DG SANTE – Health

Smart or digital health will become more and more of importance in patient's diagnostic and therapeutic methods. New approaches have as central components telemedicine and remote care, with dedicated appliances and services that rely on reliable energy and communications. The security and interoperability of health data and devices are key issues. Interoperability is explicitly requested in the Medical Device Regulation EU 2017/745, as well as in the Medical Device Directive 98/79/EC 'in-vitro diagnostic medical devices ".

In this respect, DG CNECT animates the Digital Health and Care Task Force and sponsors different research activities in H2020, planning to continue with them in the future for facilitating the sustainability and quality of health and care provision, as a consequence of demographic change and improvements in medical treatment.

The JRC SGIL considers providing support to these initiatives at different levels:

- Interoperability testing of devices;
- Participating in the JRC Transversal Activity on Evidence-based Health Project;

[29] http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/dt-ict-10-2018-19.html

- Setting up collaboration with leading European digital health/Telehealth research institutes and clinics;
- Information exchange on interoperability issues in digital health with DG DIGIT and DG ENER.

⇒ DG GROW – Smart Grid flagship studies

At the end of 2015, the Executive Agency for Small and Medium-sized Enterprises, under coordination of DG GROW and supported by the JRC, launched a tender grouped into two lots for studies on: 1) smart grid lighthouse projects; and 2) barriers and opportunities for smart grids deployment.

The purpose of the studies was twofold: 1) to identify what makes smart grid projects attractive to investors with the aim of stimulating investment towards this industry; and 2) analyse existing obstacles and opportunities for deployment of these technologies in EU to help identify where support is most needed and most relevant for smart grid deployment and European industrial competitiveness and growth.

The basis for the studies was the JRC inventory of smart grids projects and the main findings were presented in the context of the Expert Group on smart grid industrial policy of the EC Smart Grid Task Force. Amongst them, as also stated by the European Economic and Social Committee (2017), the objectives of the Clean Energy Package highly depend on the value the interactions between operators, service providers and consumers, and the availability of interoperable solutions.

⇒ CEN-CENELEC-ETSI - Coordination Group on Smart Energy Grids (CG-SEG)

After the dissolution of the Smart Grid Coordination Group in 2015, CEN-CENELEC-ETSI set up the CG-SEG for continuing with the work on standardisation. CG-SEG complements work of the European Commission Smart Grid Task Force (SGTF) Expert Groups.

CG-SEG identified some legislative proposals from the Clean Energy Package (CEP) with the highest impact on standardisation. Of these 'priority topics', two refer to interoperability:

5. Data Management, format and interoperability (CEP-EMD-1)

7. Interoperability with Consumer Energy Management systems (CEP-EMD-3)

In addition, the European Parliament (EP) amendment to Article 24 (Data format) of the Proposal for a revised Electricity Market Directive explicitly requests that interoperability standards for a common European data format be drawn up by the relevant European standards organization.

JRC takes part in the CG-SEG, taking into consideration their technical positions, and providing feedback from the work in the laboratory, mainly regarding the testing procedures. It is expected that CG-SEG will formally endorse the testing methodology and tools developed by JRC.

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