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Digitalisation of the Energy sector

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Contents

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EDITORIAL

Implementation of the Digital Agenda for Europe: interoperability across national borders, ISA² Programme

In November 2016, the European Commission proposed a Regulation on the Governance of the Union. Its main goals were: a) to ensure the achievement of the objectives of the Energy Union, especially the EU's 2030 energy and climate targets; b) to promote long-term certainty and predictability for investors; c) to reduce administrative burdens, in line with the principle of better regulation; d) to incorporate the provisions of the existing Climate Monitoring Mechanism Regulation (MMR) and harmonise them with the provisions of the Paris Climate Agreement.

As part of these regulations, the Commission announced several forthcoming new initiatives in the energy field in January and February 2018, regarding the eco-design and energy labelling of various products through its *Contribute to EU law-making* website. As part of the work carried out by the Interoperability Unit at the Directorate-General for Informatics (DG DIGIT), and in the scope of our digital screening activity, we promote semantic interoperability by applying our core criteria and evidence vocabularies and supporting the design of the EPREL system (European Registry for Energy Labelling). This project focuses on the design of energy labels to meet minimum energy efficiency standards allowing the exchange of data between different organisations.

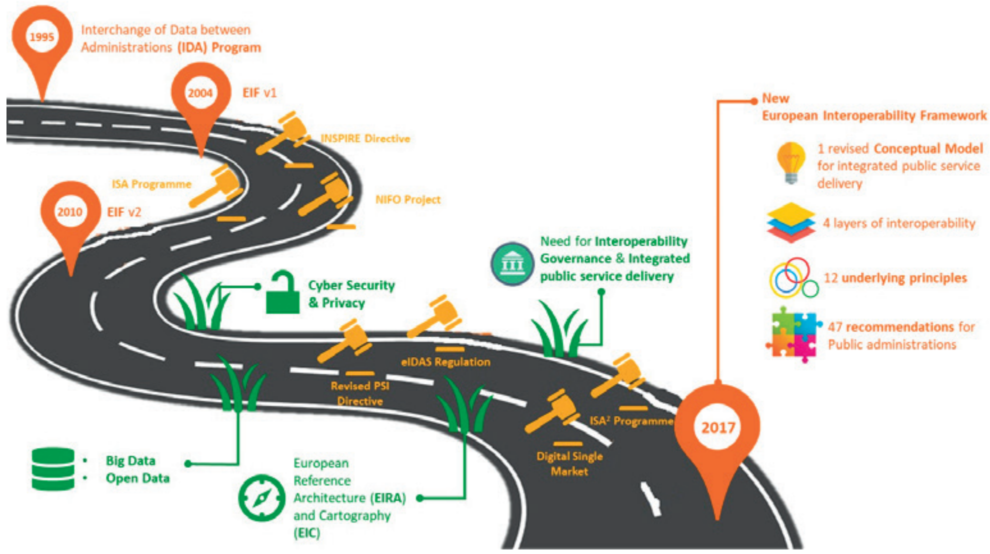
The Interoperability Unit contributes to the governance of energy in the EU but also to the digitalisation of the public sector.

At the dawn of the digital era, we imagined bureaucracy and paperwork would be reduced to a simple click. But the lack of interoperability across the national borders and sectors of Europe often makes things unbearable.

By 2020, 1,500,000 citizens and 300,000 businesses are likely to use cross-border online services every year. The European vision for digital public administrations is to be open, efficient, and inclusive, and to provide borderless, interoperable, personalised, user-friendly, end-to-end digital public services to citizens and businesses. Interoperability is therefore recognised as a condition for the modernisation of public administrations.

Is interoperability something new then? Not at all! We started supporting exchanges of data between administrations in 1995, running

> ***'By 2020, 1,500,000 citizens and 300,000 businesses are likely to use cross-border online services every year.'***



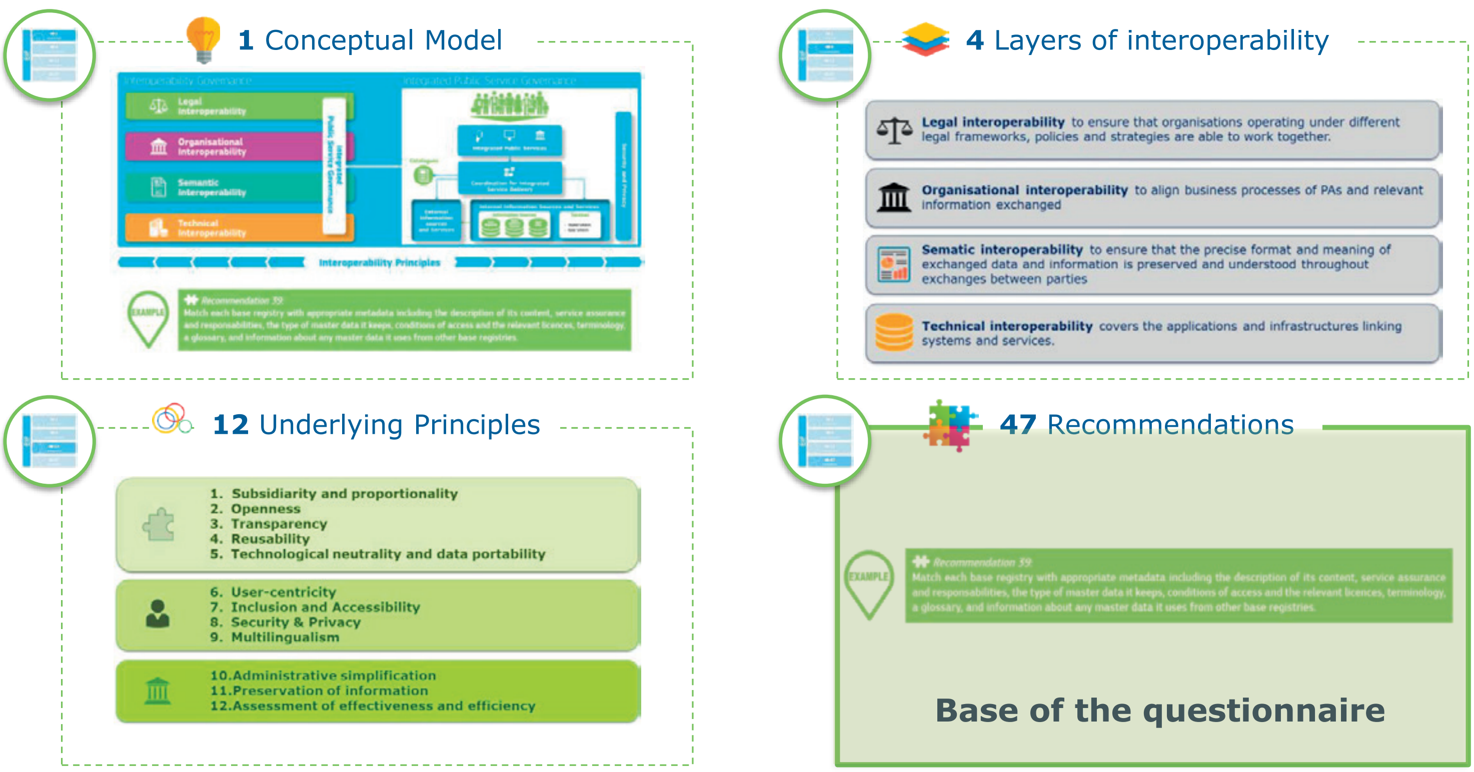
History of the Programme. Source: European Commission

the IDA Programme between 2000 and 2005, followed by the IDABC Programme (2005-2010), the ISA Programme (2010-2015) and currently the ISA² Programme (2016- 2020).

These programmes identified a continuous problem: the lack of interoperability at all levels. We took the first step towards connecting public administrations in 2005, with the first version of the European Interoperability Framework (EIF). The challenge was clear: to ensure a structurally integrated framework that provides effective support and guidance. EIF is designed to be a generic framework applicable to all public administrations in the EU at European, national, regional and local levels.

The Commission confirmed the key role of interoperability in its review of EIF 2010 as part of the Digital Single Market roadmap. Following improved regulation guidelines and a thorough consultation with Member States representatives to the ISA² Committees and with the public, a new EIF was adopted on 23 March 2017.

This framework provides one conceptual model and 47 concrete recommendations to boost interoperability and support the digitisation of public administrations in Europe. It complements the traditional four levels of interoperability, with a new vertical dimension related to 'integrated public services governance'. The latter should cross all layers: legal, organisational, semantic and technical.



European Interoperability Framework at a glance. Source: European Commission

On 6 October 2017, 32 national ministers confirmed their commitment to the European Interoperability Framework by signing the eGovernment Ministerial Declaration. The Tallinn Declaration recognised that the digital transformation of public administration can be greatly facilitated by interoperability.

To monitor the implementation of the EIF and consequently the level of alignment of Member States' National Interoperability Frameworks (NIFs) to the European one, the Interoperability Unit created the National Interoperability Framework Observatory (NIFO) under the IDABC Programme. This tool allows us to identify the gaps and needs of each Member State, helping them to react accordingly.

As Andrus Ansip, Commission Vice-President for the Digital Single Market, said at the Digital and Open Government Conference in June 2016, *'Getting rid of complex, paper-based and duplicated processes will help to make the single market a reality in the digital age. It will make it easier for everyone to interact with governments, based on openness and transparency.'*

The EIF has been used as the paradigm for interoperability-related activities not only by Member States in their NIFs and digital agendas, but also by domain specific interoperability frameworks such as the e-Health, eIDAS, Inspire.

ISA², an EU funding programme of €131M for the period 2016-2020, supports the implementation of the new EIF. It underpins 53 actions in the ISA² Work Programme for 2018, covering different domains and layers of interoperability. Through TESTA and eTrustEx, the Interoperability Unit has furnished several public administrations, companies and citizens across Europe the opportunity to exchange documents and information, guaranteeing high confidentiality, sharing and reuse of IT tools, for example in the platform JoinUp. Other solutions are more focused on companies and citizens such as Open e-Prior, for e-procurement and e-invoicing, and EUSurvey, for creating, managing and analysing the results of multilingual surveys and public consultations. The use of these tools has helped Member States to reduce the time, effort and money on spent in bureaucratic procedures across Europe.

Our main goal is to see all NIFs aligned with the European one by 2020. To be continued!

Author

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Previously, she has been the head of the units delivering solutions on human resources, decision making, document management and knowledge management domains. Since she joined the European Commission in the year 2000, she has always been involved in providing solutions making users' life easier and the institution more efficient. Holding an IT background, graduated in Deusto University (Bilbao, Spain), she has a deep knowledge of the business domains she works with.

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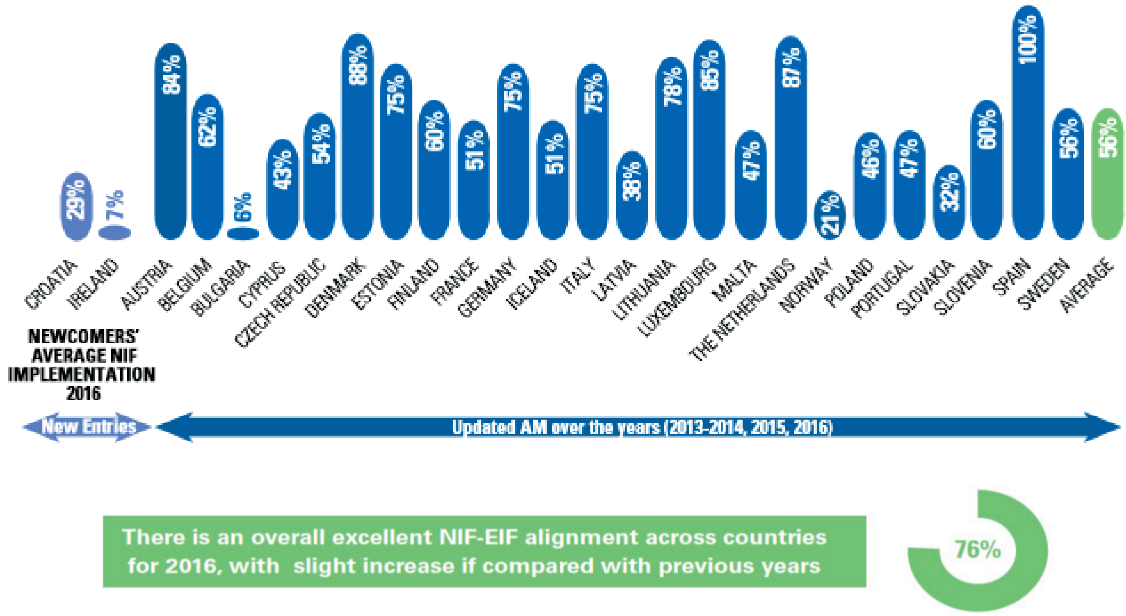


Level of alignment of the EU Member States NIFs to the EIF. Source: European Commission

SET Plan Update

The European Strategic Energy Technology Plan (SET Plan) aims to transform the way we produce and use energy in the EU, achieving EU leadership in the development of technological solutions to reach the 2020 and 2030 energy and climate goals. The SET Plan, supported by its Strategic Energy Technologies Information System (SETIS), is the key implementing instrument of the European Commission's Energy Union Research and Innovation (R&I) strategy.

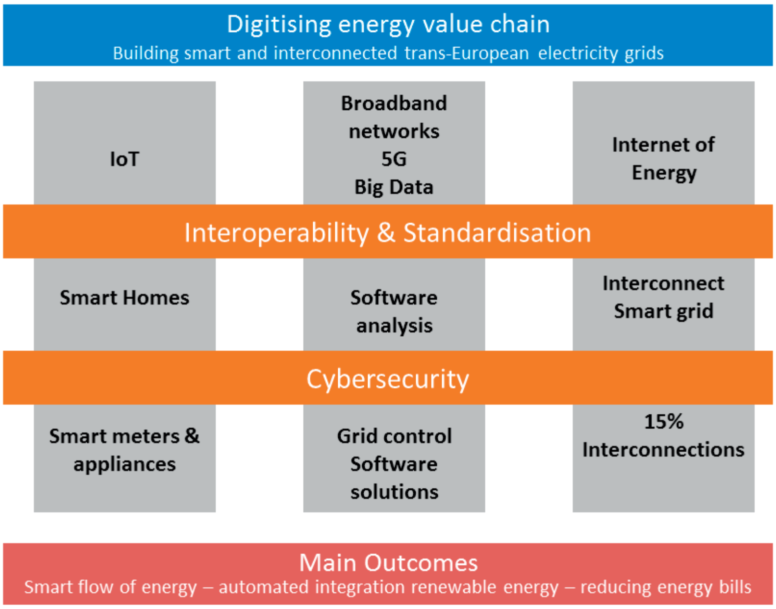
Digitalisation of the Energy sector

Digitalising the energy sector is crucial for the EU since it enables energy consumers to be at the centre and contributes to a new design for the energy markets. Digitalisation provides new opportunities for suppliers by optimising their valuable assets, integrating renewable energies from variable and distributed resources, and reducing operational costs; at the same time, it favours consumers by reducing the energy bills for citizens and enterprises, through energy efficiency and participation in mechanisms of flexible demand. For these reasons, it stands as a pivotal element in the further evolution of smart cities and communities.

Synergies are foreseen between the Energy Union and the Digital Single Market priorities of Juncker's Commission, in order to stimulate joint investments and coherence in regulatory frameworks, common standards[1] and interoperability. Digitalisation of the energy sector can boost the EU competitiveness and innovation and open new global markets for components (ICT, electronics, etc.) and services. Within this shaping framework, Europe can act as a potential market leader and become a role model, conquering new markets and propagating the 'European approach' to standards, products and services. In this context, last February in Brussels, an initiative from Directorate-General for Communications Networks, Content and technology (DG CNECT) gathered 21 experts from the energy and ICT sectors to discuss about 'Digitising the energy value chain'.

[1] As for example the Smart Appliances REFerence (SAREF) ontology, which supports communication between appliances that 'speak the same language'. to give information on their energy footprint.

'Digitalising the energy sector is crucial for the EU since it enables energy consumers to be at the centre and contributes to a new design for the energy markets.'



Source: European Commission

The EU strategy on Digitising European Industry aims to financially support research and innovation, for instance via the Horizon 2020 framework programme (H2020)[2]. The contribution of the Energy Challenge[3] is matched by a contribution from the ICT part of H2020 within two topics, *Interoperable and smart homes and grids* and *Big data solutions for energy*. In addition, the Energy Challenge contributes to the Focus Area *Boosting the effectiveness of the Security Union* with the topic *Cybersecurity in the Electrical Power and Energy System (EPES): an armour against cyber and privacy attacks*.

In the context of the Commission's strategic approach to industrial policy, during the EU Industry Day in February 2018 stakeholders from various industrial sectors discussed about cross-cutting issues and developed joint visions for the future. Additionally, in March 2018 the European Commission organised the Digitising European Industry Stakeholder Forum 2018 in collaboration with the French Ministry of Economy and Finance, offering a coordination framework between the various actions on industry digitalisation at national, regional and EU level.

'Cybersecurity is of utmost importance in order to guarantee a safe EU transition to a decarbonised, decentralised and digitalised system.'

Cybersecurity is of utmost importance in order to guarantee a safe EU transition to a decarbonised, decentralised and digitalised system. The European Commission is currently reviewing the EU Cyber Security Strategy, while DG CNECT and Directorate-General for Energy (DG ENER) are developing a comprehensive strategy on how to reinforce the operation of the Directive on security of network and information systems (NIS Directive) in the energy sector.

Digital economy and skills for the future are two priorities for the Bulgarian Presidency of the Council of the European Union. In this context, Bulgaria is organising a high-level event in June 2018: the Digital Economy Leadership Summit will take place in Sofia and the plenary session will be chaired by the EU Commissioner for Digital Agenda and Society, Mariya Gabriel.

General SET Plan related news and activities from JRC/SETIS

On the occasion of the 10th anniversary of the SET Plan, in November 2017 the Estonian Presidency of the Council of the European Union held under its auspices the 10th SET Plan Conference, opened by DG ENER's Director General Dominique Ristori. For this occasion the JRC, DG ENER and the Directorate-General for Research & Innovation (DG RTD) jointly prepared the report *The Strategic Energy Technology (SET) Plan. At the heart of Energy Research & Innovation in Europe* and published an article on *Decarbonising the European energy system: The SET Plan actions in the industry and transport sectors*. These publications showcase the overall progress achieved over the past decade in the transition to a low-carbon, innovative energy future and the SET Plan's key role as the technology pillar of EU's energy and R&I policies.

Two SET Plan Steering Group (SG) meetings took place in Brussels during the first quarter of 2018. The main result of these SG meetings was the endorsement of the Implementation Plans (IPs) on Integrated Energy Systems, Deep Geothermal and Ocean Energy led by the SET Plan countries and Industry partners; another important outcome was the discussion on the latest developments of a forward-looking SET Plan strategy. The latter will allow the SET Plan to adapt to the evolving clean energy policy landscape, through the proactive engagement of a Core Drafting Group which involves interested SET Plan countries and is led by Austria and the Netherlands.

[2] Horizon 2020 reflects the policy priorities of the Europe 2020 strategy and addresses major concerns shared by citizens in Europe and elsewhere.
[3] The Energy Challenge, under H2020, is designed to support the transition to a reliable, sustainable and competitive energy system. It has a budget of €5 931 million to non-nuclear energy research for the period 2014-2020.

'The main result of the SG meetings was the endorsement of the Implementation Plans (IPs) on Integrated Energy Systems, Deep Geothermal and Ocean Energy.'

The January SG meeting also included a joint afternoon session between the SET Plan Steering Group and the Technical Working Group on Integrated National Energy and Climate Plans (NECPs), in order to discuss the input required to prepare the plans (focusing in particular on Regional Co-operation and Competitiveness). The March SG meeting afternoon session hosted The European Energy Research Alliance (EERA) representatives to discuss how their Joint Programmes, the new Reference Group on EU R&D Alignment and the mapping of National funding opportunities can contribute to the execution of the endorsed IPs.

During these SG meetings, the SET Plan SG welcomed the new national representatives appointed to the SET Plan SG, specifically the new representatives from France, Germany, Italy, Netherlands, Portugal, Romania, Spain, Switzerland, and UK.

Finally, the Joint Research Centre (JRC), the Commission's science and knowledge service, published the following reports that are relevant to the SETIS work:

- a report on Energy R&I financing and patenting trends in the EU, which monitors the progress made by Member States with the level of investment in R&I and trends in patents. These two key indicators were identified in the SET Plan Communication and are consistent with the R&I indicators included in the 3rd State of the Energy Union Report;
- a report on cost development of low carbon energy technologies, which presents internally consistent trajectories of capital investment costs to 2050 for Carbon Capture Utilisation and Storage, Wind Energy, Concentrated Solar Power, Solar Photovoltaics, Ocean Energy, Geothermal Energy technologies;
- a report providing an overview of the supply chain of a number of renewable energy technologies addressing wind energy, geothermal energy and ocean energy;
- a review benchmarking IRENA's REmap study on Renewable Energy Prospects for the European Union.

Dominique Ristori – Director-General, DG ENER (right) and Stathis Peteves – HoU, JRC (left) at the 10th anniversary of the SET Plan. Source: European Commission

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Operational considerations for responding to the threat of cyber-attacks on critical energy infrastructure

Cybersecurity considerations for the modern energy grid

The energy infrastructure is arguably one of the most complex and, at the same time, critical infrastructures relied upon by business to deliver essential services. Because of this reliance, any prolonged disruption could trigger a cascade of effects across society.

In the past, physical access to a substation was required in order to disrupt the energy flow and seriously impact society, today the same damage can be achieved with a single keystroke from anywhere in the world.

The 'Ukraine power grid attack'[1] illustrates the impact of cyber-attacks on the electricity subsector. This attack resulted in '*several outages that caused approximately 225,000 customers to lose power*' across the country. As the use of digital devices and advanced communications grows, so too does the cyber risk.

Another important challenge to cybersecurity is the 'rapid rate of change in the energy market'. There is a shift towards renewable energy, with closer integration between supply and demand. The energy market is transforming, with new market players such as virtual power plants, and citizens themselves become energy producers.

In such a complex ecosystem, operators must focus on the 'operational environment', to protect information systems, detect potential attacks and respond to and recover from any incidents. With threats evolving, response and recovery are of increasing importance. Operators are not typically in a position to classify the threat actor without intelligence support from the Member State. For coordinated attacks from both non-state and state actors, a response structure at cyber level might be apt for the European Union and Member States, along with a coordinated response across Member States.

'Another important challenge to cybersecurity is the rapid rate of change in the energy market. There is a shift towards renewable energy, with closer integration between supply and demand.'

[1] World Analysis of the Cyber Attack on the Ukrainian Power Grid, Defense Use Case, March 18, 2016, SANS ICS and E-ISAC. Energy Council Perspectives – The road to resilience, 2016.

Author

ENISA

European Union Agency for Network and Information Security
ENISA - The EU Cyber Security Agency

The overall objective of the ENISA's 'Secure Infrastructure & Services Team' is to assist Member States in the consistent implementation of the Directive (EU) 2016/1148 on security of network and information systems (NISD). The team also supports public and private stakeholders to enhance the security and resilience of their smart infrastructures and services and delivers NISD related trainings to enhance their capabilities.

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Elements of the European cybersecurity legal framework[2]

The European Union is already working towards this in many ways; it is, however, time to streamline and synchronise all efforts. In 2013, the European Union set out a Cybersecurity strategy[3] launching numerous work streams to improve cyber resilience. The main goals of this strategy were to foster a reliable, safe and open cyber ecosystem for all, goals that remain valid today. However, the continuously evolving threat landscape calls for more effective measures.

In 2017, the European Union published its Communication[4] on resilience, deterrence and defence to build strong cybersecurity for the EU, giving the Member States the tools and policies required to address cybersecurity. Though it remains a national priority, the scale and cross-border nature of the threats (like WannaCry[5]) show that it is in fact a joint responsibility. All actors need to work together – the European Union, Member States, industry and individuals – to deliver a stronger EU response to cyber-attacks.

In 2016, the European Union adopted the Network and Information Security Directive[6]. It is the first piece of EU legislation aimed specifically at improving cybersecurity throughout the Union; a very significant step towards securing the European Union's information systems. Full implementation of the Directive by all Member States by the end of May 2018 is imperative for ensuring resilience in the Union.

The role of ENISA and key take-aways

ENISA, the European cybersecurity agency, not only plays a major role in the implementation of the NIS Directive[6] but also in supporting the Member States and private sector in achieving a higher level of cybersecurity. It has conducted numerous activities and studies[7] on cybersecurity in the energy sector, and industrial control and SCADA systems, in close collaboration with public and private stakeholders.

The Agency has engaged all relevant stakeholders and contributed to European Commission policy initiatives such as the DG Energy Expert Group 2[8] and the CEN/CENELEC Mandate 490[9]. To ensure effective information flows on evolving threats and to facilitate responses to cyber incidents, Information Sharing and Analysis Centres (ISACs)[10] should be encouraged to engage with all relevant bodies. ENISA is already a member of the existing European Energy ISAC.

We can do a lot to address the challenges identified for the energy sector at EU level:

- Harmonise the approach to cybersecurity across EU Member States to reduce the risk of weak links in the increasingly interconnected European grid.
- Develop a common understanding of the cybersecurity threat landscape.
- Develop a common cyber-response framework that helps operators to identify what is needed in order to protect themselves from cyber-attacks.

At corporate level:

- Top management must invest in cybersecurity and launch awareness campaigns, bridging the cultural gap between Operations and Information Technology divisions.
- Information sharing and knowledge exchange among energy sector actors and between public and private stakeholders would enable a greater understanding of the impact of cyber risks for energy companies and for the sector as a whole.
- Companies providing energy services should adopt a holistic approach that incorporates the key phases of cybersecurity: prepare and prevent, detect and respond, recover and share.

It is a shared ENISA view that cybersecurity is a common responsibility; we can only safely adopt new technology and reap the benefits of the evolving power grid by working together and exchanging good practice.

[2] The 'Clean Energy for all Europeans' package of 30 November 2016 acknowledges the importance of cyber security for the energy sector, and the need to assess at various levels (e.g. European, regional and national) cyber risks and their possible impact on the security of supply. The full set of documentation is available at: https://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition

[3] Commission Joint Communication to the European Parliament and the Council, JOIN(2017) 450, 13.9.2017, on Resilience, Deterrence and Defence: Building strong cybersecurity for the EU.

[4] Commission Joint Communication to the European Parliament and the Council, JOIN(2017) 450, 13.9.2017, on Resilience, Deterrence and Defence: Building strong cybersecurity for the EU.

[5] ENISA Info-note on WannaCry Ransomware Outburst, 15.5.2017, https://www.enisa.europa.eu/publications/info-notes/wannacry-ransomware-outburst

[6] Directive (EU) 2016/1148 of the European Parliament and of the Council of 6 July 2016 concerning measures for a high common level of security of network and information systems across the Union (OJ L 194, 19.7.2016).

[7] https://www.enisa.europa.eu/topics/critical-information-infrastructures-and-services/scada and https://www.enisa.europa.eu/topics/critical-information-infrastructures-and-services/smart-grids

[8] Expert Group 2 – Regulatory recommendations for privacy, data protection and cyber-security in the smart grid environment at: https://ec.europa.eu/energy/en/topics/markets-and-consumers/smart-grids-and-meters/smart-grids-task-force

[9] European Commission Standardisation Mandate no M/490 to European Standardisation Organisations (ESOs) to support European Smart Grid deployment, 1.3.2011: http://ec.europa.eu/energy/sites/ener/files/documents/2011_03_01_mandate_m490_en.pdf

[10] ENISA, Information Sharing and Analysis Center (ISACs) - Cooperative models, 14.2.2018: http://www.enisa.europa.eu/publications/information-sharing-and-analysis-center-isacs-cooperative-models

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TALK TO SETIS

From smart grids to digitalisation of the energy system

'Customers will benefit from new ways of managing and adding value to their consumption, becoming prosumers via local generation. Above all, everyone can benefit from new opportunities.'

Who are the main actors involved in this transformation and how can they contribute to the process?

The European Energy system is in transition towards clean energy and high efficiency. European citizens are at the centre of this transition. Empowered by a wider choice of services, they are becoming active players – prosumers (consumers and/or producers) – keeping energy prices at an economic optimum. Digitalisation is the revolutionary enabler for this transition of the energy sector; nobody can avoid it. We need an appropriate, reliable and secure communication system if the power system is to be operated with Dispersed Energy Resources (DER) in a dynamic way. Large quantities of data generated by sensors at all voltage levels to monitor and automate the grid, and by the progressive roll-out of smart meters, must be processed and made accessible by the relevant stakeholders in a safe and transparent way. As a result, more and more players are entering the market with expertise in areas such as ICT and mobile telecoms. The functionalities required of the communication infrastructure need a deep understanding of the rapidly changing electricity generation mix, of ageing power assets and of changing market models leading to new synergies.

Smart grids are at the centre of this emerging system, with digitalisation they will help to articulate new energy environments. It should be also noted that the smart energy system of the future will not happen in silo. It will connect – digitally and physically – different types of energy and transport networks (electricity, gas, heat and so on).

New digital services will be developed, integrated platforms will be established, and protocols will need to be devised.

What are the new opportunities and challenges for the industrial actors involved, and how are they being addressed?

The main challenge is adapting to such rapid evolution: it is not just the industry that needs to change, but also legislation, regulation and standards. But above all, everyone can benefit from new opportunities:

- New markets (storage, demand response, smart charging).
- New opportunities offered by net metering, virtual power plants, microgrids.
- Smoother integration of renewables.
- Boost in energy efficiency.
- More efficient grid operation, planning and asset management through smart networks.

- Local authorities and communities to become smart cities and regions.

Customers will benefit from new ways of managing and adding value to their consumption, becoming prosumers via local generation. Citizens will also benefit from open data, with their privacy protected by regulation. Open data will foster corporate transparency for citizens and societies.

What are the best practices put in place by industrial actors at the moment?

In recent years, EU-funded research in energy systems has put lots of focus on synergies. As a result, many RD&D projects are under way.

For instance, 'on generation forecasting', improved forecasting tools lead to more efficient operation of the grid, in combination with demand-side management, reactive power injection and dynamic line rating. In this field, the SWIFT project has shown that it is possible to connect a wind farm without a costly grid upgrade. This helps to increase the reliability of supply and the penetration of renewable energy sources, reducing OPEX and CAPEX costs, and ultimately improving the quality of service.

Concerning 'network planning and operations', improved digital options can allow the network to be operated smartly, using Information Technology (IT) & Operational Technology (OT) integration, Big Data and Predictive Services. There are also new models for transmission & distribution networks and power generators' assets with data-driven business models and technology-driven customer engagement. Benefits are manifold, including: increased reliability of supply; reduced cost of operations; improved quality of service; reduced CAPEX investments; real-time fault detection; isolation and restoration reducing the number and duration of outages; deferred grid upgrades; flexible demand; and increased renewable energy penetration.

Some key projects in this area are:
- The STAR grid project dealing with grid management at LV and MV level.
- The iTesla project addressing electrical system security within large areas.
- The GRID4EU German demonstrator on autonomous grid reconfiguration and forecasting in the MV grid.
- The GRID4EU Swedish demonstrator focused on meter data management for network operation in the LV grid.

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He holds the position of full professor in Power Systems at the Power Division of the Electrical and Computer Engineering Department of the National Technical University of Athens (NTUA), director of the Energy Systems Laboratory and founder of the SmartRue research unit.

He is Fellow Member of the Institute of Electrical and Electronics Engineers (IEEE), past Chairman of the Power System Dynamic Performance Committee (PSDP), honorary member of CIGRE, Chairman of the strategic CIGRE WG Networks of the Future and past Chairman of CIGRE SC C6 Distribution Systems and Dispersed Generation.

He is one of the top 1% most cited researchers of 2016 and 2017.

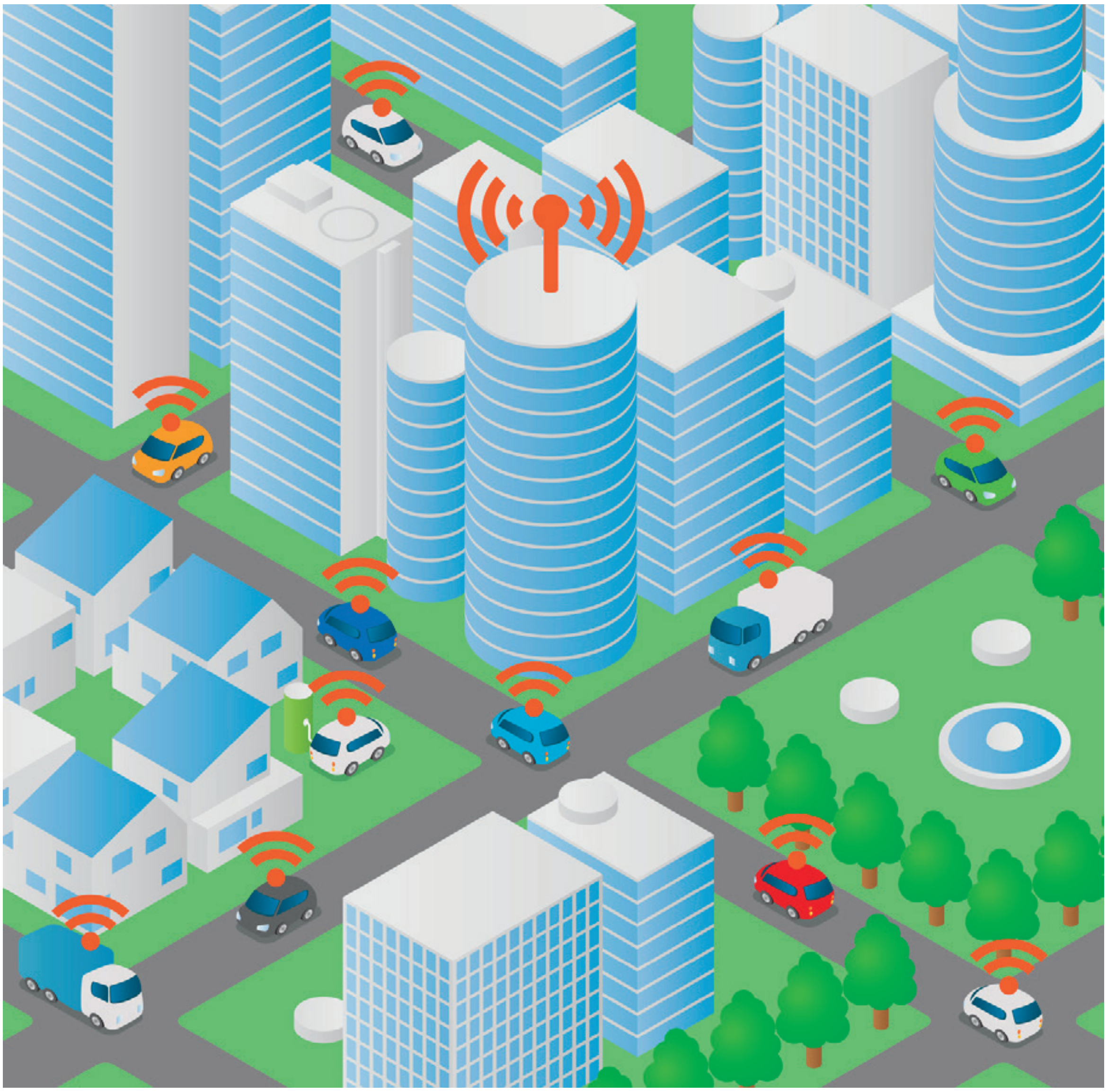
- The NOBEL GRID project working on advanced tools and ICT services for Disruption System Operators (DSOs), in their role as market facilitators.
- The Servo Platform interfacing demand side management with DSO needs.

Digitalisation can also be useful to enable regulators and retailers to access data collected and managed by market facilitators. Some projects, such as the Smarter EMC2 project, have shown how to empower market actors better through ICT technologies. The IDE4L project has developed digital tools for the technical and commercial aggregators to help integrate flexible demand in the market and to take grid constraints into account in market operation.

Customer participation in the market becomes possible with Big Data and IoT (Internet of Things), which have already entered the field. Smart devices have been developed to help utilities to understand and anticipate customer behaviour, and storage assets and electric vehicles can contribute to better grid management and more effective DER integration. Three projects have shown interesting results:
- The Linear project on dynamic pricing and SmartHouse/Smartgrid project on residential demand response.
- The FINESCE project on smart charging of electric vehicles.
- The COOPERATE project on neighbourhood energy management.

Finally, actors are working on enabling flexibility by leveraging electronic market places, by providing data facilitated by market operators (e.g. DSOs); these can be used by other commercial parties to facilitate their market operation. Relevant projects aiming to design an adequate market model for stakeholder interaction are FINESCE, Flexiciency and eBadge.

A good overview of these projects, and their contribution to the digitalisation of the energy system, can be found in the ETP Smartgrids report, *The Digital Energy System 4.0*, published in May 2016. This report addresses the use and impact of ICT as a pervasive tool along the entire value chain of power generation, transportation and use. The communication layer is one of the pillars of the smart energy system, enabling system observability, monitoring, control and protection, and specifically enabling a radical change in the relation between the final user and the energy system. It also describes new



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digital tools linked to the Internet of Things, from smart meters to social networks that aim to promote customer participation at all stages of the development and expansion of the energy system, thanks to the analysis of big data. The widespread use of digital technologies must, however, be accompanied by suitable measures for data and information protection from malicious intrusions and attacks (cybersecurity), and from uncontrolled use of customer data (data privacy).

The ETIP SNET WG4, 'Digitisation of the electricity system and customer participation', is pursuing the work started in this report and will soon publish its findings.

'The communication layer is one of the pillars of the smart energy system, enabling system observability, monitoring, control and protection, and specifically enabling a radical change in the relation between the final user and the energy system.'

'The widespread use of digital technologies must, however, be accompanied by suitable measures for data and information protection from malicious intrusions and attacks (cybersecurity), and from uncontrolled use of customer data (data privacy).'

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The digital transformation of energy: from energy silos to digitally interconnected systems

The cost, performance and deployment of many clean energy technologies have dramatically improved in recent years, accelerating transitions towards cleaner energy systems around the world. Digital technologies already play a vital role in accelerating decarbonisation efforts, but for digitalisation to reach its full decarbonisation potential, we need good policies informed by rigorous analysis. Our new IEA report, *Digitalization and Energy*,[1] shows that driven by advancing technology, falling costs and ubiquitous connectivity, the energy sector is on the cusp of a new digital era, with wide-ranging impacts for all energy sector stakeholders, from manufacturers and utilities to producers and consumers.

The trend towards greater digitalisation of energy has been enabled by advances in data, analytics and connectivity. These include: increasing volumes of data, due to the declining cost of sensors and data storage; rapid progress in advanced analytics such as machine learning; greater connectivity of people and devices; faster and cheaper data transmission. The combined application of these elements can greatly increase the lifetime, efficiency and utilisation of energy infrastructure and can reduce costs. More fundamentally, connectivity can help to break down the traditional silos separating energy sectors, so that consumers and producers in any sector can actively participate across energy system operations, greatly increasing the flexibility with which the system can cope with changes in supply and demand, and reduce the cost of integrating new technologies like distributed generation, energy storage or electric vehicles (EVs).

The electricity sector is at the heart of this digital transformation. Traditionally, electricity is generated in large power plants, transferred through transmission and distribution networks and flowing one-way to end users in the residential, commercial, industrial and transport sectors. Digitalisation is accelerating a shift towards a multi-directional, distributed energy system (one where demand sources participate actively in balancing supply at all scales. Connectivity permits the linking, monitoring, aggregation and control of large numbers of individual energy-producing units and pieces of consuming equipment) ranging from electric vehicles to wind farms and rooftop solar systems As digitalisation advances, a highly interconnected system can emerge, blurring the distinction between traditional suppliers and consumers, with increasing opportunities for trade at the local level in energy and grid services.

Digitalisation is also transforming road transport, where connectivity and automation (alongside further electrification of mobility) could dramatically reshape the sector. High utilisation rates of automated and shared vehicles, spurring faster vehicle (and fleet) turnover, could favour and accelerate the uptake of highly efficient technologies including EVs,

[1] IEA 2017. Digitalization and Energy. International Energy Agency, OECD, Paris. http://www.iea.org/digital/

reducing the emissions intensity of travel. The successful integration of shared and automated mobility services with mass public transit, walking and cycling could also help to reduce energy use. However, the overall net energy and emissions impacts of automation and connectivity are highly uncertain, depending on the combined effect of changes in consumer behaviour, policy intervention, technological progress and vehicle technology.

Many companies in the industrial sector have a long history of using digital technologies to improve safety and increase production. Connectivity is also opening up a wide range of opportunities to link industrial facilities to their surroundings. For example, producers connected along value chains can facilitate the reuse and recycling of materials. Connecting industrial equipment to the network can also help to identify and provide real-time information on the availability of local waste streams (e.g. excess heat, off-gases or organic waste), which can be captured and used to displace other forms of energy.

In buildings, digitalisation is bringing new energy services to consumers, such as smart thermostats, occupancy sensors, remote control and enhanced safety features. These technologies could cut energy use by about 10%[1] by using real-time data to improve operational efficiency. For example, smart thermostats can anticipate the behaviour of occupants (based on past experience) and use real-time weather forecasts to better predict heating and cooling needs. Smart lighting can provide more than just light when and where it is needed; light-emitting diodes (LEDs) can also include sensors linked to other systems, helping to tailor heating and cooling services for example.

Digitally interconnected energy systems also introduce risks, from the threat of cyber-attacks to concerns around data privacy and ownership. All energy sector stakeholders have a role to play in enhancing the digital resilience of an increasingly connected energy system. With solutions and processes producing and using vast volumes of data, questions remain around which data will be critical and prioritised, who should own it, and how best to balance the risks and opportunities of data-driven solutions. Digitalising traditional energy infrastructure will require careful management, given the inherent limits to interoperability found in digital business models. Finally, there is the cultural and institutional challenge generated by increased interaction of digital and energy system stakeholders, all with their own particular norms, practices and institutional frameworks.

Government policies will play a vital role in helping to steer developments towards a more secure, more sustainable, and smarter energy future. To help the energy community to navigate a rapidly changing digital landscape, the IEA has outlined 10 no-regrets recommendations for policy makers[1]. We will also continue our analysis in this important area, delving deeper in two key areas: digitalisation of the electricity sector, and automated and shared mobility.

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220 Energia teams up with WePower to develop blockchain-powered energy retail services

What are the main objectives of this partnership?
220 Energia is a privately owned energy retailer based in Estonia. It helps small and medium-sized enterprises (SMEs) and private households to buy their gas and electricity from the wholesale market. This activity started in 2013 when the Estonian retail market opened up to competition, but the company has been active on the wholesale market since 2006. More than 90% of its household customers purchase their energy at hourly spot prices, allowing them to optimise their energy consumption based on wholesale market prices.

WePower, founded in 2017, is a blockchain-based green energy trading platform. It aims to drive green energy adoption globally and to promote sustainable living. In addition to 220 Energia, the company has partnered with Elering, the Estonian transmission system operator (TSO), creating a pilot project to test the large-scale tokenisation of energy data on the blockchain. This project is the first of its kind in Europe, and will pave the way for a practical test in the future to connect European green energy producers to the Estonian electricity grid.

220 Energia seeks to develop an energy retail business that is competitive in the blockchain energy trading environment. As is often the case, the devil can be in the detail. The full potential of blockchain-based energy investment and trading in Europe can only be realised if it functions across Member-State borders.

Working together, we aim to test blockchain-based retailing solutions first in Estonia, and then in other countries in which we are active. Our goal is to find a feasible solution to deliver renewable energy across EU national borders. Rules and regulations within EU Member States can be surprisingly different. For example, not all Member States allow dynamic pricing for households: that was a real surprise to us. Blockchain can add transparency to pricing and to the Guarantee of Origin (GO) process[1]: this is already a potential game changer, transforming

[1] The Guarantee of Origin (GO) is an instrument, 'green label' or 'tracker', defined in European legislation, that labels electricity from renewable sources to provide information to electricity customers on the source of their energy. A unique body (e.g. an electricity regulator or a transmission system operator) is usually granted this authority for a given domain.

> ***'Blockchain has the profound potential to reorganise the way Europe invests, owns, trades, sells and buys energy. We want to look behind the buzzword and fully understand how much of that is potential and how much is hype.'***

the way retailers interact with their customers, increasing speed and reducing human error. Most GO today are created manually on Excel spreadsheets, where the data is a month old by the time it reaches the party responsible for its creation. Accounting for production and settlement takes even longer, meaning that the system typically lags up to three months behind reality. On the other hand, using blockchain, everything happens in real time, through a routine technical procedure.

Last but not least, we believe in learning by doing. You can read endless white papers and listen to a host of presentations, and still fail to understand the topic properly. Blockchain has the profound potential to reorganise the way Europe invests, owns, trades, sells and buys energy. We want to look behind the buzzword and fully understand how much of that is potential and how much is hype.

How can energy consumers benefit from blockchain? What are the main advantages from their perspective?

Firstly, the digitalisation of the (retail) energy sector will inevitably lead to increased competition and lower costs. But being able to change your supplier and having your energy data at your fingertips are just first steps. Efficiency gains from digital energy and the use of blockchain-based solutions can lead directly to lower bills for consumers, as the costs of doing business go down. If you have your energy data readily available, and the purchase tariff mirrors the hourly wholesale price, then you are motivated to adapt your consumption according to the state of the energy system. As an electric car owner you might pool with your neighbours to coordinate charging times through smart contracts with the grid company, reducing both your grid bills and the need for additional investment.

Secondly, the real paradigm shift will happen only when the ownership of energy assets becomes digital, cross-border and flexible. Energy has so far been the playground of big companies and capital. That is where blockchain comes into its own. Digitalisation and the use of blockchain-based technologies democratise energy investment, providing access to anyone who wants to invest in renewables. You could own a small stake in a large solar farm, secured with a smart contract published on blockchain[2]. Your smart home system would 'know' the contract and supply details, and adjust its consumption accordingly.

Author

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Peeter Pikk has been an energy entrepreneur since 2006, as a founding partner of Baltic Energy Partners OÜ, working as a trader and portfolio manager in the newly liberalised electricity markets in the Baltic States; the company has been active since 2013 in the retail energy markets. He has also been a Member of the Council of Baltic Energy Services OÜ since 2010, and a Member of the Board of 220 Energia OÜ since 2012. He is currently interested in the digitalisation of the energy sector and how it can affect the way we buy, sell and use energy. He gives lectures about Electricity Markets at Tallinn University of Technology.

The biggest barrier to green energy production today is the lack of financing to build new solar, wind and hydro facilities. WePower helps renewable energy producers to raise capital by issuing their own energy tokens, greening the smart grid a little more. WePower plans to integrate its blockchain and smart contract-powered green energy trading platform in a pilot project using the Estonian smart grid as its test lab. This will form a proof-of-concept system, demonstrating nation-state-scale tokenisation of energy consumption and production data on the blockchain.

The third advantage of blockchain is the creation of energy solutions at a personal level, matching the needs and opportunities of consumers with producers, more or less in real time. For example, a publisher in Amsterdam can use Spanish solar energy from the plant in which it has a stake, verified by a blockchain contract, and then use wind energy produced in Estonia or Portugal. Or a community in Bavaria with photovoltaic panels on its roofs can donate its excess energy to an animal shelter run by volunteers in Berlin. Consumers and producers can thus use smart energy contracts based on blockchain technology to create their own, bespoke solutions.

What are the main challenges in the scaling-up of this concept from a technical point of view?

The challenge is not technological, but regulatory, at least within the EU. There are many different rules and standards at national level, governing energy trading and retail. Data exchange uses a number of different message standards, for example. Smart meter roll-out is at different stages in different countries. Support schemes for renewables differ, and power scheduling rules do not always match. All this can be time-consuming.

In addition to the challenges of energy market regulation, the quest for technical solutions is complicated by rules for data privacy and protection. Every Member State can have their own rules and requirements, leaving the market significantly fragmented. The creation of data hubs, based on the same standards for gas and electricity retail markets across all Member States, would be a big enabler for the EU-wide retail market and scalable digital services.

2 An established contract between a renewable energy producer and the buyer of that energy for a specific amount of energy that will be produced in the future.

'Digitalisation and the use of blockchain-based technologies democratise energy investment, providing access to anyone who wants to invest in renewables.'

Estonian and Danish TSOs are taking first steps towards connected data hubs.

From the technical side, the accuracy and availability of the meter data is a challenge to begin with. Smart meter roll-out has not yet started in all Member States, meaning that near-real time metering data is not available for their consumers at all. The speed with which the correct metering data becomes available is really important. Usually it is made available in just a day if smart meters are used.

Why did you decide to start testing in Estonia? It's a small market, while blockchain has global potential.

For this kind of test, we needed a functioning retail market, advanced digital infrastructure for energy data management, an interested TSO and a legal framework for digital energy solutions. Estonia is open to new ideas; during its recent EU presidency, Estonia promoted the digital energy agenda, and 29 states signed the Tallinn e-Energy declaration. The existing TSO-led data hub and national digital-signature solution create the right development environment for advanced digital services. The Estonian TSO Elering developed the EstFeed platform, a data hub open to third parties to create new digital energy services. This is a very good place to start.

Estonia also has complete smart meter roll-out. The majority of our customers have opted for spot-priced contracts, with different prices every hour. And 220 Energia participates in the customer engagement and dynamic pricing project, PeakApp, financed by Horizon 2020, which further helps to develop potential use cases for blockchain-based energy services.

Tallinn Digital Summit 2017.

Digitalisation means more solar in Europe

Worker Information System © SMA Solar Technology

'Today, over 50 leading companies have signed SolarPower Europe's Go Digital declaration, calling for more solar digitalisation.'

One of the huge trends currently transforming the energy sector is digitalisation. This involves the application of new digital technology, such as low-cost cloud computing, the internet of things, big data analytics and blockchain to energy. In this new energy world, solar and digitalisation have emerged as a natural fit, as both help democratise and decentralise our electricity supply.

There is vast potential for new digital technology to increase the deployment of solar in Europe. It was this potential that in many ways led SolarPower Europe to set up our Digitalisation & Solar Task Force and work with our members to examine this trend in detail. This led to the launch of our report, *Digitalisation & Solar*, thought to be the first study of its kind to look specifically at how digital technology can intersect with the solar industry.

But how exactly could new Information Technology (IT) and connectivity put more solar on the roofs and fields of Europe?

When it comes to building-mounted self-consumption solar systems, digital smart building technology can go a long way to increasing self-consumption rates, optimising grid feed-in and therefore increasing the profitability of solar installations. If the theoretical holy grail within the self-consumption business model is 100% self-consumption, smart tech promises to be an important tool for realising this goal.

The essential component of a smart building is the energy management system, which should be designed to combine accurate forecasting of solar generation with artificial intelligence to optimise generation and demand. Just as important are the smart building appliances, electric heating and cooling with smart thermostats, smart electric vehicle charging, and last but not least, battery storage. All of these technologies form the 'smart building package' in which solar plays an integral role. A good example of this is the new EnnexOS energy management system from SMA Solar Technology, which links together solar PV, battery storage, gas, electric vehicles and much else in one platform.

There is huge potential for new digital technology to increase the penetration of solar on apartment blocks and multi-occupancy commercial buildings. If you go to the tallest building in almost any European city and look down at the

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roofscape, you will notice that very few roofs have solar panels. In London, solar is currently installed on just 0.5 per cent of the city's 3.4 million homes. The reason is that most of these roofs are shared between multiple landlords and tenants, creating a landlord-tenant dilemma. The full roll-out of smart metering, together with regulatory change at both EU and national level, can help to overcome this challenge. New business models are emerging in Germany and France, such as the Mieterstrom solar supply model, that allow electricity generated on a shared roof to be sub-metered and distributed among the occupants of a building.

Digitalisation can also be put to good use to reduce costs right across the solar value chain, both in the utility-scale and rooftop markets. Lower cost solar equals more solar. A great example of this is how satellite mapping and remote design software can reduce the cost and time required for customer acquisition and installation design in rooftop solar. Google Project Sunroof, E.ON, IKEA, Aurora Solar, PVSol, PVSyst and Ezzing Solar are all examples of companies using this concept. In national markets, where a lack of trust in solar installers can act as a barrier to customers signing on the dotted line, having big, credible brands behind customer acquisition can make a big difference to clinching the final deal.

Wider digitalisation can contribute to new schemes for financing solar projects. The 'blockchain buzz' has also become part of the solar industry, with the cryptocurrency SolarCoin now being used to encourage more solar production by decreasing the payback time on solar installations. Web-based crowdfunding can also help finance (and later re-finance) large-scale community projects. Smart metering (when combined with the necessary regulatory changes to allow for third party ownership) allows for 'freemium' style Power Purchase Agreements for residential and commercial customers. These were made famous by SolarCity and SunRun in the United States.

Finally – and perhaps most importantly – from a system level perspective, the more digital technology is integrated into the grid, the more solar can be integrated into the grid. Digitalisation can make better use of existing grid infrastructure, reduce the need for back-up capacity and, crucially, reduce the need for the curtailment of renewables. That is why one of our key messages to policy-makers within the debate on the Clean Energy Package in Brussels is *'go digital to make the most of the renewables revolution'*. Sector-coupling and demand response can make the most of the energy transition, and focusing on smart applications and manufacturing can also maximise the industrial value for Europe from the solar value chain. Today, over 50 leading companies have signed SolarPower Europe's *Go Digital* declaration, calling for more solar digitalisation. Indeed, solar is at the heart of the digitalisation of energy in Europe. Now we need the right regulatory framework to deliver the full potential of digital solar. We would recommend that policy-makers consider accelerating the deployment of smart grids, reforming incentives for network operators and rewarding the speed and accuracy that solar can provide in grid-supported services. This will maximise the opportunities arising from digitalisation, and increase the cost-efficient deployment of solar and renewables in Europe.

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Prior to taking the helm at SolarPower Europe, Dr Watson worked as the Director of Public Affairs for Weber Shandwick, specialising in energy and trade policy for 7 years. Before coming to Brussels, Dr Watson worked for the Commonwealth Secretariat on a European Commission project on trade and sustainable development based in Ethiopia. Earlier in his career James worked for various UK government bodies in London and worked as a lecturer in Environmental Law at the University of Manchester.

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Digitalisation of the energy system: why does it matter and how can Horizon 2020 contribute?

Why does it matter?

The EU is transforming its energy system into a more sustainable, renewables-based system, away from large-scale fossil fuel-based energy production. To honour the Paris agreement and our 2030 targets, at least 27% of our energy production (that's close to 50% of electricity) will have to come from renewables by 2030.

A big share of this variable renewable generation will be connected to the distribution grid. Electricity will also be used increasingly in sectors such as transport, heating and cooling. This calls for more flexibility in the energy system and changes in the way we build and operate our electricity networks. It calls for innovative solutions to make our market fit for renewables and distributed energy production, and conversely, to make these resources fit for the market. Digitalisation can unlock these innovative solutions, which should not only help to transform our energy system, but should also benefit consumers.

The legislative proposals for the energy market adopted by the Commission on 30 November 2016 (the Clean Energy Package) reward consumers who offer flexibility, on the wholesale market and for grid management. This will enable more efficient and effective network management and optimisation, leading to increased demand response and the ability to integrate increasing shares of renewables.

'Supporting research and innovation in the public and private domain, at both national and EU level, is key to digitalising the market.'

Supporting research and innovation in the public and private domain, at both national and EU level, is key to digitalising the market. One might expect that to happen of its own accord, but business priorities don't always match those of society, and we are in a hurry: the fight against climate change is a race against the clock.

The technologies are available

Projects we have financed in the past show what the future may look like, and how digitalisation can help to transform the energy system:

- The flexibility of energy consumption is much higher when it is automated: on the island of Bornholm in Denmark, it was shown that when half of the consumers in the test were given automated demand response, and the other half had to react in person to a price signal, 87% of the total volume of demand response came from the automated consumers;
- we can make better use of the renewables connected to the grid by using ICT and remote

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control. By using smart inverters next to the solar panels on consumers' roofs in Limburg, Belgium, the network operator was able to increase the hosting capacity of renewables by 50%, at only 10% of the cost of 'traditional' investments in hardware.[3]

From a technology perspective, the solutions are known: but how do we ensure that these technologies transform the way in which the energy system is operated, bringing benefits to consumers? Can we use Horizon 2020 funds to create an innovative ecosystem where new technologies and services can find a market? Can Horizon 2020 help to change the way the energy system works and support the implementation of the Clean Energy Package? We believe so, and in our work programme for 2018 and 2019 we will support the following projects to speed up the digitalisation of the energy system, in synergy with other Energy Union and Digital Single Market policies.

Setting up markets and digital platforms where network operators can buy services from connected consumers which help them to manage the network[4]

Key to the energy system of the future is the creation of markets where flexibility can be traded in a reliable way: Transmission and Distribution System Operators (TSOs and DSOs), suppliers and aggregators need to cooperate to set up platforms in a coordinated way. Digital technologies are the cornerstone for these markets: small volumes of energy or flexibility from many different consumers can only be aggregated and controlled profitably when they are automated. The Commission has reserved a substantial budget to support projects setting up markets and platforms to procure energy services through a combination of local markets (in particular for congestion management) and wholesale & balancing markets, that can serve as a reference model for the EU.

Make communication and installation of smart solutions easy for consumers[5]

For consumers to monetise their flexibility, and for businesses to turn this into novel consumer services that lead to a more comfortable, convenient and healthy living environment at lower energy costs, communication needs to be easy. The Internet of Things (IoT) enables a seamless integration of home appliances with related home comfort and building automation services, matching user needs with the management of distributed energy across the grid, exploiting the benefits of demand response. Horizon 2020 is supporting a large-scale pilot to develop interoperability and seamless data sharing. The pilot will look at plug-and-play energy management solutions within the home, taking into account the legacy of existing smart home and building solutions, mapping their approach to common architecture models and implementing relevant standards such as SAREF[6]. It will promote the use of these interoperable solutions as widely as possible, across many different types of appliances, including white goods, heating, cooling and ventilation, home & building automation energy management, smart metering and control, batteries, photovoltaic panels and charging for electric vehicles.

A Digitalised energy system needs reliable digital infrastructure[7,8]

A more interactive, flexible energy system, that relies on the growing use of digital devices and more advanced communications and interconnected systems, is also increasingly exposed to external threats, such as worms, viruses, hackers and data privacy breaches. Without appropriate cyber-defence measures, systems access can be violated (e.g. with malware spreading through the system) and can cause power outages, damages and cascading effects to interconnected systems and energy services. With increased digitalisation there is therefore a concomitant need to develop new security approaches to detect and prevent threats with severe impacts, and to shield the electric system against cyber attacks. Horizon 2020 supports the development of these new approaches.

As digitalisation advances, so too must the communication infrastructure, which needs to be reliable and fit for the demands of the energy system of the future. As the EU promotes the next generation of network technologies, and 5G in particular, it is important that energy system considerations are also taken into account. Horizon 2020 support for the development of 5G therefore also promotes the testing of technologies for specific sectors including energy.

Data exchange between different parties in the energy sector[9]

The energy system consists of many actors with different roles and responsibilities. Seamless data exchange and interoperability are not just important within a smart home, but also between the consumer, supplier, aggregator or service provider, and network operators. It is not yet known what business models will emerge and who else will take an interest in energy data. What is clear, however, is that tomorrow's energy grids will consist of heterogeneous interconnected systems, of an increasing number of small-scale and dispersed energy generation and consumption devices, generating huge amounts of data. Under these demanding conditions, the electricity sector in particular needs big data tools and architectures for optimised energy system management. Supporting the ability of all energy system actors to manage, analyse and exchange large quantities of data is therefore a Horizon 2020 priority.

What else?

The issues listed above address key areas where digital and energy technologies and markets meet, but there is much more to say about digitalisation. High Performance Computing, for example, can contribute to improved monitoring and prediction of the energy system; power electronics are crucial for improving the efficiency of the energy system, in particular the transport and conversion of electricity; and let us not forget blockchain, a technology that can change the way we buy and sell energy and energy services. The Commission is monitoring developments in this area closely, and organises regular workshops and seminars with experts to explore how these digital technologies can help the Energy Union's objectives, and what can be done to promote them at EU level.

'Working together is key: a digital energy system that depends on the easy, secure and seamless exchange of data is nothing without EU-wide support.'

Please contact us if you are interested in such discussions or if you have suggestions for issues we should explore.

Cooperation with Member States and industry to maximise impact: the SET Plan

Horizon 2020 cannot solve the challenges of digitalisation on its own. It is only by facilitating cooperation, by promoting interoperability and replicability, and by triggering the creativity of businesses and innovators that we will maximise its impact. The SET Plan is crucial in this respect: many of the targets and Implementation Plans that the industries, research organisations, Member States and the European Commission have jointly defined address digitalisation, from offshore wind to batteries. The Implementation Plans (focusing on consumers and smart grids, and systems) are particularly crucial for maximising the impact of our support for digitalisation. The group of Member States, research and industry actors working on the implementation plan for smart solutions for consumers has, for example, agreed to set up a special group looking at reference architectures for generic digital platforms current and future, and at specific requirements for the energy sector.

Working together is key: a digital energy system that depends on the easy, secure and seamless exchange of data is nothing without EU-wide support.

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How can digitalisation contribute to cost reductions and higher system integration for wind energy?

'The highest and largely untapped potential for digitalisation lies in high quality data exchanges between wind operators and the surrounding energy ecosystem.'

How many times have we heard that the most successful companies do not need to own anything? Uber, the world's largest taxi company, does not own any vehicles. Alibaba, the most valuable retailer, has no inventories. And Airbnb, the world's largest accommodation provider, owns no real estate. What we are witnessing is a global transformation of business models driven by usage and sharing rather than ownership. Software over hardware. Intermediation instead of ownership. But can this be applied to all economic sectors? And is the energy sector prepared for this transformation?

Variable renewable energy and distributed generation will be crucial elements of the future energy system. Their importance lies not only in the energy they produce, but also in the sheer amount of data they sense, collect, create, store and communicate to surrounding systems.

Let's take an example. A typical onshore wind farm generates 500 terabytes of data every 13 days. At a moderate 1,840 load operating hours and 20-year lifetime, this would translate into more than 61,000 terabytes for a single site. But most of the data generated by such a wind farm is never seen, let alone analysed or optimised. Engineers will select a few indicators to monitor in real-time, and monitor other indicators at semi-regular intervals. Much of the collected data will never be consulted until a failure occurs. Many operators do not adopt more sophisticated data analysis tools or digital solutions because of costs, time or a lack of knowledge on where to start.

So what does this add up to? It means that manufacturers and operators are sitting on vast banks of data that could be mined. As the economics of wind energy continue to face more pressures, digital technology applications could unlock significant value for industry participants across the entire supply chain.

This is why in 2017 WindEurope organised its first ever 'hackathon', a competition which allowed innovators from different backgrounds to come up with digital solutions for the industry in the span of 2 days. Two companies, EDPR and Envision Energy, set the challenges of reducing faults in wind turbines and improving wind speed forecasting through the use of a common software platform. Companies learned the value of sharing data and letting people outside the wind energy industry come up with solutions.

And as a result, the winners of the hackathon are now exploring the business potential of developing these solutions, including predictive maintenance and smart turbine management applications, for the two companies.

Most digital solutions for wind turbines are marketed as add-ons, not as part of the basic offering. Moreover, their value may seem marginal (1-5%) for asset owners in terms of yield improvement, reduction in operation and maintenance costs, and improved accuracy in forecasting. Digital solutions may be an attractive proposition for assets operating for several years, but it is challenging to demonstrate added value for new assets.
As a result, wind energy buyers tend to see digitalisation as a 'nice-to-have' and not as a 'must-have'. When buying new machines, they expect an optimal level of performance, above and beyond older technology; the improvements offered by additional digital solutions may seem too far in the future. New investors may focus instead on lowering CAPEX, which has a significant bearing on the levelised cost of energy.

However, as more wind farms reach the end of their lives and support schemes expire, extracting maximum value from investments becomes more important. Over the next decade, between 40 and 80 GW of wind energy capacity will reach the end of its designed operational life, according to our latest WindEurope estimates. But some of these assets will be fit to continue safe operation beyond this time, and digital solutions could play an increasing role in addressing lifetime management strategies for wind turbines. For example, creating digital 'twins' for prognosis of failures in key components would help operators to decide how long they should 'sweat the asset' (operate it without maintenance interventions) and decide at what point maintenance, overhaul and replacement of components will yield maximum benefit.

Finally, the highest and largely untapped potential for digitalisation lies in high quality data exchanges between wind operators and the surrounding energy ecosystem. Making use of this data could unlock new horizons of productivity and allow the wind energy industry to realise its enormous potential fully.

'Digital solutions for exchanging wind speed forecasts between wind and system operators in order to optimise transmission capacity are still largely untapped.'

System integration

TSO-DSO: More and higher quality data exchanges between system operators and wind power generators will improve the transmission and distribution of clean energy throughout the grid.

Real-time grid support capabilities: Enhanced digitalisation will enable wind farms to provide more grid services faster and more efficiently.

Synergies with power generators: Digital solutions to connect wind power plants with other power generators, facilitating system level energy management.

Consumer synergies: Digitising electricity consumption and demand-side management will improve consumers' connectivity and interactivity with power generators.

Sector coupling: Increased digitalisation offers opportunities to strengthen and develop synergies between the electricity sector and energy carriers.

Storage: innovative systems coupling wind power and storage will enhance wind energy abilities to become a crucial part of the energy system.

Cost reduction

Improving productivity: Enhanced forecasting and smarter control through digitalisation will enable turbines to create more energy.

Decreasing O&M costs (OPEX): Improved decision-making based on data analytics will enhance daily operations and maintenance, decreasing the MWh production cost.

Decreasing investment costs (CAPEX): Data-driven design of wind turbines and new construction and manufacturing techniques will decrease investment costs and avoid over-engineering.

Lifetime extension: Turbine lifetimes will be extended by the use of smart materials and tailor-made operations & maintenance plans through digitalisation.

Improving the value of each MWh produced: Better operations and trading through data-driven analysis of the power markets will boost the value of wind power production.

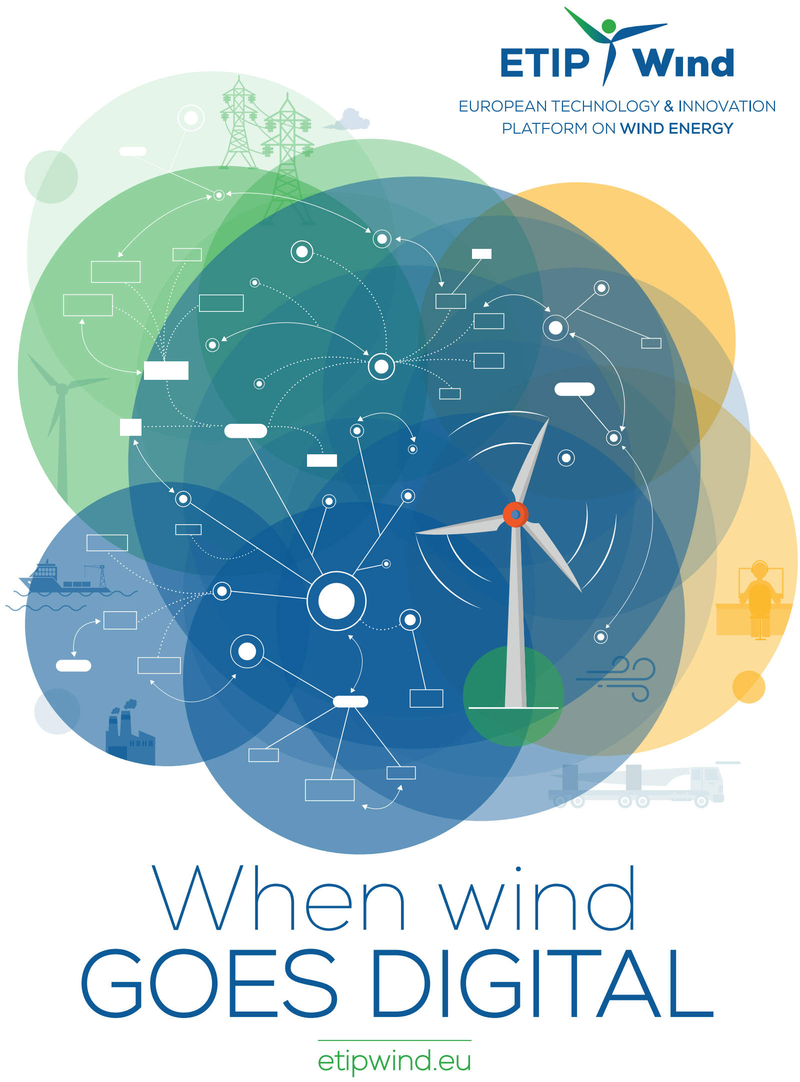
Objectives for digitalisation. Source: ETIP Wind[1]

For example, forecasting increased wind speeds over a period of time not only impacts the wind energy generated, but also the transmission capacity that power lines can host. The more the wind blows, the more it cools down the power lines. This allows more power to be transmitted beyond the line's thermal design margin, and avoids the curtailment of wind energy for safety reasons. Digital solutions for exchanging wind speed forecasts between wind and system operators in order to optimise transmission capacity are still largely untapped.

Similarly, digital solutions are at the core of direct marketing energy from geographically dispersed wind farms. Next Kraftwerke, the operator of the largest virtual power plant in Europe, trades thousands of megawatts from wind farms, storage units and other renewable energy assets without owning a single power plant. The virtual power plant facilitates the integration of these generators into the grid by offering their combined flexibility (ramping up and down at short notice for frequency control) and selling their generation output in the wholesale market. Surprisingly, virtual power plants are still a curiosity rather than a common feature in the digitalisation of wind power integration into the grid.

The European Technology & Innovation Platform on wind energy (ETIPWind) has created a mind-map compiling the opportunities offered by digitalisation for wind energy. All these can be summarised in terms of facilitating system integration and continuing cost reduction (see text box on the previous page).

Until now, renewables have created value in the power system by injecting watts; clean, affordable and locally harvested watts. But to remain a disruptive force of change, and to keep outweighing conventional power generation, they need to create value from bytes too.



Source: ETIP Wind

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Before joining WindEurope he worked for 6 years as a technical project manager on large scale mechanical and electrical installations across Europe for Procter & Gamble. His professional experience also includes working as a freelance management consultant and in finance management at Carrefour. He studied in Mexico and Canada where he graduated with a BSc. in Industrial Engineering, and in the UK where he obtained his MSc. in Sustainable Energy Technology at Imperial College London.

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TALK TO SETIS

A strategic approach to digital construction

What is the role of the European Digital Platform in support of the evolution of the construction industry towards a digital era, and what are the main challenges in this process?
The European Digital Platform for construction is intended to facilitate the uptake of digital tools and support the digital evolution of the sector. It is indeed widely recognised that digital processes included (but not limited to) Building Information Modelling (BIM)[1,2] can provide added value when applied along the complete value chain, during planning, design and engineering, construction and operational phases. Overall, digitisation of the construction sector is expected to reduce the total building life-cycle cost and construction time significantly. This means increasing productivity and delivering the desired business outcomes. Yet, the construction industry has been slow in adopting digital technologies, in changing the working environment of its employees and processes.

'Overall, digitisation of the construction sector is expected to reduce the total building life-cycle cost and construction time significantly.'

Recent statistics show that while more than 50% of European companies working in IT, telecommunications and media are highly digitised, this is true for only 10% of companies working in construction[3]. What we also know is that 91.9% of construction companies are micro-enterprises with fewer than 10 employees. It goes without saying that the main challenge of every initiative to facilitate the digitisation of the construction sector is the level of involvement of these companies.

The good news is that European industry at large is increasingly adopting digital solutions and is currently facing digital transformation. This process, also known as the fourth industrial revolution, is led by a host of technology providers, most of which are ICT small and medium-sized enterprises (SMEs). These digital SMEs are the main actors that bring technologies to the industrial companies (including other SMEs) in all the other sectors.

Digital SMEs are ready to offer innovative solutions and services for new markets created by the dawn of technology in the construction sector, complementing existing activities within the entire value chain. The creation of

[1] EU BIM Task Group (2017), Handbook for the Introduction of Building Information Modelling by the European Public Sector.
[2] Joint Research Centre (2017), Building Information Modelling (BIM) standardization.
[3] European Commission (2017), Integration of Digital Technology, Europe's Digital Progress Report 2017.

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Oliver Grün is a German engineer and entrepreneur. He is the founder and CEO of GRÜN Software AG in Aachen and President of European Digital SME Alliance, the largest network of the ICT small and medium sized enterprises in Europe. He is also President of the Federal Association of IT-SMEs of Germany (BITMI), the only information technology industry association which exclusively represents the interests of small and medium-sized enterprises (SME) in Germany. Since 2013, he is member of the Advisory Council for IT of the Federal Ministry of Economy, which gives advice on issues concerning the digital economy.

a European Digital Platform for construction should therefore build on the skills and expertise of digital SMEs; next to software and highly specialised solutions, they make knowledge and support available to non-IT small companies, such that the latter can benefit from digitisation.

I see the European Digital Platform as a reference tool for the creation of an open market for all companies and professionals in the construction sector willing to exchange products and services in a digital format. For instance, BIM offers the opportunity to digitise construction products and building projects. Powerful marketing tools like goBIM, for example, use open standards and are now available to provide construction products with a 'digital passport' that can be used by anyone at any stage within BIM-based construction processes. Construction companies and designers can already benefit from technologies based on commonly recognised open standards, such as Industry Foundation Classes and International Framework for Dictionaries (openBIM standards), allowing them to choose digital objects that correspond to the products supplied by the manufacturers on the building site. The European Digital Platform will be the perfect place to match these needs and competences, contributing to the evolution of the construction industry towards a new digital era.

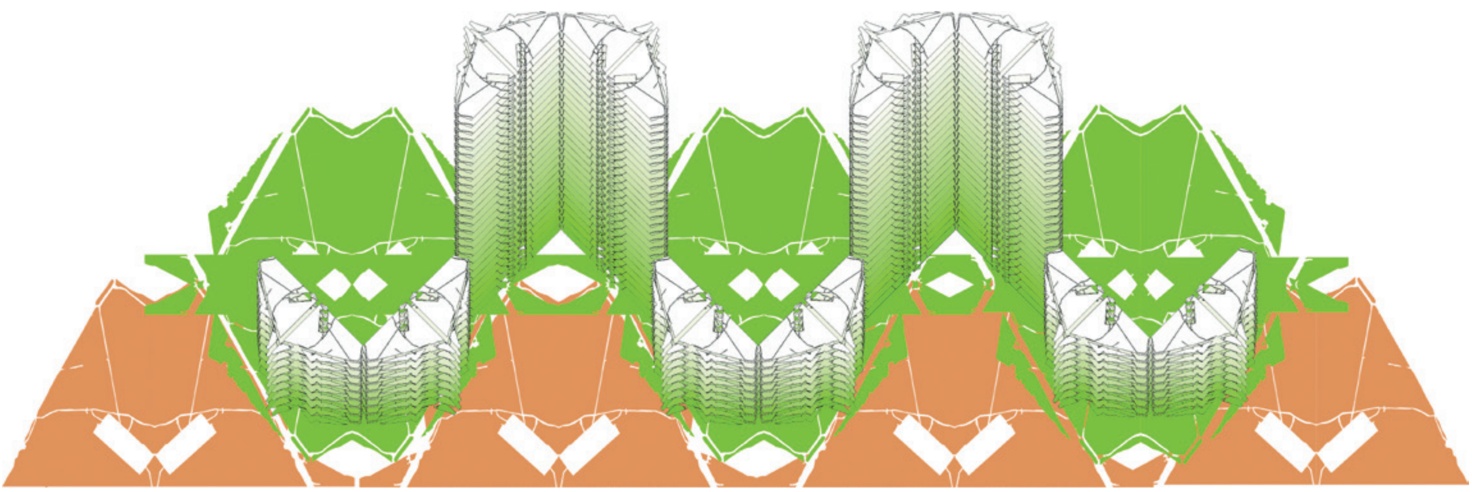
How can energy consumers benefit from the adoption of open standards in Building Information Modelling (BIM)?

The adoption of open standards in the BIM ecosystem has the potential not only to reduce operational[4] barriers for SMEs operating in the construction industry, but also to meet the needs of consumers who expect services and products to get better and cheaper over time. This includes energy management of buildings, of course.

For example, we can think about BIM applications that allow the visualisation of building energy performance. Open standards allow applications to process data from the different building components and, thus, display energy performance information to users in an effective and easily understandable way. In this way, occupants of a given building can be better informed about their energy consumption and might contemplate alternative design decisions which could make a significant impact on the energy performance of their assets.

Without a standard form or structure, the time taken to sort and structure that data to make it usable might not be convenient. In some cases, non-standard proprietary interfaces

[4] Related to on-site collaboration of construction companies, with particular reference to SMEs.



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may not allow the exchange of data between actors along the construction value chain. Open standards can serve this purpose without distorting market competition. And what energy consumers definitely do not want is to be subject to solutions based on proprietary technology that would limit their choices and confine them in technological silos.

'The European Digital Platform will be the perfect place to match these needs and competences, contributing to the evolution of the construction industry towards a new digital era.'

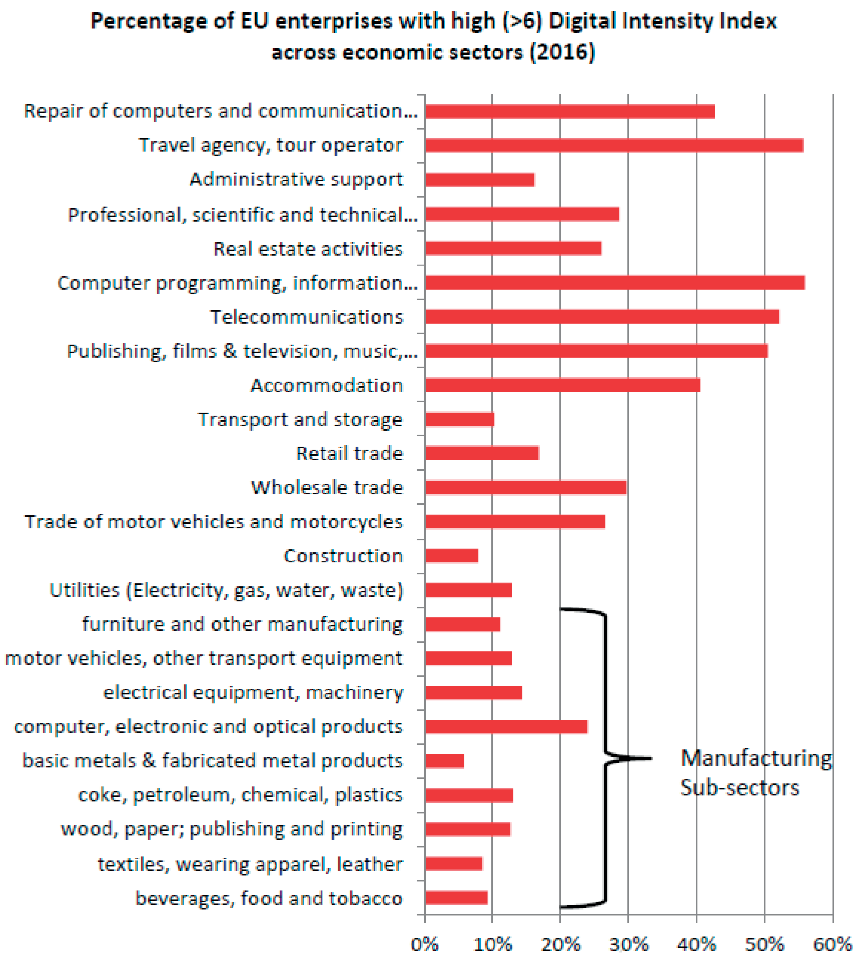
What is the potential impact of digitalisation in the heating and cooling sector?

Digitisation in the heating and cooling sector is based on sensors and connectivity. We see this going more and more into what is called the 'Internet of Things', which gives consumers full control of their energy consumption. However, the main challenge that digitisation can significantly help to overcome is the management of heating and cooling processes in the framework of more complex systems like smart grids and energy systems based on demand-side flexibility.

The European DIGITAL SME Alliance is deeply involved in the operational phases of the SABINA Horizon 2020 project that, among other objectives, aims at providing synergies between electric and thermal networks, through the optimisation of electric usage for cooling and heating purposes. Here, digitisation is key to the development of high quality thermal models to predict building thermal behaviour and to capture the heat dynamics of buildings. The benefits of such digitised models are expected to amount to 5-70% of energy savings and 10-45% peak power savings[6].

I usually repeat that for most innovations, 70% of the innovation is related to IT. The heating and cooling industry, similarly to other industries, should definitely collect data, but also use them to create new business models. In order to do so, the industry must extend its scope along the value chain and cooperate with new partners like digital SMEs, the real enablers of (r)evolutions in every sector.

[6] Henze, G. P., & Krarti, M. (2003). Predictive optimal control of active and passive building thermal storage inventory. Architectural Engineering- Faculty Publications, 1.



Europe's Digital Progress Report 2017. Source: European Commission

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