Publications Office of the European Union

Digitalisation of the energy system

Research & innovation to support the digitalisation of the energy system.

The European Commission's 'Action plan on **the digitalisation of the energy system**' lays **the** groundwork for building an integrated **energy system** that can support **the** growing interconnectedness **of the** market and enable digital and **energy** value chains to work more closely together. **The** action plan will provide strong support to REPowerEU, **the** joint European action presented in March 2022 to accelerate **the** switch to renewables and hydrogen, to become more **energy** efficient and make Europe independent from Russian fossil fuels well before 2030.

Published: 2022

Subject: *energy* grid, *energy* market, *energy* research, *energy* transition, action programme, digital transformation, digitisation, hydrogen, innovation, renewable *energy*, value chain,

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BRIDGE, Cooperation between Horizon 2020 and Horizon Europe projects in the fields of smart grid, energy storage, islands, and digitalisation : 2023 brochure.

BRIDGE is a cooperation group involving 155 projects in total (among which 97 are ongoing and 58 ended as **of** 1st **of** July 2023) involving 1510 organisations from 39 countries for a total accumulated EC funding to all projects **of** 1303 M€ in **the** areas **of** Smart Grid, **Energy** Storage, Islands, and **Digitalisation** funded under **the** Horizon 2020 and Horizon Europe program over **the** last 8 years (2015-2023). This collaborative initiative reveals **the** average growth **of** 45% per period **of** 2 years. **The** number **of** projects has experienced a remarkable growth **of** 546% from **the** beginning **of the** period (2016-2017) until 2022-2023. In this brochure we report on 147 projects (ongoing and ended) that provided **the** necessary information to **the** BRIDGE secretariat for **the** analysis. BRIDGE aims at fostering **the** exchange **of** information, experience, knowledge, and best practices among its members. Its goal is to provide field experience, feedback and lessons learned from **the** participating projects to help overcome **the** barriers to effective innovation. It aims at gathering coordinated, balanced and coherent recommendations to strengthen **the** messages and maximize their impacts towards policy makers in view **of** removing barriers to innovation deployment.

Published: 2023

Subject: *energy* efficiency, *energy* grid, *energy* market, *energy* storage, *energy* technology, digitisation, innovation, island, multiannual financial framework, project evaluation , renewable *energy*,

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METIS 3, study S5 : the impact of industry transition on a CO2-neutral European energy system.

The main objective **of** this study is to gain deeper insights into possible pathways for industry decarbonisation, their resulting **energy** demands and **the** impact on **the** overall European **energy system**.

Published: 2023

Subject: *energy* grid, *energy* market, *energy* transition, industrial reorganisation, reduction *of* gas emissions,

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Financing energy system integration in Europe : the state of play and future prospects.

Energy system integration (ESI) is **the** process **of** coordinating **the** planning and operation **of the energy system** as a whole, addressing different sectors, their markets and infrastructure as interconnected and complementary pillars. In a transition to a decarbonised and decentralised **energy** mix characterised by predominantly variable renewable **energy** sources, ESI is key to minimising cost and maximising efficiency. **The** European Union (EU) has indicated its strong support for ESI through **the** European **Energy System** Integration Strategy. However, since its publication in July 2020 there has been no announcement **of** a dedicated ESI fund or any concrete plans to finance it. To date, current non-specific financing mechanisms have provided relatively little support for ESI in **the** EU. A new approach is required to leverage **the** benefits **of** ESI and align it with **the** level **of** support in other areas **of the energy** transition. A dedicated ESI fund should be created at **the** EU level utilising an approach similar to that **of the** Connecting Europe Facility (CEF) and Projects **of** Common Interest (PCIs).

Published: 2021

Subject: *energy* grid, *energy* market, EU *energy* policy, financing, project *of* common interest,

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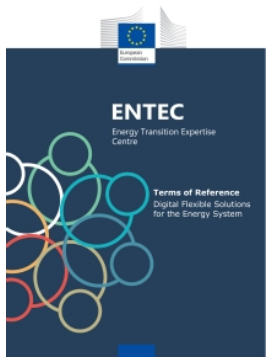

Digital flexible solutions for the energy system : terms of reference.

One important and very beneficial field **of** digital **energy** services consists in **the** provision **of** flexi-bility services (i.e. generation flexibility, demand side flexibility, storage flexibility). Thus, **the** aim **of** this study is to provide a framework for **the** development **of energy** services offering flexibility. Thus, digital infrastructure is needed to facilitate data exchange at application levels and between different players along **the energy** value chain. Providing infrastructure involves governments, regulators and stakeholders as well as consumers, and addresses (IT)-technical, or-ganisational, legal, economic and behavioural aspects **of** data exchange (or sharing) and use.

Published: 2022

Subject: *energy* efficiency, *energy* grid, *energy* technology, *energy* transition, available *energy*, digitisation, EU *energy* policy, green economy, reduction *of* gas emissions, renewable *energy*,

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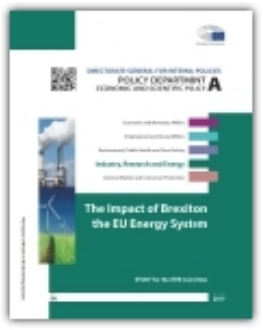

The impact of Brexit on the EU energy system.

This study provided by Policy Department A at **the** request **of the** European Parliament's Committee on Industry, Research and **Energy** (ITRE) shows that **the energy-system** related impact **of** Brexit on EU citizens and companies will be limited. **The** EU will be able to complete its market, achieve its climate and **energy** targets and maintain supply security. It appears likely (although not guaranteed) that **the** UK will continue to maintain sensible environmental policies and safeguard **the** rights **of** EU companies in **the** UK. However, special attention on **the** impact **of** Brexit on **the** Irish **energy system** is warranted.

Published: 2017

Subject: *energy* policy, climate change policy, common market, European Union, European Union membership, impact study, reduction *of* gas emissions, United Kingdom,

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Towards net-zero emissions in the EU energy system by 2050 : insights from scenarios in line with the 2030 and 2050 ambitions of the European Green Deal.

This report presents a comparison **of** 8 scenarios achieving more than 50% reduction **of** greenhouse gas emissions by 2030 compared to 1990, and 16 scenarios aiming at climate neutrality by 2050, similar with **the** ambitions **of the** "European Green Deal". This abstract summarises insights into similar and diverging elements **of the** scenarios on how **the** EU **energy system** may change by 2030 and by 2050, compared to today. **The** wealth **of** information, stemming from how different organisations see **the** EU **energy system** to evolve within their own scenario context, can provide useful input to EU climate and **energy** strategie.

Published: 2020

Subject: *energy* policy, *energy* research, *energy* technology, adaptation to climate change, bioenergy, carbon capture and storage, clean technology, climate change, climate change policy, environmental policy, environmental protection, greenhouse gas, quality *of the* environment, research report, sustainable development,

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Clean energy and digitalisation as a key enabler for Horizon 2020 Green Deal call projects.

This report explores **the** critical linkages between clean **energy** technologies and **the** digital tools and **systems** that underpin so much **of the** innovation in **the** sector. It highlights **the** opportunities, drivers, and challenges **of digitalisation** in **the** context **of the** clean **energy** transition and discusses practical strategies and actions from selected Green Deal Call Clean **Energy** Projects to address these. Finally, **the** report presents a set **of** principles, insights and lessons for cross-integration for developing and implementing clean **energy** projects across Europe and Africa.

Published: 2023

Subject: *energy* grid, *energy* transition, clean technology, digitisation, EU *energy* policy, EU research policy, Framework Programme for Research and Development, innovation, report, research programme, research project, scientific research, soft *energy*,

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Clean Energy Technology Observatory, Smart thermal networks in the European Union : status report on technology development, trends, value chains and markets : 2023.

This report is part **of the** 2023 Clean **Energy** Technology Observatory series and is focusing on smart thermal networks within **the** European Union (EU). It provides an overview **of the** current status, emerging trends, and **the** potential **of** this sector integration technology. Smart thermal networks offer a significant advancement compared to conventional district heating **systems**, operating with higher intelligence and efficiency while maintaining lower temperatures. This enables **the** integration **of** a larger share **of** renewables and positions these networks as versatile assets, offering balancing services to **the** wider **energy system**. An increasing number **of** district heating and cooling **systems** in **the** EU are transitioning towards becoming smart thermal networks. Numerous cities are investing in expanding and modernising their existing **systems** to align with future **energy** needs, characterised by a growing reliance on variable renewables. Smart thermal networks encompass a variety **of** technologies, most **of** which are technologically mature, including intelligent control **systems** with sensors, waste heat, high-efficiency cogeneration, large heat pumps, and thermal **energy** storage **systems**. One **of the** most promising avenues for further innovation lies in **digitalisation**, which allows for seamless integration and control **of energy** flows. By fostering intelligent control and data-sharing across **the** entire **system**, smart thermal networks can optimise their operation in **the** short and medium term. **The** EU is a global leader in this field and well-positioned to lead **the** transition towards smart thermal networks, showcasing their value in **the** context **of the** low-carbon transition.

Published: 2023

Subject: *energy* efficiency, *energy* grid, *energy* market, *energy* research, *energy* technology, clean technology, digitisation, heating, innovation, reduction *of* gas emissions, renewable *energy*, research report, sustainable development, value chain,

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Smart grid interoperability laboratory : annual report 2022.

Latest edition

The Energy Security, Distribution and Markets Unit has **the** Smart Grid Interoperability Laboratory (SGIL) situated in two sites, namely Ispra (Italy) and Petten (**The** Netherlands). **The** focus activities **of the** labs vary from **energy** communities, storage issues, demand response programs to remote load control, home automation and **energy** smart appliances. **The** goal is to address issues related to **energy digitalisation**, serving **the** goal **of** European Green Deal. **The** activities in 2022 are highlighted in this report.

Published: 2023

Subject: *energy* efficiency, *energy* grid, *systems* interconnection, digital technology, electric vehicle, electricity storage device, research report, smart technology,

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Common European Energy Data Space.

The energy transition towards renewables requires additional flexibility options in **the** electricity **system**, to coordinate resource-dependent generation and demand. **The** management and control **of** this flexibility needs an advanced digital ecosystem for **the** communication between organisations and devices. **The** Common European **Energy** Data Space will facilitate **the** participation by flexible **energy** resources as set forth by **the** EU action plan on digitalising **the energy system**. This report, researched and written by **the Energy** Transition Expertise Centre (EnTEC) under **the** auspices **of the** European Union, develops a plan for **the** realisation **of** this Common European **Energy** Data Space

Published: 2023

Subject: *energy* market, *energy* research, *energy* transition, electrical *energy*, EU *energy* policy, renewable *energy*, report,

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EU publications PDF Permanent link

Study on energy storage.

Flexibility **of energy** supply and demand becomes increasingly important with increasing shares **of** intermittent renewable electricity generation. **Energy** storage is one **of the** candidates to provide **the** required flexibility to **the** electricity **system**. Against this background, **the Energy** Transition Ex-pertise Centre was asked to deliver a study on **energy** storage to improve **the** understanding **of energy** storage technologies, their business case, and best practices for enabling **the** development **of energy** storage capacities.

Published: 2023

Subject: *energy* grid, *energy* storage, *energy* supply, *energy* transition, electrical *energy*, EU Member State, price *of energy*, qualitative analysis, regulatory policy, renewable *energy*, thermal *energy*,

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Policy and regulatory challenges for the deployment of blockchains in the energy field : work-package 6.

Among **the** various digital technologies and solutions, blockchain recently attracted much interest due its perspective manifold applications in **the energy**, climate and sustainability sectors. Blockchain indeed promises to support several European Union's climate-neutrality and sustainability policies, thanks to its potential to drastically change **the** market rules and streamline **the** decision-making processes and **the system** management mechanisms. **The** policy and legislative initiatives on blockchains are moving their first but quick steps, worldwide and in **the** EU, with **the** financial sector being **the** most targeted due to **the** high interest concentrated on crypto currencies and their potentially disruptive effects on **the** banking and transactive economic sectors. **The** regulations and policy actions on digital finance/blockchain represent an important reference for **the energy system digitalisation** as well, since financial transactions are at **the** core **of the energy** market operations and certain mechanisms aimed at promoting legal certainty and support innovation in **the** financial sector can well be borrowed and applied to **the energy** sector.

Published: 2021

Subject: *energy* grid, *energy* market, *energy* technology, blockchain, electrical *energy*, financial transaction, legislation, renewable *energy*, research report, smart technology, technical standard,

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Renewable energy production and potential in EU rural areas.

The green **energy** transition and its boost to **the** deployment **of** renewable **energy** can offer a unique opportunity for rural areas to benefit from their natural resources. **The** present study aims to provide a quantitative assessment **of the** technical potential **of** renewable **energy** sources in **the** EU's rural areas, focusing on solar, wind and hydropower. This will help to provide relevant insights into how rural areas and communities can contribute to and benefit from **the** EU's green **energy** transition, without undermining natural areas, key biodiversity and bird areas, high-value natural farms and food production. Moreover, a comparative analysis between current renewable **energy** production and potential in rural areas identifies which sustainable development trajectories for **the** future deployment **of** renewables are **the** most suitable in each specific territory. **The** report shows that solar photovoltaic **systems** in rural areas generate 136 TWh a year but have **the** potential to generate 60 times more (8 600 TWh /year). Rural areas produce 280 TWh a year through onshore wind but have **the** potential to produce four times more (1 200 TWh/year). Hydropower production in rural areas yields 280 TWh a year, but it could potentially be 25 % higher (350 TWh/year). This work also addresses **the** concept **of energy** communities, as an emerging framework intended to foster a just green transition for rural communities, where generated values and benefits can be retained locally, while also promoting democratic participation and citizen engagement.

Published: 2024

Subject: *energy* production, *energy* transition, EU Member State, hydroelectric power, renewable *energy*, research report, rural region, solar *energy*, wind *energy*,

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SET plan progress report 2023 : coordinated energy research and innovation for a competitive Europe.

Since its inception in 2019, **the** European Green Deal has set out **the** route for a sustainable, secure and competitive **energy system** for **the** EU, achieving carbon neutrality by 2050. Four years later, **the** legislative framework continues to develop. Earlier this year, **the** European Commission introduced **the** Green Deal Industrial Plan, which includes **the** Net-Zero Industry Act and **the** Critical Raw Materials Act. These legislative proposals are key to achieving **the** European Union's clean **energy** goals through **the** establishment and reinforcement **of** resilient clean **energy** supply chains. Clean **energy** research and innovation are pivotal for **the energy** transition. **The** Strategic **Energy** Technology Plan (SET Plan) plays a key role in coordinating European and national R&I agendas for low-carbon **energy** solutions. As **the** policy landscape is changing fast, so too must **the** SET Plan. Following an extensive consultation process, **the** Commission published a communication on 20 October outlining **the** SET Plan's revision. **The** communication proposes a refinement **of the** SET Plan's strategic objectives to align them with **the** new policy framework. It also proposes to elevate **the** SET Plan's political status, linking it structurally to **the** European Research Area (ERA), setting ambitious targets, expanding **the** technology scope, strengthening its reporting (in which this report plays a part) and establishing task forces for crosscutting issues.

Published: 2023

Subject: *energy* policy, *energy* supply, *energy* technology, carbon neutrality, climate change policy, innovation, new technology, reduction *of* gas emissions, report, research and development, sustainable development,

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Potentials and levels for the electrification of space heating in buildings : final report.

For reaching **the** EU's climate goals **the** space heating sector is **of** exceptionally high relevance. Heating and cooling accounts for 50% **of the** EU final **energy** consumption; approximately 75% **of the** heat demand is covered from fossil fuels and around 60% **of the** overall heat demand is consumed in buildings. These numbers illustrate that decarbonising **the** space heating sector is a crucial factor for reaching greenhouse gas neutrality in **the** EU by 2050. Several studies and scenarios point to electrification as a main solution for decarbonisation **of** space heating. However, there are different possible implementations for electrification **of** heat: One option is direct electrification, in particular by installing decentral heat pumps in buildings or central heat pumps in district heating and, partially, direct electric boilers. Another option is indirect electrification based on synthetic **energy** carries produced from electricity from renewable **energy** sources (RES-E), namely hydrogen or e-fuels (in particular synthetic methane). **The** objective **of** this study is to quantitatively analyse different possible levels **of** these various ways **of** direct and indirect electrification. **The** analysis looks at such scenarios from a technical and economic perspective. As a result **the** scenario with **the** lowest costs (i.e. a cost-effective level **of** direct and indirect electrification) is identified and barriers (from today's viewpoint) for realising this cost-effective level are discussed. For these analyses a modelling framework consisting **of** eight interacting sector models was applied covering **the** building stock, **the energy** supply (power, synthetic **energy** carriers, district heat) sector and infrastructures (electricity and gaseous **energy** carriers). **The** (cost) optimisation and simulation models cover all EU-27 member states (MS) with a high spatial, temporal and technological resolution. Due to close interaction **of the** heating sector with other **energy** sectors **the** modelling framework covered not only space heating but **the** whole European **energy system** also including e.g. **the energy** demand **of the** transport sector and industry. **The** modelling covers **the** time period up to 2050, where greenhouse gas neutrality is to be reached in **the** EU. Even though **the** year 2050 is in **the** focus **of** this study, **the** time steps in between were modelled as well. At **the** core **of the** scenario design is a set **of** in total 12 scenarios each reflecting a particular target for one **energy** carrier in terms "share **of** heated floor area" (e.g. **the** scenario "direct electrification 60%" defines a scenario in which 60% **of the** heated floor area in all MS has to be heated by direct electric heating **system**; **the** mix **of** heating technologies for **the** remaining 40% were optimised by **the** building stock model).

Published: 2023

Subject: *energy* consumption, *energy* grid, *energy* market, carbon neutrality, electrical *energy*, electricity supply, EU Member State, foresight, heating, hydrogen, report,

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