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ENTEC

Energy Transition Expertise Centre

Terms of Reference

Digital Flexible Solutions for the Energy System

Terms of Reference – Digital flexible solutions for the energy system

Consortium leader

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Content

1 Background and objectives

The Communication on "Powering a climate-neutral economy: an EU strategy for Energy System Integration" proposed the adoption of a system-wide **Digitalisation of Energy Action Plan** (DoEAP) as one of the key actions to accelerate the implementation of digital solutions. It aims to

- contribute to the EU **energy policy objectives** by
  - supporting the development of a sustainable, (cyber)secure, transparent and competitive market for digital energy services,
  - ensuring data privacy and sovereignty, and
  - supporting investment in digital energy infrastructure.
- provide solutions on how to **overcome challenges** related to cybersecurity, data access & sharing governance, data protection and privacy, and the growing energy consumption of the IT sector (e.g. data centres),
- take along and involve **citizens**, i.e., creating a positive experience for end-users, putting EU citizens at the centre of the energy system and benefitting the environment.

One of the key focus areas of the DoEAP is "Developing a European data-sharing infrastructure for new energy services". The aim of the action plan is to develop a digital energy infrastructure that provides the ground for a competitive market for digital energy services. This addresses cybersecurity in the electricity sector as well as the access & sharing of data together with interoperability of data, platforms, services etc.

One important and very beneficial field of digital energy services consists in the provision of flexibility 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, organisational, legal, economic and behavioural aspects of data exchange (or sharing[1]) and use.

[1] The terms data exchange and sharing is interchangeable

2 Research questions

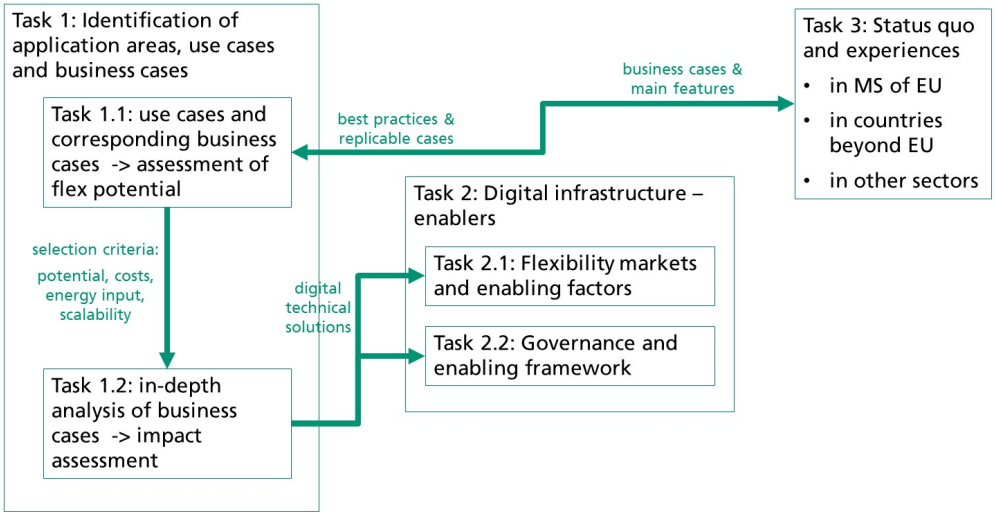
With increasing use of variable RES, different regional RES potentials and large distances between generation and consumption, flexibility along the value chain of energy use is gaining in significance for a secure, sustainable, efficient and affordable energy supply. While large scale generation, transmission and electricity exchanges employ digital services and artificial intelligence to ensure a secure and competitive energy supply, consumption and the increasing decentralised generation and storage facilities are still less driven by digital services and usage of artificial intelligence that increase flexibility of the energy system. Increasing digitalisation in decentralised, small-scale generation and consumption could unfold new innovative concepts and businesses, and harness new flexibility potentials for the electricity sector. Thus, developing a European data-sharing infrastructure for energy services is key to increase flexibility services in the energy system. In this context, the openness and willingness of energy service companies of using digital services to offer digitalisation-driven flexibility, consumers' attitudes to share their data and use digital energy services as well as handling of data and trust in established structures is important for the further harnessing of digitalisation for flexibility services. Subsequently, the development of a data sharing energy infrastructure entails several questions:

- Which digital technical solutions exist? What is their potential and how do they compare to each other? How beneficial are they for the energy system, the society and individual actors? What are use and business cases by applications per sectors or actors s, and along the energy service value chain and what is their impact?
- Is there a risk of market abuse by the gaming dimension of flexibility at retail level?
- What infrastructure and framework conditions, including governance and standards, are needed to fully employ the potential of digital technical solutions for flexibility in the energy system? What is the needed infrastructure for data exchange?
- Which measures and governance should be implemented to create such a digital infrastructure[2] and environment, to avoid look-in effects and unfold the potential and benefits of new flexibility services? Are the existing key documents of energy and digital transition consistent, and are there any gaps regarding the full employment of digital technical solutions for flexibility?

[2] Energy Data Space is part of the digital infrastructure

3 Tasks and approach

The study is structured in three Tasks as outlined in the following illustration:



3.1 Task 1: Identification of application areas, use cases and business cases and impact assessments

Task 1 gives an overview of digital solutions enabling flexibility services and their respective business cases. It strives to include solutions that have not yet been considered in other studies. Among the identified cases, the most relevant ones will be selected for an impact analysis. Therefore, this Task 1 is divided into two sub-tasks. Task 1.1 provides a framework for the identification of use cases and business cases and a description including the potential contribution of the cases to the flexibility potential (capacity) of the energy system. Task 1.2 conducts an in-depth analysis of the selected business cases and assesses their impacts on the energy system as well as their potential economic benefits, barriers and drivers.

The analytical framework distinguishes between use cases and business cases – they are briefly outlined in the following box.

Use case: covering a specific application area (sector, actors) along the energy value chain. It is an overarching term for a bundle of business cases. Examples for use cases could be: smart buildings, EV smart charging, smart storage solutions

Business case: is narrowed down for a specific market or application within the use case category and depicts the specific digital technical solution, e.g. for the use case smart buildings: smart home, tertiary building automatisation are potential business cases.

3.1.1 Task 1.1 Identification of digital solutions enabling flexibility: Overview on use cases and corresponding business cases

The aim is to

1) Identify and describe use cases along the energy value chain where digital solutions enable flexibility, and derive potential business cases for the different use case categories. This in-

cludes an outline of technical preconditions, economic aspects (investment/operation), application fields in the energy sector, actors involved. Further, this subtask includes selecting existing and new (market readiness solutions) flexibility services enabled by digital solutions.

2) Outline the potential of flexibility use and business cases on the basis of their current implementation status and future development of digital solutions enabling flexibility. Potential of the provided flexibility will be assessed along two dimensions: capacity (kW) and time span and the assumed number of uses (actors using this solution).
3) Describe the potential impact of flexibility services enabled by digital solutions on the electricity system in terms of load shift/shedding. At this stage, this is a qualitative analysis.
4) Identify and assess criteria allowing the selection of 15 business cases (for Task 1.2).

Approach:

- A first step is, to set up and apply a framework to identify possible use cases that can contribute digitally-enabled demand-side flexibility to the power system. This framework looks into different areas such as sector, actors, and identifies use cases along the energy value chain[3]. Further, it draws on the output of Task 3 and includes potential digital technical solutions used in countries outside the EU or, identifies digital technical solutions in other sectors that could be transferred and replicated in the energy sector.
- Create a comprehensive overview of selected use cases and business cases. The information for the overview is based on literature review and expert interviews. The overview includes for each use case key dimensions or aspects such as
  - Current 'state of the art' incl. involved actors along the energy or digital value chain
  - Range of investment and operational costs
  - Rough quantification and characterisation of flexibility potential (for example "absolute" MW or MWh, specifics on typical duration, geographic coverages, etc.), and indication of its energy consumption (when applied)
  - Estimation of the current implementation and use (number of users, and magnitude of use per business case), and its future potential, or when will it be available (first generation, second generation of solutions …). Potential behavioural and acceptance issues are accounted for in the number of users.
  - Qualitative assessment of the potential scalability and interoperationality (other sectors)
  - Description of the role of digitalisation in enabling / providing this solution; look at potential spill-overs of digitalisation in other sectors (see Task 3)

Use cases would likely include e.g.

- Smart buildings: e.g. including building automatisation and control systems (as business cases) at individual level (building)
- Smart storage solutions e.g. including PtX as business case
- Intelligent district solutions (cities)
- Flexible and smart charging as well as bidirectional charging through e-mobility
- Selected energy-intensive industrial processes

[3] See: EC Asset Study on Digital Technologies and Use Cases in the Energy Sector

See following illustration for the use case EV smart charging:

USE CASE	Aspect of analysis	Relevant categories
EV smart charging	Business cases	Ancillary services spot market participation congestion management fleet optimization self consumption of prosumers community energy systems / flex markets / regional platforms / P2P trading
	Technologies	EVs -> Demand response and bidirectional charging charging technologies management platforms
	Qualitative impact assessment for selection of promising business cases	

Output:

- D1.1 Overview of identified use cases and business cases with available information as outlined above in a tabulated overview and brief description of the approach (text document)

3.1.2 Task 1.2 In-depth analysis of business cases

This subtask assesses the impact of selected business cases. The selection of business cases relies on their identified contribution to the flexibility of the system (current status and future potential), its involved costs and energy consumption, scalability. The impact assessment in this task comprises several aspects: a detailed assessment of the potential contribution of the specific business cases (range) by taking into account technical and behavioural aspects as well as the aggregated flex potential of this business case for the electricity system (energy sector's flexibility capacity). In detail, the assessment includes

- The potential impact of the identified business cases on the electricity system in terms of load shift/shedding (for example for a potential business case "participation of EVs in ancillary services").
- The economic benefits of the business cases for example the impact on electricity prices or avoided costs (networks, curtailment etc.) or costs savings or expenditures for consumers
- Discussion of the potential of gamification (if applicable, i.e. if a business case represents a secondary market or is based on a secondary market that participants could exploit). This includes gamification at two levels:
  - Gaming at flexibility markets, i.e. (not necessarily large but decisive) actors behaving strategically on one electricity market to reap benefits in another market, such as day ahead, intraday, balancing, upcoming flexibility markets, …).
  - Misuse of advantages arising from market failures at the distribution level, e.g. through the size and/or potential information advantages of one actor.
- The identification of the framework conditions and derivation of the main regulatory enablers and barriers of the business cases

This entails the following information and analyses:

- Associated estimated cost to implement the business case and provide flexibility (type and magnitude of cost and contribution to flexibility
- Analysis of impacts on the energy system in terms of shifting and shedding loads, potential indicative impact on electricity prices
- Cost-benefit analysis (economic, systemic and societal; e.g. cost savings for final consumers) based on different tools (simple analyses or application of existing small models, depending on the availability) and for different actors
- Outline at which market the digital technical solutions are used and whether there it enables a potential market abuse
- Description of implementation / scale-up challenges and possible unblocks and requirements regarding digital infrastructures; replicability when applied in other sectors or regions
- Outline of potential barriers and drivers regarding the implementation of use and business cases, including also technical, economic, regulatory, societal and social aspects
- Assess whether there are important interplays between individual cases that need to be better understood and/or combined impacts on the energy system / value chain

Output:

- D1.2 In-depth business cases: describing the detailed assessment of 15 business cases. It encompasses the selection criteria, the assessments approaches, potential flexibility contribution, the impact on the energy system, benefits, barriers and enablers such as requirements regarding infrastructure, as well as the main markets, actors and gamification potential; if necessary brief outline of the methodological approaches (2-3 pages per case)

3.2 Task 2: Digital Infrastructure – enablers

3.2.1 Task 2.1 Flexibility markets and enabling digital solutions

Task 2.1 builds on the outcome of Task 1. The aim is to identify the digital infrastructure required to enable the use of the flexibility use or business cases and – where missing – outline how these could be put into place.

Approach (based on literature review, expert interviews and, where helpful, stakeholder workshops):

- Derive required target state. For each use and business case, identify required digital & data infrastructure and enablers and provide a governance. These will likely comprise business case specific requirements (e.g., for smart EV charging) as well as overarching digital energy services e.g. data access and data sharing platform
- Compare requirements against status quo (gap analysis)
- Identify barriers / challenges in filling these gaps and outline steps to overcome these

This subtask relies on literature review, expert talks and exchanges with different stakeholders.

Output:

- D2.1 i) Report: Description of required technological (data, digital infrastructure etc.) enabling factors for flexibility uses cases. Non-exclusive examples include GAIA-X, International Data Spaces infrastructure, European Data Spaces, existing data spaces, power exchanges and a gap analysis and high-level outline of approach to fill the gap (10 pages)
- D2.1 ii) Governance(s) of flexibility markets or use cases and the enabling digital solutions (text document)

3.2.2 Task 2.2 Regulations and enabling framework

Relying on the results of Task 1 and Task 2.1, Task 2.2 aims at the regulatory and legal framework to progress towards a digital energy system. It will address how different instruments on EU level contribute, whether they are consistent with respect to the use of digital technical solutions and whether they could be aligned (e.g. Clean Energy for all Europeans Package and Horizon Europe but also the Connecting Europe Facility and policy instruments to achieve a 'Europe fit for the digital age'). Beyond existing policy instruments, the task also explores regulatory issues addressing data security, protection of private spheres and behavioural aspects that might inhibit the use of flexibility options (purchase decisions, and operation) or lead to rebound effects. Questions will be asked such as: What are the rights, obligations and limits of each market actor? How do they interact? How to get private actors such as households engaged in the market. What barriers exist? What are drivers for different actors?

Approaching this task includes the following steps

- Identify legal, technological aspects hindering participations of market actors (build on Task 1, but additional expert talks and stakeholder discussion)
- Compare different EU key documents addressing the transition in energy and digitalisation along the dimensions R&I, market uptake, roadmaps or strategies and implementation (regulations, directives), and screen for inconsistencies and gaps and analyse potential limitations (e.g. EU Data framework like the GDPR, the Regulation of the free Flow of non-personal data as well as the international dimension of data treatment)
- Identify legal gaps, overlaps or barriers with respect to data security and data transfer and sharing – especially with respect to the directives, acts, regulations in the digitalisation and energy sector
- Conduct a literature review with a special focus on purchase decisions of consumers, the actual usage of digital technical solutions as well as potential rebound effects and suggest measures to address these issues.

Approaches:

Literature review, expert talks, stakeholder involvements (e.g. talks, interviews, workshops)

Output:

- D2.2 i) Text document: Recommendation for adjustments of EU documents, legal aspects and regulatory framework referring to identified gaps or inconsistencies (5-15 pages)
- D2.2 ii) Overview on technical, legal and market aspects as well as on behavioural drivers and barriers and potential measures addressing them (5 pages)

3.3 Task 3: Status quo and experiences

This task includes three parts:

- Identification and outline of the use of digital flexibility solutions in MS[4].
- Further, screening of practises and experiences with digital flexibility solutions in countries outside the EU (e.g. UK, California, China) that deemed to be replicable within the EU
- Identification of digital solutions that have a promising replication potential and are applied in other sectors that have been transforming due to digitalisation, in Europe and beyond.

[4] https://smarten.eu/wp-content/uploads/2021/03/EU_Market_Monitor_2020_1-32.pdf

The outline of good practices and experiences encompass the description of the technology, the market and specific application of the digital technical solution, the potential and impacts and infrastructure and regulatory requirements (see Task 1 and 2) as far as information are available.

To address these questions, two approaches are applied: literature review and expert talks

Output:

- D3 Report: Outline of good practices of main digital flexibility solutions applied in MS and outside the EU and cross-sectional examples of digital solutions in sectors transforming due to digitalisation (max 10 pages) (draft on preliminary cross-sectional and good practice samples outside the EU, final with solutions in MS)

4 Deliverable/expected results and reporting and resources

Deliverable	Title/ Short description	Type	Month	Lead / contribution	Person days
D1.1	Overview table" initial analysis (first learnings)	Text document	May/June 2021	McK / IEE / ISI	30
D1.2	In depth business cases	Text document	July/August 2021	McK / IEE / ISI	80
D2.1	i) Technological requirements and gaps ii) Governance	Text document Text document	Aug/Sept 2021 Aug/Sept 2021	McK / IEE / ISI	40
D2.2	i) regulatory framework ii) barriers and drivers	Text document	Sept/Okt 2021	IEE / ISI	30
D3	Practices and cross-sectional/regional experiences	Text document	Draft: May/June Final: Okt. 2021	McK/ ISI / IEE	30

Total estimation of needed human resources: 231 person days (about 10% for coordination and final reporting).

5 Timeline and work plan

5.1 Timeline

Start of the project: Beginning of May

Draft first interim output D1.1 and D3 in June 2021, D1.2 in July 2021

First interim output D1.1 and 1.2 in August 2021

Draft second interim output: D2.1 and D2.2 in Sept.

Second interim output: D2.1 and D2.2 in Oct.

Draft final: October 2021

Final Output: November 2021

5.2 Proposed team

Study Lead, Contributors: McKinsey, TNO, Fraunhofer

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