A novel smart grid architecture that facilitates high RES penetration through innovative markets towards efficient interaction between advanced electricity grid management and intelligent stakeholders

H2020-GA-863876

Data management, dissemination and exploitation plans

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Glossary of Acronyms

Project management terminology

Acronym	Definition
D	Deliverable
DoA	Description of Action
EC	European Commission
HLUC	High Level Use Case
MS	Milestone
WP	Work Package
UCS	Use Case Scenario

Technical terminology

Acronym	Definition
AC-OPF	Alternating Current Optimal Power Flow
AFAT	Automated Flexibility Aggregation Toolkit
AI/ML	Artificial Intelligence/ Machine Learning
AI-HLEG	Artificial Intelligence High-level Expert Group
API	Application Programming Interface
ATP	Automated Trading Platform
AUW	Aggregated Users' Welfare
BMC	Business Model Canvas
BRP	Balance Responsible Party
BSP	Balancing Service Provider
B2B/B2C	Business to Business / Business to Consumer
CAPEX/OPEX	Capital Expenditures / Operational Expenditures
CEP	Clean Energy Package
DA/ID	Day-Ahead / Intra-Day
DB	Data Base
DC-OPF	Direct Current Optimal Power Flow
DER	Distributed Energy Resource
DFA	Distributed Flexibility Asset
DG	Distributed Generator
DLFM	Distribution Level Flexibility Market
DMP	Data Management Plan
DR	Demand Response
DSM	Demand Side Management
DSO/TSO	Distribution/Transmission System Operator
ES	Energy Service
ESP	Energy Service Provider; BSP stands for Balancing Service Provider
ESS	Energy Storage System
FMCT	Flexibility Market Clearing Toolkit
FST	FlexSupplier's Toolkit
GUI	Graphical User Interface

ICT	Information and Communication Technology
IEGSA	Interoperable European Grid Services Architecture
KPI	Key Performance Indicator
LMP	Locational Marginal Price
MVP	Minimum Viable Product
(NE)MO	(Nominated Electricity) Market Operator; FMO stands for Flexibility MO
NRA	National Regulatory Authority
ORDP	Open Research Data Pilot
QoS/QoE	Quality of Service/Quality of Experience
POPD	Protection of Personal Data
PPA	Power Purchase Agreement
RES	Renewable Energy Sources
RESP	RES Producer
RTP	Real Time Pricing
RTM	Real Time Market
SGAM	Smart Grid Architecture Model
SGH	Smart Grid Hub
S/W	Software
SWOT	Strengths Weaknesses Opportunities Threats
VPC	Value Proposition Canvas
VPP	Virtual Power Plant; IPP stands for Independent Power Plant

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Document History

This deliverable includes an updated version of the initial FLEXGRID Data Management Plan. It also includes the dissemination, communication and exploitation plans of the consortium. Finally, it includes detailed information regarding the ethics/privacy issues addressing thus the EC comments about all the ethics requirements from the Ethics Summary Report (EthSR).

Table 1: Document History Summary

Revision Date	File version	Summary of Changes
27/11/2019	v0.1	Draft ToC circulated within the entire consortium
08/01/2020	v0.2	All partners provided comments for the draft ToC structure
22/01/2020	v0.3	ICCS provides final ToC, templates to be used and writing job delegations per partner agreed with all partners.
21/02/2020	v0.5	1st round of contributions by all partners
25/02/2020	v0.6	ICCS integrates text providing comments to all and SIN & ETRA review
10/03/2020	v0.7	2nd round of contributions by all partners
17/03/2020	v0.8	ICCS integrates updated text from all partners
24/03/2020	v0.9	ETRA reviews the pre-final version of the document
31/03/2020	v1.0	Coordinator (ICCS)addresses review comments, makes final enhancements/changes and submits to ECAS portal

Executive Summary

This report is the 3rd official deliverable of H2020-GA-863876-FLEXGRID project dealing with the market analysis and initial business modelling as well as with the assessment of the required data management, dissemination, communication and exploitation plans of the project. Based on the results from the first 6 months of the project's duration, Deliverable 8.1 (D8.1) elaborates on the architecture design, business-related use cases' analysis and technical specifications work that has already been done. FLEXGRID is a pure research project and its implementation is based on integrating targeted intelligence in already existing S/W toolkits and applications, which have been developed in other successful H2020 projects. The main FLEXGRID objective is to provide proof-of-concept results (up to TRL 5-6) that proposed advanced mathematical models and algorithms can considerably enhance the smart grid's operation and the business of several market stakeholders.

As documented in D2.2 (Month 6), the FLEXGRID S/W architecture is "modular by design" in order for all subsystems (i.e. core Automated Trading Platform - ATP deployed by ETRA, Automated Flexibility Aggregation Toolkit - AFAT deployed by ICCS and UCY, FlexSupplier's Toolkit - FST deployed by UNIZG-FER and Distribution Flexibility Market Clearing Toolkit - FMCT deployed by DTU) to be potentially exploitable as stand-alone commercial products (in the form of S/W "plug-ins") in the future. The technical APIs for the interaction between the various subsystems/modules have been appropriately designed in a way that any possible combinations of FLEXGRID modules to be commercially exploitable in the future (e.g. ATP with AFAT as one single product, ATP with FMCT as another one, ATP with FST and FMCT as another one, etc.). Moreover, each novel service provided by each S/W toolkit can be easily sold individually or together with any other combination of services from other toolkits, too. This strategic decision at the design phase provides the flexibility to the consortium to decide how to prioritize its dissemination, communication and further exploitation activities towards commercialization. Of course, the default choice and ultimate objective of the consortium is to fully integrate all 4 major modules/subsystems into one single FLEXGRID S/W platform in the context of WP6 work.

D8.1 aims at providing a clear roadmap towards achieving the ultimate goal of the project, which is the best possible commercialization of FLEXGRID products and services after the end of project's lifetime as well as the publication of its proof-of-concept scientific results in top-tier publications. There are clear inter-relations between the market analysis/business modelling activities with the respective planning of data management, dissemination, communication and exploitation activities. These inter-relations are extensively described throughout this deliverable, whose scope is thus much larger than a classic ORDP-type deliverable of an EU H2020 project.

The structure of the deliverable is the following:
Chapter 1 includes an analysis of today's markets, to which FLEXGRID aims at offering its innovative products and services. The expected impact points of the new innovations and applications generated by FLEXGRID are also analysed. Furthermore, all the EU legislation about flexibility markets' operation, flexibility services' provisioning and the role of existing and new market stakeholders are described in a sententious manner.

Chapter 2 presents an initial business modelling and a long list of value propositions by using the Business Model Canvas (BMC) tool and the Value Proposition Canvas (VPC) tool correspondingly. Moreover, a SWOT (Strengths – Weaknesses – Opportunities - Threats) analysis takes place for all proposed FLEXGRID innovations.

In chapter 3, the Data Management Plan of the project is described dealing with all the concerns about the treatment of the data involved in the whole project lifecycle and has been structured in compliance with the guidelines and the template conveyed by the European Commission. The main aspects that have been considered in the Data Management Plan (DMP), for each of the data set identified in the project are the following: a) types of data generated, collected or processed, b) standards used to manage data, c) data exploitation methodology, d) accessibility to data produced by the project, e) data dissemination level, and f) data preservation and re-use. Finally, data security and ethics requirements have been thoroughly described.

Chapter 4 includes the FLEXGRID dissemination and communication activities' plan. Eight (8) main categories of related activities have been identified, namely: a) academia-oriented publications and events, b) organization and participation in major international events, c) industry-oriented communication activities, d) open access reports, data and software, e) communication of FLEXGRID products to interested stakeholders, f) training activities and academic dissemination, g), cooperation and mutual dissemination activities with other related EU projects, and h) other general public dissemination actions. It should be noted that general dissemination activities are separated with communication activities in the sense that the latter are closely inter-related with the exploitation activities' plan presented in chapter 5 (e.g. communication with specific customer segment and business stakeholders).

In chapter 5, the FLEXGRID exploitation activities' plan is presented both from "system as a whole" and "per partner" perspectives. For each one of the FLEXGRID's exploitable assets, four (4) subsections are provided stating the asset's: a) description, b) main functionalities, c) innovation aspects, and d) target groups. We consider that each asset can be individually exploited by the partner that develops it. However, the strategy of FLEXGRID is to integrate all 4 exploitable assets into one single FLEXGRID S/W platform in order to maximize its commercial/business impact and offer respective benefits and added value/background knowledge to all partners after the end of project's lifetime.

Finally, chapter 6 concludes the report and summarizes the major action points of the consortium for the upcoming months, while chapter 7 includes Protection of Personal Data (POPD) declarations from involved key partners.

1 Market analysis and expected impact of FLEXGRID's innovations

The main focus of this section is first on conducting an extensive market analysis on key aspects connected with FLEXGRID project, analysing existing knowledge on various market projects and business models related to energy flexibility innovations. Secondly, an EU wide legislation connecting directly or indirectly with FLEXGRID project's scope is discussed, and finally the expected impact of project innovation (discussed also previously in D2.1) is mentioned as well as its contribution to energy ecosystem.

1.1 Survey of energy flexibility market projects and proposed solutions so far

A number of energy flexibility market projects have been proposed to address the high penetration of Renewable Energy Sources (RES) on electric grids providing thus grid operators (i.e. DSOs and TSOs) options to purchase flexibility services from resources like Distributed Generation (DG), Demand Response (DR) and storage in a market-based sequence. Concepts from research projects are being tested in demonstration pilots and flexibility markets are moving towards commercial operation[1]. Thus, it is important to provide a picture of the latest developments in this area, to understand the market, where the FLEXGRID project will bring impact.

FLEXGRID deliverable D2.1 outlines an overview of energy flexibility market proposals and pilots in the EU and explores some of the research areas in some of the more advanced – or pioneering – energy flexibility market projects. The following section builds on this overview to give an updated picture of the latest advancements in energy flexibility market projects, both in research and commercial operation, while exploring specific topics of interest for the FLEXGRID project. These topics include:

i) Latest commercial and research advancement in Distributed-Level Flexibility Markets (DLFMs) at the electrical distribution network level
ii) Planning and integrated optimization of flexibility assets (FlexAssets)
iii) Multi-period robust and scalable OPF algorithms
iv) Advanced interaction among energy sector stakeholders
v) Advanced Business Models (BMs) for modern ESPs
vi) Data commercialization APIs from open/linked applications in ICT sector

1.1.1 Latest commercial and research advancement in distributed-level flexibility markets at the electrical distribution network level

There are currently a multitude of projects, which make attempts to address the challenges posed by increased penetration of RES and electrification at the distribution grid level. Previous deliverable D2.1 has provided an overview of some of the most prominent projects and related design challenges. While all projects have an explicit aim to provide a venue (or else online marketplace), where DSOs can procure flexibility, TSO-DSO coordination schemes are still mostly at trial stage and is more the focus of larger-scale R&I projects.

[1] Radecke, Julia; Hefele, Joseph; Hirth, Lion (2019): Markets for Local Flexibility in Distribution Networks, ZBW – Leibniz Information Centre for Economics, Kiel, Hamburg.

Commercial projects:

The main focus of commercial projects is to provide products and services for handling network congestions at the distribution grid level. To this end, all projects offer either long-term (usually in the form of capacity products) or short-term (either capacity or power) products or a combination of both to DSOs, who act (for the time being) as single buyers[2]. Although some projects, like NODES, plan to propagate flexibility offers to adjacent TSO markets (e.g. balancing), there is currently no market design, which implemented clear rules on TSO-DSO coordination, although basic concepts exist.

Product offerings will also depend on national and EU regulation, while *Art. 32 of the Clean Energy Package (CEP) e-Directive* opens up opportunities for experimentation at national level. However, it remains to be seen whether NRAs will allow DSOs (being regulated natural monopolies) to procure energy in a competitive market landscape. Legislators in Germany are opening up for this possibility by requiring DSOs to manage their own balance group for re-dispatch volumes (mainly used for curtailing RES) and allowing them to procure the necessary balancing energy at the trading venues of NEMOs[3].

An addition to varying approaches regarding products and services, there are also differences with regards to financial settlement offered by the platforms. While Enera, NODES and Piclo will earn revenue from their customers through fees, GOPACS regards itself as an intermediary rather than a market platform with settlement taking place at ETPA's intraday market platform. It needs to be emphasized that all commercial projects are still at very early stages. There is no certainty that Member States will endorse market-based congestion management as the preferred solution. This will, naturally, greatly influence the commercial success of flexibility marketplaces[4].

An alternative business case to offering market-based congestion management could be to offer frequency or voltage related products and/or services to TSOs. Managing constraints in distribution and transmission networks is only one of the many technical scarcities that system operators are confronted with[5]. New markets may offer an alternative solution for procuring new system services, given that providers are able to meet the technical requirements of system operators and that a minimum level of competition can be reached.

R&D projects:

As part of the Horizon 2020 project Interflex, a field-tested ecosystem architecture based on an open market for energy flexibility is presented to enable Distribution System Operators to procure flexibility for congestion management. In this architecture, flexibility can be monetized in multiple ways, for example by trading it on the energy markets or by selling it

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[2] https://www.smarten.eu/wp-content/uploads/2019/09/20190903-smartEn-Flexibility-Markets-Position-Paper-Final.pdf

[3] https://www.bmwi.de/Redaktion/DE/Downloads/Gesetz/gesetz-zur-beschleunigung-des-energieleitungsausbaus.pdf?__blob=publicationFile&v=2

[4] The German Federal Ministry for Economic Affairs and Energy has published a study which dismisses market-based redispatch as proposed by Art. 13 of e-Regulation 2019/943, see https://www.bmwi.de/Redaktion/EN/Publikationen/Studien/future-redispatch-procurement-in-germany.pdf?__blob=publicationFile&v=2

[5] https://eu-sysflex.com/wp-content/uploads/2019/08/D3.1_Final_Submitted.pdf p. 22 ff.

to a DSO for congestion management. Allowing flexibility to be used for multiple purposes results in a higher value which strengthens the, currently quite weak, business case of parties that aggregate flexibility of many energy resources. As a result, the use of flexibility for congestion management is more likely to be commercially feasible, so delaying or deferring grid investments. A key feature of this architecture is that it uses existing (open) standards for communication between the different parties, preventing vendor lock-in and hence allowing an open market for congestion management services. The architecture covers the trading and dispatch of flexibility, as well as settlement[6].

The INTERRFACE project develops an interface between transmission and distribution system operators (TSOs and DSOs) and their customer in order to allow seamless integration and efficient use of renewable energy in the electricity grid. INTERRFACE creates a common architecture that connects market platforms to establish a seamless pan-European electricity exchange linking wholesale and retail markets and allows all electricity market players to trade and procure energy services in a transparent and non-discriminatory way. Another relevant objective is to drive collaboration in the procurement of grid services by TSOs and DSOs, and to create strong incentives to connected customers, by improving market signals and allowing them to procure services based on specific locations and grid conditions.

The purpose of CoordiNet is to establish different collaboration schemes between transmission system operators (TSOs), distribution system operators (DSOs) and consumers to contribute to the development of a smart, secure and more resilient energy system. Special emphasis will be on the analysis and definition of flexibility in the grid at every voltage level ranging from the TSO and DSO domain to consumer participation. The CoordiNet project aims to demonstrate how DSOs and TSOs shall act in a coordinated manner and use the same pool of resources to procure grid services in the most reliable and efficient way through the implementation of large scale "TSO-DSO-Consumer" demonstrations, in cooperation with market participants (and end users).

As part of the INVADE H2020 project, a general description of local flexibility markets as a market-based management mechanism for aggregators is presented. The focus is on the flexibility framework to enable multiple participants to compete for selling or buying flexibility. In this framework, the aggregator acts as a local market operator and supervises flexibility transactions of the local energy community. Local market participation is voluntary. This work presents needed interactions between all local market stakeholders, the corresponding inputs and outputs of local market operation algorithms from participants and a case study to highlight the application of the local flexibility market in three use case scenarios[7].

By providing incentives for all players, EMPOWER exploits the flexibility that the electricity distribution network offers to its users. The project enables the establishment and operation of local energy cooperatives that can manage renewable energy resources and serve community members, while operating in an open, competitive market environment. It puts coordinated prosumers into the centre of future local power market design.

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[6] (https://www.cired-repository.org/bitstream/handle/20.500.12455/664/CIRED%202019%20-%201959.pdf?sequence=1)

[7] https://www.mdpi.com/1996-1073/11/4/822

FLEXGRID aims at developing a novel S/W platform, which will serve as an online marketplace operated by a Flexibility Market Operator (FMO), providing innovative energy services to various intelligent market stakeholders from both the FlexDemand and FlexSupply sides. This platform will be based on S/W prototypes that belong to consortium partners' portfolio such as NODES platform and WISEGRID S/W applications targeted to DSOs (i.e. WG Cockpit), ESPs (i.e. WISECORP) and aggregators (i.e. WISECOOP).

1.1.2 Planning and integrated optimization of flexibility assets

The Flexibility Assets providing flexibility include battery energy storage systems (BESSs), electric vehicles (EV), heat pumps and various other Distributed Energy Resources (DERs) and their coordinated optimisation add a dimension to the challenge, particularly at distribution network level. An efficient planning and integration of FlexAssets can lead to significant reduction in network congestion and increase the profits/cost savings of the various stakeholders in the Distribution Level Flexibility Market (DLFM).

Commercial projects:

On the flexibility supply (FlexSupply) side, all commercial projects are relying on customers that are already active in existing energy markets. Offering location specific flexibility requires new approaches with regards to spatial and temporal portfolio optimization.

Different commercial projects use different mechanisms for planning and integration of flexibility assets. Piclo improves utilization of flexibility assets by creating active competitions during the trial. Piclo planning of flexibility assets includes creating heat map areas of network congestion and the data gathered from the platform can be used to justify investment in specific locations. Based on this, Piclo is able to accelerate the process of matching assets with competitions amongst a high number of flex assets that can propose services on the platform[8].

GOPACS/ETPA uses locational tags that are provided by flexibility providers. There are no static geographical zones defined in ETPA. Instead, GOPACS identifies through its algorithm which assets offer the cheapest solution to solve congestion. Currently now, only flexible assets connected to the transmission grid are active on GOPACS. In the near future, DSO connected assets at lower voltage levels are also expected to participate.

The NODES platform conducts different offers with the same underlying assets for the flexibility providers (Aggregators, ESPs etc.) according to the price signals within geographical zones which are defined by the DSOs. The flexibility providers have FlexContracts with the asset owners in place, and technology that makes it possible to activate the flexibility using the Distributed Flexibility Assets (DFAs) provided usually by end energy prosumers. The flexibility providers can also differentiate their offers depending on the geographical zones they are included in.

[8] https://piclo.energy/publications/Piclo+Flex+-+Flexibility+and+Visibility.pdf

Enera uses locational orderbooks to centralize flexibility offers that can be used by network operators to alleviate congestions[9].

Temporal optimization depends on the chosen market sequence by flexibility marketplaces and their interplay with existing short-term markets like day-ahead, intraday and balancing. Independent aggregators and ESPs without balance responsibility party (BRP) are important potential customers providing DR services. One of the main challenges with these actors (and for marketplaces) is how to handle imbalances incurred through flexibility activations. Some platforms (e.g. GOPACS/ETPA) require their participants to be BRPs, effectively leading to a transfer of energy between counterparties. NODES offer short-term capacity products (i.e. €/MW/h) and an add-on gateway service to the intraday market for balancing BRP portfolios. Both solutions require that transactions are executed and scheduled to TSOs within their notification deadline. This typically restricts transactions from being completed in real-time.

R&D projects:

Two approaches, e.g., integrated approach and market approach, have been developed and trialled in the Interflex project to mobilise different flexibility sources. Within the integrated approach, the DSOs as the flexibility operator or aggregator can directly manage residential and generation assets through different platform, for instance, Smart Grid Hub (SGH) platform and Demand Side Response (DSR) platform. For the market approach, the DSOs can procure flexibility from market stakeholders, e.g., aggregators, consumers, generators, etc. The DSO requests flexibilities' activations through 'commercial' aggregators, who can be contractually linked to one or several 'technical' aggregators which operate several assets with their own platform (optimisation of asset portfolio)[10].

Algorithms using machine learning are also widely deployed in R&D projects to aid in optimizing the flexibility assets, for instance, the ongoing EU horizon 2020 project INTERRFACE. Here, a combination of blockchain and machine learning technologies to activate resources locally an in cross-border collaboration help in flexibility services for system balancing. Additionally, the project uses dynamic pricing to solve congestions and balancing, while optimising the use of interconnectors between the actors of the power system[11].

In the EMPOWER project, a centralized ICT platform uses machine learning to forecast all FlexAssets. The centralised ICT platform considers uncertainties in a more efficient way than with a distributed approach, where it distinguishes flexible and inflexible assets and estimates the status of flexible assets considering physical and contractual constraints. The local flexibility market algorithm is shown in Figure 1[12].

[9] https://www.ewe.com/en/media/press-releases/2018/02/enera-project-ewe-and-epex-spot-to-create-local-market-platform-to-relieve-grid-congestions-ewe-ag

[10] Dumbs, C., Jarry, G., Willems, M., Gross, T., Larsen, A. and Wagner, T., 2019. Market models for local flexibility procurement: InterFlex'experience and main challenges.

[11] http://www.interrface.eu/Demo-Areas

[12] Olivella-Rosell, P., Lloret-Gallego, P., Munné-Collado, Í., Villafafila-Robles, R., Sumper, A., Ottessen, S.Ø., Rajasekharan, J. and Bremdal, B.A., 2018. Local flexibility market design for aggregators providing multiple flexibility services at distribution network level. *Energies*, *11*(4), p.822.

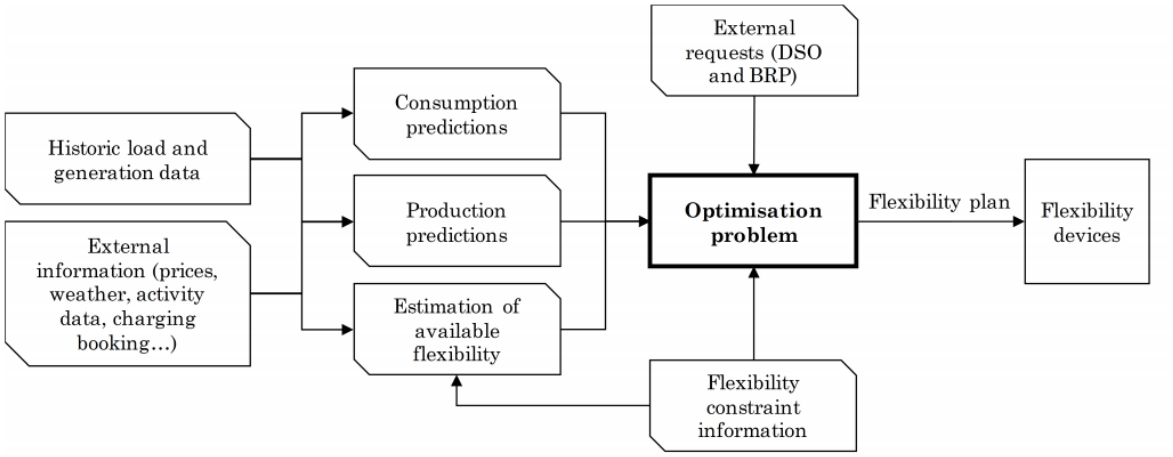

Figure 1: Local flexibility market algorithm of EMPOWER project

Two different interface mechanisms between BRP and DSO: capacity versus control based signals, have been introduced by the EU Horizon 2020 INVADE project[13]. Within the capacity-based signal mechanisms, the DSO and BRP algorithms define their requests based on the risk from the non-flexible assets' performance and the flexibility market operator (FMO) takes the responsibility to control all assets to perform within a certain limit and monitor non-flexible assets aggregately through the integrated INVADE platform.

FLEXGRID will develop advanced mathematical models and algorithms regarding the optimization of various types of heterogeneous FlexAssets and their integrated management in order to provide advanced energy services' planning and operation services to ESPs/aggregators (i.e. FlexSupplier companies).

1.1.3 Multi-period robust and scalable OPF algorithms

To the best of our knowledge, there is no project, apart from FLEXGRID, considering the use of multi-period and scalable OPF, which also takes into account uncertainty. However, ongoing European projects and commercial solutions present some of these characteristics. An overview is provided in the table below.

Table 2: Overview of advanced OPF algorithms in ongoing EU projects and commercial solutions

Name	Type	Model	Description
EUPHEMIA (Only public description available)	European market integration algorithm	Multi-period OPF	Algorithm used for the coupling of European day-ahead markets, maximizing the social welfare for all the periods of a day at once. Clears the market and gives the power flows at the interconnections.
NEPLAN	Electrical networks operation and planning software	Multi-period OPF, Handles networks above 500,000 buses	Software for the operation and planning of electrical networks. They developed many modules among which: Multi-period and N-1 constrained Optimal Power, Day-Ahead Congestion Forecast, other security assessment modules…

[13] INVADE D4.1. Overall INVADE architecture. 2017

plan4res	European project, ongoing	Large-Scale, Uncertainty, Multi-period	Planning tool aiming to increase the share of renewable energy for Europe, taking into account the interconnection with the electricity system and other energy systems. It uses a limited description of the network.
Plexos	Market simulation software	Scalable, Uncertainty, Multi-period, DCOPF	Short to long term modeling that takes into account the integration of renewable energy and storage (stochastic, different technologies, sub-hourly modeling), provides demand forecasts…
Power Factory	Integrated power system analysis software	AC-OPF, Multi-period	Software for the representation of networks and calculation on them. It includes a unit commitment tool for multi-period planning, which can run with AC-OPF.
TDX-ASSIST	European project, ongoing	Uncertainty, AC-OPF	Development of tools and techniques to facilitate communication between TSO and DSO. The project aims to develop a new Sequential Optimal Power Flow (SOPF) used to optimize the provision of reactive power for flexibility in the TSO/DSO interface substations. It should take into account the uncertainty of renewables generation.

FLEXGRID will develop advanced market clearing models and algorithms for the proposed Distribution-Level Flexibility Markets (DLFM). Sophisticated AC-OPF models will be developed, which aim at producing effective market signals to FlexSuppliers about the exact locations and timeframes, in which a local congestion and/or voltage control problem occurs.

1.1.4 Advanced interaction among energy sector stakeholders

The flexibility market allows the trading of flexibility supplied by both producing and consuming units at the distribution network level. This means that more energy sector stakeholders, e.g. DSOs, aggregators, prosumer, consumer and distributed energy resources (DER) owners, participate in the flexibility market to compete for selling or buying flexibility. Therefore, efficient frameworks defining the interactions among these stakeholders will be one of the key drivers for improving the efficiency of flexibility market.

Commercial projects:

As mentioned in previous D2.1, flexibility market operators (FMOs) aim at providing open, transparent and cost-effective marketplaces to handle flexibility transactions. With the digitalization technology development, Piclo and Enera are enabling new communication connections to be made between actors who request or can offer flexibility. For instance, Piclo is described as an independent marketplace for buying and selling smart grid flexibility services. Piclo Flex enables access for all types of DSO[14] tenders on a single platform. Thereby, it enables streamlined procurement, dispatch and settlement. In the Enera platform, the flexibility provider and the network operators can continuously submit their order. The

[14] Six DSOs are Piclo members: UK Power Networks (UKPN), Scottish and Southern Electricity Networks, Electricity North West Limited, Northern Powergrid, SP Networks and Western Power Distribution

market parties (BRPs) can use the same API that they use to trade in the energy market to access the Enera platform and interact with other stakeholders involved.

NODES, as an FMO plans to build Europe's most customer-centric, integrated energy marketplace to unlock the value of local flexible power resources and support different energy stakeholders in efficient market operation. The flexibility buyers (FlexBuyers), e.g., DSOs, TSOs, and BRP interact with the NODES platform to pay for activation for flexibility at 'grid locations' defined by the DSOs and submit orders to NODES via an API. Flexibility suppliers - FlexSuppliers act on behalf of the owners of the DFAs and feed these offers directly into NODES via another API, while prosumers have an indirect interaction with the FMO and other stakeholders. Different interactions of stakeholders involved in NODES platform is depicted below in the Figure 2.

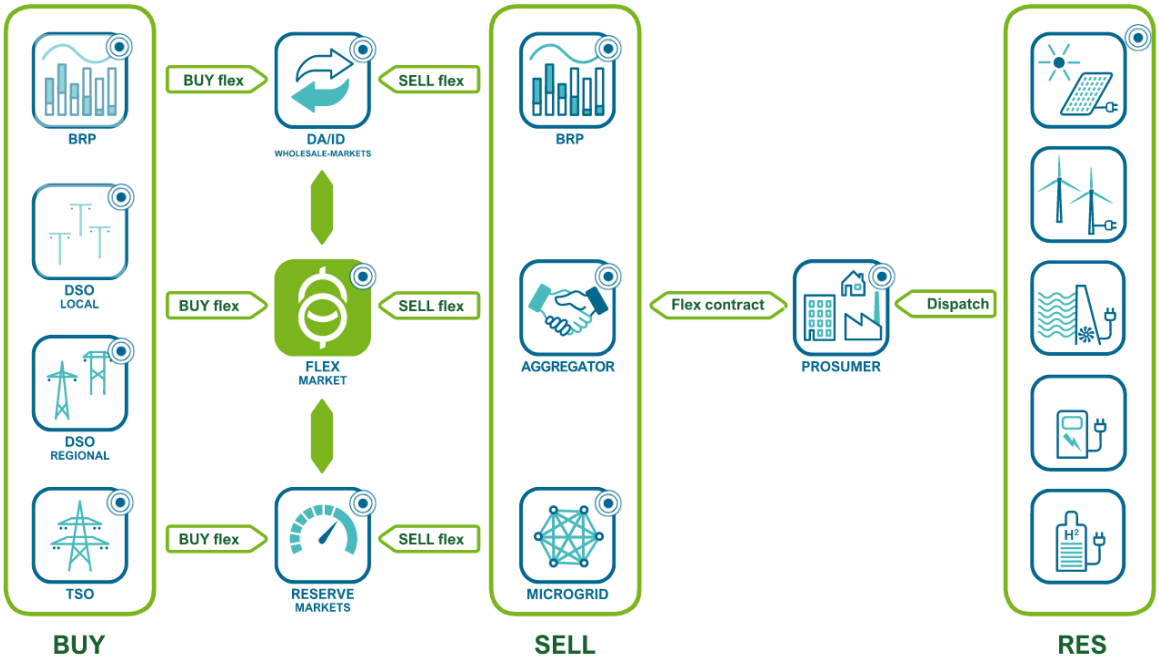

Figure 2: Interaction of various stakeholders in NODES model (taken from[15])

GOPACS uses orders on existing electricity market platforms e.g. through the intraday market platform ETPA. Here, network operators and BRPs compete to procure the same flexibility. Moreover, independent aggregators are expected to become increasingly important in the coming years. Market designs at both regional and European level have already considered the aggregators as an important facilitator of system flexibility.

Next Kraftwerke is one of the biggest German virtual power plant (VPP) operators joining biogas, biomass, CHP, wind and PV plants. They act as an aggregator which can also take the role of BRP and flexibility supplier, as well as being an independent aggregator which doesn't take any additional roles[16].

[15] https://nodesmarket.com/market-design/

[16] De Clercq, S., Schwabeneder, D., Corinaldesi, C., Bertetti, O. and Woyte, A., How to Create Value through Aggregation: A Business Model Review for Multiple Regulatory Environments in Europe.

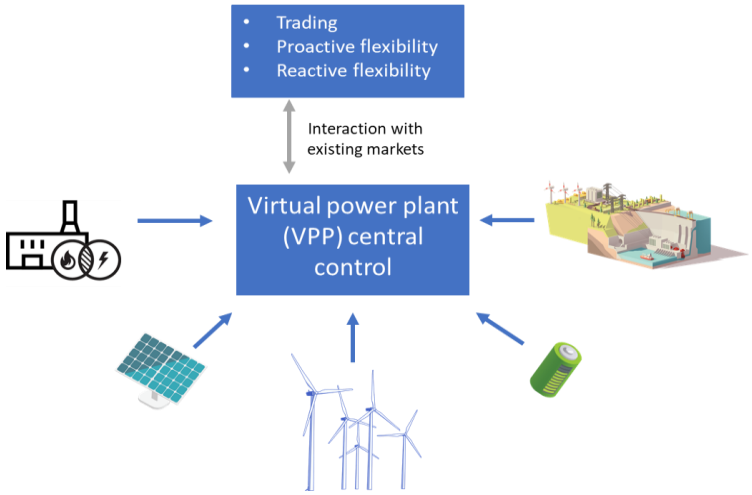

Figure 3: Interaction of independent aggregators/ESP model

R&D projects:

DSOs have an important role in the market to provide connection to end customers. Projects in R&D are exploring new services and purposes for these stakeholders in the changing electricity domain. For example, the INTERFLEX project investigates the interactions between stakeholders with different technical and economic capabilities to provide flexibility through leveraging assets to relieve grid constraints. Both the Dutch and French demonstration pilots in the project test advanced interactions between DSOs and aggregators to provide grid support, as shown in the following figure.

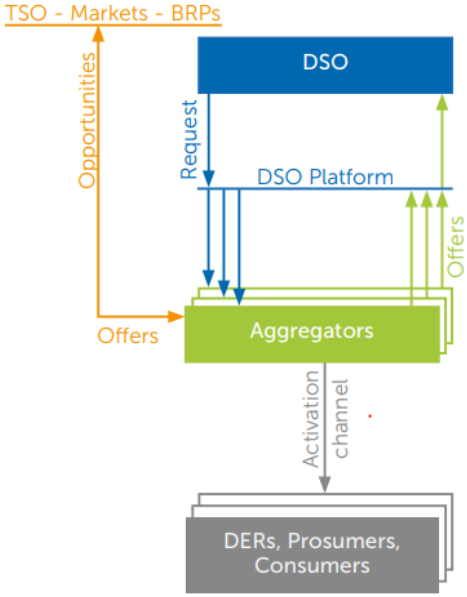

Figure 4: Interactions among different energy sector stakeholders based on INTERFLEX project's concept (from [17])

Here, DSOs sends activation requests which are matched by aggregator bids who can activate specific assets from flexibility providers. The DSO platform can then match DSOs with aggregators who can provide the expected flexibility service at the minimum cost. The DSO's

[17] https://interflex-h2020.com/results-and-achievements/local-flexibility-markets

formulation of flexibility requests, the bidding process as well as the flexibility activation process are channelled through both DSO and aggregator platforms and the corresponding interfaces[18].

In the INVADE project, the Integrated Invade Platform (IIP) provides a unique interaction model for multiple stakeholders in the flexibility domain. This is leveraged by the Flexibility Operator (FO) – a role proposed by the project which designates an actor which can leverage flexibility from different assets for the benefit of multiple actors, such as grid operators, BRPs and prosumers. In the FLEXGRID context, this is a blend of aggregator and ESP, which can also create and manage contracts between flexibility providers and flexibility buyers in an integrated manner, as opposed to the market approach proposed by FLEXGRID. The activation of DFAs is done by first receiving the flexibility requests from DSOs and BRPs through the INVADE platform. The interaction model of key stakeholders involved in INVADE flexibility platform is shown in Figure 5.

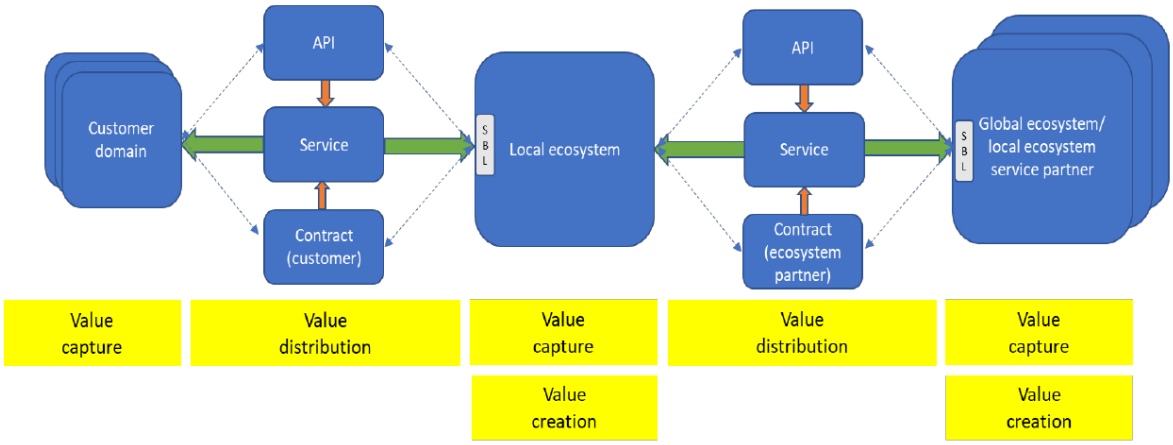

Figure 5: Interaction of key stakeholders for INVADE model (taken from [19])

The EU H2020 EMPOWER project defines the Smart Energy Service Provider (SESP), a stakeholder who acts as a key facilitator for realizing the local trade. The SESP term is comparable to the ESP in the FLEXGRID context and can act as an aggregator and a retailer. The consolidated and integrated ICT system is designed for ESP to support multiple tasks and interactions between stakeholders that want to assure attractive energy services and economical gains. Table 3 lists the interactions among ESP and the other stakeholders.

Table 3: Advanced interactions among ESP and other stakeholders in the EMPOWER H2020 project

Stakeholders	Interactions	Benefits
Generator	ESP offer a set of community benefits	Long term bilateral contract between generators and
	ESP allows generators to have access to the local market	

[18] https://interflex-h2020.com/wp-content/uploads/2019/11/Interflex-Summary-report-2017-2019.pdf
[19] https://h2020invade.eu/wp-content/uploads/2017/05/D9.4-Set-of-INVADE-business-models-including-classification-framework-simplified-.pdf

	ESP offers different services, e.., forecasting services, flexibility services, problem solving services, metering and accounting	aggregator or any other local consumer
Consumers and Prosumers	ESP provides incentives to formalize and systemize the use of latent flexibility for broader application	More profits for customers
	ESP offers contracts (demand is adjusted according to the needs of the local suppliers)	
DSOs	Curtailment of morning and evening peak loads	Outsource the load reduction and load shedding task
	Load control during highly unexpected situations	
	Feed-in control	
	Voltage control	
Other Service Providers	ESP offers contracts including energy efficiency, storage and financial services, online diagnosis and maintenance of PV	More the other service providers to participate in the flexibility market Long term engagement

FLEXGRID will research on novel energy/flexibility market architectures and emphasize on the trade-off among: i) social welfare related KPIs, ii) the level of compatibility of the proposed architecture with the existing energy networks' and markets' operation, and iii) the efficiency of various energy sector stakeholders' participation in the proposed DLFMs.

1.1.5 Advanced Business Models for modern ESPs

Energy Service Provider (ESP) is usually a profit-oriented company involved on various levels in an energy market. One of the key aspects of an ESP is to interact with the wholesale market and the retail market. Moreover, many ESPs are now also looking to interacting with new trading mechanisms such as flexibility markets. The complete definition used in FLEXGRID project is highlighted in D2.1, also highlighting the role of ESP as aggregators. D2.1 refers to many existing business models for ESP actor, ranging from energy consumption behaviours to implicit flexibility (price based) and explicit flexibility (incentive based).

Commercial Projects:

Many ESPs are currently using various business models; both flexibility and non-flexibility based. A recent study including 160 electric utilities and new contenders by Capgemini[20] discusses the trends of new business models for energy services in different regions of the world. Study highlights the two major trends of Energy as a service and Comfort as a service, serving commercial, industrial and residential consumers. Around 36% of companies in the study have already incorporated Flexibility as a service in their business models and another 40% are expected to include it within the next 2 years. By incorporating flexibility as a service, many utilities are opening doors to new business cases related to grid stability, congestion support, peak shaving and other aspects of energy sector. Key observations are on green energy becoming a differentiable aspect with customers of different utilities, resulting in increase of Power Purchase Agreements (PPAs) by many utilities to increase green energy services for their end consumers. Green energy becoming a modern trend in the energy service industry, resulting in new business models for ESPs and many evolving into a role of

[20] https://www.capgemini.com/wp-content/uploads/2018/08/IDC-Utilities-New-Business-Models-2018.pdf

RESPs. Many new RESPs have appeared in Europe, with focus on business models based on Independent Power Plants (IPPs). Voltalia, a French company now operating in many regions in the world, focused on creating IPPs in different geographical locations. With an IPP created, the company has multiple possibilities to generate revenues either from PPA based schemes, flexible generation or using microgrid-based business models, ensuring a 100% clean energy source to their end consumers.

End energy Prosumers are now becoming a central focus in the Clean Energy Package (CEP), resulting in many new business models appearing in the traditional value chain of energy industry. Many new commercial entities are bringing innovation to services for end-consumers, Energy Storage Systems (ESS) is one of the unique technologies enabling unique services using modern ICT infrastructures. Sonnen, a German company has developed an innovative business model using ESS for communities. Allowing residents to use a battery storage system at their house coupled with Solar PV system and substitute their energy bills in exchange for community membership fee. On the other hand, Sonnen uses the flexibility offered by these storage units from many different consumers and offer this flexibility as ancillary services to the grid. Prosumers are also in more centric stage with more flexible ecosystem-based business models, such as provided by Tibber, a Norwegian company. The ecosystem provided by Tibber is in three categories of smart home services, smart energy services and EV-charging services. The possibilities for other flexibility service providers to connect with system of Tibber, open doors for innovative business models for Demand Side Management (DSM) using multiple DERs. As mentioned in D2.1, many aggregation solutions for providing flexibility are focused on commercial and industry-based aggregation sources and less on the low-voltage (LV) network. Some companies like Thermovault from Belgium, have developed business model to provide flexibility using heating loads of end-consumers connected on LV network. More aggregation solutions are available for MV and HV network assets, a very popular model utilized for aggregation is using Virtual Power Plants (VPP) by Next Kraftwerke in Europe, aggregating DFA's and selling the flexibility as an ancillary service for the grid. However, there are still challenges for ESPs to generate profits in different geographical markets around Europe, with main challenges on OPEX, CAPEX and energy market participation.

R&D projects:

ESPs exploring new business models are involved in various pilot projects, such as in the INVADE project, where Smartly, a subsidiary of Norwegian energy producer Lyse Energi, is exploring new business model opportunities in addition to delivering energy services to prosumers an ESP part of the project. In this case, Smartly does not have a business model that is focused on flexibility trading, where its core business is managing energy needs of prosumers through integration of home IoT units. However, it offers flexibility services as an additional revenue stream to its customers and looks secures control of flexible assets through contracts with its customers. It can then use aggregated capacity to participate in upstream flexibility services to actors like DSO and BRPs.[21]

FLEXGRID tools developed in WP4 will particularly help business models of different types of ESPs mentioned above. Advanced Market Forecasting Algorithms will help ESPs to participate

[21] https://h2020invade.eu/wp-content/uploads/2017/05/D9.4-Set-of-INVADE-business-models-including-classification-framework-simplified-.pdf

in multiple markets and increase their profits accordingly, while still providing value addition services to end-consumer. Task 4.2 will take into account the various types of commercial business models used by different entities mentioned above and develop revenue models from multiple markets and co-optimize the ESS & DSM assets giving additional service structure to different companies working either on ESS or DSM sources. Innovative tools will help bringing stakeholders perspective for market pricing also considering needs of the network, which is currently not utilized by many ESP mentioned above. In addition, a particular focus in Task 4.2 will be on providing risk reduction strategies for RESP's, providing optimal sizing and scheduling of ESS and interaction with RES production.

Table 4: Summary of advanced business models of ESP

Business model	Key aspects	Commercial projects
RESP's business models	PPA based schemes, Balancing flexibility and micro-grid bases models	Voltalia
Prosumer focused models	Energy Storage Systems (ESS)	Sonnen
Flexible eco-system models	Demand Side Management (DSM)	Tibber
LV aggregation models	Distributed Flexible Assets (DFA)	Thermovault
HV & MV level aggregation models	Distributed Flexible Assets (DFA) and Energy Storage systems (ESS)	Next-kraftwerke

FLEXGRID will develop advanced mathematical models and algorithms for FlexSupplier companies, which want to optimize their FlexAssets' operation and planning (i.e. both CAPEX and OPEX techno-economic analysis and business modeling).

1.1.6 Data commercialization APIs from open/linked applications in ICT

Over the past few years, Application Programming Interfaces (APIs) have recast how B2B and B2C companies are sharing information and reaching new customers. Increasingly, a company's APIs represent a business development tool and a new go-to-market channel that can generate advantages and revenues from referrals and usage fees. The concept of web APIs' development for companies is emerging as the important component to merge the old and new IT platforms and to capture and store a vast amount of data.

The strategic importance of APIs is demonstrated with the revenues achieved by the main actors of the API market counted for increasingly growing revenues[22] . As a key building block for S/W applications, APIs have been instrumental in supporting new companies and products. Companies that have moved aggressively to embrace APIs have profited strongly[23]. In addition, this tendency has been reinforced by policy makers. Different public administrations worldwide have made concrete moves to promote APIs, (i.e. Open Data

[22] Open API (Application Programming Interface) Market: Global Industry Analysis 2012 – 2016 and Opportunity Assessment; 2017 – 2027

[23] APIs: Three steps to unlock the data economy's most promising new go-to-market channel - https://www.mckinsey.com/business-functions/marketing-and-sales/our-insights/apis-three-steps-to-unlock-the-data-economy039s-most-promising-new-go-to-market-channel

Executive Order[24] requiring government agencies to make their data available in open, machine-readable APIs).

Digital transformation of the energy sector is focused on improving processes that ease better management of energy generation and consumption, and this is especially crucial in the new energy markets with higher levels of uncertainty. The advent of the cloud, social networks technology, big data and analytics, and APIs-everywhere concept are driving a number of technology trends that have immense potential for the energy industry. Energy data (quantities, power, location of consumption, share of renewable energies, etc.) enables an energy stakeholder to build personalized services adapted to customer expectations.

Data commercialization APIs are used to accelerate deployment and monitoring of distributed energy resources and energy efficiency technologies. Currently, APIs are widely used in the energy industry to monitor and control a wide range of assets, S/W applications and infrastructures, data sources, etc. For electric utilities and utility vendors, seamless data access and behind the meter insights through safe, secure, and standardized data exchange platforms is also widely used, an instance of such a product is UtilityApi[25]. Moreover, regulators and local governments use them to shape effective utility data access policies. Data commercialization APIs bring value to all sides of the energy economy through easy-to-use, standardized energy data exchanges.

FLEXGRID will contribute to such a purpose by developing a S/W architecture that is based on the usage of web APIs for the interconnection between the various subsystems/modules. More technical details about the FLEXGRID S/W architecture are extensively provided in Deliverable 2.2. In a nutshell, sophisticated APIs will facilitate the high modularity, openness, multi-sidedness, configurability, replicability and extensibility of FLEXGRID's services. In this line, FLEXGRID S/W will follow a modular-by-design concept, meaning that there will be well-designed technical APIs allowing data interaction between the different tools attending project stakeholders. This modularly will trigger an inherent capability to modify, adapt or develop new software tools to better coordinate the role of the different stakeholders in the energy market. A flexible data modeling framework, which allows for a common data format for coordinated network balancing, while enabling data extensions critical for each business will also be implemented.

FLEXGRID will develop a modular-by-design S/W architecture as well as sophisticated web Application Programming Interfaces (APIs) for all S/W modules to interact with each other. Three S/W modules will integrate all research algorithms and models, namely: i) Automated Flexibility Aggregation Toolkit (AFAT), ii) FlexSuppliers' Toolkit (FST), and iii) Flexibility Market Clearing Toolkit (FMCT).

[24] https://www.data.gov/developers/open-data-executive-order/
[25] https://utilityapi.com/

1.2 EU legislation about flexibility markets' operation, flexibility services' provisioning and the role of existing and new market stakeholders

1.2.1 The European Commission's communication on "Clean Energy for all Europeans"[26]

The "Clean Energy for all Europeans" package describes amongst other subjects the creation of a new European entity as representative of DSOs entitled to define rules on grid management and EU-level cooperation with TSO. Thereby, this new entity will promote the integration of renewables, distributed generation, storage, demand response, and smart meters.

The Third Energy Package[27] established by ENTSO-E sets precise rules for participation in the transmission system. Therefore, this new entity on distribution grids will contribute to better operations of local energy systems and enable an indirect participation of end-customers.

1.2.2 Flexibility Procurement and TSO/DSO Data Exchange

More precisely, in Art. 32 of the e-Directive[28] of the CEP[29] , it is described that DSOs shall procure flexibility services in accordance with transparent, non-discriminatory and market-based procedures unless the regulatory authorities have established that the procurement of such services is not economically efficient or that such procurement would lead to severe market distortions or to higher congestion.

In addition, to ensure cost-efficient, secure and reliable network planning and operation, the e-Regulation 2019/343 [30] (Art. 57) foresees the exchange of all necessary data and information between TSOs and DSOs as well as the coordinated use of demand-side flexibility.

1.2.3 TSO/DSO Curtailment of Renewable Generation

The e-Regulation refers to different aspects of the electricity network, including curtailing of renewable generation, network tariffs and also other aspects related to flexibility mechanism. Art. 13 (5.a) of the e-Regulation, states that distribution and transmission system operators are allowed to curtail renewable generation, which is directly connected to their network if they are able to demonstrate in a transparent way that doing so is more economically efficient. Moreover, the curtailed volume shall not exceed 5 % of the annual generated electricity in the installations, which use renewable energy sources, unless otherwise specified.

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[26] European Commission. (2016, November 30). Clean Energy For All Europeans. Brussels; Online: http://eur-lex.europa.eu/resource.html?uri=cellar:fa6ea15b-b7b0-11e6-9e3c-01aa75ed71a1.0001.02/DOC_1&format=PDF

[27] https://ec.europa.eu/energy/topics/markets-and-consumers/market-legislation/third-energy-package_en

[28] DIRECTIVE 2019/944, Online : https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019L0944&from=EN

[29] European Commission. (November 30, 2016). Clean Energy For All Europeans. Brussels; Online: http://eur-lex.europa.eu/resource.html?uri=cellar:fa6ea15b-b7b0-11e6-9e3c-01aa75ed71a1.0001.02/DOC_1&format=PDF

[30] REGULATION 2019/943, Online: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R0943&from=EN

Finally, another relevant article to flexibility mechanisms is Art. 18 of the e-Regulation, in which principles for network tariff design are described in more detail. Distribution network tariffs and access charges shall be cost-reflective and non-discriminatory. Also, the use of market-based flexibility mechanisms as described in Art. 32 of the e-Directive 2019/944 in the CEP can be experimented at a national level.

It will take time until the different Member States transpose the articles of the e-Regulation into their national legislation; subject to their design and implementation, flexibility mechanisms touch upon three network code areas as described in the e-Regulation. As the activation of flexible resources influences both grid operation and balancing of the system, coordination through well-designed data exchange processes between TSOs and DSOs are important to avoid system disturbances. Note that where the use of flexibility implies data exchange between system operators, additional network code areas than the ones described in the directives therein can be considered important.

1.2.4 Prices for Residential and Non-Residential Customers

The Regulation (EU) 2016/1952[31] facilitates European statistics on natural gas and electricity prices for residential and non-residential customers. Such statistics are required to compare prices for drafting energy union policy and monitor energy markets in the Member States. Furthermore, these datasets shall increase transparency and therefore competition as it allows for customers to assess their energy bills in a broad context. Annex I and II of this regulation describe in detail the methodologies for collection and compilation of data on natural gas and electricity prices for household and non-household customers. Customers are grouped into different consumption bands. According to these annexes, prices have to display generation costs, network costs, taxes and other expenses. In addition, the obtained consumption volumes have to be reported. Similarly to Regulation 543/2013[32], Regulation 2016/1952 therefore improves transparency on a large scale. Extending these regulations or parts of these regulations towards local energy markets could tremendously improve transparency on a local scale and help establishing functioning local markets. None of those regulations, however, addresses issues directly related to local energy markets and/or distribution level flexibility markets (DLFM) at the moment.

1.2.5 Data in Electricity markets

The Regulation (EU) 543/2013[33] was implemented by the 1st of January 2015 and targets especially the submission and publication of data in electricity markets. The disclosure obligations apply to data relating to generation, transportation and consumption of electricity.

[31] Regulation 2016/1952 on European statistics on natural gas and electricity prices and repealing Directive 2008/92/EC, Online: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R1952&from=EN
[32] REGULATION (EU) No 543/2013 on submission and publication of data in electricity markets and amending Annex I to Regulation (EC) No 714/2009 of the European Parliament and of the Council; Online: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0543&from=EN
[33] Online: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0543&from=EN

Regulation 543/2013 specifies the entity subject under disclosure obligation as "the primary owner of the data" which is defined as "entity which creates the data". The nature of the data specifies the primary owner as follows:

- In most cases, the TSOs are regarded as primary owners of the data.
- Generation units and DSO must provide information on the total load and information required to calculate the year-ahead forecast margin for each bidding zone.
- Generation and production units must provide information on:
    - actual generation
    - unavailability
    - forecast of generation
- Cross-zonal capacity information must be provided by power exchanges and transmission capacity allocators.

The above-specified information is submitted to the TSO or to a central information transparency platform. The data must subsequently be delivered to ENTSO-E with sufficient time, so that it can meet its obligations.

FLEXGRID consortium must assess whether user-friendly methods to automatically meet reporting obligations should be integrated into the ATP. Moreover, the consortium should assess the kind of information needed to be transmitted to ENTSO-E and the frequency of the information for transfer.

1.2.6 Market Surveillance of Products

The Regulation (EC) 765/2008[34] provides a framework for market surveillance of products to ensure that those products fulfil requirements providing a high level of protection of public interests. In article 19 is written that Market surveillance authorities shall respond appropriately to alert users within their territories within an adequate timeframe of hazards they have identified relating to any product to reduce risk of injury or other damage. In the case of DLFM, injury can be unappropriated usage of data of the customer. The market surveillance authority is the authority of a Member State responsible for carrying out market surveillance on its territory. Therefore, from perspective of customer we need to have a party for dealing with the customer's privacy and security.

The FLEXGRID consortium will have to analyse in cooperation with the National market surveillance bodies to which extent their authorization of the ATP is required.

1.3 Expected impact of FLEXGRID's innovations

FLEXGRID innovation is designed to provide support activities of multiple actors in the energy sector working on flexibility solutions. Many of the actors defined in D2.1, will use the innovative tools developed by FLEXGRID project in different capacities and in this section, we first look at how the different actors present in Europe's energy ecosystem will benefit from these tools and how it will create a significant impact in future energy markets.

[34] Regulation (EC) No 765/2008 setting out the requirements for accreditation and market surveillance relating to the marketing of products and repealing Regulation (EEC) No 339/93. Online: http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:218:0030:0047:en:PDF

Flexibility Market Operators (FMO) are continuously designing new methods and solutions to support the activities of grid operations. FLEXGRID high level use-case (HLUC_01) described in detail in section 4 of D2.1, highlights the contribution to FMO's business in European Union by developing advanced clearing models for the FMO's efficient operation. The FMO is responsible for the operation of the proposed Distribution Level Flexibility Market (DLFM). The aim of the DLFM is to fill a gap in the current wholesale electricity market design. FLEXGRID will develop services that address these issues and offer them, via its ATP, to the newly established role of FMO. The aim is to provide grid-aware services for use case scenarios (UCS) that are currently not being addressed through market-based mechanisms. The ATP can thus be seen as an enabler for Art. 32 of the e-Directive. The ultimate goal is to align market outcomes with technical restrictions of the electricity grid in the most efficient way. By increasing the overall market efficiency, FLEXGRID aims at creating significant impact in the modern flexibility market system, which in turn contributes to the overall energy sector of the EU.

Energy Service Providers (ESPs) and RESPs need to plan and operate efficiently their FlexServices according to the context they operate in (e.g. location, dynamic state of the grid, dynamic need for FlexServices). HLUC_02 described in detail in D2.1, highlights the FLEXGRID contribution to the overall ESPs and RESPs services and business in EU. FLEXGRID marketplace operates in a transparent manner. ESPs can use FlexPrice forecasting algorithms to implicitly infer the need of flexibility per geographical area and foster the robust competition among market stakeholders in order to optimally plan and schedule their FlexAssets in both long- and short-time horizons. This transparent market operation helps in creating additional impact in the society by encouraging citizens to become prosumers and contribute to the energy transition goals. In addition, many utility companies are transforming into modern ESPs and are offering schemes for storage deployment for their end-consumers and some are using incentive-based schemes for their end-customers. Many ESPs are investing in centralized ESS. However, when these are used only for flexibility trading, profitable business cases are a challenge, and it is important to use stackable revenues by combining services from different markets and time scales. Via FLEXGRID's advanced modelling tools and algorithms, an ESP can robustly and optimally plan and schedule its FlexAssets by participating in multiple energy markets. FLEXGRID will highly increase the knowledge on how to design novel pricing models in a way that RES/ESS/DSM-DR investments are promoted to take advantage of the new market structures and business models.

System/Grid Operators (DSOs & TSOs) face a significant challenge with the interaction of more DERs in the electricity grid. The intermittency of RES creates significant challenges for the DSOs in terms of voltage regulations, congestion management and peak power. Similarly, TSOs face challenges related with the balancing of the grid and ensuring frequency regulation for an efficient system's operation. All the different challenges create significant burden for the grid operators to manage their CAPEX and OPEX costs. Advanced modelling tools for variable RES forecasting are required in order to better qualify and quantify associated issues and remedies regarding important processes for both the power system's and energy markets' operation. FLEXGRID modelling focuses on the prediction of electricity production and its interaction with the prediction of the market prices, contributing thus to efficient utilization of variable RES in order to facilitate very high RES penetration scenarios and

supporting over/under-voltage problems (or reverse power flow problems) for distribution grid. FLEXGRID's aggregated flexibility solutions will contribute to coordinated voltage/reactive power control and frequency control for TSOs. FLEXGRID ATP also contributes to cost-effectiveness for TSOs and DSOs by providing tools that enable cost-effective decision making for flexibility services. For example, this is done by giving DSOs the tools to select an optimal trade-off solution between a Business-As-Usual (BAU) way of investment on new CAPEX for network reinforcement or opt for purchasing flexibility from flexibility providers (i.e. optimal trade-off between DSO's CAPEX and OPEX). Moreover, FLEXGRID will contribute to safe and most economical operation of the electricity system in EU by studying various schemes of TSO-DSO coordination. Finally, co-optimizing the investments in flexibility assets between system operators and profit-based ESPs to minimize the overall network upgrade costs and contribute to a cost-efficient EU electricity network will also be investigated.

Interaction between **independent aggregators and end energy prosumers** is very important in modern flexibility aggregation schemes. With a significant increase of the prosumers on distribution level, there are still few opportunities for many prosumers to connect into the energy market and gain economic benefits on their DER investments. FLEXGRID's automated flexibility aggregation is modelled as a novel ad-hoc energy market development and management as a service to be offered to independent aggregators and/or ESPs. It deals with the B2C interaction between an independent aggregator or ESP entity and its business portfolio, which comprises of a large amount of end energy prosumers together with their FlexUnits (i.e. DSM, RES and storage flexibility assets). By providing an enhanced B2C interaction, FLEXGRID will contribute to various economic benefits for end energy prosumers, promoting the vision of EU Clean Energy Package for the energy transition. As mentioned in HLUC_04 in D2.1, automated aggregation of flexibilities is central in the objectives of FLEXGRID targeting the optimal use of available flexibilities from end users for providing a stack of services for maximising benefits. In principle, traders of flexibility can be private companies, energy cooperatives, or public organizations that buy energy from the wholesale market, but they also have their own end user portfolio, thus exploiting to the maximum the demand side flexibilities. The purpose of this HLUC is to create an ad-hoc flexibility market to aggregate Distributed Flexibility Assets (DFAs) in the most efficient way. Through efficient exploitation of the above possibilities, the DFA owners will be able to achieve reduction in their electricity bill e.g. in contexts with time-of-use and capacity-based tariffs. So, the ESP/aggregator will optimally schedule the energy consumption of all DFA owners trying to both maximize the ESP profits and end users' welfare.

For other energy stakeholders, FLEXGRID's expected impacts contributes particularly to the marketplace and intelligent business ecosystem design mentioned in D2.1. This is done by bringing unique innovation to multiple stakeholders involved in the energy sector. FLEXGRID ATP (mentioned in detail in D2.1 and D2.2) facilitates the automated, online and optimal trading of FlexAssets, enabling business models for energy market stakeholders at both FlexSupply and FlexDemand sides. FLEXGRID ATP's interoperability will enable further efficiency in the flexibility markets and will contribute towards a more robust European Energy market. Moreover, through FLEXGRID's innovative market architecture (advanced mathematical modelling and research algorithms), it also facilitates innovative Energy Services (ESs) that highly enhance the management efficiency of the various market

stakeholders' internal business portfolios.

A detail analysis of various use-cases is conducted in the D2.1. With reference to the High-level use-cases (HLUC) mentioned in D2.1, the following table summarizes an additional contribution of various use cases to the expected impact listed above, including the FLEXGRID innovation involved in generating the relevant impact.

Table 5: FLEXGRID HLUC contribution to expected impacts

High level use-case	Contribution to expected impacts	FLEXGRID Innovation
HLUC_01: FLEXGRID ATP offers advanced market clearing services to the Flexibility Market Operator (interaction between markets' and networks' operation)	Provide additional tool for FMO's to solve challenges for DSO and TSO and create an eco-system for other actors defined in D2.1 for creating business solutions and services for flexibility operations of energy market. Current flexibility market clearing algorithms do not account for the coupled/joint operation of markets and smart grids. FLEXGRID will develop advanced models to take into consideration both liberalized market operation and smart grid operation.	• Advanced market clearing models for DLFMs • Market-based congestion and voltage management at DSO level • Optimal FlexServices' provisioning • API integration of toolkits with FLEXGRID ATP • API for FLEXGRID ATP's interaction with existing markets
HLUC_02: FLEXGRID ATP offers advanced flexibility supply management services to Energy Service Providers (ESPs)	FLEXGRID provides advanced tool for improving services of ESPs, providing additional benefits to prosumers connected with different ESPs and providing ESPs with competitive edge in flexibility markets. Existing flexibility platforms deal with FlexAssets/Services' trading at a local level, where there are no major scalability problems. FLEXGRID will enhance the mathematical models and algorithms and extend them to more business cases at a regional/national/cross-border level. As a result, current platforms functionality and scale will be boosted through FLEXGRID's proof-of-concept results.	• Optimal FlexOffer models • Optimal FlexAsset planning models and algorithms • Optimal FlexAsset scheduling models and algorithms • Optimal FlexServices' provisioning to end users
HLUC_03: FLEXGRID ATP offers advanced flexibility demand management services to system operators	The main innovation lies in the fact that FLEXGRID will enable system operators to dynamically calculate the cost of flexibility procurement and purchase this flexibility through an innovative marketplace in a more cost-effective way. A techno-economic analysis will also take place in order for system operators to decide on the best mix of CAPEX (i.e. investing on network reinforcement) and OPEX (i.e. purchasing FlexServices from various flexibility markets).	• Market-aware upgrade planning • Optimal investment planning (i.e. optimal trade-off between CAPEX and OPEX in the long-term) • Advanced market clearing algorithms • Frequency/voltage control services' provisioning via market mechanisms
HLUC-04: FLEXGRID ATP offers	Aggregating and efficiently operating Distributed FlexAssets (DFAs) will include	• Automated flexibility aggregation management

automated flexibility aggregation management services to ESPs/aggregators (interaction with end users)	bidding protocols for market participants and market rules, that will enhance working of ESPs/aggregators in flexibility markets. Moreover, aggregators will be able to interact effectively with end users and apart from them, these models will enable aggregators to exploit their assets in order to provide better energy services. Decentralized optimization models will enable real-time market analysis and forecasting. For the proposed retail flexibility market, a pricing mechanism will be designed that will combine many attractive benefits for different stakeholders to utilize the platform efficiently.	services • Advanced retail flexibility market services • Automated composition of B2C real-time flexibility markets • Forecasters of RES generation, consumption and battery state of charge • Advanced Market Forecasting Algorithms able to exploit historical data from various markets.

2 Initial Business Modeling and long-list of value propositions

The objective of the business modeling activities in FLEXGRID WP8 is to derive a set of business models, business cases and plan to support sustainable uptake of the FLEXGRID solutions in eventual commercial operation. For this to happen, commercial exploitation of the FLEXGRID platform and individual components is foreseen, upon which additional commercial features can be developed.

The process that is used to develop the above mentioned objectives is inspired by the lean startup methodology principles. This methodology was designed as a scientific approach targeted at startups in order for them to quickly and efficiently develop products that fit customer requirements and expectations for rapid market uptake. While the FLEXGRID innovations are not directly in the intentions of the Lean Startup Methodology, its principles can be adapted to the process used in FLEXGRID.

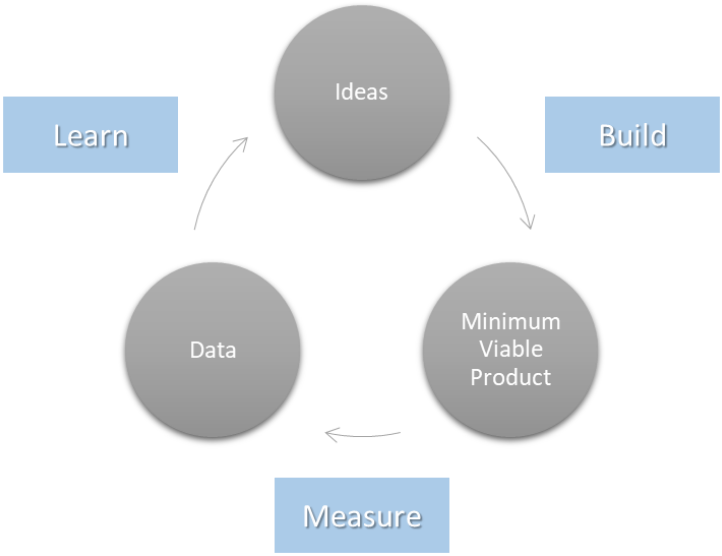

Figure 6: Lean Startup Process Adopted in FLEXGRID business model development (adapted from[35])

The first principle of the approach is to reduce the feedback loop involving the build-measure-learn steps of the innovation, as seen in **Error! Reference source not found.**. The objective is to rapidly develop a minimum viable product (MVP) that can be measured and tested with customers in order to further refine the innovation. The same can be applied to the value proposition and business model development process in WP8: initial drafts are developed early in the project development, and presented in the following sections. These concepts present initial MVPs that will be tested and further refined during the project and resulting quantifiable findings will be presented in deliverables D8.2 and D8.3.

[35] http://theleanstartup.com/principles

2.1 Summary of FLEXGRID business ecosystem and FLEXGRID S/W platform's functionalities

The value propositions offered by the FLEXGRID innovations, as well as the business models developed for the project reside in the FLEXGRID business ecosystem. This ecosystem describes the collective of the stakeholders impacted by the FLEXGRID outcomes, as well as the interlinkages between them. The background information is introduced in deliverable *D2.1 FLEXGRID use case scenarios, requirements' analysis and correlation with innovative models*[36]. Here, a high-level architecture is given which describes both the demand and supply sides of flexibility (FlexDemand and FlexSupply) that interact through the FLEXGRID Automated Trading Platform (ATP), as pictured in **Error! Reference source not found.**.

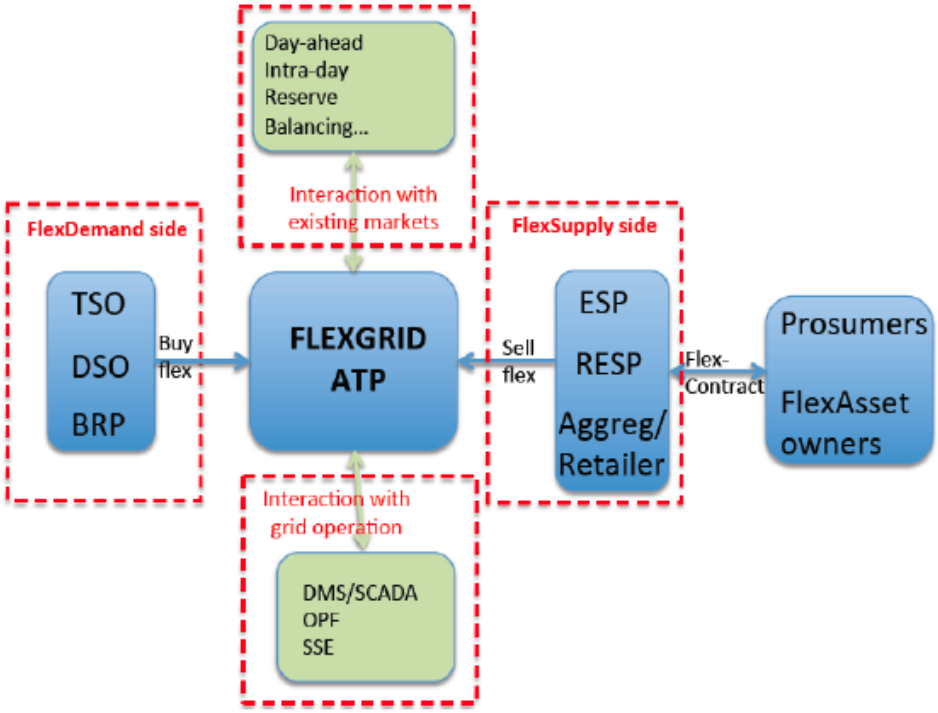

Figure 7: FLEXGRID marketplace and intelligent business ecosystem design (from D2.1)

The above marketplace is the basis for describing the FLEXGRID business ecosystem. It shows stakeholders' positioning and their interaction in trading flexibility. These stakeholders are further described in D2.1, where their role in the flexibility marketplace is detailed. The list of stakeholders in the FLEXGRID business ecosystem can be found in the following table.

Table 6: List of stakeholders in the FLEXGRID business ecosystem

	(Independent) Aggregator
BSP	Balancing Service Provider
BRP	Balance Responsible Party
DSO	Distribution System Operator
ESP	Energy Service Provider
MO	Market Operator
	Day-ahead/intraday Market Operator
BMO	Balancing Market Operator
FMO	Flexibility Market Operator

[36] https://flexgrid-project.eu/deliverables.html

	Prosumer (FlexAsset Owner)
RESP	Renewable Energy Service Provider
	Supplier (Retailer)
TSO	Transmission System Operator
WFIP	Weather Forecast Information Provider

In order to describe the FLEXGRID business ecosystem, value propositions and business model opportunities of the FLEXGRID S/W platform, it is important to identify the services and functionalities developed in the project.

D2.1 describes a functional architecture that is modular-by-design, and is centred around the FLEXGRID ATP. This provides the GUI and APIs to give further access to the intelligence included in the different FLEXGRID subsystems/modules: FlexSupplier's Toolkit (FST), Flexibility Market Clearing Toolkit (FMCT), Automated Flexibility Aggregation Toolkit (AFAT). A summary of the functionalities is given in **Error! Reference source not found.**.

Table 7: List of the FLEXGRID S/W platform functionalities

FLEXGRID subsystem	Intended user	Functionalities
ATP		Front-end for user access to the platform and interaction with all available tools.
ATP	Services to FMOs	Automated Composition of Real Time Market (RTM) architectures
ATP		Innovative Market Clearing Algorithms for B2B markets
ATP		An innovative trading model that facilitates access to combined set of tools that are specifically designed to optimally reflect the markets and user interests
ATP		Automated Operation of RTM through advanced trading services
ATP		Sophisticated Application Programming Interfaces (APIs)
ATP	Services to aggregators/ retailers & Services to ESPs for ESP/DFA interaction	Advanced Retail Market Mechanisms towards retail pricing services (B2C)
ATP		Front-end for user access to the platform and interaction with all available tools.
AFAT		"Forecasting Engine" is used for generating forecasts with respect to energy consumption
AFAT		"Flexibility Aggregation Algorithms" responsible for generating the optimal Demand Response activation schedule
AFAT		"Retail Pricing Algorithms" responsible for optimizing the pricing models and their parameters that the retailer/aggregator user will make available to its end users.
ATP	Services to ESPs for profit maximization	Front-end for user access to the platform and interaction with all available tools
FST		Fetching input data for weather forecasting and renewable energy
FST		Bidding algorithms for various energy markets with minimisation of CAPEX and OPEX.
FST		Optimal FlexAsset scheduling algorithms
FST		Optimal FlexAsset planning algorithms
FST		Optimal FlexAsset sizing algorithm
ATP	Services to DSOs/TSOs	Front-end for user access to the platform and interaction with all available tools
FMCT		Evaluation of the need for flexibility for DSO

FMCT		Auction based clearing the distribution level flexibility market (DLFM)
FMCT		Pay/as bid clearing of the distribution level flexibility market (DLFM)
FMCT		Tool for TSO, flexibility services' provision

Finally, to describe the FLEXGRID business ecosystem, it is useful to combine the marketplace structure overview presented in **Error! Reference source not found.** and the functionalities of the S/W platform of **Error! Reference source not found.** in order to transparently showcase:

- Interactions between ecosystem stakeholders
- Financial exchanges between ecosystem stakeholders
- FLEXGRID components that are owned and operated by ecosystem stakeholders.

The following figure is proposed to capture the high-level picture of the above-mentioned points.

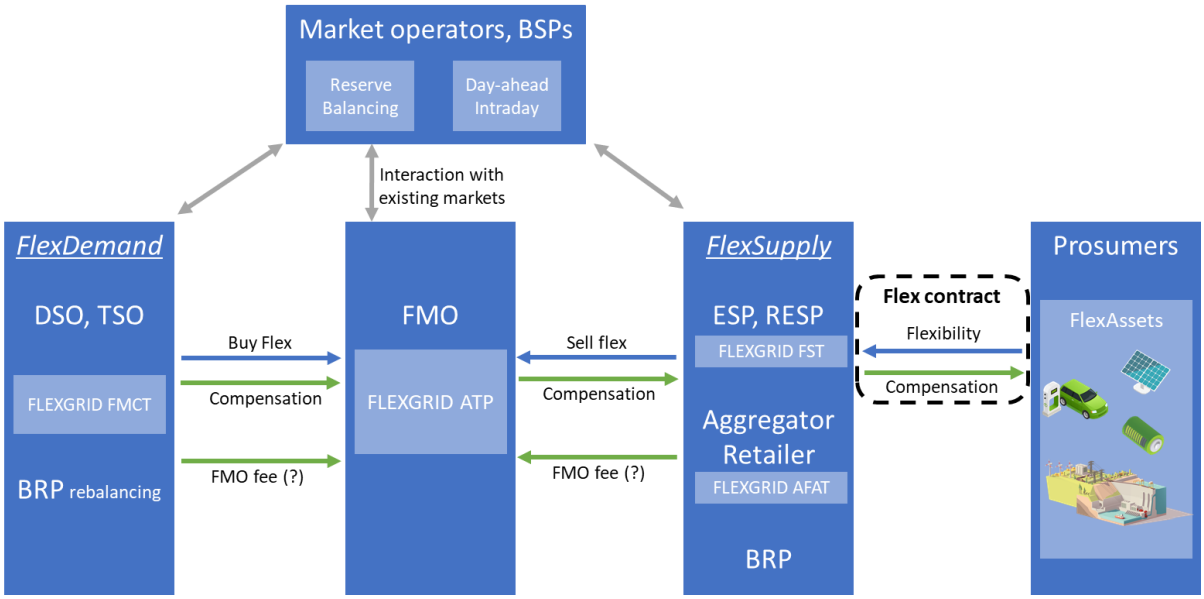

Figure 8: Initial FLEXGRID business ecosystem overview

FLEXGRID business eco-system illustrated above highlights the interactions and value addition for many stakeholders brought together by the FLEXGRID solution. Prosumers getting the opportunity to provide flexibility using FlexSupply actors (ESP, RESP, Aggregators, Retailers and BRPs) and getting compensated for the flexibility delivered. The unique tools developed for the FlexSupply contribute to the business value of different actors and also adding value to overall investments in RES. The advanced tools for FlexDemand side help flexibility procuring actors to get value and improve business processes for their respective network operation. FLEXGRID core innovation tool ATP, connects to the FMO system, bringing the overall eco-system actors a seamless interface to add value for the overall EU energy market.

2.2 Introduction to the Value Proposition Canvas

A value proposition canvas is a useful tool to map out the various problems that a customer is facing in current situations and can lead to a possible solution for the particular customer. There are two general sides to the canvas: one focusing on customer profile and the other

on the value map, as shown in **Error! Reference source not found.**. The tool, once completely mapped, serves as a useful base for framing the value proposition(s) and customer segment(s) in the business model canvas (explained in section 2.4).

It is important to establish the definition of the value proposition analysis in the context of the FLEXGRID business modelling activities. In this analysis, the value proposition definition, as proposed by [37]: **a value proposition "describes the benefits customers can expect from your products and services"**. As mentioned above, FLEXGRID proposes a modular-by-design architecture that can propose a range of services assembled in different combinations to match the needs of different stakeholders in the energy business. For this reason, the project considers that the value propositions proposed for each customer group, a set of FLEXGRID services can be considered based on the functionalities listed in **Error! Reference source not found.**. In the current deliverable a first pass at the services that build up the FLEXGRID value proposition is described. This will be further analysed and updated in subsequent deliverables D8.2 and 8.3.

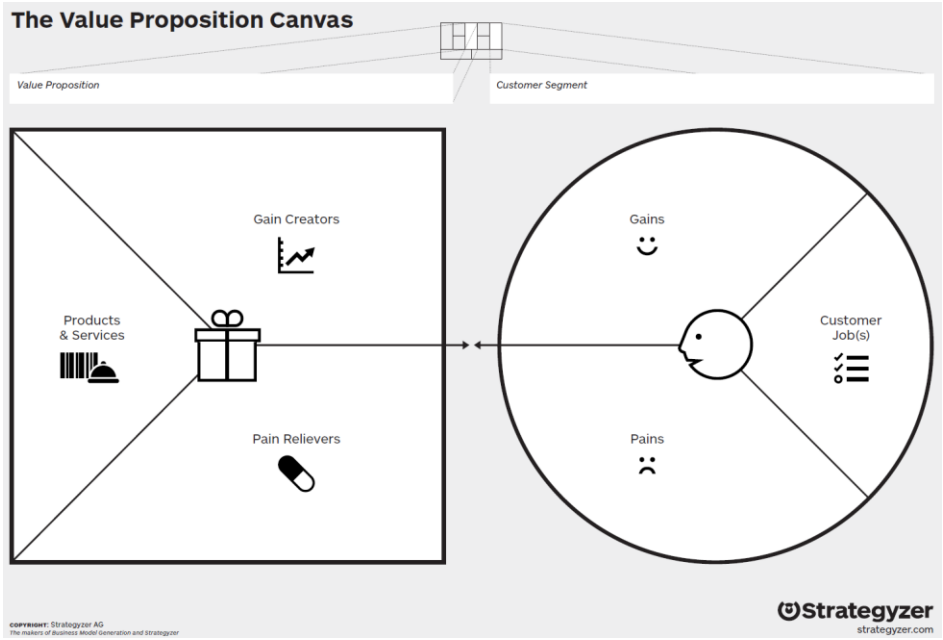

Figure 9: The Value Proposition Canvas (Taken from[38]).

Customer Profile side of the Value Proposition Canvas

A common methodology of using the Value Proposition Canvas tool is to start by listing Pains and Gains for a particular customer on the customer segment side. This is because the study of the value proposition developed focuses on the business realities of the customer in question. The building blocks in this section are as follows:

- *Customer job(s)*: This is the main focus of the stakeholders in the customer segment relevant to the value proposition.
- *Customer pains*: Things that inhibit the customers when they try to carry out their jobs.

[37] A. Osterwalder, Y. Pigneur, G. Bernarda, A. Smith, and T. Papadakos, *Value proposition design*. Hoboken, NJ: Wiley, 2014.

[38] https://www.strategyzer.com/canvas/value-proposition-canvas

- *Customer gains*: This describes how the customer measures the success off carrying out their jobs.

Value map side of the Value Proposition Canvas

The value mapping in the canvas describe the products and services that are addressed to the customers. This region describes the following:

- *Products and services:* As mentioned previously, each value proposition carries a list of product or services offered in the modular-by-design structure of the FLEXGRID solutions developed.
- *Pain relievers*: This describes how the FLEXGRID products and services help overcome the pains experienced by customers
- *Gain creators*: This describes the way in which the products and services create gains for the customers.

2.3.1 Value proposition 1

The first value proposition examines the perspective of the FMO. It is closely linked to the high-level use case (HLUC) 01 presented in D2.1.

Table 8: Value proposition 1 canvas blocks; perspective of FMO

Value Proposition 1					**Customer Segment**
FLEXGRID allows for better marketplace operation and interaction between flexibility supply and demand by providing advanced market clearing services					FMO
Value Mapping			**Customer Profile**		
Product & Services	Gain Creators	Pain relievers	Gains	Pains	Customer Job(s)
FLEXGRID ATP **-**User interaction to platform - RTM Architectures - Market clearing algorithms for B2B markets - Trading model for participation of stakeholders - Advance trading services - Sophisticated APIs	- Implementation /consideration of advanced market clearing models and optimized algorithms to enhance financial reward of FlexMarket participants may incentivise usage of the FMO - Creation of a sophisticated and easy-to-use platform that allows a reliable and realistic reflection of various market	- Tool to facilitate access to the platform to a broad range of users to offer their flexible capacity and get rewarded - Implementation / consideration of market-relevant and real-time data establish a more realistic and dynamic market model - Consideration of very diverse user-requirements and benefits	- Advanced interaction between market and grid operation - Creation of a marketplace that reliably and realistically reflects market dynamics and behaviour	- Complex integration of FlexSupplier Assets - Difficulty for a broad range of users to access platform - Very diverse user requirements and benefits across FMO platform - Inaccuracy due to limited consideration of market-relevant and real-time data and use of advanced market	- Provide intermediary for FlexBuyers to request and purchase flexibility services, and where FlexSuppliers can propose flexibility services

	dynamics and behaviour			clearing and OPF algorithms	

2.3.2 Value proposition 2

The second value proposition examines the perspective of the ESPs and RESPs. It is closely linked to the HLUC_02 presented in D2.1.

Table 9: Value proposition 2 canvas blocks; perspective of ESPs, RESPs

Value Proposition 2					Customer Segment
FLEXGRID allows ESPs to maximise profits by optimising FlexAsset siting, sizing and operation, considering the technical constraints of the grid					ESP, RESP
Value mapping			Customer Profile		
Product & Services	Gain Creators	Pain relievers	Gains	Pains	Customer Job(s)
FLEXGRID ATP: **-** User interaction to platform **FLEXGRID FST:** - Input of weather forecast and RE - Bidding algorithms - FlexAsset scheduling - FlexAsset planning - Optimal sizing	- ESP can aggregate flexibility from FlexAsset owners and sell it to the local DSO - ESP can aggregate flexibility from centralized storage & DFAs and sell it to regional TSO	- ESP can build on beneficial business cases with the local DSO - ESP can build on novel business cases with the TSO	- ESP can realize a good ROI case for its storage assets	- ESP's FlexAssets cannot be traded in flexibility markets - Large storage assets cannot be traded in a cross-regional TSO balancing markets	ESP sells Flexibility to DSO and TSO at a beneficial price per unit

2.3.3 Value proposition 3

The third value proposition examines the perspective of the DSO. It is closely linked to the HLUC_03 presented in D2.1.

Table 10: Value proposition 3 canvas blocks; perspective of DSO

Value Proposition 3					Customer Segment
FLEXGRID allows DSOs to minimise CAPEX and OPEX by exploiting flexibility offered by ESPs					DSO
Value mapping			Customer Profile		
Product & Services	Gain Creators	Pain relievers	Gains	Pains	Customer Job(s)
FLEXGRID ATP: **-** User interaction to platform	- Better management of DSO's assets and planning	- DSO can postpone the grid reinforcements and reduce its	- DSO can decide whether to buy FlexServices	- DSO does not have the opportunity to participate in a flexibility	- DSO must ensure QoS and SoS to end-users in a grid with

FLEXGRID FMCT: - Flexibility need evaluation - Auction based DLFM - Pay as bid based DLFM	of distribution grid operation	OPEX - DSO can facilitate high RES penetration and flexibility-related investments	from ESPs or operate the grid in a BAU manner - Advanced interaction between market and grid operation at DSO level	market - High RES penetration and flexibility-related investments are stagnated because of the lack of a local flexibility market	increased RES penetration

2.3.4 Value proposition 4

The fourth value proposition examines the perspective of the TSO. It is closely linked to the HLUC_03 (specifically HLUC_03_UCS_01 and HLUC_03_UCS_03) presented in D2.1.

Table 11: Value proposition 4 canvas blocks; perspective of TSO

Value Proposition 4					Customer Segment
FLEXGRID allows TSOs to minimise CAPEX and OPEX by exploiting flexibility offered by ESPs					TSO
Value mapping			Customer Profile		
Product & Services	Gain Creators	Pain relievers	Gains	Pains	Customer Job(s)
FLEXGRID ATP: **-** User interaction to platform - Tool for minimising TSO's CAPEX and OPEX	- Better management of TSO's assets and planning of transmission grid operation	- TSO can postpone the grid reinforcements, reduce its OPEX, and better coordinate flexibility at a regional and multi-national level - TSO can facilitate large storage investments and cross-regional trading of flexibility	- TSO can trade FlexServices with other regional TSOs and local DSOs	- TSO does not have the opportunity to efficiently interact with ESPs	- TSO must ensure frequency and stability of transmission grid with increased RES penetration.

2.3.5 Value proposition 5

The fifth value proposition examines the perspective of ESPs, aggregators, prosumers and FlexAsset owners. It is closely linked to the HLUC_04 presented in D2.1.

Table 12: Value proposition 5 canvas blocks, perspective of ESP, aggregator, prosumer, FlexAsset owners

Value Proposition 5	Customer Segment
FLEXGRID allows flexibility aggregation of B2C local flex marketplaces and ESP/aggregator participation in multiple energy markets	ESP, aggregator, prosumer,

					FlexAsset owners
Value mapping			Customer Profile		
Product & Services	Gain Creators	Pain relievers	Gains	Pains	Customer Job(s)
FLEXGRID ATP: **-** User interaction to platform - Advance retail market mechanisms (B2C) **FLEXGRID AFAT:** - Forecasting Engine - Flexibility aggregation - Retail pricing algorithms	- Aggregator establishes a loyal relationship with end users - New revenue streams for ESPs - Reward FlexAsset Owners maximising the value of their assets	- Better energy services offered by ESPs to prosumers - Encounter competition - Satisfy the most demanding and diversified needs of prosumers	- Aggregator's business analyst can apply the optimal policy to maximise the value of the aggregated flexibility - FlexAsset Owners have increased value from their asset - Large FlexAsset Portfolios managed efficiently by aggregator	- High churn rate due to high competition in the retail market for ESPs - End users do not want to invest in FlexAssets if they don't have strong ROI - Aggregators lack easy acccess to multiple markets and FlexAssets cannot access flexibility markets	- Maximise aggregator profits by selling flexibility in multiple markets - Maximise FlexAsset owners' engagement, QoS, QoE - Array of energy services to prosumers

2.3 SWOT analysis of the proposed FLEXGRID's innovations

As described in section 2.2, the FLEXGRID innovations will bring value to different stakeholders in the FLEXGRID business ecosystem mentioned in section 2.1. The stakeholders will be capable of leveraging the different services of the FLEXGRID subsystems, in customizable arrangements, in order to improve their business. This section explores, from the relevant stakeholders' perspectives, what are the Strengths, Weaknesses, Opportunities and Threats (SWOT) of leveraging the different components of the FLEXGRID S/W platform.

2.3.1 Tool for Flexibility Market Operator (FMO): Automated Trading Platform

Table 13: SWOT analysis of the FLEXGRID tool for Flexibility Market Operators (FMO)

Strengths	**Weaknesses**
• Innovative product addressing coordinative and numerical challenges of Flexibility Market participants • holistic approach considering market-and user specific expectations/benefits of an integrated FlexMarket • Optimized data and information exchange between FlexGrid ATP users • Adaption/Improvement of models and algorithms considering operational	• Need for building up B2B partnerships before release • Very theoretical approach (at the moment) • Lack of suitable regulation from system operators to purchase local flex

requirements and economic rewards of various FlexMarket participants and FLEXGRID ATP users	
Opportunities • Being front-runner/show case for a possible Flexibility marketplace in EU markets • Addressing present and future challenges in EU markets • System check on operational performance • Sound evaluation of adequate pricing models and cost/benefit analyses per market participant	**Threats** • Regulatory constraints in some regions • Regulatory differences across regions impeding an overall applicability

2.3.2 Tool for DSO: flexibility services' provisioning

Table 14: SWOT analysis of the FLEXGRID tool for DSO, flexibility services' provisioning

Strengths • Due to homogenization of load flows avoiding grid enhancement and in consequence minimizing CAPEX for grid infrastructure • Avoiding unnecessary stress situations for grid components leading to early aging and unplanned failures. So, minimizing OPEX for grid operation • Minimizing grid usage fees to be payed to upstream grid operator due to peak shaving • Due to minimizing over voltages more RES in distribution grids become possible without grid enhancement • Overall contributing to lower costs and in consequence to lower grid usage fees for end customers	**Weaknesses** • Detailed measuring data for surveillance of the LV (feeders and cables) on distribution grids not available today in some regions. • Initial investments necessary in measurement units and data transmission devices • Lack of the required ICT infrastructure for distribution network monitoring and control that would lead to sub-optimal working of FLEXGRID ATP
Opportunities • Low grid usage fees for end customers provide an advantage in fighting for new grid concessions[39] • Synergy potentials can be unlocked by operating new concession grids [40]with the	**Threats** • Costs for sensor units are not eligible today in the given regulatory framework (copper vs. intelligence) • Cost plus regulation does not provide an incentive for DSOs to lower costs or to follow new concepts

[39] In Germany 'concession' means, that there is a procurement every 20 years in every community regarding the operation of the electricity as well as the natural gas grid.

[40] The concession grids refer to the German context where every 20 years a new contract is signed. Sometimes with the old operator, but very often with another. If another grid operator wins, in the following a complex process starts to determine the residual value of the grid to be overtaken, very often these cases are taken to court.

same staff -> Opportunity for lowering cost and leading to higher DSO revenues • Enabling more RES without higher costs for customers leads to good public relations	

2.3.3 Tool for TSO: flexibility services' provisioning

Table 15: SWOT analysis of the FLEXGRID tool for TSO, flexibility services' provisioning

Strengths	**Weaknesses**
• minimize CAPEX/OPEX in the long-term • more choice for a TSO to choose the service providers at a lower price	• need for upfront investments in electricity grid equipment. • extra resources to manage services procurement (and settlement) at both platforms (FlexGrid ATP and BAU Balancing platform)
Opportunities	**Threats**
• A thought leader in new energy markets • If service procurement is fully utilized, a cost reduction for TSOs and ultimately for grid users	• put in high risk other traditional TSO investments (transition phase) • grid security and operation in case of bad coordination between DSO and TSO together with BRP not able to deliver services.

2.3.4 Tool for ESP for profit maximization

Table 16: SWOT analysis of the FLEXGRID tool for ESP, for profit maximization

Strengths	**Weaknesses**
• 'All in one' software tool lowers operational costs • 'All in one' software tool simplifies operation and decreases human error rate • New flexibility marketing opportunities can be unlocked not accessible for small players today (e.g. balancing markets, local markets)	• Need for high upfront investments for software licences, data transmission devices and staff training • Local markets need time to develop. So, over a period of several years an insufficient ROI must be tolerated
Opportunities	**Threats**
• Single software solution resulting in in reduction of license costs for separate software systems. • Operating a new flexibility platform may create new revenue streams • Creating a unique tool in competition to other suppliers not using FLEXGRID ATP	• Estimated revenues are not high enough compared to upfront investments • FLEXGRID ATP combined with subsystems and interconnected with 3rd party appliances becomes too complex to be run reliably. Many pilot tests are needed in order to reach high TRL

2.3.5 Tool for aggregator/retailer to operate an ad-hoc B2C flexibility market

Table 17: SWOT analysis of the FLEXGRID tool for B2C market operators

Strengths	**Weaknesses**
• Novel product • Can utilize available flexibility to potentially defer investments at the distribution level • Solution relying on sophisticated mathematical tools that can provide optimal solutions • Solution obtains input from the markets, energy production from RES, load forecasting and DSO requirements that has the potential to lead to better decisions	• Need for building up B2B partnerships before release • Flexibility market potential might be hindered by technology or regulations that are not in place • Complexity of the market compared to direct procurement of flexibility • Coordination between the different flexibility markets as well as the DSO, TSO and ESPs is not apparent.
Opportunities	**Threats**
• Being front-runner in EU markets • EU drive for active prosumers and energy communities • Advent of AI and big data tools and the push towards intelligent smart grid solutions • RES and distributed generation as well as battery storage provides an opportunity for such a solution.	• Regulatory constraints in some countries • DSO grid information and other required inputs might not be made readily available • Complexity to operate such market might discourage its uptake • Running a host of such small markets might not be optimal given that limited coordination between the players from the different markets.

2.4 Introduction to the Business Model Canvas

For every innovation to make an impact in the society and create value, it is important to define a business model to help the uptake of this innovation for various stakeholders by delivering some business benefit. **Business model is defined as the rationale of how an organisation creates, delivers and capture value in economic, social, cultural and other contexts[41].** For FLEXGRID innovation a similar business model is developed to deliver value across different parts of society by using a modular by design approach with different value propositions (described in section 2.3) for various stakeholders. FLEXGRID business model is designed keep in view the preference of various stakeholders interacting in different ways with the FLEXGRID tools, taking modular approach in business values will help each stakeholder to choose one service or multiple from various FLEXGRID tools.

One of the most popular methods of lean start-up methodology is to utilize Business Model Canvas[42] (BMC) for describing a complete business model of an innovation, targeted to create value within a business eco-system. BMC consists of different sections that highlight the summary of a business solution solving a particular problem for a relevant customer. By using a BMC, a complete overview of a business can be assessed, and this could serve as a

[41] *Business Model Generation*, Alexander Osterwalder, Yves Pigneur, Alan Smith, and 470 practitioners from 45 countries, self-published, 2010

[42] Business Model Canvas: nine business model building blocks, Osterwalder, Pigneur & al. 2010

strong base for creating a business value for any entity. The **Error! Reference source not found.** is developed for the FLEXGRID innovation, using the value proposition for different customers mentioned in the section 2.3.

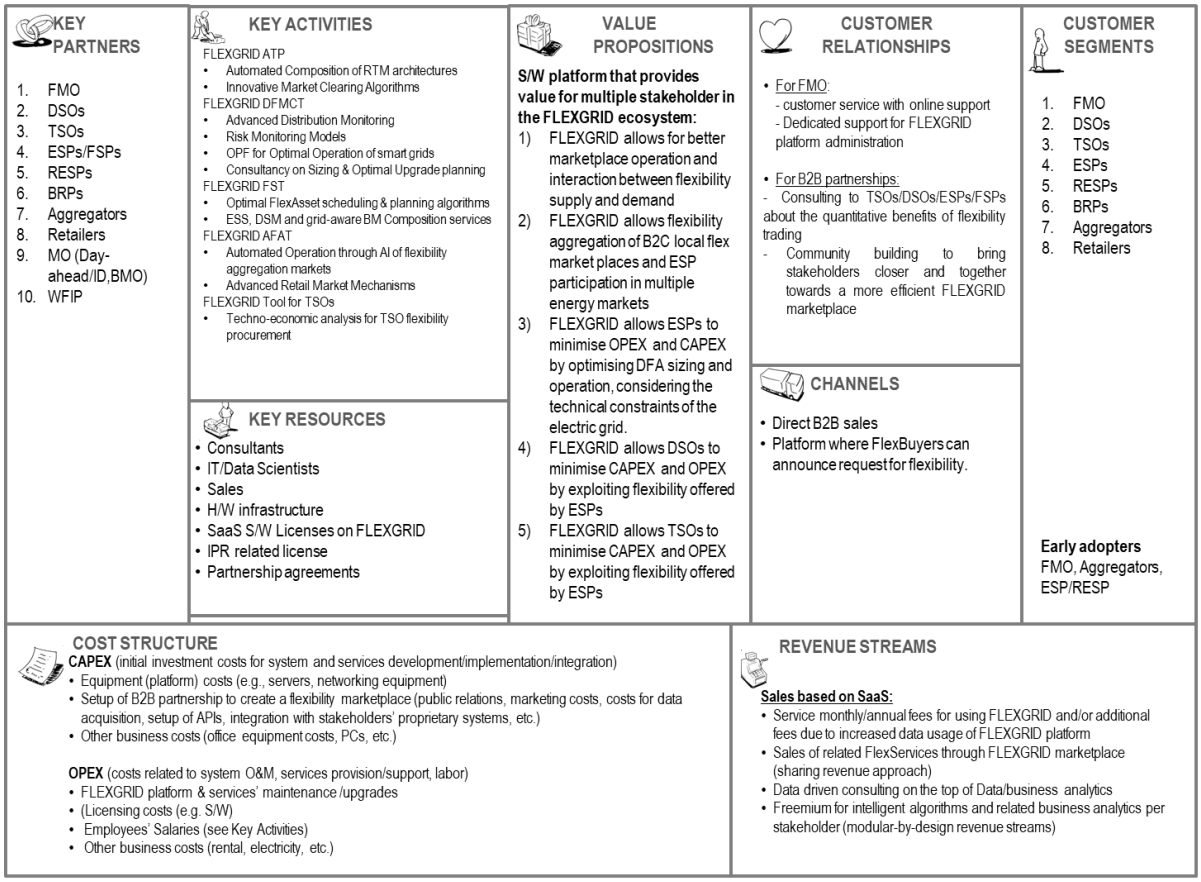

Figure 10: Initial FLEXGRID Business Model Canvas (BMC)

Following is a brief explanation for each section of the BMC of FLEXGRID innovation:

Customer Segments: Multiple innovations developed in the FLEXGRID project target different actors for utilising the innovations in the energy sector and create value addition for their respective businesses. One of the key customers highlighted is the FMO and it will utilise the ATP for optimising the supply and demand of flexibility with regards to the specific market and the required product. Among the other customers identified, some early adopters are listed considering the unique value of FLEXGRID tools and also the market trends in the flexibility industry.

Value proposition: For each key customer a value proposition is mapped to highlight the reason for the customer to pay for the respective solution/tool of FLEXGRID project. Distinctive value proposition marking helps in identifying multiple uses of the overall project and gives indication of the potential use of FLEXGRID innovation in energy sector.

Customer Relationships: For attracting the customer and creating a sustainable business solution for the FLEXGRID project, different schemes are identified for creating strong relationship of FLEXGRID solutions for each customer, resulting in a continuous use of tools for longer period of time.

Channels: FLEXGRID project have identified a direct sales process to be most effective channel for reaching out to potential customers and also by using the platform interactions, on-boarding of customer will be easy for effective running of business.

Key activities: Different activities are mentioned above in the BMC, these activities are markets as all the important tools that are developed part of the FLEXGRID solution and will help in creating value for different customers and their respective business in the long-run.

Key partners: The partners mentioned in the BMC are identified by selecting one customer from the segment section. For example: for a Flexibility market platform provider as a customer of FLEXGRID solution, the other entities can be listed as key partners that will help FMO execute effective task using the FLEXGRID tool. Similarly, the other customers can consider FMO as a key partner and will ensure effective operation of flexibility services using the ATP tool.

Key resources: The resources identified by the project are mainly related to the assets needed to run any platform. Also, the resources are selected for keeping in view the most efficient operation of the overall FLEXGRID solution.

Cost structure: The costs are divided into two main parts, CAPEX and OPEX. The reason of dividing the cost is to give a clear indication on the investments that are needed for the innovation development but also looking at the operational costs that is needed for running the platform and its services in the long run as a sustainable business solution.

Revenue streams: Currently the revenue streams mentioned above are based on the revenue structure that NODES is using for a similar platform. However, in the final business model, a revised version could be provided looking at additional revenue streams identified during the final stages of the project.

FLEXGRID will focus its research on quantifying KPIs related with the cost structure and revenue streams of all involved market stakeholders from both the FlexSupply and FlexDemand sides of the proposed DLFMs as well as from the FMO's perspective. More details and extensive techno-economic analysis results will be provided in D8.2 (M18) and D8.3 (M36).

3 Data Management Plan

This section provides the initial version of the Data Management Plan (DMP), as defined in FLEXGRID WP8 during the first six months of the project. FLEXGRID has decided to participate in the Open Research Data Pilot (ORDP), introduced in Horizon 2020 Work Programme and aimed at improving and maximizing access to and re-use of research data generated by EC-funded projects. In line with this decision, in this initial phase, FLEXGRID has identified a number of data sets, which will be generated within the project and shared with the research community. One of the main objectives of the project is to improve the exchange and dissemination of research results and, possibly, to enable and promote a wider validation of the project results and to encourage a fair comparison and evaluation of different solutions in the FLEXGRID's technical areas.

The Data Management Plan deals with all the concerns about the treatment of the data involved in the whole project lifecycle and has been structured in compliance with the guidelines and the template conveyed by the European Commission.

Hereafter, the main aspects that will be considered in the Data Management Plan are reported for each one of the datasets identified in the project:

- Types of data generated, collected and processed
- Standards used to manage data
- Data exploitation methodology
- Accessibility to data produced by the project
- Data Dissemination level
- Data Preservation and re-use

Deposition of generated research data: Following a similar strategy to publications, FLEXGRID aims to participate in the Open Research Data Pilot (ORDP). Research data generated within FLEXGRID, which the consortium decides that is suitable for sharing, will be openly accessible. End users will have the right to access, mine, exploit, reproduce and disseminate free of charge digital research data (statistics, results of experiments, measurements, algorithmic results, S/W prototypes of novel algorithms and mathematical models, input data used for run of algorithms, simulation setups, etc.) under the terms and conditions set out in the Grant Agreement. The initial Data Management Plan (DMP) of FLEXGRID is shown in the table below (taken from DoA):

Table 18: Initial Data Management Plan (DMP) of FLEXGRID (taken from DoA)

Data set reference & name	Data set description	Standards & metadata	Data sharing	Archiving & preservation (incl. storage & backup)
Datasets from Nord Pool markets and	Real-life data from day-ahead, intra-day, balancing markets,	Material will be semantically	Anonymized / historical data will be freely available	

NODES flexibility market (WP2)	etc. in a structured format. Datasets about NODES flexibility market operation.	annotated to support searching and access	for any interested party.	The deposition of data is free of charge for FLEXGRID consortium. Links in the FLEXGRID's website will facilitate access to the deposited data (e.g. GitHub tool). All datasets will be semantically annotated to facilitate searching and access. Short user manuals will be available to facilitate the efficient reuse, validation and reproduction of this data and research extensions. Research data will be available for end users for at least 10 years after their initial deposition.
WP3 algorithms about B2C flexibility aggregation energy market	Simulation data generated from: i) dynamic pricing algorithms for behavioral change, ii) flexibility trading algorithms. The data will be useful for research groups and commercial actors such as ESPs/FSPs, aggregators and retailers.	The dataset will be exported from simulation runs and will be deposited in a simple .mat or .py form.	The data set will be deposited in an open access repository. Access will be free for all interested parties. Short user manuals will be available.	
WP4 algorithms about ESP's portfolio management	Simulation data generated from: i) optimal bidding algorithms for ESP, ii) RES and market forecasting algorithms. The data will be useful for research groups, ESPs, RESPs.	Simulated results will be available and deposited in a simple .mat or .py form. "Readme" files will be available.	The data set will be deposited in an open access repository Access will be free for all interested parties.	
WP5 algorithms about OPF and interaction between grid and market	Simulation data generated from: i) multi-period & robust OPF algorithms, ii) network upgrade planning algorithms. The data will be useful for research groups, TSOs and DSOs.	Simulated results will be available and deposited in a simple .mat or .py form.	The data set will be deposited in an open access repository. Access will be free for all interested parties.	
Data analytics from FLEXGRID marketplace testbed evaluation tests (WP7)	Experimental data analytics from the validation activities (TRL 5-6) in lab environment and indicative data analytics results from real-life pilots. The data will be useful for potential customers, EU regulatory and policy making bodies to assess the impact	The datasets will be easily visualized via a simple GUI (open-source version of the platform - DEMO)	The 1st integrated version of FLEXGRID ("alpha" version) platform will be publicly available for communication purposes	

	of FLEXGRID solution.			

Based on the above table, the consortium partners have elaborated on an updated version of the Data Management Plan that will be followed within FLEXGRID project's lifetime. In the following subsections, specifications about all the datasets that will be deposited and be available in open access mode are provided. The consortium has followed the respective H2020 template[43] regarding "Guidelines on Fair Data Management in Horizon 2020" and has appropriately adapted it to the needs of FLEXGRID project.

3.1 Data Set 01: Experimental data inputs, results and analytics from FLEXGRID marketplace and S/W platform operation

Data set ref. name	FLEXGRID Automated Trading Platform (ATP) data
Description	For each specific target group of FLEXGRID ATP (i.e. DSO/TSO user, ESP user, aggregator user and FMO user), several parameters will be identified by each vertical pilot and lab experiment (e.g. geographic location, installed capacities, activation times, DN-related parameters, etc). The data received from external sources will fill in these parameters. By the term external sources, we not only mean real-life data from FLEXGRID pilot sites (e.g. BADENOVA, UCY), but also realistic datasets and system models (e.g. IEEE bus test systems, open research datasets, etc.) that will be used for validating the various scientific models and algorithms. The lab experimentations and small-scale pilots have identified some identical parameters, however some may differ. The main set of parameters is based on existing NODES marketplace and APIs[44] that are in place and will be used as a starting point for FLEXGRID data modelling work (cf. task 6.1). There are eight basic types of parameters, which will be used and analysed by FLEXGRID ATP as follows: ▪ FlexRequest data describing the bid curves of the TSO, DSO and BRPs from the FlexDemand side of the market. ▪ FlexOffer data describing the bid curves of the ESPs, RESPs and aggregators from the FlexSupply side of the market. ▪ Market clearing data results (both historical market clearing data as well as results from the novel AC-OPF algorithm for the DLFM operation), which are the outcome of the advanced market clearing process that matches aggregated bid curves of FlexDemand and FlexSupply. ▪ Market clearing data results from the existing wholesale (i.e. day-ahead, intra-day) markets operated by the MO and balancing/reserve markets operated by the TSO. ▪ Network data describing the topology of the distribution/transmission grid ▪ Digital Interactions: interactions of users with the platform (e.g. number of logins per user, number of algorithms run by each user, number of simulation scenarios, number of accepted/rejected FlexOffers for a given timeframe, etc.)

[43] http://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-data-mgt_en.pdf

[44] NODES marketplace and indicative web APIs and data modeling, Publicly available link: https://nodes-demo.westeurope.cloudapp.azure.com/swagger/index.html?url=/swagger/openapi.json#/

	▪ Notification data coming from the three S/W toolkits (i.e. AFAT, FST and FMCT) informing each user about the ongoing progress of a certain algorithmic process as well as the historical data about past algorithmic processes (or else simulation runs) ▪ Historical market price and energy data, which are stored in the central FLEXGRID database and can be retrieved and visualized in ATP frontend on demand. These datasets include all most important algorithmic results produced by AFAT, FST and FMCT and are stored in the central database. Datasets will be available over RESTful APIs from the various FLEXGRID ATP modules (or else subsystems). Data access and sharing plans include several aspects that have to be identified regarding the data resulted from the project. Below, the issues regarding the data access for FLEXGRID ATP and sharing plan are presented in a more detailed manner. **IPRs and Privacy Issues** Data access and sharing activities will be implemented in compliance with the privacy and data collection rules and regulations, as they are applied nationally and in the EU, as well as with the H2020 rules. Due to the nature of the data involved, some of the results that will be generated during each project phase will be restricted to authorized users, while other results will be publicly available. One possibility would be to ask users to pre-register to become an authorized user of the system and of the database. User profiles and associated user requirements according to their roles will be approved by the FMO/system determining the level of access that a user will be given and what they will be permitted to do. **Methods for Data Sharing** Generally, all data sets will have to be included into the FLEXGRID's central database to ensure the correct running of calculation processes of algorithms and simulations. However, as some source data provided by energy management and information management systems are commercially sensitive, access to distinctive data will be restricted to specific end users and the partners involved in the analysis of the data. The results of the data analytics in the orientation phase are set to be anonymised and made available to the subsequent layers of the framework so that external industry stakeholders can use the results of the project for their own purposes. Publications will be released and disseminated through the project dissemination and exploitation channels to make all types of targeted audiences and users aware of the project's results. Appropriate access to the data will also be facilitated (i.e. via short and comprehensive user manuals) in order to make sure that reproducibility of results is easily achieved.
Standards and metadata	In the absence of a well-defined metadata standard for this type of data, a simple README file will be used. This will be generated in raw text format and will describe basic details that will help people to find the data, including who created or contributed to the data, its title, date of creation and under what conditions it can be accessed. Documentation will also include details on the methodology used as well as file and folder naming conventions. A concise user manual will also be provided in the context of project's communication activities with interested industrial stakeholders. The following fields will be used: 1. Title of dataset

	Tentative name: FLEXGRID ATP data 2. Name(s) of dataset creator(s) ETRA's S/W development team 3. Description of data Included in the README file 4. Source of data Historical data will be collected from NPC's, BADENOVA's, HOPS and NODES business portfolios. Generated and processed datasets will be a primary output of FLEXGRID project 5. Creation date First version will be created after the release of the initial ('alpha') version of FLEXGRID S/W platform prototype (i.e. after M18). A second ('beta') version will be created after M33. The final version will also include data results and analytics from the lab experimentations and real-life pilot tests. 6. Format CSV and JPEG files where applicable. Short versions of APIs from which data results and analytics can be automatically and easily retrieved will also made publicly available. 7. Location of Data Zenodo (exact link to be provided) 8. Digital Object Identifier DOI from Zenodo 9. Access status and embargo Open data – no embargo period foreseen for this dataset 10. Funding statement This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 863876. The results of this dataset reflect only the creator's view and the Commission is not responsible for any use that may be made of the information it contains. 11. Related Publications Bibliographical details of publications based on the dataset will be listed, with links to abstracts and, where possible, full text. Performance evaluation results from scientific publications will be deposited in project's GitHub area in order to be easily reproducible and verifiable by any interested user and/or researcher in the future. 12. Dataset Citation A 'ready-to-use' citation reference for the dataset will be provided – incorporating the core descriptive elements.

Data sharing	The research data will be deposited and maintained in Zenodo (http://www.zenodo.org), the research data repository launched by CERN and OpenAIRE.
Archiving and preservation	For redundancy, besides uploading the data on Zenodo, it will be also maintained on a university-owned server at ICCS/NTUA. The server offers real-time data mirroring through RAID (redundant array of independent disks) and weekly backups to external disk drives. The approximated end-volume of this dataset is less than 500 MB. The dataset will be preserved for at least 7 years after the project end and the associated costs will be covered by ICCS/NTUA through own funds.

3.2 Data Set 02: Experimental data inputs and algorithmic results from Automated Flexibility Aggregation Toolkit (AFAT)

Data set ref. name	Automated Flexibility Aggregation Toolkit (AFAT) data
Description	The Automated Flexibility Aggregation Toolkit (AFAT) is the S/W tool that integrates the WP3 research algorithms and will be implemented by ICCS and UCY. In a nutshell, AFAT will receive a FlexRequest from the ATP, will then run a retail flexibility pricing or flexibility aggregation algorithm and will respond with a FlexOffer to the ATP. The retailer and independent aggregator user will use this toolkit. The AFAT module will mainly interact with two FLEXGRID modules, namely the core ATP module, and the central FLEXGRID Database. The ATP will issue commands for: i) executing algorithmic tasks on the Flexibility Aggregation Algorithm sub-module and on the Retail Pricing Algorithm sub-module residing at the AFAT module, ii) returning the results of the algorithmic executions, as well as monitoring the status and canceling/resubmitting tasks. The AFAT-ATP will be implemented using a JSON REST web API, which will allow for the ATP module to submit, query, and cancel tasks. Some indicative JSON messages are: 1. Flexibility Offer (FlexOffer) sent by the aggregator based on Flexibility Aggregation Algorithm submodule results. 2. Retail pricing evaluation requests sent by ATP to Retail Pricing Algorithm submodule. 3. Retail pricing evaluation response sent by AFAT to ATP (algorithmic results to be visualized by retailer/ESP user via the respective ATP GUI). Moreover, in order for the AFAT module to execute its algorithmic tasks, it may download data from the central FLEXGRID database. The central FLEXGRID database will include consumption, production, network topology and market data[45]. This data will be available to the rest of the FLEXGRID system through well-designed web APIs. The algorithmic tasks that will be executed at the AFAT may use data from this repository in order to complete their computations. The FLEXGRID database module will implement a REST API with the following resources: 1. Energy prosumption data: Includes consumption and production data for

[45] This data will mostly be static (historical) datasets to serve the validation of the various mathematical models and algorithms at TRL 3. During lab experimentations and small-scale real-life pilots, online data will also be fed in FLEXGRID central database, so that algorithms can also use real-time datasets.

	each energy prosumer in the system, aggregated in various time intervals (e.g. 1-minute or 5-minute if available, 15-minute, hourly and daily). 2. Network Topology data: This data will include the coordinates of each prosumer in the system, as well as all the grid equipment that is used to interconnect them, with their respective capacities. Standardized network model will be followed (e.g. CIM). 3. Market Data: This endpoint will make available market clearing prices in the energy markets, as well as the respective volumes. The markets that will be included may contain the day-ahead market, the various intraday markets, as well as balancing markets and markets for ancillary services (or else reserve markets). Most important AFAT algorithms' results will be deposited in central database and be shown in ATP GUI (together with respective input data and simulation setup scenarios). Thus, results can be fully and easily reproducible and verifiable by any interested user. These results will mainly be simulation data generated from: i) retail pricing algorithms, ii) automated flexibility aggregation algorithms. The data will be useful for research groups and commercial actors such as ESPs/FSPs, aggregators and retailers. The central FLEXGRID database will be filled in with real-life/realistic energy prosumption and network topology datasets provided by BDNV, UCY and HOPS for AFAT algorithms' validation purposes. Historical energy market prices provided by NPC and HOPS will be used for market forecasting algorithms' validation purposes.
Standards and metadata	In the absence of a well-defined metadata standard for this type of data, a simple README file will be used. This will be generated in raw text format and will describe basic details that will help people to find the data, including who created or contributed to the data, its title, date of creation and under what conditions it can be accessed. Documentation will also include details on the methodology used as well as file and folder naming conventions. The following fields will be used: 1. Title of dataset Tentative name: Automated flexibility aggregation models and algorithms 2. Name(s) of dataset creator(s) ICCS/UCY staff 3. Description of data Included in the README file 4. Source of data The central FLEXGRID database will be filled in with real-life/realistic energy prosumption and network topology datasets provided by BDNV, UCY and HOPS for AFAT algorithms' validation purposes. Historical energy market prices provided by NPC and HOPS will be used for market forecasting algorithms' validation purposes. 5. Creation date First version will be created after the release of the initial version of FLEXGRID functionalities (cf. D3.2 in M18). A second version will be created after the delivery of D3.3 (M26). At the end of the project's lifetime, data

	results and analytics from the lab experimentations and real-life pilot tests will be included. 6. Format CSV, XLS and JPEG files where applicable. Short versions of APIs from which algorithmic results can be automatically and easily retrieved will also made publicly available. 7. Location of Data Zenodo (exact link to be provided) 8. Digital Object Identifier DOI from Zenodo 9. Access status and embargo Open data policy– no embargo period foreseen for this dataset 10. Funding statement This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 863876. The results of this dataset reflect only the creator's view and the Commission is not responsible for any use that may be made of the information it contains. 11. Related Publications Bibliographical details of publications based on the dataset will be listed, with links to abstracts and, where possible, full text. Performance evaluation results from scientific publications will be deposited in project's GitHub area in order to be easily reproducible and verifiable by any interested user and/or researcher in the future. 12. Dataset Citation A 'ready-to-use' citation reference for the dataset will be provided – incorporating the core descriptive elements.
Data sharing	The research data will be deposited and maintained in Zenodo (http://www.zenodo.org), the research data repository launched by CERN and OpenAIRE.
Archiving and preservation	For redundancy, besides uploading the data on Zenodo, it will be also maintained on a university-owned server at ICCS/NTUA. The server offers real-time data mirroring through RAID (redundant array of independent disks) and weekly backups to external disk drives. The approximated end-volume of this dataset is less than 2 TB. The dataset will be preserved for at least 7 years after the project end and the associated costs will be covered by ICCS/NTUA through own funds.

3.3 Data Set 03: Experimental data inputs and algorithmic results from FlexSupplier's Toolkit (FST)

Data set ref. name	FlexSupplier's Toolkit (FST) data

Description	The FlexSupplier's Toolkit (FST) is the S/W tool that integrates the various WP4 research algorithms and will be implemented by UNIZG-FER. FST will run a specific algorithm to minimize ESP's OPEX (or CAPEX) and will then send an optimal FlexOffer to the ATP. Based on the market clearing results and the response/notification sent by the ATP, the FST will be able to re-schedule its FlexAssets in an optimal way (i.e. to participate in intra-day or near-real-time balancing markets). The ESP user will use this toolkit and two main algorithms are expected to be integrated, namely: i) optimal scheduling algorithm to minimize ESP's OPEX (cf. UCS 2.1), and ii) optimal investment algorithm to minimize ESP's CAPEX (cf. UCS 2.2). The FST module will mainly interact with the core ATP module and the central FLEXGRID database, which are also FLEXGRID modules. The FST module will use the central FLEXGRID database to fetch all the necessary data in order to successfully execute respective algorithms. The central FLEXGRID database will include among others, data such as consumption, generation, network topology and market prices/volumes. As central FLEXGRID database is a module which serves also other submodules and consists of various sets of data, the FST submodule will only implement RESTful APIs to fetch the needed data. More precisely, a REST API with the following resources will be implemented: 1. Market data: This set will consist of cleared market prices and volumes. The term market includes the day-ahead market, intraday markets, balancing markets and ancillary services markets. 2. Energy prosumption data: This set includes consumption and production data for energy prosumers in the observed system and storage capacity. It should be possible to observe it in various time intervals (e.g. 1-minute, 15-minute, hourly, daily,…), both historical and real values. 3. Network topology: Accurate positions of FlexAssets across the observed distributional network complemented with typical network equipment data. 4. Real data from smart meters: Includes RES production and consumption Interaction with the core ATP module will mainly consist of: i) sending FlexOffers (from FST module to the ATP core module) and ii) receiving the feedback. All important FST algorithms' results will be stored in the central FLEXGRID database. ATP GUI will enable users to see the respective results, including input data and simulation setup scenarios. This way results will be easily reproducible and verifiable by interested parties. Such results will mainly consist of simulation data generated from: i) optimal scheduling/bidding algorithms for ESP, ii) optimal investment algorithms for ESP, iii) RES and market forecasting algorithms. The data will be useful both for the academic community (research groups) and commercial stakeholders (ESPs, RESPs). The data fetched from the central FLEXGRID database will be used as the needed input data for the algorithms to be successfully executed and for validation purposes in the context of WP7 work.
Standards and metadata	In the absence of a well-defined metadata standard for this type of data, a simple README file will be used. This will be generated in raw text format and will describe basic details that will help people to find the data, including who created or contributed to the data, its title, date of creation and under what conditions it can

	be accessed. Documentation will also include details on the methodology used as well as file and folder naming conventions. The following fields will be used: 1. Title of dataset Tentative name: FlexSupplier's models and algorithms 2. Name(s) of dataset creator(s) UNIZG-FER Staff 3. Description of data Included in the README file 4. Source of data The data fetched from the central FLEXGRID database will consist of real-life/realistic energy prosumption and network topology datasets provided by BDNV, UCY and HOPS and historical energy market prices provided by NPC and HOPS. Those datasets are prerequisites for successful algorithm execution and their validation. 5. Creation date The first version will be created upon the release of the intermediate version of FST, which is due in M18 (c.f. D4.2 in M18). The second version will be created in M26 when the final version of FST should be ready and published (D4.3). At the end of the project's lifetime, data results and analytics from the lab experimentations and real-life pilot tests will be included. 6. Format CSV and JPEG files where applicable 7. Location of Data Zenodo (exact link to be provided) 8. Digital Object Identifier DOI from Zenodo 9. Access status and embargo Open data – no embargo period foreseen for this dataset 10. Funding statement This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 863876. The results of this dataset reflect only the creator's view and the Commission is not responsible for any use that may be made of the information it contains. 11. Related Publications Bibliographical details of publications based on the dataset will be listed, with links to abstracts and, where possible, full text. 12. Dataset Citation

	A 'ready-to-use' citation reference for the dataset will be provided – incorporating the core descriptive elements.
Data sharing	The research data will be deposited and maintained in Zenodo (http://www.zenodo.org), the research data repository launched by CERN and OpenAIRE.
Archiving and preservation	For redundancy, besides uploading the data on Zenodo, it will be also maintained on a university-owned server at ICCS/NTUA. The server offers real-time data mirroring through RAID (redundant array of independent disks) and weekly backups to external disk drives. The approximated end-volume of this dataset is less than 1 TB. The dataset will be preserved for at least 7 years after the project end and the associated costs will be covered by ICCS/NTUA through own funds.

3.4 Data Set 04: Experimental data inputs and algorithmic results from Flexibility Market Clearing Toolkit (FMCT)

Data set ref. name	**Flexibility Market Clearing Toolkit (FMCT) data**
Description	Flexibility Market Clearing Toolkit (FMCT) is the S/W tool that integrates the WP5 research algorithms and will be implemented by DTU. FMCT will run advanced market clearing algorithms (e.g. based on AC-OPF models for distribution networks). It will be used by the DSO user in order to calculate the nodal prices and thus send a FlexRequest to the ATP. Moreover, it will be used by the FMO user in order to automatically match FlexSupply and FlexDemand at the distribution network level. For FMCT algorithms' validation purposes, the central FLEXGRID database will be filled in with the following real-life/realistic data: ▪ Energy prosumption and network topology datasets provided by BDNV, UCY and HOPS ▪ Data from day-ahead, intra-day, balancing, reserve markets provided by NPC ▪ Realistic FlexOffer curves provided by NODES Most important FMCT algorithms' results will be deposited in central FLEXGRID database and be shown in ATP GUI (together with respective input data and simulation setup scenarios). Thus, results can be fully and easily reproducible and verifiable by any interested user. These results will mainly be simulation data generated from: i) identification of flexibility needs algorithms, ii) market clearing algorithms. The data will be useful for research groups, DSOs and commercial actors such as ESPs/FSPs, aggregators and retailers.
Standards and metadata	In the absence of a well-defined metadata standard for this type of data, a simple README file will be used. This will be generated in raw text format and will describe basic details that will help people to find the data, including who created or contributed to the data, its title, date of creation and under what conditions it can be accessed. Documentation will also include details on the methodology used as well as file and folder naming conventions. The following fields will be used:

	1. Title of dataset Tentative name: Distribution flexibility market clearing data 2. Name(s) of dataset creator(s) DTU 3. Description of data Included in the README file 4. Source of data The central FLEXGRID database will be filled in with real-life/realistic data: energy prosumption and network topology datasets provided by BDNV, UCY and HOPS, data from day-ahead, intra-day, balancing, reserve markets provided by NPC, realistic FlexOffer curves provided by NODES The algorithmic results from Flexibility Market Clearing Toolkit are a primary output of FLEXGRID project. 5. Creation date First version will be created after the release of the initial version of FLEXGRID functionalities (cf. D5.2 in M18). A second version will be created after the delivery of D5.3 (M26). At the end of the project's lifetime, data results and analytics from the lab experimentations and real-life pilot tests will be included. 6. Format CSV and JPEG files where applicable. Short versions of APIs from which algorithmic results can be automatically and easily retrieved will also made publicly available. 7. Location of Data Zenodo (exact link to be provided) 8. Digital Object Identifier DOI from Zenodo 9. Access status and embargo Open data policy– no embargo period foreseen for this dataset 10. Funding statement This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 863876. The results of this dataset reflect only the creator's view and the Commission is not responsible for any use that may be made of the information it contains. 11. Related Publications Bibliographical details of publications based on the dataset will be listed, with links to abstracts and, where possible, full text. Performance evaluation results from scientific publications will be deposited in project's GitHub area in order to be easily reproducible and verifiable by any interested user and/or researcher in the future.

	12. Dataset Citation A 'ready-to-use' citation reference for the dataset will be provided – incorporating the core descriptive elements.
Data sharing	The research data will be deposited and maintained in Zenodo (http://www.zenodo.org), the research data repository launched by CERN and OpenAIRE.
Archiving and preservation	For redundancy, besides uploading the data on Zenodo, it will be also maintained on a university-owned server at ICCS/NTUA. The server offers real-time data mirroring through RAID (redundant array of independent disks) and weekly backups to external disk drives. The approximated end-volume of this dataset is less than 1 GB. The dataset will be preserved for at least 7 years after the project end and the associated costs will be covered by ICCS/NTUA through own funds.

3.5 Data Security and ethical aspects

Initial work was conducted to examine data security and ethical aspects that should be considered in the FLEXGRID project. This served as basis for the legal/regulatory/security requirements of deliverable D2.1. These requirements served as a first screening of potential issues that the FLEXGRID systems should consider in their design and operation as identified at the start of the project.

The elaboration of the data management plan outlined in sections 3.1-3.4 provide better insights into the security and ethical considerations of the FLEXGRID project, and how they will be treated by the relevant beneficiaries and in the design of the FLEXGRID systems. The security and ethical issues that are considered most relevant to the project pertain the two following areas:

- D9.1 – H (Humans) – Requirement No.1
- D9.2 – POPD (Protection of Personal Data) – Requirements No. 2-5

POPD requirements specific to FLEXGRID concern processing of *personal data*, regardless of the method used (e.g. interviews, questionnaires, direct online retrieval etc.).

Processing of personal data (POPD) means any operation (or set of operations) performed on personal data, either manually or by automatic means. This includes:

- collection (digital audio recording, digital video caption, etc.)
- recording
- organisation, structuring & storage (cloud, LAN or WAN servers)
- adaptation or alteration (merging sets, amplification, etc.)
- retrieval & consultation
- use
- disclosure by transmission, dissemination or otherwise making available (share,
- exchange, transfer)
- alignment or combination
- restriction, erasure or destruction.

Completely anonymised data does not fall under the data privacy rules (as from the moment it has been completely anonymised).

In reference to the FLEXGRID DoA, the following examines the relevant requirements analyzed in deliverable D2.1 that are to be considered given the data management plan as elaborated in the previous sections.

D9.1 : H - Requirement No. 1
The informed consent procedures that will be implemented for the participation of humans must be kept on file.

Research participants will be involved in WP7 pilot testing. As stated in D2.1, there will be some communication with different market actors in the flexibility market. Furthermore, there will be interactions of users with the FLEXGRID ATP as noted in section 3.1. Therefore, the selected participants should be informed of their rights and duties and will be invited to sign an informed consent.
The procedures and criteria for identifying potential participants will vary depending on the pilots. The first step in the process is to determine whether the data obtained is publicly available or not. The data which is publicly available will be registered as public and the not publicly available material will be treated as confidential and in line with POPD requirements below.

Title		
FLEXGRID ATP should adopt latest ethical standards for human beings		
Code id	**Component**	**Priority**
ATP-RQT_LRS_10	ATP	Essential
Description		
During developing ATP, especially communicating with different actors in the flexibility market, the EU ethical standards about human beings should be applied.		
Notes		
Informed consent forms will be used and kept on file.		

D9.2 : POPD - Requirement No. 2
Description of the technical and organisational measures that will be implemented to safeguard the rights and freedoms of the data subjects/research participants.

Each beneficiary organisation handling personal data will deploy technical and organisational measures to safeguard the rights and freedoms of research participants. Measures required include the following:

a) Details of the technical and organisational measures to safeguard the rights of the research participants. For instance: For organisations that must appoint a DPO under the GDPR: Involvement of the data protection officer (DPO) and disclosure of the contact details to the research participants. For all other organisations: Details of the data protection policy for the project (i.e. project-specific, not general).
b) Details of the security measures to prevent unauthorised access to personal data

c) How is all of the processed data relevant and limited to the purposes of the project ('data minimisation' principle)?
d) Details of the anonymization /pseudonymization techniques
e) Justification of why research data will not be anonymized/pseudonymized (if relevant)
f) Details of the data transfers (type of data transferred and country to which it is transferred – for both EU and non-EU countries)

As stated in the data management plan, data will be collected from industrial partners' business portfolios. Most of these datasets include data from markets, commercial entities, weather, etc. Such data is often commercially sensitive and subject to IPR concerns but fall outside the scope of *personal data* protection. There is however an amount of personal data that will be collected in carrying out the pilots, most importantly by partners UCY and BADENOVA. There will also be exchange of data with partner ETRA in order to display some information in the FLEXGRID ATP; the nature of this data is not likely to be of personal nature, but given the central role ETRA has in data exchange between the partners in the project, it is important to consider their data management strategy at this point (see more details in the Annex of this report).

The general rule for FLEXGRID is that personal data will only used by the project partners with a business relation with the persons in question. All personal data will be anonymized/pseudonymized as far as it is made accessible to other parties in the research project FLEXGRID. Therefore partners involved in personal data collection and processing have prepared a POPD strategy for the project, covering the abovementioned points. This is available in the Appendices.

Sensitive personal data, e.g., health, sexual orientation, ethnicity, political opinion, religious or philosophical conviction is not involved in the FLEXGRID project. Thus, the Post-Grant Requirement 4.3. 'Justification must be given in case of collection and /or processing of personal sensitive data', is not relevant for FLEXGRID Ethics.

Title		
FLEXGRID ATP should adopt latest ethical standards for personal data		
Code id	**Component**	**Priority**
ATP-RQT_LRS_11	ATP	Essential
Description		
Contractual agreements are needed among different actors for the system to operate the flexibility market.		
Notes		
This should be in accordance with Regulation (EC) No 45/2001 of the European Parliament and of the Council (5).		

Title		
FLEXGRID ATP should adopt latest ethical standards for end-users' assets data management		
Code id	**Component**	**Priority**

ATP-RQT_LRS_12	ATP	Essential
Description		
The agreement about the permission of final users' needs to exist in order to make use of their data; anonymization of prosumer data		
Notes		
The purpose of this agreement aims to identify the necessary infrastructure (including secure communication channels) available to access the required data, as well as monitoring and data processing of aggregated units.		

D9.3 : POPD - Requirement No. 3

In case personal data are transferred from a non-EU country to the EU (or another third state), confirmation that such transfers comply with the laws of the country in which the data was collected must be submitted with the Data Management Plan.

FLEXGRID has three partners from Norway (NODES, NPC, SIN) which has the status as associated in Horizon 2020. Association to Horizon 2020 is governed by Article 7 of the Horizon 2020 Regulation. Legal entities from Associated Countries can participate under the same conditions as legal entities from the Member States. These partners have confirmed that the ethical standards and guidelines of Horizon 2020 will be rigorously applied, regardless of the country in which the research is carried out. The personal data transformation among EU countries and non-EU countries are available for the FLEXGRID project. Every member of the FLEXGRID consortium will follow EU regulations, both from EU countries and non-EU countries. None of the envisaged specific ethic issues about the participation of a non-EU country will apply to FLEXGRID. In case activities undertaken in non-EU countries raise ethics issues, consortium needs to ensure that the research conducted outside the EU is legal in at least one EU Member State.

Title		
FLEXGRID ATP should adopt latest ethical standards for Non-EU country		
Code id	**Component**	**Priority**
ATP-RQT_LRS_14	ATP	Essential
Description		
Norway is a Non-EU country. The flexibility market regulation should in line with relevant requirements		
Notes		
Legal entities from Associated Countries have a similar status and can participate under the same conditions as entities from Member States. Article 7 within H2020 Programme Multi-Beneficiary General Model Grant Agreement sets out the conditions for association of non-EU countries to Horizon 2020		

D9.4 : POPD - Requirement No. 4

4.15 In case of further processing of previously collected personal data (e.g., in the context of smart metering), an explicit confirmation that the beneficiary has a lawful basis for the data

processing and that the appropriate technical and organisational measures are in place to safeguard the rights of the data subjects must be submitted with the Data Management Plan.

As stated in the data management plan in previous subsections 3.1-3.4, historical data will be collected from NPC's, BADENOVA's, HOPS and NODES business portfolios and will be processed as described in POPD – Requirement No. 2 described above. The data management plan describes the project structure for data sharing, arching and preservation. The research data will have uniform data structure, which is convenient for the consortium to have access to the data. In addition, the research data will be deposited and maintained in Zenodo, which is launched by CERN and OpenAIRE. This should follow the EU Data Protection Directive as well as the ISO27019 standard for privacy. The European users are served and run through the European Azure Datacenters in the Netherlands and Ireland. The consortium agreement for data arching and preservation should be made for future research or commercial development.

D9.5 : POPD - Requirement No. 5
The beneficiaries must evaluate the ethics risks related to the data processing activities of the project (e.g., large scale processing of consumer data). This includes also an opinion if data protection impact assessment should be conducted under art.35 General Data Protection Regulation 2016/679. The risk evaluation and the opinion must be submitted with the Data Management Plan.

The FLEXGRID project will develop algorithms for optimal management through very advanced microgrid optimizers/OPF, game theory and AI algorithms, e.g., WP3, WP4, WP5. This relates to ground-breaking and innovative research which involves the area of artificial intelligence (AI). In this area, any use of personal data should comply with the guidelines of European Commission's High-Level Expert Group on Artificial Intelligence (AI HLEG). However, personal data collected by beneficiaries will be processed as described in D9.2 POPD – requirement No. 2 as described above. In this the data transmitted to the partners processing the data in WP3, WP4 and WP5 will no longer be considered personal data.
It is therefore the opinion of the consortium that the data protection mechanisms in place by the relevant beneficiaries in requirement No2 mitigate the ethics risk of further processing of data, and further data protection impact assessment is not relevant for the project.

Title		
FLEXGRID ATP should adopt latest ethical standards for digitalization		
Code id	**Component**	**Priority**
ATP-RQT_13	ATP	Essential
Description		
AI issues is the latest issue that has been recently added to the ethics part. Therefore, the implementation of digitalization methodology should follow the relevant guideline and policy.		
Notes		
Relevant standards: The High-Level Expert Group on Artificial Intelligence from the European Commission (AI HLEG): Ethics Guidelines on Artificial Intelligence and Policy and Investment Recommendations.		

4. Dissemination and communication plan

FLEXGRID introduces a number of R&I activities that present strong exploitation potential and could significantly impact the development of: i) advanced modeling tools for the interaction between energy markets and smart grids' operation in the context of very high RES penetration, ii) intelligent research algorithms to identify optimal trade-offs between the flourishment of liberalized flexibility markets (i.e. towards minimum energy cost) and the stability of the underlying network (i.e. towards maximum security of supply), iii) innovative smart grid architectures and respective business cases, which will facilitate the maximum possible flexibility provisioning/trading and RES penetration without incurring technical problems in the operation of distribution and transmission grid.

In order to safeguard the generated IP, FLEXGRID consortium has agreed on an initial dissemination and exploitation strategy to be followed. This strategy, overseen by the Innovation and Exploitation Committee (InEC), will be updated every 6 months (if needed) and is depicted in the figure below.

As shown in Figure 11, FLEXGRID consortium will start building its R&I activities by exploiting: i) its existing research portfolio (i.e. scientific algorithms/intelligence) offered mainly by its academic partners, ii) its existing products/services being developed within ongoing H2020 flagship energy projects (e.g. WISEGRID, CROSSBOW, INVADE), and iii) its existing real-life datasets from market stakeholders and grid operators who are currently doing business in the EU area. The consortium will decide dynamically either to disseminate or exploit and protect foreground knowledge. In the former case, publications and depositing of research data (i.e. both algorithmic and data analytics results), which will be publicly available is provisioned. In the latter case, S/W licencing and other forms of protection measures will take place towards commercialization of the new value propositions and applications generated by FLEXGRID.

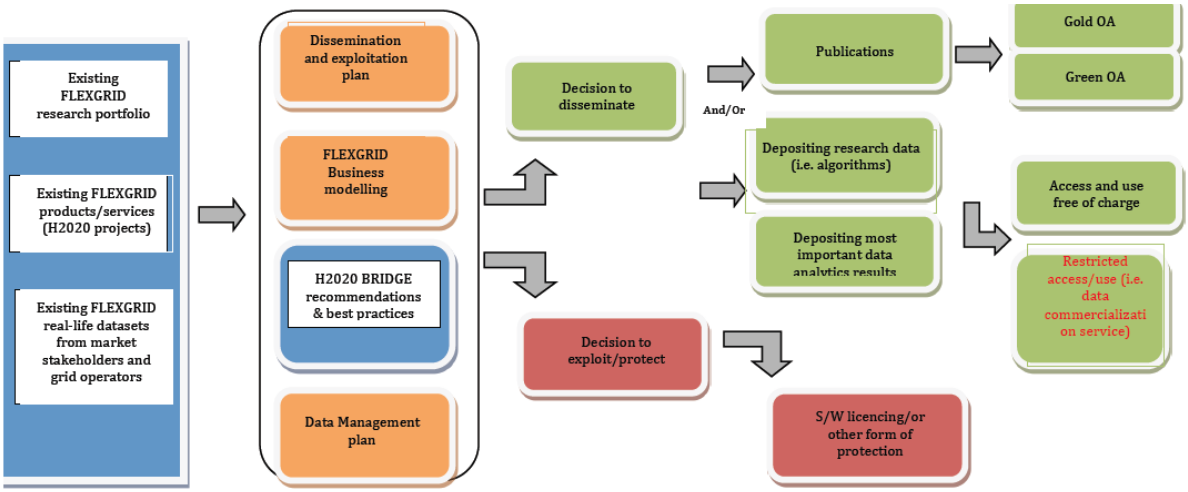

Figure 11: Dissemination and exploitation strategy of FLEXGRID consortium

4.1 Dissemination strategy

FLEXGRID will follow an open access dissemination strategy, providing online access to the appropriate scientific information and R&I actions generated in the project free of charge to

the end users. In more detail, the Innovation and Exploitation Committee (InEC) will identify dissemination target groups and propose the appropriate means of communication in order to maximize impact. Three main dissemination actions have been identified in FLEXGRID: i) publications, ii) dissemination of research-generated data to facilitate further research actions in the international research community, and iii) FLEXGRID's contributions/information exchange with relevant EU regulatory and policy making bodies and organizations:

- **Publications:** All FLEXGRID publications will be deposited to repositories enlisted in Open AIRE (Open Access Infrastructure for Research in Europe) in a machine-readable electronic copy at the latest upon publication. To ensure open access to the deposited publication, FLEXGRID consortium partners will then be free to choose between self-archiving and open access publishing ("gold" OA). In the case of self-archiving ("green" OA), FLEXGRID partners will deposit the final peer-reviewed manuscript in a repository of their choice ensuring open access to the publication within a maximum of six months. Alternatively, publications in open access journals will be pursued or in journals that also offer the possibility of making individual articles openly accessible.
- **Deposition of generated research data:** Following a similar strategy to publications, FLEXGRID aims to participate in the Open Research Data Pilot (ORDP). Research data generated within FLEXGRID, which the consortium decides that is suitable for sharing, will be openly accessible (i.e. follow the "as open as possible, as closed as necessary" approach). The Data Management Plan (DMP) of FLEXGRID is extensively described in chapter 3 above.
- **Contribution to related policy-making/regulatory efforts:** Here, the strategy is to ensure a significant contribution of the FLEXGRID to relevant EU policy-making and regulatory efforts towards promoting the clean energy transition and all political initiatives to be undertaken by Europe in the next decade (and even beyond). FLEXGRID will deposit most important data analytics results and thus inform the EU about the most promising research results in a very compact, fine-grained and structured way. Strong FLEXGRID liaisons with H2020 BRIDGE initiative (i.e. ETRA, SIN) will provide the required feedback to the ongoing BRIDGE working groups as analyzed in the subsection and table below.

4.1.1 Following up of latest EU legislative package and recommendations

Having strong liaisons with H2020 BRIDGE initiative[46], FLEXGRID consortium already has a good knowledge of and compatibility with current regulations, available/emerging standards, existing and emerging smart grid market architectures, market-related barriers and network-related constraints. Moreover, following up the legislative package "Clean Energy for all Europeans", the latest BRIDGE findings and recommendations are being used as input to FLEXGRID research activities. The table below summarizes the most relevant barriers/obstacles and regulatory framework conditions identified by the consortium, the state-of-the-art recommendations by BRIDGE and the contribution that novel FLEXGRID's R&I results will have. This last column of the table will be part of FLEXGRID's dissemination strategy.

[46] https://www.h2020-bridge.eu/

Table 19: List of barriers/obstacles and impact from expected FLEXGRID'S R&I results

Current barriers/ obstacles	Recommendations from EU BRIDGE initiative	Contribution from novel FLEXGRID R&I results
Flexibility markets in the EU area are still in an immature stage	- Need for a fair and open market for flexibility services - TSOs/DSOs should be allowed to spend more on flexibility services' provisioning - Incentives for end prosumers to participate in DSM programs	- FLEXGRID marketplace design - Business modeling for TSOs/DSOs as FlexBuyers - Advanced mathematical models for flexibility cost and value functions
Rigid regulation about unbundling of energy storage facilities	- Need for sufficient regulatory flexibility for experimentation with storage technologies by all actors, including TSOs/DSOs - Allow different parties to, temporarily and conditionally, experiment with the deployment and development of storage	- Lab-scale experimentation and simulation results from advanced models and algorithms
Proper remuneration of storage services is not guaranteed	- The legal framework should specify that TSOs/DSOs should be incentivized to procure flexibility services required for optimum operation of electricity systems	- Sustainable business modeling and value propositions for targeted B2B partnerships
No/Low flexibility value at DSO level	- Need for grid sizing/planning methodology evolution - Need to develop local flexibility even without local value in a first time	- Advanced models and algorithms for optimal FlexAssets' planning and operation
Regulation barriers on the provision of new flexibility services for and by DSOs	- FlexAssets should be allowed to offer FlexServices to the DSO either directly or via an aggregator[47] - Extend the role of DSO to take up additional responsibilities in the provision of new services to other market players[48]	- Advanced OPF models and algorithms for the interaction between the distribution grid operation and the markets (including TSO-DSO coordination schemes)
Regulation barriers related with local energy management	- Need for policy makers to provide incentives for distributed RES/storage investments - Self-consumption should be legally permissible[49]	- Optimal sizing and scheduling of distributed RES/ESS for energy prosumers
Market actor ownership of storage assets is still a public policy question[50]	- Need for coordination of centralized and distributed energy storage assets - Need for proper investment signals for distributed storage	- Optimal trade-off analysis regarding storage assets' mix - Market power mitigation analysis for social welfare maximization

[47] A few countries in the EU area allow this business. However, this is still in a rather immature stage and the majority of EU member states do not have even a regulatory framework for this.

[48] The DSOs should make sure that there is a level playing field for commercial actors and also derive future investment strategies that maximize the social welfare (i.e. find optimal trade-off between CAPEX and OPEX in the long term).

[49] Some EU member states do not even have a clear regulatory framework.

[50] Or else how much storage assets can be owned by a system operator in order to avoid instability/security of supply related problems in the future? FLEXGRID research will focus on this problem to identify the optimal trade-off between DSO's CAPEX and OPEX in the long term (cf. UCS 3.4 described in detail in previous FLEXGRID D2.1).

	- Regulated actors should not dominate flexibility markets[51]	
Lack of common EU legislation about balancing and frequency control services from storage	- Storage assets to provide active power (upward and downward); and 'response', to maintain frequency within predefined limits. - Storage owner companies should be able to bid for FlexServices in a flexibility market[52]	- Simulation results for rules development on FlexAssets' operation[53] - Lab-scale testbed for trading FlexAssets/Services via FLEXGRID S/W platform
New market design options and evolutions are not easily integrated in existing energy markets' operation	- Local grid constraints and energy transfer costs could be integrated in relevant market clearing algorithms, e.g. to prevent congestion. - Network codes should allow a more decentralised design of the market if this is economically optimal and does not endanger grid's security or stability	- Advanced game-theoretic and market mechanism design models for stakeholders' incentive compatibility and market power mitigation - Advanced market clearing algorithms taking into consideration grid constraints in the optimization problem
Lack or limited info exchange among energy market actors	- Leverage on open standard and protocols to facilitate interoperability among systems - Data accessibility to all market actors - Data granularity and (near-)real-time data availability	- Modular, configurable, customizable, open, and extendable FLEXGRID ATP - Well-designed technical APIs for easy subsystems' integration
Privacy preserving issues hinder market uptake	- Appropriate control of data access at various levels, in the respect of EU laws, legal contracts and customer wishes, need to be put in place and be supported by appropriate mechanisms	- By-design data security and privacy requirements for FLEXGRID ATP

4.2 Communication strategy

FLEXGRID's communication activities are categorized in 3 classes, namely: 1) communication activities in exhibitions and community building actions, where **ETRA, SIN and NPC** are responsible partners exploiting their large network of stakeholders and high-quality consulting capacity in the energy sector, 2) industry-oriented communication activities, being led by **NODES, BADENOVA, HOPS and Nord Pool** (as linked 3rd party of NPC) exploiting their ongoing business and B2B partnerships, and 3) training activities and academic dissemination, where **ICCS, DTU, UNIZG-FER, UCY and AIT** are responsible partners exploiting their deep scientific knowledge on the advanced interaction between the energy markets and smart grids' operation.

As a result, FLEXGRID partners are very active in promotion and dissemination actions and

[51] FLEXGRID will research novel flexibility market architectures in which DSOs/TSOs are not single FlexBuyers, but they also compete with BRPs, who may need to balance their portfolio.

[52] There are some business cases that do that now, but DLFMs are still in an immature commercial stage.

[53] Several novel energy/flexibility market architectures will be investigated within FLEXGRID. Some of them will be compatible with the existing situation, while others will be more revolutionary trying thus to maximize social welfare related metrics.

will realize a cooperative approach for converged industry and academia pathways. Communication activities in FLEXGRID are coordinated under WP8 and aim at promoting FLEXGRID and its innovation activities' results to a very diverse range of recipients. To maximize impact, the communication strategy will be guided by the following rules:

- Clearly identify different types of target audience and define respective communication strategy for each one.
- Define the objectives for each communication action with respect to the target audience.
- Define timelines for the project's promotion plan and ensure continuity of communication actions.
- Involve professionals, taking advantage of the in-house capacity available at large institutes within the FLEXGRID consortium.
- Quantify the results (e.g. number of papers, citations, visits on website, views on video clips, etc.) and provide feedback to dissemination and communication planning.
- Involve dissemination partners to multiply (press echoing) and amplify the message using their well-established communication paths. Exploit freely accessible EC tools.
- Define and agree within the consortium upon a simple procedure for checking the soundness and confidentiality level of information before disseminating (e.g. create "dissemination kits" with approved information; distribute new material and await confirmation by all partners within 7 days).

The FLEXGRID promotion plan will be updated regularly to provide concrete communication activities for each target group.

4.3 Categorization of FLEXGRID dissemination and communication activities

Summarizing the dissemination and communication strategies described above, the FLEXGRID dissemination and communication activities are presented in seven (7) main categories, namely:

- Academia-oriented publications and events
- Organization and participation at major international events
- Industry-oriented communication activities of FLEXGRID services and intelligence to interested stakeholders
- Open access FLEXGRID reports, data and software
- Training activities and academic dissemination
- Cooperation and mutual dissemination activities with other related EU projects
- Other general public dissemination actions

4.3.1 Academia-oriented publications and events

Regarding academia-oriented publications and events, there are three main sub-categories, namely: a) international conference papers, b) international journal papers, and c) organization of scientific FLEXGRID special sessions and/or workshops at international conferences.

Given the high-quality and mature research capacity of FLEXGRID's academic partners, we anticipate a total of 14 journal publications with very high impact factor (i.e. IEEE transactions on Smart Grids, IEEE transactions on Power Systems, Elsevier Sustainable Energy, Grids and

Networks, Elsevier JEPE, Elsevier EPSR, etc.) and a total of 18 conference publications in high-ranked IEEE venues (i.e. Powertech, ISGT, EnergyCon, SmartGridCom, PES GM, European Energy Markets, CIRED workshops, etc.).

Regarding (c), consortium partners are continuously seeking for related conference venues in order to organize a few scientific special sessions and/or workshops in cooperation with other related EU projects (such as the ones presented in subsection 4.3.6 below). All consortium partners aim at exploiting their participation and liaisons with other related projects in order to co-organize this type of scientific events within the project's lifetime.

ICCS will lead WP3-related contributions, UNIZG-FER will lead WP4-related contributions and DTU will lead WP5-related dissemination activities of this category.

4.3.2 Organization and participation in major international events

The FLEXGRID consortium plans to promote the project and its findings by displaying prototypes and DEMOs in international exhibitions through the boots and other promoting activities of its consortium members. In particular, SIN and ETRA will exploit its expertise on organizing ad-hoc events and workshops in the context of large-scale exhibitions towards building up communities of energy stakeholders in a bottom-up way. NPC will also exploit its direct communication pathways with prestigious market and grid operators not only within Europe, but also in international scale. FLEXGRID will target exhibitions are collocated with the biggest and most prestigious conferences in the converged energy/ICT field in Europe and the United States, and address scientific, technical and business audiences as: i) European Utility Week, ii) Energy Efficiency and Renewable Energy Forum and Exhibition for Europe, iii) Energy Efficiency Global Forum, iv) ESCO Europe forum, v) Smart Grid World Forum, vi) Distribution technology and innovation summit, vii) Energy Flexibility forum, viii) NCE Smart Energy Market's Partner Conference, and ix) EU Sustainable Energy Week, x) H2020 ICT Proposers Day. FLEXGRID industrial partners will also undertake this type of communication activities as they are all participating via sponsorships in several worldwide exhibitions.

Another dissemination path is through public events where the outputs of the project are presented to EU Officers, to experts and professionals, as well as to the general public. FLEXGRID's consortium plans to participate in the annual energy concertation meetings and/or similar events. This way, the consortium will exchange information with other similar projects funded by EC so as to increase interoperability and get new ideas on how the project should proceed. Furthermore, FLEXGRID aims at organizing special sessions/workshops in major international conferences collecting scientific contributions from many related projects. As a result, effective communication paths with other Project Coordinators will be established towards adopting the best possible practices of excellence and implementation of FLEXGRID research activities.

SIN will lead this type of dissemination and communication activities in collaboration with ETRA. SIN specializes in stakeholder engagement actions by organizing international events, supported by their NCE Smart Energy Markets cluster, in which many stakeholders attend and exchange ideas on new energy market developments and novel

business models. Moreover, ETRA will lead DEMO-related communication activities by demonstrating the FLEXGRID S/W platform's functionalities.

4.3.3 Industry-oriented communication activities of FLEXGRID services and intelligence to interested stakeholders

FLEXGRID promotion to research managers, company/industrial representatives and staff, will be pursued through the organization of workshops and public fora. Particular care will be given to the co-organization of the above activities with industrial organizations or clusters that will guarantee a high industrial participation. Moreover, for further promotion of the project and its findings to industry, communication activities will include publications in industrial magazines and participation of the industrial partners in related industrial meetings.

NODES, SIN, NPC, BADENOVA and HOPS will be mainly responsible to undertake these communication activities as they have very active participation in standardization activities and also a large customers' portfolio consisting of big players in the liberalized electricity market. Within the project's lifetime, two (2) industrial workshops or else DEMO days will be organized by FLEXGRID consortium towards interacting with the related business actors and disseminate project's results and potential innovation impact (indicatively the first event will be held right after 1st integration and validation activities and the second one within M33-M36 period).

Finally, given that B2B partnerships for participation in FLEXGRID's marketplace are an essential part of FLEXGRID's business model, we will appropriately inform interested industry partners, who would like to operate a FLEXGRID marketplace in their geographical region in the future. **NODES and NPC will lead this communication activity.**

For each one of the identified FLEXGRID's services outlined in chapter 2, communication activities will also take place with targeted customer segments towards bringing these minimum viable products as close to the market as possible at the end of the project's lifetime and attract real market stakeholders' interest, too. According to the consortium's strategy, a long list of value propositions has been created at the beginning of the project (see section 2.2) in order to identify all possible customer segments, which may be interested in purchasing FLEXGRID services. Much more details about FLEXGRID value propositions will be provided in D8.2 (M18) and D8.3 (M36).

In the following, we provide a list of indicative communication activities that will take place:

- Webinars: Organization of webinars through which energy market stakeholders, grid operators, consulting companies, energy prosumers/communities, FlexAsset owners, public authorities' representatives, grassroots community organizations etc. will be invited to become aware of FLEXGRID's platform novelties. This action is closely inter-related with exploitation activities and the functionalities from the platform will be used towards this goal. **SIN will coordinate this activity.**
- Online marketplaces for energy flexibility trading: The FLEXGRID platform is able to be exploited from Flexibility Market Operators (FMOs) as well as ad-hoc B2B partnerships of energy stakeholders (i.e. at least one big FlexSupplier and one big FlexBuyer actor). At

the final stage of the project, FLEXGRID, **through NODES' leadership**, will try to attract the stakeholders, who would like to participate in flexibility marketplaces in order to educate them on the features of the platform and persuade them to participate and extend their business through it.

- Regulators and policy makers**:** The best pathway to communicate FLEXGRID's results to EU regulating and policy making bodies and organizations is through H2020 BRIDGE initiative. BRIDGE is a European Commission initiative, which unites Horizon 2020 Smart Grid and Energy Storage Projects to create a structured view of cross-cutting issues, which are encountered in the demonstration projects and may constitute an obstacle to innovation. The BRIDGE process fosters continuous knowledge sharing amongst projects thus allowing them to deliver conclusions and recommendations about the future exploitation of the project results, with a single voice, through four different Working Groups representing the main areas of interest. FLEXGRID has many liaisons with BRIDGE (i.e. 6 partners are currently participating in projects included in the BRIDGE initiative). **SIN and ETRA (as project coordinators of several H2020 energy flagship projects like WISEGRID, CROSSBOW and INVADE) will lead this task.**
- Public authorities: Many public authorities (e.g. municipalities, ministries, etc.) own a lot of buildings (e.g. schools, hospitals, government) and influence many communities of people. FLEXGRID will use its related liaisons to establish/extend relationships with such communities in order to allow them to be informed about the recent advancements in flexibility markets and the impact that these may have in local communities and efficient grid operation. **BDNV will lead this task exploiting its experience from Thuega group and respective public municipality affiliations.**
- Grassroots community organizations: In our days, a large number of grassroots organizations are focusing on the environment and it is well known that lack of energy historically led even to the beginning of wars. FLEXGRID will try to communicate with targeted liaisons (e.g. H2020 FLEXCOOP project where ETRA is technical coordinator) in RESCOOPs and smart energy communities, which want to be front-runners in Europe's green energy transition era. **ETRA will lead this activity.**

4.3.4 Open Access FLEXGRID reports, data and software

Regarding the open access FLEXGRID reports, data and software, there are three main sub-categories, namely: **a) public FLEXGRID reports and deliverables, b) open access datasets, and c) open access FLEXGRID software and user manuals**.

Regarding (a), all FLEXGRID deliverables (together with all other dissemination material like the ones presented in subsection 4.3.7 below) are made public in the project's website (see the "Downloads" tab[54]), so as everyone may have access and download the respective material. Publishable summaries for the 2 reporting periods will also be publicly available in the same web portal. Moreover, internal consortium reports, mainly of confidential nature will be made available via "FLEXGRID Members' area" to FLEXGRID Advisory Board members (mainly stakeholders coming from NPC's, NODES, BDNV's and HOPS business portfolio).

[54] https://flexgrid-project.eu/deliverables.html

Regarding (b), each FLEXGRID subsystem/module will provide open datasets to be used mainly for research purposes. For more details about the structure and contents of these datasets, please see section 3 about the Data Management Plan – DMP above.

Finally, regarding (c), the consortium's strategy is to have a basic version of S/W prototypes fully accessible to anyone interested in understanding the basics about the whole system's operation and experiment with its innovative functionalities. In particular, a comprehensive user manual will be available for every subsystem/module and the system as a whole in order for everyone to be able to start experimenting with the platform's functionalities. This is done in order to further disseminate the project's results (i.e. FLEXGRID foreground knowledge). However, the final version of S/W prototypes (especially regarding the FLEXGRID ATP) will be kept in "closed/restricted access" in order to boost the commercial exploitation activities of the involved companies and protect the respective IPR.

ICCS will lead this activity being responsible for periodically updating the FLEXGRID's website with new dissemination and communication material.

4.3.5 Training activities and academic dissemination

FLEXGRID's training and knowledge dissemination activities will be mostly focused on young researchers, students, energy citizens, energy communities and industry professionals. These activities will include the preparation of training workshops, educational material for technical schools and universities, detailed presentations and guidebooks for professionals and online project presentations on FLEXGRID-related scientific topics publicly available through the project's website. The main responsible partners for these activities will be ICCS/NTUA, UCY, DTU, UNIZG-FER and AIT, who will exploit their mature research and tools that will be further tested and validated during demonstration phase (i.e. proof-of-concept lab experimentations). More specifically, they will use FLEXGRID's results as the basis of further research beyond the scope and lifetime of the project, strengthening their research work and achieving publications to international conferences and prestigious scientific journals with high impact factor. Finally, academic partners plan to use architectures, algorithms, methodologies and other public results of the project for advanced, specialized courses given to graduate students and for new Ph.D. theses.

Academic partners will also organize research brainstorming days, in which FLEXGRID research results will be presented to targeted audiences of scientific professionals with high impact in the research community. In these workshops, there will be exchange of ideas among PhD students, senior researchers and professors. The goal is to realize new academic partnerships in order to deepen the research in the fields that have high impact on the interaction of liberalized energy markets with the smart grids' operation.

DTU will lead this activity exploiting its large and international academic portfolio and its experience in organizing summer/winter schools and other types of research brainstorming workshops and training activities.

4.3.6 Cooperation and mutual dissemination activities with other related EU projects

FLEXGRID consortium aims at having mutual dissemination activities, collaboration and knowledge/ideas' exchange with several H2020-LC-SC3-ES-6 "sister" projects[55] [56] in which several FLEXGRID partners are also participating. Project coordination and technical management team will also try to get in contact with other project coordinators, too. In the following table, the cooperation and potential mutual dissemination activities with other related EU projects are presented:

Table 20: Cooperation and dissemination activities' potential with other related EU projects

Project Name and objectives	FLEXGRID interaction
WISEGRID[57] project coordinated by ETRA is a H2020 flagship project providing a set of solutions, technologies and business models, which increase the smartness, stability and security of an open, consumer-centric European energy grid. It also provides cleaner and more affordable energy for European citizens, through an enhanced use of storage technologies and electro-mobility and a highly increased share of RES. It aims to deliver the BMs that will facilitate the creation of an open market and enable all energy stakeholders to play an active role towards a democratic energy transition.	FLEXGRID will exploit ETRA's background knowledge and experience on developing S/W tools and applications for energy market stakeholders such as DSOs, ESPs, RESCOOPs and aggregators. FLEXGRID will also exploit existing communication channels built within WISEGRID project in order to disseminate its foreground knowledge regarding the related innovative services (i.e. intelligence provided by advanced mathematical models and research algorithms integrated in existing WISEGRID tools).
INVADE[58] project coordinated by SIN has developed a cloud-based flexibility management system integrated with EVs, ESSs and DSM to increase the share of renewables in the smart grid. It also envisages new marketplaces to trade energy and energy services, which in turn will provide end users with better services. The electric grid manager will also benefit from this by better being able to manage their resources through big data analytics.	FLEXGRID will exploit SIN's existing knowledge and experience on developing ICT platforms to facilitate the interaction and trading of flexibility assets between various energy market stakeholders. FLEXGRID will also exploit existing communication channels and liaisons built within INVADE project in order to disseminate more advanced results.
CROSSBOW[59]coordinated by ETRA is another large-scale H2020 project offering a set of technological solutions, which enable the shared use of resources to foster transmission networks cross-border management of variable renewable energy and storage units. Through it, TSOs increase their grid flexibility and robustness through: i) better control of cross-border balancing energy at interconnection points, ii) new storage solutions – distributed and centralized-, offering ancillary services, iii) better ICT	FLEXGRID will exploit ETRA's experience on developing ICT platforms that model the TSO-TSO, TSO-DSO and DSO-DSO collaboration. ETRA will also exploit the existing CROSSBOW's liaisons with EU system operators in order to disseminate FLEXGRID results related with novel energy market architectures that try to maximize social welfare. Another goal is for some CROSSBOW industrial partners (including

[55] https://cordis.europa.eu/search/en?q=contenttype%3D%27project%27%20AND%20programme%2Fcode%3D%27LC-SC3-ES-6-2019%27&p=1&num=10&srt=contentUpdateDate:decreasing

[56] https://cordis.europa.eu/search/en?q=contenttype%3D%27project%27%20AND%20%2Fproject%2Frelations%2Fassociations%2FrelatedSubCall%2Fcall%2Fidentifier%3D%27H2020-LC-SC3-2019-ES-SCC%27&p=1&num=10&srt=Relevance:decreasing

[57] https://www.wisegrid.eu/

[58] https://h2020invade.eu/

[59] http://crossbowproject.eu/

and Communications enabling flexible generation and Demand Response schemas, iv) definition of a trans-national wholesale market, proposing fair and sustainable remuneration for clean energies through the definition of new business models.	HOPS) to serve as advisory board members for FLEXGRID consortium by reviewing key project's results and providing their comments/recommendations.
GOFLEX[60] develops commercial platform able to: i) create the prerequisites to support high shares of distributed renewable energy generation, ii) improve observability and manageability of distribution grids, iii) increase the grid's available adaptation capacity avoiding investments in transmission and distribution networks, iv) develop the commercial use of prosumer flexibility to balance local energy.	FLEXGRID will exploit UCY's experience on building up UCY pilot cases and ways that these can be enhanced within FLEXGRID. Best practices, problems encountered and lessons learned will also be communicated from GOFLEX regarding the development of the Automated Trading Platform (ATP).
FLEXCoop [61] introduces an end-to-end Automated Demand Response Optimization Framework. It enables the realization of novel business models, allowing energy cooperatives to introduce themselves in energy markets under the role of an aggregator. Optimization in FLEXCoop applies to multiple levels. It spans local generation output, demand and storage flexibility, as well as the flexibility offered by EVs to facilitate maximum RES integration into the grid, avoidance of curtailment and satisfaction of balancing and ancillary grid needs.	FLEXGRID will exploit ETRA's experience in working with EU RESCOOPs towards applying its S/W products in real-life pilot cases throughout Europe. The existing portfolio of public municipalities, energy communities, smart cities and RES cooperatives will also be exploited towards communicating FLEXGRID results.
FLEXIGRID[62] is a H2020 project. Its goal is to develop solutions that will protect the security and reliability of the electricity grid as it incorporates growing amounts of RES. It aims to make the distribution grid operation more flexible and cost efficient through the development of four hardware and four software solutions. A single, open-source platform will integrate the different solutions and make them interoperable with the IT systems used by energy stakeholders. The project has defined eight use cases that will be demonstrated in four countries. The demonstration sites will be operated by three distribution system operators and two large companies.	FLEXGRID will exploit UNIZG-FER's knowledge and experience gained while participating in the FLEXIGRID project. As two projects have similar timeline, there is a big opportunity to tackle some problems together and co-integrate solutions adjusted for the respective projects. FLEXGRID will also exploit existing communication channels and liaisons being built within FLEXIGRID project in order to disseminate more advanced results.
The **EUNIVERSAL**[63] project aims to create a Universal Market Enabling Interface concentrating on interfaces to connect FSPS/ESPs, smart grid solutions, different market mechanisms and products. The concept will be tested in various distinct energy environments in Europe for its viability and universality regarding different markets, market-specific requirements and products as well as market	With regard to the universal approach of both projects, the outcome of EUniversal and FLEXGRID will provide useful insight into the potential of flexibility markets and the integration of new technologies and adaption/improvement of mathematical models for validation purposes and financial reward enhancement of every

[60] https://goflex-project.eu/
[61] http://www.flexcoop.eu/
[62] https://cordis.europa.eu/project/id/864579
[63] https://cordis.europa.eu/project/id/864334

participants and platform users. Additionally, in the context of the project, different FMO concepts will be tested thereby offering the possibility to carefully evaluate the suitability of the different platform concepts.	participant. NODES platform will provide a core system in both projects thereby being tested continuously for its potential to establish a dynamic and transparent market place in terms of interconnection with various systems, optimized and increased data input/processing as well as advanced modelling and pricing algorithms to realistically display a functional flexibility market.
FEVER [64] project will implement a comprehensive flexibility aggregation, management and trading solution that incorporates intelligence around the optimal flexibility orchestration and is capable to offer flexibility services in different markets (local, wholesale). In addition, a peer-to-peer flexibility trading toolbox will be implemented with a distributed ledger technology enabling autonomous peer-to-peer trading. FEVER will implement a set of goal-oriented applications and tools that empower DSOs with optimal grid observability and controllability.	FLEXGRID will exploit UCY's participation in FEVER in order to establish efficient communication channels between the two relevant H2020 projects. Moreover, ICCS coordination team will seek for opportunities for mutual dissemination activities with FEVER project coordination team.
INTERPLAN is a project (technically coordinated by AIT) that aims to provide an INTEgrated opeRation PLANning tool towards the pan-European network, to support the EU in reaching the expected low-carbon targets, while maintaining network security. INTERPLAN will provide a methodology for a proper representation of a "clustered" model of the pan-European network, with the aim to generate grid equivalents as a growing library able to cover all relevant system connectivity possibilities occurring in the real grid, by addressing operational issues at all network levels (transmission, distribution and TSOs-DSOs interfaces).	FLEXGRID will exploit AIT's experience in developing, emulating and validating various TSO-DSO coordination schemes by utilizing its prestigious large research infrastructure. FLEXGRID will also take advantage of INTERPLAN investigations of flexibility possibilities coming from storage and demand response singly or aggregated. AIT will also integrate novel market clearing algorithms in its existing research infrastructure to validate theoretical/ simulation results at TRL 5.
PANTERA [65] is a CSA EU H2020 project aimed at setting up a European forum composed of Research & Innovation stakeholders active in the fields of smart grids, storage and local energy systems, including policy makers, standardisation bodies and experts in both research and academia, representing the EU energy system. The main objective is to develop a pan-European multi-dimensional collaborative platform, capable of leveraging coherence and trust as a pull towards enhanced R&I in energy systems centered around an integrated grid active and responsive.	FLEXGRID can interact with PANTERA platform that will be launched within 2020 for the best interest of the project by means of having access to valuable data or sharing results etc. UCY is PANTERA project's coordinator, so it will be the liaison partner for all possible mutual dissemination and communication activities.

[64] https://cordis.europa.eu/project/id/864537
[65] https://cordis.europa.eu/project/id/824389

4.3.7 Other general public dissemination actions

Web portal: A web portal[66] (starting its operation from M2) has been developed by ICCS in order to provide a portal through which continuous updates about the project progress and the results are presented. The website has a public area, targeting users external to the consortium, and an internal, password protected area. The public area includes information about the project objectives, latest achievements, public deliverables, white papers and vision papers, as well as information on the consortium beneficiaries, their background and contribution inside FLEXGRID. This part of the website aims to raise the image of the project and improve dissemination to specialists, potential users of FLEXGRID intelligence, policy makers and public authorities, as well as the general public.

Public Events: Another dissemination path is through public events, where the outputs of the project are presented to EU Officers, to experts and professionals, as well as to the general public. FLEXGRID consortium plans to participate in the annual cluster meetings and events organized by the EC. This way, the consortium will exchange information with other similar projects funded by EC so as to increase interoperability and get new ideas on how the project should proceed. As a result, effective communication paths with other Project Coordinators will be established towards adopting the best possible practices of excellence and implementation in FLEXGRID research activities.

"Mass media" (TV, radio and the written press): For the general public, mass media is the main source of knowledge regarding science and news about innovative services and products. The FLEXGRID consortium is fully aware of the large audience that the mass media involve, as well as their power as an efficient and cost-effective way of transmitting information. Dissemination of the project results will be actively pursued through video interviews, presentations of project related events, as well as press releases, news-bulletins, press conferences and interviews for relevant European and national trade newspapers. Additional activities include: i) Press: Press releases, news-bulletins, press conferences and interviews will be organized for relevant European and national trade newspapers, as well as publication of corresponding papers, journals and articles. At least three press releases are foreseen for FLEXGRID's promotion strategy and will be provided by the industrial consortium members at the beginning and at the end of the project, and after the first demonstration of FLEXGRID's system prototype, ii) Scientific magazines: FLEXGRID members will also publish research articles containing breakthrough project results with simplified technical content, describing the vision of the project. The non-technical articles will be based on latest results from the FLEXGRID ATP in a way that is comprehensible to the general public. SIN with a huge experience in this area will lead this task, also producing marketing kit material such as booklet, flyers, posters, etc. when needed, iii) Social Media: Taking advantage of the popularity of social media, especially in the under-30s target group, FLEXGRID will create project accounts on the most popular social media sites such as Twitter, youtube, etc. SIN will also lead this activity.

NOTE: Specific and measurable dissemination and communication related targets have been set at a consortium level and are reported in the table below. The progress will be monitored by the coordinator and each activity's leader periodically (i.e. every six months).

[66] https://flexgrid-project.eu/

Table 21: FLEXGRID dissemination and communication targets at consortium level

Dissemination/ communication activity	How?	Number of Events				Target Group	Leading (and key) partners
		1st	2nd	3rd	Total		
Publications in journals	To publish papers in scientific journals with high impact factor	2	5	7	14	International research community	**ICCS (L)**, DTU, UNIZG, UCY, AIT
Publications in conferences/ workshops	To publish papers in prestigious scientific conferences	4	7	7	18	Targeted researchers related with flexibility markets	**ICCS (L)**, DTU, UNIZG, UCY, AIT
Organization of Special Sessions (SS)/ Issues (SI)	Organize SS and SIs in well-known journals and conferences	1	1	2	4	International research community	**DTU (L)**, ICCS, UNIZG, UXY, AIT
Participation in major international events	Demonstrating FLEXGRID results in international exhibitions	2	2	2	6	Energy market stakeholders	**SIN (L),** ETRA
Industry-oriented communication activities	F2f meeting with targeted industrial actors	3	4	4	11	Targeted industrial companies (DSOs, TSOs, MOs, ESPs)	**NODES (L)**, NPC, SIN, BDNV, HOPS
Open access reports	Official deliverables	6	7	6	19	Publicly available information	**ICCS (L)**
Open access datasets	Experimental data inputs, results and analytics	0	0	4	4	Researchers who want to reproduce results	**ICCS (L),** UNIZG, DTU, UCY, ETRA
Open access S/W prototypes and user manuals	Deliverables being accessible via project's GitHub area	0	1	1	2	S/W developers who want to reproduce the platform	**ETRA (L)**, ICCS, UNIZG, DTU
S/W toolkits' demonstration	Release of DEMO videos for each module and system as a whole	0	1	4	5	Policy makers, industrial/ commercial actors	**ETRA (L)**
Organization of workshops on business prospects of the project	To describe business potential of flexibility markets	0	1	1	2	Start-ups, SMEs, entrepreneurs, etc.	**SIN (L)**

Academic training events/ schools	Presenting FLEXGRID research results	0	1	1	2	MSc, PhD, PostDoc students, senior lecturers/ researchers	**DTU (L)**
Academic lectures/ talks	Presenting FLEXGRID research results	2	4	4	10	BSc, MSc students in prestigious academic hosts	**DTU (L)**, UNIZG, UCY, ICCS
Participation in standardization committees	Contributing to both project's progress and standardization efforts	1	1	1	3	Members of well-known smart grid standardizatio n committees	**AIT (L)**, UCY, DTU
Participation in EU project cluster meetings	Contribution to related policy-making/ regulatory efforts	1	1	1	3	Project coordinators from key/ flagship EU projects	**ICCS (L)**, ETRA, SIN

5. Exploitation Plan

5.1 FLEXGRID exploitable assets

For each one of the FLEXGRID's exploitable assets, four (4) subsections are provided stating the asset's: a) description, b) main functionalities, c) innovation aspects, and d) target groups. We consider that each asset can be individually exploited by the partner that develops it. However, the strategy of FLEXGRID is to integrate all 4 exploitable assets into one single FLEXGRID S/W platform in order to maximize its commercial/business impact and offer respective benefits and added value/background knowledge to all partners after the end of project's lifetime.

5.1.1 FLEXGRID Automated Trading Platform

The FLEXGRID Automated Trading Platform is a computational tool able to support the optimal and automated planning and operation of the markets that modern stakeholders require in order to interact towards competitive energy services through advanced flexibility trading between i) ESPs (i.e. FlexSupply side) and DSOs/TSOs (i.e. FlexDemand side) as B2B and between ii) ESP/aggregator/retailer and end users (i.e. end energy prosumers) as B2C.

The FLEXGRID ATP provides an online marketplace for real-time capacity trading to purposefully integrate the flexible capacity potential of production and consumption units both of industrial companies and decentralized residential units. By interconnecting the marketplace with multiple research toolkits and different markets, FLEXGRID ATP facilitates an optimized usage of available flexibilities with regard to real-time market and network conditions.

5.1.1.1 Asset description

The Automated Trading Platform (ATP) is designed to provide a realistic, transparent and multi-faceted tool for real-time capacity and energy trading. The set-up is a modular-by-design architecture to ensure compatibility of the ATP platform with the existing legacy technology of energy sector stakeholders (e.g., DSO/TSO DMS/SCADA systems) and existing energy market designs. The design of the core FLEXGRID ATP will be based on NODES market platform for real-time capacity trading between various market participants from the consumption and generation side. Three major subsystems in the FLEXGRID S/W architecture will connect to the core platform each one designed to improve the operation and coordination of the network/grid and/or to improve the financial revenue of the platform users, namely:

1) Automated Flexibility Aggregation Toolkit (AFAT)
2) FlexSupplier's Toolkit (FST)
3) Flexibility Market Clearing Toolkit (FMCT)

These subsystems are described in more detail in the following sections 5.1.2 – 5.1.4. The FLEXGRID ATP as a whole includes thus several optimized and advanced market-specific mathematical algorithms and forecasting mechanisms to place FlexRequests on the trading platform with consideration of every user and related financial targets and operational tasks, markets and market products.

Note: There exists no maintenance or update obligation for NODES in case the ATP will be used for research purposes or even commercial purposes after the FLEXGRID project termination or in case the ATP will be used outside the project context.

5.1.1.2 Main functionalities

The Automated Trading Platform's key functionalities are described hereafter:

- Platform for real-time capacity trading (Flexibility Market) with consideration of different markets and products.
- Graphical User Interfaces (GUIs) for all FLEXGRID types of users, who want to visualize the most important information, manage their business and run exhaustive system-level simulations in order to optimally operate and/or plan their energy services.
- Extraction of flexibility market data such as historical prices and bidding curves.
- Flexibility Market analyses and monitoring.
- Advanced Market Clearing and OPF algorithms for DSOs/TSOs to effectively support operational tasks and grid coordination and to reduce costs due to grid constraints and curtailment.
- A meta-service able to transform: i) Flexibility assets (e.g. ESS, EVs, load shifts and curtailments, etc.) into FlexOffers (cf. FST module), and ii) Risk Monitoring Models into FlexRequests (cf. FMCT module).
- Advanced Retail Market Mechanisms towards retail pricing services (B2C) that will: i) reflect the dynamic wholesale market prices onto the end users' payments and ii) be able to harmonize very dynamically end-user consumption patterns with frequency and voltage control dynamic requirements that are indirectly communicated to them through the FLEXGRID's B2B real time markets.
- Automated Operation of RTM through advanced trading services including timing, automation, and security preservation of each FLEXGRID transaction. FLEXGRID will pay special attention to the development of models that capture the interaction between advanced trading schemes (e.g. P2P trading through blockchain) and electricity grid cost and constraints.
- Sophisticated Application Programming Interfaces (APIs), which will facilitate the high modularity, openness, multi-sidedness, configurability, replicability and extensibility of FLEXGRID's services.

5.1.1.3 Innovation (including comparison with SotA and existing competitors)

In order to achieve the foreseen functionalities described in subsection above, the project will stand in legacy SotA software developed in successful R&D projects enhanced with innovative features tailored for such a purpose. Among these features, it is worth highlighting:

- Intelligent ESS and DSM management algorithms and business models that are related to modern ESPs. FLEXGRID proposes a simultaneous interaction of ESS systems with multiple markets and intelligent sizing, siting and scheduling of ESS in a modern landscape with high RES penetration (cf. FST asset description in subsection 5.1.3).
- Innovative features for advanced flexibility services and optimized operation of electricity grid reducing potential necessary grid investments. Increased controllability

that former software offers by exploiting the recent and vast advances in OPF theory and market clearing (cf. FMCT asset description in subsection 5.1.4).
- Advanced B2C and B2B market architectures for high RES penetration, advanced data analytics taking into account an optimal mix of energy-, end user behavior and grid topology data.
- Recent theoretical advances in convex optimization and game theory case studies will be used in order to serve network control and flexibility markets respectively.

These enhancements will bring SotA with new capabilities to attend and give new services to intelligent stakeholders in advanced electricity markets.

5.1.1.4 Target group

Smart grids are still in the R&D and demonstration phase with only few cases of true commercialization. The trend however is slowly developing towards commercialization with some smart grid applications being more advanced than other. Regulatory, financial and social barriers have slowed down wider adoption and deployment of commercialized smart grid solutions around Europe.

The target group for ATP is a new market actor called Flexibility Market Operator (FMO). In a second order of importance, DSOs, ESPs and aggregators are also key stakeholders to target on the different exploitation and dissemination activities. FLEXGRID will exploit NODES background experience in business modelling and commercial interaction with both FlexDemand and FlexSupply sides of the market.

5.1.2 Automated Flexibility Aggregation Toolkit (AFAT)

5.1.2.1 Asset description

The Automated Flexibility Aggregation Toolkit (AFAT) is one of the three S/W toolkits, in which FLEXGRID research algorithms will be integrated. AFAT serves as a backend module providing the required intelligence to the core FLEXGRID ATP (i.e. frontend) for the aggregator and retailer user. The AFAT requirements' analysis has already been reported in section 6.2.3 of D2.1 in January 2020. Moreover, D2.1 also includes the user requirements' analysis for the aggregator and retailer users (cf. section 6.1). Finally, the AFAT's internal architecture together with the technical specifications are documented in section 4.3.2 of D2.2 (to be delivered in March 2020).

In a nutshell, AFAT is the S/W toolkit that integrates the most important WP3 algorithms and its operation is closely inter-related with HLUC_04 described in detail in section 4.4 of D2.1. More specifically, AFAT will integrate three basic types of algorithms, namely: i) forecasting engine, ii) flexibility aggregation algorithms' module, and iii) retail pricing algorithms' module. The AFAT module will mainly interact with two FLEXGRID modules, namely the core ATP module, and the central FLEXGRID database. The ATP will issue commands for: i) executing algorithmic tasks on the Flexibility Aggregation Algorithm sub-module and on the Retail Pricing Algorithm sub-module residing at the AFAT module, ii) returning the results of the algorithmic executions, as well as monitoring the status and canceling/resubmitting tasks. Moreover, in order for the AFAT module to execute the algorithmic tasks, it may

download data from the central FLEXGRID database. Most important algorithmic results will also be stored in the central database from where they will be easily retrievable through a web API.

5.1.2.2 Main functionalities

As already stated, three main types of algorithms and respective mathematical models will be integrated in AFAT. *"Forecasting Engine"* is used for generating forecasts with respect to energy consumption, energy production and storage, as well as market data (prices), that will be used by the flexibility aggregation algorithm submodule, in order to produce the Demand Response activation schedule, in reaction to a FlexRequest that is received by the ATP. The required input data will be retrieved by the central database. More details about the functionality of this sub-module are provided in the description of HLUC_04_UCS_04 in section 5.4.4 of D2.1.

The "*Flexibility Aggregation Algorithms"* sub-module is responsible for generating the optimal Demand Response activation schedule, which consists of a set of end prosumers that will participate in the FlexRequest event by reducing their consumption or by raising their production. For each participating prosumer, a time-series of the demand reduction/production increase of each time interval will be produced, as well as an execution plan that will show which devices will participate for each prosumer at each timeslot. Moreover, the outcome of this algorithm will be an optimal FlexOffer that will be submitted to the core ATP via a web API. Once the flexibility market has been cleared, ATP will send an acknowledgement message to AFAT about the acceptance or rejection of the aggregator's FlexOffer. The final step will be for the AFAT to send the dispatch (i.e. setpoints) to each individual energy prosumer in order for the activation of the FlexAssets to take place. More details about the functionality of this sub-module are provided in the description of HLUC_04_UCS_01 in section 5.4.1 of D2.1.

The *"Retail Pricing Algorithms"* sub-module is responsible for providing an intelligent API that will be used for optimizing the pricing models and their parameters that the retailer/aggregator user will make available to its end users. This sub-module will also integrate the sophisticated B2C flexibility market models that are run by aggregator or retailer market stakeholder. More specifically, the aggregator/retailer user will be able to fill in the required input parameters in the ATP GUI (i.e. frontend system) and submit a request for the retail pricing algorithm to run in the AFAT. This will be a (bunch of) simulation scenario(s) that will compare various retail pricing schemes. The algorithmic results will be posted back to the core ATP, where the aggregator/retailer will be able to visualize and thus identify/define the best pricing strategy and structure of FlexContracts to adopt in the future. The most important Key Performance Indicators (KPIs) will be company's profit maximization and end users' welfare maximization between which the aggregator/retailer user will be able to easily identify the desirable trade-off that best fits its business strategy/plan. More details about the functionality of this sub-module are provided in the description of HLUC_04_UCS_02 and HLUC_04_UCS_03 in sections 5.4.2-5.4.3 of D2.1.

5.1.2.3 Innovation (including comparison with SotA and existing competitors)

The innovative features of AFAT are closely inter-related with the novelty of the integrated research algorithms that are stated above. Regarding *"forecasting engine"*, *t*he main novelties are the following:

- Forecasting accuracy enhancement in the energy prosumption curves in order to mitigate the effects of forecast uncertainty introduced by high RES penetration.
- Fine-grained and interoperable S/W tool needed to develop services that will help RESPs to compile their portfolio with high levels of accuracy towards making their RES farms dispatchable units.
- Advanced market price forecasting models able to exploit historical data from various energy and flexibility markets.

Regarding *"Flexibility Aggregation Algorithm"*, the novel mathematical models and algorithms can be summarized as follows:

- Novel energy service provisioning to enhance the end prosumer's quality of service and experience (QoS/QoE), while creating new revenue streams to aggregators.
- Novel B2C flexibility market mechanisms, which will increase the profits of aggregator and make its business models economically sustainable.
- Automated flexibility aggregation management service offered to the aggregator

Finally, as of *"Retail Pricing Algorithms"*, the respective novelty features to be offered to the retailer user are:

- Advanced retail flexibility market services
- Automated composition of B2C real-time flexibility markets
- Advanced AI-based modelling tools for retail flexibility market

5.1.2.4 Target group

AFAT is designed in a way that can be commercially exploitable as a standalone S/W toolkit, which can be integrated as S/W "plug-in" in other larger S/W platforms developed by energy aggregator and retailer companies in the future. Within the FLEXGRID's context, AFAT will be integrated in the FLEXGRID S/W platform (ATP) and its operation will be tested via extensive lab experimentations and pilot tests within WP7. The main target groups of AFAT are:

- Individual researchers and research groups, who want to use AFAT for research and experimentation purposes.
- Aggregators (either independent companies or part of progressive utility companies or else ESPs) for business provisioning of new innovative FlexContracts with their end users.
- Retailer companies for simulating advanced pricing schemes before releasing them in the retail electricity/flexibility markets.

5.1.3 FlexSupplier's Toolkit (FST)

5.1.3.1 Asset description

The FlexSupplier's Toolkit (FST), as one of the three S/W toolkits of FLEXGRID S/W platform, integrates one part of the FLEXGRID research algorithms. FLEXGRID ATP is a front-end module, so the potential users, such as Energy Service Providers (ESPs), access the desired toolkit through the mentioned module. Doing so, they gain an opportunity to use services of the FST module, which is in the backend. The FST module contains all the needed algorithms to deliver requested results through the frontend part of the whole system. The FST requirements' analysis has already been reported in section 6.2.4 of D2.1 in January 2020. In addition, D2.1 also includes the user requirement's analysis for the ESP (section 6.1). D2.2, which is to be delivered in March 2020 contains FST's internal architecture complemented with the technical specifications in section 4.3.3.

Generally speaking, FST is the S/W toolkit that encompasses the core idea of the work done in WP4. Most of the abilities of FST and tasks from WP4 are scenarios described in HLUC_02, which is described in detail in section 4.2 of D2.1. A small glimpse at the internal architecture given in D2.2. (section 4.3.3) reveals that the four main (creative) components are: i) forecasting engine, ii) optimal bidding algorithm, iii) optimal scheduling algorithm, and iv) optimal FlexAsset sizing/siting algorithm. Those four submodules use novel algorithms to help the ESP enhance its business strategy considering all relevant objectives and constraints. The FST module in vast majority of situations communicates/interacts with the core ATP module and/or central FLEXGRID database. The FST module sends FlexOffers to the ATP and ATP provides them information about the results of the bidding process and dispatch. A central database is used to fetch the market data. The central database also stores the most important algorithmic results so that they could be easily retrieved through a web API.

5.1.3.2 Main functionalities

The most important core of the FST consists of three submodules. They are developed from different mathematical models and algorithms, but when they act collaboratively, they contribute to the full and correct functionality of the FST.

Forecasting engine is primarily concerned with developing reliable forecasts upon fetching good-quality input data, ranging from weather forecasts and related renewable energy production to energy consumption and market prices.

Optimal bidding algorithm runs novel optimization algorithms to successfully bid in various energy markets while obeying the given objective function and constraints. Objective functions can differ between CAPEX minimization and OPEX minimization, considering ESP's preferences and requests. Through use case scenarios in HLUC_02, different scenarios are described where this submodule is used (see D2.1 for more information). The submodule firstly needs to collect good-quality input data. After that, the submodule runs holistic optimization algorithms and creates optimal bidding strategy for the respective user (i.e. ESP). Such strategy can then be utilized through the ATP platform or just taken in consideration to compare it with different strategies developed with possible different constraints and/or objectives.

Optimal scheduling algorithm is a complementary submodule to the previously described ones. Different use case scenarios could utilize it in a different way to meet their respective goals. It is not enough just to optimally dispatch available (Flex)units, but it is also important to schedule every single one of them in an optimal manner. From scenario where DSO tries to postpone major network investments, an optimal scheduling is required to engage respective (Flex)units in such manner that network remains stable to ESP's OPEX minimization. Obviously, both pre-mentioned scenarios (and others described in the use cases), in addition to the optimal scheduling, use optimal bidding as well. Optimal scheduling therefore presents an essential set of mathematical models and algorithms to enhance strategies of different stakeholders.

Finally, the *optimal siting/sizing algorithm* is the submodule, which identifies the optimal planning of ESP's FlexAssets in the long term. In other words, this algorithm finds the optimal investment that an ESP should do in order to achieve the maximum Return of Investment (RoI).

5.1.3.3 Innovation (including comparison with SotA and existing competitors)

Observing FST S/W toolkit as a single unit, the main novelty is in using novel algorithms and methods for each developed (and above described) submodules. Furthermore, a notable innovation is also a holistic approach to the problem, where different aspects are closely observed and constitute a single complex problem. Besides innovation and breakthroughs in the used algorithms, new business models also present a step forward. In a nutshell, state-of-the-art AI methods and (bi-level) optimization algorithms are factors that bring a significant dose of novelty and innovation to the whole toolkit.

5.1.3.4 Target group

FST's primary purpose is to be the core part of the FLEXGRID services that interested parties can use to their benefit (in both commercial and academic means). Furthermore, there will be also an option to exploit FST commercially as a standalone S/W toolkit that can be integrated in other S/W platforms in a "plug&play" form. For the time being, FST is a part of the FLEXGRID S/W platform – ATP and it will tested and validated within WP7. The main target groups are:

- Individual researchers and research groups, who want to use FST for research and experimentation purposes.
- Profit-oriented companies which may make contractual arrangements with various types of flexibility assets (here referred as ESPs and or RESPs).
- System operators.

5.1.4 Flexibility Market Clearing (FMCT)

5.1.4.1 Asset description

The Flexibility Market Clearing Toolkit (FMCT) consists of advanced Optimal Power Flow (OPF) algorithms, which optimize the distribution network operation, by including the provision of flexibility. FMCT integrates the algorithms of WP5.

The two main ways in which FMCT is used are:

- To determine the need for flexibility of the DSO
- To clear the Distribution Level Flexibility Market (DLFM) based on the requests and offers received.

5.1.4.2 Main functionalities

The main functionalities of the FMCT[67] toolkit are the following:

- **The evaluation of the need for flexibility for the DSO:** Taking as input the production and consumption schedules from the earlier stages markets (i.e. operated by the MO and/or TSO), the algorithms of FMCT can identify the line congestions and voltage deviations based on this dispatch. Thus, it can help the DSO in formulating its FlexRequests[68].
- **Clearing the Distribution Level Flexibility Market (DLFM), auction based:** Considering the production and consumption schedules from the earlier stages markets, the FlexRequests submitted by the DSO and the FlexOffers submitted by the FlexSuppliers, FMCT matches requests and offers. FMCT sets the market prices in an aggregated way: the prices are calculated based on offers and requests, and the price received does not correspond to the bid, a priori. FMCT returns the schedule for flexibility and the nodal prices.

There are two types of flexibility and corresponding distribution-level flexibility services that are considered:

  - The provision of active power to relieve line congestions. The prices determined for this type of flexibility are d-LMPs.
  - The provision of reactive power to avoid voltage deviations. The prices determined for this type of flexibility are q-LMPs.

- **Clearing the Distribution Level Flexibility Market (DLFM), pay-as-bid:** Another algorithm performs the same functionality as stated above, but is organized as a continuous market. The differences are that instead of gathering all requests and offers and settling a unique price (per type of flexibility), flexibility is continuously exchanged, as soon as there is a FlexRequest and a FlexOffer matching in terms of price and quantity. The DSO and the flexibility provider get their bid price, which is why this model is referred to as “pay-as-bid”.

5.1.4.3 Innovation (including comparison with SotA and existing competitors)

The AC-OPF is a version of the OPF in which no assumption is made to simplify the system model. It thus describes perfectly the network and is necessary when working at the distribution network/grid level, especially to evaluate voltages and reactive power and to include losses. As FMCT will be used for the provision of flexibility to avoid line congestions and voltage deviations, it is essential to use a good description of the network, such as the

[67] FMCT will also integrate state-of-the-art market clearing models at the transmission network/grid level to simulate various TSO-DSO coordination schemes.

[68] In the WP5 work context, several other energy market architectures will be considered (e.g. more advanced TSO-DSO coordination schemes, in which DLFMs play a more active role). These architectures may be evolving today’s market characteristics and structure or even be of “clean-slate” nature. From FMCT algorithms’ perspective, the main difference will be in the input parameters that are assumed for each energy market architecture variant.

one provided in the AC-OPF. However, AC-OPF is always non-linear and non-convex due to the physical constraints of the network (i.e. electrical laws).
There exist ways to deal with this:

- Approximations/Linearization: An example is DC-OPF, which is quite simple and computationally fast, since it makes several assumptions that transform the power flow equations into a linear system, at the expense of losing a lot of information about the system.
- Convex Relaxations: The constraints that are responsible for the non-convex nature of the problem are relaxed so that the feasible set of solutions becomes convex. These methods can be computationally expensive.
- Non-linear optimization techniques: Such techniques have trouble in converging, do not guarantee the optimum and have high computational cost.
- Heuristic methods: They approximate the optimal solution without making any simplification. However, the solutions reached can be very sub-optimal and there are issues with convergence.

Obtaining an OPF that describes properly the distribution network, guaranteed to return the optimal operating point and is scalable is thus a big technical challenge.

Therefore, the main innovations of FMCT are:

- The model of the distribution network in market clearing processes
- The consideration of ohmic losses, reactive power and voltage for distribution networks
- The extraction of locational marginal prices from a convexified AC-OPF
- The implementation of flexibility markets as an auction-based architecture and as a pay-as-bid architecture

5.1.4.4 Target group

The main target groups of FMCT are the following:

- DSOs, who can use FMCT, also outside of FLEXGRID ATP, in order to identify their need for flexibility. The toolkit can help them identifying lines that are often congested and locations that are critical for voltage management.
- Flexibility Market Operator (FMO), as FMCT's results can be easily communicated to a flexibility market platform such as FLEXGRID ATP (via well-designed RESTful APIs) and is also the key component for flexibility markets' clearing.
- Individual researchers and research groups, who want to use FMCT for research and experimentation purposes.

5.2 Exploitation strategy of FLEXGRID platform as a whole

The FLEXGRID S/W architecture is "modular by design" in order for all subsystems (i.e. ATP deployed by ETRA in collaboration with NODES, AFAT deployed by ICCS and UCY, FST deployed by UNIZG-FER and FMCT deployed by DTU) to be potentially exploitable as standalone commercial products in the future. The technical APIs for the interaction between the various subsystems (or else S/W modules) have been appropriately designed in a way that any possible combinations of FLEXGRID modules to be commercially exploitable in the future (e.g. ATP with FMCT as one single product, FST with FCT as another one, ATP-FST or

ATP-AFAT as another one, ATP-FST-FMCT as another one, etc.). This strategic decision at the design phase provides the flexibility to the consortium to decide how to prioritize its dissemination, communication and further exploitation activities towards commercialization. Of course, the default choice and ultimate objective of the consortium is to fully integrate all 4 main subsystems/modules into one single FLEXGRID S/W platform. This way, the FLEXGRID product and associated services are expected to be competitive enough in order to enter the liberalized energy market and be sustainable as a product from a business perspective.

The "modular by design" approach provides flexibility to our system to be commercialized taking into consideration the diversified needs of all our potential customer segments. In the following, there are some examples of possible combinations of FLEXGRID subsystems:

- ATP-FMCT combination can provide considerably more "intelligence" to the FLEXGRID product compared with the case that an ATP-like solution is commercialized as a stand-alone platform (cf. the NODES market platform). Moreover, diversified business modelling can be done according to the needs of the customer (FMO or DSO) meaning that there can be a basic version with a basic set of algorithms and a premium version incorporating additional automated functionalities based on sophisticated algorithms' execution.
- ATP-FST-FMCT combination can considerably strengthen the competitiveness of ATP because there exists at least one FlexSupplier (ESP) and one FlexBuyer (FMCT) for the DLFM to operate. In other words, the customer (either ESP or DSO) is expected to be more willing to participate in a flexibility market, if its proprietary platform is combined with ATP, which in turn facilitates advanced interaction and B2B partnership opportunities.
- ATP-AFAT combination can be considerably more appealing for aggregators and retailer companies as the latter can now have better and easier access to both DLFMs and existing wholesale/balancing markets operated by the MO or TSO.

Furthermore, for every possible FLEXGRID service combination like the ones mentioned above, it will be also possible for each customer segment to select the bunch of services that best fits its personalized needs. For example, regarding FST, it contains three main services for an ESP, namely: i) optimal bidding, ii) optimal scheduling, and ii) optimal planning. Therefore, the ESP customer may opt only for optimal bidding service because it may want to use its proprietary market platform and thus save money. Another option would be to opt only for optimal bidding and optimal scheduling services and neglect the optimal planning service. This type of functionalities are based on the sophisticated design of the FST-ATP API that facilitates the ATP administrative user to filter out the needed API features for each business case in a dynamic way and thus provide a fully customizable solution both to the ATP's administrative user as well as all other customer users.

Conclusively, it is apparent that this flexibility choice of selecting any combination of FLEXGRID modules to match specific customer segment's needs provides enormous boost to the exploitation activities of all partners of FLEXGRID consortium.

Table 22: Summary of FLEXGRID exploitation activities

Exploitation Activity	How?	When?	Who?	Target Group
Integrate FMCT and ATP enhancements in the existing product line of NODES marketplace platform	FMCT (and ATP) in NODES internal product development	Starting right after the end of project's lifetime	NODES	NODES S/W development and R&D team
Integrate research algorithms' intelligence in the existing product line of ETRA	AFAT, FST & FMCT in ETRA's WISECOOP, WISECORP and WG Cockpit tools respectively	Starting right after the end of project's lifetime	ETRA	ETRA S/W development and R&D team
Attempt to integrate FST and FMCT in the existing product line of BADENOVA and Thuega group of municipal utility companies[69]	FST and FMCT in BADENOVA's existing S/W and pilot testing infrastructure	Start pilot testing within FLEXGRID and further exploit later	BDNV	BDNV and Thuega group's S/W development and R&D teams
Integrate AFAT in the existing pilot testing infrastructure of UCY	AFAT algorithms in UCY's existing pilot infrastructure	Start pilot testing within FLEXGRID and further exploit later	UCY	UCY's researchers and Cypriot DSO/ regulatory authority
Integrate FMCT and FST in the existing research infrastructure of AIT	FMCT and FST in AIT's existing large-scale research infrastructure	Start lab experimentation within FLEXGRID and further exploit later	AIT	AIT's researchers
AFAT's advanced mathematical models and algorithms for experimentation	Make AFAT open for researchers to utilize the platform as an e-infrastructure	Make algorithmic results, data and prototypes publicly available once published in scientific journals	ICCS	Academic students, researchers around the globe

[69] Time frame for integration depends on implementation of EU-legislation on national level and in the following on the availability of wide spread sensors providing dynamic data regarding distribution grid conditions, customer behavior and RES generation.

FST's advanced mathematical models and algorithms for experimentation	Researchers to utilize the platform as an e-infrastructure	Make algorithmic results, data and prototypes publicly available once published in scientific journals	UNIZG-FER	Academic students, researchers around the globe
FMCT's advanced mathematical models and algorithms for experimentation	Researchers to utilize the platform as an e-infrastructure	Make algorithmic results, data and prototypes publicly available once published in scientific journals	DTU	Academic students, researchers around the globe

5.3 Management of Intellectual Property Rights (IPR)

The "modular-by-design" strategy of FLEXGRID architecture provides the flexibility to achieve an efficient trade-off between the efficacy of the communication activities and the protection of Intellectual Property Rights (IPR). More specifically, the consortium partners have unanimously agreed that the 1st version of the integrated FLEXGRID system prototype (delivered in M24, see Milestone #8) will be open-source in order to facilitate the maximum possible dissemination/communication to the targeted audiences and potential customer segments. Then, certain S/W sub-modules of the platform (i.e. mainly intelligent research algorithms) will be kept in closed/restricted access mode facilitating thus the maximum possible business exploitation by the project's industrial partners (i.e. ETRA, NPC, NODES, BADENOVA, HOPS). Moreover, large-scale EU H2020 projects, which are closely affiliated with FLEXGRID consortium (i.e., WISEGRID, INVADE, CROSSBOW) will also use FLEXGRID's foreground knowledge to enhance the intelligence of their already existing tools. The Consortium and Exploitation Agreement, which was signed before the start of the FLEXGRID project's lifetime explicitly sets the limits between FLEXGRID's background knowledge (both regarding industrial partners' background and H2020 project tools) and FLEXGRID's foreground knowledge to be further exploited after the project's lifetime.

In case partners develop specific S/W components that they want to protect, FLEXGRID project will stimulate creation of IPR within the project, and ensure that partners who wish to protect IPR can do so. In case of any conflict, the Innovation and Exploitation Committee (InEC) will activate and elect the IPR Audit Committee in order to resolve any issues according to the consortium agreement rules. The rules for the confidentiality of information and the access rights on IPR (foreground / background) are defined in the FLEXGRID consortium agreement (CA).

5.4 Individual partner exploitation plans

5.4.1 ICCS

ICCS Exploitation Plan

Description	**Background/Foreground Knowledge:** The Institute of Communication and Computer Systems (ICCS - www.iccs.ntua.gr) is a research organization associated with the School of Electrical and Computer Engineering of the National Technical University of Athens (NTUA). It has about 40 laboratories and research units presently active, which are established by the implementation of several structural programmes such as Mediterranean Integrated Programme on Informatics of European Community (MIP-Informatics), Public Investment and Special Development Programmes of the Ministry of Education as well as European Programs such as FP6, FP7, HORIZON2020, etc. ICCS coordinates several HORIZON 2020 projects relevant with FLEXGRID objectives and will utilize its related background knowledge on S/W platforms to design, develop and evaluate novel mathematical models and algorithms. **ICCS objectives within FLEXGRID context:** ICCS has rich previous experience in the development of: i) advanced pricing mechanisms for the retail energy market and energy storage management, ii) ICT platforms that guarantee user engagement in energy efficiency related services, and iii) aggregated demand response algorithms and respective data analytics for flexibility services that facilitate the active participation of small energy prosumers in liberalized energy markets. In the context of FLEXGRID, ICCS will: • **Lead the project management activities (WP1)** exploiting the scientific, technical, organizational and financial management expertise of the involved ICCS staff in H2020 R&I projects. • **Co-chair the Technical Management Team (TMT)** and have a leading role in the definition of FLEXGRID research methodology (i.e. advanced mathematical modelling and algorithms) as well as the definition of FLEXGRID use cases, operational scenarios and requirements' analysis per FLEXGRID subsystem and user. • Lead the research activities on the **design, development and performance evaluation of innovative B2C flexibility markets** that are run by and aggregator or retailer market stakeholder (WP3). • Participate actively in the **design of the modular FLEXGRID architecture and S/W data models** (WP2 and WP6). • Highly evolve its existing advanced pricing and aggregated demand response & ESS management algorithms in order to constitute them able to **optimize ESP's innovative business models** (WP4). • Highly evolve its existing RES and ESS sizing and management algorithms in order to constitute them able to **mitigate market power for profit seeking stakeholders and interact with underlying network (OPF) and dynamic markets** (WP5). • Play a **key role in the dissemination and exploitation strategy of FLEXGRID** by focusing on the commercial exploitation of energy services of FLEXGRID platform in collaboration with other partners. ICCS will elaborate on the development of the existing VIMSEN Decision Support System (DSS) toolkit https://github.com/vimsen, which has being developed by the ICCS team to be used by aggregators to monitor and manage decentralized RES prosumers, via a web-enabled software platform. The platform's implementation is based on ICT virtualization techniques and a wide range of functionalities have been described, tested and validated in the context of the successfully concluded EU

	VIMSEN project [70]. Results from various decision-making algorithms show that intelligently forming energy prosumers' groups (i.e., "clusterings") so as to optimize different criteria provides remarkable energy savings and monetary profits for the end users. DSS toolkit is open-source and will be exploited within FLEXGRID project as a starting point for the development of more advanced flexibility aggregation models and algorithms (cf. HLUC_04 descriptions in D2.1 delivered in January 2020). Details about DSS toolkit download and user manual are available in https://github.com/vimsen. ICCS will also use its background knowledge from H2020 SOCIALENERGY[71] project that has been finished in 2019. More specifically, Research Algorithms' and Business Intelligence Toolkit (RABIT) is a business analysis and intelligence tool for progressive electric utility companies (or else energy retailers) wishing to provide advanced energy services to their clients (energy consumers) through a digital ICT platform. Using RABIT's intelligence, the administrative user (e.g., business analyst or CEO of the company) is able to run exhaustive "what-if" system-level simulations to determine the best business strategy/scenario to adopt. For example, the retailer wants to know if (and how much) more profits can be realized in the case that all users who currently adopt a flat price tariff for their energy consumption, purchase a new Energy Program (i.e. denoted as FlexContract in FLEXGRID) that incentivizes behavioral changes. RABIT is open-source and will be exploited within FLEXGRID project's context. In particular, advanced retail pricing algorithms will be designed, developed and evaluated via the use of game theory optimization and mechanism design theory. These algorithms will be integrated in the Automated Flexibility Aggregation Toolkit (AFAT). Details about RABIT download and user manual are available in https://github.com/socialenergy-project/rat. FLEXGRID will play a very important role to evolve and experiment with ICCS existing S/W toolkits and services to constitute it more complete, intelligent and able to act as a service to a more complex platform such as FLEXGRID Automated Trading Platform (ATP) developed by ETRA. It is ICCS aim to found a spin off company towards this goal. ICCS will also exploit the research that will be carried out through FLEXGRID in order to embed the findings of the project in (post-)graduate courses. In this way, graduate students will have the opportunity to learn technologies relevant with new energy market architectures and algorithms for the development of: i) advanced retail pricing and flexibility aggregation algorithms, ii) bi-level optimization models for efficient energy markets' and networks' interaction, iii) optimal power flow and advanced energy market clearing models. FLEXGRID will also highly enforce the research that Ph.D. students in National Technical University of Athens perform through its exploitation for the statement of new research problems that are vital for the industry and the research community in such a rising topic like novel energy market architectures and flexibility services' provisioning in high RES penetration contexts.
Exploitation Targets	**By the end of the project**, the major exploitation targets based on the targeting exploitation opportunities described above are: • Novel publications and active participation in high-quality international conferences and journals with high impact factor. • Automated Flexibility Aggregation Toolkit (AFAT), which will be publicly available for use of its basic functionalities. DEMO videos about AFAT will be

[70] https://cordis.europa.eu/project/id/619547
[71] https://socialenergy-project.eu/, https://cordis.europa.eu/project/id/731767

	provided to targeted customer segments (i.e. energy aggregators and retailers). • Research e-infrastructure for FLEXGRID-related algorithms' and schemes' experimentation by research groups around the globe. **After the project's lifetime,** the major exploitation targets of ICCS will be the following: • Use the FLEXGRID project's achievements to elaborate on a new innovative project proposal both at EU and national level. • Continuously enhance the AFAT's functionalities based on the feedback from many stakeholders, reviewers and business consultants towards releasing an improved S/W version. • Continue efforts for integrating AFAT and respective functionalities to a real commercial S/W platform dealing with energy flexibility provisioning issues. • Explore the opportunity of integrating AFAT in a well-known research e-infrastructure (national or EU level) towards evolving the platform to a well-known 'experimentation hub' for researchers. • Further explore the opportunities to exploit the AFAT as a 'plug-in' module to existing products of various stakeholders as well as successful H2020 projects (e.g. WISEGRID, INVADE, CROSSBOW, etc.). • Transfer the FLEXGRID background knowledge of 'ICTs for the energy sector' to new innovative project ideas such as energy behavior analytics, B2B/B2C flexibility markets, interaction between energy markets' and networks' operation, socially-aware web platforms for sustainable energy management solutions, etc.
Targeted end users	AFAT is designed in a way that can be commercially exploitable as a standalone S/W toolkit, which can be integrated as S/W "plug-in" in other larger S/W platforms (like FLEXGRID ATP), which follow a modular-by-design approach. The main target groups of AFAT are: • Individual researchers and research groups, who want to use AFAT for research and experimentation purposes and possibly integrate it in their own research infrastructure, too. • Aggregators and retailers for business provisioning of new innovative FlexContracts with their end energy prosumers.

5.4.2 ETRA

ETRA Exploitation Plan	
Description	**Background/Foreground Knowledge:** ETRA Investigación y Desarrollo, S.A. (ETRA I+D) is the hi-tech unit within ETRA Group, one of the leading industrial groups in Spain. ETRA's mission is putting in the market the most advanced solutions and services either directly or through the 10 companies of the Group. The main market areas of ETRA Group are Spain, Portugal, Eastern Europe, LATAM, Northern Africa and the Middle East. The activity of the company (with a turnover of 200 M€ and a staff of 1,800) started in the 70's and it is centered in three main activity lines: energy management (with more than 50 major public and private large clients using ETRA's systems), smart mobility (including EV charging infrastructure management) and cyber physical security.

	ETRA has developed specific software to monitor and control advanced Microgrids allowing the different stakeholders of such structure to operate in an optimized fashion. With the work developed in FLEXGRID, this software will be enhanced with the intelligence needed to take advantage of the recent and vast advances in OPF theory and market clearing algorithms. It will also highly enhance demand response through the design of pricing schemes that automate and: i) enable stacked revenue model, ii) exploit recent advances in mechanism design. FLEXGRID also focuses on the development of more complex and efficient business models and energy markets. In particular, ETRA will take advantage from: WGSTaaS tool ("WiseGRID energy STorage as a Service"), ii) WiseCorp and WiseCoop tool, iii) WiseGRID Cockpit. Moreover, the short-listed products from H2020 CROSSBOW project are: i) CROSSBOW Wholesale and Ancillary Market toolset (AM), ii) CROSSBOW WG Cockpit (RES-DU), iii) CROSSBOW Virtual Storage Plants (VSP), and iv) CROSSBOW RES Regional Coordination Centre (RES-CC). The ultimate goal of ETRA is to exploit its high community building capacity and experience to promote the above-mentioned EU project's products for real market uptake in the EU area in the long term. **ETRA objectives within FLEXGRID context:** The FLEXGRID platform developed in the project and its respective modules will enable ETRA to reinforce its position as service provider for public authorities. In addition, ETRA core market regarding energy sector will be increased to different electric DSO that could consider its coupling to adjacent gas grid to coupled energy flows and increase the system efficiency. Moreover, thanks to the involvement of ETRA in this project, the position of the company in South-Eastern Europe will be reinforced. ETRA is WP6 leader and will exploit FLEXGRID's research outcome in order to integrate selected mathematical models and intelligent research algorithms from FLEXGRID into a short-list of H2020 WISEGRID and CROSSBOW tools. According to these large-scale EU flagship project's business planning, a number of tools and products will be released into the market by 2022-2023 (i.e. ~2 years after these projects' completion). The ultimate goal of ETRA is to exploit its high community building capacity and experience to promote the above-mentioned EU project's products for real market uptake in the EU area in the long term.
Exploitation Targets	By the end of the project ETRA will have a more advanced set of tools to control and monitor advanced high RES integrated electric grids enhancing the current SotA software legacy from successful R&I projects. The exploitation targets will be aligned with the strategy followed and the current SotA tools, this is, technological solution targeting aggregators of consumers and prosumers (particularly focused on domestic and small businesses), supporting them in their roles of energy retailers, local communities and cooperatives (which may have different objectives). Market volume is around more than 2,500 electric cooperatives in Europe, mainly located in Germany and Denmark. Several EU Member States support the deployment of renewable energy so that most of the investments come from citizens and groups of citizens. **After the project's lifetime,** the major exploitation targets of ETRA will be to place into the market the tools and products developed within FLEXGRID project. A specific

	exploitation plan will be developed in a further stage of the project and included in Deliverable 8.3 once the products are finalized and tested according to the project work plan.
Targeted end-users	ETRA's customers are typically public authorities and large corporations who use the large-scale real-time control systems and information management services provided by ETRA. ETRA's main market would be small DSOs. This means that ETRA is addressing more than 2,200 small DSOs (understanding small DSO as an operator with less than 100,000 users) in Europe. ETRA's participation in European projects and its usual participation in energy fairs and congress will allow it to contact with several of this kind of entities and offer them the tool trying to reach a 25% (550 small DSOs) of the market share.

5.4.3 SIN

SIN Exploitation Plan	
Description	**Background/Foreground Knowledge:** Smart Innovation Norway (SIN) hosts NCE Smart Energy Markets; Norway's leading cluster of industries and academic institutions within Smart Grid and Smart Energy Market Research and Innovation. SIN develops smart and sustainable solutions through research-based innovation and business development. Emphasis is on techno-economic models and analysis, business intelligence, prosumers and user flexibility. It holds key competences in relevant and applied R&D, entrepreneurship, intrapreneurship and process development to cater for new businesses based on research results generated. SIN and the associated cluster have long traditions of creating energy related spin-outs around new products and technologies. These include software and engineering companies like Scandpower, Hand-El Scandinavia, CognIT, MoreCom, Communicate, Navita/Brady, Miriam, eSmart Systems, Tiny Mesh, and more. Together with SINTEF and Narvik University College, SIN was a founding partner of the Norwegian Smart Grid Centre. **SIN objectives within FLEXGRID context:** SIN will disseminate the results of this project to two of the large industry clusters it is managing i.e. NCE Smart Energy Markets cluster, and Cluster for Applied AI. SIN is also managing a Smart Incubator and will use this incubator in different forms of business developments, spin-offs, intra- and entrepreneurship and networking. Since SIN is also a research organization, it will exploit the flexibility tools for further research and promote increased innovation activities in its business clusters.
Exploitation Targets	**By the end of the project**, the major exploitation targets based on the targeting exploitation opportunities described above are: • Exploiting its high-quality community building capabilities towards integrating targeted FLEXGRID's intelligence (i.e. advanced mathematical models and algorithms) in existing real-life pilots in Norway, Germany and other EU countries. • Exploit results from FLEXGRID's innovation tools for business and commercial partners that are part of NCE Smart Energy cluster of SIN. • AI based tool will be exploited using the AI cluster of SIN. • Market analysis and business model design of FLEXGRID innovation will help start-ups part of incubator of SIN for new market opportunities.

	After the project's lifetime, the major exploitation targets of SIN will be the following: • Use the FLEXGRID project's results to achieve the ultimate goal of SIN, which is to exploit its growing experience in facilitating the participation of mobile, distributed and centralized energy storage assets in novel flexibility markets for dealing with grid operation challenges, too. Thus, exploiting FLEXGRID's modeling and intelligence and already pilot tested tools and products, the next step is for SIN to coordinate the real market uptake of these solutions in the EU area and beyond. • For market uptake, SIN will look for cross-exploitation with Norwegian partners part of consortium, i.e. NODES and NPC.
Targeted end-users	• Startups & SMEs in Energy sector • DSOs & TSOs • Independent Aggregators & ESPs • Market operators

5.4.4 NPC

NPC Exploitation Plan	
Description	**Background/Foreground Knowledge:** Nord Pool Consulting (NPC - www.nordpoolgroup.com/services/consulting) offers services connected to market design, rulebook development and market regulation, power market systems and capacity building and provide seminars based on its unrivalled knowledge of power market development. NPC's services are linked to the experience acquired through Nord Pool's 25 years of successful operation of international power markets, serving as a blueprint model for the European target model for wholesale electricity markets. NPC has detailed insight in all EU market regulations, not only from a theoretical perspective, but also from an implementation and operational perspective. In addition to European experience, NPC has been involved in international projects around the world allowing NPC to gain experience from other parts of the international power market development stretching from India to Southern Africa. NPC's goal (as WP2 leader) is to exploit FLEXGRID's marketplace design rationale to further extend its consulting services portfolio to flexibility market design, development and operation in Europe and beyond, taking into consideration the regulatory framework of each country/region and the diverse needs and opportunities of energy market stakeholders per geographical region. Recent projects are also ongoing in China, Philippines, Georgia, Vietnam, Albania, Croatia, and Bulgaria. **NPC objectives within FLEXGRID context:** NPC has rich previous experience in: i) feasibility studies for electricity derivatives markets, ii) high level market design of electricity markets, iii) support of the implementation of the wholesale electricity market, iv) high level design and implementation of the power exchange. In the context of FLEXGRID, NPC will: • Lead Use cases/services and market design (WP2): conduct a pre-study on the existing research models and technological background from FLEXGRID partners to identify the way and the degree to which the existing research

	algorithms (e.g., OPF, pricing, ESP services planning and operation) can facilitate the build-up of the substrates of FLEXGRID platform. The output of WP2 directly feeds WP3-WP5 (to navigate FLEXGRID platform design process) and indirectly interacts through them with WP6 (S/W development and integration) and WP7 (pilots, experiments, validation, empirical platform evolution). • Play a key role in providing real data from the existing Nord Pool markets' operation (i.e., day-ahead, intraday, balance/reserve market prices, etc.) and innovative business models for ancillary services' provisioning based on the current practice and experience in this area. • Cooperates in the commercial exploitation of market clearing models that FLEXGID will develop. • FLEXGRID validation, pilot testing results and platform empirical evolution (WP7). • Business modelling, dissemination, exploitation and management of innovation impact (WP8).
Exploitation Targets	**By the end of the project**, the major exploitation targets based on the targeting exploitation opportunities described above are: • Tool for B2B and B2C market operators: Targeted B2B partnerships for extended set of business cases for flexibility trading. • NPC will also exploit its direct communication pathways with prestigious market and grid operators not only within Europe, but also in international scale. **After the project's lifetime,** the major exploitation targets of NPC will be the following: • Use the FLEXGRID project's achievements to identify new market/product opportunities for its mother company Nord Pool • Pursue interested stakeholders who would like to operate a FLEXGRID marketplace (B2B partnerships for participation in FLEXGRID's marketplace) in their geographical region.
Targeted end-users	Targeted B2B partnerships for extended set of business cases for energy flexibility services' trading.

5.4.5 NODES

NODES Exploitation Plan	
Description	**Background/Foreground Knowledge:** NODES is a Flexibility Market Operator (FMO) in its initial phase (pre-operational phase) that has evolved from the combined knowledge and expertise of energy markets of Agder Energi, one of Norway´s largest energy companies and Europe´s leading power market operator Nord Pool. The NODES platform is designed to connect local and central power markets aiming at establishing an integrated marketplace that is available to all flexibility providers and grid operators. The dynamic interaction of all market participants through an open marketplace as provided by NODES efficiently combines presently available resources including production, consumption and storage

	solutions and flexibility demand of grid owners and is thus a solid alternative to grid investments. **<u>NODES objectives within FLEXGRID context:</u>** • To test FLEXGRID S/W platform for different business cases considering various flexibility market operation scenarios and products • To test the operational performance of the FLEXGRID S/W platform with regard to standard processes and to discover potential for improvement • Implementation of various data sets and information • Evaluation of best payment scheme to be used (pay as bid/auction) • Evaluation of optimized algorithms and their impact on prices and market results
Exploitation Targets	**By the end of the project**, the major exploitation targets based on the targeting exploitation opportunities described above are: • Determination of NODES platform potential to integrate various and comprehensive data sets to provide a more complete service • Careful evaluation of different business cases and their implementation in the platform architecture. **After the project's lifetime,** the major exploitation targets of NODES will be the following: • Use the FLEXGRID project's achievements to develop the platform considering various user and market requirements with special focus on enhanced and improved/automatized data integration, time intervals, market specific conditions and regulations • Set up of a set of standardized processes related to platform users
Targeted end-users	DSOs, TSOs, ESPs, BRPs, MO (i.e. various B2B partnership scenarios)

5.4.6 UCY

UCY Exploitation Plan	
Description	**<u>Background/Foreground Knowledge:</u>** FOSS Research Centre for Sustainable Energy acquires significant research expertise as well as from industry. Members of the Centre represent Cyprus in European Energy Committees such as the Energy Committee for the Horizon 2020, the SET Plan, the European Technology and Innovation Platform SNET and PV and the European Standards Committees on PV. Moreover, FOSS is a full member of DERlab, EUREC and EERA JP for SG. The researchers comprising the working team have extensive experience in grant proposal applications and have acquired funding for a range of research topics through the EU, the National Research Funding Agency in Cyprus as well as industry. In addition, FOSS serves as the facility manager of the entire university campus with regards to all energy aspects. The campus includes tens of buildings with uses ranging from offices, sport facilities, educational facilities, dormitories and even pure residential buildings that belong to the campus grid. FOSS defines the energy strategy of the university with the main aim to reach energy self-sufficiency. To this end, it has commissioned the installation of further energy resources including generation and storage. Furthermore, FOSS operates a campus-level heating network using central CHPs for

	water heating and distributing the heat to all campus buildings. As a result, FOSS has a unique perspective of the energy needs of a variety of factors including energy users as well as network operators. Furthermore, they control the energy management systems and can provide deployments of limited scale to try out various solutions. In addition, FOSS has under its management a network of 300 prosumers as well as 15 residential battery energy storage systems as well as a network of 17 meteorological stations. It has also developed state of the art energy forecasting solutions and is heavily involved in flexibility R&D initiatives. **UCY objectives within FLEXGRID context:** • Automated flexibility aggregation architectures, advanced RES forecasting models and battery energy storage sizing algorithms. • Development of innovative bidding processes, allocation rules and communication protocols according to the challenges that high RES penetration sets. • Perform evaluation of innovative B2C flexibility markets including advanced DSM to ESPs, automation of flexibility and P2P trading based on the data from its pilots and the data that will be provided by the partners. • Contribution to the automation and intelligence of the flexibility platform
Exploitation Targets	**By the end of the project**, the major exploitation targets based on the targeting exploitation opportunities described above are: • Advanced RES and market forecasting tools • Battery sizing algorithms • Contribution to the automatic flexibility platform and its benchmarking and contributions to standardization activities. • Contribution to the automation and intelligence of the flexibility platform. **After the project's lifetime,** the major exploitation targets of UCY will be the following: • Use the FLEXGRID project's achievements to aid the Integration of new market mechanisms in Cyprus energy market • RES and market forecasting solutions • Battery sizing solutions for increased flexibility and high RES penetration. • Developing the infrastructure (hardware/software – living lab) for testing flexibility solutions. • Tools for the intelligence and automation of flexibility platforms.
Targeted end-users	Energy Stakeholders (policy makers, regulators, market operators, aggregators), battery and RES system owners, investors, industry)

5.4.7 UNIZG-FER

UNIZG-FER Exploitation Plan	
Description	**Background/Foreground Knowledge:** The University of Zagreb (1669) is the oldest and largest university in South-Eastern Europe. Ever since its foundation, the University has been continually growing and developing and now consists of 29 faculties, three art academies and the Centre for Croatian Studies. With its comprehensive programs and over 50,000 full-time undergraduate and postgraduate students, the University is the strongest teaching

	institution in Croatia. It offers a wide range of academic degree courses leading to Bachelor's, Master's and Doctoral degrees in the following fields: Arts, Biomedicine, Biotechnology, Engineering, Humanities, Natural and Social Sciences. It is also a strongly research-oriented institution, contributing with over 50 percent to the total research output of the country. FER, Faculty of Electrical Engineering and Computing is the largest technical faculty and leading educational and R&D institution in the fields of electrical engineering, information and communication technology and computing in the Republic of Croatia. Being a constituent of the University of Zagreb, FER has its roots in the Technical Faculty, founded in 1919. In 1956, the departments of Technical Faculty grew into four new faculties, Faculty of Electrical Engineering being one of them. The Faculty offers today substantial educational and R&D facilities including 35 lecture halls, more than 60 laboratories, Congress center, tele-conference center, central library and 12 department libraries, student restaurant, sport and recreation facilities on 43308 m^2. The Faculty is organized in 12 departments, which represent the focal points of education, research and development in various fields. The present research and educational staff comprises of more than 160 professors and 210 teaching and research assistants and around 3,300 students at the undergraduate, graduate level and PhD students. All those numbers clearly emphasize highly spirited activities in teaching and research. The Faculty has developed valuable international cooperation with many research institutions around the world, either directly or through inter-university cooperation. Researchers of the Faculty were/are currently leaders of 5 FP7 projects, 16 multilateral COST actions, 13 bilateral projects, 25 HORIZON 2020 projects, 1 Erasmus+, 2 Air Force Office of Scientific Research, 2 NATO Science for Peace as well as the leaders of a number of industrial projects. The number of international projects in the last five years makes Faculty of Electrical Engineering and Computing one of the most internationally active institutions in Croatia. As an endorsement of the teaching and research excellence, Faculty has obtained the accreditation for the bachelor's and master's study program from the ASIIN - Accreditation Agency for Degree Programs in Engineering. **<u>UNIZG-FER objectives within FLEXGRID context:</u>** UNIZG-FER will exploit its vast research background in innovative Business Models (BMs) for ESPs that own storage and in the context of FLEXGRID will: • Lead WP4 work and develop optimized BMs that include: i) stacked services provided at different markets; ii) ESS sizing in scenarios where the ESP actually becomes a price maker in different markets; iii) ESS capacity auctioning mechanism and evaluation of its benefits to both the ESP (ESS owner) and the market players who purchase this capacity. • Contribute in WP5 research activities regarding market-aware OPF design functionalities, requirements and models. • Play a key role in the development of FLEXGRID's architecture (ESP BMs relevant with price markers, stacked revenues and storage)

	• Lead field trials relevant with validation activities on ESS (storage) models (in cooperation with HOPS) that FLEXGRID will develop and exploit in its OPF, market clearing and ESP BM optimization algorithms (WP7). In the context of FLEXGRID, validation of ESS models for use cases based on both Nord Pool and HOPS (providing the requirements on activation times, power output/consumption stability and ramp abilities for ESS operation for different purposes, e.g. energy injection, energy consumption, black start, reserve activation. For each of them, a time step and activation times will be defined and power and energy boundaries will be imposed. This is essential for battery ESS, because its maximum charging power depends on the battery state of charge. Towards this goal, SmartGrid Lab at UNIZG-FER will use its existing equipment consisting of: • Specially designed bidirectional AC/DC converter with nominal output power 1 kW, output voltage 0 to 20 V DC, output current -50 to 50 A DC, and input 50 Hz, 230 V AC. This will be used for testing individual battery cells or smaller battery modules. • Temperature chamber with net volume 408 l, temperature range from -40 degrees C to +150 degrees C and humidity range: 20 - 98% RH. This will be used to simulate different operating conditions of a battery, e.g. located outside in a cold climate or in a warm climate. • Lithium-ferro-phosphate battery stack with 51 kWh capacity to be used as a large battery which can provide different services. • Regatron bidirectional AC/DC converter with power span on the DC side 0-20 kW, voltage span on the DC side 0-400 V and current 0-63 A. This converter will be used to charge and discharge the 51 kWh battery stack. It will also provide all the required measurements, including the power (dis)charging profile relevant to the HOPS. Smart Grid Laboratory has been established in 2015. SGLab has advanced power system components whose inter-operation can be observed: • Battery energy storage with 41 kWh capacity • Three 5 kW inverters • A 20 kW bidirectional AC/DC converter • A specially design low 1 kW converter for performing accurate tests on individual battery cells • Installed PV capacity 13 kW • Different load types (linear, nonlinear, drives) • Distributed generation model (5.5 kW microturbine and 1.5 kW cogeneration) • DC drive driven engine that simulates a 15 kW thermal power plant (busbars, protection equipment, metering equipment) • 20 kW hydroelectric power plant with a Pelton turbine (with turbine governor and rated flow of 27 liters/s) • A system of power lines with corresponding circuit breakers that simulate a transmission grid Furthermore, for UNIZG-FER, FLEXGRID project is a great opportunity for the graduate and PhD students to learn, get acquainted with and conduct research in connection with the state-of-the-art technologies and algorithms related to: (bi-level) optimization models for efficient energy markets and networks interaction, optimal power flow and advanced energy market clearing models.

Exploitation Targets	**By the end of the project**, the major exploitation targets are: • Novel publications and active participation in high-quality international conferences and journals with high impact factor. • FlexSupplier's Toolkit (FST) with integrated optimal FlexAsset scheduling and planning algorithms. Demonstration of the basic functionalities to the interested parties. **After the project's lifetime,** the major exploitation targets of UNIZG-FER will be the following: • Use the FLEXGRID project's achievements to elaborate on a new innovative project proposal both at EU and national level. • Continuously enhance the FST's functionalities based on the feedback from many stakeholders, reviewers and business consultants towards releasing an improved S/W version. • Explore possible FST compatibility with other ongoing H2020 projects.
Targeted end-users	FST could be of use both to the academic community for further research and commercial stakeholders (ESPs) for development of innovative business strategies.

5.4.8 HOPS

HOPS Exploitation Plan	
Description	**Background/Foreground Knowledge:** HOPS is the only transmission system operator in Croatia. HOPS, as an operator, is responsible for system balancing and procuring reserves for frequency and voltage control. With higher solar and particularly wind generation in Croatia, there will be an increased need to attract new service providers to secure system stability and hopefully avoid costly grid investments. More and more service providers even nowadays are connected to the DSO grid, thus it is important to build TSO-DSO cooperation. HOPS is hoping through this project to get a valuable insight into the platform design. The project should trigger questions and by the end of the project hopefully give valuable ideas and potential solutions about things to do in order to make platform commercially feasible and utilizable. **HOPS objectives within FLEXGRID context:** • To explore potential for market development and substantially savings made by operators by doing a techno-economic analysis • Investigate ways that FLEXGRID platform could allow higher RES penetration • To trigger thinking about existing and upcoming legislative changes within FLEXGRID context • HOPS will provide real life set datasets and can see if data coming out of a platform would be realistic during WP7 validation activities.
Exploitation Targets	**By the end of the project**, the major exploitation targets based on the targeting exploitation opportunities described above are: • Having access to the platform

	• Know advantages and potential space for improvements of the platform • Knowing commercial benefits of the platform **After the project's lifetime,** the major exploitation targets of HOPS will be the following: • Use the FLEXGRID project's achievements to potentially develop internal processes and procedures for using such platform • Inform stakeholders such as regulatory bodies of potential legislation framework changes required to use platform in industry • Applying knowledge and experience in similar projects • Build relationship with DSOs on sharing system services
Targeted end-users	DSOs Regulatory Authorities Service Providers

5.4.9 BADENOVA

BADENOVA's (BDNV) Exploitation Plan	
Description	**Background/Foreground Knowledge:** Badenova is a regional utility based on the city of Freiburg and its surroundings. The "Green City" of Freiburg in the south-western corner of Germany has about 220,000 inhabitants. Freiburg is one of the sunniest regions in Germany, experiencing a great penetration of renewable energy sources especially photovoltaics. Furthermore, development and use of renewable energies is not limited by a lack of resources, but more and more often by the lack of capacity in power lines leading to the outskirts of the city. Due to the relatively high sun radiation in the south-west compared to other regions in Germany, PV systems are widely installed and used in this region and often connected to the low voltage network. **BADENOVA's objectives within FLEXGRID context:** • Badenova provides the access to one medium sized battery storage with 20 kW nominal power and 120 kWh capacity based on the innovative redox-flow-technology. This battery type has a much longer life time than comparable lithium-ion batteries and it is very easily recyclable. • In addition to that, Badenova can provide access to a network of more than ten private households already equipped with PV-Systems, storage systems for home use with different capacities as well as home management systems for an optimized operation of the devices. Some customers are also equipped with EV chargers. • Furthermore, Badenova has its own DSO 'bnNETZE', which will play a substantial role in testing the FLEXGRID ATP. • Additionally, Badenova provides an own energy trading department designated for taking over the roles of ESP and BRP in the FLEXGRID ATP testing process. • Hence, concepts developed within the project can be tested under real-life/realistic circumstances. Thus, a realistic proof of concept becomes possible. • Moreover, Badenova provides real grid and operational data for simulations and theoretical analyses of the FLEXGRID academic partners.

	• Last but not least, Badenova will give inputs for the theoretical work and for algorithms' development making them valuable for real commercial application in the future and fitting within the given regulatory framework in Germany. Badenova holds stakes in other municipal utilities and network companies (e.g. in the cities of Freudenstadt, Kirchzarten, Gundelfingen, Tuttlingen). Via the Thuega Group, in which, in addition to Badenova, more than 100 other public utilities work together, solutions developed in the FLEXGRID project can be introduced to municipal utilities throughout Germany. Furthermore, information about Thuega can be found at www.thuega.de. The Thuega Group is the largest public-sector network in Germany and generated around 19 billion euros in sales in 2016 with around 17,200 employees. In recent years, Badenova has carried out several projects with funding from the EU or from the federal German government respectively (i.e. state of Baden-Württemberg). Examples include the project "Industry On Campus" with the University of Applied Sciences Offenburg (funded by the state of Baden-Württemberg with € 5 million, funding objectives: optimization of energy production from biomass, energy storage) and project "Vernetzte Industrie" (ERDF funding € 2.5 million). Badenova will further integrate its experience and conclusions form the Horizon 2020 project INVADE project (GA nº 731148 - https://h2020invade.eu/) in the project FLEXGRID. INVADE's intention was to enable a higher share of renewable energy sources to the (smart) distribution grid and to analyze business cases arising from interconnecting flexibility assets. Challenges were a deficiency of: 1) flexibility and battery management systems 2) exploration of ICT solutions based on active end user participation 3) efficient integration of energy storage and transport sector (i.e. EVs), 4) novel business models supporting an increasing number of different actors in the grid. INVADE addressed these challenges by proposing a cloud-based flexibility management system integrated with EVs and batteries empowering energy storage at mobile, distributed and centralized levels to increase renewables share in the smart distribution grid. Within INVADE, Badenova was responsible for realizing the German pilot site. FLEXGRID will build on this work that has already been done and add other aspects such as the marketing of flexibilities not only via the usual processing paths like energy exchanges and balancing energy markets, but also via the creation of a new regional market concept incorporating further stakeholders such as grid operators or energy cooperatives. FLEXGRID will play a very important role to evolve and experiment with Badenova's existing S/W toolkits, processes and services to constitute them more complete and intelligent. Badenova will also exploit the research that will be carried out through FLEXGRID by embedding the findings in graduate courses held on the university of Freiburg. In this way, graduate students will have the opportunity to learn technologies relevant with new energy market architectures and algorithms for the development of: i) advanced retail pricing and flexibility aggregation algorithms, ii) bi-level optimization models for efficient energy markets' and networks' interaction, iii) optimal power flow and advanced energy market clearing models. Badenova will also coach BSc and MSc students writing their master theses in these fields.
Exploitation Targets	**By the end of the project**, the major exploitation targets based on the targeting exploitation opportunities described above are: • Having access via FLEXGRID ATP on several flexibility marketing possibilities and having started a regional market. • New business opportunities for flexibility marketing have been evaluated.

	• Directing and communicating the findings of the FLEXGRID project within the Thuega group, a network consisting of more than 100 public utilities. • Active participation in mostly national conferences and journals with high impact factor in the German energy sector. • Skills of staff have been widened by new possibilities for flexibility marketing. **After the project's lifetime,** the major exploitation targets of Badenova will be the following: • Introduce new business models successfully into the market • Operate a regional market for new stakeholders in the market • Have a 'one-in-all' software tested and ready for easily accessing different kinds of flexibility markets • Use the FLEXGRID project's achievements to work on new innovative project proposals both at EU and national level.
Targeted end users	• DSO • BRPs • ESPs • Energy cooperatives • RESPs • Smart communities/cities with own RES and consumption

5.4.10 DTU

DTU Exploitation Plan	
Description	**Background/Foreground Knowledge:** The Technical University of Denmark (DTU) is an internationally leading university in the areas of engineering science and technology. DTU is known for its business-oriented approach, its focus on sustainability and its modern and attractive study environment. Furthermore, DTU is dedicated to benefiting society and to cultivating and advancing the natural and technical sciences to serve as a driver for development in the commercial and public sectors. The Academic Ranking of World Universities from Shanghai Jiao University (ShanghaiRanking) consistently places DTU in the top 10 universities in the world for Energy Science and Engineering (2016, 2017, 2018). The Center for Electric Power and Energy (CEE) at DTU Electrical Engineering significantly contributes to the strong reputation of DTU in Energy Science and Engineering. CEE is highly involved in research related to energy generation, transmission, distribution and consumption with the aim of establishing the most integrated, market based and flexible energy system based on renewables and digital solutions. CEE holds competences in: electric power systems, electricity markets, electric components, digital energy solutions, intelligent energy systems and end user engagement. **DTU objectives within FLEXGRID context:** DTU has a strong background on optimal power flow algorithms, both from an operational and market perspective. DTU has also considerable experience in participating (and leading) projects, with experience coordinating a number of government-funded projects in Denmark and the US (acting as the project

	coordinator and the PI/co-PI), and participating in a number of EU projects (Best Paths, IRENE-40, EU-DEEP, More microgrids). In the context of FLEXGRID, DTU will: • Lead the work package on the Optimal Power Flow and interaction between network operators and markets (WP5) • Work on the development of distribution flexibility market clearing toolkit (WP5) • Contribute in WP4 research activities regarding the OPF-aware flexibility market mechanism design and generally providing the network-related constraints imposed to WP4 mathematical and system models.
Exploitation Targets	**By the end of the project**, the major exploitation targets based on the targeting exploitation opportunities described above are: • Novel publications and active participation in high-quality international conferences and journals with high impact factor. • Distribution Flexibility Market Clearing Toolkit (FMCT), which will be publicly available for use of its basic functionalities, with exhaustive documentation to help the users. **After the project's lifetime,** the major exploitation targets of DTU will be the following: • Use the FLEXGRID project's achievements to continue the research on the future of optimal power flow algorithms. • Continue the exploitation and improvement of the FMCT tool based on users' feedback. • Apply FMCT to real systems in Denmark, especially on Bornholm Island.
Targeted end-users	FMCT can be used as a standalone S/W toolkit, also outside of the FLEXGRID platform. The main target groups of FMCT are: • Individual researchers and research groups, who want to use FMCT for research and experimentation purposes. • TSOs/DSOs, to evaluate line congestions or voltage deviations, and the need for flexibility associated.

5.4.11 AIT

AIT Exploitation Plan	
Description	**Background/Foreground Knowledge:** AIT has applied and increased its long-term experience in design and validation of IT-networked energy system solution, where a focus on the interfaces of flexibility activation and provision was given. Demonstrations of interoperable solutions in AIT laboratories as well as an extensive scalability analysis of solutions were conducted in several other EU and National projects. These activities significantly helped to strengthen the AIT research and service portfolio in these areas. In addition, we participated actively in the demonstrators with functional compatibility validation and field test evaluation, which will benefit our research Fields Power System Planning and Operation, as well as Power System Digitalisation thanks to this reference project. **AIT objectives within FLEXGRID context:** The new paradigm of distributed flexibilities is a concern for many stakeholders, in particular for network operators. Their increasing openness to investigate in this area

	will become visible in FLEXGRID. Thanks to the laboratory testing activities, AIT will develop new test procedures in this context. AIT is targeting technology providers (e.g. companies developing SCADA systems or software for aggregators) for laboratory testing services involving the physical and IT behaviour of field devices. IRegarding scientific exploitation, the testing procedures developed in FLEXGRID will be input for future projects, where a holistic validation approach could be followed that generalizes the flexibility-related work in FLEXGRID. Furthermore, the topics of the FLEXGRID demonstrators will be subject to scientific publications.
Exploitation Targets	**By the end of the project**, the major exploitation targets based on the targeting exploitation opportunities described above are: • Development of testing procedures • Scientific publications **After the project's lifetime,** the major exploitation targets of AIT will be the following: • Consulting activities within the area of scalability analysis, energy markets and power system modelling as well as network-wide integration studies for new grid participants target distribution network operators and regulatory bodies.
Targeted end-users	The market audience for the laboratory testing activities is of interest virtually for any kind of ICT companies developing power system-related products. ICT companies developing new IT-networked products or national and intranational cooperation projects can benefit from the experience gained by AIT in FLEXGRID.

6. Conclusions

Conclusively, the consortium has now reached Milestones 2 and 3, meaning that the consortium has agreed on an initial business modelling and a long list of value propositions that could potentially be offered to targeted customer segments, such as FMOs, system operators, ESPs, energy aggregators and retailers. The consortium has also clear plans for data management, dissemination/communication and exploitation of project's results. Moreover, at the end of Month 6, all the architecture design and technical specifications work has been successfully finished and all the technical APIs for the interactions among the various subsystems/modules have been agreed among the involved partners. The afore-mentioned achievements and work progress give pace to the core research work that has already begun. Step-wise, the actual work schedule plan is the following:

- The core research work will take place in the context of technical Work Packages 3, 4 and 5. Research teams will focus their work towards providing specific FLEXGRID intelligence and services to be integrated in the FLEXGRID S/W platform.
- The core S/W implementation work (FLEXGRID ATP frontend and GUIs for all users) will take place in the context of Work Package 6 and will be done by ETRA starting from Month 13.
- All backend intelligence will be developed by academic partners in the context of WPs 3-5. ICCS and UCY will develop AFAT intelligence, UNIZG-FER will develop FST intelligence and DTU will develop FMCT intelligence.
- Initial S/W integration activities will take place from Month 13 onwards, in order for an initial DEMO to be shown during the 1st review in Brussels in Month 18. In particular, initial version of web APIs for the interaction between all S/W modules will be developed, while a few algorithms will be integrated in the research toolkits.
- Industrial partners are focusing on the business/market analysis and modeling to further identify the customer segment's needs and interests and feed back the consortium with specific implementation ideas to be adopted during the S/W integration and lab experimentations. More specifically, NODES is responsible for FMO actor, HOPS is responsible for TSO actor and its collaboration with DSO, BADENOVA is responsible for the ESP and DSO actor, while NPC is responsible for providing feedback based on its vast energy markets' operation expertise. SIN is responsible for the coordination of FLEXGRID business modelling and planning.

It should also be noted that there will be two (2) future deliverables regarding the intermediate and final versions of business modeling, dissemination and exploitation of results. The intermediate version (D8.2) will be released in Month 18, while the final version (D8.3) will be released at the end of the project (Month 36).

7. Appendix for POPD declarations

This appendix includes the POPD declarations from the key involved partners of FLEXGRID consortium, namely: ETRA, UCY and BADENOVA. For each one of these partners, details of the technical and organisational measures to safeguard the rights of the research participants are provided.

7.1 POPD declaration ETRA

a. Details of the technical and organisational measures to safeguard the rights of the research participants

ETRA's data protection policy is in line with existing requirements (i.e. Regulation EU 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC - shortly: General Data Protection Regulation (GDPR)) that are matching the Privacy and Data Protection and also the resulting obligations within the Project to perform a DPIA in line with the existing template developed by the Smart Grid Task Force 2012-14 - Expert Group 2[72] .

ETRA has nominated an external Data Protection Officer (DPO)[73] to manage data protection concerns regarding the data. The DPO should be easily accessible to all establishments. A DPO can be a staff member of controller/processor or can be employed on a service contract. The DPO needs to have knowledge of data protection law and practices and the ability to fulfil the tasks referred to in Article 39 (to inform and advise the controller or the processor and the employees who carry out processing of their obligations pursuant to this Regulation and to other Union or Member State data protection provisions; to monitor compliance with this Regulation, with other Union or Member State data protection provisions and with the policies of the controller or processor in relation to the protection of personal data, including the assignment of responsibilities, awareness-raising and training of staff involved in processing operations, and the related audits; to provide advice where requested as regards the data protection impact assessment and monitor its performance pursuant to Article 35; to cooperate with the supervisory authority; to act as the contact point for the supervisory authority on issues relating to processing, including the prior consultation referred to in Article 36, and to consult, where appropriate, with regard to any other matter), hence it is likely that new DPO consultancies will manage several portfolios, perhaps specializing in particular sectors. ETRA's DPO will also collaborate with other FLEXGRID partners' DPOs in order to realize a coordinated POPD strategy.

b. Details of the security measures to prevent unauthorised access to personal data

The tools developed within FLEXGRID project will be enhanced with API web authentication protocols, which is a state-of-the-art procedure to ensure safety data management worldwide. There are ways to check for proper authorization, such as via content-based access control (CBAC), role-based access control (RBAC) or policy-based access control (PBAC), ensuring that project data remains fully protected against unapproved access. Role-

[72] P. a. C.-S. i. t. S. G. E. Expert Group 2: Regulatory Recommendations for Privacy, "Data Protection Impact Assessment Template for Smart Grid and Smart Metering Systems," Brussels, 2014.

[73] GRUPO ADAPTALIA LEGAL-FORMATIVO S.L. - B86260247 (Persona de contacto: JORGE TORRES AMBITE)

based access control (RBAC) fits well with our API design, especially when combining API Key scopes with user profiles. Both procedures will be evaluated when the APIs become ready to maximize its waterproof security. For more information and details about these security procedures, the interested reader can check Section 4.2.2 of D2.2 (delivered in Month 6).

c. How is all of the processed data relevant and limited to the purposes of the project ('data minimisation' principle)?

The data used within the project has been designed from its early stage to be optimal for the purposes of the project and it is vastly described in Section 3 of this report. There is no prevision of extending the amount of data used for the project purposes. The data is limited, known, and there are specific plans to manage it observing the European legislation in force concerning this issue.

d. Details of the anonymization /pseudonymization techniques

The European Union's new General Data Protection Regulation (GDPR) demands that stored data on people in the EU undergo either an anonymization or a pseudonymization process. As stated in Section 3 of this report, all data managed in the project provided by the different partners in charge of those task will be duly anonymized. ETRA doesn't foresee any anonymization procedures to be applied to the data received.

e. Justification of why research data will not be anonymized/pseudonymized (if relevant)

The consortium will observe that personal data is anonymized without affecting the reliability of the information used.

f. Details of the data transfers (type of data transferred and country to which it is transferred – for both EU and non-EU countries)

ETRA will receive data from FLEXGRID partners, all of them belonging to EU member countries. Thus, European legislation that will be followed within the project covers these transfers.

7.2 POPD declaration UCY

Type of data in the UCY pilot:

- Metering data (university campus) for both consumption and PV generation.
- Weather data (solar irradiance, indoors and outdoors temperature etc).
- Energy prices.

Forecast data:

- Market price forecasting
- Energy forecasting
- Load forecasting

Datasets are saved in servers of University of Cyprus and securely transmitted to online platform. Real-time acquisition and storage of data is possible, but provision of data in 15-minute intervals will be used.

a. **Details of the technical and organisational measures to safeguard the rights of the research participants**

Data management legislation in Cyprus

The GDPR is an EU law which became directly applicable law in Cyprus, like in all other Member States of the EU, on 25 May 2018. In Cyprus, the GDPR gives national data protection authorities greater powers of enforcement, with the potential for significant fines for regulatory infringement and increased litigation risk arising from aggrieved data subjects. The GDPR provides for certain areas where Member States could determine and further set exceptions within the articles of the GDPR. Because of this, Cyprus has put in place a GDPR implementation law. Cyprus' Protection of Natural Persons Against the Processing of Personal Data and the Free Movement of this Data Law 125(I) of 2018 [CHR18], in some manner implements elements of the GDPR, and in another, it could be viewed as ancillary and supplementary to it. The legislation enacted by Cyprus sets out particular rules for certain processing situations and creates criminal offences for infringement of statutory provisions. The data protection legislation in Cyprus considers the protection of information provided by both natural persons and legal entities on the Cypriot territory. The local authorities have created the legislation with the purpose of providing a legal framework which will protect the legal rights of the natural persons and legal entities in Cyprus. It provides a comprehensive image on the ways in which personal data can be collected, processed and transferred. The main authority which controls the enforcement of the data protection law is the Office of the Commissioner for Personal Data Protection. The legislation provides a clear understanding on what personal data means, which represents all types of information related to the private life of a person, such as the home address or personal phone number, the bank account, e-mail address and many others. The legislation also prescribes definitions of the "sensitive data". The term refers to personal information related to a persons' ethnicity, political orientation, health, sexual orientation or religion. Legal entities which act as data controllers in Cyprus are required to register with the Office of the Commissioner for Personal Data Protection and the procedure is compulsory for all types of data controllers. The respective entity must provide details on the business address, the main reasons for which the data must be collected, the period in which such information will be collected and many others. Data can be collected in Cyprus only if the respective companies or institutions provide evidence referring to the persons' consent on such actions.

Having said the above, UCY is in full compliance with GDPR and have appointed their own DPO will move towards the above directions before pilot deployment

b. Details of the security measures to prevent unauthorised access to personal data

Most data sets are protected by identification of accesses. Different data transfer protocols are also used in each case. For this reason, legal entities acting as data controllers in Cyprus are required to register with the Office of the Commissioner for Personal Data Protection and this procedure is mandatory. This avoids violations by unauthorized persons in the above data. Web management systems are secured according to the best practices. Regarding cyber security, the governing law 22(III)/2004 should be respected (referring to cyber-attacks).

c. How is all of the processed data relevant and limited to the purposes of the project ('data minimisation' principle)?

In case of UCY pilot, as University buildings will participate the risk of needed personal data is really low. Only personal data-if relevant- that are related to the purpose of processing should be requested.

d. Details of the anonymization /pseudonymization techniques

All relevant data of the pilot sites are completely anonymized, so they cannot become personal or "sensitive". Encryption of all transmitted data and secure transmission of all relevant data will be secured

e. Justification of why research data will not be anonymized/pseudonymized (if relevant)

No relevance

f. Details of the data transfers (type of data transferred and country to which it is transferred – for both EU and non-EU countries)

Concerning the transfer of data to countries within the EU, no additional measures are required beyond the direct application of the GDPR. Data transfer- such as metering data in this case- for research purposes among partners of the consortium will be anonymized and following the GDPR.

7.3 POPD declaration BADENOVA

Data protection information under Article 13, 14 of the German implementation (DSGV) of EU General Data Protection Regulation (GDPR)

BADENOVA contract with FLEXGRID Energy Pioneers (translated from German)

We process your personal data exclusively within the scope of the statutory provisions. This includes the following categories of personal data:

Master data (e.g. name, first name, address), contract data (e.g. customer number, counter number), consumption data, generation data, meter data, measurement data, billing data, bank data and comparable data.

Responsible entity and data protection officer

Responsible entity for the processing of your personal data is:
badenova AG & Co. KG
Tullastraße 61
79108 Freiburg
Tel.: 0800 2 83 84 85 (toll free service number)
E-Mail: service@badenova.de

You can contact our data protection officer at:
badenova AG & Co. KG
Datenschutzbeauftragter
Tullastraße 61
79108 Freiburg

Tel.: 0761 279 – 24 25
Fax: 0761 279 54 – 24 25
E-Mail: datenschutz@badenova.de

7.3.1 Purpose and legal basis for the processing of personal data: Data processing for the purpose of initiating and processing the contract (Art. 6 sec. 1 b DSGV)

The processing of the data is necessary for the initiation, execution and settlement of our contract.

During the pilot project, metering data as well as data from the Sunny Home Manager on the operation and condition of the photovoltaic system and battery storage as well as the consumption in the house are collected via a communication gateway sent to a control platform to be stored, processed and used there. They are used for optimized control of energy pioneer's devices and the development of future business models as well as new products. The data will also be made available anonymously to selected partners as part of the EU research project FLEXGRID. If the data is passed on to a third party for the purpose of data processing in the pilot project, this third party will also be obliged to provide data protection within the meaning of this contract.

7.3.2 Data processing for legitimate interest (Art. 6 sec. 1 f DSGV)

We process your data in an admissible manner to protect our legitimate interests. This includes the use of your personal data in order to

- Provide you with product information about energy products (e.g. energy production, supply, energy efficiency, electro mobility and other energy-related services and services).
- Implement measures to improve and develop services and products in order to offer you a customer-specific approach with tailor-made offers and products.
- Market and opinion research or have them carried out by market and opinion research institutes. This gives us an overview of the transparency and quality of our products, services and communication and enables us to align or design them in the interests of our customers.
- Use your data for analysis purposes.
- Use your data to optimize the operation of your generation, storage and consumption devices.
- To examine the use of not required capacities of your battery storage and test it.

If we intend to process your personal data for a previously unspecified purpose, we will inform you in advance within the scope of the legislative provisions.

7.3.3 Data processing on the basis of legal requirements (Art. 6 sec. 1 c DSGV) or in the public interest (Art. 6 sec. 1 e DSGV)

As a company, we are subject to various legal obligations (e.g. Metering Points Operating Act, Tax Laws, and Commercial Codes) that require the processing of your data in order to comply

with the law.

7.3.4 Categories of recipients / Disclosure of personal data / Third country

Within our company, those entities that need your data to fulfill the above-mentioned purposes will have access to it. This also applies to service providers and vicarious agents employed by us. We will only transfer personal data to third parties if this is necessary for the aforementioned purposes or if you have given your prior consent.

Recipients of personal data may be, for example: project partners in the EU research project FLEXGRID, coneva, scientific institutions, analysis specialists, meter operators, grid operators, energy consulting service providers, service data centers, experts, specialist companies and craftsmen.