GOFLEX

Generalized Operational FLEXibility for Integrating Renewables in the Distribution Grid (GOFLEX)

D9.2 Business Model Design and KPI Definition – Use Case 3

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Executive Summary

In this document the effects of the GOFLEX project and the consequences of flexibility creation and trading on the SWW Wunsiedel GmbH actual and future Business Models as well as related KPIs and the corresponding revenue situation are analyzed.

After introduction of the Wunsiedel trial site with use cases, functional models and UML diagrams, the methodology of Business Model Canvas, Cost-Benefit-Analysis and the definition of KPIs is introduced.

SWW Wunsiedel GmbH has created a strategic energy roadmap in the past which now is consequently executed in order to achieve the best outcome and operative structure. All activities in order to guarantee a stable and affordable energy supplying system for the citizens and customers and a viable economic basis for operation of a renewable energy generation for the years to come.

Besides the general Business Models and Cost-Benefit-Analyses for the SWW strategic migration mentioned before some more user group centered Business Models are evaluated and calculated. Most important is the integration of customers and existing prosumers.

The calculations for the SWW business scenarios for the future are done based on real business data from the year 2016 and the calculation framework and assumptions are explained in detail.

The future Business Models will be examined using key performance indicators (KPI) which will be correlated with the project KPI as far as possible.

The legal and regulatory frame in Germany is analyzed to find possible show stoppers or constraints.

The findings out of the analysis and calculation activities are gathered and combined in the conclusion chapter showing the positive effects to be expected for all parties involved from extensive use of flexibility potentials in renewable grid and energy business operation.

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List of Acronyms and Abbreviations

Abbreviation	Definition
ACER	Agency for the Cooperation of Energy Regulators
BEUC	The European Consumer Organisation
BRP	Balance Responsible Party
CEER	Council of European Energy Regulators
CEN	European Committee for Standardization
CENELEC	European Committee for Electrotechnical Standardization
DoA	Description of Action
DSO	Distribution System Operator
EASE	The European Association for Storage of Energy
EASME	Executive Agency for SMEs
EDSO	European Distribution System Operators' Association for Smart Grids
EEGI	European Grids Initiative
EERA	Technology Platforms and the European Energy Re-search Alliance
EEX	European Energy Exchange
EIIs	European Industry Initiatives
ENTSO-E	European Network of Transmission System Operators for Electricity
ESMIG	European voice of smart energy solution providers
ETIP SNET	The European Technology and Innovation Platform "Smart Networks for the Energy Transition"
ETIPs	European Technology and Innovation Platforms
ETSI	European Telecommunications Standards Institute
EV	Electric Vehicle
GEODE	European independent distribution companies of gas and electricity
H2020	Horizon 2020
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISGAN	International Smart Grid Action Network
JRC	Joint Research Centre
LCE	Low-carbon energy (see H2020 competitive low carbon energy call)
RES	Renewable Energy Source
SCADA	Supervisory control and data acquisition
SEO	Search Engine Optimization
SET-Plan	European Strategic Energy Technology Plan
TRL	Technology Readiness Level
TSO	Transmission System Operator
VPP	Virtual Power Plant

1 Introduction

A general introduction about the meaning of business models and business model KPIs to support the objectives of GOFLEX

1.1 Purpose

This document provides a progress report regarding the situation and the accomplished work of WP9 – System Deployment & Evaluation – Use Case 3 after 12 months (November 2016 – October 2017). It provides the reader with SWW´s general strategy explaining how the flexibility will be used, the different Business Models together with their Key Performance Indicators (KPIs) related to the SWW pilot, details about the Cost-Benefit Analysis approach for each category of prosumers and details about the German market and the German regulations to evaluate the feasibility of the implementation of the proposed Business Models.

1.2 Related Documents

This document is related to the similar deliverables of the other WPs and references D9.1.

1.3 Document Structure

This document presents the D9.2 deliverables of WP9: Business Model Design and KPI Definition – Use Case 3 [month 12]

Section 2 follows this introduction and presents the GOFLEX Systematic Framework Conditions. This includes a description of Use Case 3, the Canvas Model, the Cost-Benefit Analysis and the definition of the Key Performance Indicators in relation with the Project Impact Key Performance Indicators.

Section 3 presents SWW's General Strategy regarding how the flexibility is understood and will be used. This includes details about SWW's framework, SWW's customers, flexibility in the distribution and flexibility in energy retail.

Section 4 presents the different business models for SWW's four steps towards the "Cellular Approach". (1) SWW as service provider for Prosumers and flexible industry, (2) SWW using GoFlex as DSO aggregator platform, (3) SWW using GoFlex for a local market for energy and flexibility + "Autonomous Cell", (4) The cellular model enabled by GoFlex.

Section 5 presents the Cost-Benefit Analysis approach for the different services to be implemented

Section 6 and 7 present the Key Performance Indicators to be implemented in relation with the Project Impact Key Performance Indicators.

Finally, Section 8, followed by a short conclusion, describes the German market and the German regulations to evaluate the feasibility of the implementation of the proposed Business Models.

2 GOFLEX systematic framework conditions

There are three GOFLEX systemic framework conditions which are shared and used for all trial sites:

1) A shared methodology approach,
2) A shared understanding of the structure of the future energy system, its roles and processes,
3) A shared approach how to the individual KPIs of the trial sites support the KPIs of the GOFLEX project.

2.1 GOFLEX Methodology Approach

In GOFLEX new business models will be demonstrated and verified in all trial sites. To ensure a common language and the comparability of results, a specific set of methodologies will be used

1) The intended interactions between actors for the business model to work out will be described as use cases and visualised as UML Diagrams using Grady Boochs understanding of UML diagrams (Booch, 1999).
2) To describe the business models the Osterwalder business model Canvas will be used (Osterwalder, 2010)
3) No business model will be implemented if there is not the assumption of a positive business case. Though the data for this assessment are actually produced within the trial phase of this project, the financial figures will be assumed based on existing predictions and other pilot projects and a simplified projected Cost-Benefit-Analysis will be carried out per business model.

2.1.1 Use Case Descriptions/ UML diagrams

A use case is a methodology used in system analysis to identify, clarify, and organize system requirements. The use case is made up of a set of possible sequences of interactions between systems and users in a particular environment and related to a particular goal. The use case should contain all system activities that have significance to the users.

A use case diagram is a graphic depiction of the interactions among the elements of a system.

Use case diagrams are typically employed in UML (Unified Modelling Language), a standard notation for the modelling of real-world objects and systems.

A use case diagram usually contains four components.

- The boundary, which defines the system of interest in relation to the world around it.
- The actors, usually individuals involved with the system defined according to their roles.
- The use cases, which relate to the specific roles played by the actors within and around the system.
- The relationships between and among the actors and the use cases.

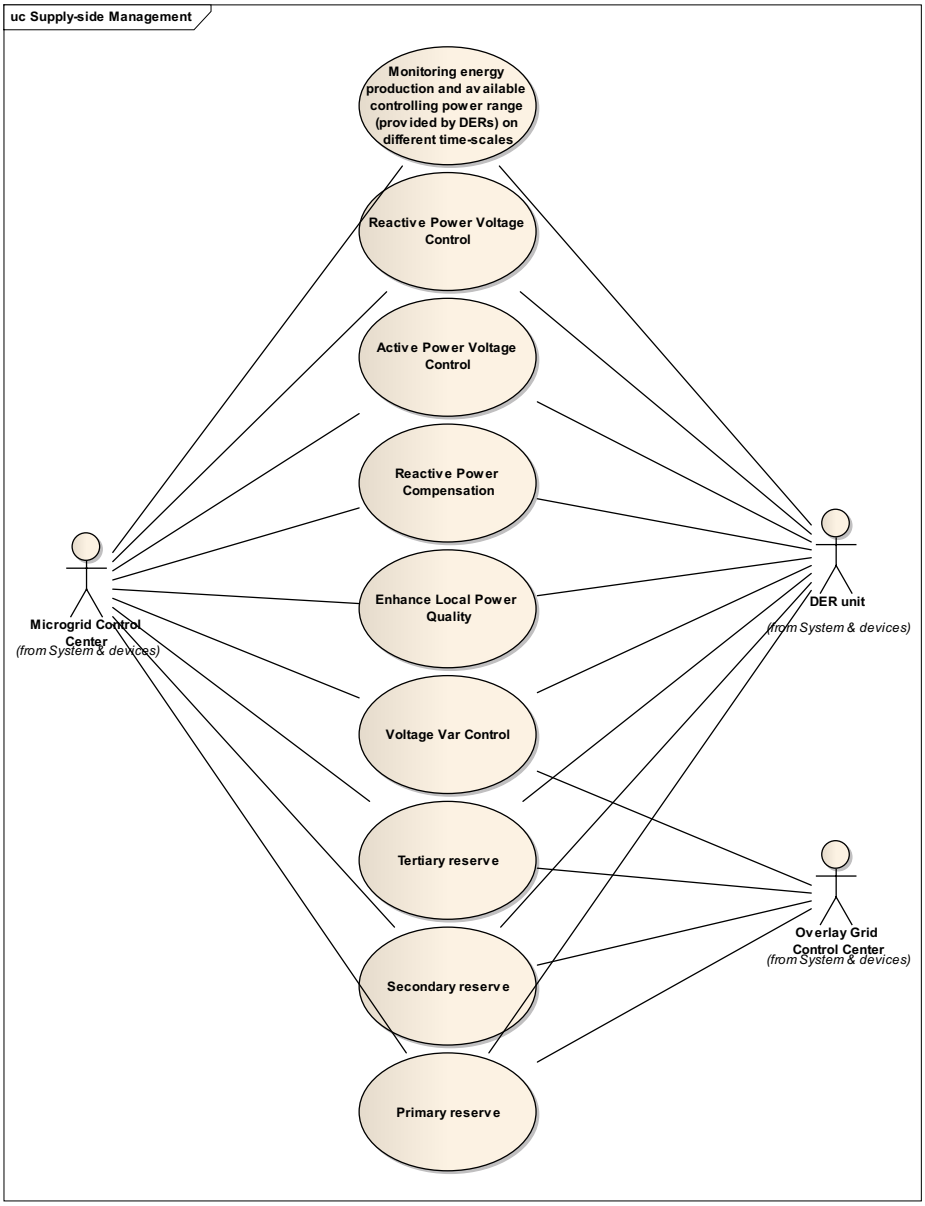

Figure 1: Use Case diagram example "Microgrid and DER owners offering ancillary services to each other and the overlay grid (FINESCE 2013)"

2.1.2 The CANVAS Model

The Business Model Canvas is a tool for describing, analysing, and designing business models It consists of 9 building blocks.

Customer Segments

The Customer Segments Building Block defines the different groups of people or organizations an enterprise aims to reach and serve

Value Propositions

The Value Propositions Building Block describes the bundle of products and services that create value for a specific Customer Segment

Channels
Value propositions are delivered to customers through communication, distribution, and sales channels. The Channels Building Block describes how a company communicates with and reaches its Customer Segments to deliver a Value Proposition.

Customer Relationships

Customer relationships are established and maintained with each Customer Segment. The Customer Relationships Building Block describes the types of relationships a company establishes with specific Customer Segments.

Revenue Streams

Revenue streams result from value propositions successfully offered to customers.

Key Resources

Key resources are the assets required to offer and deliver the previously described elements.

Key Activities

The Key Activities Building Block describes the most important things a company must do to make its business model work.

Key Partnerships

Some activities are outsourced and some resources are acquired outside the enterprise. The Key Partnerships Building Block describes the network of suppliers and partners that make the business model work

Cost Structure

The business model elements result in the cost structure. The Cost Structure describes all costs incurred to operate a business model

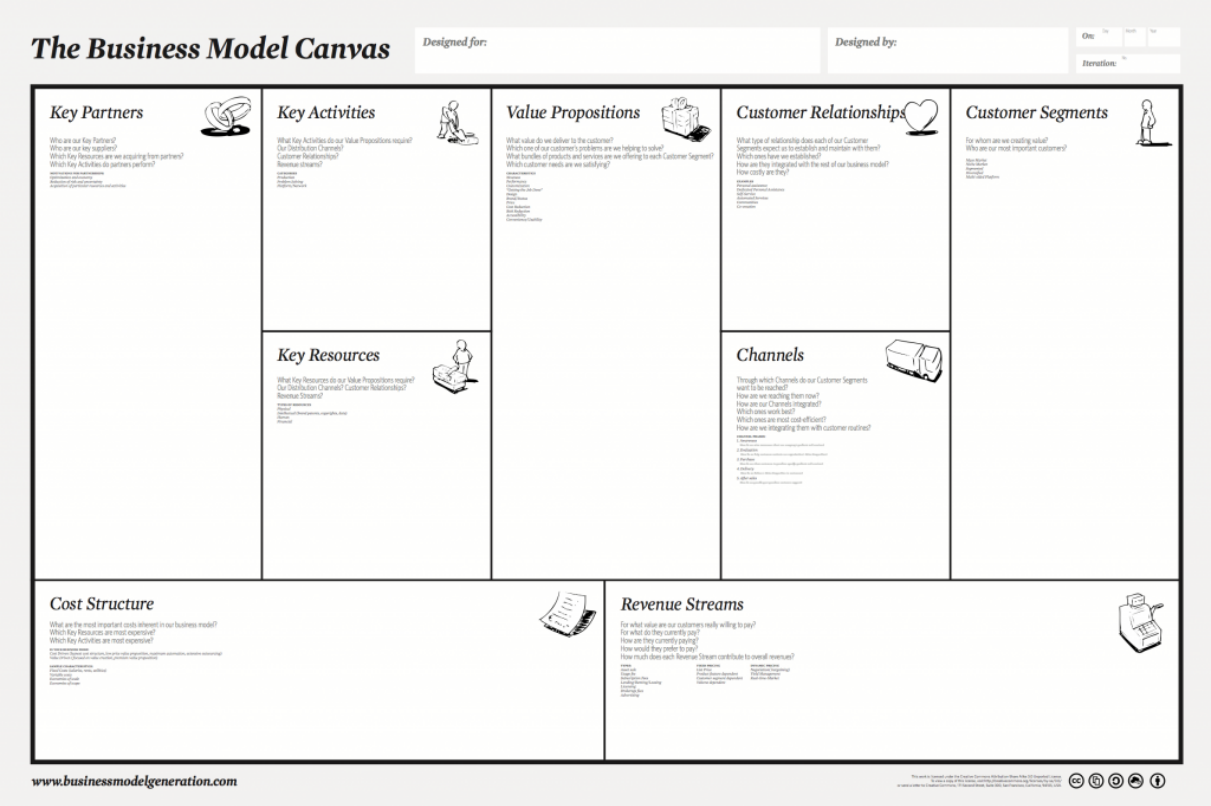

Figure 2: The Business Model Canvas

2.1.3 Cost-Benefit-Analysis

The CBA is defined as a systematic process for calculating and comparing benefits and costs of a decision, or project. In GOFLEX the CBA has the purposes to determine if an investment/decision is sound verifying whether its benefits outweigh the costs, and by how much. "Benefit" in this case is measured as the revenue flowing in from customers using the specific service.

The CANVAS building blocks 5 "Revenue Streams" and 9 "Cost Structure" will be further assessed based on past data available or assumed data:

2.1.3.1 Costs

There are two main cost categories to be assessed:

Fixed costs

Costs that remain the same despite the volume of goods or services produced. This cost category applies for example to the costs to establish a market platform for flexibility. The development costs are independent of the number of market actors using this platform.

Variable costs

Costs that vary proportionally with the volume of goods or services produced. This cost category applies for example to costs directly involved with the provided access to markets for prosumers. Each prosumer needs equipment and software.

2.1.3.2 Revenue streams

There are several ways to generate revenue streams from GOFLEX business models which needs to be assessed.

Asset sale

The most widely understood Revenue Stream derives from selling ownership rights to a physical product. In GOFLEX this revenue stream can be applied to selling equipment (PV, EMS, batteries) to the prosumers to support their self-consumption and to enable them to participate in the flexibility trading.

Lending/Renting/Leasing

This Revenue Stream is created by temporarily granting someone the exclusive right to use a

particular asset for a fixed period in return for a fee. For the lender this provides the advantage of recurring revenues. Renters or lessees, on the other hand, enjoy the benefits of incurring expenses for only a limited time rather than bearing the full costs of ownership.

In GOFLEX this can be applied by utilities renting out equipment (PV, battery, EMS etc.) to prosumers for example as part of a tariff model (comparable to the tariff models for mobile phones).

Usage fees

This Revenue Stream is generated by the use of a particular service. The more a service is used, the more the customer pays. In GOFLEX a usage fee can be applied to the usage of the flexibility trading platform by the market actors (to be paid by transaction). It also applies to the actors purchasing the flexibility of other actors.

Subscription fees

This Revenue Stream is generated by selling continuous access to a service. In the example of the market actors getting access to the flexibility platform this could be also implemented as monthly or yearly subscription fee.

Licensing fees

This Revenue Stream is generated by giving customers permission to use protected intellectual property in exchange for licensing fees. Licensing allows rightsholders to generate revenues from their property without having to manufacture a product or commercialize a service.

In GOFLEX this model can be used for software suppliers (flexibility market applications, aggregator platforms) offering their products to utilities as licensed “white label” products.

2.2 GOFLEX Systemic Roles and Processes

The GOFLEX Use cases are the use cases for trading energy flexibilities of parties connected to the grid - (active) consumers, producers and prosumers, in which the trading takes place in one cellular subsystem or between two cellular subsystems in electricity market system, according to the GOFLEX roles and process model.

The GOFLEX roles and process model is based on the Harmonized Electricity Market model in Europe (ENTSO-E, 2009, ENTSO-E 2015), and its adaptation by Mirabel project (Mirabel 2013).

The GOFLEX roles and process model is presented in deliverable D6.2 but briefly explained here; the explanation is intended to be reasonably self-contained.

The main characteristics and assumptions of GOFLEX roles and process model are:

<u>The electricity system:</u>

The electricity market system in Europe is vertically structured into vertically nested fractal-like systems. This means that the subsystems into which a system is decomposed are fully contained in the original system (“parental” system), and that the new subsystems have essentially the same functions as their parental system (“fractal-like”); for convenience within GOFLEX project we term such systems also »cellular« systems and such vertical structure as “cellular structure”.

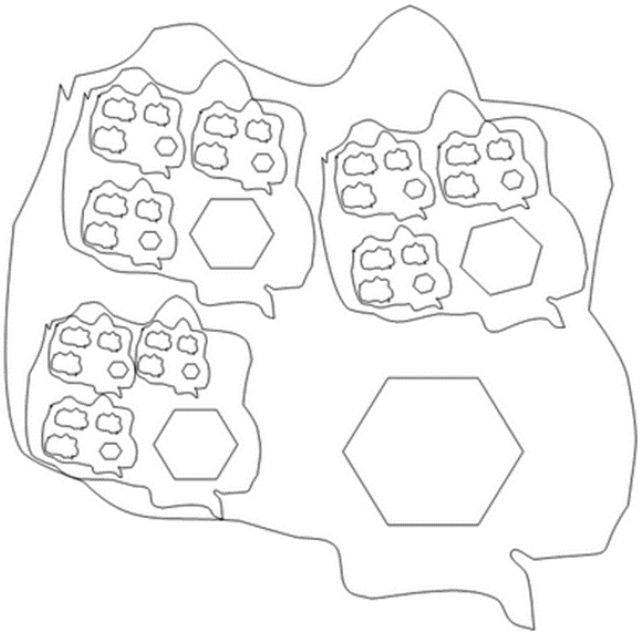

Figure 3: Schematic representation of vertical decomposition of electricity market system into nested fractal-like subsystems

The vertical structuring, defined in the Harmonized electricity market model to Balance Group level, is carried downwards to (Local Community) Microgrid systems and (Local) Energy community systems. The shared property of these two subsystems is that they are in the cross-section of Balance Group (BG) or sub-balance group (SBG) and the territory of DSO (or sub-DSO); and that they can be separated from the grid and optimize its electricity supply and consumption tending to balanced operation and thus to self-supply (the limiting case would be islanding operation). The difference is that the latter subsystem tries to extend this approach to include all energy carrying media.

The electricity grid system, which is presently not organized in a cellular structure, will be harmonized by structuring it into cellular subsystems;

the first level of structuring is DSO subsystem within the TSO system. This implies a new business model for DSO vs TSO, with DSO becoming responsible for all functions for controlling the grid on its level, including the responsibility for local balancing of energy flows on the grid. TSO system becomes parental system of DSO subsystem.

The next level of structuring can be sub-DSO subsystem (taking care of the lower voltage levels) within the DSO parental system. The same cellular characteristics are applied – sub-DSO becomes responsible for all functions for controlling the grid on its level.

Local balancing of energy flows

The challenges of achieving the target of 100% RES on the grid will to large extent be based on local (dispersed) generation of energy. The techno-economic optimum in balancing the local production and consumption is local balancing of energy flows on the distribution grid. In order to be able to do this effectively, avoided costs (long term & short term marginal costs) principle is the governing principle for business evaluation of the business models, in particular in use cases where DSO is the user of energy flexibilities.

Dynamic prices of energy flexibilities

the price of energy flexibilities is dynamic – it changes in trading intervals based on local conditions on the grid. Such dynamic price is the necessary prerequisite for un-leashing the full potential of energy flexibilities in prosumers and for local cost-effective investments into explicit energy storage systems.

The dynamic prices are communicated in GOFLEX trading process by Flex-Offers, issued by prosumers for selling flexibilities, and issued by the flexibility users such as DSO for purchasing energy flexibility.

Roles in GOFLEX

The roles used in GOFLEX roles and process model are:

- roles or sub-roles of the Harmonized electricity market model and Mirabel roles and processes model,
- new roles due to its cellular extension downwards; examples of such roles are Microgrid Responsible Party, Local supplier of energy, and
- new roles due to proposed cellular structuring of the electricity grid system, i.e. DSO (new "cellular" role), sub-DSO.

Additionally, some roles are structured further to make use of the GOFLEX technologies, which makes them scalable to various use cases. These are "GOFLEX roles"

The GOFLEX roles are "unit roles" – they can be integrated in different use cases to suit the business models of actual players. This is an important characteristic adding to GOFLEX operational scalability and adaptability. An example of GOFLEX role is FMAR operator (Flexibility Market Operator); this role is scalable to all the use cases where GOFLEX technology is used. The actual role in each use case is termed according to the use case, e.g. Local market operator plays out the GOFLEX role FMAR operator in the use case with descriptive name "Local Balancing market for energy flexibilities for DSO".

To ease understanding, all new roles are labelled using descriptive names. Coded names will be introduced in next stage of definition of business models.

GOFLEX Processes

The processes in GOFLEX are structured according to the Harmonized model and following Mirabel roles and process model:

- The primary process in the electricity market and grid system consists of energy production, transmission – flow of energy, consumption and trading. This process is broken down into unit processes
- Joint and supportive processes are processes necessary for operation of the electricity market, mainly processes for maintaining the electricity grid They are also structured into unit processes

The use cases

The GOFLEX use cases are those use cases in the Market Balance Area (MBA) that are enabled by GOFLEX integrated solution using the GOFLEX roles and process model. They comprise

- The use cases within the Harmonized electricity market model
- The new use cases made possible through further vertical structuring of the electricity market and harmonization of joint and supportive processes of the electricity grid system, as explained above in the section "Roles in GOFLEX"

The GOFLEX project focus is local, with DSO as the dominant user of energy flexibility for avoiding congestion and local balancing of the grid. The list of these use cases as given in the Table 1 below.

Table 1: The list of Use Case for local levels of electricity market and grid system for GOFLEX roles and process model

UC no.	Use Case	EM sub-system	driving case role		grid sub-system	type of trading
			Business role	Grid operator		
UC1	Tertiary reserves of TSO	MBA	BRP_{AGG}	TSO	TransG	many:1
UC2	Optimized operation of microgrid	LCM	MRP	(S-)DSO	(sub-)DistG	1:many
UC2-1	Islanding operation of microgrid	LCM	MRP	(S-)DSO	(sub-)DistG	many:many
UC5	Local energy community	LEC	LSE	(S-)DSO	(sub-)DistG	1:many
UC5-1	Islanding operation local energy community	LEC	LSE	(S-)DSO	(sub-)DistG	many:many
UC4	Congestion management at DSO	BG	BRP_{AGG}	DSO	DistG	1:many
UC4-1	Local Balancing market for en.flex for DSO (Local Flexibility market)	BG	LMO	DSO	DistG	1:many
UC6	Regional Balancing Market for en.flex for DSOs (Regional Flexibility market)	MBA	MORBO	DSOs	DistG/ TransG	many:many

Table 2: Legend GOFLEX roles and processes

Legend:

Acronym	Name	Note
MBA	Market Balance Area	
BG	Balance Group	
LCM	Local community microgrid	
LEC	Local Energy community	Also known as Virtual Power System.
MO	Market operator	The role in Market Balance Area for energy trading between BRPs
BRP	Balance Responsible Party	

BRP_{AGG}	BRP in the role of an aggregator	
MRP	Microgrid Responsible party	
LSE	Local Supplier of Energy	
LMO	Local Market Operator	Plays out the GOFLEX role FMAR operator
DSO	Distribution System operator	Cellular role of DSO
SDSO	Sub-DSO	Cellular sub-role of DSO
MORB	Market operator for Regional Balancing Market for DSOs	Plays out the GOFLEX role: FMAR operator
TransG	Transmission Grid of TSO in MBA	
DistG	Distribution Grid of a DSO in MBA	
sub-DistG	Sub-Distribution Grid of a DSO	Grid belonging to SDSO
FMAR	Flexibility Market Platform	Building block of the GOFLEX solution

In the Table, UC1 is the Use case that is not a case on local but MBA level system, but it is directly accessible to roles involved in local trading of energy flexibilities.

It is important to note that these use cases are based on different level of assumptions as regards the necessary regulatory framework for carrying them out. Accordingly, they must be positioned at different times in future horizon.

A scenario for deployment of these use cases has to be elaborated based on specific conditions applicable to different Demonstration cases.

2.3 Definition of Business Model KPIs supporting the Project Impact KPIs

Key performance indicators (KPI) are a set of quantifiable measures that a trial uses to gauge its performance over time. These metrics are used to determine the trials' progress in achieving its strategic and operational goals, and also to compare the trial's finances and performance against other trials within GOFLEX (e.g. if they implement the same business model).

For each KPI a goal is supposed to be set which refers to the goals of the business model of each trial.

In GOFLEX all trial sites will define their own quantifiable KPIs and match them with the KPIs of the project depending on the specific business model they are focusing on to measure how the individual trial site has contributed to the overarching objectives of the GOFLEX project as a whole.

Table 3: List of Project KPIs:

Project Performance Indicator	Quantification	Measurement unit
Integration of Renewables		
Capable of integrating large share of renewables	**>15 %**	Safe increase of installed capacity (MW) with respect to initial capacity margins with no available demand response. ***(*)***
Electricity load adaptability level	**>15 %**	Energy demand variation (ΔMWh /h) with respect to peak demand (MWh/h)
Demand Response		
Demand response generated by virtual energy storage in demonstrated use cases in the project (during 3 months' testing & evaluation period)	**≥15%**	Energy demand variation (ΔMWh /h) with respect to peak demand (MWh/h)
Increase of prosumer involvement	**≥15%**	Augmented DR (%)
Benefit for aggregator	**≥ 35.000 EUR/MW/year + 200 €/MWh (1)**	Increased business in supply of DR
Benefit for DSO	**1.0 mio EUR/MW**	The reduced cost of congestion avoidance (2)

Grid Stability		
Avoid congestions: reduction of peak demand	**>15%**	Reduction of MWh/h
Lessen the burden of power grids through self-consumption	**>10 %**	MWh/h of self-consumed energy
Distribution grid stability through responsiveness of flexibility services	**30 min (>25% of DR)** **1 hr (>50% of DR)** **24 hrs (>100% of DR)**	Time required to activate portion of available load flexibility through DR services
Operational DR ready prosumer		
Prosumers with implemented virtual energy storage in processes	**≥ 15 prosumers**	No of established operational DR ready prosumers
Prosumers with implemented charging/discharging EV battery storage (with parked EV)	**≥ 5 prosumers**	No of established operational DR ready prosumers
Public charging (CEMS)		
Flexibility range at average occupancy of charging spots	**+10 / -30 %**	% of charging load variation (without violation of user needs) compared to baseline
Charging/discharging EV Station in house (CDEMS)		
Flexibility range for varying parking time	**2 hours: ±10%** **8 hours: ±25%**	% of charging load variation (without violation of user needs) compared to baseline
Gain for EV prosumers		
Charging timing reduction (battery buffer) and peak power need reduction (covering peaks from storage)	**>15%**	% of peak load reduction

3 General strategy of SWW: Why and how will flexibility be utilized?

The business models trial site in Wunsiedel are meant as proof of concept for the supremacy of the cellular approach covering three main issues:

- Wunsiedel aims to achieve 100% regional supply
- Wunsiedel aims to maintain the distribution grid in controlled islanding mode balanced by regional flexibility
- The supply of energy and flexibility will be provided bottom up, Prosumer/Microgrids -> Aggregators->BRP/DSO->TSO by automated trading.

All these goals are in accordance with SWW's energy strategy and roadmap as described in D9.1. To implement the SWW roadmap into the GOFLEX models all possible use cases were identified and put in interdependencies (time, contents, cost).

Because of the complexity of the way and the large variety and diversity of Business and Use Cases and roles SWW could choose along this way a clustering was undertaken to combine different levels of flexibility generation out of GOFLEX-models with market roles SWW needs to achieve to create the maximum economic benefit out of creating and dealing of flexibility.

The roles consist of Sub-BRP (partial Balancing Responsible Party), BRP (Balancing Responsible Party), Sub-DSO (partial Distribution System Operator), DSO (Distribution System Operator), LSE (Local Supplier of Energy), MRP (Microgrid Responsible Party), LMO (Local Market Operator), MO RB (Market Operator for Regional Balancing Market of en.flex for DSOs).

The possible use cases for SWW consist of UC1 Terciary reserves of TSO, UC4 Congestion Management at DSO, UC4-1 Local Balancing Market for en.flex for DSO, UC2 Optimized operation of microgrid, UC2-1 Islanding operation of microgrid, UC6 Regional Balancing Market for en.flex for DSOs, LMO Local Market Operator, MO RB Market Operator for Regional Balancing Market of en.flex for DSOs.

Starting from Todays' situation four steps were defined consisting of minimum one and maximum three Business Models and combinations of Use Cases, each. From the conceptual point of view step 3 could be spared after integration of several contents into the package of step 2. All of these actions and assumptions should take SWW to the final goal of the energy roadmap – the cellular approach. The method you have seen in Chapter 2.1 GOFLEX Methodology Approach.

3.1 Today's situation: SWW as service provider for prosumers and flexible industry

As you can see at **Fehler! Verweisquelle konnte nicht gefunden werden.** SWW works as energy retailer and buys electricity directly from of Uniper (former EON) using Uniper's services as Balance Responsible Party (BRP).

SWW is also is involved in energy generation and the energy is traded by Lumenaza, another BRP which is specialised in trading renewable energies according to the German "Marktprämienmodell" (market bonus scheme). Some generation plants are still remunerated according to the German "EEG-Umlage" (a feed-in tariff).

SWW retail also buys energy back directly from Lumenaza and sell it as regional energy product "Fichtelgebirgsstrom" to its customers. Lumenaza trades the surplus at the European Energy Exchance (EEX).

SWW is also the local DSO (since there are less than 100.000 consumers for SWW, the unbundling is not applied) with grid connection to the Bayernwerk (DSO MV) and Tennet (TSO HV) as upstream networks.

Tennet is authorized to use a special measure for grid emergency, the so called "BDEW Kaskade" which describes the merit order of DSOs who have to provide load shedding in such an emergency case. SWW today has currently no flexibility scheme in place to respond to this request apart from switching off consumers and handle the consequences.

SWW is also provider of a 8 MWh storage which is currently under construction and will be used to trade flexibility at the power reserve market (primary and secondary power reserve) owned by the TSO Tennet. The storage cannot be owned and used by the DSO under current German regulation.

All existing prosumers in Wunsiedel are currently remunerated according to the EEG. A few of them have storage solutions in place.

Industry mainly purchases energy from SWW retail and partly uses flexibility internally to avoid costs for peak loads.

The current situation is typical for a small active utility in Germany.

SWW aims to improve the situation and take a full position as regional energy service provider guaranteeing security of supply and grid security for *all citizen* independent of the energy retailer which the citizen has chosen. As retailer, it aims to provide 100% regional renewable energy ("Wunsiedler Weg - Energie").

The SWW grid is considered as cell within the European energy system which aims to achieve energy autonomy (balancing regional demand and supply) and is able to operate in islanding mode for emergency situations. The utilization of regional flexibility is key for this vision.

Several steps will be implemented and the GoFlex solution plays a prominent role in these steps.

SWW takes several roles in the area of Wunsiedel today:

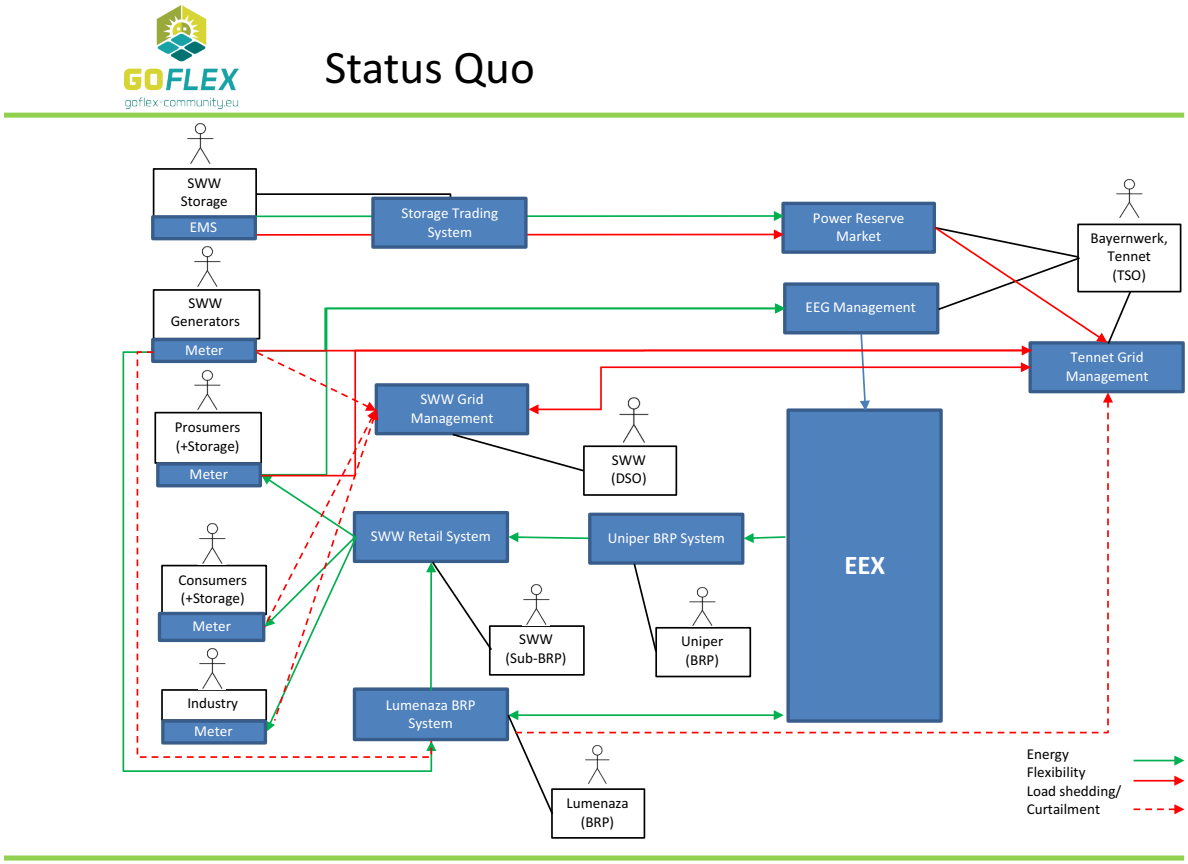

Figure 4: UML-Diagram for scenario "SWW as service provider for Prosumers and flexible industry"

Table 4: List of actors and systems for scenario "SWW as service provider for Prosumers and flexible industry"

Name	Actor/ System	Description
SWW Storage	Actor	SWW Spin-off to manage the … MW Battery storage
Storage Trading System	System	System to offer flex offers to the Tennet power reserve market
SWW Generators	Actor	SWW spin off companies that own energy generators (wind turbines, CHPs etc.)

Meter	System	Metering Systems for production and consumption
EMS	System	Energy Management System (managing the flexibility options)
SWW DSO	Actor	SWW distribution grid management department
SWW Grid Management	System	System that comprises all devices and applications for SWW to manage the LV distribution grid
SWW Sub-BRP	Actor	SWW Retail department
SWW Retail system	System	System of appliances which handles the retail transactions (purchasing form BRPs, selling to SWW customers)
Prosumers (+Storage)	Actor	All private and public consumers who also generate energy (via PV, CHP etc.) and are able to store energy (via battery, thermal storage etc.)
Consumers (+Storage)	Actor	All private and public consumers who are also able to store energy (via EVs, thermal storage, etc.)
Industry	Actor	All industrial plants in the area
Reserve Power Market	System	Market for flexibility options for the TSO (primary, secondary and tertiary reserve)
Tennet	Actor	Responsible TSO (high voltage) for the SWW grid (low voltage)
Bayernwerk	Actor	Responsible DSO (medium voltage) for the SWW grid (low voltage)
Tennet grid management	System	System that comprises all devices and applications for Tennet to manage the HV transmission grid
EEG management	System	System to organize and the feed-in from electrical generation under the EEG regulation (providing fixed feed-in tariffs to generators of renewable energy)
Uniper	Actor	BRP for the balance group in which SWW is a subgroup
Uniper BRP System	System	System handling the balancing requirements of the Uniper balancing group
Lumenaza	Actor	BRP handling the renewable generators of SWW which are marketed directly
Lumenaza BRP System	System	System handling the balancing requirements of the Lumenaza balancing group
EEX	System	European Energy Exchange

3.2 Step 1: SWW (DSO) as aggregator of local flexibility

This step contains three different settings or scenarios how SWW could position itself and stir the business depending on decisions that have to be taken in the near future but are not worked out in detail yet.

Changes to “Todays’ situation”: Integration of (local) GOFLEX aggregator in SWW, bundles all local (Non-EEG)-Prosumers, enters market through Storage trading. All other actors and business process remain the same, but the DSO uses the GoFlex Aggregation Management System to aggregate flexibility.

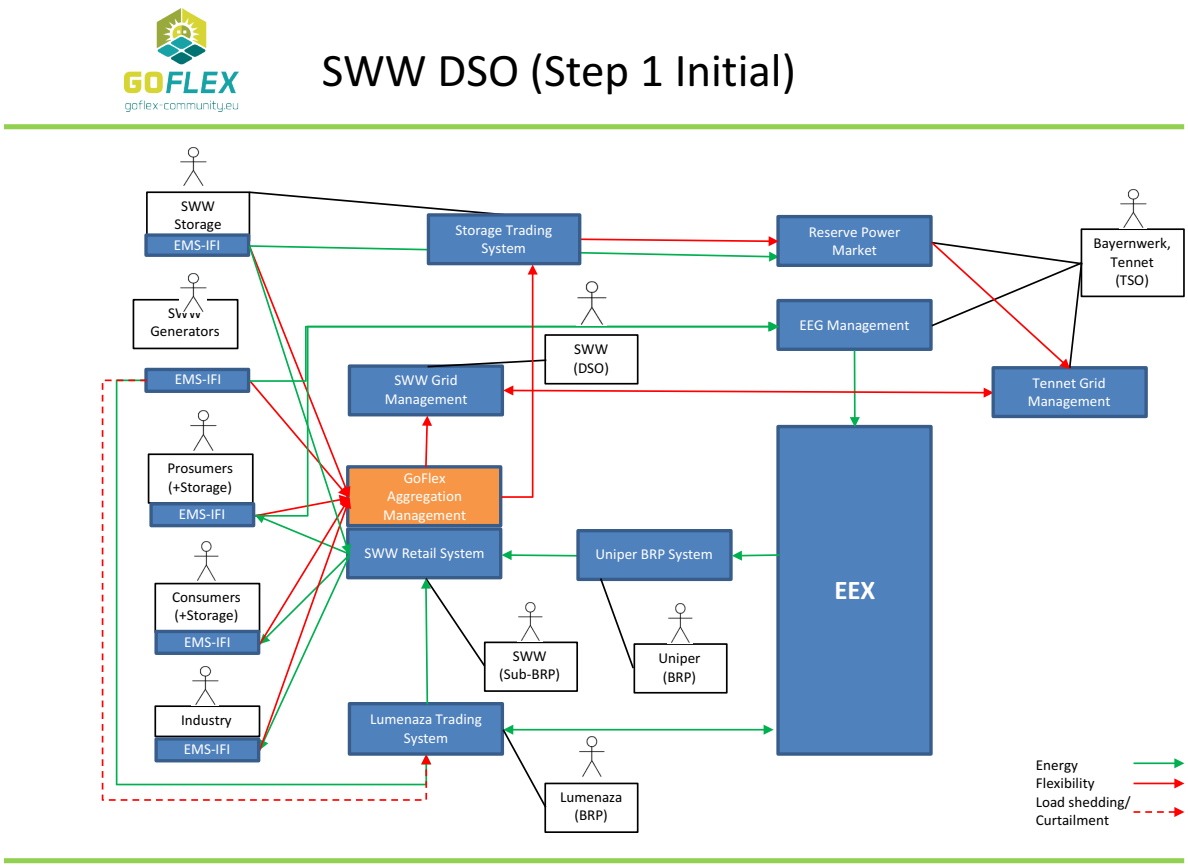

Figure 5: UML-Diagram for scenario "SWW using GoFlex as DSO aggregator platform - initial"

Table 5: List of actors and systems for scenario "SWW using GoFlex as DSO aggregator platform - initial"

Name	Actor/ System	Description
SWW Storage	Actor	SWW Spin-off to manage the … MW Battery storage
Storage Trading System	System	System to offer flex offers to the Tennet power reserve market
SWW Generators	Actor	SWW spin off companies that own energy generators (wind turbines, CHPs etc.)
Meter	System	Metering Systems for production and consumption
EMS-IFI	**System**	**Energy Management System (managing the flexibility options) with flexibility trading interface (IFI)**
SWW DSO	Actor	SWW distribution grid management department
SWW Grid Management	System	System that comprises all devices and applications for SWW to manage the LV distribution grid
SWW Sub-BRP	Actor	SWW Retail department
GoFlex Aggregation Management	**System**	**System managing the aggregation of flexibility of the connected generators, prosumers, consumers and industry plants**

Name	Actor/ System	Description
Platform Operator	**Actor**	**Platform Operator could be a SWW spin-off or the municipality or any other trusted party**
SWW Retail system	System	System of appliances which handles the retail transactions (purchasing form BRPs, selling to SWW customers)
Prosumers (+Storage)	Actor	All private and public consumers who also generate energy (via PV, CHP etc.) and are able to store energy (via battery, thermal storage etc.)
Consumers (+Storage)	Actor	All private and public consumers who are also able to store energy (via EVs, thermal storage, etc.)
Industry	Actor	All industrial plants in the area
Reserve Power Market	System	Market for flexibility options for the TSO (primary, secondary and tertiary reserve)
Tennet	Actor	Responsible TSO (high voltage) for the SWW grid (low voltage)
Bayernwerk	Actor	Responsible DSO (medium voltage) for the SWW grid (low voltage)
Tennet grid management	System	System that comprises all devices and applications for Tennet to manage the HV transmission grid
EEG management	System	System to organise and the feed-in from electrical generation under the EEG regulation (providing fixed feed-in tariffs to generators of renewable energy)
Uniper	Actor	BRP for the balance group in which SWW is a subgroup
Uniper BRP System	System	System handling the balancing requirements of the Uniper balancing group
Lumenaza	Actor	BRP handling the renewable generators of SWW which are marketed directly
Lumenaza BRP System	System	System handling the balancing requirements of the Lumenaza balancing group
EEX	System	European Energy Exchange

Changes to “Step 1 Initial”: SWW becomes BRP for VPP, stays Sub-BRP for Non-VPP part of grid. All other actors and business process remain the same.

All relevant systems of storage providers, generators, private/industrial prosumers and flexible private/industrial consumers which potentially can offer flexibility to the system shall be connected to the GoFlex Flex-Aggregation management (VPP-system).

SWW DSO (VPP for supplying energy flexibilities for (tertiary) reserves (Step 1 Full)):

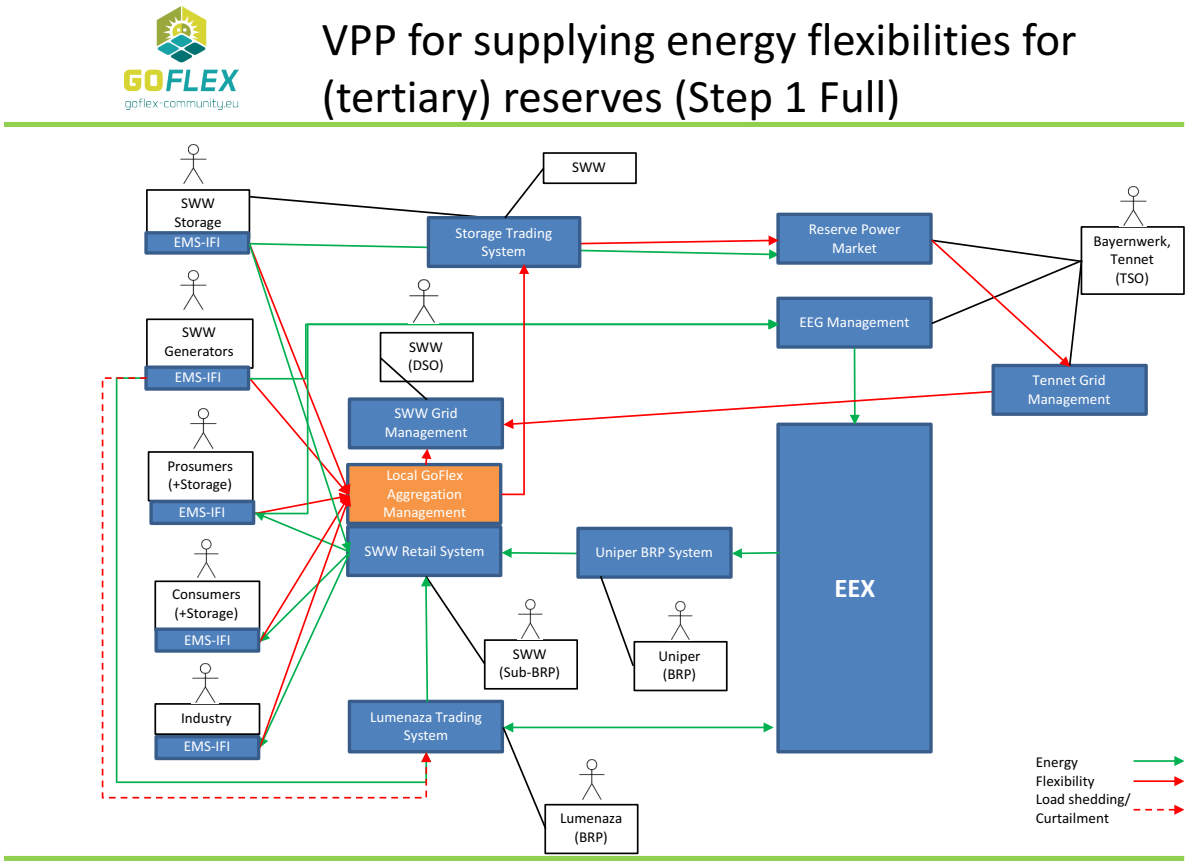

Figure 6: UML-Diagram for scenario "SWW using GoFlex as DSO aggregator platform, forming a Virtual Power Plant (in the role of a BRP) aiming for 100% supply of renewable energy – full (VPP)"

Table 6: List of actors and systems for scenario "SWW using GoFlex as DSO aggregator platform, forming a Virtual Power Plant (in the role of a BRP) aiming for 100% supply of renewable energy – full (VPP)"

Name	Actor/ System	Description
SWW Storage	Actor	SWW Spin-off to manage the … MW Battery storage
Storage Trading System	System	System to offer flex offers to the Tennet power reserve market
SWW Generators	Actor	SWW spin off companies that own energy generators (wind turbines, CHPs etc.)
Meter	System	Metering Systems for production and consumption
EMS-IFI	**System**	**Energy Management System (managing the flexibility options) with flexibility trading interface (IFI)**
SWW DSO	Actor	SWW distribution grid management department
SWW Grid Management	System	System that comprises all devices and applications for SWW to manage the LV distribution grid

Name	Actor/ System	Description
SWW Sub-BRP	Actor	SWW Retail department
GoFlex Aggregation Management	**System**	**System managing the aggregation of flexibility of the connected generators, prosumers, consumers and industry plants**
Platform Operator	**Actor**	**Platform Operator could be a SWW spin-off or the municipality or any other trusted party**
SWW Retail system	System	System of appliances which handles the retail transactions (purchasing form BRPs, selling to SWW customers)
Prosumers (+Storage)	Actor	All private and public consumers who also generate energy (via PV, CHP etc.) and are able to store energy (via battery, thermal storage etc.)
Consumers (+Storage)	Actor	All private and public consumers who are also able to store energy (via EVs, thermal storage, etc.)
Industry	Actor	All industrial plants in the area
Reserve Power Market	System	Market for flexibility options for the TSO (primary, secondary and tertiary reserve)
Tennet	Actor	Responsible TSO (high voltage) for the SWW grid (low voltage)
Bayernwerk	Actor	Responsible DSO (medium voltage) for the SWW grid (low voltage)
Tennet grid management	System	System that comprises all devices and applications for Tennet to manage the HV transmission grid
EEG management	System	System to organise and the feed-in from electrical generation under the EEG regulation (providing fixed feed-in tariffs to generators of renewable energy)
Uniper	Actor	BRP for the balance group in which SWW is a subgroup
Uniper BRP System	System	System handling the balancing requirements of the Uniper balancing group
Lumenaza	Actor	BRP handling the renewable generators of SWW which are marketed directly
Lumenaza BRP System	System	System handling the balancing requirements of the Lumenaza balancing group
EEX	System	European Energy Exchange

SWW DSO (Autonomy plus (Step 1 Final)):

Changes to “Step 1 Full”: SWW Full-BRP, Storage trading is out, Lumenaza is out. All other actors and business process remain the same.

All relevant systems of storage providers, generators, private/industrial prosumers and flexible private/industrial consumers which potentially can offer flexibility to the system shall be connected to the GoFlex Flex-Aggregation management. A remuneration system to remunerate the flexibility offers of these actors will be developed within the project time.

The purpose of the system at this stage is the possibility for the DSO to use flexibility either for emergency (to fulfil or rather to prevent the requests of the BDEW Cascade) or to offer flexibility to the power reserve market of the large-scale storage via the established SWW BRP. SWW BRP now also buys energy on the EEX directly.

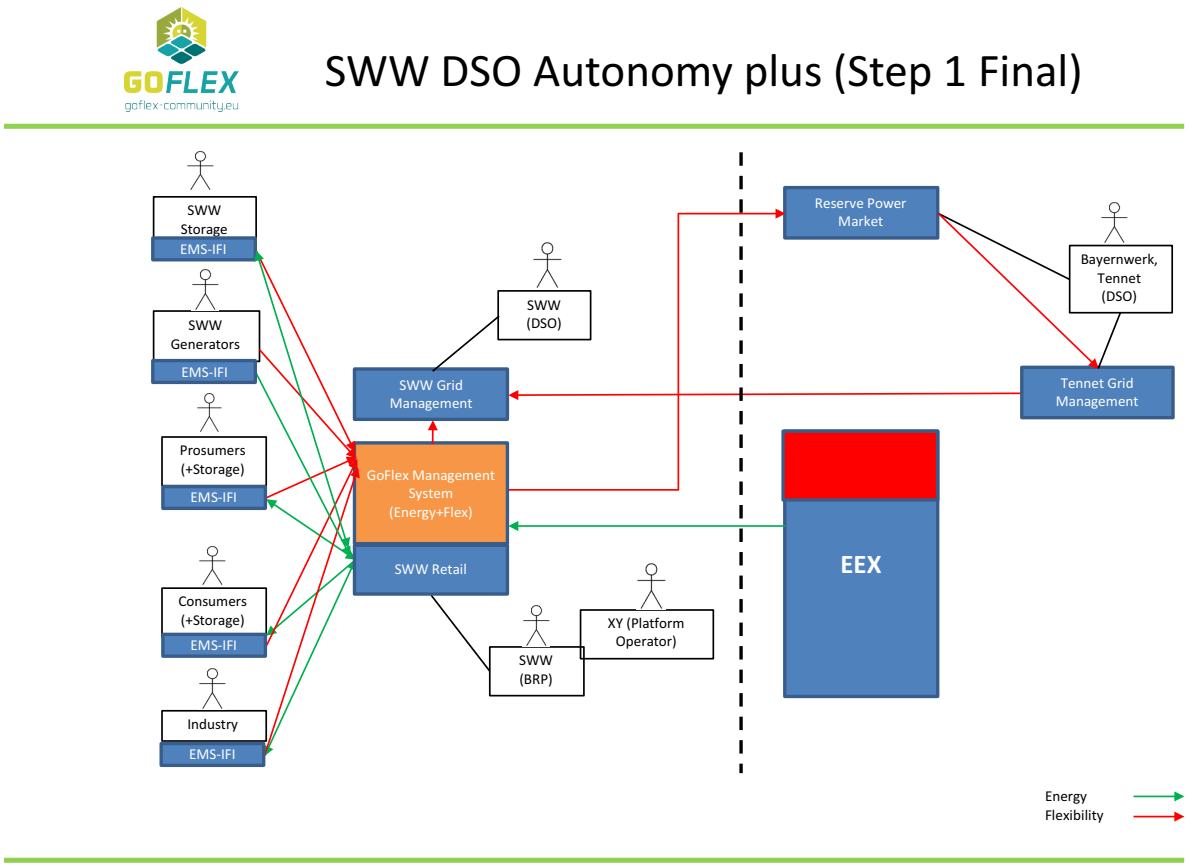

Figure 7: UML-Diagram for scenario "SWW using GoFlex as DSO aggregator platform – final (Autonomy plus)

Table 7: List of actors and systems for scenarios "SWW using GoFlex as DSO aggregator platform"

Name	Actor/ System	Description
SWW Storage	Actor	SWW Spin-off to manage the … MW Battery storage
SWW Generators	Actor	SWW spin off companies that own energy generators (wind turbines, CHPs etc.)
Meter	System	Metering Systems for production and consumption
EMS-IFI	**System**	**Energy Management System (managing the flexibility options) with flexibility trading interface (ITI)**
SWW DSO	Actor	SWW distribution grid management department

Name	Actor/ System	Description
SWW Grid Management	System	System that comprises all devices and applications for SWW to manage the LV distribution grid
SWW BRP	Actor	SWW Retail department
GoFlex Aggregation Management	**System**	**System managing the aggregation of flexibility of the connected generators, prosumers, consumers and industry plants**
Platform Operator	**Actor**	**Platform Operator could be a SWW spin-off or the municipality or any other trusted party**
SWW Retail system	System	System of appliances which handles the retail transactions (purchasing form BRPs, selling to SWW customers)
Prosumers (+Storage)	Actor	All private and public consumers who also generate energy (via PV, CHP etc.) and are able to store energy (via battery, thermal storage etc.)
Consumers (+Storage)	Actor	All private and public consumers who are also able to store energy (via EVs, thermal storage, etc.)
Industry	Actor	All industrial plants in the area
Reserve Power Market	System	Market for flexibility options for the TSO (primary, secondary and tertiary reserve)
Tennet	Actor	Responsible TSO (high voltage) for the SWW grid (low voltage)
Bayernwerk	Actor	Responsible DSO (medium voltage) for the SWW grid (low voltage)
Tennet grid management	System	System that comprises all devices and applications for Tennet to manage the HV transmission grid
EEG management	System	System to organise and the feed-in from electrical generation under the EEG regulation (providing fixed feed-in tariffs to generators of renewable energy)
Uniper	Actor	BRP for the balance group in which SWW is a subgroup
Uniper BRP System	System	System handling the balancing requirements of the Uniper balancing group
EEX	System	European Energy Exchange (MBA)

3.3 Step 2: Local market for energy and flexibility + “Autonomous Cell”

As next phase the functionality of GoFlex will be enhanced and more regional partners will participate in the developing flexibility market.

This step covers two different ways SWW could take.

Changes to “Step 1 Final”: SWW merges Retail and GOFLEX Management System, SWW forms Local Balancing System to deal with other BRPs (regular and flexible BRPs) supplying Non-SWW consumers in SWW grid.

The “local market for energy and flexibility” is a targeted mode for the SWW. The SWW grid is able to balance supply and demand of *all* parties.

The GoFlex trading platform turns automatically into a management platform which balances supply and demand of the cell and takes the needs of the grid as priority consideration into account.

Services to the overlay grid can be offered but a full islanding mode can also be performed.

This scenario is in the scope of the GoFlex project (at least as a simulated scenario)

SWW DSO (Local Balancing Market at DSO (Step 2):

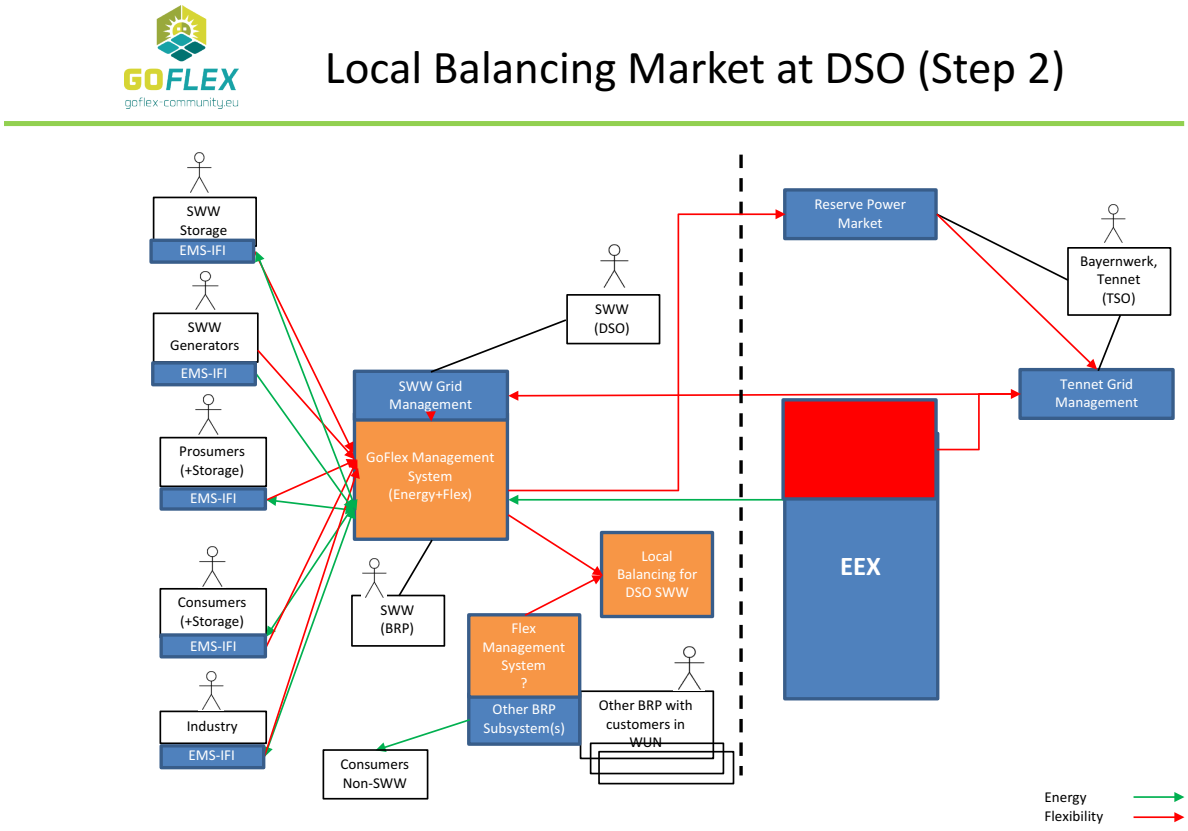

Figure 8: UML-Diagram for scenario “SWW using GoFlex for a Local Balancing Market at DSO (Step 2)”

Table 8: List of actors and systems for scenario:” SWW DSO (Local Balancing Market at DSO (Step 2)”

Name	Actor/ System	Description
SWW Storage	Actor	SWW Spin-off to manage the … MW Battery storage
SWW Generators	Actor	SWW spin off companies that own energy generators (wind turbines, CHPs etc.)

EMS-IFI	System	Energy Management System (managing the flexibility options)
SWW DSO	Actor	SWW distribution grid management department
SWW Grid Management	System	System that comprises all devices and applications for SWW to manage the LV distribution grid
SWW BRP	Actor	SWW Retail department
Prosumers (+Storage)	Actor	All private and public consumers who also generate energy (via PV, CHP etc.) and are able to store energy (via battery, thermal storage etc.)
Consumers (+Storage)	Actor	All private and public consumers who are also able to store energy (via EVs, thermal storage, etc.)
Industry	Actor	All industrial plants in the area
Reserve Power Market	System	Market for flexibility options for the TSO (primary, secondary and tertiary reserve)
Tennet	Actor	Responsible TSO (high voltage) for the SWW grid (low voltage)
Bayernwerk	Actor	Responsible DSO (medium voltage) for the SWW grid (low voltage)
Tennet grid management	System	System that comprises all devices and applications for Tennet to manage the HV transmission grid
Other BRP System	System	System handling the balancing requirements
EEX	System	European Energy Exchange
Local Balancing for DSO SWW	Actor	Platform Operator could be a SWW spin-off or the municipality or any other trusted party
GoFlex Management System (Energy+Flex)	System	System trading flexibility with the connected generators, prosumers, consumers and industry plants and using the aggregated flexibility for the autonomous cell (for BRP and DSO needs)

SWW DSO (Optimized operation of microgrid (SWW Islanding Ops, Step 2 Special/Step 3):

Changes to “Step 2 Local Balancing Market”: SWW uses Local Balancing System guarantees other BRPs (regular and flexible BRPs) to supply all Non-SWW consumers in SWW grid. SWW does not trade to Energy Reserve Market any longer.

The autonomous cell is a targeted emergency mode of for the SWW grid e.g. when the overlay grid faces congestions.

The GoFlex trading platform turns automatically into a management platform which balances supply and demand of the cell and takes the needs of the grid as priority consideration into account.

Services to the overlay grid can be offered but a full islanding mode can also be performed.

This scenario is in the scope of the GoFlex project (at least as a simulated scenario)

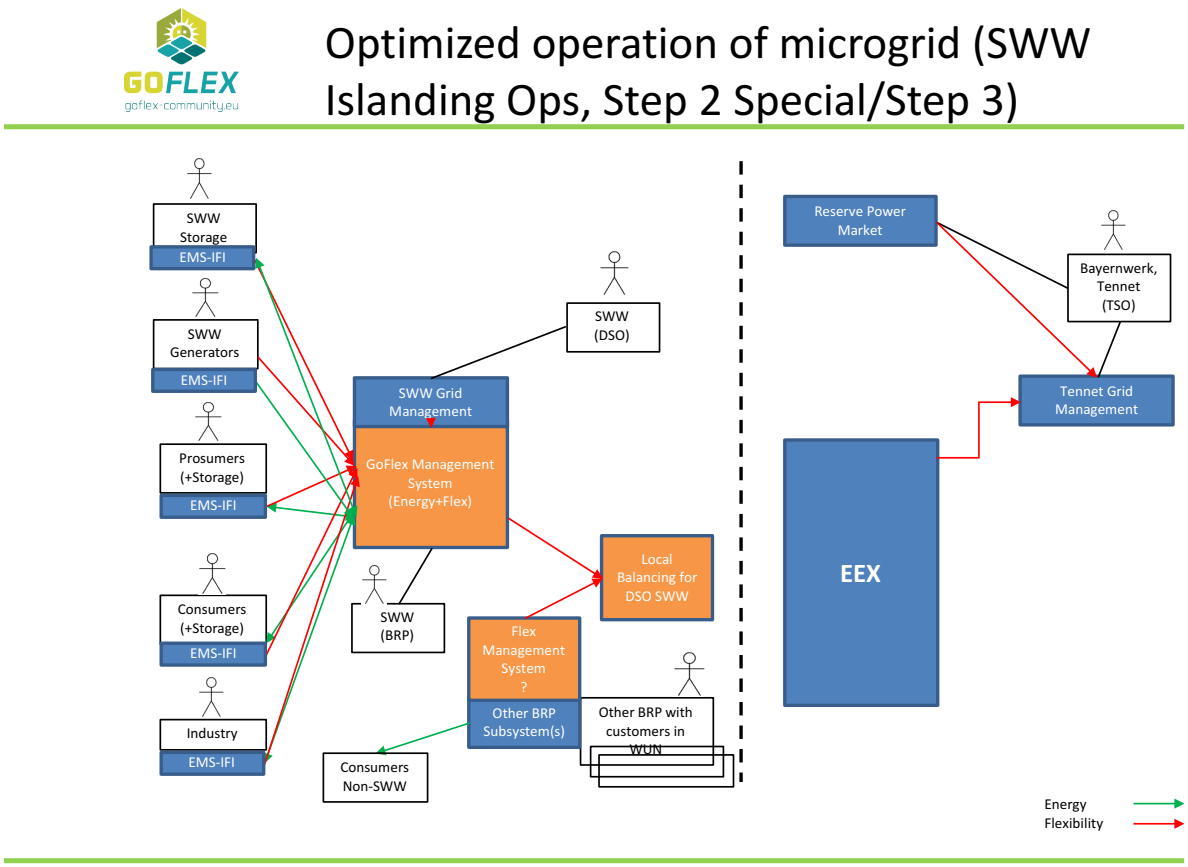

Figure 9: UML-Diagram for scenario "SWW using GoFlex for an Optimized operation of microgrid (SWW Islanding Ops, Step 2 Special/Step 3)"

Table 9: List of actors and systems for scenario "SWW using GoFlex for an Optimized operation of microgrid (SWW Islanding Ops, Step 2 Special/Step 3)"

Name	Actor/ System	Description
SWW Storage	Actor	SWW Spin-off to manage the … MW Battery storage
SWW Generators	Actor	SWW spin off companies that own energy generators (wind turbines, CHPs etc.)
EMS-IFI	System	Energy Management System (managing the flexibility options) with flexibility trading interface (ITI)
SWW DSO	Actor	SWW distribution grid management department
SWW Grid Management	System	System that comprises all devices and applications for SWW to manage the LV distribution grid
SWW BRP	**Actor**	**SWW Retail department with BRP function**
GoFlex Management System (Energy and Flexibility)	**System**	System trading flexibility with the connected generators, prosumers, consumers and industry plants and using the aggregated flexibility for the autonomous cell (for BRP and DSO needs)

Name	Actor/ System	Description
Platform Operator (Local balancing for DSO SWW)	Actor	Platform Operator could be a SWW spin-off or the municipality or any other trusted party
Prosumers (+Storage)	Actor	All private and public consumers who also generate energy (via PV, CHP etc.) and are able to store energy (via battery, thermal storage etc.)
Consumers (+Storage)	Actor	All private and public consumers who are also able to store energy (via EVs, thermal storage, etc.)
Industry	Actor	All industrial plants in the area
Reserve Power Market	System	Market for flexibility options for the TSO (primary, secondary and tertiary reserve) (not active in islanding mode)
Tennet	Actor	Responsible TSO (high voltage) for the SWW grid (low voltage)
Bayernwerk	Actor	Responsible DSO (medium voltage) for the SWW grid (low voltage)
Tennet grid management	System	System that comprises all devices and applications for Tennet to manage the HV transmission grid
EEX	System	European Energy Exchange

3.4 Step 4: The cellular model

The cellular model describes a new energy system, which is organized bottom-up.

The main responsibility for the grid stays with the local DSOs which have installed systems (like GoFlex) to manage their grid locally. Regional energy (balancing) markets organize the local supply and demand completed by central power plants based on renewables.

Cells are interconnected and communicate surplus or lack of power to their neighbour cells and negotiate solutions, in case of emergency or when the internal flexibility options are not sufficient.

The TSO and the “Market Operator for Regional Balancing Market for DSOs” organize the exchanges between the cells and assume the role of an insurance company.

This scenario is out of the scope of the GoFlex project but shall be realized after the project time with partner DSOs.

Regional Balancing Market for energy flexibility for DSOs, Cellular Exchange/Model (Step 4):

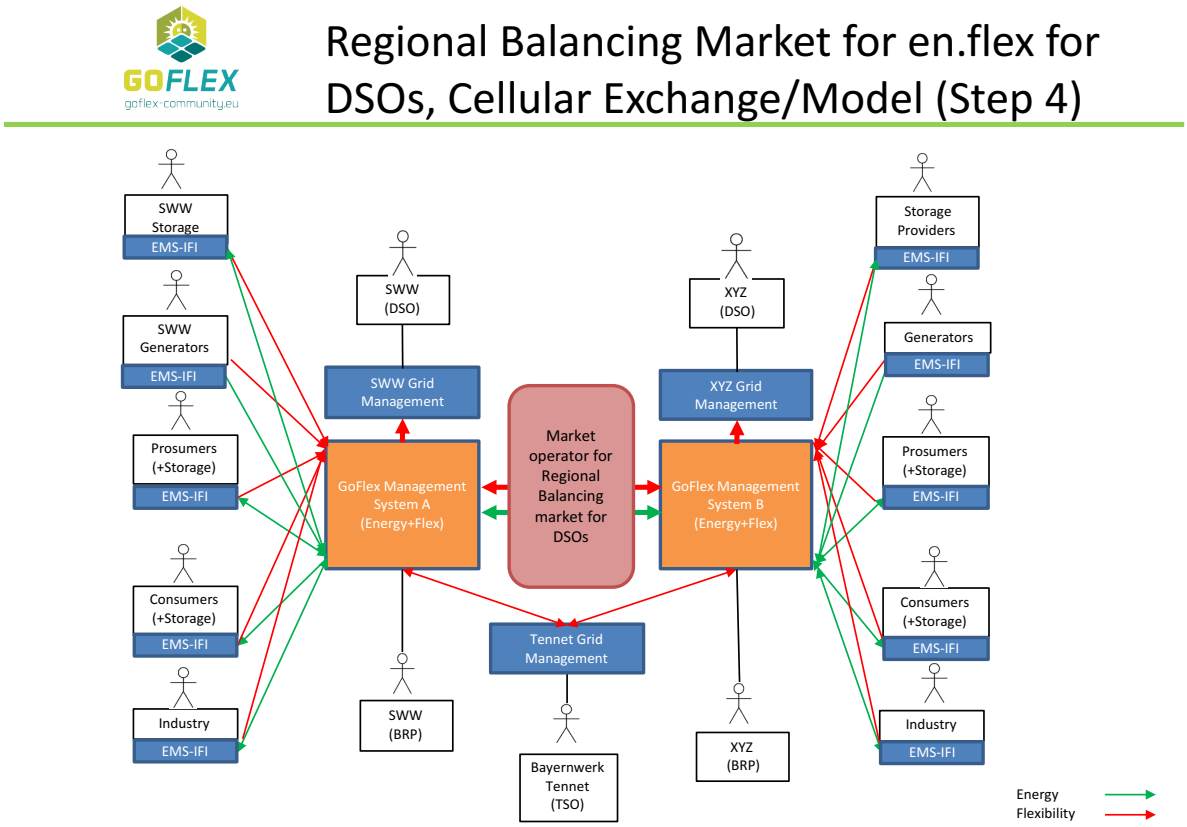

Figure 10: UML-Diagram for scenario "Regional Balancing Market for energy flexibility for DSOs, Cellular Exchange/Model (Step 4)"

Table 10: List of actors and systems for scenario "Regional Balancing Market for energy flexibility for DSOs, Cellular Exchange/Model (Step 4)"

Name	Actor/ System	Description
SWW Storage	Actor	SWW Spin-off to manage the … MW Battery storage
SWW Generators	Actor	SWW spin off companies that own energy generators (wind turbines, CHPs etc.)
EMS-IFI	System	Energy Management System (managing the flexibility options) with flexibility trading interface (IFI)
SWW DSO	Actor	SWW distribution grid management department
SWW Grid Management	System	System that comprises all devices and applications for SWW to manage the LV distribution grid
SWW BRP	Actor	SWW Retail department with BRP function

Name	Actor/ System	Description
GoFlex Management System (Energy and Flexibility)	**System**	**System trading flexibility with the connected generators, prosumers, consumers and industry plants and using the aggregated flexibility for the autonomous cell (for BRP and DSO needs), communicating surplus or lack of power to other cells and handle the transaction**
Platform Operator (Market operator for Regional balancing market for DSOs)	Actor	Platform Operator could be the municipality or any other trusted party
Prosumers (+Storage)	Actor	All private and public consumers who also generate energy (via PV, CHP etc.) and are able to store energy (via battery, thermal storage etc.)
Consumers (+Storage)	Actor	All private and public consumers who are also able to store energy (via EVs, thermal storage, etc.)
Industry	Actor	All industrial plants in the area
Tennet	Actor	Responsible TSO (high voltage) for the SWW grid (low voltage)
Bayernwerk	Actor	Responsible DSO (medium voltage) for the SWW grid (low voltage)
Tennet grid management	System	System that comprises all devices and applications for Tennet to manage the HV transmission grid

4 CANVAS Business models for services offered by SWW/Prosumers

Time Scale of flexibility services to be implemented (now and future)

- Prosumers offering flexibility to the DSO (or DSO requesting flexibility from prosumers)
- Prosumers offering flexibility to a virtual power plant (integrated in a balance group)

Table 11: Time Scale of flexibility services to be implemented (now and future)

Service	Step 1	Step 2	(Step 3)	Step 4
Actor/Role	(Sub-)BRP DSO (Aggregator)	BRP DSO Aggregator	BRP DSO Aggregator	BRP DSO Aggregator
Planned time for implementation	2018/19	2019	2019/20	2020
Tested in GOFLEX	Y	Y	Y	N

4.1 Business model of today´s situation: SWW as service provider for Prosumers, micro grids and flexible consumers

Creating flexible prosumers, which try to achieve 100% self-consumption but also offer their flexibility to balance the SWW supply area (SWW Solar and retail appearing as full service provider).

4.1.1 Use Cases descriptions/ Actors involved

Today distributed energy production of renewable energy is organised in the framework of EEG feed-in tariffs, guaranteeing a fixed income for a period of time for the prosumer. Flexibility of the production is not required, curtailment is remunerated, self-consumption in this framework is not encouraged. Energy generation and energy consumption is totally separated and measured with 2 meters.

Everything is organized by the TSO. There is no income for BRPs, the needs of the DSO are not considered.

SWW retail will use the direct marketing model of the German regulation to offer to purchase energy directly from EEG-prosumers and create an individual balance group for this purpose. The same balance group will purchase the energy from the SWW generation (wind turbines and WunBio) to sell it in the local electricity product “Fichtelgebirgsstrom”.

Since SWW is not a BRP yet, they will ask their partner Lumenaza to take over this business meanwhile.

In parallel SWW retail will make a special offer to prosumers: If they decide to buy a battery from SWW, they will automatically become GOFLEX project pilots, they will get the Robotina HEMS for free and participate in the local flexibility market and generate additional income. SWW will provide energy in times of high demand and purchase the energy surplus in times of low demand.

Consumers who want to become Prosumers, get the same offer plus a full service (PV+Battery+HEMS). An option for E-cars is also discussed.

A leasing model is considered for all of these models to offer customers a flat energy fee (similar to mobile flat fees).

Industrial prosumers get the same offers including a FEMS for free during the project time.

All flexible consumers will be enabled to trade their flexibility directly with the SWW aggregator, or get the opportunity to offer it directly to the local flexibility trading platform, if the flexibility is big enough.
GOFLEX provides the prosumers with HEMS and FOA trading interface. The challenge for the project is, that the flexibility of the prosumers must be created first, before it can be traded.

4.1.2 Time Scale

Within project time and beyond.

4.1.3 CANVAS drawing

Table 12: SWW as service provider for Prosumers, Microgrids and flexible consumers

Key Partners	*Key Activities*	*Value Proposition*	*Customer Relationships*	*Customer Segments*
Who are our Key Partners? Who are our Key Suppliers? Which Key Resources are we acquiring from partners? Which Key Activities do partners perform?	What Key Activities do our Value Propositions require? Our Distribution Channels? Customer Relationships?	What value do we deliver to the customer? Which one of our customer’s problems are we helping to solve?	What type of relationship does each of our Customer Segments expect us to establish	For whom are we creating value?

TSO HEMS FEMS CEMS BRPs (Uniper+Lumenaza) Sub-BRP (SWW) (EEG-Management) (Storage Trading System Operator)	Revenue streams? Enhanced controllability and visibility up to the lower level (e.g. sensors) Enhanced energy management Energy production and consumption forecasting Energy scheduling and optimization of energy flows Better usage of local resources (PV, storage) Introduction of storage facilities Cheap tariffs	What bundles of products and services are we offering to each Customer Segment? Which customer needs are we satisfying? Optimisation of the energy usage with reduced energy cost Enhancement of the environmental footprint – become more environmental-friendly Reduction of grid losses Reduce energy cost but retain the same level of comfort Increase self-consumption environmental friendly tariffs (Eco-tariffs)	and maintain with them? Which ones have we established? How are they integrated with the rest of our business model? How costly are they? Automated DR services upon request of SWW by industrial customers Energy pass for customer Sales or contracting of all facilities (PV, Battery, e-mobility-EDM) Overall (Full) Energy-Service from one provider Affordable tariffs	Who are our most important customers? Storage trading system Industry SWW Energy SWW Storage Prosumers Consumers BRP Lumenaza BRP Uniper TSO

	Key Resources What Key Resources do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue Streams? Central and decentralized storage units Prosumer households and factories ICT-system Microgrid control and monitoring tool for optimal advanced energy management system Sensor systems Skilled HR Customer information system	Prevent load peaks by service to industrial customers	*Channels* Through which Channels do our Customer Segments want to be reached? How are we reaching them now? How are our Channels integrated? Which ones work best? Which ones are most cost-efficient? How are we integrating them with customer routines? SWW Homepage Advertising via customer brochure, mail & E-mail Advertising and articles in newspapers Energy bills (Smart metering infrastructure)	

	Facilities			

Cost Structure	*Revenue Streams*
What are the most important costs inherent in our business model? Which Key Resources are most expensive? Which Key Activities are most expensive? Installation, operational and maintenance costs of generation, distribution and storage infrastructure Infrastructure for controlling the load and communicating with the DSO Installation of smart meters, sensors, etc. Staff cost Technology development costs Distribution network operating costs	For what value are our customers really willing to pay? For what do they currently pay? How are they currently paying? How would they prefer to pay? How much does each Revenue Stream contribute to overall revenues? Contracting for the invest (Flat) cheap rate for energy-consumption Load-dependent tariffs Reduction of overall electricity generation and generation costs for SWW Enhancement of the overall energy efficiency of the electrical system (both microgrid and distribution grid) Reduction of power losses due to the local energy production and consumption Deferral of investments for new grid infrastructure

4.2 Business model of step 1: SWW (DSO) as aggregator of local flexibility

SWW WunBio becoming a full BRP , e.g. with a VPP (wind turbines, biogas etc.) which produces more local energy then the overall energy demand in the SWW supply area (and thus save taxes)

4.2.1 Use Cases descriptions/Actors involved

Today the direct marketing of the SWW generation (wind turbines and WunBio) is executed by Lumenaza, which has created a balance group to sell the energy directly to the eex. Today SWW purchases energy with a green certificate back via Uniper (BRP) and sells it to their customers as "Fichtelgebirgsstrom". SWW pays a flat maintenance fee to Uniper for the BRP service.

SWW plans to become a BRP and run a VPP for their own generation plus the generation surplus of the prosumers.

4.2.2 Time Scale

Preparation and proof of concept within project time, implementation during GOFLEX.

4.2.3 CANVAS drawing

Table 13: SWW (DSO) as aggregator of local flexibility

Key Partners	*Key Activities*	*Value Proposition*	*Customer Relationships*	*Customer Segments*
Who are our Key Partners? Who are our Key Suppliers? Which Key Resources are we acquiring from partners? Which Key Activities do partners perform? HEMS FEMS CEMS	What Key Activities do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue streams? Use power reserve market and EEX Enhanced controllability and visibility up to	What value do we deliver to the customer? Which one of our customer's problems are we helping to solve? What bundles of products and services are we offering to each Customer Segment? Which customer needs are we satisfying? Reserve power market	What type of relationship does each of our Customer Segments expect us to establish and maintain with them? Which ones have we established? How are they integrated with the rest of our business model? How costly are they? Automated DR services upon request	For whom are we creating value? Who are our most important customers? Industry (Prosumers) SWW

Generation units (BRPs) Reserve Power Market	the lower level (e.g. sensors) Energy production and consumption forecasting Energy scheduling and optimization of energy flows Better usage of local resources (PV, storage)	Optimization of the energy usage with reduced energy cost Enhancement of the environmental footprint – become more environmental-friendly Reduction of grid losses Flexibility	of SWW for industrial customers Sales or contracting of all facilities (PV, Battery, e-mobility-EDM) Overall (Full) Energy-Service from one provider Automatic trading of reserve power	
	Key Resources What Key Resources do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue Streams? Enough generation and storage facilities to form virtual power plant Prosumer households		*Channels* Through which Channels do our Customer Segments want to be reached? How are we reaching them now? How are our Channels integrated? Which ones work best? Which ones are most cost-efficient? How are we integrating them with customer routines? SWW Homepage Advertising via customer	

	and factories ICT-system Microgrid control and monitoring tool for optimal advanced energy management system Sensor systems Skilled HR Customer information system Facilities		brochure, mail & E-mail Advertising and articles in newspapers Energy bills (Smart metering infrastructure) Trading channel for reserve power	

Cost Structure	*Revenue Streams*
What are the most important costs inherent in our business model? Which Key Resources are most expensive? Which Key Activities are most expensive? Installation, operational and maintenance costs of generation, distribution and storage infrastructure Infrastructure for controlling the load and communicating with the DSO Installation of smart meters, sensors, etc. Staff cost Technology development costs Distribution network operating costs	For what value are our customers really willing to pay? For what do they currently pay? How are they currently paying? How would they prefer to pay? How much does each Revenue Stream contribute to overall revenues? Contracting for the invest (Flat) cheap rate for energy-consumption Load-dependent tariffs Reduction of overall electricity generation and generation costs for SWW Enhancement of the overall energy efficiency of the electrical system (both microgrid and distribution grid)

Investment in HW and SW and operation of VPP on power reserve market Investment into BRP capability	Reduction of power losses due to the local energy production and consumption Deferral of investments for new grid infrastructure Flexibility

4.3 Business model of step 2: Local market for energy and flexibility + "Autonomous cell"

4.3.1 Use Cases descriptions/ UML diagram/ Actors involved

SWW retail will simulate this role in the project but it is unclear how the pricing will be created. According to the multi-side platform approach of other companies, the supply of flexibility will be free of charge to get the business going, purchase of flexibility will be charged. Potential requests for flexibility will be expected from the SWW Retail (simulating a BRP optimizing its portfolio) and SWW grid-ops (simulating grid congestions and islanding mode)

4.3.2 Time Scale

Preparation and proof of concept within project time, implementation after GOFLEX

4.3.3 CANVAS drawing

Table 14: Regional market for energy and flexibility + "Autonomous Cell"

Key Partners	*Key Activities*	*Value Proposition*	*Customer Relationships*	*Customer Segments*
Who are our Key Partners? Who are our Key Suppliers? Which Key Resources are we acquiring from partners? Which Key Activities do partners perform?	What Key Activities do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue streams? SWW retail becomes "Energy	What value do we deliver to the customer? Which one of our customer's problems are we helping to solve? What bundles of products and services are we offering to each Customer Segment?	What type of relationship does each of our Customer Segments expect us to establish and maintain with them? Which ones have we established?	For whom are we creating value? Who are our most important customers? Power reserve market

DSOs B-Z (GOFLEX Management Systems) Prosumers Storage Consumers Storage TSO HEMS FEMS CEMS (Reserve Power Market)	+Flex" and platform operator SWW becomes full size BRP and trades most of power and flexibility locally Sell flexibility related power to power reserve market Trade flexibility on "EEX Flex regional" Ability to execute full islanding mode Enhanced controllability and visibility up to the lower level (e.g. sensors) Enhanced energy management Energy production and consumption forecasting	Which customer needs are we satisfying? Use local and regional flexibility combined with storage to balance the regional grid Create additional revenues from trading surplus flexibility and do it directly Reduce operational cost with TSO Optimizationoptimization of the overall energy generation and usage with reduced overall cost (also for customers) Enhancement of the	How are they integrated with the rest of our business model? How costly are they? Direct and exclusive relation to all prosumers in the region Direct relation to power reserve market Direct relation to "EEX Flex regional" Open new segment "flexibility providers" Automated DR services upon request of SWW by industrial customers Energy pass for customer Sales or contracting of all facilities	Flexibility providers Industry SWW Energy SWW Storage Prosumers Consumers TSO

	Energy scheduling and optimization of energy flows Better usage of local resources (PV, storage) Introduction of storage facilities Cheap tariffs	environmental footprint – become more environmental-friendly Reduction of grid losses Reduce energy cost but retain the same level of comfort Increase self-consumption and storage environmental friendly tariffs (Eco-tariffs)	(PV, Battery, e-mobility-EDM) Overall (Full) Energy-Flexibility Service from one provider Affordable flex-tariffs Create new prosumers Migrate prosumers to flexibility providers	
	Key Resources What Key Resources do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue Streams?	*Cost Structure* What are the most important costs inherent in our business model? Which Key Resources are most expensive?	*Channels* Through which Channels do our Customer Segments want to be reached? How are we reaching them now? How are our Channels integrated? Which ones work best?	*Revenue Streams* For what value are our customers really willing to pay? For what do they currently pay? How are they currently paying?

	Flexibility management and trading system including platform as well as EEX Flex and EEX Power reserve trading system BRP management system Contracting programs More and advanced prosumer households and factories Full-fledged ICT-system Microgrid control and monitoring tool for optimal advanced energy management system Sensor systems Skilled HR	Which Key Activities are most expensive? Installation, operational and maintenance costs of generation, distribution and storage infrastructure Infrastructure for controlling the load and communicating with the DSO Installation of smart meters, sensors, etc. Staff cost Technology development costs Distribution network operating costs Investment in HW and SW and operation of	Which ones are most cost-efficient? How are we integrating them with customer routines? SWW Homepage Advertising via customer brochure, mail & E-mail Advertising and articles in newspapers Direct approach Energy bills (Smart metering infrastructure) Trading channel for reserve power Trading channel for EEX Flex regional and EEX Flexibility-App	How would they prefer to pay? How much does each Revenue Stream contribute to overall revenues? Optimal balancing of regional grid including maximum savings out of grid losses and grid operation fees collected by TSO before Best prize for surplus flexibility created Maximum volume and earnings out of flexibility and power reserve market Contracting for the invest (Flat) cheap rate for energy-consumption

	Customer information system Facilities	flexibility collection management and trading system towards EEX Flex regional, EEX and power reserve market Becoming BRP and platform operator		Load-dependent tariffs Reduction of overall electricity generation and generation costs for SWW Enhancement of the overall energy efficiency of the electrical system (both microgrid and distribution grid) Reduction of power losses due to the full use of flexibility in local and regional energy production, storage and consumption Deferral of investments for

				new grid infrastructure

4.4 Business Model of Step 4: The cellular model

SWW Grid aims to be able to perform islanding mode (future scenario) based on the capacity of the VPP and an emergency plan using the local emergency flexibilities, if needed.

4.4.1 Use Cases descriptions/ UML diagram/ Actors involved

It is unclear today how much flexibility SWW Net requires for the normal business operation in the future. The range of activities which are remunerated by the "BundesNetzAgentur" (and charged back as grid fee to all consumers) are limited and mainly supports the expansion of grid capacity. Unless there is a remuneration for purchasing. Today the main issue is the separate.

The business model has two aspects.

1. The physical autarky of SWW: there is physically no energy inflow into the SWW grid, since the physical generation within the SWW service area is always higher than the consumption, independent of the actual commercial contracts.
2. For the direct islanding mode, the physical autarky is a prerequisite. In the controlled islanding mode, the energy supply for the non-SWW consumers must be secured and correctly measured in the time when the islanding mode takes place by smart meters. There should also be a merit order of loads to be shed in an emergency case of not enough generation capacity in the grid. The flexibility market is used by the DSO. Ancillary grid services must be in place. The contracts with customers and generators for this scenario must be agreed.

4.4.2 Time scale

Preparation and proof of concept within project time, implementation after GOFLEX

4.4.3 CANVAS drawing

Table 15: Cellular Modell

Key Partners	Key Activities	Value Proposition	Customer Relationships	Customer Segments
Who are our Key Partners? Who are our Key Suppliers? Which Key Resources are we acquiring from partners? Which Key Activities do partners perform? DSOs B-Z (GOFLEX Management Systems) Market operator for Regional Balancing Market for DSOs Prosumers Storage Consumers Storage TSO HEMS FEMS CEMS (Reserve Power Market)	What Key Activities do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue streams? SWW retail becomes "Energy +Flex" SWW becomes full size BRP and trades most of power and flexibility locally Sell flexibility related power to power reserve market Trade flexibility on "EEX Flex regional" Collect and use local and regional flexibility to improve SWW BC Enhanced controllability and visibility up to the lower level (e.g. sensors)	What value do we deliver to the customer? Which one of our customer's problems are we helping to solve? What bundles of products and services are we offering to each Customer Segment? Which customer needs are we satisfying? Use local and regional flexibility combined with storage to balance the local grid Create additional revenues from trading surplus flexibility and do it directly Reduce operational cost with TSO Optimization of the overall energy generation and usage with reduced overall cost	What type of relationship does each of our Customer Segments expect us to establish and maintain with them? Which ones have we established? How are they integrated with the rest of our business model? How costly are they? Direct and exclusive relation to all prosumers in the region Open new segment "flexibility providers" Automated DR services upon request of SWW by industrial customers Energy pass for customer Sales or contracting of all facilities (PV, Battery, e-mobility-EDM)	For whom are we creating value? Who are our most important customers? Flexibility providers Industry SWW Energy SWW Storage Prosumers Consumers TSO

	Enhanced energy management Energy production and consumption forecasting Energy scheduling and optimization of energy flows Better usage of local resources (PV, storage) Introduction of storage facilities Cheap tariffs	(also for customers) Enhancement of the environmental footprint – become more environmental-friendly Reduction of grid losses Reduce energy cost but retain the same level of comfort Increase self-consumption and storage environmental friendly tariffs (Eco-tariffs)	Overall (Full) Energy-Flexibility Service from one provider Affordable flex-tariffs Create new prosumers Migrate prosumers to flexibility providers	
	Key Resources What Key Resources do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue Streams? BRP management system Contracting programs More and advanced		Channels Through which Channels do our Customer Segments want to be reached? How are we reaching them now? How are our Channels integrated? Which ones work best? Which ones are most cost-efficient? How are we integrating them with customer routines? SWW Homepage	

	prosumer households and factories Full-fledged ICT-system Microgrid control and monitoring tool for optimal advanced energy management system Sensor systems Skilled HR Customer information system Facilities		Advertising via customer brochure, mail & E-mail Advertising and articles in newspapers Direct approach Energy bills (Smart metering infrastructure) Flexibility-App

Revenue Streams	Cost Structure
For what value are our customers really willing to pay? For what do they currently pay? How are they currently paying? How would they prefer to pay? How much does each Revenue Stream contribute to overall revenues? Optimal balancing of regional grid including maximum savings out of grid losses and grid operation fees collected by TSO before Best prize for surplus flexibility created Maximum volume and earnings out of flexibility and power reserve market Contracting for the invest (Flat) cheap rate for energy-consumption Load-dependent tariffs Reduction of overall electricity generation and generation costs for SWW	What are the most important costs inherent in our business model? Which Key Resources are most expensive? Which Key Activities are most expensive? Installation, operational and maintenance costs of generation, distribution and storage infrastructure Infrastructure for controlling the load and communicating with the DSO Installation of smart meters, sensors, etc. Staff cost Technology development costs Distribution network operating costs

Enhancement of the overall energy efficiency of the electrical system (both microgrid and distribution grid) Reduction of power losses due to the full use of flexibility in local and regional energy production, storage and consumption Deferral of investments for new grid infrastructure	Investment in HW and SW and operation of flexibility collection management and trading system towards EEX Flex regional, EEX and power reserve market Becoming BRP

5 Cost-Benefit-Analysis approach for the steps to be implemented

The approach to cost benefit analysis that we will follow in the OGOFLEX project will be to set and carry it out largely as a substantiation of defined key performance indicators and not as the basis for defining the KPIs, and in the framework of the dissemination and exploitation plan:

1) The framework and methodology, the link to OGOFLEX business and marketing models, and the integrated contributing exploitation plans of solution providers will be carried out in the WP10 as part of task T10.4 (Marketing the GOFLEX Solutions), which will be updated throughout the project; it will be used as input to actual CBA's; and will be made part of deliverable D10.1 (Business and marketing plan). Solution providers will contribute their inputs to it as part of their exploitation plans.
2) The actual CBA will follow the project life cycle, starting from design in the first task up to validation in the final task.
3) The reference situation is specified in the “today`s situation” in 5.1.
4) Today´s situation is the reflection of the current market condition based on the year 2016.
5) In each CBA reference is made to and showing this basic data to avoid switching between the single pages and to show up the project progress within a single view. The yellow and green marked table elements show the development between reference situation and actual result of the business case.

For SWW there must be a profit after purchasing costs of devices and installation costs. For the prosumers: there must be return of investments after a period x taking into account the additional income from the FLEX-offers. The Flex-offers must create more money than the

self-consumption of the generated energy and create no or little costs in case of load shedding.

For establishing a cost-analysis for prosumers to be combined with the possible benefits SWW needs to have an idea on how to calculate the flexibility (kWh) related investment cost per step for achieving the different equipment and capability levels of the different steps.

- Equipment Generation
- Storage
- Charging
- Energy Management
- Balancing
- Trading
- Manpower

This task will be covered during the project and first results will be shown in D9.6.

5.1 Today's situation: SWW as service provider for Prosumers, micro grids and flexible consumers

5.1.1 COST-BENEFIT-ANALYSIS descriptions and assumptions

For this analysis we use the current state of the financial year 2016 as base for all our further projections and assumptions. Scope of this current state is the balance sheet, income statement and various statistics, for instance sales statistics, procurement statistics, generation statistics and so on.

In the year 2016 the distribution grid had a pass-through amount of electricity of 78.627.403 kWh in total. This value consists of 2 elements:

- quantity of sales in the distribution grid (the amount of energy foreign energy retailers sell to customers in our grid) = 18.068.737 kWh

- quantity of sales of energy retails (the amount of energy which sells SWW in its market role as retailer, restricted to our grid) = 60.558.666 kWh

In opposite to the amounts of electricity we insert the monetary values of income/revenue and costs/expenditures which projects in the following way:

- Income/distribution grid 986.040,55 €
- Income/energy retail 10.750.071,38 €

- Costs/distribution gird 1.495.035,82 €
- Costs/energy retail 7.158.864,81 €

As result we show a contribution margin that is calculated as subtraction of income and costs. This margin will be used as indicator of the economically performance of the business cases and to demonstrate the economically development throughout the several states of the business cases.

The reference situation is specified in the so called "today`s situation" in 5.1.

The todays situation is the reflection of the current market condition based on the year 2016.

In each CBA I´m referring to and showing this basic data to avoid switching between the single pages and to show up the project progress within a single view. Pleas notice the yellow and green marked table elements show the development between reference situation and actual result of the business case.

5.1.2 COST-BENEFIT-ANALYSIS Approach for Todays' situation

Table 16: COST-BENEFIT-ANALYSIS Approach for Todays' situation

Basics (financial year 2016) **based on the balance sheet/income statement/statistics of the year 2016**					
quantity of sales / distribution grid		18.068.737	kWh		
quantity of sales / energy retail		60.558.666	kWh		
income / distribution grid		986.040,55	€		
income / energy retail		10.750.071,38	€		
	income			11.736.111,93	€
costs / distribution grid		1.495.035,82	€		
costs / energy retail		7.158.864,81	€		
	costs			8.653.900,63	€
contribution margin				3.082.211,30	€

These positions with regard to the market roles in the unbundled regulatory market environment in Germany			
amount of electricity in the distribution grid		78.627.403	kWh
flexibility in the distribution grid	0%	0	kWh
assumed used flexibility in this business case	0%	0	kWh

Assumed Development by trading flexibility

quantity of sales / distribution grid		18.068.737	kWh
quantity of sales / energy retail		60.558.666	kWh
income / distribution grid		986.040,55	€
income / energy retail		10.750.071,38	€
	income		11.736.111,93 €
costs / distribution grid		1.495.035,82	€
costs / energy retail		7.158.864,81	€
	costs		8.653.900,63 €
contribution margin			3.082.211,30 €

These positions are regarding to the market roles			
amount of electricity in the distribution grid		78.627.403	kWh
flexibility in the distribution grid	0%	0	kWh
assumed used flexibility in this business case	0%	0	kWh

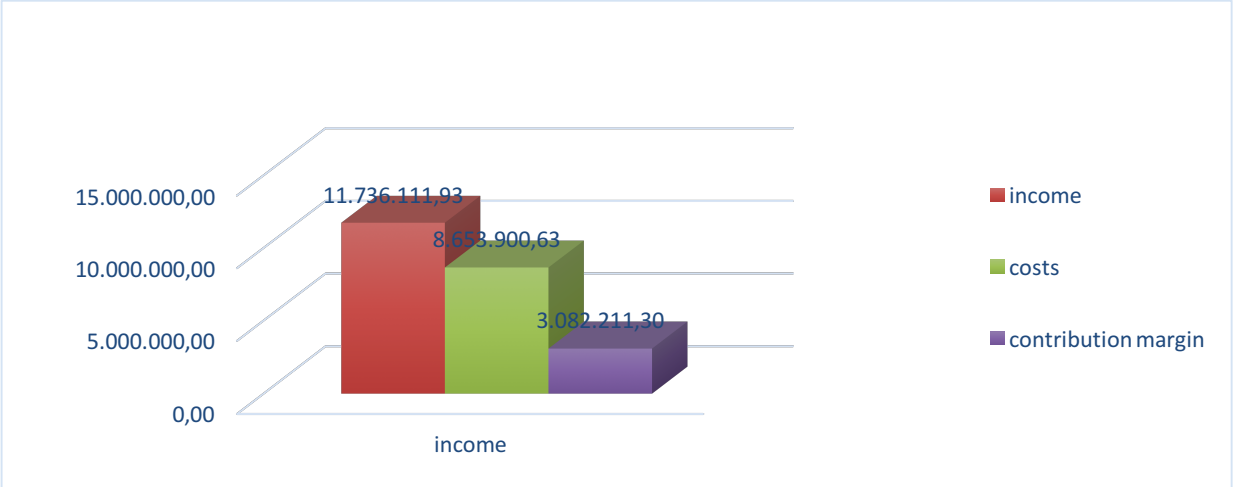

Figure 11: Today`s Situation - Assumed Development by trading flexibility for SWW as service provider for Prosumers, micro grids and flexible consumers

5.2 Step 1: SWW (DSO) as aggregator of local flexibility

5.2.1 COST-BENEFIT-ANALYSIS descriptions and assumptions

SWW as DSO builds the infrastructure to facilitate local flexibility

The first progression of the “today`s situation” is to integrate an 8 MW storage system, which is currently under construction, into the distribution grid.

Through this integration we achieve the point where we can deal with positive and negative flexibility on the reserve power market. We assume an average value of 10.600 €/MW as its been in the year 2016, only load – exclusive work.

Under current market conditions for primary control energy there are auctions of the TSO`s (as organization of responsible of the control area) once a week, so we assume to get an acceptance of 5 MW load at least once a month which means to end up in additional revenues of 636.000 € a year.

Besides the already mentioned basic data, specified before and set as constant, we are going to add flexibility traded with the prosumer apart from the flexibility dealt on the reserve energy market.

The energy generated by all the renewables will also be aggregated to a virtual power plant. This virtual power plant is going to be traded on the reserve power market regarding its load, the generated work is subjecting to balancing mechanism of the renewable energy law (EEG) in Germany, so it will be purchased from the DSO, forwarded to the TSO and ends up on the European Energy Exchange (EEX).

The only thing that is going to be changed is the relation between procurement and demand. The used and traded flexibility from the prosumer is going to decrease our needed amount of procurement, what is in a turn going to decrease our costs of procurement the same way. The costs of procurement decrease from 7.158.864,81 € to 6.601.174,57 €, only by using the flexible work in the grid to avoid procurement of the wholesale market.

For SWW flexibility is a form of active load displacement. Load never changes the amount of consumed energy. But the consume attitude of the customer affects to the required load.

In SWWs’ opinion flexibility consists of 3 forms, which are: load, work and capacity. Load is the active displacement and balancing of required load between generation and demand. Load can either only be provided for measures of system stability or be actually traded. Work is the flexible generation of renewable energy which results of dealing and demanding of positive load. Capacity mainly represents storage systems which deal not only with positive but also with negative load. Capacity allows balancing overload in the grid, avoiding load peaks and balancing the needed work in the grid.

Flexibility allows to integrate that amount of locally available energy and avoid the procurement on the market. Through this integration SWW is able to use this flexibly produced energy in the local grid and avoid the respective procurement. This act is conforming to the current legal and regulatory situation in Germany.

To measure the worth of the flexibility we assume its value as mixed price of

- avoided grid use (grid charge) from the TSO
- avoided procurement of energy on the wholesale market

In this case we do have a used amount of flexibility from about 4.717.644 kWh. That means for the SWW an income of 422.876,06 € consisting of 0,0267€/kWh avoided grid use and 0,0629 €/kWh avoided procurement. The prosumer participates to 50 % on these costs savings of SWW and creates an income of 211.438 € in this way.

Under current market conditions for primary control energy there are auctions of the TSO`s (as organization of responsible of the control area) once a week, so we assume to get an acceptance of 25 MW load at least once a month which means to end up in additional revenues of 3.180.000 € a year.

Furthermore, all inflexible generators are integrated in our trading platform. Those get remuneration according to the German EEG (average price of 0,1810 €/kWh). These expenditures are items of transit for SWW, which is shown as income and costs on exact the same level.

Our assumptions

- a value of 10.600 €/MW reserve market energy (average price of the year 2016)
- the amount of electricity demand in the distribution grid to be on the same level
- a constant quantity of sales (distribution grid and energy retail)
- an average remuneration (EEG) of the generators of 18,10 ct/kWh (based on average price in SWW grid 2016)
- we assume the value of "flexibility" as a mixed price of elements of:

  avoided grid use (grid charges) from the TSO /

  avoided procurement of energy /

  depending on supply and demand

5.2.2 COST-BENEFIT-ANALYSIS Approach for services to be implemented

Table 17: COST-BENEFIT-ANALYSIS: SWW (DSO) as aggregator of local flexibility

Basics (financial year 2016)
based on the balance sheet/income statement/statistics of the year 2016

quantity of sales / distribution grid		18.068.737	kWh	
quantity of sales / energy retail		60.558.666	kWh	
income / distribution grid		986.040,55	€	
income / energy retail		10.750.071,38	€	
	income (exkl. flex)			11.736.111,93
costs / distribution grid		1.495.035,82	€	
costs / energy retail		7.158.864,81	€	
	costs (exkl. flex)			8.653.900,63
contribution margin (exkl. flex)				3.082.211,30
These positions with regard to the market roles in the unbundled regulatory market environment in Germany				
amount of electricity in the distribution grid		78.627.403	kWh	
flexibility in the distribution grid	0%	0	kWh	
assumed used flexibility in this business case	0%	0	kWh	

Assumed Development by trading flexibility

quantity of sales / distribution grid		18.068.737	kWh	
quantity of sales / energy retail		60.558.666	kWh	
income / distribution grid		986.040,55	€	
income / energy retail		10.750.071,38	€	
income / flexibility (reserve market only load and without work)		3.180.000,00	€	
income / flexibility (trading prosumer)		422.876,06	€	
income / energy generation		8.889.604,46	€	
	income (incl. flex)			23.805.716,39
costs / distribution grid		1.495.035,82	€	
costs / energy retail		6.601.174,57	€	
costs / flexibility (trading prosumer)		211.438,03	€	
costs / energy generation		8.889.604,46	€	
	costs (incl. flex)			17.197.252,88
contribution margin (incl. flex)				6.608.463,51
positions with regard to the market roles in the unbundled regulatory market environment in Germany				
amount of electricity in the distribution grid		78.627.403	kWh	
flexibility in the distribution grid	30,00%	23.588.221	kWh	
assumed used flexibility (prosumer) in this business case	20,00%	4.717.644	kWh	0,0267 €
assumed used flexibility (reserve market) in this business case		25	MW	10.600,00 €
assumed generation in the distribution grid		49.116.686	kWh	0,1810 €
assumed procurement (inclusive EEG)		55.841.022	kWh	0,1182 €
assumed avoided procurement (exclusive EEG)		4.717.644	kWh	0,0629 €

Our calculations

- average remuneration in SWW grid (based on the today`s results 2016)					
water power	177.786	13.636,19 €	0,36%	0,0767 €	0,0003 €
wind power	15.625.816	1.087.215,29 €	31,81%	0,0696 €	0,0221 €
biomass power	21.638.972	4.502.838,33 €	44,06%	0,2081 €	0,0917 €
solar power	9.397.082	2.863.992,71 €	19,13%	0,3048 €	0,0583 €
cogeneration	2.277.030	421.921,94 €	4,64%	0,1853 €	0,0086 €
	49.116.686	8.889.604,46 €	100%		0,1810 €
- assumed price for flexibility					
grid use charge TSO/€		953.659,59 €			
procurement TSO/kWh		35.727.977			0,0267 €
- assumed avoided procurement					
procurement wholesale/kWh		60.558.666			
procurement wholesale/€		7.158.864,81 €			0,1182 €
thereof EEG charge		3.347.006,35 €			
procurement wholesale/€		3.811.858,46 €			0,0629 €

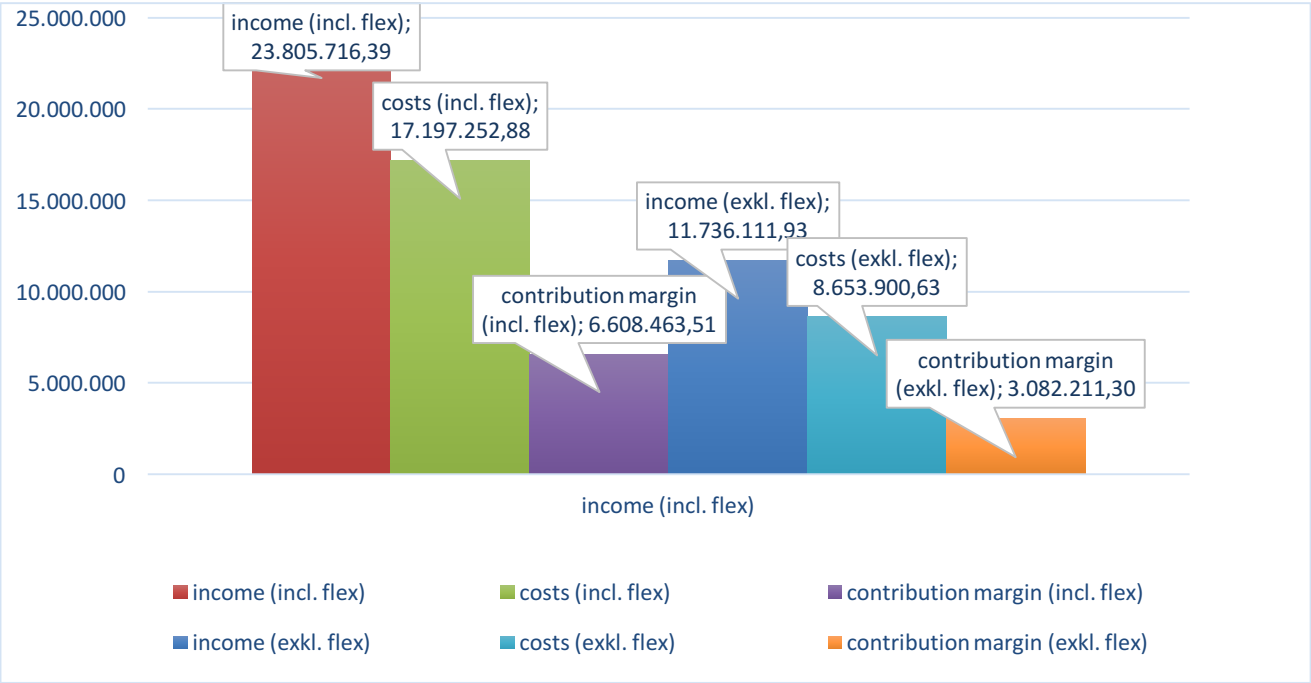

Figure 12: Local market for energy and flexibility. SWW (DSO) as aggregator of local flexibility.

Assumed development by trading flexibility

5.3 Step 2: Local market for energy and flexibility + "Autonomous Cell"

5.3.1 COST-BENEFIT-ANALYSIS descriptions and assumptions

This case shows the full automatically trading and acting development of case 5.3. including the integration of all possible renewables to avoid any procurement from the TSO grid, the so-called island mode ability.

The permanent autarky scenario saves 2% energy tax. No additional costs.

The business case for the controlled islanding mode is calculated against the avoided costs of an uncontrolled black-out.

All base data are still the same regarding to the amount of needed electricity in the distribution grid. We expand the scenario in ways that all generated flexibility in load and work is going to be used in the grid. The platform is going to balance supply and demand full automatically and acts as needed.

For our calculations we use all known values as they are:

- avoided procurement
- avoided grid use
- average price wholesale
- average price EEG charge
- average remuneration of renewable

The demand in the distribution grid of 78.627.403 kWh work is still constant. Thereof will be avoided the complete procurement of 60.558.669 kWh of SWW as retailer. Furthermore, will the load of flexibility increase to a value of 40 MW due to the integration of all renewables and flexibilities.

Consequently, the increase of the load (40 MW) traded in the reserve power market generates revenues of 5.088.000 €, also the flexibility traded with the prosumer goes up to more than 5.400.000 €.

This case is financial worthwhile for all prosumer, they are going to participate on the revenues of 50 % what means an additional income of 2.714.000 € for all those which are generating energy and offering their flexibility in this system.

The income of energy retail is decreasing, because the price of electricity will not include the EEG reallocation charge anymore, the price that the customer has to pay decrease equally. his case is an optimal form of a regional market system.

Furthermore, all inflexible generators are integrated in our trading platform. Those get remuneration according to the German EEG (average price of 0,1810 €/kWh). These expenditures are items of transit for SWW, which is shown as income and costs on exact the same level. We assume that the EEG will be still in force when we achieve this case. Nevertheless, the trade with generated electricity could also be integrated in this autonomous market system.

Our assumptions

- a value of 10.600 €/MW reserve market energy (average price of the year 2016)
- the amount of electricity demand in the distribution grid to be on the same level
- a constant quantity of sales (distribution grid and energy retail)
- an average remuneration (EEG) of the generators of 18,10 ct/kWh (based on average price in SWW grid 2016)
- we assume the value of "flexibility" as a mixed price of elements of:
  avoided grid use (grid charges) from the TSO /
  avoided procurement of energy /
  depending on supply and demand

5.3.2 COST-BENEFIT-ANALYSIS approach for services to be implemented

Table 18: COST-BENEFIT-ANALYSIS- Step 2: Local market for energy and flexibility + "Autonomous Cell"

Basics (financial year 2016)				
based on the balance sheet/income statement/statistics of the year 2016				
quantity of sales / distribution grid		18.068.737	kWh	
quantity of sales / energy retail		60.558.666	kWh	
income / distribution grid		986.040,55	€	
income / energy retail		10.750.071,38	€	
	income (exkl. flex)			11.736.111,93
costs / distribution grid		1.495.035,82	€	
costs / energy retail		7.158.864,81	€	
	costs (exkl. flex)			8.653.900,63
contribution margin (exkl. flex)				3.082.211,30
positions with regard to the market roles in the unbundled regulatory market environment in Germany				
amount of electricity in the distribution grid		78.627.403	kWh	
flexibility in the distribution grid	0%	0	kWh	
assumed used flexibility in this business case	0%	0	kWh	
Assumed Development by trading flexibility				
quantity of sales / distribution grid		18.068.737	kWh	
quantity of sales / energy retail		60.558.666	kWh	
income / distribution grid		986.040,55	€	

income / energy retail	6.096.743,48	€	
income / flexibility (reserve market only load and without work)	5.088.000,00	€	
income / flexibility (trading prosumer)	5.428.304,89	€	
income / energy generation	14.230.734,39	€	
income (incl. flex)			26.401.518,42
costs / distribution grid	1.495.035,82	€	
costs / energy retail	-0,30	€	
costs / flexibility (trading prosumer)	2.714.152,44	€	
costs / energy generation	14.230.734,39	€	
costs (incl. flex)			18.439.922,35
contribution margin (incl. flex)			7.961.596,07

positions with regard to the market roles in the unbundled regulatory market environment in Germany

amount of electricity in the distribution grid		78.627.403	kWh	
flexibility in the distribution grid	100,00%	78.627.403	kWh	
assumed used flexibility (prosumer) in this business case	77,02%	60.558.669	kWh	0,0267 €
assumed used flexibility (reserve market) in this business case		40	MW	10.600,00 €
assumed generation in the distribution grid		78.627.403	kWh	0,1810 €
assumed procurement (inclusive EEG)		-3	kWh	0,1182 €
assumed avoided procurement (exclusive EEG)		60.558.669	kWh	0,0629 €

Our calculations

- average remuneration in SWW grid (based on the today`s results 2016)

water power	177.786	13.636,19 €	0,36%	0,0767 €	0,0003 €
wind power	15.625.816	1.087.215,29 €	31,81 %	0,0696 €	0,0221 €
biomass power	21.638.972	4.502.838,33 €	44,06 %	0,2081 €	0,0917 €
solar power	9.397.082	2.863.992,71 €	19,13 %	0,3048 €	0,0583 €
cogenera-tion	2.277.030	421.921,94 €	4,64%	0,1853 €	0,0086 €
	49.116.686	8.889.604,46 €	100%		**0,1810 €**

- assumed price for flexibility

grid use charge TSO/€	953.659,59 €	
procurement TSO/kWh	35.727.977	**0,0267 €**

- assumed avoided procurement

procurement whole-sale/kWh	60.558.666	
procurement whole-sale/€	7.158.864,81 €	**0,1182 €**
thereof EEG charge	3.347.006,35 €	
procurement whole-sale/€	3.811.858,46 €	**0,0629 €**

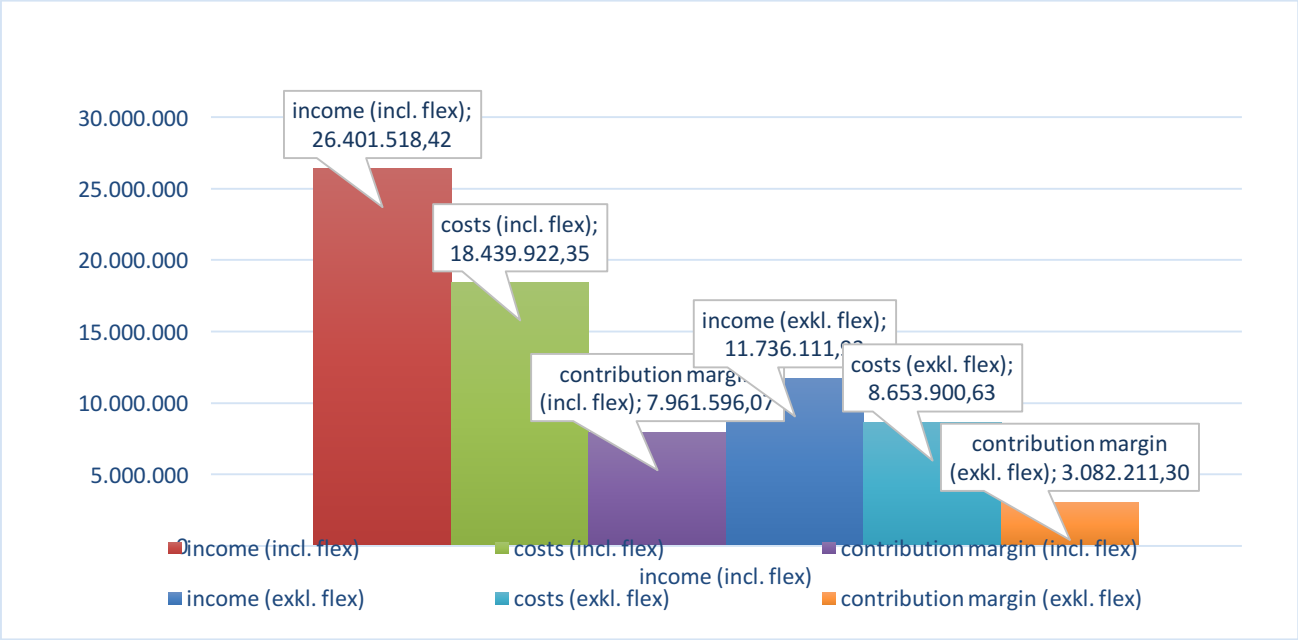

Figure 13: Local market for energy and flexibility "Autonomous Cell" – Assumed Development by trading flexibility

5.4 Step 4: The cellular model

5.4.1 COST-BENEFIT-ANALYSIS descriptions and assumptions

The cellular model expands the existing model from 5.3 by various market players which also use an autonomous business model. These different market players can support and stabilize the grids among themselves.

Our assumptions

- a value of 10.600 €/MW reserve market energy (average price of the year 2016)
- the amount of electricity demand in the distribution grid to be on the same level
- a constant quantity of sales (distribution grid and energy retail)
- an average remuneration (EEG) of the generators of 18,10 ct/kWh (based on average price in SWW grid 2016)
- we assume the value of "flexibility" as a mixed price of elements of:
  avoided grid use (grid charges) from the TSO /
  avoided procurement of energy /
  depending on supply and demand

5.4.2 COST-BENEFIT-ANALYSIS Approach for services to be implemented

See 5.3 the figures are identically.

5.5 Comparison of contribution margins for SWW during migration phase

With the introduction of flexibility trading SWW will be able to nearly double the contribution margin.

5.5.1 Summary Cost-Benefit Analysis

Table 19: Today´s situation – Assumed Development by trading

	Today´s situation – Assumed Development by trading	**Step 1**	**Step 3**	**Step 4**
costs	8.653.900,63	17.197.252,88	18.439.922,35	18.439.922,35
income	11.736.111,93	23.805.716,39	26.401.518,42	26.401.518,42
contribu-tion margin	3.082.211,30	6.608.463,51	7.961.596,07	7.961.596,07

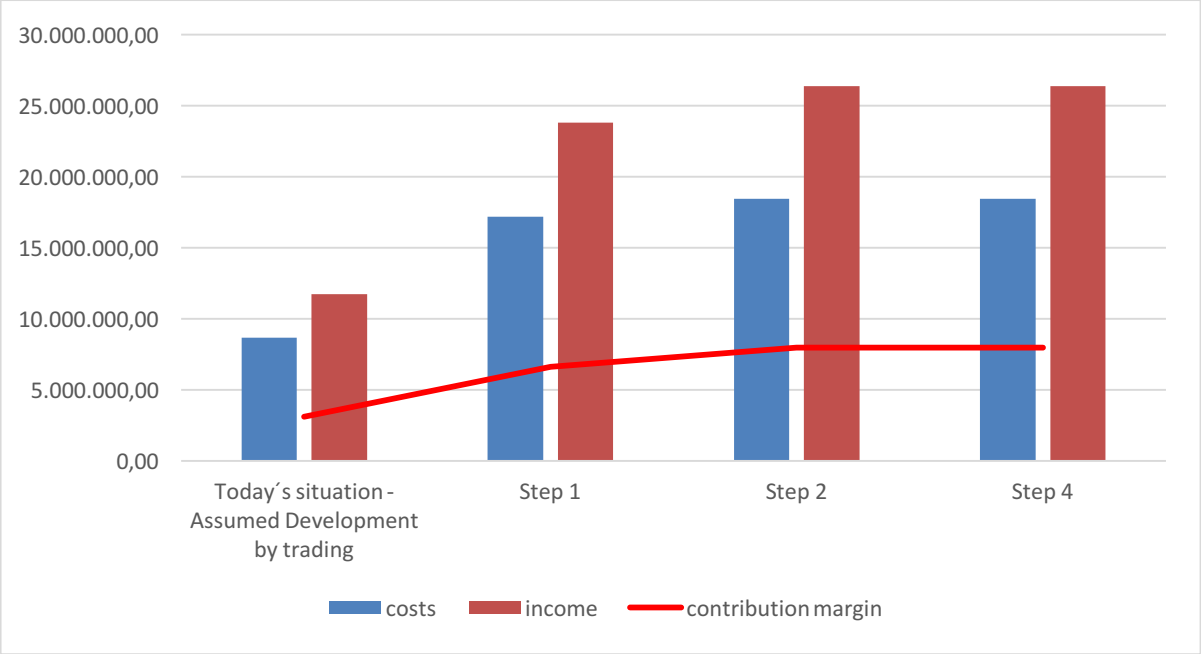

Figure 14: Summary Cost-Benefit-Analysis

6 Business Key Performance Indicators for steps to be implemented

The planned impacts of GOFLEX come from individual solutions and their business & marketing models as well as the integrated GOFLEX system and its overall system dissemination and business & marketing model. These are measured with a set of key performance indicators (KPI).

The KPIs in the table below shall be used for all steps that SWW might reach throughout the project duration.

Table 20: Business KPI´s

Steps	Business KPIs	Target value during GOFLEX test phase
Step 1-4	KPI 1.1 Level of self-generation in % Target: 100%	75%
Step 1-4	KPI 1.2 Deviations from balance in the balance group in %	5%
Step 1-4	KPI 1.3 Amount of flexibility achievable in kWh	60.558.669 kWh
Step 1-4	KPI 1.4 Amount of flexibility achieved in kWh	60.558.669 kWh
Step 1-4	KPI 1.5 Amount of money achieved for flexibility in EURO	10.516.000 €
Step 1-4	KPI 1.6 Flexibility out of storage	20.000.000 kWh
Step 1-4	KPI 1.7 Earnings out of Virtual Power Plant (VPP)	1.000.000 €
Step 1-4	KPI 1.8 Earnings out of aggregation of flexibility	1.350.000 €
Step 1-4	KPI 1.9 Number of new PV-installations	>5%
Step 1-4	KPI 1.10 Number of new battery operators	10
Step 1-4	KPI 1.11 Number of Prosumers that provide energy data	50

7 Correlation of trial business KPIs and Project Impact KPIs

The project performance indicators are based on key performance indicators of preceding research & development of contributing solutions and on estimated impact of the integrated

GOFLEX system. This is to be tracked and evaluated during the project on the SWW demonstration case.

Table 21: Individual business KPI supports the Project Impact KPIs

Steps	Business KPI	Related Project Impact KPI
Steps 1-4	KPI 1.1 Level of self-generation in % Target: 100%	Increase of prosumer involvement ≥15% Benefit for aggregator ≥ 35.000 EUR/MW/year + 200 €/MWh Benefit for DSO 1.0 mio EUR/MW ≥ 10 industrial prosumers ≥ 50 building/ residential prosumers Avoid congestions: reduction of peak demand Lessen the burden of power grids through self-consumption
Steps 1-4	KPI 1.2 Deviations from balance in the balance group in %	Benefit for aggregator ≥ 35.000 EUR/MW/year + 200 €/MWh Benefit for DSO 1.0 mio EUR/MW ≥ 10 industrial prosumers ≥ 50 building/ residential prosumers Avoid congestions: reduction of peak demand Lessen the burden of power grids through self-consumption

Steps 1-4	KPI 1.3 Amount of flexibility achievable in kWh	Increase of prosumer involvement ≥15% Benefit for aggregator ≥ 35.000 EUR/MW/year + 200 €/MWh Benefit for DSO 1.0 mio EUR/MW ≥ 10 industrial prosumers ≥ 50 building/ residential prosumers ≥ 15 charging stations prosumers Prosumers with implemented charging/discharging EV battery storage (with parked EV) ≥ 5 prosumers Lessen the burden of power grids through self-consumption
Steps 1-4	KPI 1.4 Amount of flexibility achieved in kWh	Increase of prosumer involvement ≥15% ≥ 50 building/ residential prosumers ≥ 15 charging stations prosumers Prosumers with implemented charging/discharging EV battery storage (with parked EV) ≥ 5 prosumers Avoid congestions: reduction of peak demand

		Lessen the burden of power grids through self-consumption
Steps 1-4	KPI 1.5 Amount of money achieved for flexibility in EURO	Increase of prosumer involvement ≥15% ≥ 50 building/ residential prosumers ≥ 15 charging stations prosumers Prosumers with implemented charging/discharging EV battery storage (with parked EV) ≥ 5 prosumers
Steps 1-4	KPI 1.6 Flexibility out of storage	Increase of prosumer involvement ≥15% Benefit for aggregator ≥ 35.000 EUR/MW/year + 200 €/MWh Benefit for DSO 1.0 mio EUR/MW Energy demand variation (ΔMWh /h) with respect to peak demand (MWh/h) Avoid congestions: reduction of peak demand Lessen the burden of power grids through self-consumption
Steps 1-4	KPI 1.7 Earnings out of Virtual Power Plant (VPP)	Benefit for aggregator ≥ 35.000 EUR/MW/year + 200 €/MWh Benefit for DSO 1.0 mio EUR/MW

		Energy demand variation (ΔMWh /h) with respect to peak demand (MWh/h) Avoid congestions: reduction of peak demand
Steps 1-4	KPI 1.8 Earnings out of aggregation of flexibility	Benefit for aggregator ≥ 35.000 EUR/MW/year + 200 €/MWh Benefit for DSO 1.0 mio EUR/MW Energy demand variation (ΔMWh /h) with respect to peak demand (MWh/h)
Steps 1-4	KPI 1.9 Number of new PV-installations	Increase of prosumer involvement ≥15% Benefit for aggregator ≥ 35.000 EUR/MW/year + 200 €/MWh Benefit for DSO 1.0 mio EUR/MW Augmented DR (%) Avoid congestions: reduction of peak demand Lessen the burden of power grids through self-consumption
Steps 1-4	KPI 1.10 Number of new battery operators	Increase of prosumer involvement ≥15% ≥ 10 industrial prosumers ≥ 50 building/ residential prosumers ≥ 15 charging stations prosumers

		Prosumers with implemented charging/discharging EV battery storage (with parked EV) ≥ 5 prosumers Avoid congestions: reduction of peak demand Lessen the burden of power grids through self-consumption
Steps 1-4	KPI 1.11 Number of Prosumers that provide energy data	Increase of prosumer involvement ≥15% ≥ 10 industrial prosumers ≥ 50 building/ residential prosumers ≥ 15 charging stations prosumers Prosumers with implemented charging/discharging EV battery storage (with parked EV) ≥ 5 prosumers Avoid congestions: reduction of peak demand Lessen the burden of power grids through self-consumption

8 Can the business models be implemented under current market conditions and current regulation?

Principally the trading of flexibility is active load balancing, technically speaking, which will be honored financially only in the GOFLEX project in order to gain desire and acceptance for the installation of a futureproof energy system.

There is no active law in Germany against active load management neither out of liberalization of retail nor out of regulation of grid operation.

8.1 Fully according to the actual legal and regulatory situation

“Todays’ Situation”, “Step 1: SWW (DSO) as aggregator of local flexibility”, “Step 2: Local market for energy and flexibility + “Autonomous Cell”” and “Step 4: The cellular Model” are fully according to actual law and regulation.

8.2 Release from EEG remuneration payments

For “Step 2: Local market for energy and flexibility + “Autonomous Cell”” and “Step 4: The cellular Model” SWW needs to be released from EEG remuneration payments.

Same requirement is necessary for all other cellular “players”.

9 Conclusions

For SWW it is a huge effort to enter the future flexibility market to reach the final goal of the “Cellular Approach”. From the “pre-calculation” it seems to pay off.

9.1 Expected value of flexibility in SWW scenarios

For SWW the calculated prize for “tradable” flexibility is calculated with

0,0629 €/kWh

The project will show whether this calculation was right or to high or too low.

9.2 Expected potential of flexibility in SWW scenarios

The expected potential amount for “tradable” flexibility is calculated with

60.558.669 kWh

yearly.

9.2.1 Summary volume of Flexibility used by GOFlex

Table 22 Summary volume of Flexibility used by GOFlex

	Today´s situation	Step 1	Step 2	Step 4
Flex in kWh (available)	0	23.588.221	78.627.403	78.627.403
Flex in kWh (used and dealt)	0	4.717.644	60.558.669	60.558.669
Flex in €	0	3.602.876	10.516.305	10.516.305

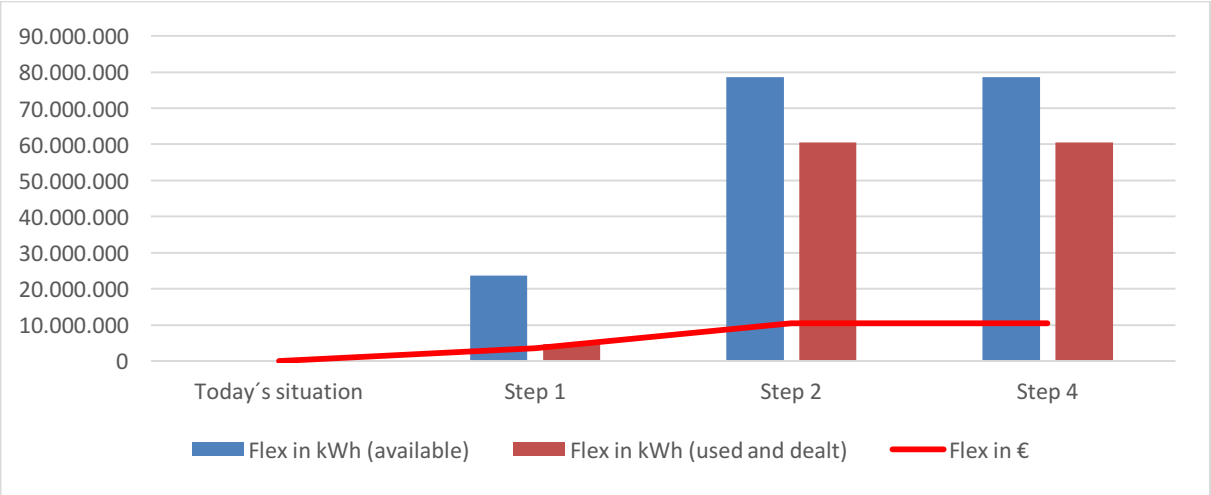

Figure 15: Summary Volume of Flexibility used by GOFlex in kWh

9.3 Expected potential overall value of flexibility in SWW scenarios

The expected overall value of “tradable” flexibility in the Power Reserve Market for SWW is calculated with

5.088.000€

yearly.

The expected overall value of “tradable” flexibility from/with Prosumers for SWW is calculated with

5.428.305€

yearly.

The expected overall value of “tradable” flexibility for Prosumers is calculated with

2.714.152€

yearly.

9.3.1 Summary Income in Euro by Flexibility used by GOFlex

Table 23: Summary Income in Euro by Flexibility used by GOFlex

	Today´s situation	Step 1	Step 2	Step 4
Income Flex Prosumer	0	211.438	2.714.152	2.714.152
Income Flex SWW (Prosumer)	0	422.876	5.428.305	5.428.305
Income Flex SWW (PRM)	0	3.180.000	5.088.000	5.088.000

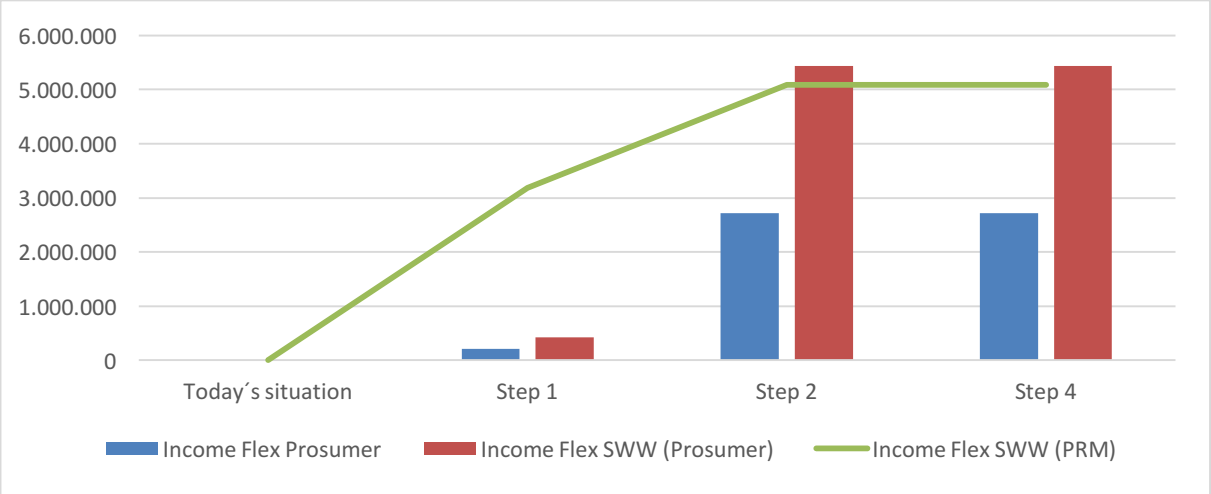

Figure 16: Summary Volume of Flexibility used by GOFlex in €

In this report a first reflexion about flexibility for SWW and the prosumers has been done. Flexibility harvesting at end consumer is strongly influenced by the service SWW can provide to them. For simple consumers, the benefits must be identified and presented clearly. For prosumers with PV, the services must first meet the self-consumption goals and then the DSO goals.

The potential conflicts between local, regional, national and the global goals are a key point to identify. The business model canvas helps to identify the customer goals, included in the value proposition and the way to make the flexibility profitable.

In order to have a chance that the GOFLEX pilot is followed by a successful large scale deployment of flexibility services, the business framework must be carefully considered. This was a first study, but concepts will evolve along with the project feedback.