BestRES

Best practices and implementation of innovative business models for renewable energy aggregators

Monitoring and Performance Evaluation of the Real-life Pilot Projects

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The logos of the partners cooperating in this project are shown below and information about them is available in this report and at the website: www.bestres.eu

This report has been written by Simon De Clercq and Carlos Guerrero Lucendo (3E). The authors thankfully acknowledge the valuable contributions from the co-authors and reviewers to complete this report.

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List of abbreviations and acronyms

aFRR	automatic Frequency Restoration Reserve
B2B	Business-to-business
BM	Business Model
BRP	Balance Responsible Party
CHP	Combined Heat and Power
DSM	Demand Side Management
DSO	Distribution System Operator
EAN	Electricity Access Point
FCR	Frequency Containment Reserve
FSP	Flexibility Service Provider
Hz	Hertz
IP1	First Implementation Phase
IP2	Second Implementation Phase
IP3	Third Implementation Phase
KPI	Key Performance Indicator
kW	Kilowatt
kWh	Kilowatt hour
MGP	Mercato del Giorno Prima - Italian Day Ahead Market
MI	Mercato Infragiornaliero - Italian Intraday market
MSD	Mercato per il Servizio di Dispacciamento - Italian Balancing Market
MW	Megawatt
MWh	Megawatt hour
n.a.	Not applicable
NKW BE	Next Kraftwerke Belgium
NKW DE	Next Kraftwerke Germany
OTC	Over-The-Counter
PPA	Power Purchase Agreement

R1	See FCR
R2	See aFRR
R3	manual Frequency Restoration Reserve
RES	Renewable Energy Source
REST	Representational State Transfer
SOC	State Of Charge
ToE	Transfer of Energy
ToU	Time of Use
TSO	Transmission System Operator
UDD	Utente Del Dispacciamento - Italian BRP
UK	United Kingdom
UVAC	Unità Virtuale Abilitata di Consumo - Aggregation of consumption units
UVAM	Unità Virtuali Abilitate Miste - Aggregation of consumption and production units including storage
UVAP	Unità Virtuali Abilitate di Produzione - Aggregation of production units

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Executive summary

In electricity systems and markets under transition towards carbon neutrality, where the share of variable renewable energy sources is increasing, system flexibility becomes crucial. As part of the solution, the aggregation of renewable energy can significantly accelerate the integration of variable electricity sources, complement demand flexibility and decrease the reliance on renewable energy support schemes. Aggregators of demand and/or generation are therefore expected to have an increasingly important role to play in the future.

The BestRES project investigates the current barriers for aggregators and suggests ways of improving the role of aggregators in future electricity market designs. In an earlier phase, 12 business models (BMs) were proposed by six aggregators in different regulatory environments in Europe. In the BestRES report "Improved Business Models of Selected Aggregators in Target Countries", the proposed BMs are improved using the canvas business model approach [1]. In the report "An Assessment of the Economics of and Barriers for implementation of the improved Business Models" the feasibility of each of the improved BMs is investigated [2]. The BMs are allocated to different groups based on their readiness for implementation.

So-called *Group 1* BMs are BMs that are economically viable and do not face barriers that prevent implementation. They are implemented by the aggregators in an implementation period. The following BMs are implemented:

- Automation & control, implemented by Good Energy in the UK.
- Supplying mid-scale consumers with time variable tariffs including grid charges optimization, implemented by Next Kraftwerke Germany in Germany.
- Market renewables on spot markets, implemented by Next Kraftwerke Germany in Italy.
- Market renewables on balancing markets, implemented by Next Kraftwerke Germany in Italy.
- Trading PV & Wind Power, implemented by Next Kraftwerke Belgium in Belgium.
- Using flexibility of customers as third party, implemented by Next Kraftwerke Belgium in Belgium.
- Demand side flexibilization of small consumers, implemented by oekostrom in Austria.
- Activation and marketing of end user's flexibility, implemented by EDP in Portugal.

The implementation of each of these improved business models is monitored and evaluated over an 18-month implementation period that ran from September 2017 until December 2019. This period is divided in 3 implementation phases (IPs) to have a methodological way of reporting. The timing and reporting activities for each phase are shown in Figure 1.

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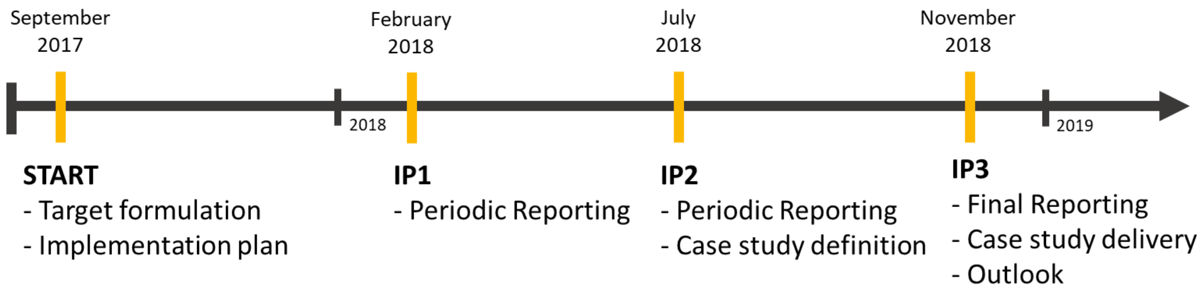

Figure 1: Timeline of the BestRES Implementation period

After each of the implementation phases, an assessment was made of the state of the implementation progress. Four distinct stages of implementation progress are identified: ‘preliminary’ to denote the earliest stage, ‘start-up’ when a limited number of clients have been recruited, ‘Expansion’ when there is a portfolio of several clients across diverse customer segments and ‘Mature’ when the BM is fully operational with a large and steady customer base.

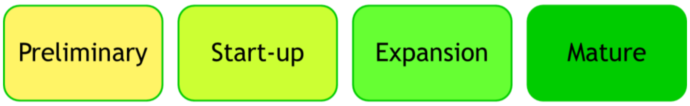

Figure 2: Stages of implementation progress

An overview of the assessment of the implementation progress per implementation period is shown in Figure 3. The figure indicates that several BMs stay within the same category during the entire implementation period, or only move up one stage. This is in contrast with the implementation activities and internal progress that happened during the implementation of each of the BMs. This indicates that a common framework for all BMs is unable to simultaneously capture both the developments across the BMs and within the BM.

Other reporting methods are used to follow the implementation progress take on a BM-specific approach. These include: development of an implementation plan, periodic reporting of implementation KPIs, qualitative reporting of implementation activities, a case study of the BM activities and a BM outlook at the end of the implementation period. An overview of the implementation activities and results, including the final implementation KPIs, is given below.

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		IP1	IP2	IP3
good energy	Automation and control	Startup	Startup	Startup
NEXT KRAFTWERKE	Supplying „mid-scale“ customers with time variable tariffs including grid charges optimization	Startup	Startup	Startup
NEXT KRAFTWERKE	Market renewables on the spot market	Expansion	Expansion	Expansion
NEXT KRAFTWERKE	Market renewables on MSD	Preliminary	Preliminary	Preliminary
NEXT KRAFTWERKE	Trading PV and wind power	Expansion	Expansion	Mature
NEXT KRAFTWERKE	Using flexibility of customers as third party	Startup	Startup	Startup
oekostrom AG	Demand Side flexibilization of small customers	Preliminary	Preliminary	Preliminary
edp	Activation and marketing of end user’s flexibility	Preliminary	Startup	Startup

Figure 3: Overview of implementation progress per implementation period

Startup

Good Energy

BM1: Automation and Control (UK)

- Good Energy launched the *Home Innovation Trial* to demonstrate how domestic electricity consumption behaviour can be reduced or shifted through a smart home device that is connected to a mobile app.
- The trial is structured in three phases. In the first phase, *Energy Basis*, a reference consumption profile is created by collecting the customers’ baseline electricity consumption. In the second phase, *Energy Awareness*, the impact of primary intervention is identified by assessing the participants’ behaviour to real-time information on their electricity consumption and its associated cost. In the third stage, *Energy Attention*, the impact of secondary intervention is identified to analyse participants’ responsiveness to unique signals.
- Around 40 households participated in the trial. The final implementation KPIs are shown in the table below.
- The implementation results show that the BM can influence the electricity consumption of residential consumers. In the case study it is calculated that the load shift can yield £4.20 annual savings per household.

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- The *Home Innovation trial* continues after the BestRES project has finished and will assess the potential engagement of the customers through messaging and gamification.

Number of implemented households	Portfolio's monthly consumption	Monthly energy bill reduction	Breakeven
43	14.63 MWh	-2%	n.a.

Good Energy was able to gain several insights in residential electricity consumption through its *Home Innovation Trial*. There was a strong focus on customer experience and user interaction. The trial continues and aim to show the potential engagement and direct interaction of the customers through the mobile app.

Startup

NEXT KRAFTWERKE **Next Kraftwerke Germany**

BM2: Supplying mid-scale consumers with time variable tariffs including grid charges optimization (Germany).

- This business model aims to add value to flexible supply contracts by considering the impact of both the wholesale price and the capacity component of the grid charges on the customer's electricity bill. An alternative implementation furthermore includes participation on balancing markets.
- In the implementation process of this BM, water pumps are identified as a customer segment with a high potential because most water management processes can be executed in a flexible manner.
- A major barrier in the implementation of the BM is its complexity.
- At the end of the BestRES implementation period, the portfolio consisted of 32 MW of water pump capacity. The final implementation KPIs are shown in the table below.

	Portfolio size	Price reduction	Reduction of peak load	Breakeven
Water pumps	32 MW	7.5%	20-25%	Yes
Battery storage	0 MW	n.a.	n.a.	
Emergency generators	0 MW	n.a.	n.a.	

Next Kraftwerke Germany identifies that this BM's complexity is the main barrier to its implementation. At the end of the BestRES trial, the company is therefore not planning to continue promoting the BM. However, when the market conditions in Germany improve, they foresee to restart their implementation activities.

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Mature

Next Kraftwerke Germany

BM3: Market renewables on spot markets (Italy)

- Next Kraftwerke Germany expanded its trading service to the Italian market. The aim of this BM is to maximise the revenue of electricity production by renewable energy sources on the day-ahead market (MGP) and intraday market (MI).
- The main activities during the BestRES implementation period were to adapt the trading processes to the Italian context.
- The contracted portfolio saw a steep increase during the BestRES trial period, with acquisition across different technologies. The final implementation KPIs are shown in the table below.

	Portfolio size	Trading turnover	Breakeven
PV Wind Hydro/biogas CHP	15 - 30 MW 300 - 350 MW 5 – 15 MW 0 - 5 MW	Not disclosed	Yes

Next Kraftwerke Germany's expansion of its trading service to the Italian market has been a succes. The BM reaches the maturity stage during the BestRES trial. The portfolio is expected to continue to grow after the BestRES trial.

Preliminary

Next Kraftwerke Germany

BM4: Market renewables on balancing markets (Italy)

- The aim of this BM is to participate in Italy's ancillary services market with an aggregated portfolio of renewable energy sources. Historically, these markets were only accessible to large thermal power plants, though now it is possible for distributed generation and consumers to participate with aggregated portfolios.
- The main activities in the frame of this BM were discussions with Terna, the Italian TSO, on the role of aggregation in ancillary service provision.
- At the end of the BestRES implementation phase, NKW DE was in ongoing negotiations with potential clients to enter Terna's aggregation trials projects.
- Slow regulatory development meant that this BM could not be launched during the BestRES implementation phase. The KPIs are therefore all zero.

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However, NKW DE used the BestRES implementation period to adapt its technical set up to the Italian balancing market.

- NKW DE is eager to enter the market and willing to further develop this BM after the BestRES implementation period ends.

Due to a delayed regulatory process, Next Kraftwerke Germany was not able to succesfully implement this BM during the BestRES implementation period. However, the aggregator is positive that this will be possible in the near future.

Mature

Next Kraftwerke Belgium

BM5: Trading PV & Wind Power (Belgium)

- In this BM, Next Kraftwerke Belgium trades power from weather dependent electricity sources such as solar PV and wind power on the different power markets in Belgium.
- There was a strong focus on client acquisition during the BestRES implementation period. NKW BE made the strategic decision to diversify its trading services to include other commodities such as Guarantees of Origin. Several events in the Belgian electricity market, such as the bankruptcy of a BRP and a national security of supply crisis, had a significant effect on the implementation activities.
- A major barrier to win large-scale trading tenders was the need for long-term hedging securities. To overcome this barrier, NKW BE planned to partner with a financial institution.
- The portfolio of this BM saw a significant increase during the BestRES trial period. From a portfolio size smaller than 10 MW for both solar and wind, it increased to more than 100 MW in both segments. The final implementation KPIs are shown in the table below.
- Forecasting and trading renewables as part of a larger service package, as with the roll-out of their BRP services, has proven to be a unique and competitive offer in the Belgian market. This allowed NKW BE to expand its portfolio quickly. It is likely that NKW BE keeps contracting renewables in that way in the near future. In addition, NKW BE sees high potential to apply the same strategy in the rest of the Benelux.

	Portfolio size	Annual turnover	Breakeven
PV Wind	>100 MW >100 MW	0-100k€ 0-100k€	Yes

Next Kraftwerke Belgium succesfully launched its trading services in Belgium. By offering these services as part of a larger package that includes BRP services, Guarantees of Origin trading, the company achieved to aggregate a significant portfolio of renewable energy sources.

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Startup

Next Kraftwerke Belgium

BM6: Using flexibility of customers as third party (Belgium)

- In this BM, the client's installation is used to offer flexibility services to the Belgian transmission grid operator on different reserve markets.
- Next Kraftwerke Belgium reached several milestones during the BestRES implementation period: It managed to successfully participate on the Belgian R3 reserve market and started operating a battery on the Belgian FCR market.
- An important barrier in this BM was the Transfer of Energy rules, which came into effect in Belgium during the fall of 2018. Not only did it create a lot of extra workload for the NKW BE team, it might furthermore hinder market participation of flexibility production units.
- The portfolio saw a steady increase across the different implementation phases. At the end of the trial, the combined portfolio consisted of between 5-10 MW. The final implementation KPIs are shown in the table below.
- NKW BE foresees to continue to expand its R3 pool to gain a better position in the Belgian market. However, it remains to be seen how scalable energy storage for FCR applications in Belgium are.

Portfolio size	Flexibility providers as % of portfolio size	Annual Turnover	Break even	Successful R3
0-10 MW	0%	0-100k€	Yes	Yes

The results of the BestRES trial period are positively evaluated. Next Kraftwerke plans to continue to grow its pool of reserve power products with flexibility on sites which fall under a third-party supplier.

Preliminary

oekostrom

BM7: Demand side flexibilization of small consumers (Austria)

- In this BM, oekostrom offers a dynamic Time of Use tariff to its residential customers.
- A customer survey was carried out to poll the perspective of residential consumers on Time of Use tariffs. The results indicated that there is considerable customer interest in time-of-use-tariffs. However, the

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participants indicated that they believe that benefits of ToU tariffs would be small. Based on the survey results, the design of the product was finalised. The other main goal during the BestRES implementation period was to make the data processing process operational.

- There were major data communication issues on the side of Austrian DSOs. Both the quality of the data, and the communication between the DSO and oekostrom, was not advanced enough to invoice clients based on that. This was a major barrier for the successful BM implementation.
- As a result of the significant barriers with data communication, oekostrom was not able to officially launch the BM during the BestRES implementation period. All implementation KPIs therefore remained zero throughout the BestRES trial.
- Nonetheless, oekostrom's outlook is positive. The company is planning to officially launch the BM once the automated customer processes are up and running with the most relevant Austrian DSOs. On the long run, its plans to implement automated customer processes with all Austrian DSOs.

oekostrom took a pioneering role in the implementation of time-variable electricity tariffs in Austria. The company has faced significant barriers regarding the data communication process with the DSO, which prevented it to succesfully implement this BM. However, it is continuing its implementation activities in the future.

EDP

Startup

BM8: Activation and marketing of end user's flexibility (Portugal)

- The business model implemented by EDP Portugal aims to activate and valorise load flexibility of its supply costumers. This is done by providing installations of large office buildings, industrial and agro-industrial customers with price signals that are used to control electricity consumption
- EDP developed a flexibility infrastructure that calculates flexibility offers that are sent to the client's local agent. Its initial plan to contract several customers in the agro-industrial sector did not work; instead the BM was implemented on the HVAC system of a single office building.
- A major barrier in the implementation was the high investment cost for the control infrastructure. Due to a missed subsidy opportunity, the original implementation plan had to be adapted.
- The portfolio, consisting of a single HVAC system, has a flexibility availability of around 25 kW. This is valorised through imbalance optimisation and day-ahead electricity sourcing optimization, which results in a revenue of 1660 €/year. The final implementation KPIs are given in the table below.

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- EDP plans to carry out more pilot projects across Portugal to assess to what extent it is possible to activate flexibility in buildings in different climates.

Number of controlled customers	Capacity of portfolio	Annual consumption of portfolio	Annual Revenue	Breakeven	Avoided imbalance
1	0.625 MW	1511 MWh	1660 €/year	Yes	3-4 MWh

EDP implemented a trial project to valorise flexibility in office buildings. The company faces several barriers that prevented it from aggregating a significant portfolio. In the future, it plans to implement the pilot in other office buildings in Portugal

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1. Introduction

In the past, European electricity markets were designed around centralized fossil-fuel generation along national or regional borders. The electricity market landscape is however changing due to a rising share of distributed generation which increases intermittency and price volatility in the system. This requires a more flexible system with more flexible consumption. As highlighted in the state aid guidelines published in April 2014 by the European Commission, this implies that renewable sources are better integrated in electricity markets and rely less on subsidies as was the case in the past. Renewable energy aggregation can significantly accelerate the integration of intermittent electricity sources, enhance demand flexibility and decrease the reliance on renewable energy support schemes.

More aggregation and market integration can however not be achieved by individual commercial or domestic consumers since they would only have a limited impact. It is only through a coordinated steering of vast amounts and types of consumers and producers in a market that the use of distributed generation, demand response and battery storage can be effective. A lot of literature has been published with respect to demand response management and more and more market players are active in this field but management of distributed generation and storage including electric vehicles is less developed. An explanation for this might be that this requires the extensive use of new technological solutions and ICT to directly control consumption and generation at lower costs.

For this reason, there is an important role for Renewable Energy Aggregators who act on behalf of consumers and use technological solutions and ICT for optimization. They are defined as legal entities that aggregate the load or generation of various demand and/or generation/production units and aim at optimizing energy supply and consumption either technically or economically. In other words, they are facilitators between the two sides of electricity markets. On the one hand, they develop energy services downstream for industrial, commercial or domestic customers who own generation and storage units or can offer demand response. On the other hand, energy aggregators offer value to the market players upstream such as BRPs, DSOs, TSOs and energy suppliers to optimize their portfolio and for balancing and congestion management. Furthermore, wholesale electricity markets might benefit from aggregation if appropriate incentives are present. A last option is that energy aggregators offer value to specific customers such as is the case for ESCOs. In this situation, the player downstream and upstream could potentially be the same entity.

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1.1 The BestRES project

The main objective of the BestRES project is to investigate the current barriers and to improve the role of Energy Aggregators in future electricity market designs. In the first stage, the project focused on existing European aggregation business models taking into account technical, market, environmental and social benefits. In the second stage, improved business models were developed that are replicable in other countries in the EU considering market designs and with a focus on competitiveness. These improved business models are then implemented or virtually implemented with real data and monitored in the following target countries: United Kingdom, Belgium, Germany, France, Austria, Italy, Cyprus, Spain and Portugal.

The BestRES project lasted for three years. It entered into force on March 1st, 2016 and ends on February 28th, 2019.

The target group, the Renewable Energy Aggregators, has been directly involved in the BestRES project consortium as partners:

- Good Energy, renewable energy aggregator active in United Kingdom
- Next Kraftwerke Belgium, renewable energy aggregator active in Belgium
- Oekostrom, renewable energy aggregator active in Austria
- Next Kraftwerke Germany, renewable energy aggregator active in Germany, France and Italy
- Energias de Portugal, renewable energy aggregator active in Spain and Portugal

The BestRES activities to be implemented in Cyprus are carried out by FOSS, the research centre for sustainable energy of the University of Cyprus. This is because there are no aggregators in Cyprus at the time being (2016) and no market entrants are expected until 2020.

The innovative business models developed during the project are based on on-going business models available in Europe and adapted to the future market design by research institutions and energy expert partners such as the Energy Economic Group of the Technical University of Vienna (TUW-EEG) and 3E. The consortium also includes a legal expert, SUER (Stiftung Umweltenergierecht /Foundation for Environmental Energy Law), who will provide a relevant contribution to the development of National and European recommendations on the business models implementation.

The BestRES project is coordinated by WIP – Renewable Energies. The project communication and dissemination will be carried out by WIP with the support of Youris.

A short description of the BestRES project partners is provided in the following paragraphs.

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WIP - Renewable Energies (WIP)

WIP - Renewable Energies has been founded in 1968 in Munich, Germany, and has been active in the renewable energy sector for over three decades, working with both industrial and public sector clients at the international level. The company's mission is to bridge the gap between research and implementation of sustainable energy systems. WIP's interdisciplinary team of professionals provides consultancy services to improve the grid and market integration of renewable energies. WIP offers project development, project management, technical supervision and realization of projects, which involve the co-ordination of international consortia. WIP counts more than 300 projects accomplished. WIP organizes international events in the field of renewable energies. Website: www.wip-munich.de

3E

3E is an independent consultancy and software service company, delivering solutions for performance optimisation of renewable energy and energy efficiency projects. We provide expert services to support project developers, asset managers, operators, investors and policy-makers and our key areas of expertise are solar, wind, sustainable buildings & sites and grids & markets. Bridging the gap between R&D and the market, 3E combines in-house innovation and partnerships with leading R&D centres. 3E's international team operates from Brussels (HQ), Toulouse, Milan, Istanbul, Beijing and Cape Town. The company has a project track-record of over 15 years in over 30 countries. Website: www.3e.eu

Technische Universitaet Wien (TUW-EEG)

The Energy Economics Group (EEG) is a department of the Institute of Energy Systems and Electric Drives at TU Wien, Austria. The core fields of research of EEG are: (i) system integration strategies of renewable and new energy technologies, (ii) energy modelling, scenario analysis and energy policy strategies, (iii) energy market analysis in general (competition and regulation), (iv) sustainable energy systems and technologies and (iv) environmental economics and climate change policies. EEG has coordinated and carried out many international as well as national research projects, international and national organizations and governments, public and private clients in several fields of research. Website: www.eeg.tuwien.ac.at

Stiftung Umweltenergierecht (SUER)

The Foundation for Environmental Energy Law (Stiftung Umweltenergierecht – SUER) was created on 1 March 2011 in Würzburg. The research staff of the foundation is concerned with national, European and international matters of environmental energy law. They analyze the legal structures, which aim to make possible the necessary process of social transformation leading towards a sustainable use of energy. Central field of research is the European and German Law of renewable energy and energy efficiency. The different legal instruments aiming towards the substitution of fossil fuels and the rise of energy efficiency are analysed systematically regarding their interdependencies. Interdisciplinary questions, e.g. technical and economical questions, are of particular importance. Website: http://stiftung-umweltenergierecht.de/

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Good Energy

Good Energy is a pioneering clean energy company, powering the choice of a cleaner, greener future together with its people, customers and shareholders. Having led the way in renewable energy development since 1999 in areas including small and larger scale wind turbines, solar panels, biogen and hydro, and now in technologies like battery storage and electric vehicles, Good Energy is making it easier for people and businesses to make renewable energy part of their lives. Good Energy powers homes and businesses with 100% renewable electricity from a community of over 1,400 UK generators and owns and operate two wind farms, including the UK's first commercial wind farm, and eight solar farms. In addition, Good Energy offers a green gas product which contains 6% biomethane — gas produced here in the UK from food waste. To make it completely carbon neutral, emissions from the rest of the gas its customers use is balanced through supporting verified carbon-reduction schemes in Malawi, Vietnam and Nepal. As of 30 December 2017, Good Energy had over 250,000 domestic and business customers. Website: www.goodenergy.co.uk

Next Kraftwerke Belgium (NKW BE)

Next Kraftwerke Belgium pools distributed renewable generation and flexible demand in a virtual power plant (VPP). We trade and deliver the aggregated power on the most relevant markets and, most importantly, we make the virtual power plant's flexibility available to the grid operator to support the management of the Belgian power system. Next Kraftwerke Belgium is a joint venture with Next Kraftwerke GmbH in Germany. Website: www.Next-Kraftwerke.be

Next Kraftwerke Germany (NKW DE)

Next Kraftwerke Germany is the operator of a large-scale Virtual Power Plant (VPP) and a certified power trader on various European energy exchanges (EPEX). The concept of a Virtual Power Plant is based on the idea to link and bundle medium- and small-scale power producing and power consuming units. The objective is to smartly distribute supply and demand and to profitably trade the generated and consumed power. Next Kraftwerke's VPP now bundles around 3,000 medium- and small-scale power-producing and power-consuming units. Among other energy sources, it includes biogas, wind, and solar power generators. Next Kraftwerke also operates in Belgium, France and Austria. Website: https://www.next-kraftwerke.com/

Oekostrom

Oekostrom AG is a holding company owned by about 1.900 stockholders. It was founded in 1999 aiming at building a sustainable energy industry, supplying customers with clean energy and supporting the development of renewable energy sources in Austria. All products and services of oekostrom AG represent an active contribution to climate and environmental protection and increase independence from fossil and nuclear energy sources. Oekostrom AG engages in the fields of power production, trading, sales and energy services and currently supplies 100 % renewable energy from Austria to more than 52.000 customers in all parts of the country. Website: http://oekostrom.at/

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Research Center for Sustainable Energy of the University of Cyprus (FOSS)

The Research Centre for Sustainable Energy of the University of Cyprus (FOSS) was created in order to play a key role in research and technological development activities in the field of sustainable energy within Cyprus and at international level with the aim of contributing to the achievement of the relevant energy and environment objectives set out by Europe. FOSS is heavily involved in all spheres of sustainable energy spreading from sources of energy, smoothly merging RES in the integrated solutions of the grid, development of enabling technologies such as storage and ICT that will facilitate the seamless merging of sustainable technologies in the energy system of tomorrow, the complete transformation of energy use by the effective introduction of sustainable alternatives in meeting the needs for mobility, heating and cooling and exploring ways of achieving even higher levels of efficiency in all areas of the economy. Website: http://www.foss.ucy.ac.cy

Centre for New Energy Technology (EDP-CNET)

EDP Group is an integrated energy player, with strong presence in Europe, US and Brazil and the third player in the world in terms of wind installed capacity. EDP is an innovative European Utility with an important presence across all the energy value chain, in Generation, Distribution, Energy Trading and Retail of electricity and gas. EDP owns HC Energia, the 4th Energy Utility in Spain and Energias do Brasil. EDP Centre for New Energy Technologies (EDP CNET) is a subsidiary of the EDP Group with the mission to create value through collaborative R&D in the energy sector, with a strong focus in demonstration projects. Currently, EDP has no activity as an aggregator, but, as the electricity sector evolves, EDP may consider aggregation either on the generation or supplier side through different companies within EDP Group. In the scope of this project EDP has chosen to focus on the supplying activity, therefore the information provided in this report is focused on the retailer side.

Websites: https://rd-new.com and http://www.edp.pt/en/Pages/homepage.aspx

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2. Methodology

2.1 Classification of the business models

The BestRES project includes 4 aggregators and 1 research centre in 9 countries in different regions in Europe:

1. Western Europe: Germany (Next Kraftwerke Germany), France (Next Kraftwerke Germany), Belgium (Next Kraftwerke Belgium) and Austria (Oekostrom)
2. Southern Europe: Spain (EDP), Portugal (EDP), Italy (Next Kraftwerke Germany) and Cyprus (FOSS)
3. British Isles: United Kingdom (Good Energy)

In the previous stages of the BestRES project, business models (BMs) for each of these aggregators were identified and improved. In the BestRES report “Improved business models of selected aggregators in target countries” [1], a total of 13 improved BMs for the aggregators were described. In the report “An assessment of the economics of and barriers for implementation’ [2], each of the 13 improved business models is classified in three categories according to the BM’s economic feasibility and legal and social barriers:

- Group 1: Aggregators that have economic BMs and no substantial barriers.
- Group 2: Aggregators with BMs that are economically viable but face barriers that prevent direct implementation only in the short or medium term.
- Group 3: Aggregators with BMs that are not economically viable and/or face substantial barriers.

The classification for each of the BMs is shown in Figure 4. The BMs that were classified in Group 1 are implemented by the aggregators in a pilot project. The report “Pilot Business Model Implementation Support” [3] describes the specific implementation support provided to each of the aggregators as part of the BestRES project.

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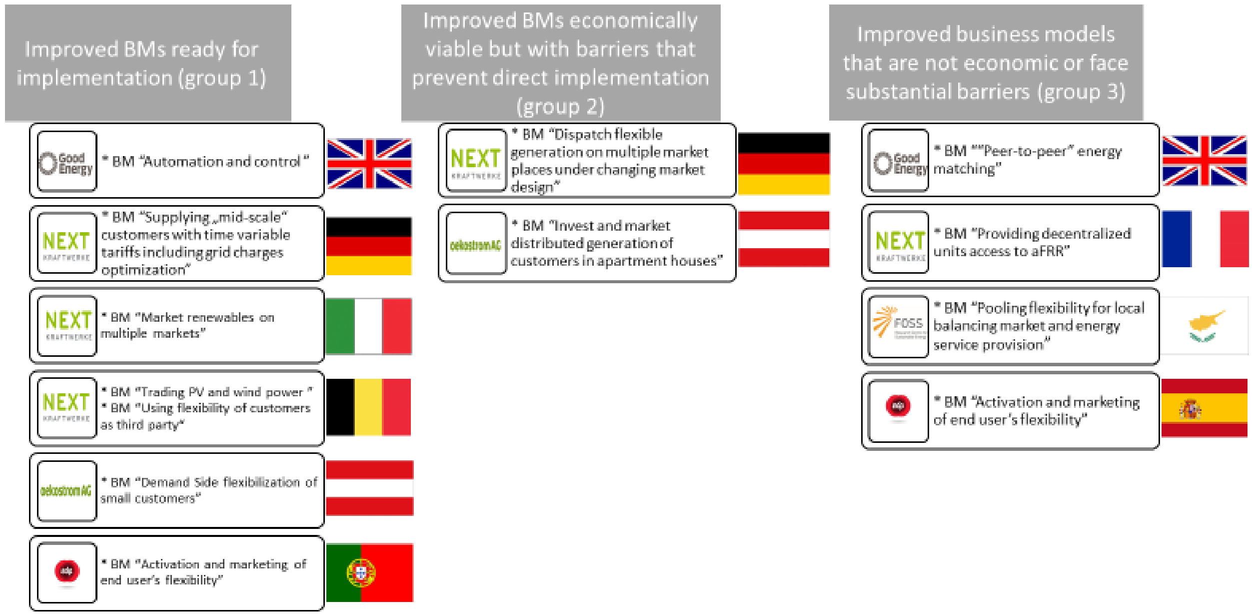

Figure 4: Classification of aggregation BMs

2.2 Real-life implementation and monitoring

The implementation of each of the Group 1 BMs is monitored and evaluated during an 18-month implementation period. The following report documents and analyses the implementation progress that is made by the aggregators for each of the Group 1 BMs. It evaluates the performance of the projects and identifies the drivers and barriers to implementation. The final evaluations are used in the follow-up report on best practices and lessons learnt.

The implementation period started in 09/2017 and ran until 12/2018. This period is divided in 3 implementation phases (IPs) to have a methodological way of reporting. The first implementation phase, IP1, ran from 09/2017 until 02/2018, the second, IP2, from 03/2018 until 07/2018 and the final phase, IP3, ran from 09/2018 until 12/2018.

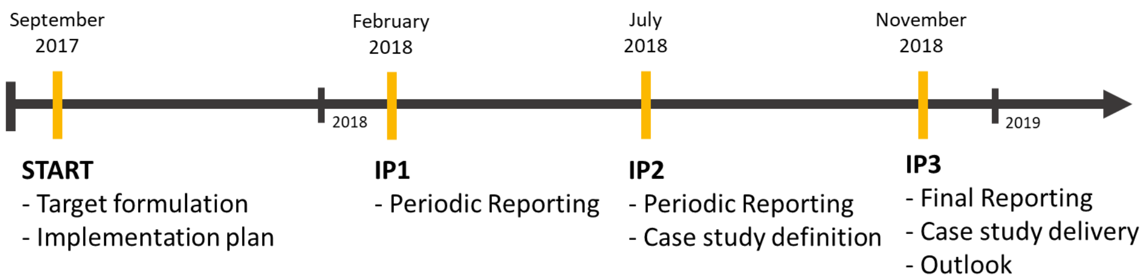

Figure 5: Timeline of the BestRES Implementation period

The report includes the planned time schedule and the aggregator's targeted portfolio size for each BM. These were reported by the aggregators in September 2017. The monitoring happens by means of quantitative data collection and a qualitative set of questions. The quantitative reporting is carried out using a

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worksheet that lists the BM-specific KPIs. This worksheet is sent out to the aggregators for each of the implementation phases. The results of the reporting are discussed individually with each of the aggregators in a conference call. Additionally, a list of questions is answered by each of the aggregators. This report synthesises the output of both the quantitative and qualitative data collection. It serves as input to formulate lessons learnt and recommendations in the BestRES report “Lessons Learnt and Best Practices”.

Since the implemented BMs cover a wide range of activities, a specific set of KPIs is identified for each BM. The KPIs that are evaluated include the following:

- **Portfolio size terms of energy consumption, capacity, or number of customers** (economic KPI)
- **Turnover or Cost Reduction** (economic KPI)
  Can be reported as turnover or as a cost reduction, depending on the specific business model.
- **Break even or not** (economic KPI)
  Whether the business model breaks even at the end of the implementation period.
- **Various technical KPIs**
  Depending on the specific activity of the BM, various technical KPIs are defined such as: amount of shifted load, peak load reduction, etc.

Some of the values are reported using ranges in order not to disclose commercially sensitive information.

Ecological KPIs are not evaluated in this report since it was found that none of the implemented BMs leads to a direct reduction of CO_2 emissions. In many cases, renewable energy assets would anyway produce the electricity, regardless of whether there is an aggregator involved or not. This means that on the short term there is no difference in CO_2 emissions. However, the additional revenue that is generated through aggregation creates a more favourable climate for renewables. This means that on the longer term, aggregation paves the way for more renewables. The BestRES report “Life Cycle Analysis of the Improved Business Models” [4] presents a more elaborate discussion on the impact of aggregation on CO_2 emissions.

After each of the implementation phases, an assessment is made of the state of the implementation progress. Four distinct stages of implementation progress are identified. They are shown in Figure 6. When the product or service is still not completely defined and there has been no finalised client acquisition, the BM is labelled as ‘preliminary’. The ‘start-up’ stage corresponds to a BM with limited number of connected clients that are all part of the same customer segment, e.g. either solar or wind, households with similar consumption profiles. The product or service is completely defined, and the first implementation has just finished. A BM is labelled ‘Expansion’ when there is a portfolio of several clients across diverse customer segments and new acquisition is in the pipeline. ‘Mature’ refers to the point when the BM is fully operational with a large and steady customer base.

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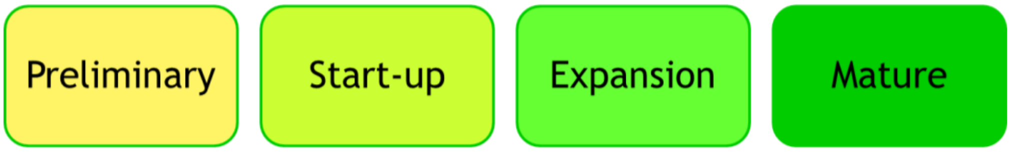

Figure 6: Stages of implementation progress

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3. Implementation of the improved business models of Good Energy (UK)

3.1 Automation and control (BM1)

In its automation and control BM, Good Energy provides a selected group of customers with a home energy management device called Verv, developed by Green Running. This device allows customers to live-monitor the consumption of different appliances in their homes. The objective of the business model is to demonstrate how energy consumption of domestic customers can be reduced or shifted, while sales margin of Good Energy can be maintained. The pilot is marketed to Good Energy customers as the *Home Innovation Trial*.

3.1.1 Implementation plan

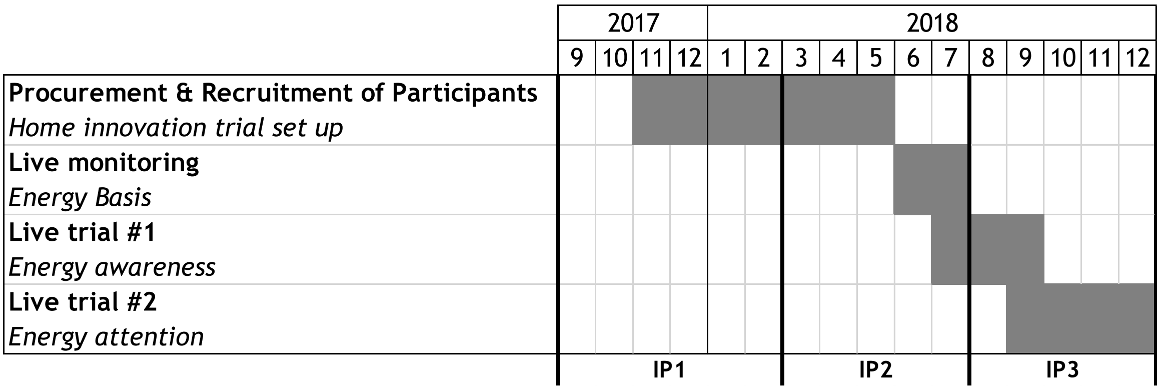

Figure 7: Implementation plan BM1 (Good Energy)

The BM implementation plan is shown in Figure 7. The trial consists of 4 stages. In the preliminary stage, the trial is prepared, the necessary equipment is procured, and the participants are recruited from among existing Good Energy customers. In the first implementation stage, called *Energy Basis*, a reference tool is created by collecting the customers' baseline electricity consumption. The saving potential of the individual households and the total portfolio is then identified by comparing *Energy Basis* reference tool to relevant national benchmarks. In the second stage, *Energy Awareness*, the impact of primary intervention is identified by assessing the participants' behaviour to real-time information on their electricity consumption and its associated cost. This step validates whether the saving potential calculated in *Energy Basis* is being achieved. In the final stage, *Energy Attention*, the impact of secondary intervention is identified to analyse participants' responsiveness to unique signals and infographics, therefore aiming to close the gap between the reference tool and the saving potential calculated in *Energy Basis*.

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3.1.2 Implementation targets and monitored KPIs

Table 1 shows the implementation targets that were set out in September 2017. The focus during IP1 lies on the preparation of the trial and Good Energy therefore does not foresee to have any connected customers. During the initial months of IP2, 50 customers are foreseen to be recruited. These customers will participate in the monitoring phase *Energy Basis* and the first live trial *Energy Awareness*. Good Energy expects about 20 customers to withdraw from the program after the second implementation phase, either because their profile does not fit the BM or because they lose interest. This results in an expected total of 30 customers by the end of the BestRES implementation period. The portfolio's expected annual consumption is based on an assumed consumption of 4.2 MWh/year per household [1]. It is expected that during the trial, the households' consumption decreases by 10 %.

Table 1: Target KPIs September 2017 BM1 (Good Energy)

	IP 1 February 2018	IP 2 July 2018	IP 3 December 2018
KPI 1 (economic KPI) Number of implemented households	0	50	30
KPI 2 (economic KPI) Portfolio's monthly consumption	0	17.5 MWh	11.1 MWh

Table 2 gives the actual implementation KPIs as reported by Good Energy throughout the implementation phases. These KPIs are discussed per implementation phase in the next sections and are based on values measured directly by Good Energy.

Table 2: Reported implementation KPIs BM1 (Good Energy)

	IP 1 February 2018	IP 2 July 2018	IP 3 December 2018
KPI 1 (economic KPI) Number of implemented households	0	34	43
KPI 2 (economic KPI) Portfolio's monthly consumption (billing data)	0 MWh	12.2 MWh	14.63
KPI 3 (economic KPI) Monthly energy bill reduction	0%	0%	-2%
KPI 4 (economic KPI) Breakeven or not	-	-	n.a.

[1] Ofgem TDCV

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3.1.3 Implementation phase 1

Start-up

The KPIs for IP1 are shown in Table 2. They correspond to the September 2017 targets and are all zero. As was planned, Good Energy focused on the preparation of the trial during IP1. Two main tasks were undertaken: the procurement of the measuring equipment and the preparation of the recruitment of the customers.

Regarding the procurement of the equipment, 50 Verv units were purchased. The Verv unit is described by its makers as "… a clever home energy assistant that gives you intelligent information about key appliances and electricity usage in your home via an app. It uses cutting-edge artificial intelligence technology to identify appliances in your home by their unique energy signatures and tells you how much each one is costing you to use, in real-time. As it learns more about your home it will also monitor the health and efficiency of your appliances and provide safety alerts when you've left appliances on." The *Home Innovation Trial* uses a customised version of the Verv hub that is adapted to the specific functionalities of the trial. At the end of IP1, the Verv smart hubs were still with the manufacturer Green Running and would be delivered to Good Energy once the development team of Green Running has implemented its adaptation to the standard Verv software.

Specifically, Good Energy required that participants did not have access to the dashboard containing live information on their electricity usage and associated cost during the first stage of the trial, *Energy Basis*. The aim of the first phase is to measure household consumption without access to real time information. The adaptation involved developing a trial app that hides live consumption information on the dashboard and sends participants an update notification after the reference tool in the first stage has been created. It also entailed changing the packaging and installation instructions for the 50 Verv smart hubs.

Green Running advised that the 50 Verv hubs will be delivered in the third week of March 2018, which is when Good Energy aims to have identified and recruited 50 participants. Because of this expected development, this BM in IP1 is labelled 'Start-up'.

The recruitment of the participants happens in 3 steps:

- Step 1: Customer segmentation

  The trial targets Good Energy's Economy 10 (E10) and Economy 7 (E7) customers. Ideal participants will be E10 customers as they have tariffs that provide ten hours[2] of off-peak electricity split between night, afternoon and evening, and therefore provide more incentive and

[2] The structure of the ten off-peak hours is determined by the local distribution network operator rather than the electricity supply company and therefore varies across the fourteen regions in the UK.

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flexibility for participants to shift their consumption. Second to the E10 customers are E7 customers, as they have tariffs that provide off-peak electricity during night-time hours. After filtering on internal parameters such as information held on customers, a group of 7428 pre-selected E10 and E7 customers are identified, as presented in Table 3.

Table 3: E10 and E7 targetable customer base

Tariff Type	# of Cust's
E10	214
E7	7214
Total	**7428**

- Step 2: Segmentation strategy

A segmentation tool which categorises the UK's population into demographic types (segmenting households, postcodes and neighbourhoods into 6 categories, 18 groups and 62 types) was used to segment the 7428 customers. An index was developed on knowledge and information on affluence, likelihood of having an internet enabled phone/tablet and interest in new technologies. This index aims to refine the segments further ensuring that the most suited participants for the Home Innovation Trial are targeted. This maximizes the response as well as installation success rate.
Following the target market analysis, Table 4 shows the groups in order of target (i.e. likely to respond and be eligible based on information at hand). Assuming a worst-case scenario response rate of 20% and a 20% Verv installation success rate, Table 5 gives the number of possible eligible participants. Looking at it cumulatively, it is possible to get 50 participants out of Group 1, Group 2 and Group 3 together. For the benefit of genuine and effective segmentation, Good Energy intends to analyse and test the segments during the stages that follow.

Table 4: Customers per Target Group

Tariff Type	# of Cust's
Group 1	214
Group 2	599
Group 3	1315
Group 4	657
Group 5	2410
Group 6	284
Group 7	764
Total	**6243**

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Table 5: Eligible Participants

Tariff Type	# of Cust's	Cumulative # of customers
Group 1	8	8
Group 2	23	31
Group 3	52	83
Group 4	26	109
Group 5	96	205
Group 6	11	216
Group 7	30	246
Total	**246**	

- Step 3: Invitations to participate and response evaluation

Three versions - short, medium and long – of trial invitations were drafted, reviewed and approved internally by Marketing and Compliance teams, as well as externally by Green Running. The email text also contains a link to the survey that customers have to complete in order to assess whether they are eligible. The survey is focused on installation success at this stage and a more in-depth survey is sent to the 50 participants in the first stage of the trial. The medium-length trial invitation is included in Appendix A.1.

3.1.4 Implementation phase 2

Start-up

Invitations were sent to Group 1, 2 and 3 customers in March 2018. Responses were collected and assessed from a technical perspective until a total of 70 were found eligible. Table 6 gives an overview of the responses per group. By April, a sufficient amount of positive responses was collected.

Table 6: Invitation responses per group

	# Invitations	# Responses		# Eligible responses		# Signed T&Cs	# Online Participants
Group 1	214	33	15%	12	36%	9	5
Group 2	599	92	15%	26	28%	18	12
Group 3	1311	92	7%	32	35%	20	15
Total	2124	217	10%	70	32%	47	32

After contacting the 70 eligible customers, 66 were still keen to participate in the trial. At the end of May 2018, 66 Welcome letters and Terms & references (T&Cs) were posted. From the 66 eligible participants, 47 signed and returned the T&Cs. One participant declined to participate due to the clause under the T&Cs which is related to cancellation fee in case a participant wants to opt out of the trial. The Verv hubs that were acquired in IP1 were packaged with Verv installation instructions and posted to the 47 participants that signed and

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returned the T&Cs. Emails with instructions to download the Verv app after reception of Verv hub were sent to the 47 participants.

The installation of the Verv device was acknowledged after a picture of the connected Verv was sent by the participant to the Home Innovation Trial inbox. Installation was confirmed by Green Running when the hub status was “online”. This means that the Verv is installed in the participant home and is collecting energy consumption. When the installation was not possible and further support was needed, participants had the choice to contact either Verv support or the Home Innovation Trial inbox. Few customers received faulty Verv devices from Green Running, which had to be replaced. Other troubleshooting issues were mainly related to the digital handshake between the Verv app and the hub.

Table 7: Installation success rate

Verv posted	47	
Online	34	72%
Troubleshooting	7	15%

Of the 47 participants that returned signed T&Cs, 34 entered Stage 1, *Energy Basis*, on June 20th, 2018. The duration of this stage was one month and entailed collecting and measuring electricity consumption data from the Verv to create the baseline data for the trial.

The implementation KPIs for IP2 are shown in Table 2. A total of 34 customers were acquired with a total monthly consumption between June 20th and July 19th of 12.2 MWh. Since the *Energy Basis* forms the reference scenario, there is neither reduction in energy bill, nor shifted load.

The baseline data in *Energy Basis* is the measurement of the households’ behaviour taken before interventions are started. It serves as a starting point for setting improvement goals (against regulatory and national benchmarks such as Ofgem) as well as a comparison point for evaluating intervention efforts and trending overall performance. The added value of the Verv device is that it not only measures real-time electricity consumption, but also identifies which appliance causes the consumption.

Good Energy provided the measured data that was collected during the *Energy Basis* for an individual household. The consumption was monitored from 15/05/2018 until 19/07/2018 (65 days), during which a total of 170 kWh was consumed. Compared to the national average, this is a low value. Good Energy understands that the Verv hub can be disconnected during the day, which can lead to consumption that is not recorded. A time series of electricity consumption per appliance per settlement period between 20/06/2018 and 19/07/2018 is shown in Figure 8. The electricity market in the UK has 30-min settlement periods, or 48 periods per day. The Verv device was able to categorise almost 50% of the consumption, as shown in Figure 9. The appliances that account for the highest share of consumption in the given household are the

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shower, the fridge and the kettle. This information can for example be used to inform the household member of possible energy shifting techniques and its associated benefits.

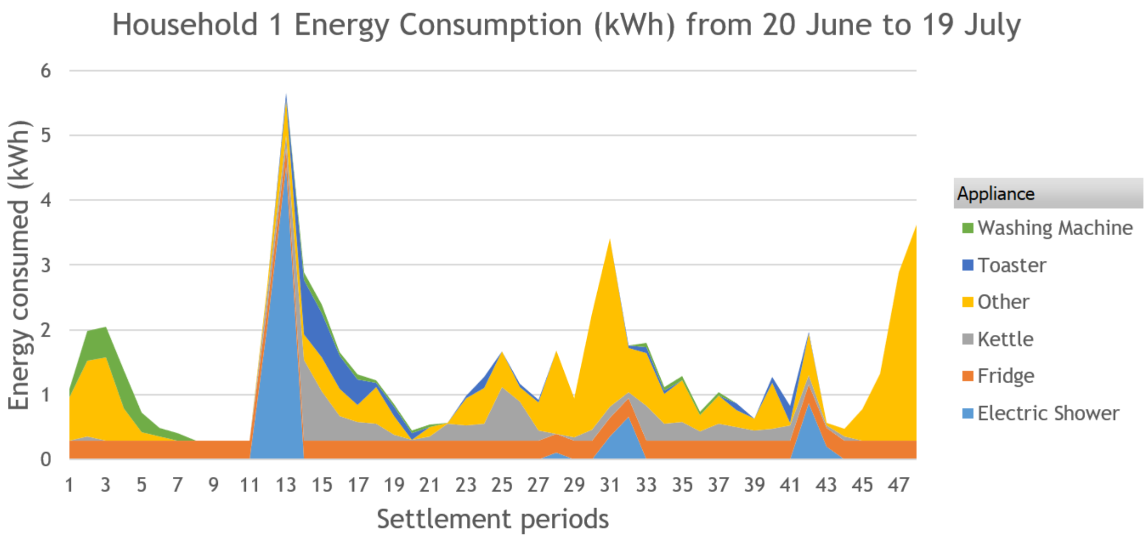

Figure 8: Household 1 Timeseries of consumption per appliance per settlement period

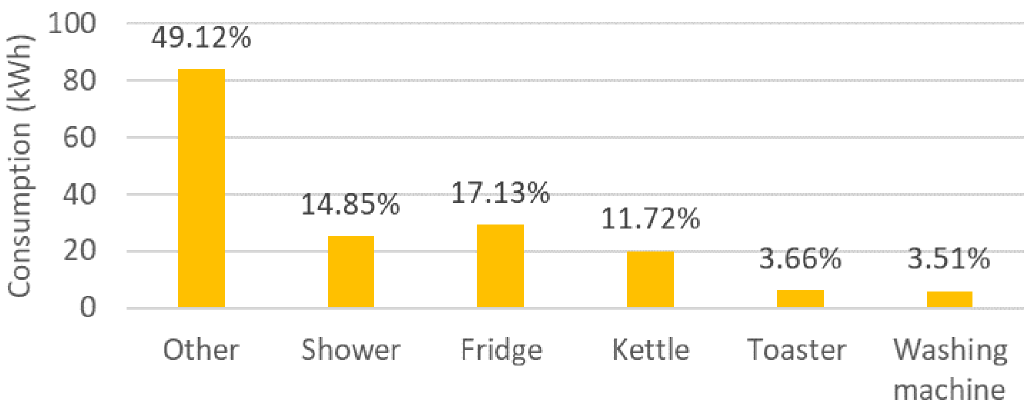

Figure 9: Household 1 Consumption breakdown per appliance

3.1.5 Implementation phase 3

Start-up

After collecting baseline data in Stage 1, *Energy Basis*, participants entered Stage 2, *Energy Awareness*, in July 2018. During this stage, the households were asked to download the main Verv app that provides access to Verv features including real time cost and energy information on home appliances.

Energy Awareness tests the effect on the consumers of having access to visual consumption data through the mobile app. The consumption data obtained

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during phase 1 (*Energy Basis)* is compared with the data from the second phase (*Energy Awareness)*.

Figure 10 shows the daily consumption profile of a typical household before and after having access to visual information. While the peak/off-peak consumption ratio has not changed between the Energy Basis and Energy Awareness phase (71% Peak consumption & 29% Off Peak consumption), the portfolio energy consumption has increased by 7%. This could be explained by seasonal differences in energy consumption.

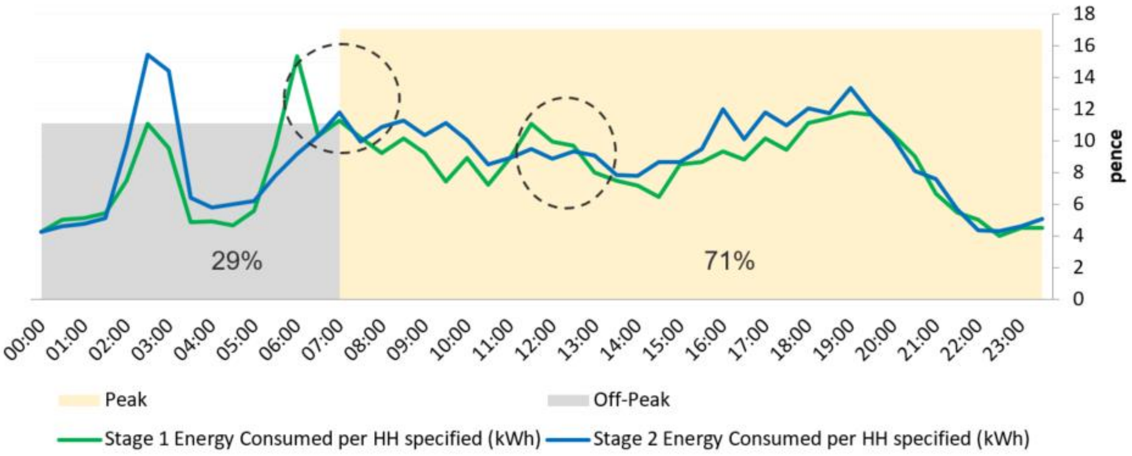

Figure 10: Daily consumption profile of typical household during Energy Basis and Energy Awareness

Individual daily profiles show that households behave differently between the different phases, yet it is not possible to identify clear trends: some households did not reduce or shift their consumption, while others consumed the same but reduced their peak consumption. Further analysis shows that even though the overall portfolio has reduced its energy consumption by only 7%, 63% of households have reduced their energy consumption by 16% on average. Furthermore, even if the peak/off-peak split has not changed between Energy Basis and Energy Awareness, 37% of households have reduced their peak consumption by 2% on average.

On the back-end, Good Energy developed an app analytics platform to understand the participants' engagement with the Verv app better. The platform tracks user's interaction with the Verv app and is used to measure user engagement and retention. It provides a tool for targeted communications with users. Specific user events and statistics, such as number of app sessions, the length of app sessions, viewing time per user statistic (information per appliance vs. for all appliances, power consumption vs. monthly electricity bill, etc.) are stored per unique user id.

At the end of September 2018, the level of engagement with the participants was stepped up when the trial entered Stage 3, *Energy Attention*. Infographics were sent to 32 participants on the 24th September 2018 with the objective to give them further insights on their energy behaviour. The infographics contained two main parts. The first part shows the appliances that were most used in a one-month period. This includes the number of times it was used and at what time of the day. The infographic's second part indicates the day with highest energy consumption in the same period and compares it with the consumption of the average day of the period.

Further in IP3, households have been clustered into two groups using historic consumption data, data collected by Verv as well as data from the app analytics platform. Group 1 comprises households that show awareness of the difference between their peak and off-peak tariffs. The second group comprises of households that show no evidence of taking advantage of the discounted off-peak tariff for example by using "flexible" appliances such as a washing machine during their peak hours.

One of Good Energy's hypotheses is that households in Group 1 do not have much more additional load to flex and will therefore not be able to benefit as much as Group 2 from Verv's real time information and any added knowledge of time of appliance consumption use. On the 14th of December, another infographic was produced as a first step to test this hypothesis. The infographic was called "When are you using electricity in your house?" and is designed to help households better understand their electricity behaviour during different times of the day and perhaps even initiate some changes. It includes graphs that (1) show the household's percentage peak and off-peak consumption for each appliance (2) show the contribution of each appliance to the household's total peak and off-peak consumption separately and (3) illustrate the daily electricity consumption profiles of individual appliances. Good Energy requested feedback on the infographic. This feedback, together with the consumption data pre and post implementation of Verv, and the consumption data pre and post receiving the infographic, will be analysed to test this hypothesis.

At the end of IP3, the *Home Innovation Trial* was still ongoing with 43 participants taking part. This is higher than the objective of 30 participants in the September 2017 targets. The trial participants had an aggregated monthly consumption of 14.63 MWh in November 2018. Compared to the baseline from the Phase I, Energy Basis, there is a 2% reduction in the electricity bill. Good Energy furthermore reports 0.11 MWh of shifted load per year. The BM is again labelled *start-up* for this final implementation phase.

3.1.6 Case studies

An analysis is carried out based on the load flexibility potential for trial participants on a two-rate tariff (peak: 7am – midnight, off-peak: midnight – 7am). Potential flexibility lies in shifting all washing machine loads into off-peak hours and shifting the rest of loads by maximum half an hour into off-peak hours. This can result in a reduction in the household's electricity bill.

This theoretical exercise is done for a typical household in the trial's portfolio. Under the two-rate tariff, the flexible load potential (washing machine and consumption during the period switch) is 7% of the household's consumption. It

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is calculated that the resulting load shift can yield £4.20 annual savings per household. A breakdown of the flexibility sources per device, as expressed in pounds of savings, is shown in Figure 11.

The calculated value based on the real load profile is about four times higher than the value of residential flexibility that was calculated in the BestRES report "Quantitative Analysis of Improved BMs of Selected Aggregators in Target Countries" [5]. Good Energy notes that the load flexibility potential could be even bigger if households had the opportunity to shift their load across multiple rates in the day.

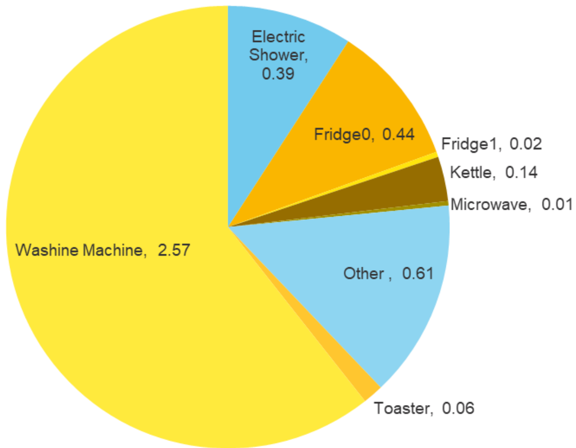

Figure 11: Breakdown of flexibility sources per device, expressed in electricity bill savings in pounds

3.1.7 Outlook

For the final months of the trial, Good Energy is planning to test various messaging (social, environmental, financial etc.) via similar infographics on households, through control and experiment groups. This will show the potential engagement of the customers through messaging and gamification.

The impact of the messaging is followed with the launch of a game that challenges the participants of the *Home Innovation Trial* to shift consumption from peak hours to off-peak hours. Shifting electricity usage into off-peak hours can decrease pressure on the grid at times of high demand, meaning more demand can be met by renewable energy sources.

Towards the end of the trial, Good Energy is planning to conduct a final primary research with the participants of the *Home Innovation Trial*. The objectives are to validate the findings of the data analysis via survey or face to face interviews, and to obtain additional insights on customer experience.

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4. Implementation of the improved business models of Next Kraftwerke Germany (Germany)

4.1 Supplying mid-scale consumers with time variable tariffs including grid charges optimization (BM2)

The implementation of this business model aims to add value to flexible supply contracts by considering the impact of both the wholesale price and the capacity component of the grid charges on the customer's electricity. Initially, Next Kraftwerke Germany (NKW DE) only carried out an optimisation of the wholesale price. The research from the first phase of the BestRES project showed that flexible power consumption that considers the peak-load component of the grid charges can lead to an additional cost reduction. Hence, the result was that these two optimisation approaches are combined, and that the combination leads to the lowest electricity costs. By jointly reducing the wholesale price as well as the grid charges, all components of electricity costs that can be influenced by demand side management are addressed. This is shown in Figure 12.

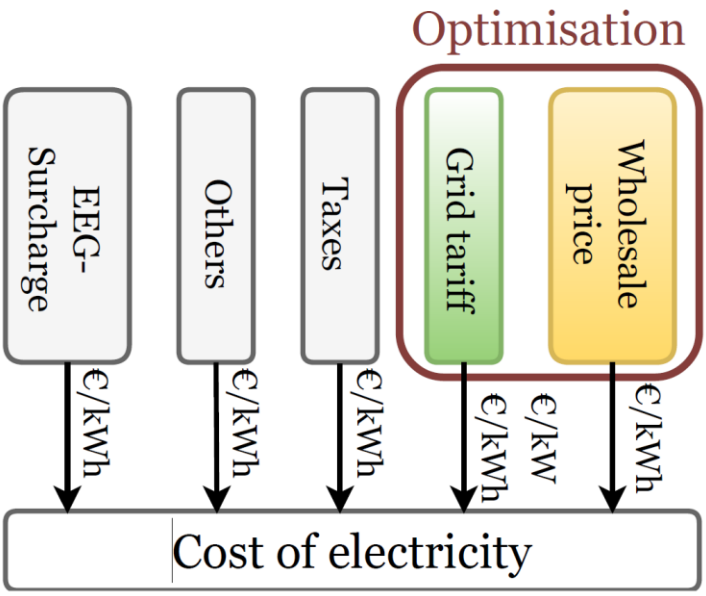

Figure 12: Break down of electricity cost and optimisation potential

4.1.1 Implementation plan

The implementation plan for this BM is shown in Figure 13. There are two main parallel tasks: Developing the portfolio regarding water pumps and marketing battery storage and emergency generators to new customer segments.

In the first instance, water management companies are expected to be targeted. In a later stage, other customers groups are added, such as for example

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emergency generators and battery storage. These assets are currently not attractive for flexible power supply. However, NKW DE wants to assess to what extent the optimization of wholesale prices and grid charges can be combined with the provision of ancillary services such as FCR or aFRR to create a lucrative business model.

The specific implementation of software and hardware for **water pumps** is a continuous task during the rollout of this BM. It spans across the three implementation phases. At the end of IP1 and IP3, the economic attractiveness of this aspect of the business model is assessed. The potential of the **new customer segments** is analysed, starting at the end of IP1 and during IP2. By the end of IP3, a final assessment is made.

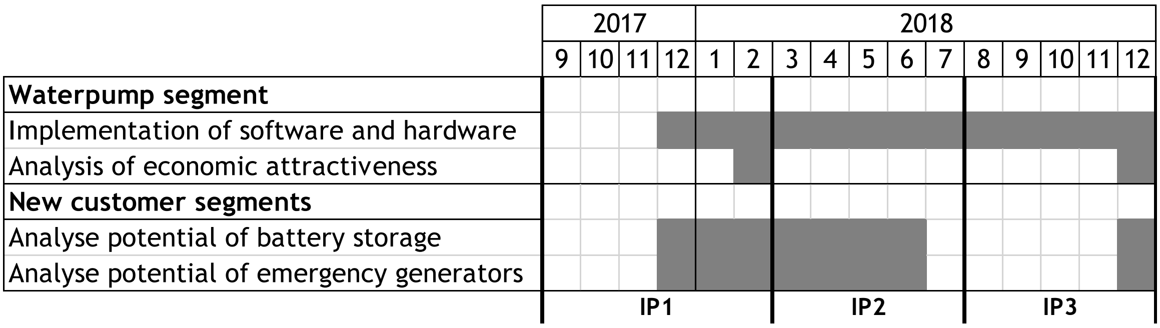

Figure 13: Implementation plan BM2 (NKW DE)

4.1.2 Implementation targets and monitored KPIs

The targets set out in September 2017 are shown in Table 8. NKW DE expects 32 MW of hydropower and neither battery storage nor emergency generators by the end of IP1. By IP2, the portfolio size is expected to grow uniformly across the different technologies, with an increase of between 1 and 3 MW for water pumps, battery storage and emergency generators. By the end of the BestRES project, NKW DE foresees a further doubling of the portfolio size for battery storage and emergency generators compared to IP2, to respectively 2 MW and 5 MW, and an increase to 36 MW for water pumps.

Table 8: Target KPIs September 2017 BM2 (NKW DE)

	IP 1 February 2018	IP 2 July 2018	IP 3 December 2018
KPI 1 (economic KPI) Portfolio size *Water pumps *Battery storage *Emergency generators	 32 MW 0 MW 0 MW	 34 MW 1 MW 3 MW	 36 MW 2 MW 5 MW

Table 9 gives the actual implementation KPIs as reported by NKW DE throughout the implementation phase. These KPIs are discussed per implementation phase in the next sections. All the KPIs in this BM are based on values measured directly by NKW DE.

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Table 9: Reported implementation KPIs BM2 (NKW DE)

	IP1 February 2018	IP2 July 2018	IP3 December 2018
KPI 1 (economic KPI) Portfolio size *Water pumps *Battery storage *Emergency generators	32 MW 0 MW 0 MW	32 MW 0 MW 0 MW	32 MW 0 MW 0 MW
KPI 2 (economic KPI) Price reduction *Water pumps *Battery storage *Emergency generators	10% n.a. n.a.	10% n.a. n.a.	7.5% n.a. n.a.
KPI 3 (technical KPI) Reduction of peak load *Water pumps *Battery storage *Emergency generators	20-25% n.a. n.a.	20-25% n.a. n.a.	20-25% n.a. n.a.
KPI 4 (economic KPI) Break even or not	-	-	Yes

4.1.3 Implementation phase 1

Start-up

The reported KPIs for the first implementation phase are shown in the second column of Table 9. Next Kraftwerke has 32 MW of water pumps in its portfolio. The portfolio size for battery storage and emergency generators is zero. These values correspond to the company's targets and the BM is labelled 'Start-up' for IP1. The grid charge optimisation causes a cost reduction of 10% in the case of the water pumps and there is a peak reduction of 20 to 25%. Since the cost reduction due to the peak load reduction is only calculated by the grid operator once a year, it is not possible at this point to quantify the breakdown between the two optimisation methods. According to the performance of this BM during IP1, NK DE expects it to be break even by the end of the 18-month trial. NKW DE identifies that a general barrier to customer acquisition is that a flexible power supply can only be applied when the load profile is metered. In Germany, this is only done for consumers with a yearly consumption greater than 100 000 kWh.

Water pumps

Water pumps are identified early in the implementation process of this BM as a customer segment with a high potential because most water management processes can be executed in a flexible manner. The flexibility is based on the inherent storage of connected water basins and the fast reaction of water pumps.

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Figure 14 shows how the consumption of electricity can be shifted towards times of low prices.

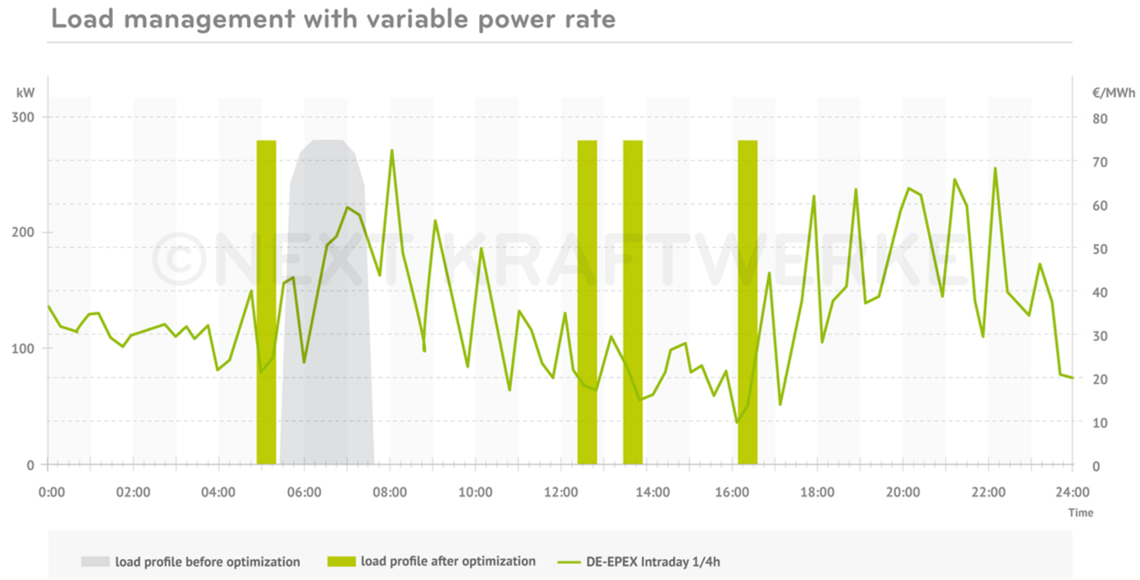

Figure 14: Load management with variable power rate

Furthermore, some water management companies already consider grid charges and optimise their consumption profile by considering peak load periods. NK DE has previous experience with this customer group through its product *flexible power supply*, so the company is aware of the restrictions of the installations. The first step of the implementation plan is to setup flexible power supply contracts with water management companies that already perform grid charges optimization.

Figure 15 illustrates the interfaces and processes which are required to implement the flexibility power supply concept. The illustrated processes require several interfaces and coordination and forecasting tools that have to be set-up for each customer individually. The information needs to be exchanged in a cost-efficient manner. To this end, NK adapts and implements its REST API. Setting up the interface and the development of forecasting models is the main investment cost for this BM.

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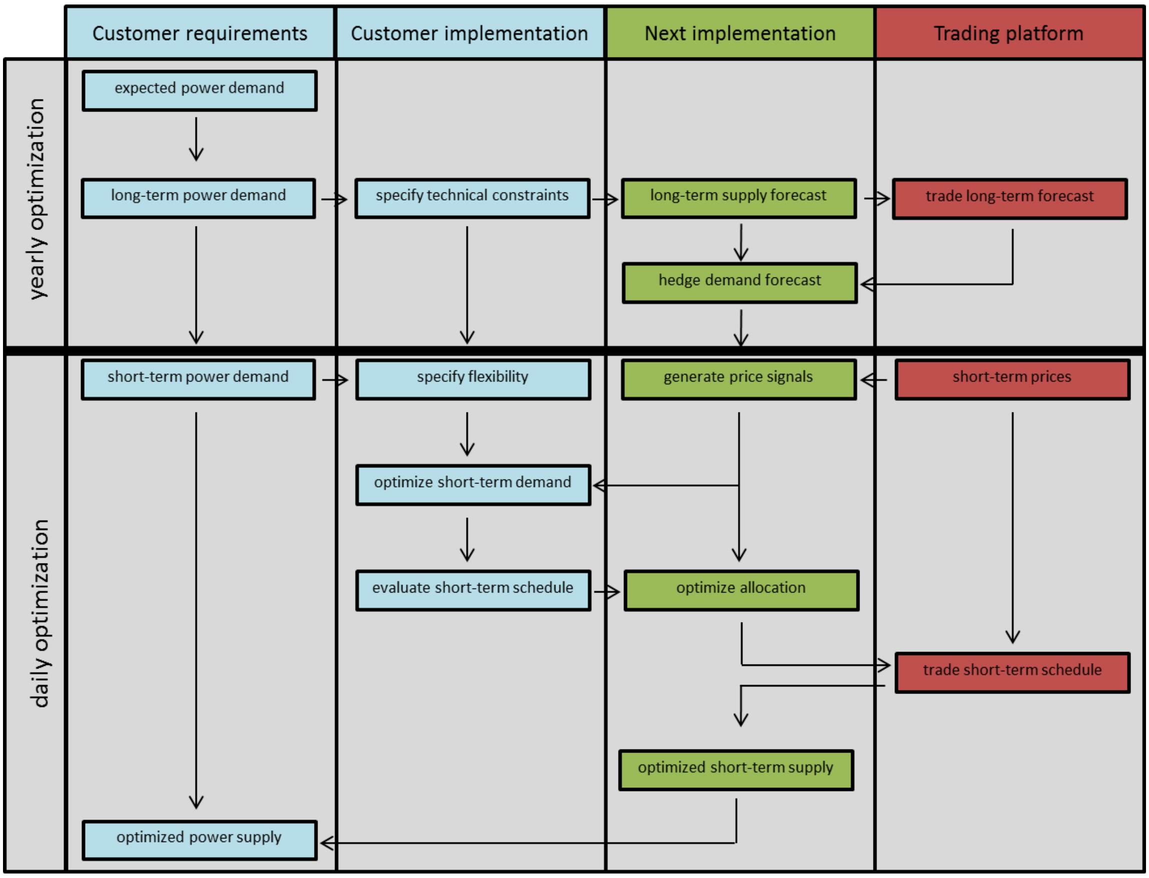

Figure 15: Block diagram of flexible power supply provision

Long-term optimization:
As a first step, NKW DE fixes a price level for its flexible power supply customers since the electricity consumer does not want to be exposed to the risk of a long-term increase in electricity prices. That means that the customer has a fixed price level per kWh, which cannot be crossed. Therefore, the yearly power demand profile is forecasted. Grid charges reduction plays already a crucial role at this stage since the profile which is going to be hedged is influenced by these grid charges optimization activities.

Short-term optimization:
The long-term profile is further optimised taking into account the prices from the Day-Ahead and Intraday market. NKW DE forecasts these prices and supplies the pumps' central control system with energy prices for the following 96 fifteen-minute intervals on an hourly basis. In case the consumer can further optimise within the applied restriction (such as peak load reduction) NK trades this adapted schedule on the short-term markets.

Battery storage and emergency generators
Batteries can be used to reduce the peak-load of an industrial site without impacting its regular processes. They have as an additional advantage that peaks usually only occur few times per year and are triggered either by exceptional circumstances such as an outage of an onsite generation unit or by seasonality effects. Therefore, the storage has a lot of downtimes concerning peak load reduction. During these periods, the battery can be used to provide ancillary

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services such as FCR. Figure 16 illustrates the combined usage of Peak load reduction and FCR provision. NKW DE reports that a combination of 10% peak shaving and 90% R1 provision can be a viable business case.

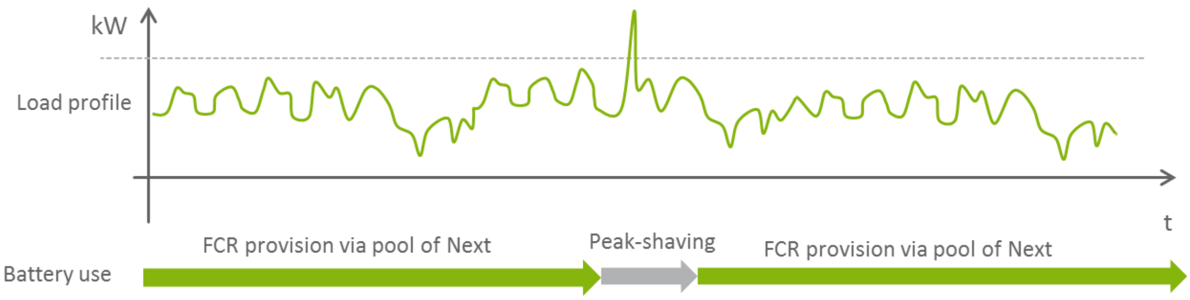

Figure 16: Battery use for grid charge optimisation

However, a barrier to use batteries as a way to reduce grid charges is that lithium-ion technology only recently developed in terms of cost efficiency. Currently, there are just a few batteries installed for this use case. As a result, there is little project experience in this customer segment and the potential client should be prepared to be an early adopter of the technology. NKW DE is in contact with battery suppliers in order to follow up closely on developments, though during IP1 it did not close any contracts.

Emergency generators can only be used for this BM in case different technical requirements can be fulfilled. This makes it generally tough to identify the right clients. During IP1, opening discussions have taken place between a potential customer and Next Kraftwerke but nothing concrete was set up. Next Kraftwerke recognises the potential of emergency generators for this BM but the activities during IP1 have shown the barriers for the implementation.

4.1.4 Implementation phase 2

Start-up

By the end of the second implementation phase, July 2018, NKW DE cannot report an increase in this BM's portfolio. The portfolio contains 32 MW of assets in the water pump segment. The BM is therefore again labelled *Start-up* for IP2, as was the case in IP1. This is below the targeted growth that was set out in the September 2017 objectives.

NKW DE identifies that the main barrier for the implementation of this BM is its complexity: it combines several optimization systems and therefore requires that the customer has an advanced understanding of the operation of power markets. This complicates this BM's marketing and technical implementation. In all customer segments, the BM's roll out requires a large customer commitment to electricity price reduction that supports the lengthy installation process and facilitates the necessary coordination between the different departments within the same company. In the specific case where ancillary services are provided,

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the DSO requirements regarding pre-qualification add an additional step to the process.

NKW DE further developed the BM in the emergency generator segment through its active lead, though the company was not able to reach the implementation phase during IP2. A specific barrier to using emergency generator is that the DSO requires a different certification for generators used as power supply and generators used as back-up (additionally to the pre-qualification for ancillary services). This means that the BM needs to create enough value to pay back the cost of both certification procedures. A positive development happened in July 2018: the period for aFFR products in Germany changed from weekly to 4-hourly. This makes the peak-shaving and aFRR provision better combinable since an expected peak limits the balancing service provision only for 4 hours.

Due to these barriers, NKW DE reported that it is uncertain whether the company will be able to contract any new capacity before the end of the BestRES implementation trial.

4.1.5 Implementation phase 3

Start-up

By the end of the third implementation phase in November 2018, the portfolio still consisted of 32 MW of assets in the water pump segment. The BM is therefore again labelled *Start-up* for IP3, as was the case in the previous IPs. The final implementation target of 36 MW in the water pump segment has been reached for 88%. NKW DE reports that due to specific market conditions, the BM's price reduction has decreased to 7.5%. Nonetheless, the BM breaks even considering the trial period.

Since the deployment of the BM that combines electricity sourcing and peak load optimisation showed a high complexity, its potential customer group is very limited. NKW DE did also not contract any batteries or gensets for the combined approach that reduces grid charges and provides balancing. A barrier for this segment is the postponement of the daily procurement of FCR, which was shifted from November 2018 to July 2019. This delayed the implementation since the weekly availability requirement for FCR restricts the combination of revenue from peak-shaving and FCR. NKW DE is not planning to actively promote the combined approach of this BM after the BestRES project is finished but would reconsider this in case there is specific interest from customers.

4.1.6 Case study

The pricing strategy for the water pump portfolio is illustrated in Figure 17. Short term price signals are transmitted in 15-minute blocks for the following 24 hours to the asset's control system. The customer keeps control of its power consumption by informing NKW DE which prices should be validated. The figure shows the relation between the price cap and short-term price signals. The green line represents the prices that are transmitted to the customer based on prices observation of the day-ahead and intraday market. The grey line illustrates the price cap that NKW DE guarantees the customer. In case that the average price over a certain period lies above the price cap, the customer is settled according to the price cap instead. When the average price stays below the price cap, the customer is settled based on the average price that was achieved by its optimised operation. The average price is calculated on a monthly basis.

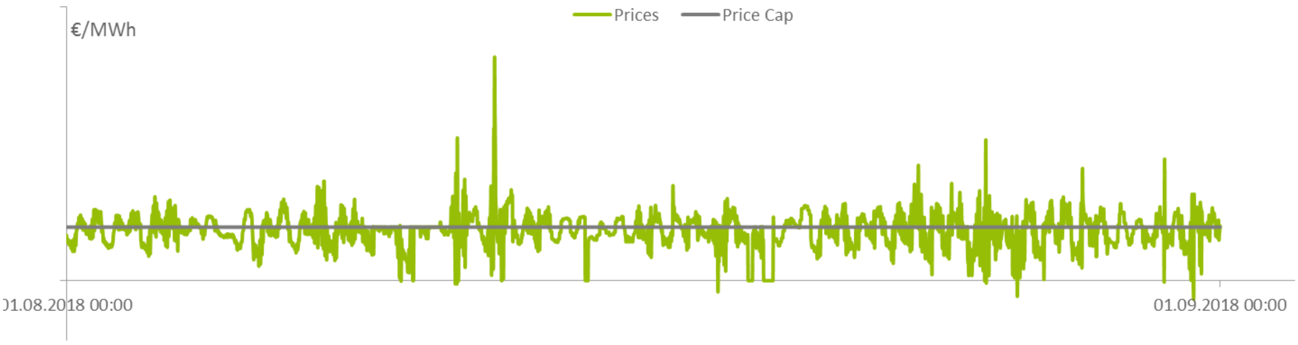

Figure 17: Pricing strategy for water pump portfolio (BM2)

4.1.7 Outlook

NKW DE identifies that the current tariff structure and price trends in the German market do not make the BM sufficiently profitable to overcome its complexity. At the moment, the company is therefore not planning to continue promoting the BM.

Concerning future development, NKW DE would consider the BM's approach as highly relevant as soon as grid charges give a more accurate reflection of real-time scarcity in the grid and when the price spread on spot markets increase. Currently, Germany already witnesses an increase in the price level of electricity, which indicates a certain dynamic which could also be followed by price spreads. Once the market conditions are right, NKW DE is planning to reconsider its decision regarding the future of the BM. Similarly, in case a potential customer is highly interested to implement the BM and the general conditions indicate an economic value, NKW DE would be eager to provide the product.

The combination of grid charges and balancing services is another opportunity that NKW DE is still following up on. However, as long as batteries on industrial sites are not common and the TSOs tender FCR on a weekly base, it is hard to envision a large-scale rollout. As soon as the battery market becomes more active and the FCR market design changes towards shorter procurement periods, NKW DE foresees to increase its efforts in this market segment.

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5. Implementation of the improved business models of Next Kraftwerke Germany (Italy)

5.1 Market renewables on spot markets (BM3)

Next Kraftwerke Germany (NKW DE) has started its services in Italy under a subsidiary named Centrali Next. It optimises the marketing of the energy produced by its clients' renewable production units on the day-ahead market (MGP) and intraday market (MI). For variable energy units (PV and wind), a trading strategy is used that maximises the customer's trading revenue. Similarly, NKW DE optimises the operation of controllable plants such as biogas and CHP units.

5.1.1 Implementation plan

Figure 18 shows that the preliminary tasks of the implementation of this BM were completed before the start of the trial. Access to the power exchange had been obtained, a pricing model had been developed and data management infrastructure had been put in place. The remaining tasks in the trial consist of repetitively assessing the performance of the BM for each of the targeted customer segments: PV, Wind, Hydro/Biogas and CHP. This is planned at the end of IP1 (February 2018) and at the end of IP3 (December 2018). Furthermore, customer acquisition is a constant task during the trial period.

	2017				2018											
	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Preliminary tasks																
Access to power exchange									Done							
Pricing model									Done							
Data management									Done							
Repetitive assessment (Pricing, compatibility withs subsidies, competition)																
PV																
Wind																
Hydro/Biomass																
CHP																
				IP1					IP2					IP3		

Figure 18: Implementation plan BM3 (NKW DE)

5.1.2 Implementation targets and monitored KPIs

The September 2017 targets are shown in Table 10. From the start of the Italian portfolio in 2017, NKW DE expects that by the end of IP1 the portfolio grows to include 20 MW PV, 20 MW Solar and 10 MW CHP. By the end of IP3, it expects to have 100 MW of both PV and wind, 20 MW of Hydro/biogas and 50 MW of CHP.

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Table 11 gives the actual implementation KPIs as reported by NKW DE throughout the implementation phase. These KPIs are discussed in the following sections.

Table 10: Target KPIs September 2017 BM3 (NKW DE)

	IP1 February 2018	IP3 December 2018
KPI 1 (economic KPI) Portfolio size *PV *Wind *Hydro/biogas *CHP	 20 MW 20 MW 0 MW 10 MW	 100 MW 100 MW 20 MW 50 MW

Table 11: Reported implementation KPIs BM3 (NKW DE)

	IP1 February 2018	IP2 July 2018	IP3 December 2018
KPI 1 (economic KPI) Portfolio size *PV *Wind *Hydro/biogas *CHP	 5 - 10 MW 60 - 80 MW 0 - 5 MW 0 - 5 MW	 5 - 10 MW 120 - 140 MW 0 - 5 MW 0 - 5 MW	 15 - 30 MW 300 - 350 MW 5 - 15 MW 0 - 5 MW
KPI 2 (economic KPI) Trading turnover	0 - 100k€/year	Not disclosed	Not disclosed
KPI 3 (economic KPI) breakeven or not	-	-	Yes

5.1.3 Implementation phase 1

Expansion

The KPIs for IP1 are shown in the second column of Table 11. At a value of 5-10 MW in the portfolio, the target for PV has not completely been achieved. This is compensated by the nearly doubling of wind power, which shows a greater implementation success than expected. Both CHP and Hydro/biogas are at zero for IP1. The BM is labelled *Expansion* for IP1, as the portfolio is significant and consists of more than one technology.

NKW DE reports that the revenues of this BM depend on how much insight it has in the portfolio. In the early stages of the implementation, the exact revenues are therefore highly variable. The company expects to be able to give a more detailed range as the implementation continues and a better understanding of the portfolio is gained.

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> Marketing with **Centrali Next as trader:**

Figure 19: Marketing process of Next Kraftwerke

The market process, from a customer point of view, is shown in Figure 19. In the first step, NKW DE trades the produced electricity on the trading platform of the Italian Power Exchange GME. All trading activities in the Italian markets (electric energy in short and long-term, as well as certificates and ancillary services) are centrally managed via this platform. While many European markets are centrally organised in the platforms of EPEX SPOT and can be accessed via uniform front-end interfaces ETS (for day-ahead) and Comtrader (for intra-day), bids and trades in the Italian market are submitted via browser-based XML-upload. For this reason, NKW DE's trading team designed and implemented new processes and tools for efficient short-term trading in the Italian markets. In the second step, the imbalance costs are reduced through balancing group management. The allocation of plants to a Balancing Responsible Party (BRP) in the Italian market is significantly different compared to the trading arrangements in other European countries. While in many European markets, production units located within one control area can be allocated to one balancing group of a BRP independent of its technology type (i.e. wind, PV, biogas, etc.), the Italian regulatory system differentiates between different technologies as well as relevant (i.e. > 10 MVA) and non-relevant (i.e. < 10 MVA) units. An Italian BRP (Utente Del Dispacciamento, UDD) can only aggregate non-relevant units of one technology per market zone and submit trades/nominations for each of these portfolios. Relevant units (e.g. wind farms > 10 MVA) need to be forecasted and traded individually per unit. This requirement hampers portfolio effects and the natural balancing between e.g. wind and PV within one balancing group.

To facilitate the trading, several additional processes were integrated in NK's trading infrastructure during the first implementation phase:

- UDD registration: One month before a production unit is traded in the Power Exchange, it needs to be allocated to a certain balancing group . This process is managed via an online portal of the TSO Terna, similarly to other European markets.
- Production data and imbalance settlement: Final measurement data is provided through the same Terna portal on a monthly basis by the middle of month M+1. The imbalance data for the respective balancing groups follows by the 17th of month M+2.
- Curtailment of large wind production: for congestion management reasons, TSO Terna regularly curtails large wind production via the Mancata Produzione Eolica process. This requires registration and administrative processes in portals of Terna and the renewable regulatory agency GSE.

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Generally, the international portfolio of Next Kraftwerke contains a high share of flexible renewables such as smaller hydro plants and biogas plants. During IP1 in Italy, however, there was a much larger growth in the portfolio of PV and wind. This has two reasons: on the one hand, PV and wind power units in Italy are very often subsidised by Feed-In premiums, which makes it attractive to the operator to use NKW DE's trading services. The operator of an asset under a feed-in premium receives subsidies only on top of the market prices. That means that the electricity has to be sold on the regular electricity market. On the other hand, the number of installation of these technologies is relatively high compared to other countries. Figure 20 shows how NK creates added value in this BM for the customers that receive a subsidy from the *Conto Energia* or *DM 23/06/16*.

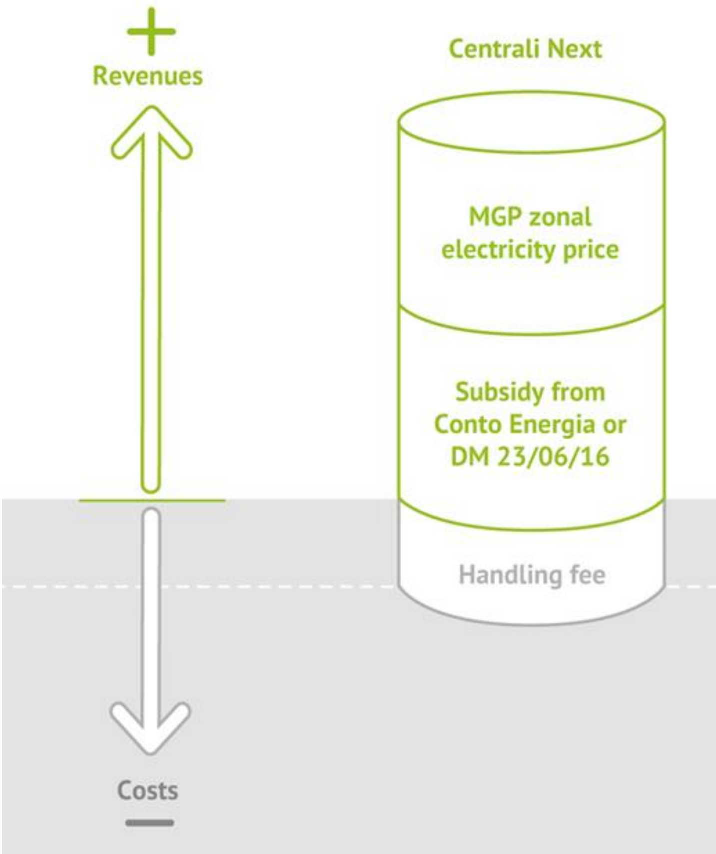

Figure 20: Revenue model of Next Kraftwerke

Activities concerning Biogas and smaller scale hydro were started during IP1 and continued during the next implementation phases. However, many of these plants are subsidised by "Tariffa onnicomprensiva" which can be compared to a fixed feed-in tariff. The "Tariffa onnicomprensiva" does not allow trading activities since all electricity is directly sold to GSE. In case operators of such plants like to use the services of Centrali Next, they would need to leave this scheme. An example of a scheme that can foster market integration, is a sliding market premium model.

5.1.4 Implementation phase 2

Expansion

NKW DE reports that there has been successful customer acquisition in IP2 and that it is trading an additional 60 MW of wind power. This brings the total portfolio to around 127 MW. The BM is still labelled *expansion* as there has been no acquisition in other customer segments (biogas, hydro, CHP).

While in 2017 (IP1) there were some major changes regarding the intra-day market and imbalance settlement, there were no legislative changes during IP2. This means that during IP2, NKW DE focused on keeping its portfolio operational.

5.1.5 Implementation phase 3

Mature

During IP3, significant acquisition was reported. The BM's portfolio consists of PV, wind and hydro/biogas with a total portfolio size of around 400 MW. For these reasons, the BM is labelled *Mature*.

NKW DE gathered more experience concerning the prices in the different zones during IP3. It reports that this was crucial since autumn is the most important sales season. The company was able to triple its portfolio for 2019, with many contracts starting in the beginning of that year. Besides wind and PV, also additional hydro and biogas plants were added to the portfolio. This confirms that the company is able to propose competitive offers in the Italian market.

Another focus during IP3 was to further improve the client portal and automatize the trading processes. As discussed above, in Italy it is necessary to create bids not only on a portfolio level, but per individual unit. Practically this means that forecasts are created on a per-unit basis. In case the live production data and the updated weather data indicate a deviation from the forecast, the day-ahead bids are corrected on the intra-day markets. The automatization of this correction process was ongoing during IP3.

5.1.6 Case study

The concrete implementation of this BM is shown through a case study of a PV installation in NKW DE's portfolio. The data is modified for confidentiality reasons. Figure 21 shows the differences between the day-ahead forecast, based on which bids are made on the day-ahead market, and the actual production infeed during a particular week in summer. In case the deviation between the day-ahead forecast and the actual production would not be mitigated, imbalances would occur, as shown in Figure 22. In the considered period, the imbalance without corrections would roughly cost 0.95 €/MWh. By continuously

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updating its forecast based on real-time data and weather forecasts, Next Kraftwerke is able to reduce the related imbalance costs.

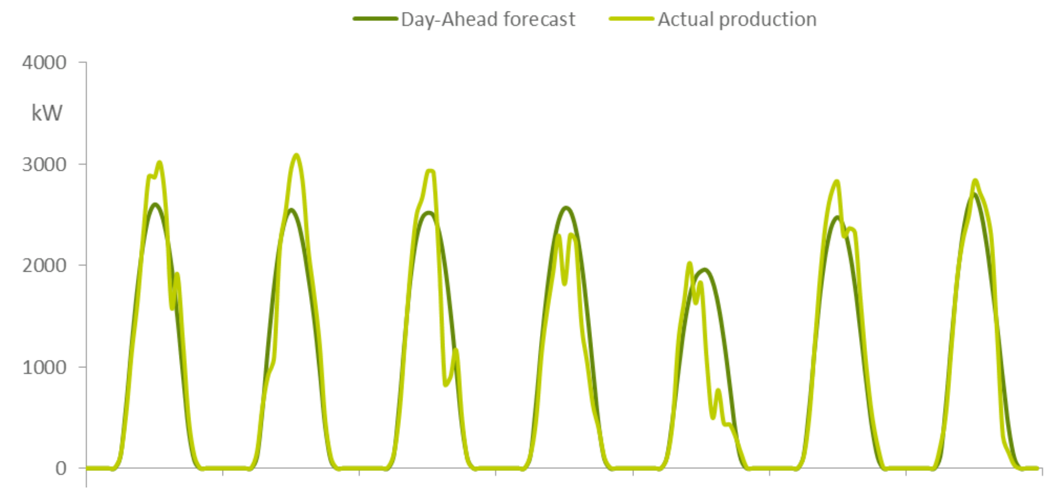

Figure 21: Production forecast and actual production

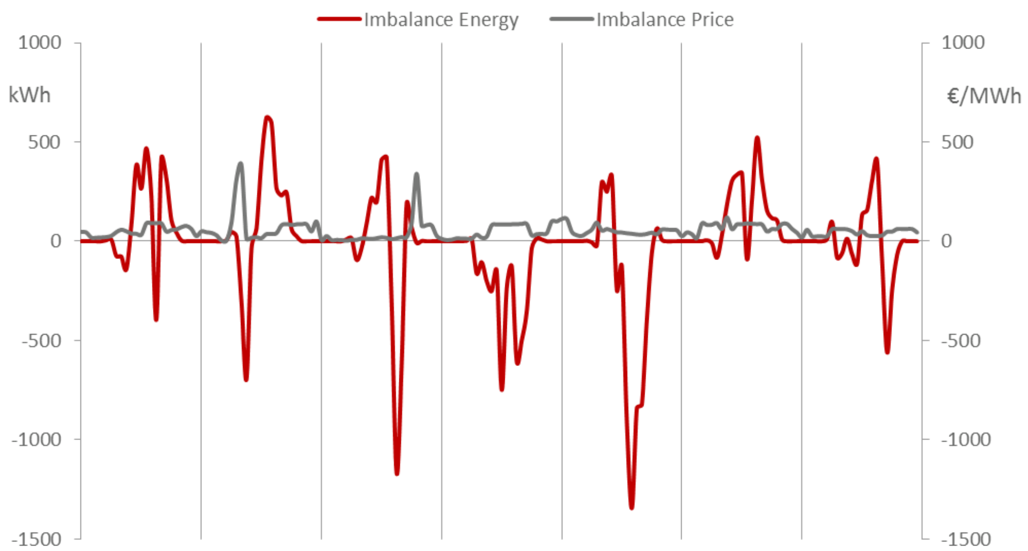

Figure 22: Imbalance energy and imbalances price

5.1.7 Outlook

NKW DE is keen to further grow within this market after the project is finished. The implementation success the company has achieved during the BestRES trial is an indicator that this BM has a lot of potential in the Italian market.

5.2 Market renewables on balancing markets (BM4)

NKW DE's third business model in the BestRES project is marketing renewable energy sources on Italy's ancillary services market (MSD - Mercato per il Servizio di Dispacciamento). Historically, MSD was only accessible to large thermal power

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plants. However, the market has been opened and it is now possible for distributed generation and consumers to aggregate in Enabled Virtual Units (UVA) to participate in MSD.

5.2.1 Implementation plan

The implementation plan is shown in Figure 23. Developing the technical feasibility of the pricing model and data management is scheduled in February 2018. Repetitive assessments of the pricing, compatibility with subsidies and competition are planned periodically every six months, starting in January 2018.

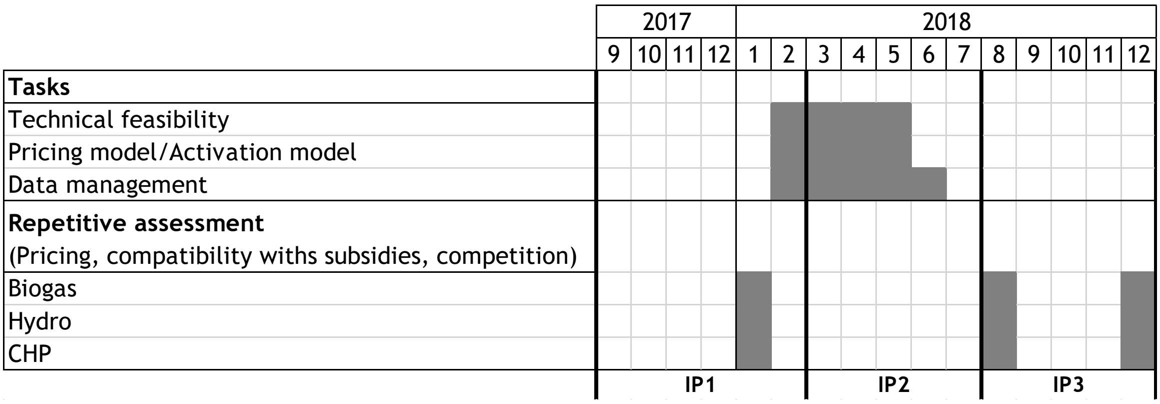

Figure 23: Implementation plan BM4 (NKW DE)

5.2.2 Implementation targets and monitored KPIs

The September 2017 targets are shown in Table 13. The initial expectations for the growth of the BM are lower than for the other two NKW DE BMs. This is because the commercialisation of the MSD market is still ongoing. It is expected that 5 MW of CHP/Demand response will be acquired by the end of IP1 and 10 MW by the end of the BestRES project.

Table 12: Target KPIs September 2017 BM4 (NKW DE)

	IP1 February 2018	IP3 December 2018
KPI 1 (economic KPI) Portfolio size *Biogas *Hydro *CHP/demand response	 0 MW 0 MW 5 MW	 0 MW 0 MW 10 MW

Table 13 gives the actual implementation KPIs as reported by NKW DE throughout the implementation phase. These KPIs are discussed per implementation phase in the sections below.

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Table 13: Reported implementation KPIs BM4 (NKW DE)

	IP 1 February 2018	IP 2 July 2018	IP 3 December 2018
KPI 1 (economic KPI) Portfolio size *Biogas *Hydro *CHP/demand response	0 MW 0 MW 0 MW	0 MW 0 MW 0 MW	0 MW 0 MW 0 MW
KPI 2 (economic KPI) Flexibility turnover	0 EUR	0 EUR	0 EUR
KPI 3 (economic KPI) breakeven or not	-	-	n.a.
KPI 4 (technical KPI) Balancing capacity offered	0 MWh	0 MWh	0 MWh

5.2.3 Implementation phase 1

Preliminary

Table 13 shows the reported KPIs after the first implementation phase. There has been no acquisition yet and the KPIs are all zero. The BM is still in the *Preliminary* phase.

The slower implementation is due to the developments and regulatory changes that took place during IP1. Until 2017, the participation in the daily MSD and MB auctions, through which capacity for ancillary services is contracted, was limited to “relevant units” (> 10 MVA). In May 2017, through the deliberation AEEGSI 300/2017/R/eel, the Italian balancing market was opened to non-dispatchable renewable energy sources and distributed generators (<10MW) as well as storage systems and loads. This includes aggregated portfolios.

The MSD market differentiates between three different types of aggregated portfolios:

- **UVAP** – aggregation of virtual production units
- **UVAC** – aggregation of virtual consumption units
- **UVAM** – mixed consumption and production units including storage

For UVAC, which comprises aggregation of consumption units, the first pilots were set-up during IP1. UVAP, or aggregation of production units, is possible in theory but with the current system for renewable production units it is not attractive: the production units would face high opportunity costs due to missed subsidies in the case of ramping down activities. UVAM, aggregation of mixed portfolios, is currently still under development. Next Kraftwerke plans to further investigate opportunities related to UVAM und UVAP during the next implementation phases.

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An overview of the MSD-Market in Italy is shown in Figure 24.

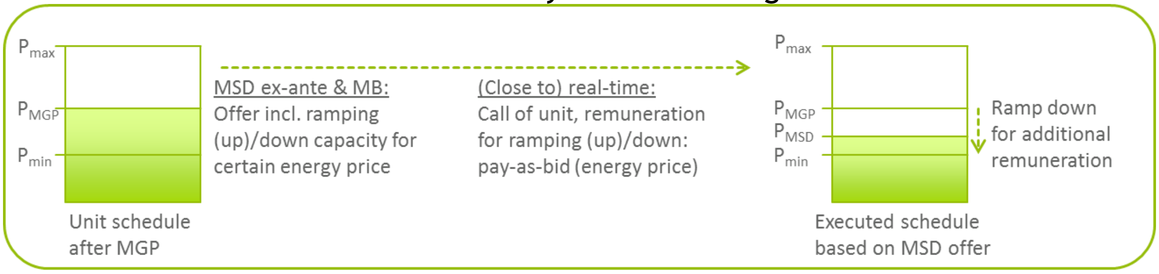

Figure 24: Representation of the MSD Market

5.2.4 Implementation phase 2

Preliminary

NKW DE reports that there has been no customer acquisition in IP2. The KPIs are all zero and the business model is still labelled *preliminary*.

NKW DE had a meeting with Terna to discuss the role that aggregation could play in the provision of ancillary services in Italy. NKW DE realises that the implementation of this BM will require more time than what was foreseen in the BestRES project. However, it is confident that the market will eventually evolve to allow aggregated units to participate in balancing markets.

Recently, Terna published a new consultation with regards to so-called UVAM (Unità Virtuali Abilitate Miste). Before it was only possible to aggregate either consumption units (UVAC) or production units (UVAP). With this new approach, Aggregators can build their MSD-Markets portfolio more flexible. Furthermore, there was an announcement for additional capacity payments for aggregated MSD capacity. NKW DE is currently developing a concrete approach to address these opportunities.

5.2.5 Implementation phase 3

Preliminary

Also, during IP3, this BM was plagued with slow regulatory developments. As a result, at the end of the BestRES trial, the portfolio size is still zero and the BM is labelled *Preliminary*.

Terna’s pilot projects to investigate the future market design for the participation of aggregated assets in ancillary services are still in the planning phase. During IP3, Terna published the requirements for two new pilot phases. The participation will be tendered and the aggregator with the lowest availability fee will be selected. The tendering takes place in the beginning of 2019 and in March 2019, which is after the end of the BestRES trial. NKW DE is in ongoing discussion with potential clients and has planned its technical set up for the

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market. The company foresees to enter the trials briefly after the last implementation phase of the BestRES project.

5.2.6 Case study

The potential market value of this BM is analysed through a retrospective case study of 500 kW average upward flexibility in the MSD Market in 2017. The case study aims to provide market insights in the Italian MSD market. The result is a plot that maps several market parameters, shown in Figure 25. The prices for activation are plotted on the x-axis, and the historical activated hours for each activation price are plotted on the secondary y-axis. The corresponding revenue, the total activation cost, and the contribution margin for the 500 kW upward flexibility are plotted on the primary y-axis. The specific activation cost of the studied flexibility is 80 €/MWh. To illustrate, 120 €/MWh creates a margin per MWh of 40 €/MWh. In 2017, the average price for upward flexibility in the pricing northern zone was above 140 €/MWh for 831 hours. In case the flexibility would be activated in all 831 hours, it could create a total revenue of roughly 60 000 €. The activation costs in this scenario would be around 33 000 €.

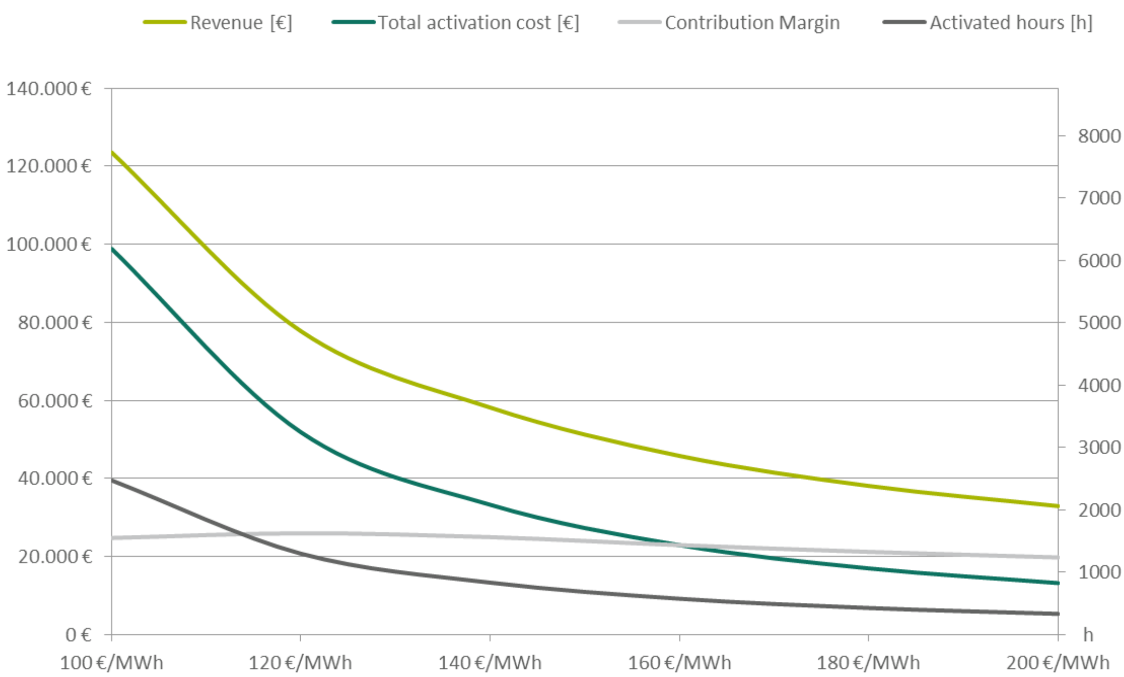

Figure 25: Market analysis of the Italian MSD market[3]

5.2.1 Outlook

NKW DE is eager to enter the balancing markets in Italy and is willing to further develop this BM after the project ends. The company realises that the market opening happened slower than it expected, though it looks positively the process moving in the right direction.

[3]Data publicly available at http://www.mercatoelettrico.org/En/Esiti/MSD/MB_PAltriServizi.aspx

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 691689.

6. Implementation of the improved business models of Next Kraftwerke Belgium (Belgium)

6.1 Trading PV and wind power (BM5)

As part of its first BM, Next Kraftwerke Belgium (NKW BE) trades PV and wind power on the different power markets in Belgium. The company is active on the day-ahead and intra-day markets. The assets in its portfolio are connected in a virtual power plant that collects large amounts of data from the renewable sources. The company's algorithms use this data to optimally trade the generated electricity and the available flexibility. A complete overview of this BM is given in report "Improved Business Models of Selected Aggregators in Target Countries" of the BestRES project" [1].

6.1.1 Implementation plan

The implementation plan is shown in Figure 26. A price analysis on the different markets (Day-ahead, Forward, OTC, etc.) is planned at the end of 2017. The offer is designed simultaneously and target companies in Belgium are listed and identified. The advertising campaign is launched in the beginning of 2018.

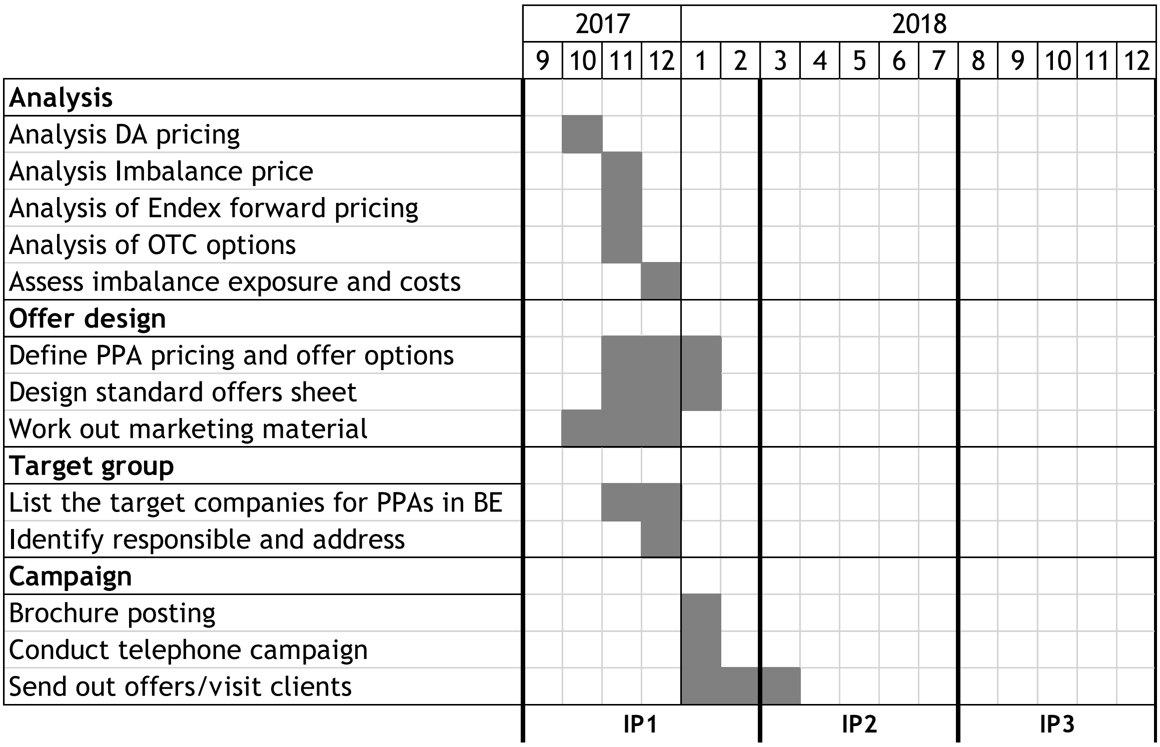

Figure 26: Implementation plan BM5 (NKW BE)

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6.1.2 Implementation targets and monitored KPIs

The target KPIs that were defined in September 2017 are shown in Table 14. NKW BE targets to have a gradual increase of PV units in the portfolio throughout the BestRES trial to more than 10 MW in IP3. The acquisition of wind is planned to take off in the third implementation phase.

Table 14: Target KPIs September 2017 BM5 (NKW BE)

	IP1 February 2018	IP2 July 2018	IP3 December 2018
KPI 1 (economic KPI) Portfolio size * PV * Wind	0-5 MW 0 MW	5-10 MW 0 MW	>10 MW 0-10 MW

Table 15 gives the actual implementation KPIs as reported by NKW BE throughout the implementation phase. These KPI's are discussed per implementation phase in the next sections.

Table 15: Reported implementation KPIs BM5 (NKW BE)

	IP1 February 2018	IP2 July 2018	IP3 December 2018
KPI 1 (economic KPI) Portfolio size * PV * Wind	0-10 MW 0-10 MW	50-100 MW 100-150 MW	>100 MW >100 MW
KPI 2 (economic KPI) Annual turnover * PV * Wind	0 k€ 0-100 k€	0-100k€ 0-100k€	0-100k€ 0-100k€
KPI 3 (economic KPI) breakeven or not	-	-	Yes

6.1.3 Implementation phase 1

Expansion

The KPIs for the first implementation phase are shown in Table 15. The portfolio can be broken down into PV and wind. In both cases the value for IP1 is between 0 and 10 MW, which follows the targets that were set out in September in 2017. For PV, NKW BE has one client with a relatively small installation (<1 GWh of production per year). There is however no self-consumption, which means that all generated electricity is traded. The contract starts in May 2018. For wind, there is a contract with a smaller client (<10 GWh per year) that is part of a

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larger contract in cooperation with an energy supplier. The contract has been signed at the end of 2017. Since there is a significant amount of both solar and wind assets in the BM's portfolio, it is labelled *Expansion* for this IP. The turnover for solar is still zero because the solar contract did not start in this implementation phase. The wind portfolio generates a turnover of between 0 and 100k€ per year. NKW BE is unable to report at this stage whether the BM is break-even. It is however expected that the sites that were contracted during IP1 will break even, since the risk of imbalances is accounted for and hedged in the trading fees.

There were several developments regarding the implementation activities during IP1. At the end of 2017, the brochures for the advertising campaign were made and they were sent out in January 2018 to a list of potential clients. The list of potential clients is partly based on a public list of installations that receive GSCs, composed by the Flemish regulator, VREG. The status of the advertising campaign agrees with the implementation plan described above. NKW BE reports that its offer is in line with the market and in some cases better than contracts offered by competitors. However, NKW BE notes that by the end of IP1, customer acquisition slowed down compared to the initial timeline. During discussions with the first potential clients for a solar power PPA, NKW BE found that the potential clients are not only interested in selling their solar or wind electricity. They are also looking to sell their Guarantees of Origin (GOs), since those cannot be sold to the regulator against a minimum price (as is the case for Green Certificates). NKW BE does not have prior experience with brokering GOs and is working out a strategy. The company contacted a broker and two brokerage platforms to explore different options. The preferred option though is to make a bilateral agreement with one or more energy suppliers, which are looking for GOs from Belgium due to an increasing demand from end consumers to be supplied with local renewable energy. Such an arrangement would result in as little administrative burden as possible for NKW BE. Until a final decision is made, no new potential clients are being contracted.

After it has resolved this issue, NKW BE indicates that it will continue to primarily target solar installations, and in a second phase, also wind installations. The installations should fulfil the following requirements:

- Installed solar capacity (without local consumption): >500 kW
- Installed wind capacity (without local consumption): >1 MW
- In case there is local consumption, NKW BE will decide on a case-by-case basis. The amount of energy that is net injected in the grid, as well as the predictability of the onsite consumption, are important. If these cannot be predicted accurately enough, the imbalance risks cause higher risks on the spot markets and as a result, a higher trading fee has to be charged. This can make NK's offer less competitive.

The requirements regarding the size are based on the fixed costs that NKW BE faces when integrating a unit in the next Pool. These costs include setting up a production data interface, staffing the 24/7 trading team, invoicing and administration and customer service for questions and information. If an

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installation is too small, then the revenue would not be able to cover all the costs.

NKW BE intends to first target installations in Flanders, because of the language and its better knowledge of the green power certificates (GSC) and GO system (In Belgium, GSCs and GOs fall under the regional authority). The company furthermore identifies that it has a larger business network in Flanders.

6.1.4 Implementation phase 2

Expansion

The project KPIs for the second implementation phase are given in Table 15. The portfolio has grown to between 50-100 MW for PV and 100-150 MW for wind. This is a significant increase from the last implementation phase, which shows that the implementation is progressing well. The BM is labelled as *Expansion*. The revenue for each technology lies in the range of 0-100k.

In IP1, NKW BE identified that customers of this BM are also looking for the option to take over guarantees of origin as part of a PPA. NKW BE convinced the German team to invest in market access to these commodity markets. Prices for GOs in both Belgium and Netherlands are on the rise, since a lot of consumers demand from their supplier to supply local renewable energy. If these suppliers cannot fulfil the demand with their own renewable production park, they must buy the guarantees of origin on the market. The rising prices make trading in the guarantees more appealing than was the case before. Until recently, the very low prices meant it was not profitable to spend human resources to follow-up and trade in these markets. NKW BE however reports that trading electricity on power markets still brings in far more revenue than the GOs.

In IP2, NKW BE participated in a tender to trade part of a 600 MW wind portfolio. The company was invited to participate in the final selection round because of its competitive offer for short term trading. However, the customer additionally wanted to secure payback of its investment even when, on the long-term prices, in the electricity markets drop significantly. This requires long-term hedging securities including risk premiums for which in-depth financial risk assessment is necessary. As an aggregator whose strengths are short-term valorisation on spot markets and imbalance optimization, long term hedging is outside the scope of NKW BE's current operations and the company was therefore not selected. NKW BE reports that this long-term hedging issue shows up at several large-scale tenders and that it is actively looking for a solution. The company will collaborate with a financial institution to be able to offer a long-term product.

At the end of June 2018, one of the major balance responsible party (BRP) in Belgium found itself in financial difficulties. This BRP was specialized in managing the balancing obligations of other market parties, which it did for several smaller Belgian suppliers. A BRP is responsible for nominating injection and offtake volumes towards the grid operator for electricity access points (EAN) within the portfolio it manages. This task is primordial in the unbundled

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electricity market. Therefore, on a very short notice, clients of this struggling market party needed to look for a replacement before it would effectively file for bankruptcy. NKW BE is a registered BRP in Belgium and already manages a portfolio including several suppliers. The company reports that it required a lot of development in previous years to set-up this branch of the business, and that this BRP crisis was the perfect moment to scale up this service. NKW BE offered clients to take care of portfolio forecasting, BRP-management, and trading. It hence includes the business model under discussion. The company was successful in closing new contracts with several small Belgian suppliers. Most of them are renewable energy suppliers with biomass, wind, and solar farms, which NKW BE is now forecasting and trading. Due to the take-overs, NKW BE increased the managed portfolio of solar and wind with about 200 MW.

6.1.5 Implementation phase 3

Mature

In the third Implementation Period, NKW BE focused on improving the performance of its BRP services for the new clients that joined its portfolio in the wake of the financial difficulties of the Belgian BRP (see section IP2). Due to the urgency of the situation, about 200 MW of solar and wind and 100 000 consumption points were added to NKW BE's balancing group in a single week. NWK BE reports that, as a result, the implementation happened in a hastened manner, which led to small issues which had to be eliminated.

A first area of improvement was the accuracy of the solar and wind forecasts. For several clients, no or limited historical injection and offtake data was available to feed into the algorithms at the start of the contract. After a couple of months, enough data has been collected to finetune the predictions and bring them in line with NKW BE's high-quality standards. Secondly, NKW BE improved the data management, reporting, and invoicing. As a result, the clients get both daily and weekly reports with the forecasted power, and final trading results. A scheme of weekly invoicing is set up, to reduce the cash impact for both the client and NKW BE. These improvements have led to positive evaluations by the clients. The aptitude of the NWK BE team to listen to their concerns and requests for new features is appreciated. NKW BE reports that its tailored service has proven to be a successful and unique offer to the market, which allows to combine the trading of renewables in a larger service package.

With the unavailability of 6 out of 7 nuclear reactors during the month of November, the Belgian production park was short of several gigawatts. Since the shortage was unforeseen in the beginning of the year, the Belgian government decided against contracting strategic reserve for the 2018-2019 winter period, a decision that turned out to be unlucky. The government and grid operator Elia set out to find additional capacity and flexibility both in the Belgian system and abroad. Elia, the Belgian TSO, launched a new ancillary product, called R3 Slow Start, which is a last resort reserve power product aimed to unlock demand side flexibility that was not able to fit in one of the existing products because requiring a long start-up time. This can be, for example, an industrial process that needs an hour of preparation before it can be switched off. Such a process would never fit in the existing R3 products, which have an activation lead time of maximum 15 minutes. NKW BE considered this new product but did not see potential for it among the sites of its clients. Given the extremely short timeline to contract and prequalify power, it was also not deemed possible to set up a specific sales campaign for this product. The launch of R3 Slow Start also coincided with the go-live of the Transfer of Energy legislation for some of NKW BE's existing R3 products outside this BM, which in itself created a considerable administrative burden. This is further discussed in BM6.

As a result of the shortage in the market, future electricity prices spiked up for the month of November during September and October, at certain times reaching levels of 250 EUR/MWh. Parties looking to buy power on a short term faced a big financial risk. Especially supplier companies that sell electricity at a fixed price to their clients faced the problem of having to buy power at a far higher price than they can charge their clients. Most suppliers hedge the largest amount of their volume long term to avoid the largest part of this risk.

One smaller Belgian supplier announced it would start decreasing its activities and switching its clients to another player. Although the supplier did not file for bankruptcy yet, it is likely that bad risk management has brought the supplier in financial problems. Since NKW BE took several smaller suppliers on board in the beginning of summer, (due to the bankruptcy of a Belgian BRP, see IP2), there was a risk that one of its own clients would get into financial difficulties. Yet, due to the fact that the NKW BE team did the necessary due diligence before contracting the new clients, it only started up collaborations with financially sound suppliers. They all have a portfolio with enough production to cover their consumption. Hence little must be bought or sold on the market and the exposure to the high price fluctuations during the winter months is quite limited.

6.1.6 Case Study

It was decided, in consultation with NKW BE, that no cases would be produced for this BM.

6.1.7 Outlook

During the implementation of this business model, NKW BE has had the opportunity to try out one of its most successful German products in the Belgian market. It has learned that the market conditions are quite different and require a different sales approach.

Contracting solar and wind farms in Belgium has proven to be a complex process with several barriers:

- Wind farm tenders only take place every few years and PPAs usually have durations of 5-10 years, something NKW BE as a small player prefers not to engage in.

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- Solar farms with a capacity above 500 kW are relatively scarce in Belgium, and installations might not have real-time monitoring of production and/or have one contract for supply and injection.
- There are some specialized trading companies who go in with offers on which they will make losses, just to increase their volume. It is difficult to compete with such parties.

NKW BE identifies that forecasting and trading renewables as part of a larger service package, such as with the roll-out of its BRP services, has proven to be a unique and competitive offer in the Belgian market. This allowed to quickly expand the company's portfolio. This is why it is likely that NKW BE keeps contracting renewables in that way in the near future. In addition, NKW BE sees high potential to apply the same strategy in the rest of the Benelux, which makes this approach scalable.

6.2 Using third party flexibility (BM6)

NKW BE's second BM uses the client's installation to offer flexibility services to the Belgian transmission grid operator on different reserve markets. The choice for a specific market is based on a case-by-case basis depending on the technical constraints of the installation. The aim is to generate the highest revenues for the client. A complete overview of the BM is given in the BestRES report "Improved Business Models of Selected Aggregators in Target Countries" [1].

6.2.1 Implementation plan

The implementation plan is shown in Figure 27. There are four main tasks that will take place during the first implementation phase: analysis of the power markets, price definition, development of marketing material and launching the advertising campaign. The analysis of the markets precedes the other tasks. The pricing and marketing happen simultaneously during the final months of IP1. The sales campaign runs on a continuous basis depending on the leads that come in.

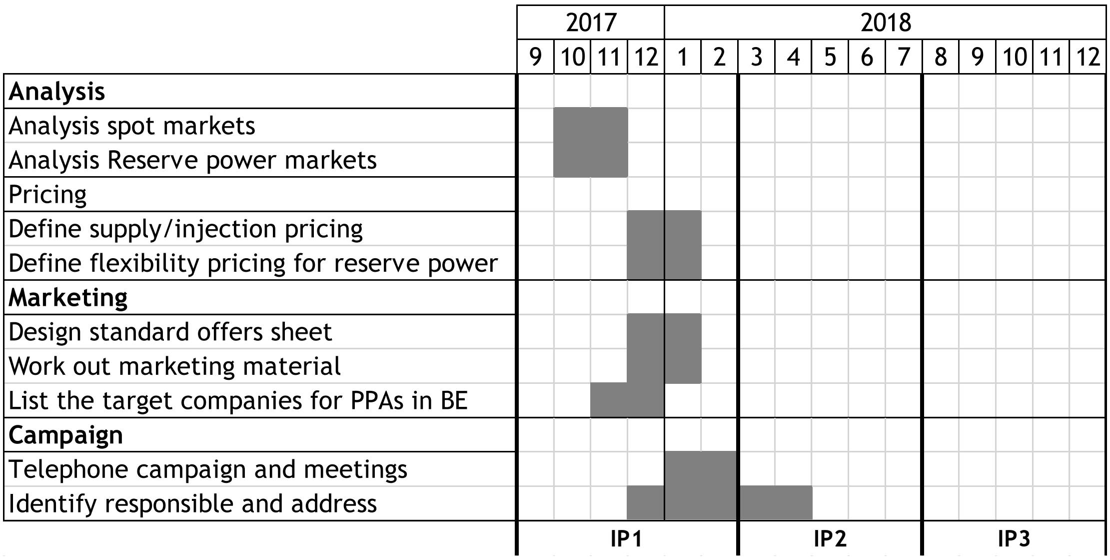

Figure 27: Implementation plan BM6 (NKW BE)

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6.2.2 Implementation targets and monitored KPIs

The September 2017 targets are shown in Table 16. It is expected that the first contracts will start during the second implementation phase.

Table 16: Target KPIs September 2017 BM6 (NKW BE)

	IP 1 February 2018	IP2 July 2018	IP3 December 2018
KPI 1.1 (economic KPI) Portfolio size	0 MW	0-5 MW	>5 MW

Table 17 gives the actual implementation KPIs as reported by NKW BE throughout the implementation phases. These KPI's are discussed per implementation phase in the next sections. All the KPIs are based on values measured directly by NKW BE.

Table 17: Reported implementation KPIs BM6 (NKW BE)

	IP 1 February 2018	IP 2 July 2018	IP 3 December 2018
KPI 1.1 (economic KPI) Portfolio size * Combined portfolio	0-10 MW	0-10 MW	0-10 MW
KPI 1.2 (economic KPI) Portfolio size * Flexibility providers as % of portfolio size	0%	0%	0%
KPI 2 (economic KPI) Turnover	0	0-100k€/year	0-100k€/year
KPI 3 (economic KPI) Break even or not	-	-	Yes
KPI 5 (technical KPI) Successful R3	No	Yes	Yes

6.2.3 Implementation phase 1

Start-up

The values for the KPIs for IP1 are shown in Table 17. While several developments took place in terms of client acquisition for this BM, the portfolio size is zero and all the KPIs are as a result zero. This was foreseen in the September 2017 targets.

In terms of client acquisition, there are several updates that took place in IP1.

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- NKW BE won a project with diesel emergency generators for the delivery of R3flex to Elia. NKW BE notes that this is a new flexibility product for the company, and that it takes a considerable amount of time to finalise the contract and prepare the prequalification of the pool.
- NKW BE agreed to valorise some of a client's assets in R3flex, to complement the diesel gensets and create sufficient redundancy.
- NKW BE won a battery project that will be used to offer R1 to Elia. In January, meetings were held between NK, the battery manufacturer and Elia to verify the technical and regulatory boundaries for the charging strategy that is being developed. The battery will be installed on a site with local wind production and an industrial plant. The aim is to offer R1 balancing power and later on potentially increase the site's self-consumption.

Since many of these are closed or almost closed but the BM has not been formally implemented yet, the BM is labelled *Start-up* for this IP.

An important issue in the development of flexibility activities in Belgium for independent aggregators is the topic of Transfer of energy (ToE). It applies to the situation where the flexibility of a site is valorised in the balancing markets by a flexibility service provider (FSP) that is not the BRP of the site. The BRP that has the site in its balancing perimeter, denoted as the BRP_{source}, is hence confronted with imbalances when the FSP activates the flexibility. These imbalances result in financial penalties for the BRP_{source}. Currently, this issue is typically dealt with in bilateral agreements between the FSP and the BRP_{source}. Yet, NKW identifies that it is possible that a BRP_{source} poses such harsh conditions that no agreement can be reached. This not only violates the right of each end user to valorise its flexibility and do so with their FSP of choice (a right embedded in the guiding principles of the Belgium energy regulator CREG), it can also limit the amount of flexibility offered to the grid operator.

The current ToE proposal by the CREG and Elia foresees a regulated fall-back solution in case no bilateral agreement between the FSP and the BRP_{source} can be struck. NKW BE considers this a good improvement and supports this initiative. Yet, in the current proposals, only access points (individual EAN codes) with net consumption are considered and all sites with net injection do not fall under the ToE framework. NKW BE notes that this unnecessarily limits flexibility to (net) demand sites and creates an unfair playing field in the sector. Furthermore, the company find that this limitation creates a grey zone of regulation.

NKW BE assumes that CREG and Elia have limited their proposals to net consumption access points, because in the updated energy law (July 2017) flexibility is only defined as demand-side flexibility. This one-sided definition has already been addressed by NKW BE and other parties before, yet the company has the feeling that its concerns fell on deaf ears at the cabinet of the Belgian federal minister of energy Marghem. Nonetheless, in its opinion, since the energy law simply omits and does not explicitly forbid production flexibility, CREG and Elia could include net injection points in the ToE proposal without violating the energy law. NKW BE voiced these concerns during the public consultation round

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from the CREG and Elia and developed a broader definition of flexibility to be included in the ToE proposal.

Furthermore, NKW BE advocates the inclusion of so-called pass-through contracts in the rules for ToE. Already before the discussion of the ToE started, several flexible grid users (both with injection and offtake) worked out so called pass-through contract arrangements. The pass-through contract arrangement can be described as follows:

- The grid user himself nominates (communicates) a fixed consumption/production profile to the BRP_{source} before real-time – typically before gate closure time of the day-ahead market.
- The grid user bears all financial consequences of the imbalances (difference between nomination and metered offtake/injection) typically at the imbalance price and an additional fee.

This arrangement allows the grid user to divert from any nomination made, for instance to react on imbalance prices or provide reserve power, without causing financial harm to its BRP_{source}. The flexibility can be controlled either by the grid user himself or via a contracted FSP. In the latter case there is no need for an agreement between the FSP and the BRP_{source} anymore. This has the additional advantage that the identity of those parties remains confidential.

6.2.4 Implementation phase 2

Start-up

The KPIs for IP2 are given in Table 17. While in IP1, the portfolio size was still zero since none of the signed contracts had started, the portfolio in IP2 has increased to a capacity <10 MW. NKW BE reports that it is active on both R1 and R3, though it is not possible for the company to give a breakdown between the different markets. As there are a limited number of participants on the Belgian reserve markets, this is very sensitive information. While the BM is clearly expanding, it is still labelled *Start-up* because of the limited portfolio size.

Since the beginning of July 2018, NKW BE is operating a battery on the Belgian FCR market. Besides continuous delivery of FCR power to flatten out frequency deviations, part of the battery is used to increase self-consumption of the locally produced wind power by the factory on site. NKW BE developed an innovative way to combine different assets with the battery, to ensure the battery can deliver power in the inner frequency band around 50 Hz (fluctuations lie in the ± 100 mHz band for about 95% of the time) and less stable and somewhat slower assets in the outer. Biogas units have already been contracted to fill these bands. This allows to offer overall more FCR volume to grid operator Elia and increase revenues.

Three gensets were prequalified for the R3 product in July. This allowed NKW BE to participate in the R3 tender for September 2018, which took place on the 16th of August. From then on, NKW BE provided R3 flex for the first time. However, NKW BE reports that prices have been going down during the first half of 2018,

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which makes the turnover for such products quite low. On the other hand, Elia is working on a major revision of the regulation of the R3 product. This will introduce, among other things, a stricter check of offered R3 volumes and harsher penalizations if awarded volume is not available when requested. NKW BE expects that a significant volume will be taken out of the market. This will cause a price increase, at least in the short term.

NKW BE reports an update regarding the ToE. Starting this fall, the new Transfer of Energy rules will apply to aggregators offering R3 power with ‘non-CIPU’ units. As explained in the section above, NKW BE does not support this legislation and is afraid that it will be a barrier to the development of its activities. It created an additional workload for NKW BE during IP2, since the company is no longer allowed to offer R3 with a unit for which it cannot lay down a formal agreement between the supplier, aggregator, and both their BRPs. NKW BE is currently in the process of drafting these new contracts.

6.2.5 Implementation phase 3

Start-up

During the summer and fall months of IP3, NKW BE’s activities were focused on the preparation for the go-live of the Transfer of Energy legislation for the R3 Flex product on the 1st of December. This date also marked the introduction of energy bids for R3 Flex, which have to be submitted daily for every quarter hour. With this change in product design, installations that are activated get an activation remuneration on top of the capacity remuneration.

These two developments took away time from sales activities to grow the pool further. Nonetheless, a number of offers were made, and Next also decided to contract a part time sales person for the Walloon region. The current team has a limited network in French speaking Belgium and focused sales activities mainly on Flanders. The KPIs, shown in Table 17, indicate that there was no significant client acquisition during this IP. The BM is therefore again labelled *Start-up*.

As discussed in earlier reporting periods, the Transfer of Energy framework created a lot of additional administrative work for NKW BE in the implementation of this BM. New contracts had to be drawn up with the energy suppliers of its customers, a series of documents needed to be (re-)submitted to Elia, a bank guarantee to be foreseen etc. All contract work and documentation for the Transfer of Energy framework needed to be finalized and submitted to Elia by the beginning of November, so that NKW BE could participate in the R3 tender for December, which is held mid-November. NKW BE successfully concluded Transfer of Energy agreements with the suppliers of the sites where it has R3 flexibility contracted. Most of the suppliers preferred to work with the same agreement for all the aggregators, to reduce work from their side. Most of them also preferred to stick to the proposed Transfer price formula of the CREG instead of negotiating a custom one.

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NKW BE encountered problems with the bank guarantee formalities requested by Elia. The document template provided by the grid operator was not in line with the expectations of NKW BE's bank and NKW BE voiced these concerns to the CREG, who is responsible for approval of this form. As CREG decided to leave the form as is, NKW DE needed to have several discussions and negotiations before the bank agreed. This caused additional work and delays.

6.2.6 Case study

Since the beginning of July 2018, Next Kraftwerke Belgium operates a 2 MW battery as part of its FCR pool. This means that the battery is used to flatten out frequency deviations in the grid. As a secondary application, the battery is used to increase self-consumption of the locally produced wind power by the factory on site. The focus in this case study is the FCR provision.

FCR, Frequency Containment Reserve, is a European wide ancillary service product which is automatically delivered by selected market parties to counteract the fluctuations of the frequency in the power system in a band of 200 mHz around 50 Hz. When the frequency rises above 50 Hz, there is too much power injected in the grid compared to the offtake. FCR-providing installations will therefore reduce their production or increase their consumption proportionally to the size of the deviation. Vice versa when there is more offtake than injection. A battery providing FCR power will hence charge when the frequency rises above 50 Hz and discharge when it drops below.

Every FCR-providing installation should be capable of delivering its full FCR power for half an hour in one direction (either increasing or decreasing its production/consumption), which would happen in case of a grave disturbance in the European grid frequency. To do so, the battery needs to keep its state of charge (SOC) around its midpoint, i.e. stay more or less charged at 50% at all times. Therefore, NKW BE developed a charging strategy which triggers the 'SOC Management Power' when the SOC goes out of a safe band around 50%. This charging strategy is in line with the strict regulations of the grid operator and was approved by Elia before provision of the FCR service with the battery started in July. These regulations make sure operators of energy storage systems do not counteract their own FCR response with their SOC management power.

Figure 28 shows the grid frequency, the battery power output, and the SOC Management Power for one day. Negative power values correspond to charging, positive values correspond to discharging. During the day shown, the battery needed to be discharged 4 times for about half an hour. This is also shown in Figure 29, where it is clear that the battery started discharging when the SOC hit the upper threshold. Note that power values are scaled as if the battery was providing 1 MW FCR.

Since a couple of years, the TSOs of Belgium, the Netherlands, Germany, France, and Austria, organize a common auction where they can tender part of their obligated FCR volume from market players in other countries. This is known as

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the FCR Common Auction. NKW BE bids its FCR power either in the local market or the common auction, depending on where the prices are higher.
In addition, Next Kraftwerke developed an innovative way to combine different assets with the battery, to ensure the battery can deliver power in the inner frequency band around 50 Hz (fluctuations lie in the ± 100 mHz band for about 95% of the time) and less stable and somewhat slower assets like biogas motors in the outer bands. This allows to offer overall more FCR volume to grid operator Elia and increase revenues for the whole pool.

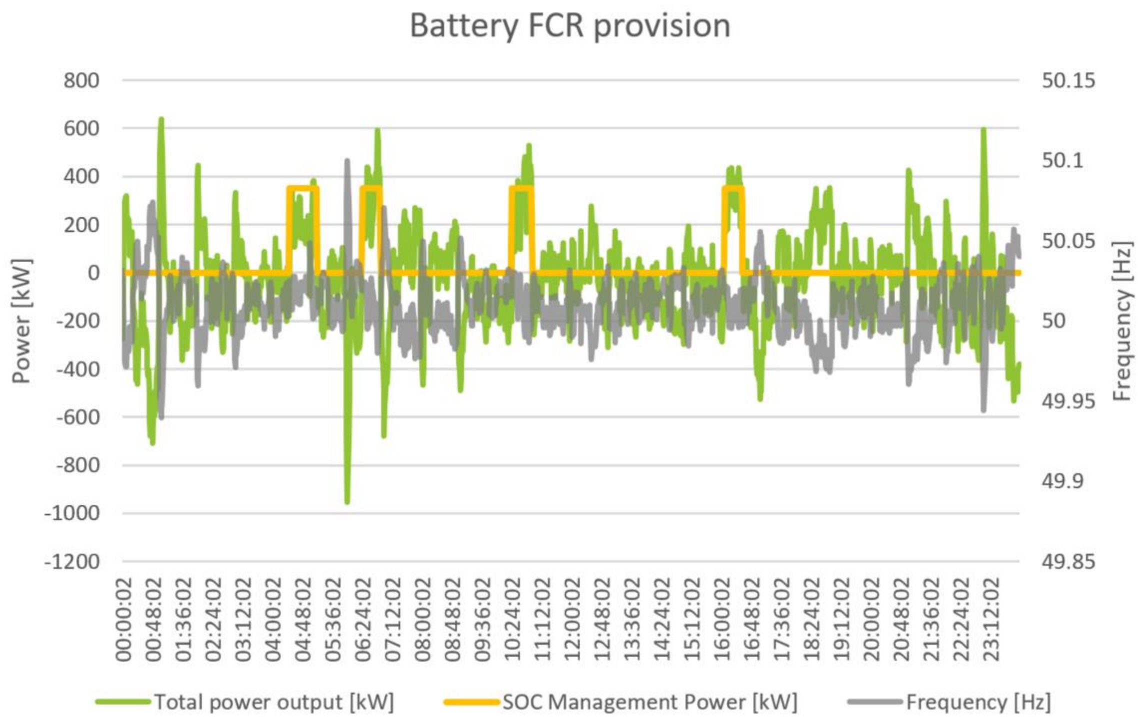

Figure 28: Grid frequency, battery power output, and SOC management power for one day

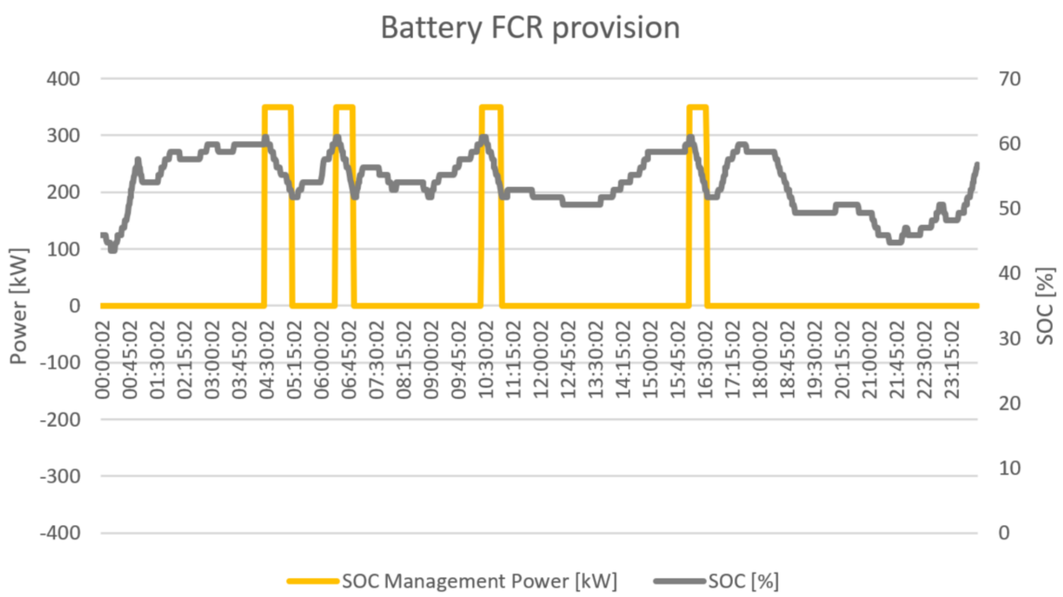

Figure 29: State of Charge (SOC) and SOC power management for one day

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6.2.7 Outlook

NKW BE positively evaluates the results of this business model. It plans to continue to grow its pool of reserve power products with flexibility on sites which fall under a third-party supplier.

With respect to R3, the Transfer of Energy scheme required a lot of time and effort, but once in place it should make negotiations with suppliers easier. In essence, there is now no way for suppliers to block independent aggregators from valorising flexibility on sites that they supply (at least if the sites are net off takers).

NKW BE report that it wants to continue to expand its R3 pool to gain a better position in the market. It is confident that its new part-time sales manager for the Walloon region in the south of Belgium can tap into some not valorised flexibility potential. The company has noticed that there is less competition in Wallonia from other aggregators compared to Flanders.

The implementation of a battery as part of its FCR pool has been a major step forward for the team. A lot of knowledge has been built up around the control, response, and limitations of energy storage devices. NKW BE hopes to use this knowledge in future energy storage projects and has been in contact with several developers over the last months.

Due to the risk profile of energy storage projects, the decision-making process at the investor's side usually takes a long time and so far, no new concrete project has been confirmed. It remains to be seen how scalable energy storage for FCR applications is in Belgium. NKW BE therefore already started looking at the application of batteries in other Belgian markets, such as intraday, imbalance, and R2 markets (in anticipation of its opening in the end of 2019).

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7. Implementation of the improved business models of Oekostrom (Austria)

7.1 Demand side flexibilization of small customers (BM7)

In this BM, oekostrom offers a dynamic Time of Use tariff to its customers. The aim is to incentivise the customers to use their flexibility to shift consumption from the network's times of peak demand to times of off-peak demand. The business model works in two ways. Primarily, oekostrom expects to attract new price-sensitive clients that are interested in a ToU tariff. This allows oekostrom to avoid the cost of client acquisition and address new customer groups. In the long run, the BM allows oekostrom as an aggregator-supplier to source more of its electricity at times of lower prices (off-peak). A ToU tariff forwards part of this reduction to flexible customers as a reduction in the electricity bill.

7.1.1 Implementation plan

The implementation plan is shown in Figure 30. The implementation tasks can be split up in three categories. The first category is the acquisition of pilot customers. To this end, potential customers are identified and contacted via various channels during IP1 and IP2. A survey is conducted to find out their specific needs and the results are used as an input in the other two categories.

The second category consists of the technical data processing setup. This group of tasks depends on the consultation on the DataExchange processes that is carried out by the Austrian DSO. The results of this consultation should be available by September 2017. Furthermore, oekostrom's billing and EDM system is planned to be updated to facilitate the data processing in the BM. These tasks are foreseen to be finished by April 2018.

The implementation of the variable tariff is the third category of tasks. Defining and setting up the tariff concept will run simultaneously with the tasks in the other two categories. It is expected that the tariff is operational by April 2018, by which the first customers are foreseen to be connected.

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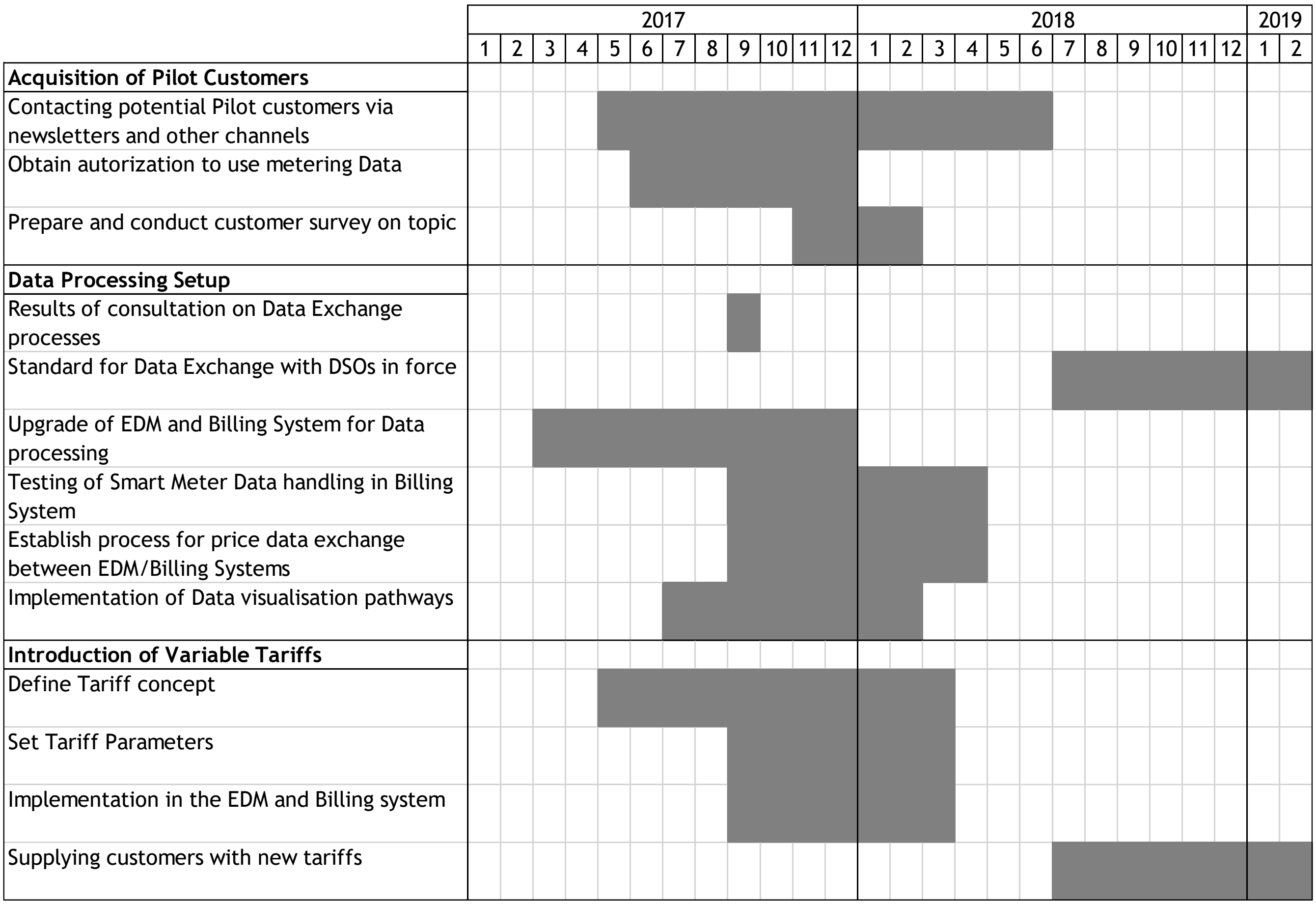

Figure 30: Implementation plan oekostrom BM7

7.1.2 Implementation targets and monitored KPIs

The September 2017 targets are shown in Table 18. In IP1, several of the preliminary tasks are scheduled. The target KPIs are as a result all zero. oekostrom expects that five customers are acquired in IP2. It is targeted that this number grows to 17 by IP3.

Table 19 gives the actual implementation KPIs as reported by oekostrom throughout the implementation phase. These KPI's are discussed per implementation phase in the next sections.

Table 18: Targets KPIs September 2017 BM7 (oekostrom)

	IP1 February 2018	IP2 July 2018	IP3 December 2018
KPI 1 (economic KPI) Number of implemented households	0	5	27
KPI 2 (economic KPI) Portfolio size	0 kW	6.5 kW	35.1 kW

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Table 19: Reported implementation KPIs BM7 (oekostrom)

	IP 1 February 2018	IP2 July 2018	IP3 December 2018
KPI 1 (economic KPI) Number of implemented households	0	0	0
KPI 2 (economic KPI) Portfolio size	0 kW	0 kW	0 kW
KPI 3 (economic KPI) Flexibility turnover	0 k€/year	0 k€/year	0 k€/year
KPI 4 (economic KPI) Breakeven or not	No	No	No

7.1.3 Implementation phase 1

Preliminary

The KPIs for the first implementation phase are shown in Table 19. As expected in the September 2017 targets, the BM was still in the development phase and the KPIs for IP1 are still zero. The BM is as a result labelled *Preliminary*.

A customer survey was launched in April 2018, which targeted 17 000 existing oekostrom customers who are living in areas with advanced smart meter roll out. Around 1000 customers participated. The survey questions can be found in Appendix A.2. The survey results were still being analysed at the end of IP1 and they will be described during IP2.

oekostrom reports that getting in touch with interested customers was challenging. In a first step, potential suitable customers are identified. Only customers who have smart meters installed can be addressed and this group represents only a small percentage of the company's current customer base. Because the clients may find the BM complex, oekostrom contacts each potential client individually by phone to give a proper explanation. One of the main concerns from the customers is that data security is guaranteed. An additional barrier regarding data privacy is that each customer has to explicitly authorize the grid operator to forward its metering data to oekostrom.

Roughly 20 000 oekostrom customers are within regions of grid operators who have rolled out smart meters already. However, up to now the grid operator only has hourly metering data for around 100 of those customers. 50 relevant customers have been identified and contacted. During IP1, 10 customers gave their authorization for the implementation of the dynamic tariff.

A major barrier for the rollout of this BM is the development of a standardised market-wide data exchange process. During IP1, oekostrom found that the

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regulatory delays hindered the start of the implementation of the new tariff. The regulation on data format and display of consumption data should have been implemented and in force by the end of 2016. However, in 2017 it was still not in force and only then a consultation among the market participants was started. The results of the consultation process were communicated at the end of September 2017. oekostrom reports that during IP1, the data exchange processes were defined and harmonised within Austrian market participants, including those between suppliers and DSOs. The harmonization process is still ongoing. Theoretically the new processes should be in force by June 2018, but a further delay seems likely. The implementation of the interface to other data exchange systems is still being developed.

7.1.4 Implementation phase 2

Preliminary

The KPIs for the second implementation phase are given in Table 19. Due to persistent issues with the data exchange process between oekostrom and the DSOs, the implementation KPIs are still all 0. The BM is labelled *Preliminary* for IP2.

The results of the survey that was conducted in IP1 indicate that about 20% of the participants are equipped with a smart meter. While only 29% have dealt with the topic of time-variable tariffs in the past, around 76% can well imagine the use of a time-variable electricity tariff in the future. The participants indicate three main concerns regarding smart meters and Time-of-Use tariffs:

1. Electricity consumption behaviour could be specifically analysed by the grid operator and the supplier.
2. Suppliers could raise the electricity price at specific times.
3. The risk of becoming the target of a hacker attack would be increased.

The results indicate that there is considerable customer interest in time-of-use-tariffs, which is encouraging oekostrom to put efforts into bringing this business model to the market. However, the participants think that the benefits of ToU tariffs would be small.

During IP2, the design of the time of use tariff has been defined. The tariff consists of the following elements:

- A monthly basic charge
- Power pricing based on the Austrian day-ahead spot prices (www.exaa.at)
- A fixed fee on top of the power price
- Visualisation of consumption and power prices in the customer portal.
- Monthly billing of actual consumption at the realized prizes

oekostrom reports that it was not able to resolve the data communication issues during IP2. oekostrom is currently in contact with several DSOs with high roll-out rates and who are most advanced in the implementation process of the data

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exchange. oekostrom has implemented the new customer process into its own system in February 2018 and was ready to enter the test phase in June 2018.

In June 2018, communication with the most advanced Austrian DSO in the field of smart metering could not be activated due to deficits in the configuration of the corresponding Austrian exchange platforms (Ponton/EDA). In July 2018, oekostrom received the first smart metering data. However, the automated transfer process did not work, and the data transmission process still had to be triggered manually on the DSO side. From August until the middle of September, no further data was sent by the DSO, so oekostrom escalated the issue to the responsible authorities at the DSO level.

In August, a second relevant DSO started to send daily consumption data of selected customers. However, it turned out that the process did not work reliably. For some days, no data was transferred. Consequently, the data quality was still insufficient for a product launch.

Due to the above-mentioned issues, the product could not be launched during IP2. oekostrom foresees that before going live with the actual product, a significant amount of further testing and coordination with the DSOs is necessary.

7.1.5 Implementation phase 3

Preliminary

In September 2018, a third relevant DSO was contacted who is currently rolling out smart meters. However, before starting to implement the exchange process, the DSO tried to delay the process by bringing up legal issues concerning the customers' power of attorney for the access to their consumption data. oekostrom tried to resist this demand, since it finds that a simple, yet clear and unambiguous declaration of consent of its customers for the usage of smart meter data should be accepted by the DSOs. At the end of IP3, oekostrom had a meeting with E-Control, the Austrian Energy Regulator, to discuss the legal issues concerning the customers' power of attorney for the access to their consumption data.

The three Austrian DSOs that were selected for oekostrom's trials were those with the highest percentage of smart meter roll-out and the most advanced in the implementation of the exchange process. With none of these DSOs could a fully automated process be achieved during IP3, because of issues with either data communication, data quality, or data consent. This means that also during IP3, oekostrom has been unable to officially launch its BM. The KPIs are as a result all zero and the BM is labelled *Preliminary*. Oekostrom reported that it plans to talk to the energy regulator to flag the significant problem with the transfer and quality of metering data on the DSO side.

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7.1.6 Case study

The case study for this BM compares oekostrom's *Smart Home* ToU tariff with the fixed-price tariff *oekostrom Family* for five different oekostrom customers based on smart meter data provided by an Austrian DSO. The details of each tariff are given in Table 20. The load profiles that were used for this case study were provided by an Austrian DSO and are representative of the smart meter load profiles that oekostrom receives from its customers.

Table 20: oekostrom's Family and Smart Home tariff

	Oekostrom Family	Oekostrom Smart home
Unit rate	hourly day-ahead spot prices + 0,0119 EUR/kWh	0,0599 EUR/kWh
Monthly basic fee	4,9 EUR/month	4,16 EUR/month

Table 21: Comparison of the tariff Family vs Smart Home

	Customer 1	Customer 2	Customer 3	Customer 4	Customer 5
Consumption (kWh)	13 387	1 627.9	3 079	4 152	10 044.07
Electricity bill "oekostrom Family" (€/year)	840.91	148.69	234.84	296.54	650.36
Electricity bill "oekostrom Smart Home" (€/year)	690.08	148.31	142.12	237.55	442.96
Difference	-22%	0%	-65%	-25%	-47%

The resulting monthly electricity bill for each customer is given in Table 21. Differences of up to 65% are noted between the two tariffs. A visual check of the load profiles, as shown in Figure 31, reveals that the load profiles contain significant errors. Specifically, there are hours with positive and negative peaks, that in some cases can be higher than the total annual consumption. This has a significant impact on the calculation of the electricity bill. Most of the positive peaks have a negative counterpart, which means that the annual consumption is correct and that the *oekostrom Family* tariff remains relatively unaffected. However, it has a strong effect on the *oekostrom Smart Home* tariff.

The results of this case study indicate that the quality of the metering data is not sufficient to use the load profiles for an accurate invoicing of customers.

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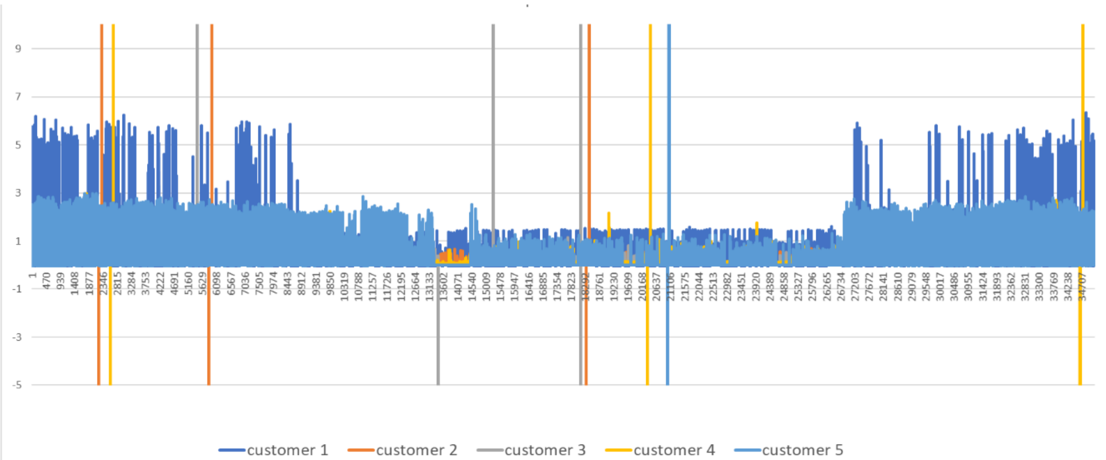

Figure 31: Smart Meter Load profiles (BM7)

7.1.7 Outlook

oekostrom finds that it is taking a pioneer role in the implementation of time-variable electricity tariffs in Austria. While the company had assumed that at the start of the BestRES trial, all of the necessary data services from the DSO would be in place, it found out that the DSOs only started developing these services at oekostrom's request. This is the reason of the experienced delays.

oekostrom is planning to continue to get the automated customer processes up and running with the most relevant Austrian DSOs. On the long run, the company's goal is to implement automated customer processes with all Austrian DSOs.

When the daily exchange of the metering data is up and running with the first DSO, oekostrom will start testing an automated bill run on a monthly basis for at least two or three months with the data of some test customers. If the test is positive, in a next step, the company will launch the time of use tariff in the grid of this DSO. This way oekostrom rolls out its dynamic ToU tariff step by step in all regions of Austria.

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8. Implementation of the improved business models of EDP (Spain and Portugal)

8.1 Activation and marketing of end user’s flexibility (BM8)

The business model implemented by EDP Portugal entails the activation and marketing of the flexibility of end users. It is described in detail in the report “Improved Business Models of Selected Aggregators in Target Countries” of the BestRES project” [1]. EDP provides installations of some of its large office buildings, industrial and agro-industrial customers with price signals that are used to control the customers’ electricity consumption. This flexibility is used to lower the imbalance cost and electricity sourcing cost of EDP’s entire portfolio. The customer, who is the flexibility provider, receives a remuneration for the offered flexibility. The offered flexibility is only from the demand side, production is not considered.
The Portuguese demonstration and evaluation of the BM activities is organised by CNET in cooperation with EDP Comercial (EDP’s retailer). It is part of a larger DSM development and demonstration project that falls under the Plan for the Promotion of Efficiency in the Electric Energy Consumption, financed by ERSE, the Portuguese Energy Services Regulatory Authority.

8.1.1 Implementation plan

The implementation plan is shown in Figure 32. From November 2017 to April 2018, EDP focuses on three tasks: specifying and developing the solution that will be offered, recruiting interested applicants and analysing and selecting the consumers that are most suitable for trial. It is foreseen that by the end of April 2018, the software and equipment will be acquired and installed on the customers installation. It is however not expected that all customers will participate from the beginning; additional customers can join after the trial has started. The demonstration period starts after the connection of the first customer, which is foreseen in May 2018. The trial runs for several months and is concluded by an evaluation period during which the results are evaluated.

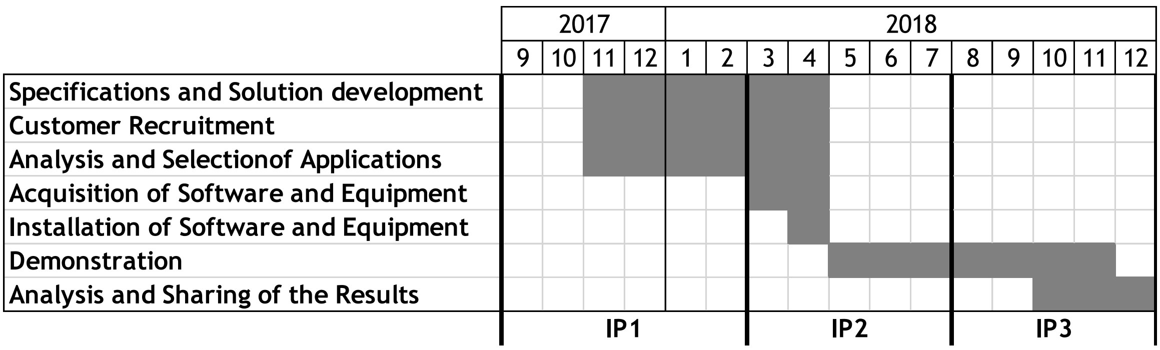

Figure 32: Implementation plan BM8 (EDP Portugal)

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8.1.2 Implementation targets and monitored KPIs

The targets that were set out by EDP Portugal in September 2017 are shown in Table 22. EDP does not foresee to have any customers during the first implementation phase. During IP2, it expects to connect 3 customers and plans to have 5 by the end of the trial. In its forecast, EDP expects each customer to have a capacity of 29.4 MW and an annually amount of shifted load of 610 MWh (KPI 2 and KPI 5). The annual revenue per customer is foreseen to be 12k€/year, which results in an expected revenue of 36 k€/year for IP2 and 60 k€/year for IP3. Because of the large up-front investment for the implementation of the BM and the limited number of expected customers, it is not expected that EDP will run break-even by the end of the 18-month trial.

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Table 22: Target KPIs September 2017 BM8 (EDP Portugal)

	IP 1 February 2018	IP 2 July 2018	IP 3 December 2018
KPI 1 (economic KPI) Number of controlled customers BM	0	3	5
KPI 2 (economic KPI) Capacity of controlled customers	0 MW	88 MW	147 MW

Table 23: Reported implementation KPIs BM8 (EDP Portugal)

	IP 1 February 2018	IP 2 July 2018	IP 3 December 2018
KPI 1 (economic KPI) Number of controlled customers BM	0	1	1
KPI 2a (economic KPI) Capacity of controlled customers	0 MW	0.625 MW	0.625 MW
KPI 2b (economic KPI) Annual consumption of controlled customers	0 MWh	1511 MWh	1511 MWh
KPI 3 (economic KPI) Revenue from flexibility	n.a.	n.a.	1660 €/year
KPI 4 (economic KPI) Breakeven or not	-	-	Yes
KPI 5 (technical KPI) Avoided imbalance	0 MWh	3-4 MWh	3-4 MWh

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8.1.3 Implementation phase 1

Preliminary

The reported KPIs for IP1 are shown in **Fehler! Verweisquelle konnte nicht gefunden werden.**. As foreseen in the 2017 targets and the implementation plan, no customers were acquired during this IP and all the KPIs are thus zero. The BM is therefore labelled *Preliminary* for IP1.

During this IP, EDP's R&D centre CNET performed a benchmark of the existing flexibility solutions on the market. It made a comparison of 7 different demand response strategies based on the profile and specifications of the solution. This benchmark was an important step in the design of EDP's own solution.

Figure 33 presents the architecture of EDP's proposed flexibility infrastructure. The grey blocks already exist in the company's platform, while the green ones are currently being updated or under development. All development happens internally in EDP. The VPP has a central node where flexibility offers are calculated and sent to the client's local agent (HW/SW). This agent decides on its own, according to pre-defined conditions and the state of the client's activity and consumption, if the flexibility offer is accepted or not. Communication protocol compatibility, data transfer and control are handled on a case by case basis. Depending on the customers installation, either there will be an integration of the existing control system, or, in the case of a smaller asset, there can be direct actuation without integration.

Several advances were made in terms of customer acquisition during IP1. EDP Comercial launched a website to inform the potential clients about the BM. Furthermore, the flexibility services are being integrated in the usual commercial activities of EDP. This means that it is part of the general set of services that is proposed to large clients during the business development process. During IP1, there were several applications submitted by industrial and agro-industrial clients. A technical committee evaluates these applications monthly and the customers that comply with the project rules receive a visit from a team of technical experts. The results of the technical visits are assessed, and all customers are classified according to their flexibility potential and economical rational (expected revenues vs costs). The number of customers selected is limited by the available budget.

In terms of the contractual agreement, EDP and the clients sign a standard service contract, allowing EDP to manage the clients' flexibility. The service consists of providing the customer with a price signal, similarly to a bid and offer system, but it does not include the direct control of the installation. As a result, the clients benefit from reduced energy costs by shifting loads from more expensive energy periods to cheaper ones and from the limitation of peak load.

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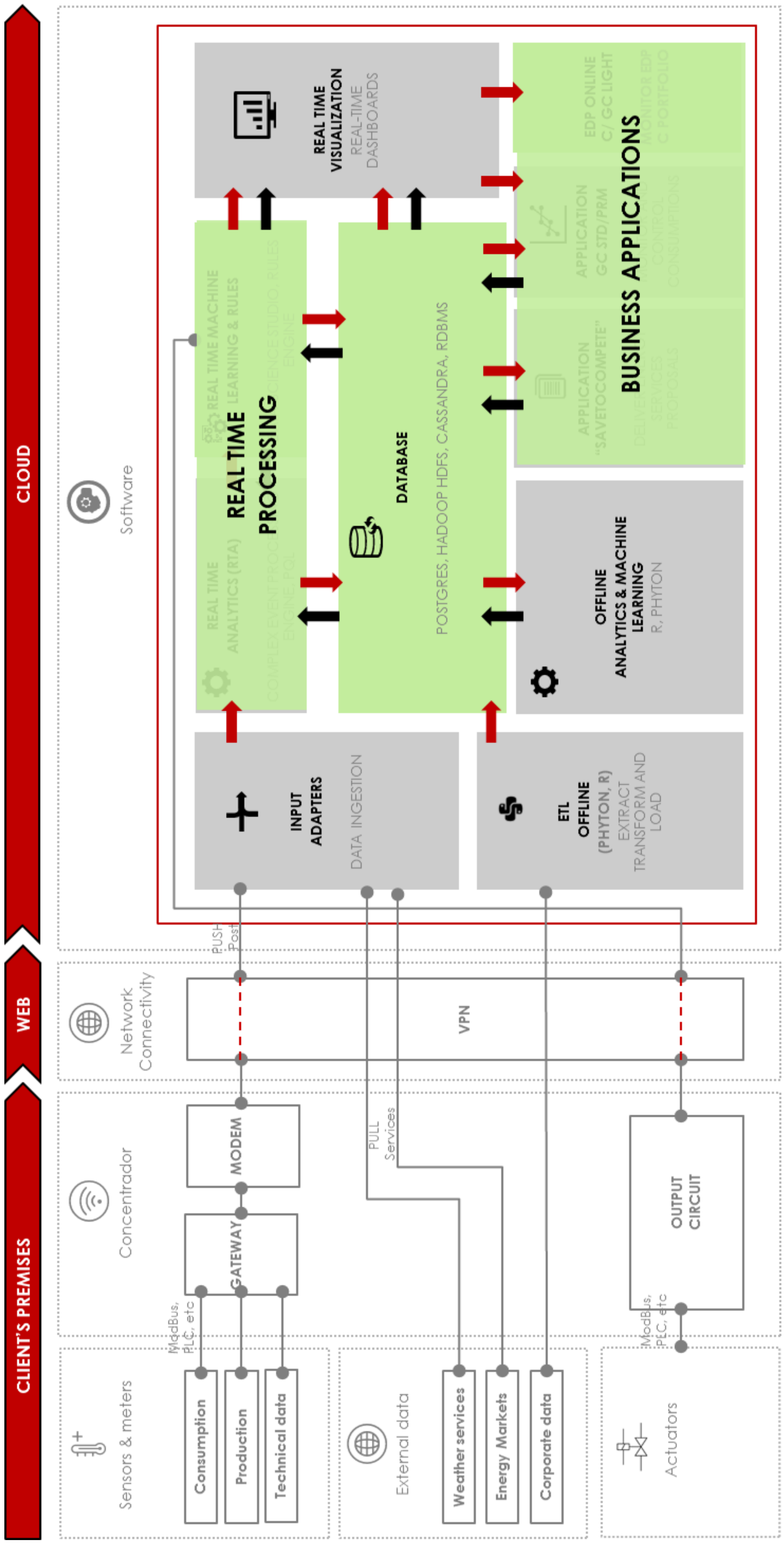

Figure 33: Block diagram of EDP's aggregation infrastructure

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8.1.4 Implementation phase 2

Start-up

During the monitoring phase of IP2, a slight deviation related to this BM was identified compared to the original implementation plan. The targets for August 2018 and December 2018 were to respectively contract 3 and 5 clients. However, some of the potential clients that were identified by EDP during IP1 can no longer take part in the BestRES project. These clients would have been provided by the National Portuguese Program PPEC (Plan to Promote Efficiency in Electric Energy Consumption), which had the aim to run a pilot project on demand response (DR) and demand side management (DSM) technologies for industry and agroindustry companies. However, EDP decided not to continue with the PPEC program and it is therefore not possible to use these clients for the BestRES project. Furthermore, an important barrier to rollout this project to other EDP customers is the lack of real-time metering data. Most of EDP's clients have smart meters, though the DSO only makes the data available one or two days later. This makes real-time control for these clients impossible.

Instead, EDP Comercial has installed its own monitoring and control equipment in an office building that provides DR based on the control of its HVAC systems. The KPIs of this asset are given in **Fehler! Verweisquelle konnte nicht gefunden werden.**. The building has a capacity of 0.625 MW and an annual consumption of 1511 MWh. This is lower than the September 2017 targets. Despite the deviation, the fundamental activities in this BM remain the same. Studying only one client means that the available flexibility is lower, and the outcomes of its activation are less significant considering the portfolio size.

In the considered building, all necessary hardware and software solutions have been implemented to start the monitoring and control. Data is collected using 270 temperature measurement points spread over the 7-story building and local sensors that measure the building's total energy consumption and HVAC energy consumption. This data is fed to a thermal building model. Other inputs to this model are weather data (temperature, humidity, wind speed, sunrise and sunset time, etc.) and the day of the week. The building model uses a neural network to calculate the amount of available flexibility at each moment, as described in the section above. The algorithm models and predicts the electric load of the chiller and validates the results using experimental analysis. EDP is additionally working on a flexibility forecast. In IP2, only the monitoring system is operational. The functionality regarding real-time active control starts in IP3. The control system sends set points to the 270 controllable AC loads that are installed in the building to activate the flexibility. This allows to valorise the available flexibility through imbalance deviations and day-ahead electricity sourcing optimization.

The fixed costs in this BM are due to the procurement of the monitoring and automation equipment, its installation and programming. The total estimated CapEx of the system is 3000 €/building. The variable costs consist of the cost of

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load shifting whenever the flexibility is activated at a client's site. The BM is marketed through an ESCO contract between EDP and the client. EDP is the 'energy manager' of the building and the client receives a share of the value that EDP Comercial is able to create by reducing its overall imbalance and optimize day-ahead electricity sourcing. The quantification of the correct remuneration in terms of €/MWh of activated flexibility was still ongoing during IP2.

8.1.5 Implementation phase 3

Start-up

For IP3, EDP reported that it has continued its pilot project targeting an office building. The KPIs remain the same compared to IP2 and the progress is again labelled *Start-up*. There is around 25 kW of flexibility available in the building that can be activated on average 8 hours per day for 20 days per month. EDP finished its economic analysis and reports that it is remunerated for this system service for approximately 1660 €/year. Part of this revenue is passed on to the client that provides the flexibility.

EDP did not finalise its study of the distribution of the created value. If EDP shares 50% of the remuneration with the customer, there is an annual monetization of 830 €. Considering the CapEx of 3000 € per building, this results in a payback time of 3.6 years.

Besides the financial assessment, EDP carried out a business model analysis that looks at the values involved for each of the parties. This exercise did not yet result in well-structured business models. So far, it has led to a list of potential issues that can arise when the BM is implemented in a commercial context. These issues are listed below:

- The lack of HVAC control systems, and, when they exist, the requirement of a certain level of personalization in the developed automation.
- Difficulty in convincing building owners of the value they could receive from installing this pilot, bearing in mind their fears regarding:
    - Increased complaints from the building population;
    - Failure to comply with contractual elements when certain floors or areas are rented to other entities;
- The difficulty in controlling a whole building via alteration of setpoints and infer the available power in each moment;
- Biasing of the population of the building, where sometimes only the indication that a test will be done in the HVAC system will cause complaints with the population.

8.1.6 Case study

For the case study, EDP provides a graph that shows the flexibility activation and the control signal. This is shown in Figure 34.

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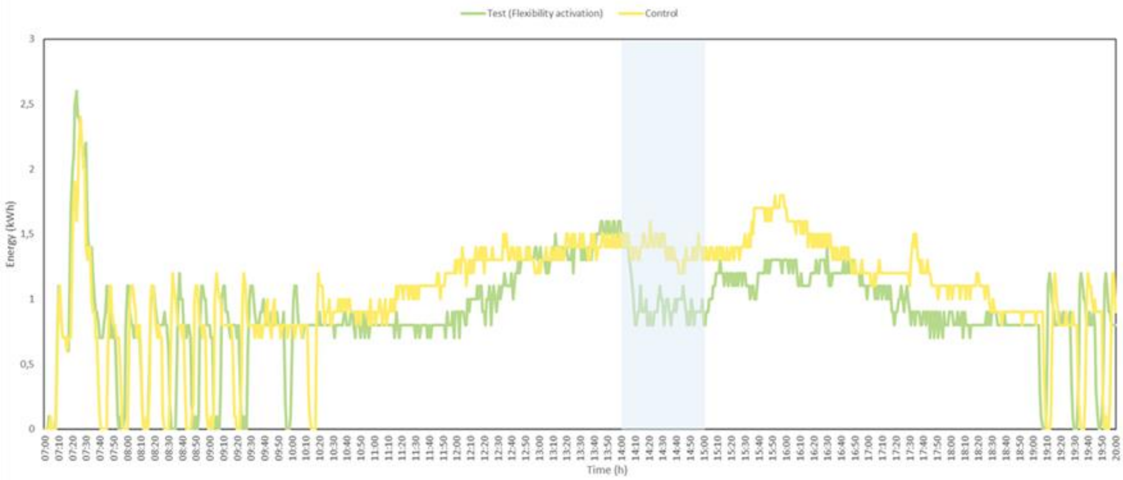

Figure 34: Case study for BM8

8.1.7 Outlook

At the end of IP3, EDP Comercial is implementing the pilot in a second office building. After a successful implementation in the building, the company plans to implement the pilot in other office buildings in more cities around Portugal. The aim of these pilot projects is to prove that it is technically possible to activate flexibility in buildings in different climates. Expanding the BM to Spain is an option. However, EDP reports that as long as the Spanish markets for grid services are not liberalised to include non-production units, there are no concrete plans to start activities in Spain.

9. Conclusion

The aim of the BestRES implementation period was to evaluate the performance of the BestRES aggregation business models in a real-life pilot project. The implementation of each of the business models was monitored and evaluated over an 18-month implementation period, during which periodic reporting occurred.

Figure 35 shows the implementation progress that was made for each of the BMs. Due to the wide variety in business models, a common evaluation framework is unable to capture the detailed progress that was made during the BestRES trial. While some BMs, such as the BMs by Good Energy and EDP, were implemented as innovation trials, others were implemented in a commercial context.

Conclusion remarks for each of the implemented BMs are provided below.

		IP1	IP2	IP3
good energy	Automation and control	Startup	Startup	Startup
NEXT KRAFTWERKE	Supplying mid-scale consumers with time variable tariffs including grid charges optimization	Startup	Startup	Startup
NEXT KRAFTWERKE	Market renewables on spot markets	Expansion	Expansion	Mature
NEXT KRAFTWERKE	Market renewables on balancing markets	Preliminary	Preliminary	Preliminary
NEXT KRAFTWERKE	Trading PV and wind power	Expansion	Expansion	Mature
NEXT KRAFTWERKE	Using flexibility of customers as third party	Startup	Startup	Startup
oekostrom AG	Demand Side flexibilization of small customers	Preliminary	Preliminary	Preliminary
edp	Activation and marketing of end user’s flexibility	Preliminary	Startup	Startup

Figure 35: Implementation progress per BM during the BestRES implementation period

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Good Energy

BM1: Automation and Control (UK)

- Good Energy launched the *Home Innovation Trial* to demonstrate how domestic electricity consumption behaviour can be reduced or shifted through a smart home device that is connected to a mobile app.
- The trial is structured in three phases. In the first phase, *Energy Basis*, a reference consumption profile is created by collecting the customers' baseline electricity consumption. In the second phase, *Energy Awareness*, the impact of primary intervention is identified by assessing the participants' behaviour to real-time information on their electricity consumption and its associated cost. In the third stage, *Energy Attention*, the impact of secondary intervention is identified to analyse participants' responsiveness to unique signals.
- Around 40 households participated in the trial,
- The implementation results show that the BM can influence the electricity consumption of residential consumers. In the case study it is calculated that the load shift can yield £4.20 annual savings per household.
- The *Home Innovation trial* continues after the BestRES project has finished and will assess the potential engagement of the customers through messaging and gamification.

Good Energy was able to gain several insights in residential electricity consumption through its *Home Innovation Trial*. There was a strong focus on customer experience and user interaction. The trial continues and aim to show the potential engagement and direct interaction of the customers through the mobile app.

Next Kraftwerke Germany

BM2: Supplying mid-scale consumers with time variable tariffs including grid charges optimization (Germany)

- This business model aims to add value to flexible supply contracts by considering the impact of both the wholesale price and the capacity component of the grid charges on the customer's electricity bill. An alternative implementation furthermore includes participation on balancing markets.
- In the implementation process of this BM, water pumps are identified as a customer segment with a high potential because most water management processes can be executed in a flexible manner.
- A major barrier in the implementation of the BM is its complexity. The current tariff structure and price trends in the German market are make the BM only viable for a limited number of customers.
- At the end of the BestRES implementation period, the portfolio consisted of 32 MW of water pump capacity.

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Next Kraftwerke Germany identifies that this BM's complexity is the main barrier to its implementation. At the end of the BestRES trial, the company is therefore not planning to continue promoting the BM. However, when the market conditions in Germany improve, they foresee to restart their implementation activities.

Next Kraftwerke Germany

BM3: Market renewables on spot markets (Italy)

- Next Kraftwerke Germany expanded its trading service to the Italian market. The aim of this BM is to maximise the revenue of electricity production by renewable energy sources on the day-ahead market (MGP) and intraday market (MI).
- The main activities during the BestRES implementation period were to adapt the trading processes to the Italian context.
- The contracted portfolio saw a steep increase during the BestRES trial period, with acquisition across different technologies.

Next Kraftwerke Germany's expansion its trading service to the Italian market has been a succes. The BM reaches the maturity stage during the BestRES trial. The portfolio is expected to continue to grow after the BestRES trial.

Next Kraftwerke Germany

BM4: Market renewables on balancing markets (Italy)

- The aim of this BM is to participate in Italy's ancillary services market with an aggregated portfolio of renewable energy sources. Historically, these markets were only accessible to large thermal power plants, though now it is possible for distributed generation and consumers to participate with aggregated portfolios.
- The main activities in the frame of this BM were discussions with Terna, the Italian TSO, on the role of aggregation in ancillary service provision.
- At the end of the BestRES implementation phase, NKW DE was in ongoing negotiations with potential clients to enter Terna's aggregation trials projects.
- Slow regulatory development meant that this BM could not be launched during the BestRES implementation phase. However, NKW DE used the time to adapt its technical set up to the Italian balancing market.
- NKW DE is eager to enter the market and willing to further develop this BM after the BestRES implementation period ends.

Due to a delayed regulatory process, Next Kraftwerke Germany was not able to succesfully implement this BM during the BestRES implementation period. However, it is positive that this will be possible in the near future.

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Next Kraftwerke Belgium

BM5: Trading PV & Wind Power (Belgium)

- In this BM, Next Kraftwerke Belgium trades power from weather dependent electricity sources such as solar PV and wind power on the different power markets in Belgium.
- There was a strong focus on client acquisition during the BestRES implementation period. NKW BE made the strategic decision to diversify its trading services to include other commodities such as Guarantees of Origin. Several events in the Belgian electricity market, such as a bankruptcy of a BRP and a national security of supply crisis, had a significant effect on the implementation activities.
- A major barrier to win large-scale trading tenders was the need for long-term hedging securities. To overcome this barrier, NKW BE planned to partner with a financial institution.
- The portfolio of this BM saw a significant increase during the BestRES trial period. From a portfolio size smaller than 10 MW for both solar and wind, it increased to more than 100 MW in both segments.
- Forecasting and trading renewables as part of a larger service package, as with the roll-out of their BRP services, has proven to be a unique and competitive offer in the Belgian market. This allowed NKW BE to expand its portfolio quickly. It is likely that NKW BE keeps contracting renewables in that way in the near future. In addition, NKW BE sees high potential to apply the same strategy in the rest of the Benelux.

Next Kraftwerke Belgium succesfully launched its trading services in Belgium. By offering these services as part of a larger package that includes BRP services and Guarantees of Origin trading, the company achieved to aggregate a significant portfolio of renewable energy sources.

Next Kraftwerke Belgium

BM6: Using flexibility of customers as third party (Belgium)

- In this BM, the client's installation is used to offer flexibility services to the Belgian transmission grid operator on different reserve markets.
- Next Kraftwerke Belgium reached several milestones during the BestRES implementation period: It managed to successfully participate on the Belgian R3 reserve market and started operating a battery on the Belgian FCR market.
- An important barrier in this BM was the Transfer of Energy rules, which came into effect in Belgium during the fall of 2018. Not only did it create a lot of extra workload for the NKW BE team, it might furthermore hinder market participation of flexibility production units. However, now that it is in place it should make negotiations with suppliers easier.

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- The portfolio saw a steady increase across the different implementation phases. At the end of the trial, the combined portfolio consisted of between 5-10 MW.
- NKW BE foresees to continue to expand its R3 pool to gain a better position in the Belgian market. However, it remains to be seen how scalable energy storage for FCR applications in Belgium are.

The results of the BestRES trial period are positively evaluated. Next Kraftwerke plans to continue to grow its pool of reserve power products with flexibility on sites which fall under a third-party supplier.

oekostrom AG oekostrom

BM7: Demand side flexibilization of small consumers (Austria)

- In this BM, oekostrom offers a dynamic Time of Use tariff to its residential customers.
- A customer survey was carried out to poll the perspective of residential consumers on Time of Use tariffs. The results indicated that there is considerable customer interest in time-of-use-tariffs. However, the participants indicated that they believe that benefits of ToU tariffs would be small. Based on the survey results, the design of the product was finalised. The other main goal during the BestRES implementation period was to make the data processing process operational.
- There were major data communication issues on the side of Austrian DSOs. Both the quality of the data, and the communication between the DSO and oekostrom, was not advanced enough to invoice clients based on that. This was a major barrier for the successful BM implementation.
- As a result of the significant barriers with data communication, oekostrom was not able to officially launch the BM during the BestRES implementation period.
- Nonetheless, oekostrom's outlook is positive. The company is planning to officially launch the BM once the automated customer processes are up and running with the most relevant Austrian DSOs. On the long run, its plans to implement automated customer processes with all Austrian DSOs.

oekostrom took a pioneering role in the implementation of time-variable electricity tariffs in Austria. The company has faced significant barriers regarding the data communication process with the DSO, which prevented it to succesfully implement this BM. However, it is continuing its implementation activities in the future.

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EDP

BM8: Activation and marketing of end user's flexibility (Portugal)

- The business model implemented by EDP Portugal aims to activate and valorise load flexibility of its supply costumers. This is done by providing installations of large office buildings, industrial and agro-industrial customers with price signals that are used to control electricity consumption
- EDP developed a flexibility infrastructure that calculates flexibility offers that are sent to the client's local agent. Its initial plan to contract several customers in the agro-industrial sector did not work; instead the BM was implemented on the HVAC system of a single office building.
- A major barrier in the implementation was the high investment cost for the control infrastructure. Due to a missed subsidy opportunity, the original implementation plan had to be adapted.
- The portfolio, consisting of a single HVAC system, has a flexibility availability of around 25 kW. This is valorised through imbalance optimisation and day-ahead electricity sourcing optimization, which results in a revenue of 1660 €/year.
- EDP plans to carry out more pilot projects across Portugal to assess to what extent it is possible to activate flexibility in buildings in different climates.

EDP implemented a trial project to valorise flexibility in office buildings. The company faces several barriers that prevented it from aggregating a significant portfolio. In the future, it plans to implement the pilot in other office buildings in Portugal

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Appendix

A.1 Invitation letter Good Energy

Version MEDIUM (226 words)

Subject: <Sign up today to our Home Innovation Trial and get a free Verv hub>

Dear <XXX>,

As a valued customer of Good Energy for the past <X> years, we'd love to invite you to take part in our revolutionary nine-month Home Innovation Trial designed to help improve energy efficiency in your home. We will give you a Verv smart hub worth £249 that gives you intelligent information about key appliances and electricity usage in your home. At the end of the trial, you will be able to keep this at no cost.

Interested? Next Steps
- Complete the survey link click here
- If you are suitable to participate we will call you to discuss the trial in more detail
- If you are eligible and like what you hear, we will send you your contract and your very own Verv via special delivery post service
- Install Verv in your home (no electrician required)
- Start taking control of your energy

To get started
Please follow this link to the Home Innovation Trial survey link click here. It should only take you 2-3 minutes to complete. The survey closes on the 23rd of March, however please be aware that we only have a limited number of Verv smart hubs to give to our customers, so we will close the survey sooner if we have enough eligible participants.

Kind regards,
The Good Energy Home Innovation Trial Team

A.2 Survey oekostrom

1. **Has your home already been equipped with a smart meter?**

2. **Are you familiar with the concept of time variable tariffs from past experiences?**

3. **Which of the following statement apply for you? (Independently of how the time variable tariff is designed)**
   - I can imagine using a time variable tariff.
   - I would pick a time variable tariff.

4. **Which of the following statement apply for you? (Independently of how the time variable tariff is designed)**
   Variable Tariffs can lead to…
   … a reduction of my electricity bill.

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… power prices becoming fairer since supply and demand is considered
… better awareness of my consumption behaviour.
… more competition between suppliers.
… less environmental impact.
… more efficient use of renewable power.
… better grid stability.

5. **Which further advantages of time variable tariffs can you think of?**

6. **Which disadvantages of time variable tariffs do you see?**

7. **During the roll-out of smart meters, various concerns have been subject to public discussion. Which of the following concerns apply for you?**
   - The supplier could manipulate prices at certain times.
   - The saving potential would only be minimal.
   - Only larger households could generate significant savings.
   - My consumption behaviours could be analysed by the distribution grid operator and the supplier.
   - I would have to change my power consumption behaviour.
   - There is risk of becoming a target to hacker attacks.

8. **After seeing some pros and cons of time variable tariffs: do you think you could personally benefit from such a tariff?**

9. **Given that oekostrom would introduce a time variable tariff in the upcoming months, how important to you are the following aspects?**
   - I am actually saving costs.
   - Visualisation of consumer data in the portal.
   - Visualisation of the expected price development in the next 24 hours. being warned of price leaps via SMS.
   - A cost cap, so that I don't pay more than I would pay with a conventional tariff.
   - Data protection in order to make sure that no unauthorised parties can get information on my demand profile.
   - I don't have to actively change my consumer behaviour.
   - oekostrom AG has to provide equipment to for load control (Batteries, Smart-Home-Solutions etc.)

10. **I would like to be informed as soon as oekostrom AG is introducing a time variable tariff in the market**
11. **Yes, I would like to participate in the competition for an oekostrom share.**

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Technical references

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* PU = Public
PP = Restricted to other programme participants (including the Commission Services)
RE = Restricted to a group specified by the consortium (including the Commission Services)
CO = Confidential, only for members of the consortium (including the Commission Services)

v	Date	Beneficiary	Author
1.0	05/06/2018	3E	Simon De Clercq and Carlos Guerrero Lucendo
2.0	10/10/2018	3E	Simon De Clercq and Carlos Guerrero Lucendo
3.0	13/12/2018	3E	Simon De Clercq and Carlos Guerrero Lucendo
3.1	14/12/2018	3E	Ruben Baetens and Antoon Soete
3.2	16/12/2018	3E	Review by the project partners
3.3	19/12/2018	WIP	Silvia Caneva
4.0	19/12/2018	3E	Simon De Clercq

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