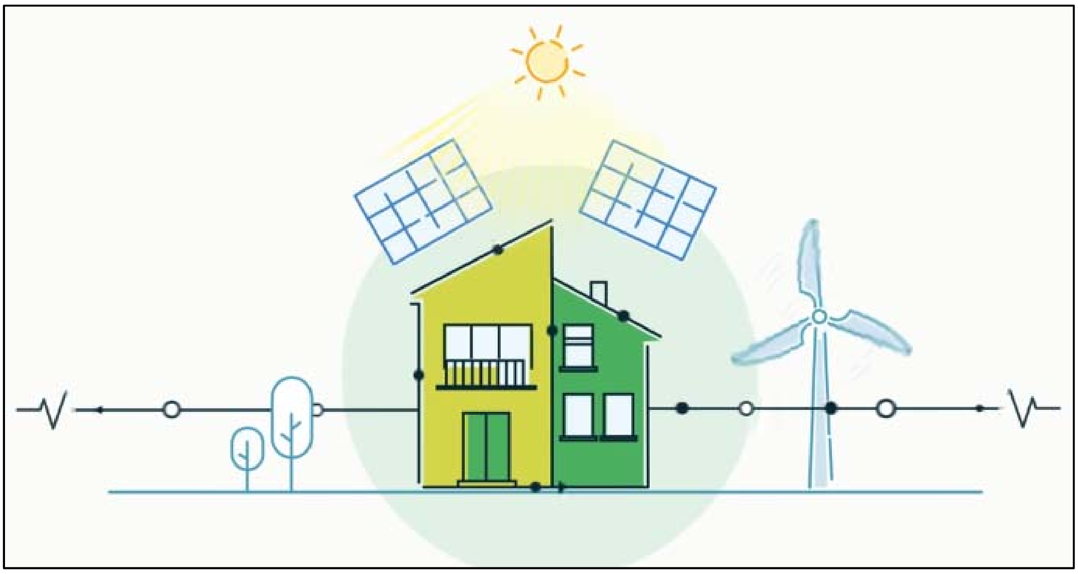

ECONOMICS OF AGGREGATING FLEXIBILITY BASED ON INCREASE SOLUTIONS

INCREASE Policy Brief No.3 – February 2017

Andreas Tuerk (Joanneum Research)

Andrej Gubina and Jernej Zupancic (University of Ljubljana)

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no. 608998.

TABLE OF CONTENTS

THE INCREASE PROJECT

The FP7 INCREASE project focused on how to manage renewable energy sources in low and medium voltage networks, provide ancillary services in particular voltage control and the provision of reserve. The market design and regulatory framework was also considered. Finally, the costs and benefits for different actors were assessed.

This policy brief gives insight into result of the INCREASE report: D.5.3 Enabling frameworks for INCREASE solutions published in June 2016:

http://www.project-increase.eu/cms_files/hofer/D5_3_final_report.pdf?PHPSESSID=dqo3v67ci299kagp4a6a58m115

1 INTRODUCTION

In several EU countries, aggregators are entering the electrical energy or reserve markets, and regulatory frameworks are slowly being reformed in order to better enable their market access. The proposed new EU electricity market directive will give aggregation in the EU a boost, as it requires EU member states to provide regulatory frameworks for aggregators. Business models for aggregation are not yet fully developed in particular in the residential sector, when combining PV, demand response and storage providing flexibility to markets.

The grid tariffs don't always provide sufficient incentive for demand response. Also current business models often focus on a single service/technology without taking into account their combinations as well as grid constraints and market signals. This Policy Brief presents the results of the INCREASE project regarding the economics of aggregation aiming at contributing to this discussion.

2 THE EU CLEAN ENERGY FOR ALL PACKAGE[1]

In November 2016, the European Commission published the "Clean Energy for All Europeans package" of legislative proposals that cover energy efficiency, renewable energy, the design of the electricity market, security of electricity supply and governance rules for the Energy Union[2]. The proposal for a new electricity market directive aims for a better demand participation: the remuneration for demand response should be more in line with the flexibility provided by such services, creating a better economic case for distributed resources and for self-generation[3]. Transparent and fair rules should be established to also allow independent aggregators to fulfil this role[4]. The proposed new directive defines an 'aggregator' as a market participant that combines multiple customer loads or generated electricity for sale, for purchase or auction in any organised energy marketplace, including ancillary services markets and capacity markets so as to encourage the participation of demand response. Aggregators are likely to play an important role as intermediaries between customer groups and the market the proposed directive emphasizes[5]. Transparent and fair rules should be established to also allow independent aggregators to fulfil this role. The planned new directive further requires Member States to define frameworks for independent aggregators and for demand response along principles that enable their full participation in the market (EC, 2016)[6].

3 INCREASE RESULTS

In the INCREASE project, we have developed innovative solutions for control of distributed renewable energy sources and of demand response units. They include advanced inverters for small-scale PV generation, as well as a hierarchical multi-agent system (MAS) for their control. The supervisory control level, the scheduling control, is in charge of the flexible energy portfolio optimization, where demand response units' flexible energy is optimized to maximize the value of the ancillary services (AS) provided in the electricity markets and prevent grid conflicts of interest. In order to

[1] REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the internal market for electricity (recas
[2] ibid

[3] http://ec.europa.eu/energy/en/news/commission-proposes-new-rules-consumer-centred-clean-energy-transition
[4] ibid
[5] ibid
[6] REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL on the internal market for electricity (recast)

show the economic, environmental and operational value of the proposed INCREASE solutions, the solutions were simulated using a wide range of operating scenarios. In this brief we present the most salient ones, along with the assumptions used.

INCREASE control strategies

For PV owners, different types of active power controls of inverters were compared from the economic point of view. The Business as Usual control, **Simple Control** (SiC), represented a control of the inverters in the network before the implementation of the INCREASE solutions. The inverters are programmed to shut down the production of the PV unit if the voltage level in the point of connection rises above upper threshold of 1.1 p.u. Through software upgrade **Local Control** (LC) can be implemented at PV plants. PV and DR units are aggregated within **Scheduling Control** into the Aggregators' portfolio, where he manages the sales of PV produced energy and flexible energy products, offered by DR units. Scheduling control allows the aggregator to schedule the operation of DR units. After the schedules for units in his portfolio are prepared, the DSO evaluates the impact of DR operation on the network conditions. In addition we assumed two optimization options used in the scheduling control process of DR units: the economic optimization (the standard case) where the aggregator aims to make as much profit as possible and the energy based optimization (where he schedules DR units as to maximize injected PV energy), the best option from the public view as it helps to meet the national RES targets.

A representative EU grid

To apply INCREASE solutions within the wider, EU region, data on grid design and operation were gathered from several DSOs in central, southern and northern Europe. A representative synthetic grid was created based on a questionnaire about typical network settings and parameters in different European regions comprising the typical amount of feeders per transformer station, size of loads connected per feeder, and typical loading of the transformer and lines in the network. In the representative grid, the impact of INCREASE technologies' implementation was analyzed using a scenario approach. The sensitivity of those results to key drivers was subsequently analyzed.

Key assumptions[7]

For PV the number of units reach up to 20,000 in the biggest pool size for 10,000 Demand response (DR) units. 7,5 kW DR units were used in simulations, along with 20 kWp PV installations. The outcome of the control of flexible energy sources is highly dependent on the rules and boundary conditions within which the system operates. These rules encompass technical, economic, market and regulatory provisions and define the framework specific for each country in which the control solutions are deployed. The chosen cost structure is of high importance for the subsequent assessments. We assumed corresponding personnel or overhead cost and varying number of needed personnel dependent on the DR pool sizes, ranging from one to four. If an established company such as an energy trader starts with aggregation as part of a broad portfolio of business activities the costs may be lower.

[7] For details see: D.5.3 Enabling frameworks for INCREASE solutions published in June 2016: http://www.project-increase.eu/cms_files/hofer/D5_3_final_report.pdf?PHPSESSID=dqo3v67ci299kagp4a6a58m115

Sensitivities investigated[8]

Parameter	Variation of default values
Energy price	100 %, 200 %, 300 %
Agg. share from PV sales	10 %, 20 %, 30 %
Agg. share from DR sales	75 %, 50 %, 25 %
Agg. SW cost [€]	100 000, 75 000, 50 000
Agg. DR pool size	100, 1000, 10000
Availability fee/DR unit	300 €, 600 €, 900 €

We investigated the sensitivities regarding the energy price, the share of the profit that the aggregator receives from PV and demand response flexible energy sales, the software costs and the DR pool sizes. The PV pool sizes went similarly from 200, 2000 up to 20 000. They were scaled together with the DR pool size to keep the same ratio PV/DR. The impact of individual parameters was analysed with a scenario analysis of the simulated grid, where we defined five different levels (scenarios) of PV and DR installations in the network (SC1 to SC5). They were scaled together with the DR pool size to keep the same ratio PV/DR.

As **Figure 1** (left) shows, for 1000 units only at higher penetration cases profits are made, for 10.000 units all cases are profitable.

In case of the aggregator's pool size of 10.000 DR units, which represents 75 MW of aggregated power, the costs were spread across enough units to achieve profits. Scenarios with lower level of integration of PV and DR units were less profitable, which can be problematic for the aggregators with smaller DR pool sizes. There the aggregator became profitable only with increased energy prices or by including more PV units in his business portfolio as well that are result in more profit than the DR units.

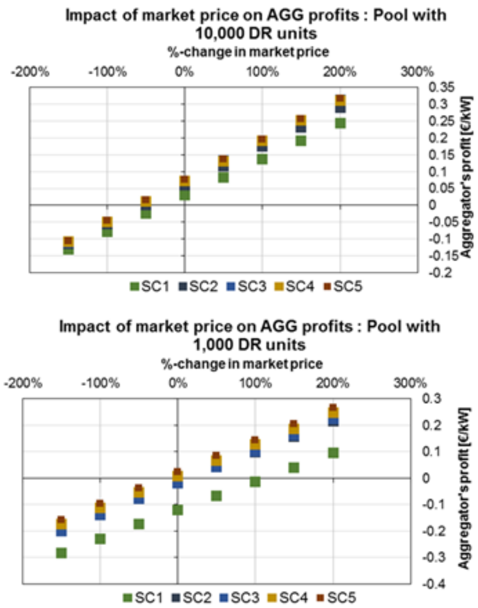

Figure 1: Economic optimization with 10.000 and 1000 units, for different penetration scenarios

Comparing the effect of increasing the number of DR units with increasing the number of PV units showed that under the cost assumptions employed in the investigated business models, flexibility from DR units alone was hardly profitable for small DR pools. When PV units are included in the aggregator's pool, also smaller aggregation pools became profitable. This meant the aggregators should strive to include PV units in the portfolio when operating smaller DR unit pools. However even smaller flexible energy portfolio sizes may lead to profitable business cases for the aggregator if we modify our cost assumption e.g. if the aggregator doesn't need additional personnel but carries out the aggregation activities as a part of his normal business. Market requirements regarding the minimum bid size should not be prohibitive for small aggregated amounts. Also the government could pay a premium to enable energy optimization, stimulating the aggregator to inject as much as possible PV-generated green energy into the grid.

[8] For details see: ibid

4 OUTLOOK

We acknowledge that our calculations represent a simplistic energy system. DR will most likely be accompanied by different storage options and the services will be sold on different markets having important impact on the revenues stream, still we aimed to provide a basic understanding of cost structures and sensitivities. Overall the energy market of the future will be characterized by a multitude of market actors with different business portfolios and costs structures. We investigated only one of many possible solutions that can be applied in the smart grid environment. The new electricity market directive will boost new approaches and business models. The markets and regulatory frameworks should be inclusive to a large diversity of actors, traded sizes, timeframes and emerging products. Only an inclusive approach will lead to the needed transition of the EU energy systems.to a large diversity of actors, traded sizes, timeframes and emerging products. Only an inclusive approach will lead to the needed transition of the EU energy systems.