

## **Involving Consumers in the Programmes of Consumption Adjustment by Using Dynamic Tariffing Within the European Project Flex4Grid**

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**Abstract** The distribution company Elektro Celje d.d. as a member of the International Consortium has successfully applied for the European Programme Tender on Research and Innovations Horizon 2020 with Flex4Grid project focusing on solutions that would allow flexibility management of users – the so-called prosumers of the distribution network in the field of consumption as well as power generation.

Flex4Grid, a European Development Project, focuses primarily on the development of an open technological system for data management and service provision which would allow managing user or prosumer flexibility of the distribution network in respect of their power consumption as well as power generation. Prosumer flexibility is a capability of prosumers to adjust their consumption or power generation to the needs of other stakeholders within the system, and could be rewarded for such adjustment. The service will be offered in a computer cloud where anonymised data will be collected. Some new business models will be developed and some new incentives for prosumer participation in such projects will be introduced.

**Keywords:** • Horizon 2020 • Flex4Grid • data management • service provision • distribution networks •

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## 1 Introduction

The emergence of diffuse sources, such as photovoltaics, wind energy and other sources, has given rise to new users of electricity, the so-called 'prosumers' (i.e. a producer and consumer as one person), who generate and consume electricity in parallel. Power consumption and generation of a prosumer is very variable and as such it may on a larger scale affect the network and the stakeholders in the electricity market. However, the prosumers may to a certain extent be flexible and thereby prevent their eventual negative impact [1].

Flex4Grid, a European Development Project, focuses primarily on the development of an open technological system for data management and service provision which would allow managing prosumer flexibility/adaptability of the distribution network in respect of their power consumption as well as power generation. Prosumer flexibility/adaptability is a capability of prosumers to adjust their consumption and/or power generation to the needs of other stakeholders within the system. Principally, the prosumer is supposed to be rewarded for providing such flexibility. Power distribution enterprises will be able to use such flexibility to reduce peak loads of the network and to narrow the gap between the consumption and the diffuse power generation. Other or new participants will be allowed in the electricity market that will offer services based on the data and open interfaces of Flex4Grid technological system. The system will be built with the use of the existing ICT elements which were being developed by the members of the consortium for several years within previous research projects. This means this project has a lot of potential to be rapidly implemented in practice.

Flex4Grid will include the following:

- a) data cloud service with the anonymised interface with advance security and privacy mechanisms designed for data exchange and service management,
- b) prosumer flexibility in the field of power generation and consumption, and consumer flexibility in the field of power consumption, and
- c) a viable business model that can easily be applied in practice.

The system validation will be performed in real environments - pilot projects in three European distribution systems with different scenarios. The last major pilot project will be carried out in Slovenia in the distribution area of Elektro Celje d.d. with its potential participation of 8,700 users or consumers of the power distribution network within the pilot project of dynamic tariffing.

The project was launched on 1 January 2015 when the contract was signed with the European Commission. Flex4Grid project involves eight partners coming from Slovenia, Finland, Slovakia and Germany that are a mix of knowledge and research institutes, power distributors and industrial partners. Among them there are three Slovenian partners: Elektro Celje d.d., Smart Com d.o.o. and Jožef Štefan Institute. The project value amounts to nearly 3.2 million euros and is almost entirely funded by the European Commission. The duration of the project is 36 months (finishing on 31 December 2017) and is coordinated by VTT Finnish research institute.

## The Concept

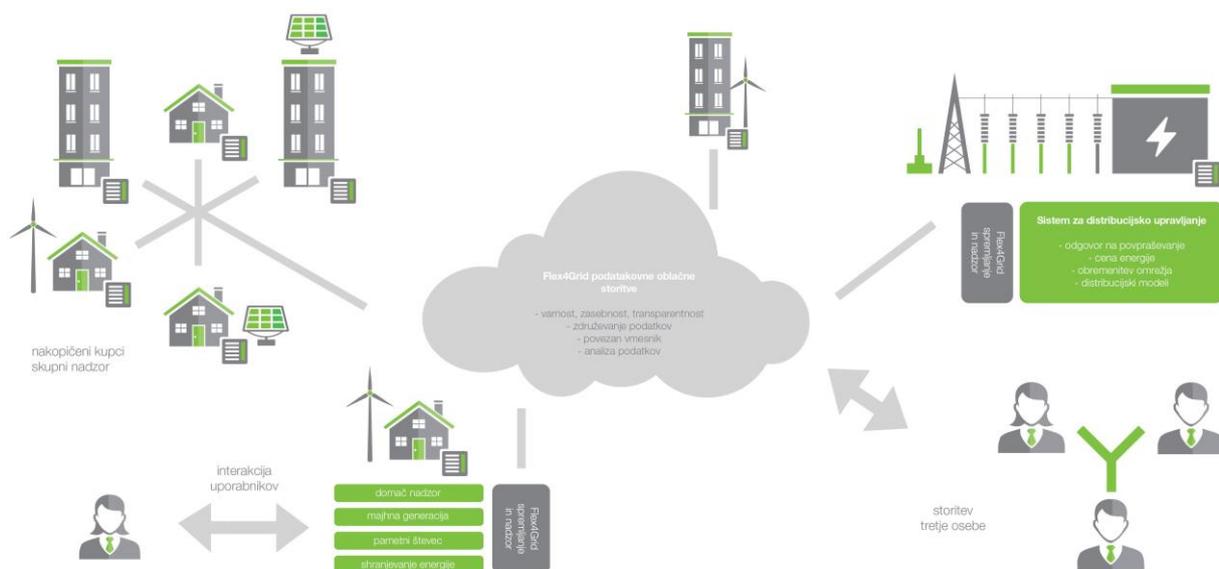


Figure 4.1: The aim of Flex4Grid activity

The aim of the activity within Flex4Grid (see Figure 4.1) is to assure the system to include new participants in the electricity market who will be in position to provide aggregate data analyses for forecasting electricity demand. The main idea is to anticipate the effect of power consumption and generation in the distribution network (most locally in the distribution network). By using such forecasts we will be able to avoid any potential power failures (critical services of the highest priority in critical infrastructure of each country) due to overload and imbalanced power consumption and generation in some energy-related critical points in the network.

Flex4Grid offers a comprehensive system of data management with solutions for intelligent networks, which integrates data exchange between the distribution network operator and its users by incorporating various complementary components contributed by other project partners. The construction of the central cloud system for energy management along with a smart electrical meter, smart measuring and control devices supported by a mobile application shall result in an effective network management in the sense of the so-called intelligent network at the lowest level, i.e. in households.

## 2 The role of Elektro Celje d.d. in the project

There will be three main pilot projects established within the project in 2017; two in Germany and one in the distribution area of Elektro Celje d.d. with up to 8,700 household consumers of

electricity. Unlike the German pilot project implementations, where prosumers will be treated in a smaller number, the Slovenian pilot project will not include prosumers due to regulatory restrictions that apply to power generated by power producers. The project will only include consumers of electricity which will be selected in a relatively large sample (a large scale pilot project).

## Implementation

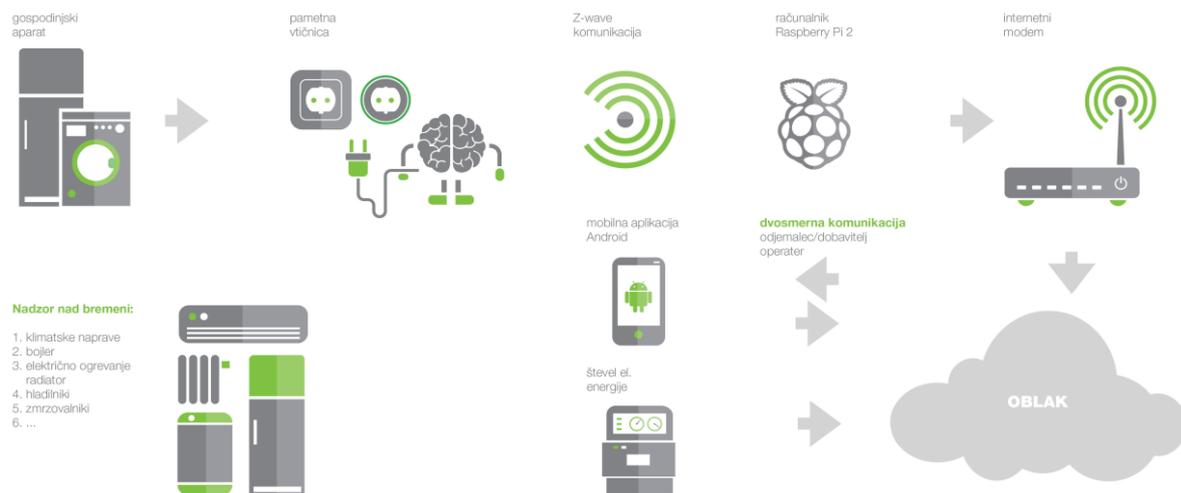


Figure 4.2: Flex4Grid integration of components and services

The pilot participants in Slovenia will receive a measuring and control device consisting of a central unit Raspberry Pi with the addition of Z-wave wireless communicators and two smart outlets to be used to plug in household appliances (Figure 4.2). By using this kit, consumers will be able to control the power consumption of their household appliances via the mobile application. They will also be able to control the total electricity consumption in their household via the mobile application, and to make comparison which electric appliances consume more electricity depending on the total electricity consumption. From time to time, they will receive a note on their mobile appliances to reduce the electricity consumption for a shorter period of time.

In terms of power management, not all electric appliances are of interest. However, of particular interest are those appliances that do not substantially reduce the comfort level of living in case they are disconnected for a shorter period of time, such as refrigerators, electrical heating, more recent air conditioning devices, boilers and freezers. Those household appliances are major electrical appliances that could be disconnected for a shorter period of time and could have a significant effect on the total electric consumption. On the other hand, those electric appliances accumulate heat or cold for a longer period of time. For this reason, their disconnection from the network is not considered problematic.

Power distribution company will, within the applicable legal restrictions, provide the programme on power management in respect of power consumption and its adjustment. The power management programme will be target-oriented in reducing power consumption in critical moments or in the moments of peak load of the system, and in improving energy efficiency.

Consumers may nevertheless not want to participate in programmes of power consumption adjustment, since they do not wish to diminish their comfort level of living, or they may not want to be burdened with adjustment of their power consumption. Despite all those limitations, we believe that if we want for the consumers to reduce or adjust their consumption, they can do so only when they know their consumption really well. Consumers take such decisions much easier when they learn about their consumption after the smart kit is installed in their homes. However, only knowing about their consumption is not enough; they also need a financial incentive.

### **3 Testing The Effectiveness Of Active Participation Of Consumers In The Programmes Of Consumption Adjustment By Using Dynamic Tariffing**

Taking into account that one of the targets of Flex4Grid pilot project is reducing peak loads by 3% at a specific network point, such objective will be hard to achieve. The main limitation is focusing only on widely dispersed households which consume only one third of the total energy. The limitation is also included in financial incentives for consumers. Upon opening the electricity market and with the EU requirement the operators and suppliers of electricity in Slovenia separated. There are only a few incentives provided by power distribution enterprises or network operators since this business activity is highly regulated in Slovenia, unlike the activity of supply, where suppliers are very flexible when setting their prices for electricity consumption, and thus can offer more.

Irrespective of the above mentioned restrictions, Elektro Celje d.d. has used the statutory opportunity of testing the implementation incentive which came into force on 1. 1. 2016 when Act on methodology for setting the regulatory framework and the methodology for calculating network charge for network operators (Official Gazette of the RS 66/15, 105/15) was adopted [2]. The implementation incentives are in the current regulatory period focused on testing the effectiveness of active participation of consumers in the programmes of consumption adjustment by using dynamic tariffing. The approval of Flex4Grid project by Energy Agency, the network regulator, forms the basis for the use of pilot dynamic tariff from Article 123 of the above mentioned Act, which is limited solely to electricity consumers who will voluntarily join the programme of consumption adjustment within this project.

Article 123 of the Act applies to a pilot critical peak rate and is intended for a dynamic redirection of final consumers from the peak system load to the off-peak system load with regard to the availability of renewable energy sources, energy generated in combined heat and power generation (CHP generation) with high efficiency, and distributed generation of electricity.

The critical peak pricing rate (CPPR) [3] is a trial network tariff for the distribution system with a special tariff rate of transferred active energy (kWh) which deviates from the usual tariff rate, and is valid during the time of peak system load (a critical moment). To perform such tariff, there is a pre-determined limited number of critical moments in a specific time period, their duration and time conditions of informing the consumers about the occurrence of such critical moments. Power distribution company shall inform its final consumers about the occurrence and the time of CPPR at least 24 hours in advance. At the same time such information shall be published on the website of the distribution company. The number of CPPR hours in one calendar year is 50.

Tariff rates for network charge for the distribution system of the transferred electricity (kWh) included in the pilot project are determined in the way that in case of consumption unresponsiveness of the final consumer in the period of CPPR, the network charge for the period of one year will be equally calculated as in the case of the network charge for the final consumer based on normal tariff rates. The CPPR tariff rate occurs in the time of critical peak pricing rate, which can occur in the time of the higher tariff (HT) or the smaller tariff (ST) and is 10 times higher than the common higher tariff rate (HT). Out of the times of critical peak pricing rates the higher tariff (HT) or the smaller tariff (ST) is 13% lower than common tariff rates.

#### 4 Conclusion

Electricity is a specific commodity in its nature since it cannot be stored properly or its storage is related to high storage costs. For this reason, power generation must always be implemented in the way to provide or cover the entire consumption. In the times when power consumption is high, the price of its production is also high, since enterprises that gradually, with increasing load, generate electricity, run their production units with higher production costs [4].

In such periods of time, the power distribution network is much more loaded which may give rise to network failure which can jeopardise the whole system stability. Power distribution networks are planned on the basis of peak power, i.e. the maximum power, which normally occurs in the network only a few times during the year. New networks and reinforcement of the existing network belong to demanding investments in terms of costs, which are borne by all consumers of electricity, and have quite a significant effect on the environment.

Consumption adjustment of electricity by consumers means that consumers adjust their power consumption to different electricity rates in specific time intervals and take decisions on their consumption adjustment mostly because they are encouraged by the programmes providing lower prices of their consumption in the times of higher wholesale prices (suppliers) or in the time when the energy distribution system is jeopardised (network operators).

With the programmes of power consumption adjustment, consumers will adjust their power consumption only in case they will know their actual consumption well and in case they will be successfully encouraged by new innovative cheaper electricity tariffs. With gradual introduction of such programmes we wish to establish bigger flexibility of the consumers when making decisions on their power consumption. On the other hand, this is a great opportunity to explore the potential of dynamic electricity tariffing for household consumers, and to answer the questions related to consumer willingness to adjust their electricity consumption, at what price and to what extent. This is also an opportunity to improve the dynamic tariffing model in Slovenia based on the results obtained in the project.

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