Local flexibility markets and the role of active customers and communities supporting grid system operators – DOMINOES engagement plan

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Abstract: This study offers an overview of the H2020 DOMINOES project, led by EMPOWER, which targets the development of new demand response, aggregation, grid management and peer-to-peer trading services by designing, developing and validating a transparent and scalable local energy market solution. Presenting the experience on the DOMINOES project and leverage simultaneously the experience from the past experiences associated with previous H2020 projects such as InteGrid and SENSIBLE, regarding the implementation of consumer’s engagement and targeting strategies, the impact of local energy markets will be analysed and the low-voltage consumer’s participation in flexibility markets will be evaluated. With the focus on the strategic engagement plan for consumers and communities, the relation that system operators and technologic providers can, both, benefit and enhance active participation in flexibility markets, this study will present a real and planned systematic analysis of how local energy markets will allow assessing the economic value of flexibility, and the innovative possibilities created when the engagement plan advocates the importance of active consumers supporting grid systems operators.

1 Introduction

Flexibility can be defined as the capability of the energy resource to change its consumption/demand or generation from the usual pattern. For the effective utilisation of the flexibility resources, the local flexibility market could be organised. The role of DSO is twofold, on the one hand, it must have visibility on the implications of the market transactions for the grid and also a possibility to procure flexibility to handle the grid constraints. DOMINOES project proposes a market model, which enables the use of flexibility where it is most valuable within the sequence of markets ranging from local to wholesale.

Considering the central role of DSO in the energy transition, particularly focusing on the DOMINOES project at the local level, the assessment of potential services to be provided to the DSO in future grid scenarios of high RES integration is needed to realise if these services can match the grid needs. This will be done through different timelines according to specific technical requirements at the local level permanently ensuring two major guidance principles: security of supply and technical supervision. In addition to the ‘classical’ congestion management and voltage support functions, the consumer and prosumer engagement will set complementary use cases and leverage, both, aggregated and individual active participation, where different interests, commitments and challenges will be tied to the goal of increasing of energy efficiency and renewable penetration.

To use the customers’ and the communities’ flexibility, in addition to the necessary technical solutions including smart metering, HEMS (House Energy Management System), control and command hardware and the IT platforms, one needs to define the necessary strategies not only to enroll the communities and the customers but to engage them in the long term into the necessary actions to provide in a continuous manner their available flexibility. The enrolment strategy, the engagement, the training sessions etc., shall be considered in the Engagement Plan, which will also consider the learnings from past projects realised in the same area. Balancing is needed between keeping the customers involved and not burdening them excessively. Provided information should be designed according to the customers’ level of knowledge as especially residential end-users may not be aware of the benefits of flexibility and may find units such as kilowatts hard to understand. In addition to information provision, gamification – i.e. inclusion of elements such as points, rewards and feedback – can motivate customers and help retain their interest.

2 Local energy market

The local energy market is a technology that is currently widely considered for making several use cases possible which were previously not possible for end-users. Local markets could enable local peer-to-peer trading with more granularity and special uses than possible in current markets, as well as other potentially non-monetary benefits such as empowerment through active participation in their energy use.

An important aspect in designing local markets is the connection to overarching value mechanisms in order to not resort to sub-optimisation and unscaleable solutions. In the DOMINOES local market model [1], the existing market sequence is considered, and the proposed local market solution first enables trading locally and then on the wholesale markets for energy and flexibility separately.
In local markets where multiple stakeholders are present, the effects of traded flexibility have to be considered in a settlement. In the DOMINOES model, local balances are considered for each end-user. These balances can either be under existing retailer balance portfolios or by making balance responsibility mandatory for end-user metering point level. In addition, the DSO can procure flexibility, which results in changes in balances that have to be either compensated using counter trading locally or within other distribution grids. The local balances can then be used, for example in conjunction with actuation signals and baseline estimation methods, for the verification and settlement of flexibility. Flexibility is another major motivation for local markets, either for energy management and ancillary services in the distribution grid, for retailer balancing value or for aggregation for system-level value.

3 Concept

In the sequence of the liberalisation of the electricity sector, with the establishment of competitive wholesale and retail markets, a progressive engagement of consumers has been considered and targeted by sector regulatory policies. With the objective of promoting market competition while protecting consumer’s interests, by transferring some of the benefits from upstream competition to the end-users while reaching a fair distribution of system costs, market models promoting operators/retailers/ aggregators competition for consumers’ demand are envisioned.

LEFM (Local Energy Flexibility Markets) – implications to the local environment at the community level: digitally enabled grids are transforming local community environments where demand response (DR) potential is significant. A highly granular view of the available assets and contracts in place could help assess available flexibility within different demand areas, creating different dynamics around how to manage demand locally and encourage customers to change their behaviours [2]. The most relevant opportunities related to the aggregation of DR at the energy community level are related to the decarbonisation of local energy systems, lowering the costs of energy delivery in the long-term, improving systems’ reliability and security of supply, and providing market access to the engaged consumers/prosumers.

As economy of scale, social and environmental obligations and regulatory requirements are still pointed as some of the most relevant barriers impacting local competitiveness, intermediary parties on the rise are expected to influence market access at the community level and change customer engagement, redefining the interactions between the stakeholders directly involved in the LEFM or affected by the market actions undertaken.

LEFM – implications to the system’s operation: In a TSO–DSO joint report, on integrated approaches to active system management [3] marketplaces and platforms are identified as fundamental tools for enabling flexibility services, namely at the local level. System operators’ responsibility, as neutral market facilitators, is particularly relevant towards ensuring the access of all market parties and provides them a fully transparent view on the system’s needs and rules for requesting, selecting and validating transactions for flexibility services provision.

Within the local market, the system operator is responsible for providing validation services over every transaction. By assessing the technical validity and the impact on the grid of every transaction proposed for the same timeslot, the system operator will be able to influence the transactions which do not comply with the grid’s stability. Additionally, for each timeframe, local network constraints can be established, limiting the procurement and provision of services.

In the DOMINOES project, following the market architecture, defined in [4], the general concept proposed foresees a flow of market actions, technical validations, subsequent deliveries of energy and/or flexibility and balance settlements. Since the market operation should be dynamic and capable of addressing different requests, either prioritising balancing and prosumer services or system’s operation, direct procurement of flexibility within the local market must also be considered. The project enables consumers/prosumers empowerment, by allowing them to value their demand flexibility and DER. Moreover, local liquid flexibility may support innovative distribution grid management mechanisms, focused on local balancing and congestion management, voltage control and grid restoration. Within the LEFM concept proposed, consumers/prosumers, system operators, aggregators, retailers and other service providers may trade energy and flexibility, mainly provided by DER (distributed energy resources) and DR, for grid, community, services and markets value.

4 Consumers’ motivation and awareness

According to previous research [5, 6], economic incentives are the most important motives for consumers to change their energy behaviour (e.g. take part in DR). The potential revenue streams for end-users and prosumers depend on the characteristics of their flexible resources, the markets open for such resources and the prices in these markets. Loads that are typically considered flexible include electric heating, cooling and ventilation. In addition, due to the need to reduce the use of fossil fuels, batteries of electric vehicles as well as storages acquired to complement solar panels are likely to provide increasingly important flexible resources.

Flexibility may be utilised in the minimisation of electricity procurement costs (based on retailer/DSO tariff structures or wholesale portfolio optimisation by a retailer/community manager) or sold as a service to DSOs or TSOS. Based on analyses done in the DOMINOES project for the Nordic market [7], it seems that larger benefits are possible in the power-based (e.g. frequency control reserves for the TSO) than in the energy-based markets (e.g. shifting consumption based on wholesale prices). This, however, depends on the price development in both ancillary service and wholesale markets.

However, in many countries, only generators and large individual loads (i.e. industrial end-users) are at the moment eligible to provide ancillary services at the TSO level (see e.g. [8]). In addition, in some country’s economic regulation of DSOs favours CAPEX over OPEX which reduces motivation to buy flexibility services [9]. However, once transposed into national legislation of the member states, the recast Electricity Directive (2019/944) [10] should improve the position of flexibility at both TSO and DSO levels as it requires TSOS and DSOs to treat DR aggregators in a non-discriminatory manner alongside producers when procuring ancillary services. Furthermore, the regulatory framework should allow and provide incentives to DSOs to procure flexibility services and it should ensure that DSOs can procure such services from providers of distributed generation, DR or energy storage. Since consumers’ awareness of their energy consumption is typically quite low [11], in addition to incentives, it is also important to provide them with relevant information. However, information overload should be avoided and the balance between displayed and requested information in consumer interfaces should be maintained [12]. As information alone may not suffice to retain interest, gamification, defined in [13] as ‘the use of game design elements in non-game contexts’ can be utilised. Beck et al. [14] studied the use of gamification components (e.g. points, leader boards, badges/achievements, feedback, rewards, challenge) in mobile energy applications and found that app ratings increased with the number of included gamification components. Furthermore, sharing results within a community may also help build motivation [12].

5 Systems operators as market facilitators

As referred previously in this paper, system operators are taking a central role in the energy transition. Moreover, they are well suited to become market facilitators. As a neutral, agnostics and essentially regulated business, system operators are the most prepared and placed entities for managing detailed data and ensuring its privacy. The improvement on the consumer awareness
to network related issues it has been directly linked to the penetration of smart metering systems, where real-time analysis and communication between consumer and SOs is becoming a reality. Once such communications are possible with the customers, the level of awareness of consumers and its impact on the grid support can shape and have a real impact on the network flows, by exchange of some benefits in the tariff and establish dynamic processes of alternative pricing.

The system operators must follow some key principles in order to have this role, such as [15]:

- SOs must run their business in a way that reflects the reasonable expectations of network users and other stakeholders including new business models.
- SOs must act as neutral market facilitators in undertaking their core functions.
- SOs act in the public interest taking account of costs and benefits.
- Consumers own their data and DSOs need to recognise this when handling data.

The system operators will be suited to assume this role, as they will have all the smart meter information, which makes them responsible to act impartially and make available their data to facilitate the existence of new players and services in the market. In a local market, the system operators will have the role to impartially give the local market the master data and consumption information to all the participants, being suppliers or customers. To conclude, the regulatory framework should be improved in order to reward the use of flexibility. This should be considered, and the customers should have incentives when they give their flexibility to help maintain the grid stability. The power system operators will have a fundamental role in the local markets, as they will collect and share data, they will enable new customer services, and they will interact with the new flexibility available, in order to solve grid constraints, forecasted, or planned. In the DOMINOES project, scenarios were made where the DSO will have the role of technical validator of all the market transactions and will also access the available flexibility to solve grid constraints.

6 Local engagement plan

Successful implementation of research projects that comprise demonstration activities depends on the full engagement of all stakeholders, namely the direct participants in the demonstration sites. Indeed, the DOMINOES project encompasses a real demo in Valverde, in the countryside of Portugal at Évora municipality which poses several challenges. According to Census 2011 [16], Valverde has 436 inhabitants of which 132 are >65 years old and 142 are retired. Regarding their education level, only 31 inhabitants hold a tertiary education degree and 125 have only received basic training. Thereby, some of the inhabitants may do not fully understand the innovative concept of DOMINOES. In addition, several projects have been launched there, namely Sensible [17] and InteGrid [18] so an extra effort would be needed to keep the population interested in enrolling in this new research project once again, knowing that it will not offer PV systems, energy storage systems nor smart appliances for the participants in the previous ones. On the other hand, the number of engagement activities shall be well balanced, otherwise, participants may leave the project for being burdened excessively. Thus, based on the experience of project Sensible [19, 20], a structured engagement plan is in place and it comprises three phases: Phase 1: Project presentation – This phase encompasses the project presentation to the main stakeholders and to the Valverde community in particular. A first presentation was already arranged there, where the concept of the project was explained, and a first questionnaire was launched to gather their views and willingness to participate in Local Energy and Flexibility Markets (LEFM) and peer-to-peer (P2P) transactions.

Phase 2: Concept validation – This phase corresponds to the validation of the concept, namely to promote some tests for P2P transactions among the community. Therefore, some training sessions will be given and, in order to get them on board throughout this important stage of DOMINOES, a gamification strategy will be carried out. In the end, a reward will be given to the participant with the highest score. Furthermore, a final questionnaire will be prepared to investigate how their views on LEFM have evolved during the project implementation.

Phase 3: Results dissemination – at the end of the project, the main results and key findings will be disseminated to all DOMINOES stakeholders. Furthermore, it is of utmost importance that ethical issues are ensured throughout the project. Aspects such as informed clients, non-discriminatory procedures and data confidentiality will be given special attention by the DOMINOES team.

7 Conclusion

The DOMINOES project proposes an innovative model to foster and induce active consumer participation, where the importance of former and ongoing initiatives [18–20] of consumer engagement are encompassing critical topics such as the systems operators’ needs, community awareness, perceived consumer benefits and local social impact. The collaborative participation of local (communities, authorities, municipalities and citizen associations) and energy centred stakeholders (DSOs, retailers, aggregators and service providers) in the development and facilitation of local energy markets started to reshape the consumer’s perception of local markets and the associated economic value of flexibility. Instruments of equality and social empowerment are contributing to the consolidation of the energetic transition and the penetration of decentralised energy resources, where, with the utmost contribution of individual and collective active consumers, new renewable capacity is supporting and sustaining mechanisms of investment deferral and congestion management at a granular level.

8 Acknowledgments

This work was supported by European Union’s Horizon 2020 research and innovation programme under grant agreement no. 771066

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CIRED, Open Access Proc. J., 2020, Vol. 2020, Iss. 1, pp. 646–649

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