Defining community-based Virtual Power Plant

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In the Interreg NWE funded cVPP project (no. 588) three communities from Ireland, Belgium and the Netherlands are developing and implementing their own community-based Virtual Power Plant (cVPP). But what is a cVPP?[1]

This report represents the views of the consortium on what is considered to be a community-based Virtual Power Plant (cVPP). These views and the definition is based on many discussions, literature reviews, and interviews carried as part of the Interreg cVPP project. The report first discusses what is meant by (1) VPP and (2) community followed by the identification of the possible (3) roles communities could play in the energy system. Finally, it proposes a definition of the (4) cVPP.

1. Virtual Power Plant

A Virtual Power Plant (VPP) can be defined as: "*A portfolio of distributed energy resources, which are connected by a control system based on information and communication technology (ICT). The VPP acts as a single visible entity in the power system, is always grid-tied and can be either static or dynamic.*" (Plancke, De Vos, Belmans, & Delnooz, 2015, p. 2)

A VPP can serve different functions in the energy system, a distinction is often made between technical- and commercial-VPPs, which aim at providing grid support services to grid operators and trading energy in wholesale energy markets respectively. Many existing VPPs and other similar smart grid experiments fulfil a combination of both functions and most of them are driven by, and serving the needs of, utilities and incumbents in the current energy system (Verkade & Höffken, 2018). A VPP driven by a community, which is referred to as community-based Virtual Power Plant (cVPP), is a novel phenomenon, which is only just emerging. It requires a good definition of 'community' and the implications of their involvement.

2. Community

Community, in relation to an energy system, is a social network of people (and organisations) that collectively engage in energy related initiatives and projects, ranging from renewable energy generation, energy conservation and efficiency to energy management. These networks are often place- or interest-based (Klein & Coffey, 2016) *but can also be virtual or sectoral* (Heiskanen et al., 2010)*. They may include not only citizens but potentially also actors like municipalities and (local) companies. The involvement of a community distinguishes community-based from commercial projects such as the VPP because it implies that such initiatives operate on a different 'community logic':*

[1] *This report builds on* Van Summeren et al. (2019)

Community-based initiatives and projects operate on a community logic. Community logic consists of seven elements[2], which are described below. However, rather than deciding upfront which, or how many of these have to be present for a project or an initiative to be considered community-based, it is the community members who collectively decide which of the elements are relevant for their own case.

1. *Community' needs and values[3] drive the initiative and/or project.*

The needs and values often go beyond monetary assets and energy supply rationale, and can be categorized as financial (e.g. lower energy bills), environmental (e.g. reduce CO_2 emissions), social (e.g. community building), institutional (e.g. influencing energy policy), and technical or infrastructural (e.g. energy independence) (Hicks & Ison, 2018; Seyfang, Park, & Smith, 2013).

2. *The outcomes (e.g. values, costs and risks) are distributed in a fair way.*

In line with the community' needs and values, these outcomes do not have to be financial or energy related (Walker & Devine-Wright, 2008). The community members decide what fair distribution is for them.

3. *The community owns the assets, platform and/or the entity.*

There are different community ownership models ranging from co-ownership to 100% community owned (Hoffman & High-Pippert, 2010; Seyfang et al., 2013). Most commonly used ownership model is the cooperative model, in which all members own one share of the entity (e.g. an energy cooperative) (Šahović & da Silva, 2016). Other models are possible if the community decided so.

4. *The community collectively makes decisions.*

The decision making process depends on the ownership model. In the cooperative model mentioned above each member has one vote and often votes for representatives who take care of the daily operation (Šahović & da Silva, 2016; Walker & Devine-Wright, 2008).

5. *Uninvolved community members are actively engaged.*

The engagement can range from being informed to active participation. Being labelled as a community energy project gives rise to expectations regarding engagement during the whole process, from development to implementation (and possibly beyond) (Seyfang & Haxeltine, 2012; Walsh, 2018).

6. *All community members can join.*

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[2] A systematic literature review performed by Van Summeren et al. (2019) highlighted these seven elements of 'community logic' as most relevant for community-based energy projects.
[3] We refer to values as motivations and goals communities strive for.

When part of the community members feel excluded, even a community energy project can become controversial (Walker & Devine-Wright, 2008; Walsh, 2018).

7. The local energy demand defines the scale of energy generation.

Rather than maximising economic benefits, the community energy projects often link the scale of energy technology to their own needs and motivations, such as e.g. self-sufficiency. In addition, one major motivation for communities to set up an energy initiative is to gain control over both the scale and siting of renewable energy generation in their environment (Hicks & Ison, 2018).

3. Roles in the energy system

Contrary to the current community energy projects that have so far focussed on collective ownership of energy generation technology, joint purchasing, energy efficiency and energy conservation (Gui & MacGill, 2018), a VPP that is community-based, enables a community to also become involved in the management, distribution and trading of energy. This implies the community may play any, or a combination of, (new) roles in the electricity system. In order to identify the possible roles, the USEF Framework by Van der Veen et al. (2018) (figure 1) was adopted because it largely represents the logic of the current centralized electricity system, except that it includes two new roles: Energy Service Company (ESCo) and Aggregator. On the short term it can be expected that the energy system's organisation will not change radically. On the long term however alternative ways can be envisaged along which the future energy system could be organised (e.g. in a more decentralized or distributed way), with potentially substantially different roles and position of the communities.

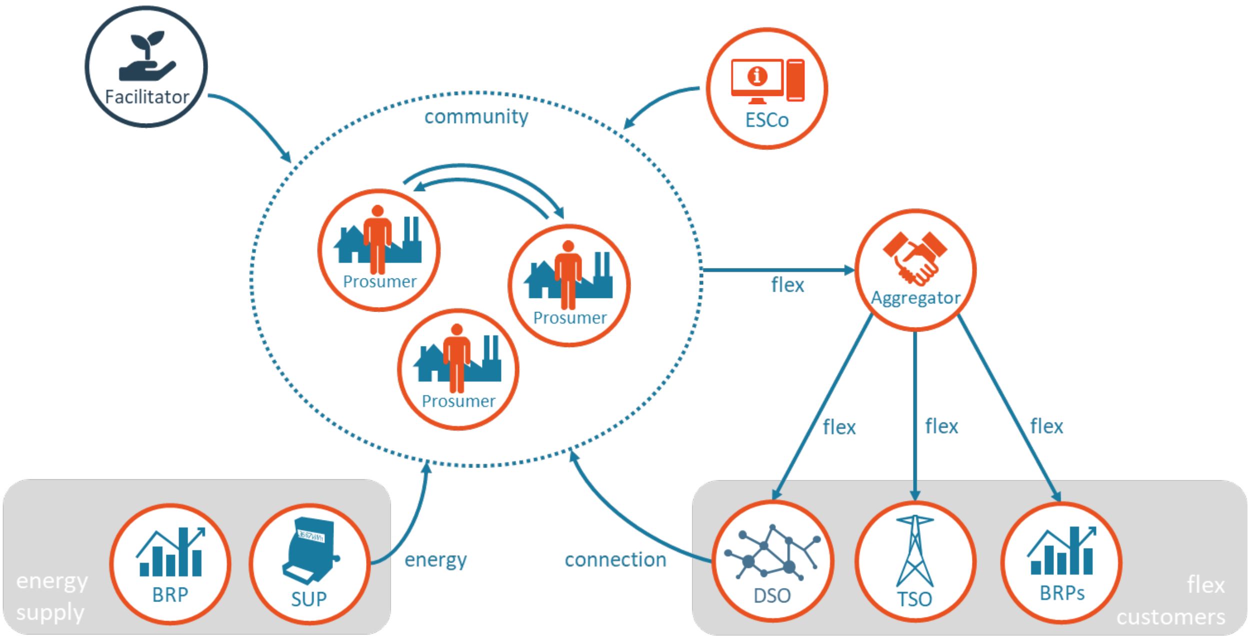

Figure 1: Illustration of different roles that could be played by communities and the potential energy and flexibility services they could offer.[4]

Community as Facilitator takes care of activities that contribute to the development, implementation and/or expansion of the cVPP. This role might include a wide range of activities related to informing, financing, advising, organising, joint purchasing, etc. Potentially a community facilitates the collective participation in a cVPP which is operated by a third party Aggregator or Energy Service Company (ESCo).

Community as Supplier participates in energy trading. This might include supplying (self-generated) energy to (members of) the community, trading self-generated energy on the wholesale energy market and/or facilitate trading of energy within the community either through a community energy market platform or through direct peer-to-peer energy trading.

Community as Energy Service Company (ESCo)[5] optimises individual and/or community energy profiles (e.g. demand and supply) in relation to e.g. dynamic prices (implicit demand response) or the availability of locally generated and/or renewable energy. Objectives for optimisation relate closely to the values of communities, e.g. lowering energy bills, self-sufficiency and/or lowering carbon emissions.

Community as Aggregator sells aggregated flexibility to interested parties such as the DSO, TSO or Balance Responsible Parties. This flexibility is used for e.g. grid stabilisation and balancing, and can be provided by dispatching generation, (explicit) demand response (e.g. automatically or manually switching appliances on/off) and/or energy storage.

Community as DSO is involved in balancing and transporting electricity on the local grid. In practice this could mean that the community becomes (partly) responsible for operating and maintaining their own (micro) grid.

4. Community-based Virtual Power Plant (cVPP)

Based on the above, a cVPP is a *portfolio of community-owned distributed energy resources aggregated and coordinated by an ICT-based control system, adopted by a (place-based, interest-based, virtual or sectoral) network of people (and organisations), who collectively perform a certain role in the energy system. What makes it community-based is not only the involvement of a community, but also the community-logic under which it operates* (Van Summeren et al., 2019).

5. References

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[4] Figure 1 and the roles discussed are developed in the cVPP project and build on the USEF White Paper 'Energy and Flexibility Services for Citizens Energy Communities' by Klaassen & Van der Laan (2019).

[5] The term 'ESCo' is often used to describe a much broader variety of activities than described here. In the cVPP project a narrow definition for ESCo is adopted, which limits to activities related to the optimization of energy profiles by means of energy management. The facilitator role is introduced to cover all other activities related to the provision of energy related services to the community.

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