Business models for a campus-scale demonstrator for DC resilient communities

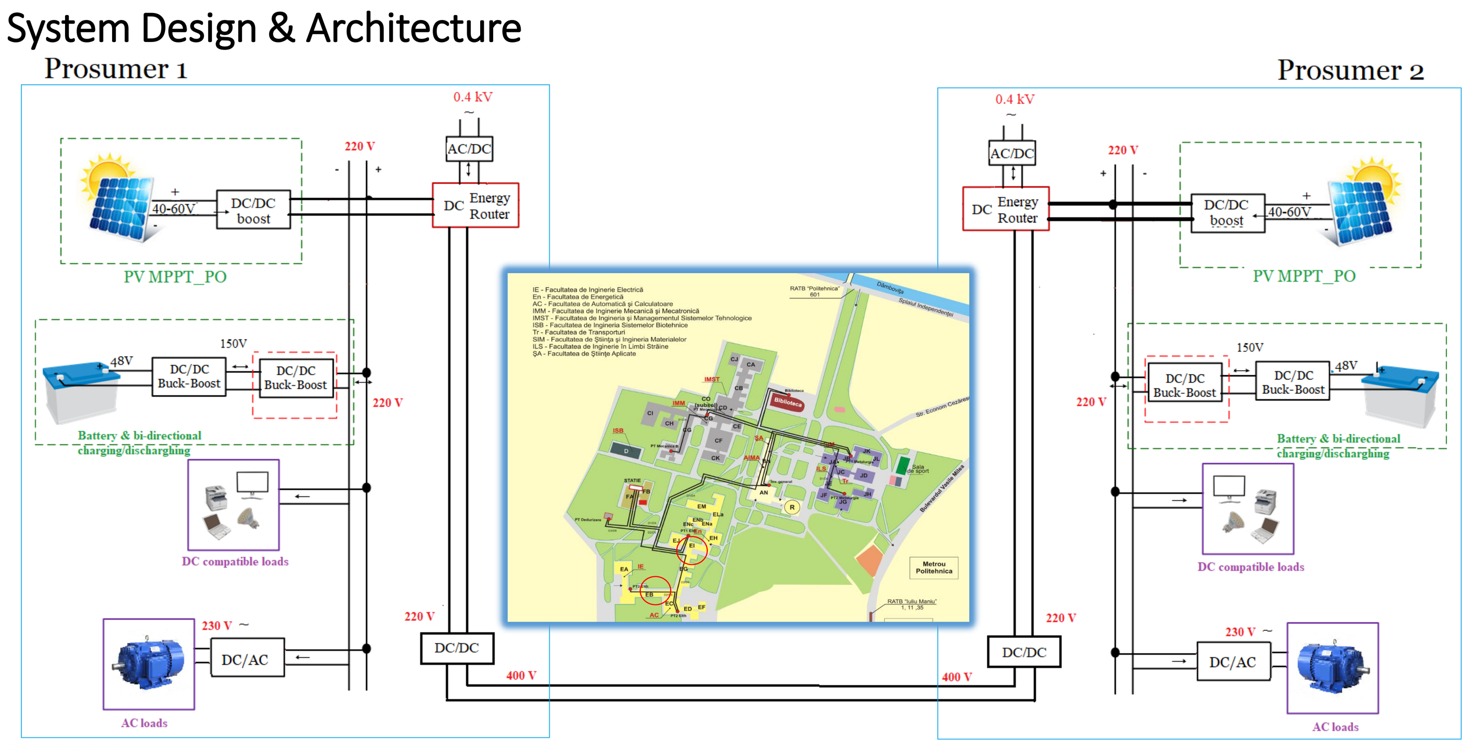
Abstract

This work analyzes a number of business models that are exemplified for a lab/campus-scale demonstrator for DC-resilient communities in Bucharest, Romania. The aim of this study is to pave the path that could unlock some of the above mentioned challenges and barriers, and help such networks to flourish in the near future. The analysis is carried out using the Business Model Generation Framework (BMGF), one of the most popular and systematized industry's state of the art (SoA) tools for developing and creating innovative business models and tools.

Background

Battery energy storage systems (BESS) in conjunction with already or future to be installed PV/wind distributed generation are seen as viable options for increasing self-consumption of residential or low voltage commercial buildings. Furthermore, formation of resilient communities arranged as clusters of residential or commercial microgrids within a small territory is also appealing due to the potential of buying and selling locally produced renewable energy, while reducing the risk of curtailment of RES in weak distribution networks. This fact is favored by: (a) the smoothing effect of load aggregation; (b) reduced power losses in the distribution grid to which prosumers are connected; (c) potential of sharing static

System Design & Architecture



Use cases

Case 1 is for *Storage as a Services*

- *between two prosumers*. At least one of the two prosumers has energy storage system (ESS) on site, which is connected at a common low-voltage DC bus. Assumption: if one prosumer has ESS, it will allocate a share of it to absorb the surplus electricity from a neighboring prosumer, which otherwise would be curtailed by the DSO due to grid constraints reasons.
- *between the grid operator and prosumers* connected to the [legacy] low-voltage network. In the case of a consumption reduction request from the grid operator (e.g. due to network constraints) the prosumer can use the local ESS in order to inject the locally generated electricity into its own LV network, thus being able to reduce the power requested from the upstream MV/LV transformer. This is a service for enhancing network capacity without investment on DSO side. In fact, it can be a stacked business case, combining peer-to-peer energy transaction and also network capacity enhancement.
- *black-start grid capability* as ancillary service when the microgrid is operated in isolated mode. The prosumer which is able to deliver such black-start and grid-former service, is expected to be financially remunerated. Such a case could be a section of the grid with load matching the available electricity to be supplied from microgrid installations only.

Case 2 is for *Resilience by design service* where the prosumers have a hybrid solution, i.e. including a DC bus to which all sensitive loads are directly connected.

Case 3 is for *Advanced cooperative resilience by design service* for communities formed by clusters of prosumers, each deploying a hybrid solution (internal DC bus for all sensitive loads) and, in addition, a DC exchange line with the neighborhood. It is a cooperative resilience by design service.

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Details

Table 1: Stakeholder analyses for Case 1

Stakeholder	Role	The stakeholders' contribution and position	Possibility to affect the project	Actions toward the stakeholder
Prosumer	Investor	Avoids curtailment due to over generation at DSO level (wide area)	Invests in own storage or in energy router/ communication with other entities (DSO, storage owners, other prosumers)	Incentives included in the connection agreement and contract with DSO
DSO	Balance Compliance	Grid-owner, committed to ensure maximum RES-based energy (sustainability), has the incentives to dispatch energy and power among the controlled entities	Invests in communication and accepts different contractual agreements with prosumers and storage owners	Regulator accepts/ incentivizes the local energy flows
Storage owner	Investor	Essential contributor to local balance compliance and to sustainability by enabling higher local consumption of RES-based production while avoiding curtailment of another entity	Invests in communication and accepts different contractual agreements with prosumers	Incentives included in the connection agreement and in the contract with the DSO

Table 2:Stakeholder analyses for Case 2

Stakeholder	Role	The stakeholders' contribution and position	Possibility to affect the project	Actions toward the stakeholder
Prosumer	Investor	Maximizes the consumption of locally produced RES-based energy and increases the resilience against price variability and market rules (e.g. one price scheme for load –only type of customers);	Invests in own storage and in energy router; Selects the DC-loads and the overall loads' priority; Invests in storage based on assumed scenarios [3]	Incentives included in the connection agreement (based on maximum load) and the contract with the DSO
DSO	Balance Compliance	Grid-owner, committed to ensure maximum RES-based energy (sustainability), has the means to plan the distribution of energy, based on load/generation modelling	Avoids back generation and has protected installations against the effects of local, intermittent generation; It has to deal with new load models (Pload<<Pinitially approved for connection)	To support the operational costs, one might need to include in the contract a connection fee, independent from the energy delivered; The Regulator needs to consider this new context of self-consumption in the calculations for the compensations for power distribution losses of the DSO.

Table 3: Stakeholder analyses for Case 3

Stakeholder	Role	The stakeholders' contribution and position	Possibility to affect the project	Actions toward the stakeholder
Prosumer	Investor	Avoids curtailment due to over generation at DSO level (wide area)	Invests in energy router/ communication with other entities (DSO, storage owners, other prosumers)	Incentives included in the connection agreement and contract with DSO; Legal contractual agreements with the storage owner (can be also another prosumer); Meters for local energy exchange (outside DSO's area).
DSO	Balance Compliance	Grid-owner, committed to ensure maximum RES-based energy (sustainability), has incentives to dispatch energy among the controlled entities.	Invests in communication and accepts different contractual agreements with prosumers and storage owners;	Regulator accepts/incentivizes the local energy flows
Storage owner	Investor	Essential contributor to local balance compliance and to sustainability by enabling higher local consumption of RES-based production, while avoiding curtailments (own or from neighbours).	Invests in communication and accepts different contractual agreements with prosumers	Incentives included in the connection agreement and contract with DSO and other prosumers.

Summary

This work elaborated on a number of design and operational use-cases and their corresponding business models for a Lab/Campus scale demonstrator of DC distribution of two *UniRCon* compliance microgrids located at UPB in Bucharest, Romania. The proposed analysis follows the industry SoA Business Model Generation Frameworks. Within the analysis, a number of possible services to benefit the grid or the community were identified. Associated risks and threats as well as solutions to overcome them were also presented.

References

[1] A. Osterwalder, and Y. Pigneur, *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers*. Portland, USA: Wiley, 2010.

[2] M. Sanduleac, M. Albu, L. Toma, J. Martins, A. Gonçalves Pronto, and V. Delgado-Gomes, 'Hybrid AC and DC Smart home resilient architecture: Transforming prosumers in UniRCons', 23rd ICE/IEEE ITMC Conference, pp. 1-6, Madeira Island, 27-29 June 2016.

[3] M. Sanduleac, I. Ciornei, M. Albu, L. Toma, M. Sturzeanu, and J. F. Martins, "Resilient Prosumer Scenario in a Changing Regulatory Environment—The UniRCon Solution," *Energies*, vol. 10, no. 12, p. 1941, Nov. 2017.

Dr. Irina Ciornei*, Eng. Marta Sturzeanu*, Prof. Dr. Mihaela Albu*, Dr. Mihai Sănduleac**, and Dr. Lucian Toma**
*MicroDERLab, Department of Electrical Engineering, **Department of Power Systems, University Politehnica of Bucharest

313 Splaiul Independentei
Bucharest
Romania

Phone Number: +40214029740
E-Mail albu@ieee.org
Web address: www.microderlab.pub.ro