Business Models design for Advanced Energy Communities increasing decarbonization, energy security and lower energy prices

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Luisa Matos, Gonçalo Mendes

Abstract

The current international energy crisis has accelerated the need for new solutions to solve the most urgent trilemma of our times: decarbonizing energy sector while strengthening energy security and reducing energy prices. Energy Communities (ECs) are the next step in the global energy transition with multidirectional flow of data and electrons, diverse participants and wide range of assets. Advanced ECs enabled with virtual power plants (VPP) platforms and AI algorithms are increasing the access to affordable local renewable energy and lowering energy costs. Through the aggregation of energy assets and their automated orchestration it is possible to increase integration of more affordable distributed renewables in the grid and, on the long-term, the deferral of infrastructure investments to meet with growing electrification needs. ECs can have several configurations, including ECs with distributed members using the distribution grid for energy sharing and microgrid configuration under a residential condominium or industrial park using their internal grid. Under FleXunity project multiple business models were designed and tested for distributed mixed-used energy communities (commercial and residential) with multiple distributed energy resources (DER), including PV systems, battery storage and EV charging stations. Implementing the business models and technology developed, results have proven that ECs with higher energy surplus (energy above individual self-consumption shared with EC members) are enabling higher savings for community members, thus contribution the current energy crisis making available more renewable energy locally generated.

Three-level business Models' Framework (strategic, Value proposition, Value chain)

Business Models Levels	BM1 - P2P energy sharing within an Energy Community		BM2 - P2P energy sharing with flexibility for DER optimization	
	Case 1 – Competitive P2P with distributed ownership	Case 2 – P2P energy sharing with centralized ownership	Case 1 – Competitive P2P with distributed ownership + flexibility	Case 2 – P2P energy sharing with centralized ownership + flexibility
First Level: Strategy Level				
Strategic model	Prosumer wants to reduce its energy costs, have additional revenues from its RES, become more sustainable and support its community.	EC manager wants to deploy ECs and share economic, social, and environmental benefits with end-users and local communities.	Prosumer wants to reduce his energy costs, have additional revenues/savings from his RES enabled by flexible loads and storage devices, become more sustainable and support his community.	EC manager wants to deploy flexible energy communities and share economic, social, and environmental benefits with end-users and local communities.
Resources model	Knowledge of renewable generation and P2P trading. Rooftop PV panels assets.	Knowledge of legal REC frameworks, renewable projects deployment and EC engagement. Distributed renewables power plants. VPP platform for EC management.	Knowledge of renewable generation, legal REC frameworks, and P2P trading. Rooftop PV panels assets. Flexible loads and storage devices. Access to VPP platform for P2P trading management.	Knowledge of legal REC frameworks, renewable projects deployment and EC engagement. Distributed renewables power plants, flexible loads, and storage. VPP platform for EC management with automated controls.
Network model	Connection with local energy markets and peers.	Strong partnerships with EPCs and private funding parties, and connectivity with DSOs smart meters. Partnerships with municipalities and/or local agents to facilitate trust and member enrolment.	Connection with local energy markets and peers.	Strong partnerships with EPCs and private funding parties, connectivity with DSO's smart meters, and interoperability with third party-systems/ loads. Partnerships with municipalities and local agents to facilitate trust and member enrolment.
Second Level: Value Proposition Level				
Customer model	Peers and consumers in the local energy market.	Anchor EC members/ prosumers and consumers in the local energy market.	Peers and consumers in the local energy market, with or without flexible assets.	Anchor EC members/ prosumers and consumers in the local energy market, with/without flexible assets.
Market offer model	Prosumers sell electricity surplus in a local energy market. Consumers buy this electricity cheaper than grid electricity.	Sell electricity for self-consumption for prosumers and electricity surplus to consumers cheaper than grid electricity.	Prosumers sell electricity surplus in a LEM and consumers buy this electricity cheaper than grid electricity. Prosumers maximize LEM revenues with flexibility, consumers minimize electricity costs with flexibility.	Sell self-consumption electricity to prosumers and electricity surplus to consumers cheaper than grid electricity. Minimize community generated electricity surplus with flexibility.
Revenue exchange model	Price per kWh sold defined with a market bidding strategy.	Electricity tariff for self-consumption and for surplus electricity sold to members of the community.	Price per kWh sold defined with a market bidding strategy.	Fix or dynamic electricity tariff for self-consumption and for energy sold to members of the community.
Third Level: Value Chain Level				
Delivery model	Electricity is delivered through the distribution grid.	Electricity is delivered behind-the-meter for self-consumption and through the distribution grid for EC members.	Electricity is delivered through the distribution grid.	Electricity is delivered behind-the-meter for self-consumption and through the distribution grid for EC members. HEMS and BEMS for flexibility optimization.
Procurement model	Initial installation of renewables, if not pre-existing, for set-up and rely on P2P market platform operator and O&M provider.	Initial installation of renewables for set-up and O&M provider and EC platform SW provider.	Initial installation of renewables and IoT for set-up and rely on P2P market platform operator and O&M provider.	Initial installation of renewables and IoT for set-up, O&M provider, EC platform SW and VPP provider.
Financial and cost model	Possibility of loan for initial set-up. On-going fees for market participation and assets O&M costs. Network fees for energy shared.	Third-party funding for EC CAPEX. On-going operational costs for EC management and EC platform SW license. Network fees for energy shared.	Possibility of loan for initial set-up. On-going fees for market participation and assets O&M costs. Network fees for energy shared.	Third-party funding for EC CAPEX. On-going operational costs for EC management and EC platform SW and VPP license. Network fees for energy shared.

Tested business case with centralized ownership (prosumer view)

Initial results 2 months after installation of PV capacity and Cleanwatts™ OS

Without our system

June 2022	Energy (kWh)	Weight (100%)	Average cost (€/kWh)	Total cost (€)
Total consumption	33 730	100	€0.14	€ 4 554
			Total	€ 4 554

With Cleanwatts system and business model

June 2022	Energy (kWh)	Weight (100%)	Average cost (€/kWh)	Total cost (€)
Solar Generation*	21 570	64	€0.07	€ 1 510
Grid	12 160	36	€0.13	€ 1 556
			Total	€ 3 066

* Anchor client is currently limiting their energy generation until the REC is fully established as they receive no compensation from the grid operator for the excess generation

Savings: 1 488€ (33%)

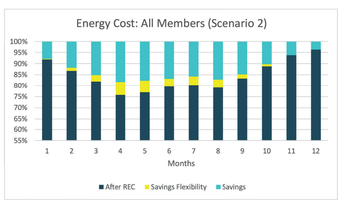
340 k€ — Total estimated returns during the duration of the lease contract (15 years)
- ✓ Savings from optimized self-consumption: 235k€
- ✓ Surplus sold to community: 70,5k€
- ✓ Savings from optimization & efficiency by Cleanwatts™ OS: 32k€

750k€ — Returns in the 10 years after the lease period

1 100k€ — **Total returns in 25 years**

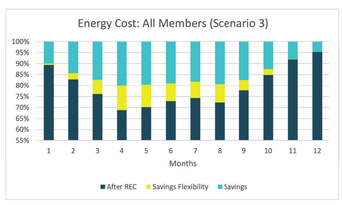
FleXunity pilot case with P2P energy sharing with flexibility for DER optimization with centralized ownership

EC with P2P and centralized ownership enhanced with additional surplus and flexibility



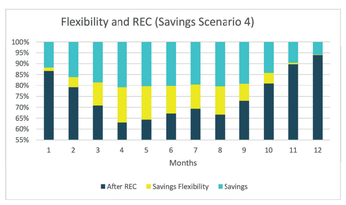
New surplus 10% — Savings 13.60% (+surplus) + 2.71% (+flex)

Scenario 2: original generation was multiplied by 1.5, resulting in a surplus of 10%



New surplus 20% — Savings 16.33% (+surplus) + 5.89% (+flex)

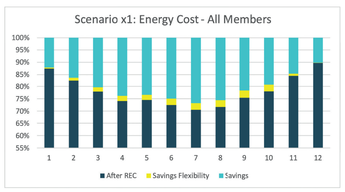
Scenario 3: original generation was multiplied by 2, resulting in a surplus of 20%



New surplus 30% — Savings 18.44% (+surplus) + 8.58% (+flex)

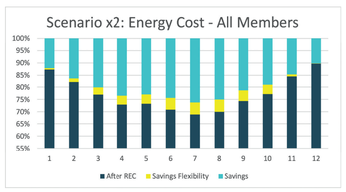
Scenario 4: original generation was multiplied by 2.5, resulting in a surplus of 30%

EC with P2P and centralized ownership surplus of 20% and additional flexibility



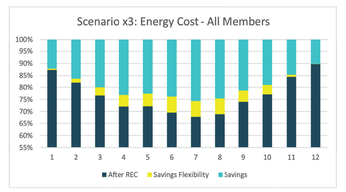
Savings: 21,80% (+total) 1,82% (+flex)

Scenario 1: original flexible load was used



Savings: 22,90% (+total) 3,01% (+flex)

Scenario 2: flexible load was multiplied by 2



Savings: 23,70% (+total) 4,77% (+flex)

Scenario 3: flexible load was multiplied by 3

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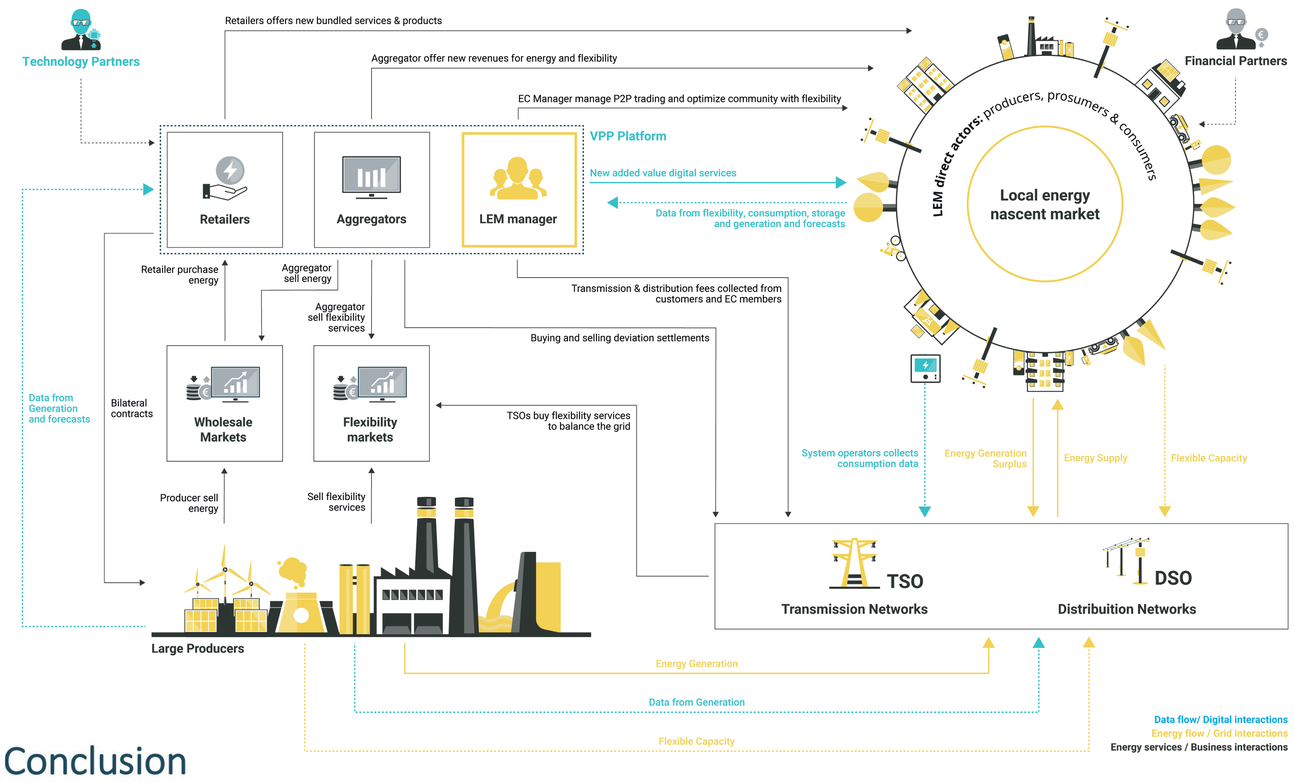
Local energy nascent markets



Conclusion

New business models for Energy Communities and the rise of Local Energy Markets have the potential to facilitate the access to renewable energy at lower prices, allow the direct participation of small prosumers, who can access new revenues and lower their carbon footprint, and support security of supply challenges. Additionally, they can alleviate constraints on transmission and distribution networks, especially in peak periods, alleviating congestion problems. Models supported on the centralized ownership can help accelerate the setting-up of LEM and latter attract new independent participants aiming to monetize their surplus and flexible loads.

This study was undertaken as part of the FleXunity project, Energy Community projects of Cleanwatts and doctoral research of Luisa Matos. Contacts:

Luisa Matos, Co-founder and Chief Innovation and Product Officer
Cleanwatts, S.A., Coimbra, Portugal
lmatos@cleanwatts.energy
www.cleanwatts.energy

Gonçalo Mendes, Senior Researcher
LUT School of Energy Systems, LUT, Lappeenranta, Finland
Goncalo.Mendes@lut.fi
www.lut.fi