Renaissance

RENEWABLE INTEGRATION & SUSTAINABILITY IN ENERGY COMMUNITIES

D3.2 – Benchmarked Business Model Report v2.0– Update Replication Sites

Document author(s) and Company – **M.L. Lode (VUB)**

Document Number	D3.2
Document Title	Benchmarked Business Model Report – Replication Sites (updated version)
Version	1.0
Status	Final
Work Package	WP 3
Deliverable Type	Report
Contractual Date of Delivery	30.06.2022
Actual Date of Delivery	30.06.2022
Responsible Unit	VUB
Contributors	IKERLAN, BAX
Keyword List	Social enterprise canvas models, international energy communities, organizational models, legal challenges, technical optimization of energy communities
Dissemination level	PU

This project has received funding from the European Union's H2020 research and innovation programme under the grant agreement No **824342**. This document reflects only the author's view and the Commission is not responsible for any use that may be made of the information it contains.

RENAISSANCE Consortium

RENAISSANCE "Renewable Integration & Sustainability in Energy Communities" (Contract No. 824342) is a Collaborative project) within the H2020-LC-SC3-2018-2019-2020/H2020-LC-SC3-2018-ESSCC. The consortium members are:

1	VUB VRIJE UNIVERSITEIT BRUSSEL	VRIJE UNIVERSITEIT BRUSSEL **(VUB)** 1050 Brussels, Belgium	Contact: Thierry Coosemans thierry.coosemans@vub.be
2	Atos	ATOS SPAIN SA **(ATOS)** 28037 MADRID | Spain	Contact: Javier Valiño javier.valino@atos.net
3	ikerlan	IKERLAN S COOP **(IKE)** 20500 MONDRAGON | Spain	Contact: Aitor Milo Urkiola amilo@ikerlan.es
4	deepblue	DEEP BLUE Srl **(DBL)** 00193 ROME | Italy	Contact: Alessandra TEDESCHI Alessandra.tedeschi@dblue.it
5	ingeniería everis	EVERIS ENERGIA Y MEDIOAMBIENTE SL **(EXE)**	Contact: Miguel Fontela Miguel.Fontela.Martinez @everis.com
6	oca MANZANEDA ESTACIÓN DE MONTAÑA	ESTACION DE INVIERNO MANZANEDA SA **(MEISA)** 32780 A POBRA DE TRIVES | Spain	Contact: Gustavo Samartín direccion@manzaneda.com
7	circe RESEARCH CENTRE FOR ENERGY RESOURCES AND CONSUMPTION	FUNDACION CIRCE CENTRO DE INVESTIGACION DE RECURSOS Y CONSUMOS ENERGETICOS **(CIRCE)** 50018 ZARAGOZA | Spain	Contact: Andreas Munoz renaissance@fcirce.es

Horizon 2020
European Union Funding
for Research & Innovation

8	DEMOCRITUS UNIVERSITY OF THRACE	DIMOKREITIO PANEPISTIMIO THRAKIS **(DUTH)** 69100 KOMOTINI | Greece	Contact: Pantelis Botsaris panmpots@pme.duth.gr
9	CERTH CENTRE FOR RESEARCH & TECHNOLO HELLAS	ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS **(CERTH)** ANAPTYXIS 57001 THERMI THESSALONIKI | Greece	Contact: Nikos Nikolopoulos n.nikolopoulos@certh.gr
10	BAX & COMPANY/ VALUE FROM SCIENCE AND TECHNOLOGY	BAX INNOVATION CONSULTING SL **(BAX)** 08013 BARCELONA | Spain	Contact: Maarja Meitern m.meitern@baxcompany.com
11	sdm elektro	SDM-PROJECTS **(SDM)** 3090 OVERIJSE | Belgium	Contact: Ellen Vanderdood vanderdood@sdme.be
12	NAPE NATIONAL ENERGY CONSERVATION AGENCY	NARODOWA AGENCJA POSZANOWANIA ENERGII SA **(NAPE)** 00 002 WARSZAWA | Poland	Contact: Andrzej Wiszniewski awiszniewski@nape.pl
13	ABB	ABB OF ASEA BROWN BOVERI **(ABB)** 1930 ZAVENTEM | Belgium	Contact: Van Rysselberge wouter.vanrysselberghe@be.abb.com
14	Sunamp	SUNAMP LIMITED **(SUN)** EH33 1RY MACMERRY | United Kingdom	Contact: Tianyue Li tianyue.li@sunamp.com
15	GEMEENTE EEMNES	GEMEENTE EEMNES **(EEM)** 3755 ZH EEMNES | Netherlands	Contact: Wilma de Boer w.deboer@Eemnes.nl

Horizon 2020
European Union Funding
for Research & Innovation

Document change record

Version	Date	Status	Author (Unit)	Description
0.1	01.12.2021	Draft	M.L.Lode (VUB)	[First Draft]
0.2	15.01.2022	Draft version	M.L.Lode (VUB)	[Addition of Spanish Case]
0.3	05.05.2022	Draft version	M.L.Lode (VUB)	[Addition of Spanish and International cases]
0.4	20.05.2022	Draft version	M.L.Lode (VUB)	[Addition of Italian case]
0.5	01.06.2022	Final version	M.L.Lode (VUB), W. Brosius (VUB)	[Preparation of Final version to be reviewed]
0.6	10.06.2022	Final version	A.Milo (IKERLAN), V. Zea (BAX)	[Final review]
1.0	30.06.2022	Final version	M.L.Lode (VUB), S. Arapoglou (VUB)	[Submitted version]

Horizon 2020
European Union Funding
for Research & Innovation

Executive summary

This deliverable provides a summary of the researched Business Models (BMs) across the international replication sites located in Spain, Italy, Poland, India, and Uganda. An overview of the most (socially) preferred technical option, and implications for the regulatory and organizational model for the local ECs is given leading to the development of different Business Models (BMs), that fulfil the local conditions, requirements, and social preferences the best. The most fit BMs are then shown in the Social Enterprise Model Canvas (SEMC). Based on the findings, we highlight the commonalities and differences across the BMs and conclude on their feasibility and challenges.

Horizon 2020
European Union Funding
for Research & Innovation

Table of Contents

1. Introduction 10
2. Framework of Benchmarking 10
   2.1. Social Enterprise Model Canvas 12
3. Vega de Valcarce 14
   3.1. General scenarios 15
      3.1.1. Technical options for Vega de Valcarce 15
      3.1.2. Stakeholder Preferences 17
      3.1.3. Regulatory and organizational models 17
   3.2. Vega's Social Enterprise Model Canvas 20
   3.3. Feasibility and challenges 21
4. Relleu, Spain 22
   4.1. General scenarios 23
      4.1.1. Stakeholder scenarios and preferences 23
      4.1.2. Regulatory and organizational models 23
   4.2. Relleu's Social Enterprise Model Canvas 24
5. Szaserow and Beli Bartoka Housing Association 25
   5.1. General Scenarios 25
      5.1.1. Technical Scenario for Szaserow 25
      5.1.2. Technical Scenario for Beli Bartoka 27
      5.1.3. Preferences of stakeholders 29
   5.2. Regulation and organization 31
   5.3. Social Enterprise Model Canvas 32
   5.4. Feasibility and challenges 34
6. Auroville India 35

Horizon 2020
European Union Funding
for Research & Innovation

6.1. General Scenarios 35
6.1.1. Technical Options for Auroville 35
6.1.2. Stakeholder Preferences 36
6.1.3. Regulatory and organizational models for Auroville 37
6.2. Auroville's Social Enterprise Model Canvas 39
6.3. Feasibility and challenges 40
7. Lacor Hospital,Gulu, Uganda 40
7.1. General Scenarios 40
7.1.1. Technical scenarios for the Lacor Hospital 40
7.1.2. Stakeholder preferences 43
7.1.3. Regulatory and organizational options 43
7.2. St.Mary's Social Enterprise Model Canvas 44
7.3. Feasibility and challenges 46
8. Impruneta, Italy 46
8.1. General scenarios 47
8.1.1. Technical options for Impruneta 47
8.1.2. Stakeholder Preferences 48
8.1.3. Regulatory and organizational models 49
8.2. Impruneta's Social Enterprise Model Canvas 50
8.3. Feasibility and challenges 51
9. Summary of challenges 52
10. Conclusions 53
11. References 55

List of figures

Horizon 2020
European Union Funding
for Research & Innovation

Figure 1 - Social Enterprise Model Canvas 14
Figure 2: Multi-Actor View for Vega de Valcarce 17
Figure 3: Multi-Criteria results Szaserow 30
Figure 4: Multi-Criteria results Beli Bartoka 31
Figure 5: Installed capacity per scenario at Auroville 36
Figure 6: MCA result for Auroville 37
Figure 7: Installed capacities for each scenario 41
Figure 8: Results environmental analysis 42
Figure 9: Results economic analysis 42
Figure 10: Multi-Actor View for St.Mary Hospital 43
Figure 11: Economic analysis Impruneta (a) 48
Figure 12: Economic analysis Impruneta (b) 48
Figure 13: Multi-Actor View Impruneta 49

List of Tables

Table 1 - Comparison of CEC and REC 11
Table 2 - Overview of scenarios of Vega 15
Table 3 - Economic results 16
Table 4 - Organizational models 20
Table 5 - SEMC for Vega de Valcarce 21
Table 6 - Building blocks for scenarios 23
Table 7: Relleu's SEMC 24
Table 8: Szaserow's Technical Scenarios 26
Table 9: Economic results for Szaserow 27
Table 10: Beli Bartoka‘s Technical Scenarios 28
Table 11: Economic results of installation 29
Table 12: Organizational options in Poland 32

Horizon 2020
European Union Funding
for Research & Innovation

Table 13: SEMC for Szaserow 33
Table 14: Beli Bartoka's SEMC 34
Table 15: Technical scenarios for Auroville 36
Table 16: Auroville's SEMC 39
Table 17: Technical options for St. Mary Hospital 41
Table 18: SEMC for St. Mary Hospital 45
Table 19: Overview of scenarios of Impruneta 47
Table 20: Impruneta's Social Enterprise Model Canvas 51

Horizon 2020
European Union Funding
for Research & Innovation

1. Introduction

Energy Communities (ECs) are emerging across the European Union (EU) following different forms of business models (BMs). This deliverable summarizes the developed BMs for the international replication sites of the RENAISSANCE project; it is building on the first version of D3.1 which was summarizing the business ecosystem, and potential BMs for ECs from a general perspective, and analysed the BMs developed for the pilot sites of RENAISSANCE in detail. RENAISSANCE replicated its approach at ten additional sites across the globe situated in Spain, Italy, India, Uganda, Argentina, Chile, and Colombia. This deliverable shortly describes the replication sites and analyses the BMs developed in detail, using the Social Enterprise Model Canvas (SEMC), an adapted version of the BM canvas for social enterprises. Doing so, the deliverable highlights which BMs were considered (not) feasible at the different sites. The evaluation of the BMs was conducted using various options for ECs presented in the Multi-Actor Multi-Criteria Analysis (MAMCA) deliverable D2.1. Depending on the sites, the options for ECs entail information about technical/financial, and organizational aspects. Additionally, this report also addresses challenges and barriers towards the implementation of specific BMs.

2. Framework of Benchmarking

For the framework of benchmarking, the MAMCA results in D2.1 are used as an input.

Because the legal definitions of a Citizen Energy Community (CEC) and Renewable Energy Community (REC) pursue a social and environmental focus rather than an economic one, the traditional BM canvas is less suitable for EC initiatives. See Table 1 for the differences between CEC and REC

Horizon 2020
European Union Funding
for Research & Innovation

according to the Renewable Energy Directive (REDll) and the Internal Electricity Market Directive (EMD) [1,2]. The overview is taken from [3].

Criteria	Renewable Energy Communities (RECs) Arts. 2 (16), 22 REDII	Citizen Energy Communities (CECs) Arts. 2 (11), 16 EMD
Primary Purpose	"Environmental, economic or social community benefits for its shareholders / members or for local areas where it operates, rather than financial profits";	
Energy	‣ Natural persons, ‣ SMEs, ‣ · Local authorities, incl. municipalities;	Any entity;
Eligibility	„open and voluntary participation of the members based on principles of non-discrimination "	
Member-ship		
Owner-ship and Control	‣ Effectively controlled by shareholders or members that are located in the proximity of the RE project; ‣ Is autonomous (no individual shareholder may own more than 33% of the stock).	‣ Effectively controlled by shareholders or members; ‣ Limitation for firms included in shareholders controlling entity to those of small/micro size (not medium); ‣ Shareholders engaged in large scale commercial activity and for which energy constitutes the primary area of activity excluded from control.
Advantages to qualify as REC or CEC	‣ "Enabling framework" to promote and facilitate the development of RECs; ‣ "Equal footing" principle takes into account size and ownership structure of RECs vis-à-vis commercial projects;	‣ Level playing field; ‣ Although elements of support to integrate RES are present no specific advantages to increase CECs competitiveness vis-a-vis commercial projects foreseen;
Energy Sharing	Right to share energy / electricity produced by the production units owned by an energy community within that community including over the public grid if it owns two metering points	

Table 1 - Comparison of CEC and REC

Horizon 2020
European Union Funding
for Research & Innovation

To account for this social and environmental value proposition that ECs should pursue, we use the SEMC to analyse the preferred EC option resulting from the MAMCA analysis. In contrast to the BM canvas used in D3.2. v1, the SEMC adds some layers of information specific for social enterprises. The SEMC is introduced in the next section. To show the SEMC for the replication sites, we use the input generated through the application of MAMCA, the energy system optimization (using the Renergise tool), and the regulatory analysis. In this deliverable, the replication sites are shortly introduced, then the technical scenarios for each site are explained, the stakeholder preferences are shown through the MAMCA results and the key findings from the regulatory analysis are summarized.
All findings combined, we provide a SEMC for the optimal social, technical, and regulatory EC option for communities located at Vega de Valcarce (ESP), Florence (IT), Relleu (ESP), Auroville (IN), Gulu (UGA), Beli Bartoka and Szaserow (PL). Since the visits to the replication sites in Argentina, Colombia, and Chile are scheduled for July 2022, they are not included in this deliverable. Information about the MAMCA can be found in Deliverable D2.1. and D2.2, and about the Renergise tool in D2.4 and D2.6, and about the regulatory analysis in D6.5, which can all be found on the RENAISSANCE website once published.

2.1. Social Enterprise Model Canvas

The SEMC allows to visualize the BM of social enterprises that do not follow a mere revenue driven objective. Therefore, the SEMC adds several layers to the traditional BM canvas by Osterwalder [4] which was used for the first version of D3.1. In the context of ECs, it can show how the initiative is governed, so which mechanisms and governance mechanisms enable the provision of the (social) value proposition (SVP). This is shown in the added governance (GOV) aspect in Figure 1. The key resources (KR) which are the resources/assets needed for the BM to function properly, the key activities

Horizon 2020
European Union Funding
for Research & Innovation

(KA) are the activities that the BM needs to follow to provide the social value proposition. The channels (CH) describe the means of communication and dissemination to its customers and beneficiaries. The cost structure (C$) includes all occurring costs in the entire BM including social and environmental costs are considered. In contrast, the income structure (I$) entails also occurring benefits and revenue streams of the BM. The entire BM is centred around the social value proposition, so the products/services the BM provides to create its unique value to its customers. The non-targeted stakeholders (NtS) replace the key partnerships of the traditional BM canvas, it shows who could be affected by the BM while not being considered as a customer or main beneficiary. On the other side, there are the customer and beneficiaries (C&B) who are considered as the main target group of the BM. Also, the mission values (MV) which are the long-term, normative goals of the BM, and the objectives (O), the short-term, practical goals of the BM, are added in the SEMC. The impact measures (IM) describe the measures used to assess the progress on the MV, while the output measures (OM) describe the measures used to assess the progress on the objectives.

Horizon 2020
European Union Funding
for Research & Innovation

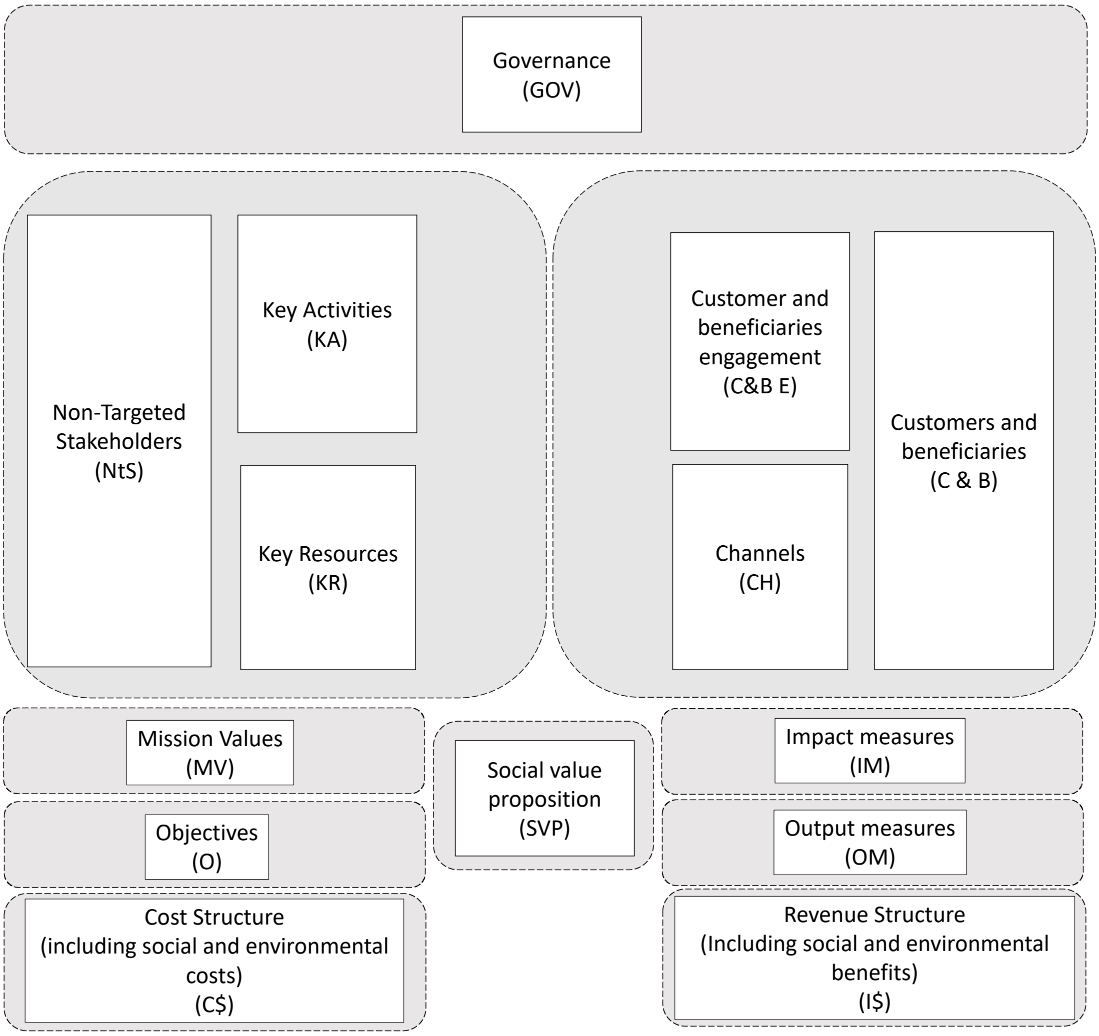

Figure 1 – Social Enterprise Model Canvas

3. Vega de Valcarce

Vega de Valcarce is a rural town with 200 residents located in the autonomous region of Castille and León in the Northwest of Spain. ReViEVAL, a non-profit association has collaborated with the municipality of Vega de Valcarce to foster the local economy by setting up an EC [5]. Vega de Valcarce and ReViEVAL have searched for external support on

Horizon 2020
European Union Funding
for Research & Innovation

socio-economic, technical, legislative, and regulatory aspects to set-up such an EC. RENAISSANCE has contributed by providing insights from the MAMCA analysis, and the Renergise tool. The SCORE project [6] also supported the initiative by providing a legal and regulatory analysis and showing which organizational model could be most suitable for Vega de Valcarce.

3.1. General scenarios

3.1.1. Technical options for Vega de Valcarce

The potential technical options for the ECs were introduced and analyzed in the MAMCA process, they are shown in Table 2. The scenarios differ in the number of EC members (so changing total consumption), and number of installed capacities of photovoltaic (PV) assets. The scenarios range from putting PVs and involve only the municipality, to the municipality and school, then, adding a different number of residential and commercial consumers (seen on the column for involved consumer).

Scenario	Number	Involved consumers	Total consumption
Reference	0	Municipality (townhall)	61,541 kWh/year
Public buildings	1	Municipality and school (townhall and school building)	107,646 kWh/year
Small community	2	Municipality and school (townhall and school building), residential (10) and commercial (5) consumers	249,886 kWh/year
Medium-sized community	3	Municipality and school (townhall and school building), residential (50) and commercial (5) consumers	303,933 kWh/year
Large Community	4	Municipality and school (townhall and school building), residential (100) and commercial (5) consumers	443,034 kWh/year

Table 2 - Overview of scenarios of Vega

Horizon 2020
European Union Funding
for Research & Innovation

The results of the economic analysis of the differently sized ECs are shown in Table 3. The average unit costs without EC are based on calculations for when the PVs are operating, this results in slightly different average unit costs for the different sizes of PV and their respective demand curves. As a general conclusion, the results show that the higher the number of EC participants, and as more diverse the involved consumer groups are, the better their performance on the selected indicators reflecting the most important objectives of the MAMCA exercise.

Scenario	Average unit cost without EC	PV production	PV system capacity	Cost of the PV plant	Self-consumption ratio	PV electricity consumed within the EC	Required tariff by REC to meet 10% economic rate of return	Saving per unit of energy
	€/MWh	kWh/ year	(kWp)	€	(%)	(kWh/ year)	(€/ MWh)	(€/ MWh)
0	133	9,828	7.3	7,399	56	5,460	154	-21
1	140	27,627	20.5	20,799	78	21,504	110	30
2	141	82,139	60.9	61,839	83	68,456	103	38
3	142	102,891	76.3	77,462	84	86,107	103	39
4	144	134,820	100.0	101,500	91	122,489	95	49

Table 3 – Economic results

Horizon 2020
European Union Funding
for Research & Innovation

3.1.2. Stakeholder Preferences

During the MAMCA workshop at the site, the participants were in favour of the largest EC scenario, as shown in Figure 2. In this figure, the x-axis shows the participating stakeholders, and on the y-axis the evaluation score results are shown. The selected objectives on which the evaluation is based on are emission reduction, reduction of the energy bill, increase of local employment, increase of energy autonomy, behaviour change, maintenance costs, return on investment, inclusion, landscape changes, replicability, and grid stability.

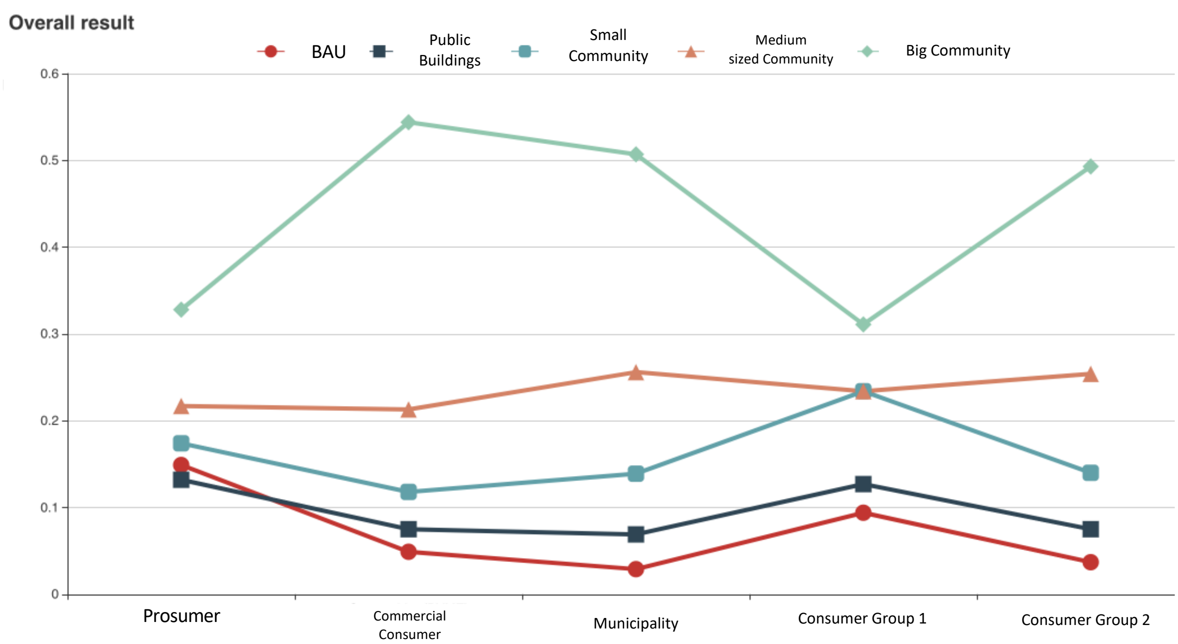

Figure 2: Multi-Actor View for Vega de Valcarce

3.1.3. Regulatory and organizational models

This section addresses the regulatory and organizational options specific to the country of Spain and then highlights the most feasible option for Vega de Valcarce. The findings here also apply for Relleu which is the second replication site in Spain, with the most feasible option for Relleu explained in Section 4.1.2.

Horizon 2020
European Union Funding
for Research & Innovation

3.1.3.1. Regulatory options

Currently (June 2022), the Spanish regulation defines an EC as the following: *"Legal entities based on open and voluntary participation, autonomous and effectively controlled by partners or members that are located in the vicinity of renewable energy projects owned and developed by such legal entities, whose partners or members are natural persons, SMEs or local authorities, including municipalities and whose primary purpose is to provide environmental, economic or social benefits to their partners or members or to the local areas where they operate, rather than financial gain"* (*Real Decreto-ley 23/2020 [7]*)

Currently, there are two options to implement an ECs:

1. **Self-supply/off-site self-consumption without energy surplus**: no export to the transmission or distribution grid is allowed, only a consumer role exists, self-contracting, there is a maximum of 100kW for the production size
2. **Individual/Collective Self-consumption with energy surplus:** allows export of energy surplus to the transmission and distribution grid, producer and consumer roles exist, this model has two sub-models:
   a) **With compensation:** usage of compensation mechanisms for systems less than 100kW, compensation contract must be signed, distance between the consumer's properties must be lower than 500m and the consumption points must share the first 14 digits of the cadastral Reference, must be connected to low-voltage grid, maximum amount of energy that can be compensated is the amount purchased from the grid and cannot be negative, it cannot compensate the payments for access
   b) **Without compensation mechanisms:** must be signed as an energy producer in the register and energy is directly sold to the market, may be higher than 100kW

Horizon 2020
European Union Funding
for Research & Innovation

For Vega de Valcarce, and for residential consumers in general, collective self-consumption with a compensation scheme (requiring installations lower than 100kW) is more attractive as it has the least administrative burden and generation can be shared between the neighbours (within the same building or within 500m).

3.1.3.2. Organizational Models

There are several organizational models in Spain that would allow to implement an EC with different organizational implications. In the analysis for Vega de Valcarce, the entities; partnerships, limited partnerships, limited liability company (LLC), a cooperative, or the trustee scheme "Consumer Stock Ownership Plan" (CSOP) were considered as suitable. The different options and their implications on voting rights, rights on information, compatibility with strategic commercial investors, and municipal investments, personal liability, changes in participants, and start-up costs are shown in Table 4 [3,8].

	Partnerships	Limited partnership	LLC	Cooperatives	CSOPs
Voting rights	Direct, often proportional to shares	Only for general partners (GPs), direct, proportional to shares) / not for limited partners (LPs)	Direct, proportional to shares	Direct, one member, one vote	Conveyed through trustee / representative
Rights of information	Given	Limited for LPs	Given	Given	Given / but may be delegated
Compatibility with strategic commercial investors	Not practised	Given	Less common	Unusual	Given

Horizon 2020
European Union Funding
for Research & Innovation

Compatibility with municipal investments	Not possible	Possible, but not common	Given	Limited	Given
Personal liability	Unlimited	For LPs limited to investment / for GPs personal, unlimited	Limited to investment	Usually limited to investment	Limited to investment
Changes in participants	Possible, no registration	Limited / costly unless trustee relationship	Limited / conditional on the agreement of shareholders	Possible, easy / according to statutes	Possible, easy / according to statutes
Start-up costs	Low	Medium	Low	Low	Medium

Table 4 - Organizational models

At Vega de Valcarce, the LLC is the most feasible option as it is suitable for small-medium sized projects (in contrast to the CSOP), and allows for the inclusion of commercial investors, and the municipality (in contrast to the cooperative and partnership model). The Vega case study has extensively been studied and is available via [3].

3.2. Vega's Social Enterprise Model Canvas

Combining the findings of the technical, and socially preferred MAMCA scenario and the information of the regulatory and organizational findings, we compiled the most suitable SEMC. The SEMC of the EC at Vega de Valcarce (from the viewpoint of the LLC members) is shown in the Table 5.

Horizon 2020
European Union Funding
for Research & Innovation

GOV			
Limited Liability Company			
NtS	KA	CH	C&B
Non-members	Investment in RES, generation of PV, co-ownership of RES	Newsletter, e-mail,	Members, citizens within 500m radius from generation assets
	KR	C&B E	
	PV, smart meters,	Membership, co-ownership, co-investment	

MV	SVP	IM
Re-attract people to visit/move to Vega de Valcarce, and revive the local/rural economy	Generation and supply of local, and renewable energy, decreased energy costs and strengthening local economy (re-attraction of rural area)	People moving to Vega de Valcarce or know/travel to the municipality
O		OM
Objectives selected in the MAMCA*		KPIs selected in the MAMCA**

C$	I$
Investment costs PVs, maintenance costs of PVs, creation of LLC	Investment contribution from members

Table 5 - SEMC for Vega de Valcarce

**emission reduction, reduction of the energy bill, increase of local employment, increase of energy autonomy, behaviour change, maintenance costs, return on investment, inclusion, landscape changes, replicability, and grid stability.*

***e.g., CO_2 savings, total energy costs in Euro (including costs for maintenance), number of jobs created, % of self-sufficiency, increased knowledge (survey), perceived landscape changes (survey), policy on inclusion, number of blackouts*

3.3. Feasibility and challenges

In the process, Vega de Valcarce was faced with various challenges emerging from mainly regulatory and practical barriers.

Horizon 2020
European Union Funding
for Research & Innovation

For example, the distance between the consumers' properties must be lower than 500m and the generation and consumption point must share the first 14 digits of their Cadastral Reference. The regulation of collective self-consumption is not dynamic, this is very limiting which prevents ECs to reach their maximum potential. While the citizens seemed in favour of the development of an EC, they expressed the desire for the municipality to take the lead in the process. However, a lack of support for municipalities both financially and practically (through legal support) was communicated.

From a practical viewpoint, there was also a lack of companies that could build and maintain the installations.

For an extensive analysis of the Vega de Valcarce replication site, refer to the document "Coupling rural development with the development of Energy Communities: A participatory study in Vega de Valcarce, Spain"[3].

4. Relleu, Spain

Relleu is a village of approximately 1,300 inhabitants near Alicante. In Relleu, there is a newly built compound of 37 houses which is the subject of this pilot site. This community has a strong interest in renewable energy systems, in particular solar PV, and is exploring all avenues to achieve this goal. It has a well organised Home Owners'Association which governs all decision-making that applies to the exteriors of the houses and the commons. Most owners are foreigners and typically from The Netherlands and Belgium while only a minority is from Spain. The potential energy community is still at its infancy stage and still needs awareness-raising and information gathering. It is for this reason that a small group of key homeowners joined the MAMCA process.

Horizon 2020
European Union Funding
for Research & Innovation

4.1. General scenarios

4.1.1. Stakeholder scenarios and preferences

In Relleu, no technical scenarios were developed. The MAMCA workshop was used to develop EC scenarios in a participatory way and let the stakeholders develop and evaluate the scenarios themselves.

For the development of the scenarios, the stakeholders were provided to combine different building blocks that compose an EC. The components and possible examples for the building blocks used are summarized in Table 6.

	Component	Examples for the building blocks
1	Legal form	Cooperative, commercial company
2	Size of the community and members	Only for residents, sports hall and other public facilities to participate, entire village to participate
3	Installations and technologies	Solar panels only, adding a windmill, Adding batteries
4	Energy exchange mechanisms	Peer-2-peer exchange with neighbours Exchange with the grid as a “community”
5	Energy services offered	Energy exchange, sell of excess energy, shared electric vehicles (EVs)
6	Timeframe	Short-term, medium-term, long-term
7	Degree of autonomy from the grid	Complete energy self-sufficiency as a community, make everyone as self-sufficient as possible
8	Investment and ownership of installation	Own ownership and investment, Shared ownership and investment, External investment

Table 6 - Building blocks for scenarios

4.1.2. Regulatory and organizational models

In Relleu, the same regulatory findings apply, as summarized in section 3.1.3. In contrast to Vega de Valcarce, the participants of the workshops favored the cooperative model to implement an EC at Relleu.

Horizon 2020
European Union Funding
for Research & Innovation

4.2. Relleu's Social Enterprise Model Canvas

Table 7 shows the SEMC for Relleu. The homeowner's association would set up a cooperative which is a common form for ECs. The model is specified below.

GOV			
Cooperative, managed by the Homeowners' Association			
NtS	KA	CH	C&B
Other Relleu residents and public/commercial stakeholders outside of the compound	Investment in and management of PV (goal: electricity supply to its members)	Through regular meetings and emails of the Homeowner's Association	Cooperative members
	KR	C&B E	
	PV, smart meters	Through the cooperative system, one member-one vote, ownership,	
MV	SVP		IM
Locally sourced energy to increase autonomy, community strengthening, and lower energy bills for the members	Incentive for more PV installations, provision of locally sourced renewable energy at a lower cost, increased autonomy of electricity provision		Number of PV installations, number of cooperative members, yearly amount of member meetings on the topic, electricity cost
O			OM
Objectives selected in the MAMCA*			KPIs relating to the measurement of the communicated objectives**
C$		I$	
Investment, installation and maintenance costs PVs, smart meters, creation of legal entity (Cooperative), notary fees		Reduced exposition to fluctuation of energy prices, emissions reduction, created ownership and voting rights, sense of community, knowledge creation	

Table 7: Relleu's SEMC

**Safety, lower energy bill, inclusiveness, grid stability, energy independence, direct user participation, increased share of renewable energy, emissions reduction, reducing energy poverty*

Horizon 2020
European Union Funding
for Research & Innovation

***number of blackouts, costs for energy, distribution mechanisms for energy poor, number of members, ratio of renewable energy in the energy mix, reduction of CO_2 emissions,*

The same feasibility and challenges from Vega de Valcarce apply to the case study of Relleu, found in Section 3.3.

5. Szaserow and Beli Bartoka Housing Association

Both Polish replication sites are building complexes with the aim to reduce CO_2 emissions and locally produce affordable energy. Since Russia launched its war against Ukraine, the aspect of energy autonomy has increased in importance for the replication sites.

Szaserow consists of 28 buildings with over 1400 inhabitants. The key stakeholders of Szaserow are the housing co-operative, tenants who are owners of dwellings and co-owners/users of common areas.

The Beli Bartoka dwelling is a residential building with 128 apartments units, 4 commercial premises and 150 square meters of underground garages. The building gets frequently modernized to reduce the overall energy consumption. Both replication sites are in Warsaw.

5.1. General Scenarios

5.1.1. Technical Scenario for Szaserow

The technical scenarios for Szaserow differ in the size, and distribution of produced solar energy. As a baseline scenario, the PV installations of twelve buildings only provide energy for the common areas of the twelve buildings where the PVs are installed. In the second scenario, the PV installations on the twelve buildings are used to for the common areas and the resident's private flats. In the third scenarios, 28 buildings join the scheme and energy generated through the PVs is supplied to all common areas and the flats. In

Horizon 2020
European Union Funding
for Research & Innovation

contrast, in the fourth scenario, the twelve buildings with PV installations become energy prosumers and sell the surplus energy to the remaining buildings.

The scenarios are affected by the following assumptions/considerations.

The energy community is a single "big consumer", meaning that the optimization is done for the whole community and results for each user are extracted afterwards. Only yearly consumption data were provided, the same synthetic consumption profile was used for every user. The results of each scenario will be compared to the situation without PV. The maximum PV capacity allowed is 975 kWp, based on the roof area and there are three types of users based on flat size:

- Type 1: < 39 m2
- Type 2: 40 – 70 m2
- Type 3: < 70 m2

The summary of the technical scenarios is shown in Table 8.

Scenario	Number	Involved consumers	Total consumption
Common areas of 12 buildings with suitable roof for PV	1	12 buildings	(27098 kWh/year)
12 buildings with suitable roof for PV, common areas + flats	2	12 buildings, common areas and flat	(667139 kWh/year)
28 buildings, common areas + flats (1739249 kWh/year)	3	28 buildings and inhabitants	(1739249 kWh/year)
12 buildings with suitable roof for PV become prosumers	4	12 buildings as "prosumers", rest as consumers	(667139 kWh/year) – prosumer, (1739249 kWh/year) – consumer

Table 8: Szaserow's Technical Scenarios

As shown in Table 9, the larger the PV installations and the bigger the community, the savings on the energy bill increase. Batteries are not

Horizon 2020
European Union Funding
for Research & Innovation

economically viable yet and the installations have a payback time of between 9-10 years. The savings provided by PV are limited by low electricity prices and by the electricity bill structure since almost half of the total cost is coming from fixed connection costs and taxes. Furthermore, the feed-in tariff for PV is based on electricity market prices, which introduces a lot of uncertainties about the calculations. Yet, the increase of electricity prices makes PV more economically interesting.

Scenario	PV capacity (kWp)	Self-consumption ratio (%)	Self-sufficiency ratio (%)	Payback time (years)	Scenario
1	9.99	74.65	30.98	9.55	1
2	184.65	71.97	22.43	9.64	2
3	480.28	71.93	22.37	9.64	3

Table 9: Economic results for Szaserow

**4th scenario excluded because different concept for calculation applies*

5.1.2. Technical Scenario for Beli Bartoka

At Beli Bartoka, the scenarios differ in the exploitation of PV potential in and surrounding the replication site. The reference scenario is considering an installation of PV and a windmill to cover the building's consumption and EV chargers. The first scenario optimizes how much PV can be installed in addition to the existing ones using the available roof space at Beli Bartoka. In contrast, the second scenario considers renting an external PV plant to increase the energy generated through solar PV. The scenarios are affected by the following assumptions/considerations:

Horizon 2020
European Union Funding
for Research & Innovation

- The energy community is a single “big consumer”, meaning that the optimization is done for the whole community
- Hourly consumption profile of common areas, 128 flats (aggregated) and the shop are simulated using monthly/yearly consumption and Innogy standard profiles
- Simulated hourly EV charging demand for a full year for 75 cars:
    - Average arrival time: 6 pm ±1 hour
    - Parking time: 14 hours ± 1 hour
    - Energy needs: 15 kWh ± 5 kWh
    - Charging power: 3.5 kW
    - Everyone needs to charge 5 times a week

The summary of the scenarios is shown in Table 10.

Scenario	Number	Involved consumers	Total consumption
Reference	0	Common area, EV users	(953.1 MWh/year)
Exploitation of roof space available	1	Common area users , EV users	
Renting of a parcel to install an external PV plant	2	Common area users, EV users	

Table 10: Beli Bartoka‘s Technical Scenarios

Similar to the case of Szaserow, increasing the capacity of PV installations is positive both from an economic and environmental point of view. However, due to high evening demand peaks caused by EV chargers, it is not possible to achieve a high level of self-consumption when increasing PV capacity. The potential savings generated through PVs are also limited by the high investment costs (7000 PLN/kWp) and the electricity bill structure in Poland. Almost half of the total cost is coming from fixed connection costs and taxes which do not change across the scenarios. An overview of the economic results is shown in Table 11.

Horizon 2020
European Union Funding
for Research & Innovation

Scenario	Cost-optimal PV capacity (kWp)	Self-consumption ratio (%)	Self-sufficiency ratio (%)	Payback time (years)
1	40	97.39	7.06	7.35
2	497	42.25	25.26	7.75

Table 11: Economic results of installation

5.1.3. Preferences of stakeholders

At Szaserow and at Beli Bartoka, the workshops took place online. For practical reasons, and because only residents (owners/renters) of the replication sites were participating, we opted to conduct a multi-criteria analysis (MCA) and not a MAMCA. So, the criteria were all the same across all participants and the participants were not divided by their role in the energy sector.

At Szaserow, the most important objectives concerning the energy supply and the implementation of an EC were: emission reductions, affordability, inclusiveness, participation, and grid functionality. Figure 3 shows the results of the MCA. The scenario with most members and the highest installation of PVs is performing best on the criteria the participants have shared.

Horizon 2020
European Union Funding
for Research & Innovation

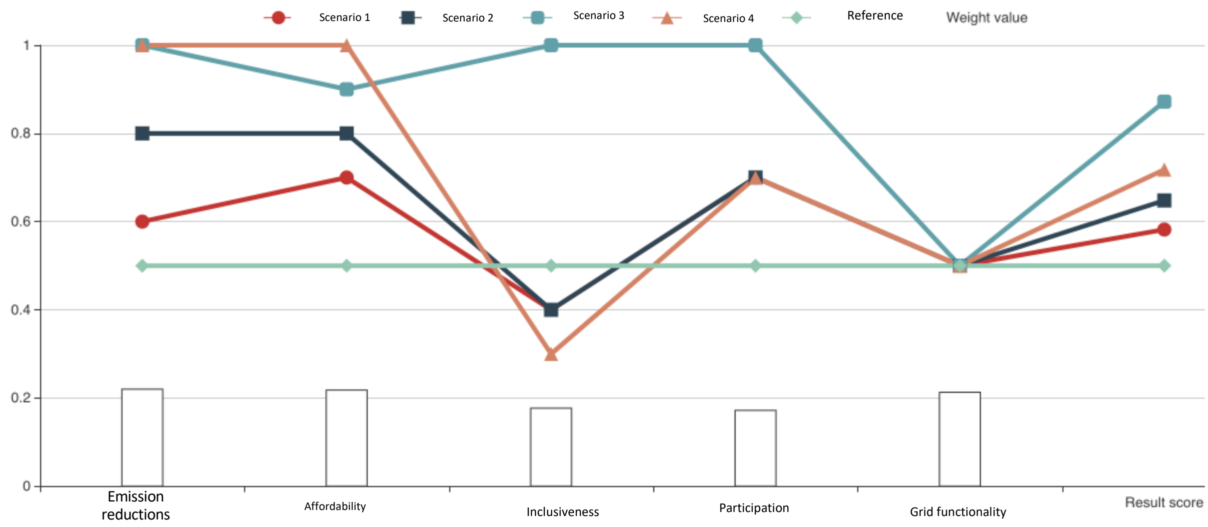

Figure 3: Multi-Criteria results Szaserow

At Beli Bartoka, the participants of the workshop shared the following main objectives concerning the set-up of an EC and their energy supply, lower energy bill, energy autonomy, grid stability, return on investment, and increase of renewables. The objectives received approximately the same weight of importance.

Following the results of the economic analysis, the stakeholders preferred the scenario in which an external PV field is rented, see Figure 4.

Horizon 2020
European Union Funding
for Research & Innovation

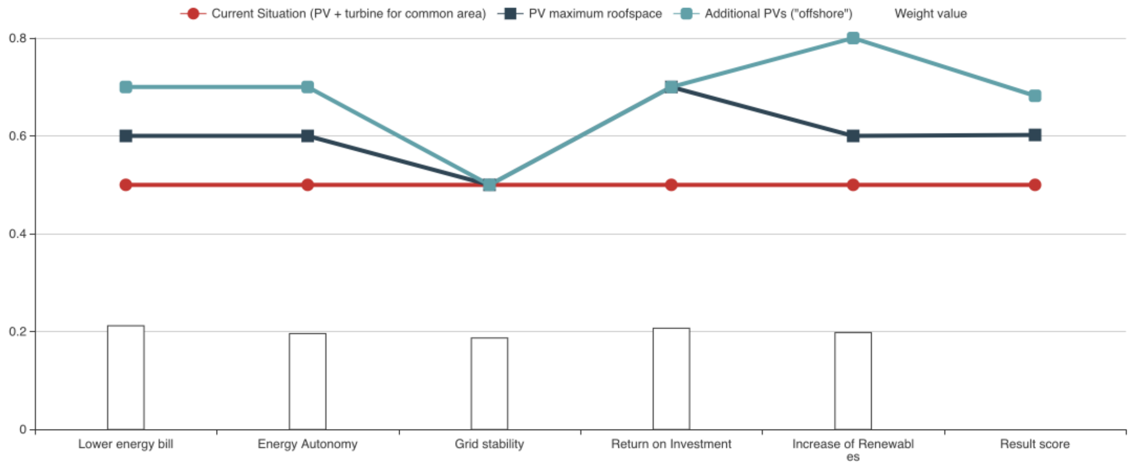

Figure 4: Multi-Criteria results Beli Bartoka

5.2. Regulation and organization

Currently (June 2022), Poland has no (direct) transposition of REDII, but different laws include some aspects of RECs. Further, there is no (direct) transposition of EMD, yet different laws include some aspects of CECs. There are two options to implement a REC or CEC, namely 'energy clusters' or 'energy cooperatives'. However, the transposition of the EMD Poland will introduce Civil Energy Communities in 2023. The three types are summarized and explained in Table 12.

Energy Clusters	Group of independent entities that are interested in generating green energy based on a Civil-Law-Agreement concerning the balancing of demand and generation, distribution, or trade of energy from renewables or other sources. The Cluster does not have a legal personality and generates energy to achieve profit. Concern for and commitment to local values, sustainability and engagement must be shown. The area must not exceed one county or five communes.
Energy Cooperatives	An administrative Unit with a legal personality based on Cooperative Law. The objective is to generate electricity, biogas or heat from renewables and balancing the demand for the members of the cooperative. 70% of the energy produced must come from renewable sources and members can be up to 999.

Horizon 2020
European Union Funding
for Research & Innovation

Civil Energy Communities (from 2023 on)	An entity with legal capacity based on voluntary and open participation aimed at ensuring environmental, economic, or social benefits for its members. May deal with generation, distribution, trade, aggregation and storage, the provision of electrical vehicle charging services and other services. Sale of energy-to-energy company or aggregator will be possible by a contract between them and must take financial care of caused grid imbalances. Possible Forms that the CEC must be based on are Cooperatives, Associations and a Partnership. Points of connection are limited to 40 partners of the community.

Table 12: Organizational options in Poland

Although currently not possible, the Civil Energy Community is the most suitable model for both Szaserow and Beli Bartoka, but with different organizational forms, cooperative and association respectively.

5.3. Social Enterprise Model Canvas

Szaserow's SEMC is shown in Table 13. Szaserow would ideally implement a Civil Energy Community based on a cooperative model, since there is already a cooperative present and existing structures can be used.

GOV			
Civil Energy Community (based on Cooperative model)			
NtS	KA	CH	C&B
Other initiatives that profit from the experience of Szaserow, visitors to Szaserow	Local generation and distribution, onboarding of members	Meetings, discussions, newsletter (digital & paper format	Members of the cooperatives, residents of Szaserow
	KR	C&B E	
	Smart meters, PVs, roof space	Co-ownership and voting (one member-one vote is the principle of cooperatives)	
MV	SVP		IM
Contributing to the local energy transition and	Locally sourced affordable energy, increased autonomy		Reduced emissions, more

Horizon 2020
European Union Funding
for Research & Innovation

combat climate change		environmentally friendly behavior
O		OM
Objectives shared for the MCA*		KPIs connected to the measurement of the objectives**
C$		I$
Investment, installation, maintenance of PVs, membership fees, software		Increased self-sufficiency and less depending on the (increasing) costs for energy from the grid, emission reductions, shared mobility,

Table 13: SEMC for Szaserow

The SEMC of Beli Bartoka is shown in Table 14 which builds on the existing structure of the housing association. In addition to the elements also present at Szaserow, Beli Bartoka has a unique SVP with the provision of EV infrastructure.

GOV			
Civil Energy Community (based on an (housing)association)			
NtS	KA	CH	C&B
Other initiatives that profit from the experience of Beli Bartoka, visitors, EV users	Local generation and distribution, onboarding of members	Meetings, discussions, newsletter (digital & paper format)	Members of the association, renters and owners of dwellings at Beli Bartoka, EV users
	KR	C&B E	
	Smart meters, PVs, roof space, EVs, EV chargers, software	Reduced costs for members	
MV	SVP		IM
Contributing to the local energy transition and combat climate change	Locally sourced affordable energy, increased autonomy, and green mobility		Reduced emissions, more environmentally friendly behavior
O			OM

Horizon 2020
European Union Funding
for Research & Innovation

Objectives shared for the MCA*	KPIs connected to the measurement of the objectives**
C$	I$
Investment, installation, maintenance of PVs and EV infrastructure, membership fees	Increased self-sufficiency and less depending on the (increasing) costs for energy from the grid, emission reductions, shared ownership, and decision-making power

Table 14: Beli Bartoka's SEMC

**lower energy bill, energy autonomy, grid stability, return on investment, and increase of renewables*
***energy bill reductions, self-sufficiency ratio, number of blackouts, payback time, ratio of renewable energy in local energy mix*

5.4. Feasibility and challenges

In Poland a lot of administrative hurdles hinder the emergence of ECs. For example, the participation in the auctions requires a lot of administration, knowledge and financial pre-requirements and the administration is complicated due to fragmented law and procedures with the planning and establishing of the cluster/cooperative, as well as the access process to the grid. There exist regional limitations to the existing regulatory options. Energy Clusers and Energy Cooperatives must be set up in rural or urban-rural municipalities and cannot include more than 3 municipalities at the same time, they can only have one distribution operator and must be connected to low- or medium-voltage network. Economically, up to 40% of the value of the surplus energy that is fed into the grid is captured by the operator and its profits. Struggles to obtain data from the distribution system operator (DSOs) have been reported, since the DSO has no incentive to share and/or support EC initiatives [9]. Also, participation in the auctions requires a lot of administrative knowledge and pre-requirements.

Horizon 2020
European Union Funding
for Research & Innovation

6. Auroville India

Auroville is a city located 9km away from Pondicherry, India. It is designed to become a home to around 50,000 inhabitants from around the world, it currently has 3300 permanent residents. Auroville is structured into four zones: the industrial, cultural, residential, and international zone. Auroville follows a unique governance structure with the Auroville Foundation at its core. Under the Auroville Foundation, over 20 trusts are operating in Auroville which are responsible for the management of the funds and assets of Auroville's 'working units' (commercial, research, and service units). Auroville's vision is to jointly work together towards a more fair and communal society, to achieve this also green energy practices are part of their agenda. Together with Auroville Consulting, a service unit, we worked on different options to transition to a low carbon system at Auroville.

6.1. General Scenarios

6.1.1. Technical Options for Auroville

In Auroville, the technical options are slightly different compared to the other case studies, since Auroville can already be considered a community. Therefore, we did not make a differentiation between the involved consumers. The first technical scenario considers an increase in installed PVs at Auroville, the second an additional investment in batteries, and the last one investigated the needed capacities installed to cover around 350hours of blackout that occur at Auroville on a yearly basis (see Table 15).

Scenario	Number
Reference – Auroville as it is without additional investments	0
Additional investments in PV	1
Additional investments in battery	2

Horizon 2020
European Union Funding
for Research & Innovation

Blackouts counteract (350hrs of blackout per year	3

Table 15: Technical scenarios for Auroville

The main difference are the installed capacities per scenario which are shown in Figure 5.

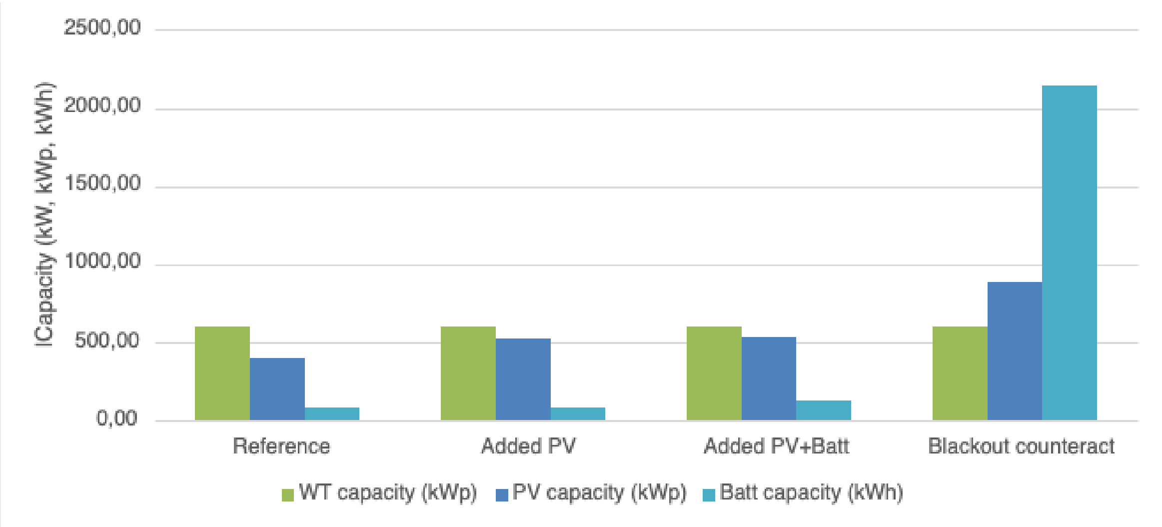

Figure 5: Installed capacity per scenario at Auroville

Scenario 3 (blackouts counteract) is an explorative scenario since it is oversizing the system to cover the occurring blackouts.

6.1.2. Stakeholder Preferences

Since at Auroville all decisions are made for the community, the stakeholders wished not to be separated into different stakeholder groups. As also done for the replication sites in Poland, an MCA was conducted for the entire community. The workshop participants shared increase of renewable, energy autonomy, behaviour change, energy efficiency, grid functionality, service, and support as their main objectives. "Service and support" were added as one objective which addresses the availability of support and skilled workers that can be contacted in case there are

Horizon 2020
European Union Funding
for Research & Innovation

problems with the installed assets and for general maintenance. The results are shown in Figure 6.

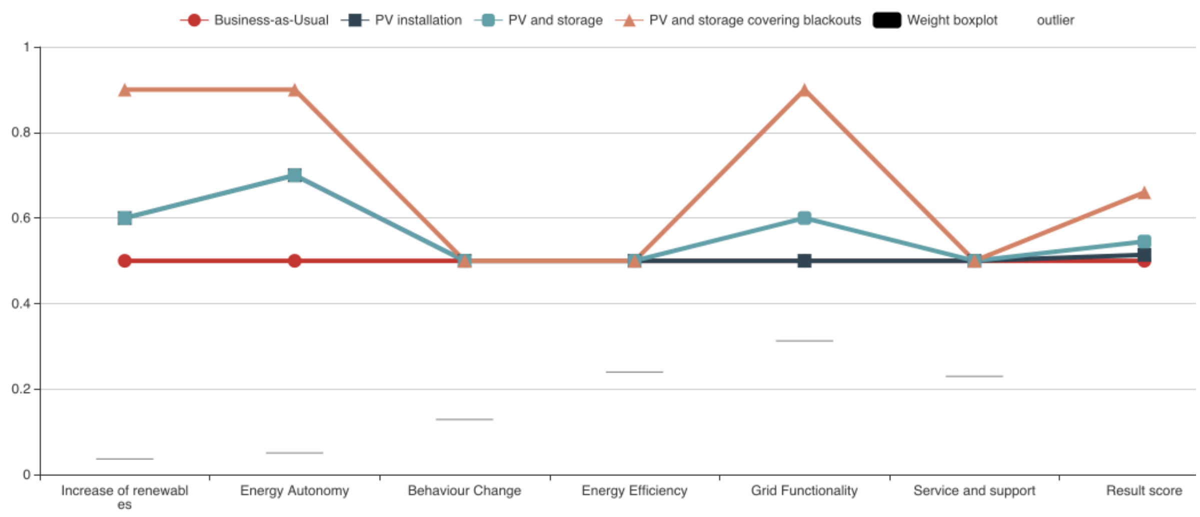

Figure 6: MCA result for Auroville

The MCA result shows that the PV and storage covering blackouts, and the PV and storage scenario are the best performing scenarios for the objectives mentioned by the stakeholders. However, the PV and storage scenario that covers blackouts was discussed only exploratively since the system would be oversized in an uneconomical way. Therefore, the optimal sizing of the PV and battery systems lies between the second and third scenario. Grid functionality, energy sufficiency, and service and support were the objectives with the highest weight.

6.1.3. Regulatory and organizational models for Auroville

India does not underly European regulation and therefore does not aim to transpose the REDII or EMD.

Currently (June 2022), two organizational models allow for self-consumption in India.

Horizon 2020
European Union Funding
for Research & Innovation

1. **Prosumer:** Prosumers are both consumers and producers of energy supply: they use the same point of energy supply from which they consume electricity from the grid to also generate electricity into the grid for the DSO. Members can be all current consumer categories.

2. **Mini/Microgrids:**
    a. Mini Grid: a system that has a renewable energy-based electricity generation with a capacity of 10KW and above, and supplies energy to a target set of customers through a public distribution network. Customers can be residents for household usage, commercial customers, industrial and institutional setups.
    b. Micro-Grid: work equivalently to the Mini Grid, but the capacity must be below 10KW.

Both models can operate in isolation from electricity networks of the grid but can also be interconnected to exchange power. They are then called grid connected mini/micro grid. (Financial) benefits emerging from the mini or micro grid must be passed to the consumers.

Operations are specific to each state and require the Micro-grid operator to acquire a license. The generation of energy itself does not require a license. Distribution, transmission, and trading of energy are licensed activities, and network costs must be paid.

For the mini/micro grid, the cost of infrastructure and meters from its system up to the interconnection point must be paid by the mini/ micro grid operator. Possible technologies are solar, biomass, small hydro, diesel generators and hybrid systems. This is the regulation found for India, however, every federal state (here Tamil Nadu), can develop and set-up different regulations.

Horizon 2020
European Union Funding
for Research & Innovation

6.2. Auroville's Social Enterprise Model Canvas

Table 16 shows the SEMC for Auroville. As explained, Auroville can only operate as a mini-grid with one single connection to the main grid. Technically, the SEMC should pursue a configuration of assets that lies between the second and third scenario.

GOV			
Auroville operating as a mini-grid with one single connection to the main grid.			
NtS	KA	CH	C&B
Auroville visitors / tourists	Installation and maintenance of renewable energy assets (PVs)	Community events, email, Auroville consulting	Residents of Auroville, Aurovillians
	KR	C&B E	
	PV systems, smart meters, battery storage	Auroville's specific community goal building on co-ownership, joined decision-making	
MV	SVP		IM
Locally sourced energy to increase autonomy of the community	Provision of locally sourced renewable energy to increase local autonomy and reliability of energy provision based on a communal scheme		Members participating and being aware of the local energy system
O			OM
*the MCA objectives			KPIs used to measure the stakeholder objectives **
C$		I$	
Upfront investment, installation and maintenance		Governmental funds, other funding	

Table 16: Auroville's SEMC

**Increase of renewable, energy autonomy, behaviour change, energy efficiency, grid functionality, service, and support*

Horizon 2020
European Union Funding
for Research & Innovation

***CO_2 emissions, self-sufficiency ratio, awareness/knowledge on consumption, grid continuity/reliability, service experience*

6.3. Feasibility and challenges

Currently, there is no central finance assistance for mini/ microgrids if they are connected to the grid. Financing only exists for off-grid systems. Technological complexity, missing economic profiles, long payback times and low returns lead to high risks for the members and requires for knowledge and funds available to implement such a system. Further, the current top-down market-oriented market-structure for renewables in India makes the channelling of benefits to local communities difficult in the Indian context.

7. Lacor Hospital,Gulu, Uganda

St. Mary's Hospital Lacor is a private, non-profit hospital located at Gulu Uganda. The hospital's mission is to guarantee affordable medical services, especially to the people most in need. The hospital is both providing medical care to the local population, but also serves as a training institute for nurses and doctors. The hospital has an intricate internal electrical system that can operate as an island which is comparable to the Belgian pilot site, the Brussels Health Campus. The site at Gulu already has a few solar PV systems, back-up generators, a well-organized internal grid, and a connection to the local public distribution network.

7.1. General Scenarios

7.1.1. Technical scenarios for the Lacor Hospital

For the St. Mary's hospital two scenarios were analyzed in comparison to the reference scenario, which represents keeping the current situation. In

Horizon 2020
European Union Funding
for Research & Innovation

the first scenario, additional investments in battery storage to increase the PV self-consumption are made, in the second scenario, investments both in the PV and storage are made, see Table 17.

Scenario	Number
Reference (no new investments, BAU)	0
Investment in additional battery storage system (BESS) to increase PV self-consumption	1
Investment in both additional PV and BESS to counteract blackouts from main grid	2

Table 17: Technical options for St. Mary Hospital

The installed capacities for the different scenarios are shown in Figure 7.

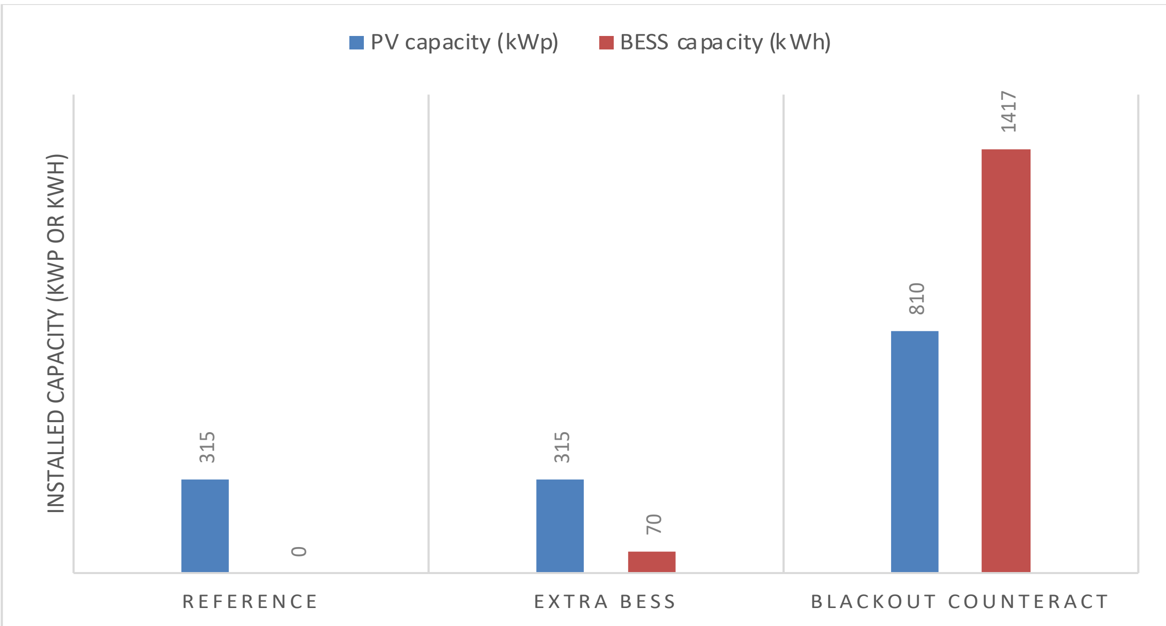

Figure 7: Installed capacities for each scenario

The results of the economic analysis show that the second and third scenario outperform the current situation regarding self-sufficiency ratio, emissions, yearly costs, and costs per kWh (see Figure 8 and Figure 9). The payback time lies between 9 and 7 years (for scenario 2 and 3 respectively).

Horizon 2020
European Union Funding
for Research & Innovation

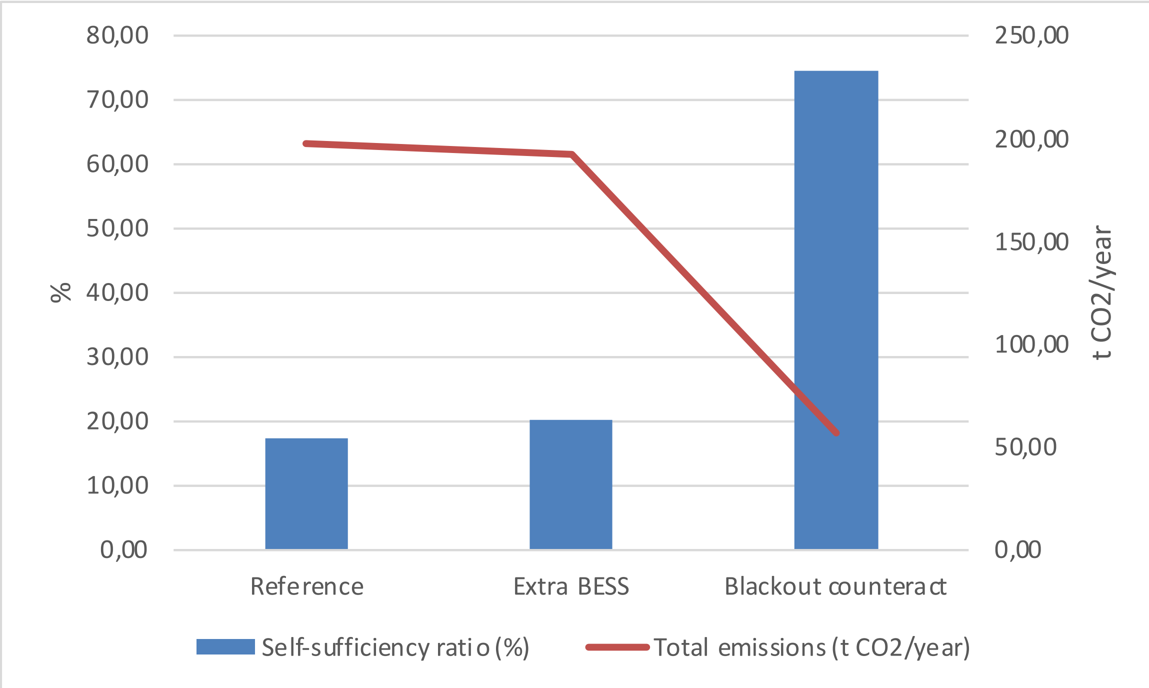

Figure 8: Results environmental analysis

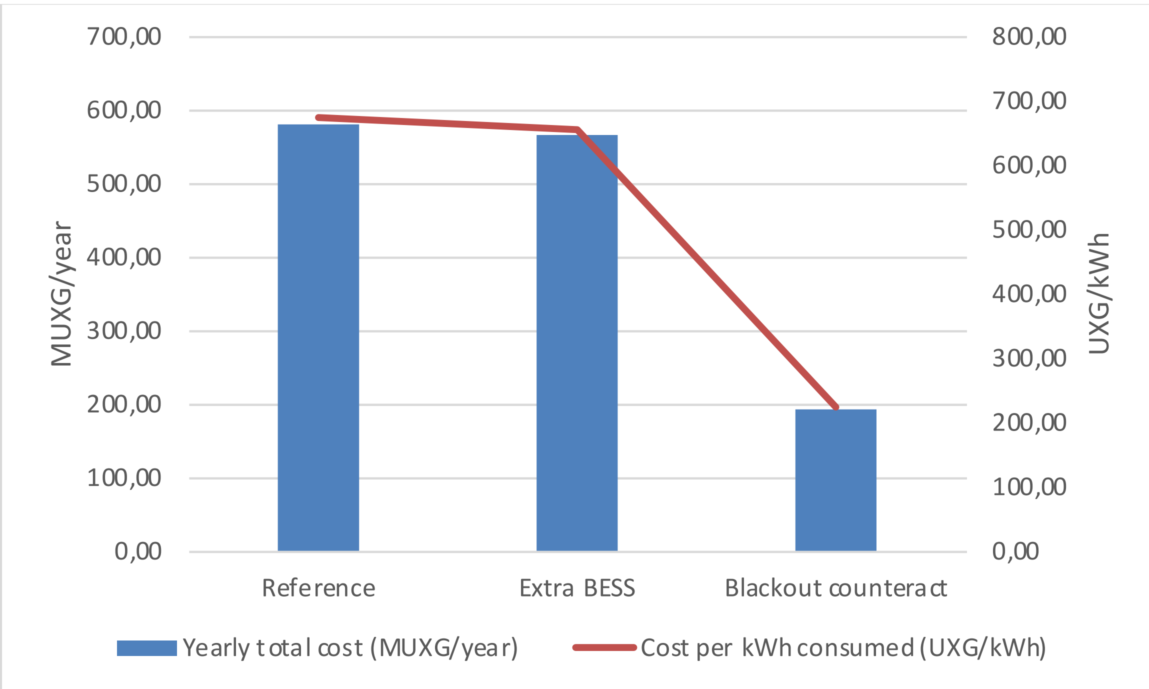

Figure 9: Results economic analysis

Horizon 2020
European Union Funding
for Research & Innovation

7.1.2. Stakeholder preferences

During the MAMCA workshop, two stakeholder groups were participating: representatives from the hospital and residents of the residential area. They communicated grid stability and reliability, lower energy bill, energy independence, emissions reduction, safety, lower visual and noise impact as their most important criteria. The second scenario to counteract blackouts and replace the generators is also preferred on site.

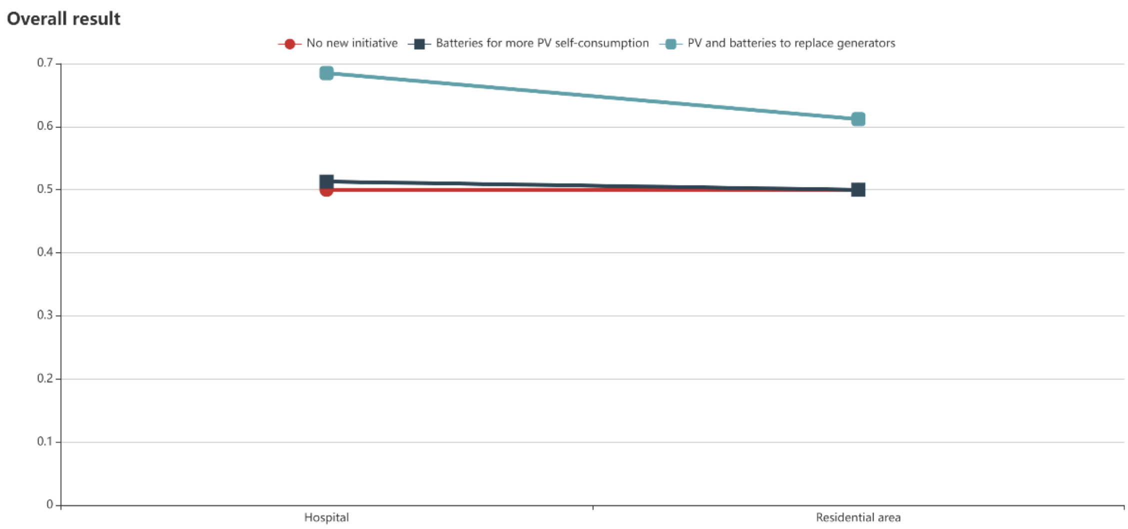

Figure 10: Multi-Actor View for St.Mary Hospital

7.1.3. Regulatory and organizational options

Uganda is not subject to European regulation and therefore does not aim at transposing REDII or EMD. Uganda has low electrification rates with around 40% national wide which creates a rather different environment compared to the other replication sites. There are two different options to set-up self-consumption mechanisms, either as an individual self-consumer or within an isolated grid system:

1. **Individual self-consumption**: there is no specific definition of energy self-consumption in the regulation, but everyone may construct a generation station for energy if it is not exceeding 500kW. Transmission of energy is not allowed without a license.

Horizon 2020
European Union Funding
for Research & Innovation

2. **Isolated grid system**: an isolated electricity supply system with its own power generation and distribution network, supplying energy to consumers that are not connected to the primary grid. It can be used for commercial purposes and the energy surplus energy may be sold to the grid.

   A: if the generation station has a capacity up to 500 kW only registration is needed.

   B: if the generation station has a capacity up to 2 MW, in this case, a license is required but exemption might be possible, and the license fee would not apply. A feasibility study is therefore required. Calibrated energy meters shall be used.

   C: if the generation station has a capacity of up to 20 MW the installation needs to participate in the license process, must do reporting and must pay fees. Additionally, distribution- and sales licenses are required.

For all isolated grid systems, a Consumer Service Agreement is required, and the ministry pays the surplus energy that was injected to the grid.

Therefore, the current legislative and organizational models are limited. Legally, the St. Mary's Hospital can only follow an isolated electricity supply system with its own power generation and distribution network, supplying electrical energy to consumers, it can be used for commercial purposes and the energy surplus energy may be sold to the grid.

7.2. St.Mary's Social Enterprise Model Canvas

Table 18 shows the SEMC for the St.Mary Hospital. The hospital can operate as an isolated grid system investing in PV and BESS to counteract the occurring blackouts from the main grid.

Horizon 2020
European Union Funding
for Research & Innovation

Isolated grid system operated by the hospital			
NtS	KA	CH	C&B
Main grid customers in the neighbourhood	Generation of PV, energy supply in case of general power outages	Direct communication with surrounding neighborhoods, information channels of the hospital	All actors surrounding hospital site activities (hospital, residential area, workplace…), grid operator
	KR	C&B E	
	additional PVs, smart meters (already in place), battery storage	Reliable energy supply, grid operator through direct benefits (more reliability)	
MV	SVP		IM
reliability, more autonomy, economic savings, less emissions	Reliable electricity supply at lower cost causing less emissions		Money saved, amount of kWh generated by diesel generators replaced by RES
O			OM
additional amount of PV installed, installed battery capacity, amount of CO2 saving, economic saving*			Amount of electricity generated by RES that would otherwise be generated by diesel generators**
C$	I$		
Investment costs PVs and batteries, maintenance costs of PVs and batteries, licenses	financial revenue for selling excess energy, CO2 emissions saved by replacing the diesel generators with renewable alternatives, economic savings by raised self-consumption		

Table 18: SEMC for St. Mary Hospital

** Grid stability and reliability, lower energy bill, energy independence, emissions reduction, safety, lower visual and noise impact*
***number of blackouts, price for electricity consumed, self-sufficiency ratio and self-consumption ratio, perceived change of landscape/noise level.*

Horizon 2020
European Union Funding
for Research & Innovation

7.3. Feasibility and challenges

Uganda has no specific regulation for ECs which leads to limited general knowledge and awareness regarding the use, importance and benefits resulting from RE and its technologies is limited. This is also related to the high initial investment and installation costs which are too high for most consumers, including the hospital, especially without additional support and funding. There is a lack of financial tools that could allow to cover the costly maintenance and operation costs. The current infrastructure is characterized by a few transmission and distribution lines in rural and remote areas, with a generally low electricity load. The unsteady nature of the electricity grid in most parts of Uganda is also seen as a big challenge. Further, missing import controls result in low quality products, that are sold to unsuspecting public and erode the public's trust in renewable installations. 25% of the Ugandan population is living below the poverty line. The generally low disposable income among the population causes that most rural population prioritize food, education, and health over installing renewables. Also, thefts of infrastructure have been reported and, there is no standard insurance package for solar PV systems, so the risk is borne by the lenders and buyers.

Locally, there are only a few reliable companies and technicians that could provide services for installations and maintenance, which additionally contributes to eroding public trust in solar installations.

Generally, allocating needed resources and providing with support for set-up and maintenance of EC schemes can have a great positive impact on the local energy system similar to the one of the St. Mary hospital in Uganda.

8. Impruneta, Italy

The Italian start-up Enco - Energia Collettiva aims to start ECs by taking away the barriers that citizens experience during the first stages of

Horizon 2020
European Union Funding
for Research & Innovation

developing an EC. The start-up takes over the installation of smart meters, PV panels and storage systems, the practical set-up and registration of the EC as well as its management. Profits are used to pay back installation costs and are distributed fairly among the participants. Located near the city of Florence, Impruneta is a rural town that aims to set-up an EC jointly with neighboring citizens.

8.1. General scenarios

8.1.1. Technical options for Impruneta

Like the other replication sites, the technical scenarios differ in the number of assets installed PV, the implementation of a REC, and the number of members. The different scenarios are shown in Table 19. The scenarios were compiled using electricity price values, simulated consumer load curves based on electricity bills of 2021, and simulated photovoltaic productions using meteorological data of 2021.

Scenario	Involved stakeholders	Total consumption (kWh/year)
Business-as-usual	4 consumers + 3 prosumers	23345
Extension of PV plant without REC (no energy sharing)	4 consumers + 3 prosumers	23345
REC (energy sharing allowed)	4 consumers + 3 prosumers	23345
REC with extra members	8 consumers + 5 prosumers	33217

Table 19: Overview of scenarios of Impruneta

The energy system optimization shows that the REC and bigger REC with additional members perform best on the performance indicators (see Figure 11 and Figure 12. The simple REC option performs slightly better in terms of costs (e.g., costs per kWh consumed), the EC with more members involves the doubled number of consumers.

Horizon 2020
European Union Funding
for Research & Innovation

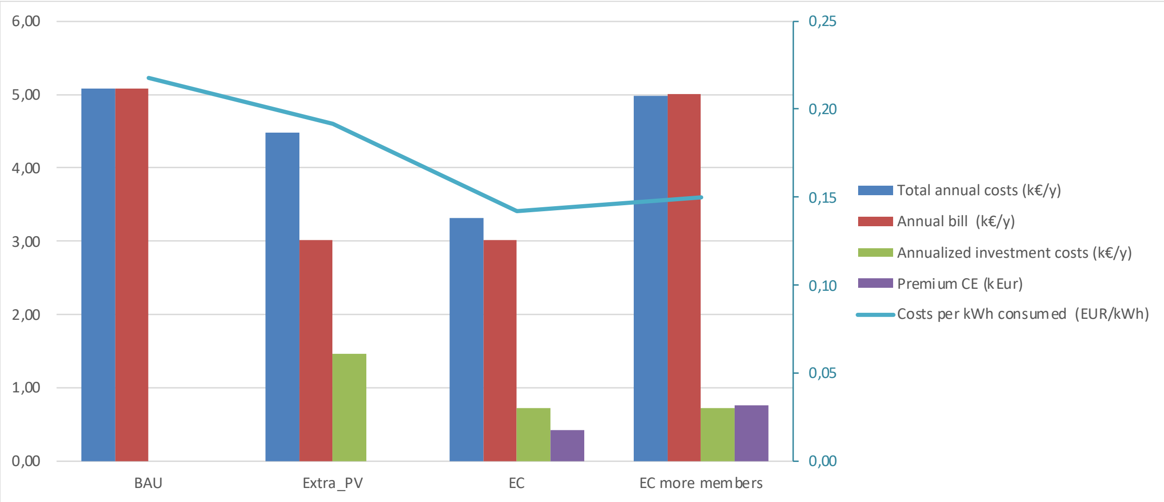

Figure 11: Economic analysis Impruneta (a)

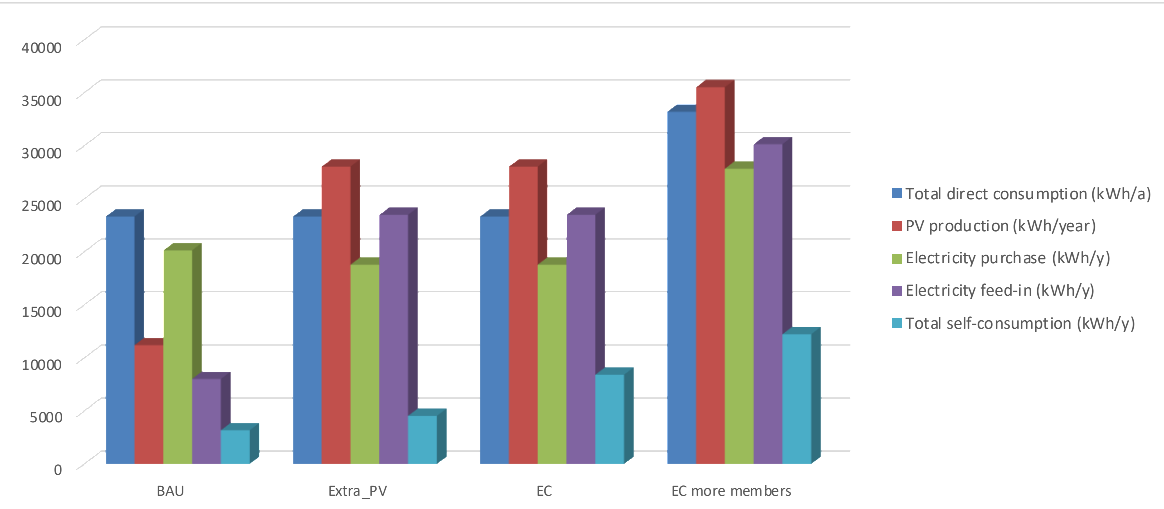

Figure 12: Economic analysis Impruneta (b)

8.1.2. Stakeholder Preferences

During the MAMCA workshop, the different technical scenarios were discussed. The participating stakeholders were consumers, energy producers and the local government. The stakeholders shared the following objectives as most important: lower energy bill, inclusiveness, energy independence, behavioural change (awareness), emissions reduction, lower

Horizon 2020
European Union Funding
for Research & Innovation

visual and noise impact, grid stability and reliability, return on investment, increased share of renewable energy, and direct user participation. As shown in Figure 13, the REC with a higher number of members was performing best on the objectives mentioned by the stakeholders.

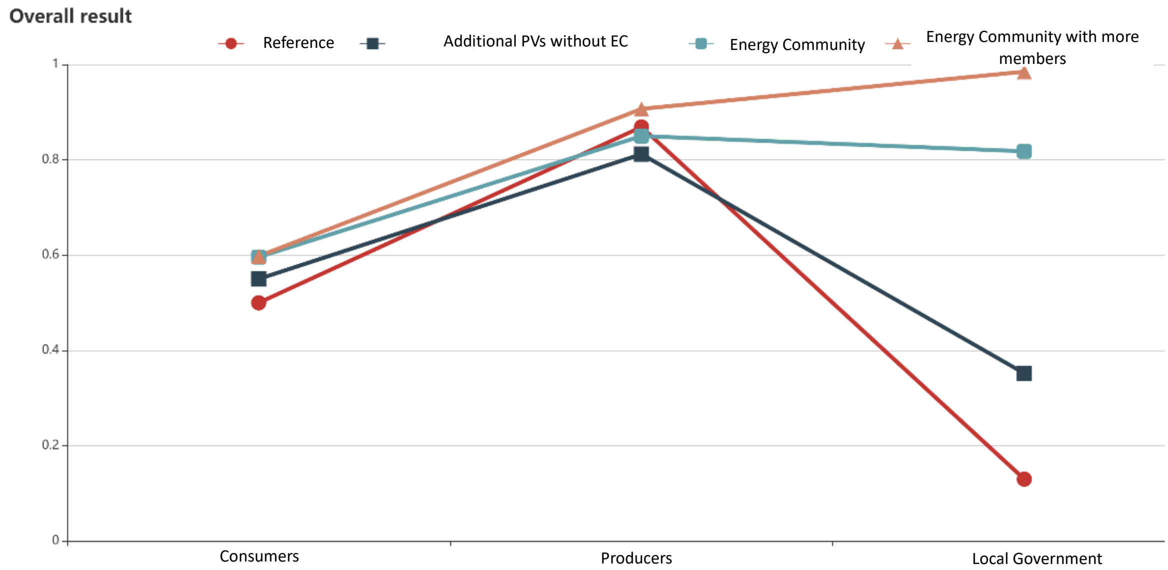

Figure 13: Multi-Actor View Impruneta

8.1.3. Regulatory and organizational models

Currently (June 2022), Italy has two viable forms for self-consumption:

The first one is the Collective Self-Consumption in which two or more self-consumers are in the same building, with one or more renewable energy plants, members can be natural persons.

The second, and the more suitable one for Impruneta, is the Renewable Energy Community. RECs in Italy are composed of participants that reside in different buildings but are connected to the same medium/low voltage transformer substation. The REC must use the pre-existing distribution networks, and based on renewable resources, it cannot exceed a maximum power of 200 kWp. Members can be natural persons, SMEs, or local authorities. The amount of energy (shared and/or stored) and the energy that is provided to the grid must be higher than the energy that is withdrawn

Horizon 2020
European Union Funding
for Research & Innovation

from the grid. From June 2022 onward the substation is extended to high voltage (HV)/and medium voltage (MV) and the maximum capacity may be up to 1 MW. For both cases a "contact person" is required. This is the legal representative of the building or condominium, or an electricity producer operating one or more production facilities. RECs represent the community itself as a legal entity.

8.2. Impruneta's Social Enterprise Model Canvas

Table 20 shows the SEMC for Impruneta. Enco would set up the legal entity of a REC. The REC invests in new renewable energy assets and is responsible for generation and supply of locally sourced renewable energy.

<table>
<tr><td colspan="4">GOV</td></tr>
<tr><td colspan="4">Renewable Energy Community with Enco as contact person</td></tr>
<tr><td>NtS</td><td>KA</td><td>CH</td><td>C&B</td></tr>
<tr><td rowspan="3">Surrounding rural residents who are not members, similar initiatives can learn from their experience</td><td>Investment in PV, generation and exchange of electricity by/between members, maintenance and management of REC</td><td>Neighbour meetings, direct communication, newsletter,</td><td rowspan="3">Members</td></tr>
<tr><td>KR</td><td>C&B E</td></tr>
<tr><td>PVs, smart meters, (load-shift enabling devices, battery storage), members</td><td>Membership, ownership, decision-making,</td></tr>
<tr><td>MV</td><td colspan="2">SVP</td><td>IM</td></tr>
<tr><td>Build a community that jointly works together for a greener local energy system</td><td colspan="2">Achieving a local low-carbon energy system with stable energy prices through a community</td><td>Members of the community being aware of</td></tr>
<tr><td>O</td><td colspan="2"></td><td>OM</td></tr>
</table>

Horizon 2020
European Union Funding
for Research & Innovation

Objectives mentioned by the stakeholders during the MAMCA process*	KPIs measuring the objectives**
C$	I$
Investment and maintenance costs of PVs (load-shift enabling devices and batteries), payback costs	Reduced exposition to fluctuation of energy prices, emissions reduction, governmental subsidies per kWh for collectively self-consumed energy, energy savings

Table 20: Impruneta's Social Enterprise Model Canvas

**lower energy bill, inclusiveness, energy independence, behavioural change (awareness), emissions reduction, lower visual and noise impact, grid stability and reliability, return on investment, increased share of renewable energy, and direct user participation*
***reduced energy costs, number of social tariffs/distribution mechanisms, self-sufficiency ratio, reduced energy consumption/knowledge, CO_2 emissions, number of blackouts, perceived change in build environment and noise, ratio of renewable energy in the mix, number of people participating*

8.3. Feasibility and challenges

Italy, compared to the other countries where the replication sites are located, has the legal entity of RECs. However, there are still challenges with the implementation of RECs. For example, if the capacity is capped, the installed plants of an Energy Community must not exceed 200kWp. RECs cannot use private distribution networks since the pre-existent distribution networks must be used and current regulation does not allow the creation of new grid sections. The renewable energy plants and demand points of the renewable energy community must be connected to the low voltage electric network under the same MV/LV transformer substation. This regulation imposes geographical restrictions that are an obstacle in areas with low population density, but from June 2022 onwards also HV/MV transformer substations are eligible.

Horizon 2020
European Union Funding
for Research & Innovation

Moreover, only plants that were installed after March 2020 can join a REC. From June 2022: Only plants installed after December 2021 can fully join Recs. Older plants can join with 30% of the total power.

9. Summary of challenges

This section summarizes first which shared barriers and challenges occurred in the set-up and development of the EC schemes. Generally, the barriers and challenges relate to legal and organizational, technical, social, and practical reasons.

Currently (June 2022) ECs are subject to a fast-changing policy environment. For the European case studies, the situation has become clearer with the transposition of the REDII and EMD to national law. However, most EU countries have no specific legal entity for ECs leading to many different legal and organizational options for communities to implement ECs. While this is necessarily a barrier to the development of ECs, it leaves communities with many options and an unclear overview of the advantages and disadvantages of the different legal and organizational options they could pursue to implement an EC. Despite the positive development of legislation, there are several re-occurring barriers in the national regulations that hinder the development of ECs. Examples for such barriers are restrictions on the location (e.g., radius for self-consumption, restriction on building complexes), on the licenses (who can give and obtain licenses), administrative burdens (choice of legal entity and organizational model, permissions), and there is no clear reference point for communities to obtain support. Such restrictions hinder reaching the full potential of ECs. Technically, there were clear advantages for communities to set-up ECs. The system optimization was accompanied by problems surrounding data availability, and data sharing. The lack of metering infrastructure and the challenges to obtain data from the DSO or individual end-consumers made

Horizon 2020
European Union Funding
for Research & Innovation

the technical analysis time-consuming. This was also related to the problem that energy end-consumers are hesitant to share their consumption and production data, and/or are not informed how to read their energy bill, and often do not know how to obtain a detailed overview of their data. Setting-up ECs does require a more active involvement of energy end-consumers which also teaches some fundamental information on the own energy consumption/production. Most stakeholders that participated in the workshops were in favour of the biggest EC scenarios but the need for practical, legal, and technical support was communicated.

From a practical point of view, the communities also communicated during the workshops that there is often a lack of construction companies (installing the infrastructure, and maintenance) which results in long-waiting times for the actual construction of the ECs and the fear there is no available support in case the installations fail.

10. Conclusions

In general, the compilation of SEMC has shown that there is a great variety of different legal and organizational models that could be implemented to fulfil the technical configuration of ECs.

In the replication sites, the cooperative model, association, and limited liability company were the most common organizational models for the ECs to be implemented. Among the studied cases, only Italy has an organizational model that is equal to the legal entity of a REC. From 2023 onwards, also Poland provides clearer options for urban communities to set-up ECs under the regulatory scheme of Civil Energy Community scheme, with cooperatives, associations, and partnerships as organizational models. The SEMC share a social and environmental value proposition, key activities, and key resources. The SEMC also build on a revenue margin created through energy savings compared to reference scenarios. While there is a

Horizon 2020
European Union Funding
for Research & Innovation

rather clear overview of cost savings resulting through the (technical) configuration of ECs, there is a lack of information on the costs related to the set-up and maintenance of ECs. This encompasses re-occurring service costs (e.g., maintenance, software updates), licensing, updating of infrastructure, legal support, costs for the legal entity (e.g., cooperative) and details on the membership fees. There was also less focus on the costs related to the recruitment of members/customers of the SEMC.

The non-European replication sites at Gulu, Uganda and Auroville, India are embedded in a very different local context including the regulatory, socio-economic conditions. Especially, Gulu could benefit from a local EC scheme but the lack of financial resources to cover the high upfront costs is a great barrier to overcome. In India, especially the national focus on large scale renewables does not provide many opportunities to local initiatives. In both sites, blackouts from the main grid played a greater role, as also the availability of support and maintenance for the installed assets.

Generally, restrictions on the location of ECs and its members, permissions, and licenses (for grid connections), capacity caps, and other regulatory barriers hinder the uptake of EC BMs. Energy end-consumers require an introduction to ECs and training to become informed members and to recruit more members for the EC. Currently, costs that are not considered in the set-up or maintenance costs of BMs for ECs may reduce the viability of their SEMC more. Here, the demand for the unique value proposition of the ECs will show if the ECs can compete with other market actors by providing similar (technical) benefits.

Horizon 2020
European Union Funding
for Research & Innovation

11. References

1] European Commission, Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources, Official Journal of the European Union. 61 (2018). https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=OJ:L:2018:328:FULL&from=EN (accessed July 6, 2020).

[2] European Commission, Directive (EU) 2019/944 of the European Parliament and of the Council of 5 June 2019 on common rules for the internal market for electricity and amending Directive 2012/27/EU, Official Journal of the European Union. 62 (2019). http://data.europa.eu/eli/dir/2019/944/oj.

[3] M.L. Lode, A. Felice, A. Martinez Alonso, J. De Silva, M.E. Lopez, J. Lowitzsch, T. Coosemans, L. Ramirez Camargo, Coupling Rural Development with the Development of Energy Communities: A Participatory Study in Vega De Valcarce, Spain, SSRN Journal. (2022). https://doi.org/10.2139/ssrn.4084306.

[4] A. Osterwalder, Y. Pigneur, Business model generation: a handbook for visionaries, game changers, and challengers, John Wiley & Sons, 2010.

[5] ReViEVAL, ReViEVAL : Sustainable revitalisation of rural communities, ReViEVAL : Sustainable Revitalisation of Rural Communities. (2021). https://revieval.org/ (accessed November 12, 2021).

[6] SCORE H2020 – Supporting Consumer Ownership in Renewable Energies, SCORE H2020. (2022). https://www.score-h2020.eu/ (accessed February 1, 2022).

[7] Jefatura del Estado, Real Decreto-ley 23/2020, de 23 de junio, por el que se aprueban medidas en materia de energía y en otros ámbitos para la reactivación económica, 2020.

Horizon 2020
European Union Funding
for Research & Innovation

https://www.boe.es/eli/es/rdl/2020/06/23/23 (accessed February 1, 2022).

[8] F. Hanke, J. Lowitzsch, Empowering Vulnerable Consumers to Join Renewable Energy Communities—Towards an Inclusive Design of the Clean Energy Package, Energies. 13 (2020) 1615. https://doi.org/10.3390/en13071615.

[9] Microinstallations on a turning point | How to secure the future of distributed energy in Poland? - Forum Energii, (n.d.). http://www.forum-energii.eu/en/analizy/pv-na-zakrecie (accessed June 8, 2022).

Horizon 2020
European Union Funding
for Research & Innovation