


Project Title	Achieving a New European Energy Awareness (AURORA)	
Grant Agreement	101036418	
Coordinator	Universidad Politecnica de Madrid, Dr. Ana Cristobal	

Deliverable	3.1 – Report on the business models to follow-up by the different local energy communities	
Due Date	31 May 2022	
Responsible beneficiary	UEVORA	
Contributing beneficiaries	UL, UPM, AU and FoDDC	
Dissemination Level	PU	Public
Version	1.3 (31 May 2022)	

Version	Lead Author	Version / revision description	Submission Date
1.0	Celísio Pires	Overall structure	18 Mar 2022
1.1a	Zhe Zhang, Marta Victoria	Demonstrator site in Aarhus	7 April 2022
1.1b	Matej Guštin, Matevž Bokalič, Marko Topič	Draft of demonstrator site in Ljubljana (work in progress)	8 April 2022
1.1c	Rachel Haycock, Keith Hempshall, Alastair Chapman, Emma-Jayne Williams	Draft of demonstrator site in Forest of Dean (work in progress)	11 April 2022
1.1d	Celísio Pires, Luís Fialho	Draft of demonstrator site in Évora (work in progress)	12 April 2022
1.1e	Matevž Bokalič, Alastair Chapman, Celísio Pires	Demonstrator site finalization in Ljubljana, Forest of Dean and Évora	27 May 2022
1.2	Luís Fialho, Celísio Pires	Executive Summary, Introduction and Conclusion	29 May 2022
1.3	Celísio Pires	Final editorial changes	31 May 2022



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Statement of Originality

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Executive Summary

The EU-Funded AURORA project will empower 7,000 people from across the social spectrum to deliver substantial carbon emission reductions. Five communities (four from universities and one from a rural deprived area) will become citizen science hubs that will deliver reductions in carbon and costs for heating, lighting and transport. The project will provide apps for participants to monitor their energy behaviours and receive personal advice on reducing energy demands. As 'citizen scientists', these communities will use crowd-funded photovoltaic facilities to show how to install ca. 1 megawatt in total of renewable energy in their communities. Successful participants will become ambassadors for change and the findings will be shared with global citizen science communities.

This deliverable reports on the business models to follow-up by the different local energy communities. The local energy communities will be established in 5 different locations across Europe: Denmark (Aarhus University), England (Forest of Dean District Council), Portugal (University of Évora), Slovenia (University of Ljubljana) and Spain (Technical University of Madrid). The description of the business models by each location can be found in this document.

This deliverable links to the Work Package 3 – Upgrading Social Communities to Local Energy Communities and is a direct result of the work done in Task 3.1 – Business Models Development.

Disclaimer

The information in this document may suffer alterations since the business models are still pending approval.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101036418.

Contents

1. Introduction.....	6
1.1. Opportunity	6
1.2. Legal Guidance on EU.....	7
1.3. Demonstrators Sites.....	7
2. Demonstrator Site – Madrid, Spain	10
2.1. Opportunity	10
2.2. Legal Framework.....	12
2.3. PV Power Plant.....	14
2.4. Energy Community.....	17
2.5. Mobilization	23
2.6. Financial Plan	25
2.7. Forecast.....	26
2.8. Timeline	27
2.9. SWOT Analysis.....	28
2.10. Risks	31
3. Demonstrator Site – Évora, Portugal	32
3.1. Opportunity	32
3.2. Legal Framework.....	33
3.3. PV Power Plant.....	34
3.4. Energy Community.....	35
3.5. Mobilization	37
3.6. Financial Plan	37
3.7. Forecast.....	39
3.8. Timeline	41
3.9. SWOT Analysis.....	42
3.10. Risks	42
4. Demonstrator Site – Ljubljana, Slovenia.....	44
4.1. Opportunity	44
4.2. Legal Framework.....	45
4.3. PV Power plant.....	46
4.4. Energy Community.....	47



4.5.	Mobilisation	50
4.6.	Financial Plan	50
4.7.	Forecast.....	52
4.8.	Timeline	52
4.9.	SWOT Analysis.....	53
4.10.	Risks	53
5.	Demonstrator Site – Aarhus, Denmark.....	55
5.1.	Opportunity	55
5.2.	Legal Framework	56
5.3.	PV Power Plant	58
5.4.	Energy Community	59
5.5.	Mobilization.....	63
5.6.	Financial Plan.....	63
5.7.	Forecast	64
5.8.	Timeline	65
5.9.	SWOT Analysis	66
5.10.	Risks.....	66
6.	Demonstrator Site – Forest of Dean, United Kingdom.....	68
6.1.	Opportunity	68
6.2.	Legal Framework	71
6.3.	PV Power Plant.....	75
6.4.	Energy Community.....	78
6.5.	Mobilization	83
6.6.	Financial Plan	85
6.7.	Forecast.....	87
6.8.	Timeline	88
6.9.	SWOT Analysis.....	88
6.10.	Risks	90
6.11.	Conclusion.....	92
7.	Conclusion	93



1. Introduction

1.1. Opportunity

Problem

The European Union (EU) is committed to reducing greenhouse gas emissions by 55% by 2030 when compared to the 1990 levels. This is also the EU's commitment to the Secretariat of the United Nations Climate Change Convention under the Paris Agreement. In addition, the EU aims to become the first climate neutral-continent by 2050.

Achieving climate neutrality by 2050 requires an authentic revolution in the energy sector that will only be carried out with local or proximity production and with the active participation of citizens. As a form of self-consumption in buildings, Renewable Energy Communities (REC) promise to democratize access to clean energy and its social and environmental benefits.

As climate change is becoming more pronounced each year, several solutions must be researched and developed to empower more sustainable citizens' behavior. The main aim of AURORA is to reduce carbon dioxide emissions to reach the ambitious European Green Deal targets for greenhouse emissions. This implies that citizens must play a much more active role in transforming the energy sector by adopting different behaviors to achieve a near Zero-Emissions community.

"We must end fossil fuel pollution and accelerate the renewable energy transition, before we incinerate our only home."

ANTÓNIO GUTERRES, United Nations Secretary-General, 18 May 2022

Solution

The project AURORA will empower around 7,000 citizens from five different locations in Denmark, England, Portugal, Slovenia and Spain. This empowering involves making more informed energy decisions; monitoring individual energy behavior; and crowdfunding a local renewable energy community with low-cost shares as low as 20 €. In the scope of the project, five solar photovoltaic energy demonstrators with ca. 200 kW each will be installed in five different locations (in four universities and a rural deprived area), resulting in a total of 1 MW photovoltaic power plants installed. By crowdfunding, each participating citizen will become an active "prosumer" and democratize the governance of the community and energy system. Additionally, each participant will be able to monitor his individual energy mix demand behavior in the AURORA mobile app, that, together with the energy production of the solar system, will allow accurate know-how on the corresponding carbon footprint managed by the app. The app will also include individual and automated recommendations to clarify the several energy behaviors taken by the user.

Market

The main target of AURORA will be marginalized groups and young generations to create local energy communities to act as Citizen Science hubs. Within universities, the main targets will be the academic community, such as students, professors, researchers and other staff. Ideally, the project will involve the local community where the demonstrators are installed.



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1.2. Legal Guidance on EU

The present project must follow the next EU directives:

- 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;
- 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.

Directive (EU) 2019/944 establishes common rules for generation, transmission, distribution, energy storage and supply of electricity, including consumer protection provisions with a transparent, competitive, consumer-centered, flexible and fair electricity markets, including the integration of electricity from renewable energy sources.

Directive (EU) 2018/2001 establishes a common framework to promote the use of renewable energy sources for electricity generation, and rules for financial support, self-consumption and the use for heating, cooling and transport of electricity from renewable sources. A binding Union target was set for the overall share of renewable energy in the Union's gross final consumption of energy in 2030, which should be at least 32%.

1.3. Demonstrators Sites

Technical University of Madrid, Spain

The Council Hall of Madrid is very active in Climate Change Strategies, taking part of several EU initiatives, being one of the 100 European cities that will be promoted to reach carbon-neutrality by 2030. Moreover, the Technical University of Madrid (UPM) committed to design and implement a strategic decarbonisation plan on its campuses, engaging students, administration and services staff and teaching and research staff, as well as all schools, research centres and institutes, departments and groups, in this effort. The Campus-Sur will be a cornerstone in these initiatives, through the implementation of the AURORA project, in which a renewable energy community will be established and supported by the UPM and the Campus-Sur university community (students, professors and administrative staff).

The UPM Campus-Sur is one of the different campuses belonging to the UPM in Madrid. It is comprised of 4 University Schools, 4 Research Centres, 1 library and 1 entrepreneurship centre. There are around 4,800 people integrating the university community in Campus-Sur, among which, around 4,300 are students, 300 are professors and 200 administrative staff.

The creation of a Renewable Energy Community in the Campus-Sur aims to fulfill the commitments of the UPM regarding the state of climate emergency declaration, through the installation of a 200 kW photovoltaic (PV) power plant on the rooftops of the Campus-Sur buildings for the self-consumption of energy by the UPM's Centres. The owners of this facility will be the Campus-Sur community and the UPM, where the members of the Campus-Sur will finance the PV installation and the UPM will provide the surface of the rooftops. As return, the Campus-Sur members will participate in the generation of green energy, reducing their CO2 footprint, and receiving a small economic return from the sale of energy to the UPM. On the other hand, the UPM will receive energy at a price much lower than the market prices.

The initiative aims to engage the entire Campus-Sur university community in this Renewable Energy Community creating an energy awareness framework with a bottom-up approach to promote a more responsible use of energy.



University of Évora, Portugal

The University of Évora (UÉ) has not yet set any climate targets, although having a long tradition of researching solar energy, by having one of the first bachelor's degree programme in Renewable Energy Engineering, a master's degree in Solar Energy Engineering and a doctoral program for Mechatronic and Energy. Additionally, about 11 years ago, the Renewable Energy Chair was funded, a large research infrastructure for photovoltaics and solar thermal energy.

UÉ is divided into two campuses, a distributed campus located in the historical centre of Évora and the second ca. 12 km outside of the city, the Polo da Mitra Campus. In the Polo da Mitra Campus, the electricity is supplied by one energy supplier through three transformer stations, with a significant imbalance of the supply-generation so that the energy is not generated where it is consumed. To solve this, an energy community will be set that distributes renewable energy better across the campus and provides a better self-consumption ratio. As in AU, a solar power plant of 200 kW is planned, corresponding to about one-fifth of the maximum power demand of this campus. As the campus is outside of the city of Évora, there is enough available area for the solar plant to be ground-mounted, considering that from the ca. 280 hectares available only a fraction of a hectare will be needed.

In the framework of the planned demonstrator of the European Energy Awareness, students, professors, researchers and other staff will have a chance to crowdfund the demonstrator and also to monitor their carbon footprint with the AURORA mobile app. The crowdfunding process aims to engage about 1,500 citizens, who can participate with shares between 20€ and 1000€. Different interventions to encourage citizens to a more sustainable lifestyle will be performed, which also contributes to the community behavioural changes.

UÉ also contributes to the dissemination and communication of the different actions within the project, including the organization of a webinar with key actors in Portugal. Finally, the main attribution is the adequate treatment of data linked to the crowdfunded solar system for evaluating the climate impact of energy infrastructures.

University of Ljubljana, Slovenia

The team from the Laboratory of Photovoltaics and Optoelectronics (LPVO) of the University of Ljubljana (UL) resides at the Faculty of Electrical engineering, where they will also build their demonstrator and start transforming the existing student social community into energy community.

The Aurora demonstrator will be installed on the roofs of Faculty of electrical engineering next to the existing 17 kW power plant built in 2010 and three test sites for photovoltaic modules. With current module technologies, the final power of newly installed photovoltaic power plant will approach 200 kW. Based on the analysis of the electricity consumption of the faculty, all the electricity produced by the demonstrator solar power plant will be self-consumed and none will be fed into external grid. This, combined with recent sharp increase in price of electricity, enables very good economics of the proposed power plant.

Preliminary meetings with potential participants revealed that students are not willing to invest initially. Therefore, the UL team will put strong emphasis on raising awareness by establishing the Student Energy Club (ŠEK) and organizing several events discussing climate and energy crisis and focusing on photovoltaics as a renewable energy technology that is available and affordable to everyone, especially by investing into a community power plant such as AURORA demonstrator.

Due to the detected hesitation, UL will install the demonstrator in units of a few 10 kW each. The first 39 kW unit already has the permit and selected installer and is currently negotiating last details about the installation. This unit will be financed internally by LPVO and used as a demonstrator to promote PV and raise awareness between possible participants. The shares will be offered virtually by the AURORA app providing risk free investment and hands on demonstration. By raising awareness and willingness to participate, later stages will exploit the crowdfunding approach.



The initial stage will have different module orientation and will include modules with different PV technologies (such as TOPCon, SHJ, IBC and PERC). This variability will provide different monitoring data, which will be available to citizen scientists and students for data analysis and research purposes.

Aarhus University, Denmark

Aarhus University (AU) is responsible for defining the labelling scheme to identify citizens based on their energy consumption and the metrics to monitor behaviour changes and how fast they are achieved; conducting the international peer-reviewing of the proposed methodology; planning the citizen research meetings to be implemented by all partners; and for coordinating the establishment of a local energy community in Aarhus, with defining the corresponding business model and implementing the strategies to engage the participants and the practicalities of the rooftop solar system. In addition, AU will take advantage of the data collected in AURORA and combining it with its extensive expertise on energy modelling, implement the analysis of energy transition paths for Europe and investigate the impact of behavioural changes and efficiency improvements such as those monitored in AURORA.

In the demo site, the AU team will build an energy community by crowdfunding a solar installation of 200 kW on the rooftop of some buildings of the university's campus Nobelparken, where the school of arts and social sciences reside. The installation is planned to start in 2023. According to a preliminary analysis, 90 % of the produced electricity by the future solar installation will be consumed on-site by the university. Everyone in the community will have a chance to invest and get annual economic returns, as also to participate in public discussions and hands-on workshops.

All of this will be done in close collaboration with the university's Green Team, who coordinates the work around the university's climate strategy. The university has an ambitious target of reducing the emissions of carbon dioxide by 35% in 2025 and by 57% in 2030, both against a 2018 baseline.

A challenge for AU is that the university does not own any building itself, which leads to a more complicated matrix of stakeholders. The team is discussing with the university and the building owner to establish a viable business model for the crowdfunding process. The current proposed model for the energy community is cooperative. Though Denmark has a long history of energy cooperatives, the proposed model for AURORA's Aarhus demonstrator as illustrated in detail in this report involves a public institution (i.e. the university) and has no prior example. At the time of writing this report, the legal advisor is drafting the cooperative statutes, which will describe the involvement of the university and later be reviewed by the university's legal advisor. Nevertheless, students and employees of AU have shown great enthusiasm and willingness to become part of the future energy community. The first public informational meeting of the AURORA project with potential participants occurred on the 10th of March 2022.

Forest of Dean District Council, United Kingdom

The Forest of Dean District Council (FoDDC) contributes with expertise, ideas and help to shape and distribute the online survey and to input the Zero-Emission citizen labelling design and periodic citizen researcher meetings. FoDDC will also assist the co-creation process for developing the AURORA mobile app.

In cooperation with the Centre for Sustainable Energy (CSE), FoDDC will deliver an innovative Local Energy Initiative that provides a demonstrator for citizen engagement, including research for the legal, planning and community set-up and business model development focused on the solar system installation on the council-owned buildings/sites. CSE also advises and supports the crowdfunding process and provides technical support on specifying and procuring the installation and for communicating the project locally.

FoDDC leads on RoadMap development and offers support for energy behaviour interventions for local individuals, households and communities.



2. Demonstrator Site – Madrid, Spain

2.1. Opportunity

Our Solution

The Campus-Sur of the Technical University of Madrid (UPM) is located at the South-East of Madrid in the Puente de Vallecas District.

The creation of the Campus-Sur Renewable Energy Community (REC) aims to engage around 1,500 members (among students, professors and administrative staff) belonging to the Campus-Sur university community to be part of a strategy aligned with the objectives of the 2030 Agenda, such as mitigating the climate crisis, reducing greenhouse gas emissions to zero by 2050 and the systematic decarbonization of the energy system as also declared on January 21, 2020 by the Spanish Council of Ministers.

In this regard, on the occasion of the Governing Council of November 28, 2019, the UPM declared a state of climate emergency and committed to launch an action plan aiming to achieve climate neutrality by 2040^[1]. Thus, the UPM joins the action against climate change in accordance with the 17 SDGs of the 2030 Agenda and sets the intermediate goal of reducing its net direct emissions of greenhouse gases by 2030.

In this context, the creation of the Campus-Sur Renewable Energy Community aims to contribute to such objectives through the development of the following actions:

- Generation of electricity from a 200 kW photovoltaic (PV) power plant located on the rooftops of the Campus-Sur buildings;
- Distribution of the electricity generated, either by sharing it with the UPM or by injecting surplus energy to the distribution network;
- Management of micro-investments in participation accounts and/or donations required for effectively putting in place the PV power facility;
- Promotion of behavioral change of community members to enable the reduction of the carbon footprint;
- Carrying out any activities that are necessary for the development of the goals of the Renewable Energy Community.

The REC is constituted under the legal framework of a Foundation. In this regard, the REC is integrated into the General Foundation of the UPM (FGUPM)^[2]. Within this Foundation, a Commission is created to manage the REC, whose operation is governed by a regulation approved by the governing body of this Commission (Board).

The structure of the Commission allows all the members of the REC to intervene in the decision-making process. For this purpose, a Members Section is created, made up of students, professors and administrative staff. Regarding the vote, the UPM has 55% of it, while the other three categories of members have 15% each.

Contributions and consideration of the REC members

The UPM carries out a management assignment to the FGUPM for the constitution and development of the REC. This allows the FGUPM to use the rooftops of the Campus-Sur buildings to install the 200 kW PV power plant.

The UPM receives electricity generated by the REC facilities and pays to the REC based on the electricity bill savings achieved. Thus, the UPM will avoid consuming a certain level of energy from the electrical grid. The price of the service provided by the REC to the UPM will be stipulated by an energy saving agreement.



Students, professors and administrative staff may make economic contributions to the REC (micro-investments) in order to finance the necessary equipment for the PV installation. Depending on the magnitude of the investment, there are two possibilities:

- Less than 100 €: in this case, a donation is made and the members may participate in non-monetary benefits (scholarships, travel grants, training courses exchangeable for ECTS credits and others).
- 100 € or more: the members are able to sign one or several participation accounts contracts, and they will receive a yearly economic return of around 4%.

Financing and management.

In a first phase of capitalization, the REC is financed through the contributions of its members (micro-investors).

In a second phase, the REC delivers the energy generated by the PV facilities to the Campus-Sur buildings of the UPM, receiving in exchange the agreed price in terms of energy savings. Likewise, the REC will reward funders who have made a financial contribution of 100 € or more by signing a participation account contract.

The completion date of the REC project is set in 2050.

^[1] <https://sostenibilidad.upm.es/28-nov-declaracion-del-compromiso-de-la-upm-con-la-accion-contra-el-cambio-climatico/> (April 11, 2022)

^[2] The FGUPM is a non-profit entity, created in 1981 by the UPM, dedicated to the support of the management of scientific research and the University's own teaching.

Market Size & Segments

The UPM Campus-Sur is one of the different campuses belonging to the UPM in Madrid. It is comprised of 4 University Schools: Telecommunication, Computing Science, Topography and Design & Fashion; 4 Research Centres: Solar Energy, Automotive, Laser and Software Technologies; 1 library; 1 entrepreneurship center “La Arboleda”; a primary school for children with learning difficulties and a secondary school.

There are around 4,800 people integrating the university community in Campus-Sur, among which, around 4,300 are students, 300 are professors and 200 administrative staff. The distribution of these people on the campus is shown in Table 1 according to 2020 data:

Table 1 - Distribution of Campus-Sur university community in 2020.

Center		Students	Professors	Administrative staff	Other
University schools	Telecommunication	1,920	131	57	
	Computing Science	1,898	110	50	
	Topography	276	44	35	
	Design & Fashion	143	20	21	
Research institutes	Solar Energy Institute	2	0	2	
	Automotive	7	3	7	
	Laser	5	2	4	
	Software Technologies	8	2	5	
Library		0	0	17	
“La Arboleda”, entrepreneurship center		0	0	6	10
TOTAL		4,259 (89.0%)	312 (6.5%)	204 (4.3%)	10 (0.2%)



From this data there are 290 professors working full-time and 22 part-time. Students are divided into Bachelor's degree (92%) and Postgraduate education (8%). Performance, success and absenteeism ratios of the Campus-Sur students^[3], according to the 2020-21 academic year, are shown in Table 2.

Table 2 - Performance ratios of the Campus-Sur students in 2020-21 academic year.

Center	Performance	Success	Absenteeism
Telecommunication	63.94%	71.26%	10.65%
Computing Science	67.69%	73.45%	8.55%
Topography	58.75%	82.23%	26.72%
Design & Fashion	100.00%	100.00%	0.00%

Finally, the administrative staff represents 4.3% of the university community, of which half are civil service employees and the other half are non-statutory permanent posts.

^[3] Performance ratio: students who have passed the exams / enrolled students

Success ratio: students who have passed the exams / students who have taken the exams

Absenteeism ratio: students who have not taken the exams / enrolled students

2.2. Legal Framework

Country Regulations

Spain has not yet transposed the EU **Directives 2019/944** on common rules for the internal market for electricity and the **2018/2001** on the promotion of the use of energy from renewable sources, regarding the regulation of Energy Communities, in particular, the Citizen Energy Communities (2019/944) and the Renewable Energy Communities (2018/2001). Nevertheless, the **Law 24/2013** of 26 December 2013, on the Electricity Sector of access and connection to the electric power transmission networks, defines, in Art. 6 paragraph 1.j), the Renewable Energy Communities as a subject able to develop activities aimed at supplying electricity. In particular, the Law defines the Renewable Energy Communities as *legal entities based on open and voluntary participation, autonomous and effectively controlled by partners or members that are located close to the renewable energy projects that are owned by these legal entities, whose partners or members are individuals, 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.*

Many initiatives related to Renewable Energy Communities have been developed until now under the umbrella of the renewable energy self-consumption regulation: the **Royal Decree (RD) 244/2019** that regulates the administrative, technical and economic conditions for the self-consumption of electricity. This RD recognizes the figure of shared self-consumption, which enables several users to benefit from the same generating facility, allowing the establishment of Energy Communities. In addition, Spain has recently regulated the variable distribution coefficients in collective self-consumption (**Orden TED/1247/2021**) for the adequate distribution of the generated renewable energy among the members of the collective self-consumers.

The lack of a specific regulation for the establishment of Renewable Energy Communities has not hindered the launch of the first support program for the implementation of Energy Communities. This program, called **CE IMPLEMENTA**, was launched in February 2022 by the IDAE (Spanish Renewable Energy Agency)^[4] based on the Renewable Energy Community concept defined by the Law 24/2013. The program has also extended this concept to the Citizen Energy Communities, which has not yet been recognised by the Spanish regulation. The support program is aimed at those



legal entities, public or private, that encourage the participation of non-traditional actors in the energy sector and whose purpose is the development of electrical and thermal renewable energy, energy efficiency, infrastructure for sustainable mobility and demand management through the establishment of energy communities.

[4] <https://www.idae.es/en/node/25209> (April 20, 2022)

Process

The process to create the Campus-Sur Renewable Energy Community can be summarized as follows:

1. UPM's commitment to climate change action.

On the occasion of the Governing Council of November 28, 2019, the UPM declared a state of climate emergency and committed to launch an action plan with the goal of achieving climate neutrality by 2040. In accordance with this declaration, the UPM *committed to design and implement a strategic decarbonisation plan on its campuses, engaging students, administration and services staff and teaching and research staff, as well as all schools, research centres and institutes, departments and groups, in this effort.*

2. Proposal to create an Energy Community in Campus-Sur.

The Solar Energy Institute of the UPM has proposed in 2021 the creation of a Renewable Energy Community in the Campus-Sur with the aim of fulfilling the commitments of the UPM regarding the state of climate emergency declaration. The idea is to install a 200 kW photovoltaic (PV) power plant on the rooftops of the Campus-Sur buildings for the self-consumption of energy by the UPM's Centres. The owners of this facility are the Campus-Sur community (students, professors and administrative staff) and the UPM, where the members of the Campus-Sur finance the PV installation and the UPM provides the surface of the rooftops. As return, the Campus-Sur members participate in the generation of green energy, reducing their CO₂ footprint, and receiving a small economic return from the sale of energy to the UPM. On the other hand, the UPM receives energy at a price much lower than the market prices.

The proposal aims to engage the entire Campus-Sur university community to participate in this Renewable Energy Community creating an energy awareness framework with a bottom-up approach to promote a more responsible use of energy.

3. Creation of the Campus-Sur platform.

A Campus-Sur platform has been created in 2021 by the three main collectives - students, professors and administrative staff - with the aim of promoting, developing and carrying out projects in the Campus-Sur area. AURORA is the first project that is going to be developed by the platform and new ideas are expected to be launched in the future to benefit the Campus community in terms of energy savings, emission reductions, improved adaptation to climate change and others, involving students, administrative staff, teaching and research staff in this effort.

4. Expert advice.

The UPM has hired a legal expert in 2021 to advise the UPM regarding the options, requirements and criteria both for the constitution and execution of a Renewable Energy Community. The expert prepared a document analyzing the figure of the Renewable Energy Community in the context of the University's participation, as well as, in each case, the applicable legislation and the requirements that must be met for each specific case.

5. Legal framework and business plan.

The Campus-Sur platform representatives together with the expert advisor have established a dialogue with the UPM Governing Council about the legal framework options for the constitution of the REC as well as its business plan until 2050. These options are based on some common principles:



- The Campus-Sur community must be part of the REC.
- The UPM has to provide the rooftops of the Campus-Sur Centres for the PV installation.
- The UPM's Centres have to consume the energy generated by the REC PV facility.

In accordance with the UPM internal and legal principles the most suitable legal model for the constitution of the REC is a Foundation. Other options have been considered, such as a cooperative, association or limited company, but the only model suitable to integrate the UPM, as a public body member, is a Foundation. In this regard, two options have been considered:

- To create a new Foundation integrated by the Campus-Sur community members and the UPM.
- To integrate the REC into the already existing General Foundation of the UPM (FGUPM).

Once the legal structure has been defined, according to option b), all the statutes, regulations and contracts will be elaborated and approved by the relevant bodies.

6. Communication plan.

Once the REC has been constituted, a communication plan has to be approved aiming to raise awareness among the different target groups of the Campus-Sur community.

2.3. PV Power Plant

Location

The UPM Campus-Sur is located in the South-East of Madrid in the Puente de Vallecas District. The UPM Campus is comprised of 4 University Schools: Telecommunication, Computing Science, Topography and Design & Fashion; 4 Research Centres: Solar Energy, Automotive, Laser and Software Technologies; 1 library; and 1 entrepreneurship center “La Arboleda”. Figure 1 and Figure 2 show the Campus-Sur location and the aerial view.



Figure 1 - Campus-Sur Location.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101036418.



Figure 2 - Campus-Sur aerial view.

The PV power plant is planned to be installed on the roofs of some of the different buildings at the campus.

A first potential capacity study has been made just using the rooftops belonging to the Telecommunication, Computing Science, Topography and Design & Fashion Centres.

Table 3 summarizes the Campus-Sur buildings and their rooftops surfaces shown in Figure 3.

Table 3 - Campus-Sur buildings and their rooftops surfaces and PV power capacity.

Centres	Area (ZONA)	Surface (m ²)	PV Power (kW) capacity
BUILDING 1: Telecommunication Computing Science Design & Fashion	4	1,773	126
	5	776	55
	6	1,402	100
	7	1,643	117
	8	212	15
BUILDING 2: Design & Fashion	9	662	47
	10	796	57
TOTAL		7,264	516





Figure 3 - Rooftops view of Telecommunication, Computing Science and Design & Fashion Centres (BUILDING 1 on the left) and Topography Centre (BUILDING 2 on the right).

Installation details

The selection of the rooftops for the PV facilities will be done taking into account the following criteria:

- Shade-free rooftops.
- Surfaces to install units of at least 25 kW.
- Proximity to low voltage electrical connection points.
- PV generators installed in a way that maximizes energy production.
- Representative technologies present in the PV market.
- Potential for research and teaching activities.

The chosen rooftops will belong to zones 6, 7, 9 and 10 (see Figure 3), where a **200 kW** power plant will be installed based on the mentioned criteria.

About the technological diversity on the campus-sur rooftops

Current photovoltaic modules use crystalline silicon as the base material for the manufacture of solar cells. An increasingly wide technological diversity is based on this common base, since, in 2018, the **BSF (Back-Surface Field)** structure on polycrystalline material was replaced by the **PERC (Passivated Emitter Rear Contact)** structure on monocrystalline material, and, in 2020, the size of silicon wafers increased from 158 mm x 158 mm to 210 mm x 210 mm. These advances opened the door to high efficiency, which brought the advent of bifacial modules, and high-power modules (> 500 W), reducing the cost of photovoltaic systems. High efficiency solar cells are nowadays being developed by new technological innovations, which are already in an industrial manufacturing phase: n-type silicon, **TOPCon contacts (Tunnel Oxide Passivated Contact)**, **IBC contacts (Interdigitated Back Contact)** and **HJT (Hetero Junction Technology)** cells. Furthermore, in the field of cell interconnection and module encapsulation, half-cell, even third-cell, are predominant in industrial manufacturing as well as the glass-glass encapsulation.



Hence, the PV power plant located in Campus-Sur will incorporate a variety of modules that cover the previous spectrum with the aim of serving as a demonstration and as basis for teaching photovoltaic engineering. Currently, the Solar Energy Institute in Campus-Sur operates two monofacial PV generators with traditional technology (Si-p, multicrystalline, BSF cells) and a bifacial generator with more advanced technology (Si-n, monocrystalline, PERC cells). Therefore, to achieve a representative sample, at least one generator of each of the following varieties will be incorporated:

- TOPcon cells
- PERC cells
- IBC cells
- HJT cells

2.4. Energy Community

Goals

The purpose of the Campus-Sur Renewable Energy Community (REC) is to provide economic, social and environmental benefits to its partners, members and to the Campus-Sur community.

On the one hand, the benefits that the REC will provide will be environmental, due to the PV power plant installation, which will generate clean, renewable and modern energy to the University's Campus, so that the electricity consumed from the electrical grid, which is largely generated through fossil fuels, will be considerably reduced. In addition, the electricity produced by the PV power plant will be consumed locally, avoiding being transported through the electrical distribution network, with the consequent energy losses that it entails.

On the other hand, the REC will have the capacity to promote the green energy sector in Spain, whose experience could also serve as an example for other initiatives, whether by universities or other institutional, corporate or citizen structures throughout the country.

The REC also aims to be a vector for the promotion of knowledge and research on renewable energies by the members of the Campus-Sur community.

Legal Form

The Campus-Sur Renewable Energy Community (REC) will be constituted under the legal form of a Foundation to be integrated in the General Foundation of the UPM (FGUPM). This General Foundation FGUPM is a not-for-profit entity, created in 1981 by the UPM, dedicated to support the management of scientific research and the University's teaching. The purposes of the FGUPM are defined in Article 6 of its statutes and include *"the analysis, promotion, development, dissemination and execution of projects that foster respect and commitment to environmental conservation and sustainable development"*, as well as *"The promotion, development, dissemination, and execution of projects related to the information of society and innovation in technology (biotechnology, home automation, new materials, alternative energies and others)"*.

To carry out the formalization of the REC, the following considerations must be taken into account:

- The UPM carries out a management assignment to the FGUPM for the constitution of the REC. Consequently, the Commission in charge of the REC of the FGUPM will have the right to use the roofs of the Campus-Sur buildings on which the PV energy facility will be installed.
- In exchange, the UPM will receive electricity generated by the PV facilities at a lower price than the market price and will remunerate the REC's activity through the price agreed in the Energy Saving Agreement.



- Students, professors and administrative staff from the Campus-Sur may make economic contributions to the community (micro-investments through participation accounts and/or donations), in order to finance the PV power plant installation. These contracts will be awarded through a tender process and the only criterion will be on a first-come, first-served basis. The amounts contributed by the micro-investors will be considered for all purposes as Net Assets of the Foundation.
- The micro-investment 100 € or more. It will be done through participation accounts. In exchange, the micro-investors will receive an economic return.
- The micro-investment is less than 100 €. The micro-investors will make a donation free of charge and may participate in activities carried out by the Foundation. For example, obtaining scholarships, travel grants, training courses exchangeable for ECTS credit and others.
- Any natural or legal person may make a financial contribution to the Commission through micro-investments - either through participation accounts or donations - as a participant. This will not imply the consideration of the contributor as a member of the REC.

Thus, The Campus-Sur REC is organized and managed through the Commission in charge of the REC ("REC Commission") of the General Foundation of the UPM. The operation of the REC Commission is structured through a regulation, approved by the Board (governing body of the Commission) with the aim of achieving a good corporate governance, proper management of resources, and respect for the rights and duties of all parties involved.

The main activity of the REC Commission is the development and management of a Renewable Energy Community in the Campus-Sur. The following activities arise from this:

- a. The generation of electricity from a PV power plant located on the rooftops of the Campus-Sur buildings;
- b. Distribution of the energy generated by the PV facility, either by sharing it with the UPM or by injecting surplus energy into the distribution network;
- c. Management of micro-investments in participation accounts and/or donations required for the effective development of the PV power plant installation;
- d. Promotion of behavioral change to enable the reduction of the carbon footprint through, for example, dissemination of the principles of Renewable Energy Communities or training in the field of renewable energies;
- e. Carrying out any activities that are necessary for the development of the purposes of the Commission and the Renewable Energy Community.

Documentation

The following documentation is necessary to constitute and operate the Renewable Energy Community:

- Regulation of the Commission created within the FGUPM. This Regulation structures the creation and operation of the Commission in charge of the Energy Community of the UPM General Foundation (FGUPM), established for the purpose of setting up a Renewable Energy Community in the Campus-Sur. This regulation will be included in the current statutes of the FGUPM, with the prior agreement of the Foundation Board.
- Order from the UPM to the FGUPM for the creation, development and management of a Renewable Energy Community and the installation and operation of a PV power plant for the generation of renewable energy in the Campus-Sur.
- Energy Saving Agreement. This agreement is an essential part of the assignment from the UPM to the FGUPM for the creation, development and exploitation of the REC, as well as the corresponding delivery of energy to the UPM that the REC will carry out accordingly. The REC is considered as "UPM's own means", which allows the UPM to provide the REC with the rooftops on which the PV power plant will be installed. The UPM will



receive part of the energy, contributing to the REC the price agreed in this agreement, which will be established based on energy savings.

- Specific administrative clauses for the bidding of contracts for adhesion of participation accounts which are intended to fund the installation and operation of the PV power plant of the REC. The bidding procedure will be processed by FGUPM as a public foundation.
- Contract of adhesion of accounts in participation. The purpose of this contract, signed by the FGUPM and the individual micro-investors, is the installation, construction, operation and management of the PV power plant through micro-investments of 100 € based on the subscription of participation accounts.
- Operation Manual of the REC. Document addressed to the general public and especially to the REC members and micro-investors where the REC regulation and operation clauses are summarized.

Contracts

The contract of participation accounts is signed by the FGUPM and every individual micro-investor. This contract includes the following clauses, among others:

- The purpose of the contract is the installation, construction, operation and management of the PV power plant through micro-investments of 100 € or more based on the subscription of participation accounts.
- It is expected that the end of the operation will take place in 2050, which corresponds to the end of the lifetime of the PV facility.
- The management of the PV power plant corresponds to the FGUPM (that is, the REC).
- The contributions of the individual micro-investors are a multiple of 100 €.
- Participation in the result of exploitation. The participation in the performance is that obtained from the sale of electricity to the UPM, in accordance with the planned schedule for return and amortization of contributions included in this contract.

Members of the Community

The Members of the REC, who establish themselves as the immediate beneficiaries of its activity, have been defined as follows:

- a. The Technical University of Madrid (UPM)
- b. Campus-Sur's students
- c. Campus-Sur's research and teaching staff
- d. Campus-Sur's administrative staff
- e. Other members (as long as they are close to the project)

The UPM is a member of the Renewable Energy Community from the moment of its creation, since its contribution is essential for its operation and to start generating energy.

The UPM will receive electricity generated in the REC PV facilities, and the Campus-Sur community will be able to use green, sustainable, and local-generated energy.

The UPM will pay the REC Commission based on the energy savings achieved.

The students, research and teaching staff and administrative staff will be able to belong to the REC through their adhesion to the Members Section. These members may make economic contributions to the REC (micro-investments) in order to finance the PV power plant.



The REC may establish agreements with any other members it considers convenient. This will always be done with the prior agreement of the Commission Board and respecting its purposes. The local criterion must be taken as the limit, since the members of a Renewable Energy Community must be located close to the project.

Types of Participations

There are two types of participation in the REC in accordance with the following definitions:

- **Member of the REC:** natural or legal person, belonging to the Camus-Sur community or located close to the campus, who participates in the Commission in charge of the REC through a contribution, either monetary or in kind. Members will be organized into sections (students, professors, administrative staff and others). The members of the Foundation will in turn be members of the REC.
- **Participant:** natural or legal person who participates in the REC by making an economic or in-kind contribution, but is not located close to the campus or is not part of the Commission as member.

Types of Shares

Depending on the quantity of the investment, there are two possibilities:

- Micro-investment of less than 100 € – in this case, a donation is made and the micro-investors may participate in non-monetary benefits. This donation could also be made through a donation to the UPM, who would be in charge of offering the non-monetary benefit.
- Micro-investment of 100 € – the micro-investors may sign one or more joint account contracts, which will be awarded by a tender process, and in exchange they will receive an economic return for the investment made. Each contract will be made for an amount of 100 euros, therefore the contributions made will always be multiples of 100.

The economic contributions of 100 € will be carried out through a contract of adhesion of participation accounts and will allow the financing of the installation, construction and management of the PV power plant.

Figure 4 summarizes the operational outline of the Campus-Sur REC:

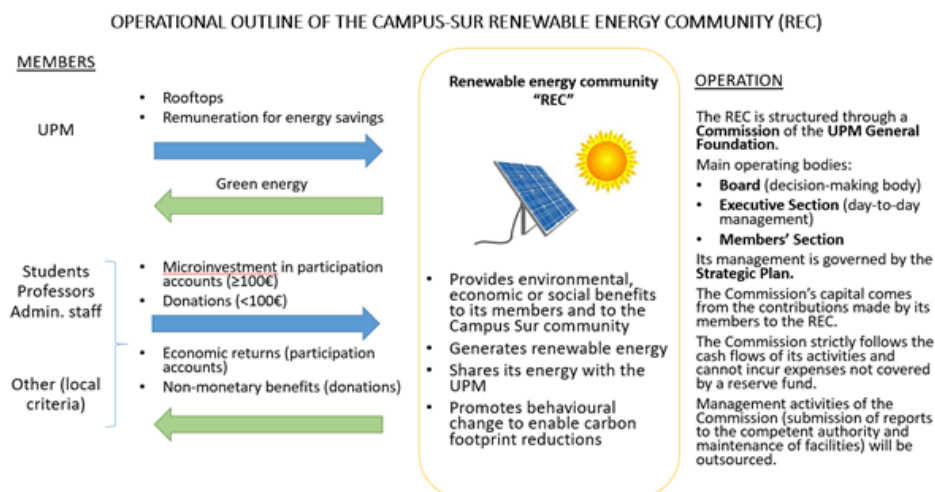


Figure 4 - Operational outline of the Campus-Sur REC.



Requirements

To become a member of the REC, the following requirements are mandatory:

- To be natural or legal person, belonging to the Camus-Sur community (University, students, professors, administrative staff and others) or located close to the campus;
- To express the will to participate in the power generation project based on photovoltaic energy;
- To be willing to participate in the investment, through a contribution, either monetary or in kind and in the expected benefits of this business.

Electricity Management

The delivery of energy by the Campus-Sur REC to the UPM will be carried out under the self-consumption rule, protected by the regulations of the Spanish legal system established by the Royal Decree 244/2019. In other words, the consumption of such energy will be made in the context of shared self-consumption and the right of the renewable energy communities to share, within it, the renewable energy produced by the production units owned by them.

Shared self-consumption is allowed close to the grid and in the internal electrical network, partially implementing what the Directive (EU) 2018/2001 establishes regarding the right of renewable energy communities to share the energy produced.

An Energy Savings Agreement, signed between the UPM and the FGUPM, will allow the UPM's contribution to be regulated in favor of the REC. The UPM will pay the REC for the energy savings achieved during the entire duration of the agreement, which will allow the proper functioning of the PV power plant and the generation of renewable energy. Such price will take into account the energy savings or avoided consumption of electricity from the electrical power distribution network, due to the consumption of renewable energy from the PV power plant owned by the REC.

Community Management

The governing and administrative body of the REC is the Commission Board, made up of a minimum of four members, one of them the UPM and three other members (representatives of students, professors and administrative staff). The two main management processes are defined as follows:

- Decision-making process. The structure of the Commission allows all the members of the REC to participate in the decision-making process. The Commission Board will have a President and a vice-president. A Members Section will be created, which will be made up of students, professors and administrative staff. The Members Section must appoint three candidates, who will be the representatives, respectively, of students, professors and administrative staff. On the other hand, the UPM will also appoint a representative for the Commission Board. Regarding the vote, the UPM will have 55% of it, while the other three categories of members will have 15% each. However, decisions must always be taken by consensus and in the event that this is not obtained, the President will have the casting vote to avoid obstruction of the procedure.
- Decision implementation process. An Executive Section will be created to be in charge of the day-to-day management of the Commission. Such a Section is the body that manages, monitors and promotes government and administrative actions, and will be made up of the president and vice-president of the Commission Board, as well as the people elected by co-option.

For a better understanding, Figure 5 summarizes the Governance Structure of the Campus-Sur Renewable Energy Community.



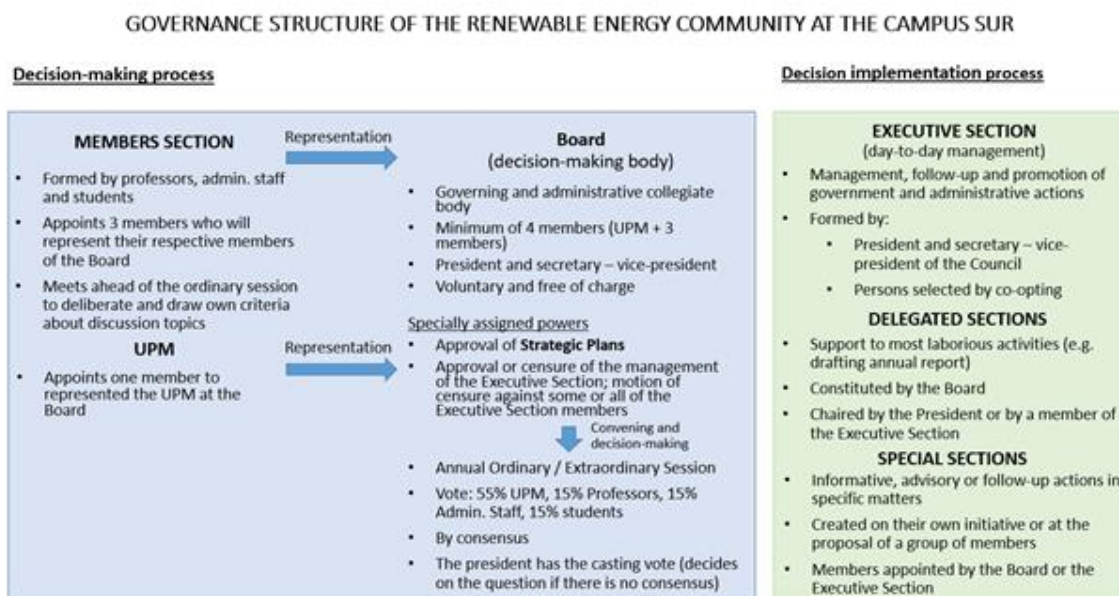


Figure 5 - Governance Structure of the Campus-Sur Renewable Energy Community.

Sustainability Strategy

As mentioned above, one of the activities to be carried out by the REC is the management of micro-investments in participation accounts and/or donations required for the effective development of the PV power plant installation. In this sense, the REC must render accounts annually to the REC members (micro-investors), presenting a settlement of the result within the first six months following the close of the financial year. During the first semester following the expired year, the REC will proceed to pay the participant-account the amount corresponding to the liquidation. Payment will be made by transfer to the bank account designated by the member.

The final closure of the account must take place in 2050 or, if the operating time of the solar energy generation facility has been extended, the definitive date of completion of the electricity generation activity.

The ACCOUNT-PARTNER (micro-investor) may, at any time, assign the rights and obligations arising from this contract to a third party, setting the price they deem appropriate, for the period remaining until its final termination.

The Commission must carry out two management activities: the submission of reports to the competent authority and the maintenance of the PV facilities. During the term of the Energy Savings Agreement, the REC will be in charge of maintenance activities to keep the PV power plant in perfect working order, carrying out both the necessary corrective and preventive maintenance actions.

Finally, the REC must guarantee that the PV system covered by the contract will achieve the minimum electrical performance from the commissioning of the facilities until the end of the contract. If the minimum electrical yield is not reached at the end of the contract period based on the accumulated annual electrical yield, the REC will reimburse the ACCOUNT-PARTNER (micro-investor) for the difference between the amount of electricity actually produced in kWh and the guaranteed minimum electrical yield.



2.5. Mobilization

Engagement process

The goal of the awareness rising campaign is to engage in the REC the largest possible number of people from the Campus-Sur. From the 4,800 persons integrating the campus, the goal of the project is to involve 1,500 people (31%). A specific communication plan will be designed for each of the three different target groups: students, professors / researchers and administrative staff. The communication strategy will include the creation of a project website and the design of flyers, banners and other marketing materials for dissemination activities. In addition, the strategy will focus on direct contact of the AURORA coordination group with the target groups. In a second stage, designated representatives or "ambassadors" of the different target groups will develop a peer-to-peer communication strategy as a key step to promote the project and create awareness within each group.

- Professors / Administrative staff. A communication plan will be developed to participate in the Council meetings of the different Departments to introduce the project directly to the professors and administrative staff and resolve any doubts and questions about the REC that may arise. This activity will be implemented in each of the 20 Departments present in the Campus-Sur.
- Research Centres. The different research groups located on the campus will be contacted to organize a communication session to introduce the project to researchers. There are 4 research centres on the campus: Solar Energy Institute, Research Center on Software Technologies and Multimedia Systems for Sustainability (CITSEM), Auto Research University Institute (INSIA) and Laser Center (UPM).
- Library. A communication session will be organized to inform the administrative staff of the library located on the campus about the project.
- Students. This is the most important target group of the campus as they represent 89% of the campus community. They are also the young citizens of today and the future leaders of society who will have to handle the projected negative consequences of climate change. Thus, their involvement is crucial to meet the project objectives. The approach to raise awareness within this group will be articulated according to the following actions:
 - The different student delegations from each university centre of the campus will be contacted to introduce the project.
 - Student involvement in communication tasks is considered key and will be promoted. In this regard, some working groups of students have already been created in the framework of the UPM initiative IDEATON^[5] with the aim of developing a communication plan addressed to the campus students.
 - Participation in events organized by students. Events such as the Spring Festival and others will be used as platforms for communication actions addressed to students.

It is worth mentioning that a first survey has been carried out among a group of 140 students from the Telecommunication University School who were informed about the AURORA project in Campus-Sur. 90% of them considered the project very interesting and innovative. About their possible involvement in the project, they responded as follows:

1. I'm not really interested.
2. I will not be part. I spend enough hours in the campus to get more involved!
3. I am not going to be part of it, but I could reconsider, especially if my colleagues join it.
4. Whoa! I need more information to make a decision.
5. I am interested in taking part, but possibly my participation will be just enough to support the project.
6. I am very interested in being part. I could even collaborate in starting up an activity within the energy community if it can be linked to my academic training or my own hobbies.
7. To infinity and beyond! You have my full support. Here you have the first ambassador of AURORA.



The results of the survey (Figure 6) show the willingness of a number of students to participate in the project and some of them have already submitted their email address to be contacted to contribute to the first communication actions to be organized in the Campus-Sur.

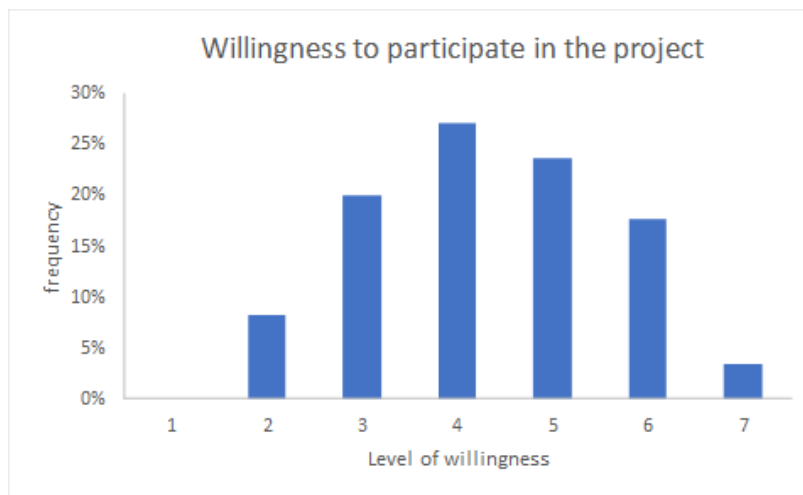


Figure 6 - Survey results about the willingness of 140 students to participate in AURORA.

Creation of an REC office on the campus. An office will be opened on the campus as information point about the REC and the project. It will be working for the entire duration of the project in order to inform the new students arriving to the campus every year. Moreover, the office will offer services related to the REC, such as subscriptions for new members, support to use the REC-app, or means to obtain scholarships or training courses exchangeable for ECTS credits in case of donations (participation with less than 100 €).

In addition, 3 displays to communicate AURORA around the campus will be installed and periodically upgraded to maintain informed the campus community about the progress of the project, events, opportunities, energy and CO₂ savings and others.

^[5] IDEATON is a “hackathon” of ideas and initiatives that can become a reality of projects conceived to improve the environment in the framework of the Sustainable Development Goals (SDG). It is intended that university students investigate a situation in the global and/or local sphere related to some SDG to develop initiatives and specific actions. <https://sostenibilidad.upm.es/ideaton-por-los-ods/> (April 22, 2022)

Sustainability

University students leave the campus in an average of four/five years. As they will be the core of the REC members, it is important to encourage further engagement from students -current and newer- in order to preserve the long-term financial stability of the Renewable Energy Community. In this regard, the creation of the REC office aims to inform the new students who arrive to the campus every year about the ways to be part of the REC and its environmental and economical benefits. Therefore, any student who has micro-invested in the PV power plant, wishing to leave the REC, can do it at any time, just assigning the rights and obligations arising from the contract of participation accounts to a new student or to another person.

In addition, the PV power plant installed in the Campus-Sur will be a platform for teaching and researching activities in which new students will be involved every year through the participation on training courses, degree projects, researching works and others. These academic activities, that will be offered in the syllabus of the different engineering



degrees, will keep the interest, among the university community, in PV technology, citizen science, energy communities and environmental issues.

Finally, the Campus-Sur REC aims to be a model for further replication energy communities in other UPM campuses and other universities in Spain. In this regard, the REC aims to support new initiatives through the organization of open day-journeys at the campus for any interested participants, the training of “ambassadors” at every level (students, professors and administrative staff) who might transmit knowledge peer-to-peer to other university colleagues, through platforms such as seminars, conferences and others.

2.6. Financial Plan

Financing Needed

The total budget for the 200 kW PV power plant installation has been estimated to be **222,200 €**. It comprises the following components and services:

- 200 kW PV modules
- 200 kW inverters
- Supporting structures
- Wires, connectors and protection elements (switches, fuses, etc)
- Monitoring system
- Quality control
- Administrative management (applying for permits, connection points, etc)
- Installation and commissioning
- Spare-parts

Sources of Funds

Funds for the financing of the **200 kW PV power plant** will be obtained by the following means:

- Members of the REC: belonging to the Camus-Sur community or located close to the campus, they participate in the financing of the PV facility through a monetary contribution.
- Participants: natural or legal persons who participate in the REC by making an economic contribution, but are not located close to the campus or are not part of the Commission as members.
- Subsidies. The REC may apply for grants from funding programs aimed at the development of renewable energy projects or the constitution of Energy Communities if they are available during the design phase of the project.

Identification of Stakeholders

The Campus-Sur project has not considered, so far, the involvement of third parties to the REC scheme.

Return of Investment

In a first capitalization phase, the REC will be financed through the contributions of its members and those who wish to invest in the community without being a member (participants). That is, the REC will obtain capital through micro-investments through participation accounts and donations.



In a second phase of investment, the REC will deliver the energy generated by the PV power plant to the UPM, receiving in exchange the agreed price in terms of energy savings. Likewise, the REC will reward funders who have made a financial contribution of more than 100 € by signing the participation account contract.

The Commission strictly attends to the cash flows of its activity, not being able to assume expenses if these were not previously insured with a reserve fund.

Figure 6 shows the flow chart of the Campus-Sur REC:

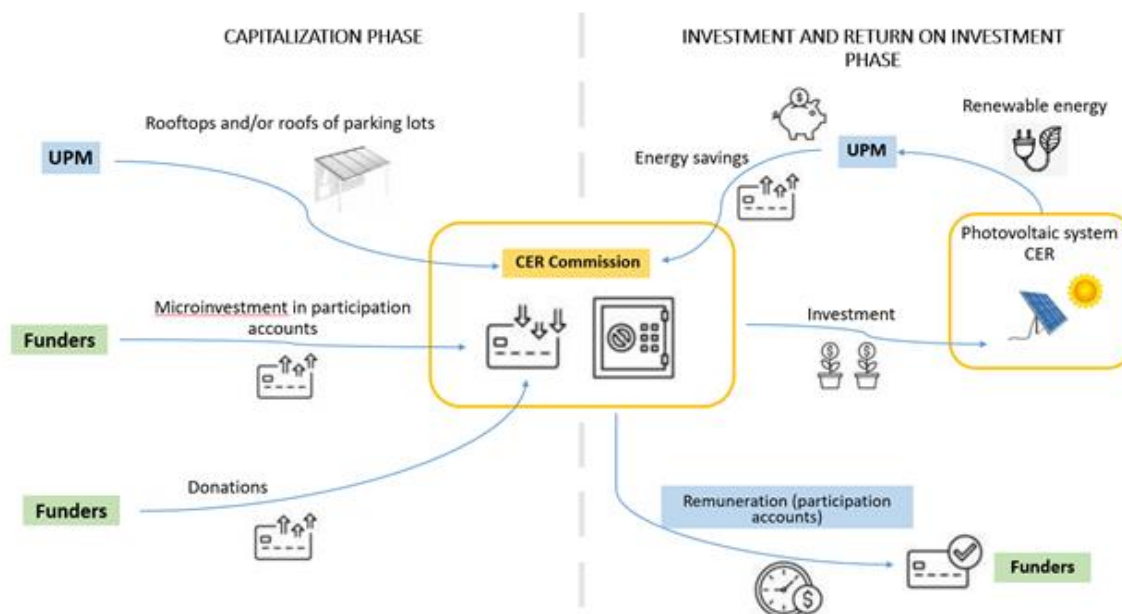


Figure 7 - Flow chart of the Campus-Sur REC.

Exit Strategy

Any REC member who has micro-invested in the PV power plant (account-partner or micro-investor) may, at any time, assign the rights and obligations arising from this contract to a third party, setting the price they deem appropriate, for the period remaining until its final termination in 2050.

2.7. Forecast

Revenue

The duration of the project has been established until 2050. To calculate the revenues of the micro-investors obtained by the PV energy production during all this periods, the following starting data has been considered:

- Installed PV power: 200 kW
- PV average energy yield: 1,250 kWh/kW/year
- PV power average degradation rate: 0.5%/year
- Contract start date: 2023
- Contract period: 28 years
- Investment cost: 1,100 €/kWp



- Consumer price index: 1%
- Subsidies: 0%
- Average market electricity tariff: 14 c€/MWh
- Self-consumed PV electricity tariff: 8.20 c€/MWh
- Self-consumed PV electricity rate: 100%
- Average share for REC participation: 150 €
- Expected number of participants: 1500
- CAPEX (including management expenses): 222,200 €
- OPEX: 3,210 €/year

The expected revenue for the micro-investors is indicated by an internal rate of return of **4.09 %** as shown in Table 4:

Table 4 - Forecast of results of the business model.

Payback period	28 years
Investment REC members	222,200 €
Tariff for the sale of electricity	8.20 c€/kWh
Utility's average tariff	14 c€/kWh
PV energy yield	1,250 kWh/kWp
Yearly energy production	248.75 MWh/year
Yearly incomes	20,398 €/year
OPEX	3,210 €/year
Cash flow	17,188 €/year
Net income	14,609 €/year
IRR	4.09%
UPM electricity bill savings	14,428 €/year

Expenses

The expected expenses are summarized as follows:

- Creation of the Campus-Sur REC
 - Legal consultant (reports, elaboration of documents, contracts, etc): 10,000€
- Awareness raising campaign
 - 3 displays to communicate AURORA around the campus: 5,250€
 - Edition of banners, brochures and flyers: 1,500€
- REC management and PV power plant
 - Supply and installation of the PV power plant: 222,200€
 - REC management of micro-investments: 1,500€ per year
 - PV power plant maintenance: 1,710€ per year

2.8. Timeline

Table 5 summarizes the timeline of the different necessary phases to constitute and operate the Campus-Sur Renewable Community.



Table 5 - Timeline for the Campus-Sur REC constitution and operation.

		may-22	jun-22	jul-22	ago-22	sep-22	oct-22	nov-22	dic-22	ene-23	feb-23	mar-23	abr-23	may-23	jun-23	jul-23	ago-23	sep-23	oct-23	nov-23	dic-23
1	Constitution of the REC																				
1.1	Final approval of the legal framework																				
1.2	Elaboration of documents, regulations and contracts																				
1.3	Constitution of the Commission Board within the FGUPM (Foundation)																				
1.4	Documents approval																				
1.5	Launch of the REC																				
1.6	Launch of the REC																				
2	Information, Awareness and communication campaign																				
2.1	Office opening																				
2.2	Displays to communicate AURORA																				
2.3	Edition of banners, brochures, etc																				
2.4	Participation in the 20 different Departments Council meetings																				
2.5	Meetings with the four researching centres and the library staff																				
2.6	Meetings with the four student delegations																				
2.7	Development of a communication plan within the IDEATON project with students																				
2.8	Spring Festival participation																				
2.9	Crowdfunding and support in the constitution of the REC																				
3	Opening a REC bank account																				
3.1	Launch of crowdfunding campaign																				
3.2	Subscription management																				
3.3	Subscription management																				
4	Local Energy Infrastructure, Open Monitoring and Characterization																				
4.1	Final PV power plant design																				
4.2	Request of offers for supply and installation																				
4.3	Quality control																				
4.4	Installation phase																				
4.5	Commissioning																				

2.9. SWOT Analysis

Strengths

UPM's commitment to climate change action. AURORA will be developed in the framework of a climate emergency declaration stated by the UPM, which launched an action plan with the goal of achieving climate neutrality by 2040. AURORA is aligned with this objective through the establishment of a Renewable Energy Community and the production of renewable energy for the self-consumption of the Campus-Sur university community.

Campus-Sur university community commitment to climate goals. The Campus-Sur platform was created in 2021 by the three main collectives (students, professors and administrative staff) to both develop projects in the Campus-Sur area



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101036418.

to benefit the Campus community in terms of energy savings and emission reductions and to raise awareness about climate change challenges.

Team's commitment to the project. The AURORA coordination group created at the Campus-Sur is highly committed to the purposes of the project. The group integrates some experts on PV technology (members of the Solar Energy Institute of the UPM specialized in photovoltaic systems), on citizen science (members of the Solar Energy Institute of the UPM specialized in citizen science) and the person in charge of the SDGs nodes of the different engineering schools located in the Campus.

Favourable environment for this kind of projects. A university campus context has some advantages for the development of a REC:

- Its members have the potential to develop innovations and the willingness to embrace new challenges.
- The campus is a structure that facilitates the development of actions involving the campus community.
- The campus integrates people with very different capabilities including strong technological skills (professors and researchers specialized in different science fields) and generational perspectives given by young people (students) and adults.

Availability of rooftops. The university centres of Campus-Sur are large buildings with broad and flat rooftops suitable for the installation of PV generators. The rooftops' surface is able to hold more than 500 kW of PV power.

Weaknesses

Short stay of students at the university. Students stay at the university just a few years (between 4 and 6 on average). This may affect their willingness to be part of the REC on the long term once they leave the university. However, the project will last more than 25 years.

Legal organization that slows down decision-making. In accordance with the legal organization that will be adopted (Foundation), the decision-making capacity of the REC depends on the UPM, which is a public entity. Thus, the decision-making process is subject to UPM internal procedures, for example, the obligation to comply with the public sector contracting law when hiring a service, among others.

Uneven distribution of vote among the different members of the REC. As the UPM holds 55% of the vote, this might unbalance the decision-making processes and disregard the interests and views of the other members.

Opportunities

National policies favorable to the development of energy communities. Even if Spain has not yet transposed the EU **Directives 2019/944** and **2018/2001** that regulate the Citizen Energy Communities and the Renewable Energy Communities, the Spanish **Law 24/2013**, *on the Electricity Sector of access and connection to the electric power transmission networks*, defines the Renewable Energy Communities as a subject able to develop activities aimed at supplying electricity. Moreover, the Spanish Renewable Energy Agency (IDAE) has recently launched (February 2022) the first program to support the implementation of Energy Communities based on Renewable and Citizen Energy Communities.

Adapted national regulation for self-consumption from renewable energy. The **Royal Decree (RD) 244/2019** *that regulates the administrative, technical and economic conditions for the self-consumption of electricity* recognizes the figure of shared self-consumption, which enables several users to benefit from the same generating facility, allowing the establishment of Energy Communities.



Global strategy against climate change. The AURORA project is developed in the framework of the main international initiatives against climate change, such as the UN 2030 Agenda for Sustainable Development, which, among the 17 goals, includes Goal 13 to take urgent action to combat climate change and its impacts and Goal 7 to ensure access to affordable, reliable, sustainable and modern energy for all; or the European Green Deal to transform the EU into a modern, resource-efficient and competitive economy, ensuring no net emissions of greenhouse gases by 2050.

Current energy crisis. Spain is one of many European countries that has suffered a dramatic spike in electricity prices in recent months, reaching figures never seen before such as 628.04 €/MWh on March 8, 2022 in the day-ahead market (see Figure 8). The self-consumption of energy coming from a PV power plant can significantly reduce the electricity bill of the UPM, as PV technology is able to produce electricity at much lower cost, among 40 and 50 €/MWh during the next 28 years.



Figure 8 - Spanish and Portuguese electricity day-ahead market prices evolution from October 2021 to April 2022^[6].

Threats

Low participation. The goal of the REC is to generate renewable energy from a 200 kW PV power plant which requires an investment made by the REC members. The economic contribution of the members must be affordable as most of them will be students who might have low or no income. Therefore, the number of members needs to be high to cover the installation costs. The objective of the project is to reach 1.500 members among 4.800 people integrating the campus, which represents 31% of the total Campus-Sur community.

Low social commitment for environmental actions. In accordance with the results of the last survey carried out by the Spanish public research institute (CIS) in April-2022^[7] regarding the issues of concern to the population, the environment is ranked in position number 28, while the rising of energy costs is ranked in position 8. This might decrease social interest to support and participate in the project.

Increase in PV market prices. In the current context of global crisis, raw materials, transport and manufacturing costs are increasing, which can affect the final cost of the PV facility and consequently the project feasibility.

Exit-entry management of members. As mentioned above, students stay few years in the university campus, which can lead to a massive and constant exit and entry of members within the REC.

^[6] <https://www.omie.es/en> (April 20, 2022)

^[7] https://www.cis.es/cis/opencms/EN/NoticiasNovedades/InfoCIS/2022/Documentacion_3359.html (April 20, 2022)



2.10. Risks

Identification of Risks

The risks of the project include weaknesses and threats identified in section 2.9. Possible mitigation actions are described below.

Risk Mitigation Strategy

Short stay of students at the university. This may result in students abandoning the REC before the project ends or when finishing their studies. The project will put in place an exit-entry management procedure in which any REC member who has micro-invested in the PV power plant may, at any time, assign the contract to a third party, setting the price they deem appropriate, for the period remaining until its final termination in 2050.

Legal organization that slows down decision-making. The project will ensure appropriately planning the decision making processes, informing the members involved in due time and preparing documentation relevant to the topic to support informed and timely decisions.

Uneven distribution of vote among the different members of the REC. The regulation that will manage the Commission should include articles to ensure the adequate representation of views and interests of all members, such as that decisions should be taken by consensus or that certain type of agreements should be unanimously approved.

Low participation. The project will mitigate this issue in the different phases of the project through a continuous awareness raising campaign for each of the three membership groups (students, professors and administrative staff) which is already included in the communication plan described in section 2.5. In addition, the project will try to identify new incentives of becoming a member of the REC.

Low social commitment for environmental actions. The project has the potential to raise awareness on climate change challenges among a broader group of stakeholders, such as family members of students, which might support behavioural changes in society.

Increase in PV market prices. The project will address this issue in two main ways. It will try to expand the profile of potential investors through crowdfunding and donations to increase the investment capital. Moreover, as mentioned above, funding institutions such as IDAE offer opportunities to support the establishment of Renewable Energy Communities which could be explored.



3. Demonstrator Site – Évora, Portugal

3.1. Opportunity

Our Solution

The University of Évora has not yet set any climate targets. However, the university has a long tradition in researching solar energy. 9 years ago, the university established one of the first bachelor's degree programmes in Renewable Energy Engineering, later followed by a master's programme in Solar Energy Engineering. There is also a doctoral programme in Mechatronic and Energy. The Renewable Energies Chair, which has the mission to develop solar technologies for the energy transition, has built up a large research infrastructure for photovoltaics and solar thermal energy, both coupled with energy storage solutions.

The university is divided into two campuses. One is located in the historic centre of Évora, the other about 12 kilometres outside. This second campus is supplied with electricity by one energy supplier via three transformer stations. The supply has a significant imbalance, meaning that the energy is not generated where it is consumed. For example, most of the buildings are supplied via a transformer to which only a small photovoltaic system is connected. On the other hand, there is a solar thermal power plant, but there is hardly any consumption in that point. The idea is to set up an energy community that distributes renewable energy better across the campus via the public grid.

The demonstrator power plant in the AURORA project is operated by this Energy Community and is intended to make an important contribution to the energy self-consumption of the campus. A photovoltaic power plant with a capacity of 200 kW is planned, which is about one fifth of the maximum power currently required on campus. An area of 280 hectares is available on campus for the construction of the AURORA solar power plant, and only a fraction of a hectare is needed for it.

The power plant is to be financed by 1,500 citizens, mainly students and employees of the university, who will participate with investments between 20 and 1,000 €.

The proposed solution is the University of Évora owning the PV facility. Several reasons motivate this choice:

- This solution eliminates the need to create a new legal entity. This also allows to reduce legal maintenance costs over the lifetime of the facility (expected to be over 30 years) and all the participants will be managed internally, since the University will be the responsible for managing this REC.
- The current electricity supplier contract is fixed by public procurement rules, therefore the University of Évora cannot sell/buy electricity to another legal entity. This would block any other legal option for creating this energy community.
- In accordance with the legal framework in force in Portugal (see section below), participants' access to a REC must not be subject to unjustified or discriminatory procedures that impede their free participation. It would thus be difficult to legally delimit the participation of users outside the academic community, without the creation of a specific legal entity with internal rules for this purpose.

Thus, the solution involves creating a virtual renewable energy community managed internally by the University of Évora.

Another important aspect for the operating model of this REC is related to the operation of this virtual REC. The University of Évora does not have the status of a banking entity, so it could not have financial products offering interest or payments resulting from capital income to participants or having outgoing cashflows (due the public entity accounting rules). The proposed model for this REC overcomes this offering the participants discounts on University services,



tuitions, or delivering goods directly to the participants. This return of the investment strategy will be detailed further ahead in the document.

Market Size & Segments

There are around 9,200 people integrating the University of Évora community and its distribution can be seen on Table 6. The University of Évora is comprised of: 5 schools (Fine Arts, Social Sciences, Science and Technology, Nursing, Health and Human Development); 1 Institute of Research and Advanced Training (IIFA); 3 Experimental Estates; 1 Veterinary Hospital; 1 Living Science Centre; 18 Research Units and 6 Chairs.

Table 6 - Distribution of University of Évora community (data from 2022^[1]).

Group	Number of members	Percentage
Students	8,060	87.76 %
Academic Staff and Researchers	669	7.28 %
Non-Academic Staff	455	4.96 %
Total	9,184	100 %

As we can see in Table 6, as expected, the students compose almost 90% of the university community and it will be in this group that we will focus more our attention, without discarding the other groups.

^[1] <https://www.uevora.pt/universidade/factos-numeros>

3.2. Legal Framework

Country Regulations

In Portugal in the year 2019 brought a first advance to the subject, with the approval of Decree-Law n.º 162/2019, referring to the legal regime applicable to the self-consumption of renewable energy. Among the novelties, the diploma introduced the modalities of collective self-consumption and RECs into national law, but it was only in March 2021 that these were able to effectively advance, following the approval of the regulation that implements the regime by the Regulatory Entity for Energy Services (ERSE).

The legislation in Portugal is clear and does not suffer setbacks, the current Decree-Law was an update to facilitate and favour self-consumers. Decree-Law n.º 153/2014 served as the basis for the creation of Decree-Law n.º 162/2019, which is the Decree-Law currently ruling for self-consumption. The Decree-Law n.º 162/2019 already allows the creation of REC (Renewable Energy Communities) and removed power limits, also allowing the sale of the surplus at prices negotiated directly with the trader. This evolution arises from the transition of European Directives to the national Law.

The latest Decree Law that addresses and regulates energy communities (REC) in Portugal is Decree-Law n.º 15/2022, published on 14th January 2022, where Section II is dedicated to Renewable Energy Communities. The REC's main objective is to provide environmental, economic and social benefits to members or to the locations where the community operates rather than financial profits.

Process

The University of Évora will own the PV facility and won't be registered as an REC. It will be registered as an UPAC (production unit for self-consumption) for the motives mentioned before. According to Decree-Law n.º 15/2022 an



UPAC with 200 kW is only subject to prior registration and exploitation certificate given by DGEG (General Directorate for Energy and Geology).

The REC will be created and managed internally by the University, without being registered legally as an REC.

3.3. PV Power Plant

Location

The location of the PV plant will be in the Polo da Mitra Campus of the University of Évora, where an area of 280 hectares of land is available for the construction of the AURORA PV plant. This campus is located in Valverde, about 12 km from the city of Évora.

Preferably, the PV Plant will be installed near the Distribution Transformer (low voltage, three-phase with 860 kVA). This internal grid has high electricity needs and registered an electricity consumption of 1,615 MWh in 2018.



Figure 9 - Aerial photo of the Polo da Mitra Campus.

This location is excellent for the installation of a PV Plant due to the amount of free space available, even considering further expansions if the REC evolves positively. In addition, being Portugal one of the countries with higher yearly solar irradiance in Europe, this further reinforces and enhances this REC business model.

Installation details

The Évora demo-site is aiming to install a 200 kW PV system, but its final installed power may change according to the number of participants and available funding. The PV modules will be installed in a standard ground fixed structure with 35° of inclination and orientated to 0° South. To enhance the research nature of this system, different PV module types will be installed. The PV system will be connected to the Distribution Transformer, enabling to achieve 100% self-consumption due to the high electricity consumption of this campus grid.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101036418.

3.4. Energy Community

Goals

The main goal is to reduce the carbon footprint of the University of Évora members by promoting the consumption of clean energy and new environmentally friendly habits, while providing profits to the participants at the same time. This REC aims to raise energy awareness and provide environmental, social and economic benefits to the members of the community.

Due to the significant imbalance on the energy consumption/generation in the Polo da Mitra Campus, it intends to make an important contribution to the campus energy sustainability, providing new clean solar energy, that will also stabilize, partially, long term overall electricity costs.

This REC also aims to improve communication within the University of Évora community by promoting public events and workshops.

Legal Form

Since the University of Évora will own the PV facility, no new legal form will be required. Formally, the installed PV system will constitute a UPAC, within the Decree Law in force.

Documentation

The following documentation will be necessary to establish the virtual REC:

- Agreement with the University of Évora accepting all terms established
- Internal Regulation for the REC, including aspects such as adhesion for participants, internal management of the REC, duties of the university and the participants, etc.

Contracts

The management of participants and contracts will be done by the University of Évora.

Members of the Community

This community will be closed for the members of the University of Évora: students, staff and researchers. No external citizens will be allowed to join the community.

Types of Participations

The participations will be in-cash, via donations to the University of Évora.

Types of Shares

The donations will be flexible with a minimum value of 20 € and a limit of 1,000 €, with increments of 20 €.



Requirements

The requirements for accessing the community are being a member of the University of Évora and making a donation.

The participants are free to leave the community at any time by selling its discounts coupon (only the current balance) to another member or by using all its available balance. Students in the final year of its studies must use all its balance by the end of the academic year, since they will not be able to participate in the community once they stop being a student. If the participant no longer belongs to the academic community, the only movement allowed for their investment is the sale to a current/new member of the academic community, thus ending their participation in this REC.

Electricity Management

All the electricity produced by the AURORA PV plant will be self-consumed in the University of Évora buildings, since the consumption of this campus grid (buildings, laboratories, canteen, offices, classrooms, etc.) is much higher than the production of the PV plant. The existing consumption load curve clearly represents a typology of service buildings, so solar production is in line with the existing peak consumption. The comparison between the consumption and solar PV production can be seen in the following figure.

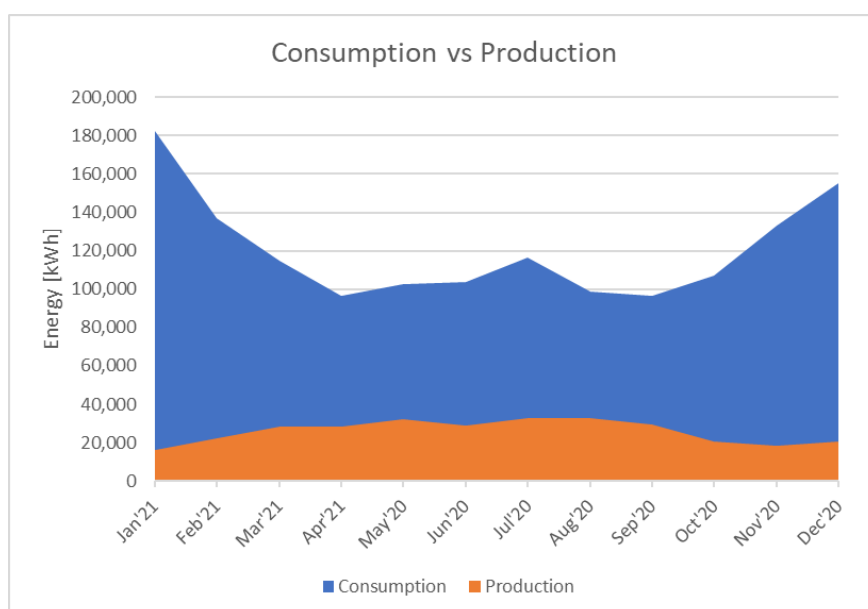


Figure 10 - Comparison of the UÉvora buildings consumption with the 200 kW PV plant production (simulated on SISIFO^[2]).

A detailed electricity monitoring will also be implemented in the Campus buildings per electric circuit, so that the University can analyse and monitor the consumption with detail, and thus implement energy efficiency policies.

^[2] <https://www.sisifo.info>

Community Management

The community will be managed internally by the University of Évora as will be defined in the REC Regulation.



Sustainability Strategy

The sustainability of the project will be secured by the University of Évora and will also be defined on the Agreement signed by the University.

3.5. Mobilization

Engagement process

To engage the community, several accounts will be set up on major social media platforms: Instagram (@auroraevora), Twitter (to be created) and Facebook (to be created). Several existing internal mailing lists of the University of Évora will be used as a fast way to reach all the community.

To further engage the citizens, several public events and meetings will be promoted, such as lectures and presentations at the several schools that compose the University of Évora. A preliminary meeting with students was done on the 9th of March 2022 and an Innovation Café on the 18th of May 2022. These events have already resulted in new ideas and opinions that have made it possible to improve this business model, building it collaboratively.

The student's association was already reached and will be used for the dissemination and sustainability of the project, in order to beneficiate of their direct contact with the students.

So far, engaging the students has presented itself as a challenge, but in-person participation is improving after a long remote participation period due to Covid-19 restrictions.

Sustainability

As the project proves successful, new crowdfunding events can be developed to expand the PV Plant and engage new students/staff into the community. With new rounds of crowdfunding, additional renewable energy power or storage, or even electric vehicles charging points can be part of the REC assets, offering more solutions and increasing the amount of clean energy consumed by the community. For this, new events will be hosted every year so that the new students may get to know this project.

This demonstrator also intends to serve as seed for other Universities and organizations in Portugal, hoping that it can lead to the creation of more local energy communities by sharing this experience, outcomes and lessons.

3.6. Financial Plan

Financing Needed

The range of costs for standard PV plants with fixed ground structure varies between 0.75 €/Wp to 1 €/Wp, average values regarding similar PV plants here in Portugal in 2021. Based on these values, a total cost of around 200,000 € is estimated for the AURORA PV plant, but a potential rise in the prices is possible. The current European economic context brings additional uncertainties for the CAPEX.

Sources of Funds

The source of funds will come from donations from the University of Évora members, through a crowdfunding process.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101036418.

Identification of Stakeholders

The University of Évora community project has not, to date, considered the involvement of third parties in the REC.

A subcontracted company will be the PV system installer, selected through the public tender rules due to the total amount value.

Return of Investment

The participant members that made a donation to the University of Évora will receive a discount card with a value equal to the donation made plus 20% interest per year. The interest value will be calculated based on the current balance available on the discount card at the end of the year.

The products and services where the members of the community can use their card to receive discounts are listed on Table 7. The participants can use the discount card balance partially or use all their balance, depending on the specific discount.

Table 7 - Products/Services where is possible to use the discount card.

Product/Service	Students	Academic Staff	Researchers	Non-Academic Staff
Students Tuitions	✓	X	X	X
Meal Tickets	✓	✓	✓	✓
University Housing	✓	X	X	X
University Bicycles – E-bikes	✓	✓	✓	✓
University Parking	✓	✓	✓	✓
University Store	✓	✓	✓	✓
Local agricultural baskets	✓	✓	✓	✓
Partners network	✓	✓	✓	✓

The University of Évora wants to improve the circular economy approach and bring to the project local agricultural baskets of fresh food and vegetables from local farmers, also decreasing the carbon footprint of our food by making these baskets available to the members of the community.

Commercial partners in the city will be approached in order to create a network that can offer discounts to the participants on their services. These partners can be gyms, restaurants, stores, bars, the students' association, etc.

To donations of the participants can receive tax benefits statute due to scientific patronage context, which according to the article 62-A of the Portuguese Tax Benefits Statute can correspond to a return of 130% of the value of donations in terms of IRS or IRC to the citizens, making this investment even more attractive.

Exit Strategy

The University of Évora owns the lands where the PV system will be installed and at the same time ensures electricity consumption for the entirety of the production from its own PV facility, so there is no need to develop an exit strategy.

Long term participation of the University is ensured.

The participants can exit the REC either using all discount balance or selling the existing balance to other academic community member.



3.7. Forecast

Revenue

The revenues from this project will come from the electricity savings in the energy bill of the University of Évora. For the projected revenues, the following data was used:

Table 8 - Values used for calculating the projected revenue.

Electricity produced by the PV Plant in the first year	310,652 kWh
Annual efficiency power degradation per year	-0.45 %
Average electricity price paid by UÉvora	0.0925 €/kWh
Raise of electricity price per year	5 %

With this data, a projected a revenue from the electricity savings over 25 years of operation of the PV Plant can be seen on the following table.

Table 9 - Projected revenue.

Year	Revenue	Year	Revenue	Year	Revenue
0	0.00 €	9	42,804.65 €	18	63,762.60 €
1	30,036.30 €	10	44,742.63 €	19	66,649.45 €
2	31,396.19 €	11	46,768.35 €	20	69,667.01 €
3	32,817.66 €	12	48,885.79 €	21	72,821.18 €
4	34,303.48 €	13	51,099.10 €	22	76,118.16 €
5	35,856.57 €	14	53,412.61 €	23	79,564.41 €
6	37,479.97 €	15	55,830.86 €	24	83,166.69 €
7	39,176.88 €	16	58,358.60 €	25	86,932.06 €
8	40,950.61 €	17	61,000.79 €	Total	1,343,602.61 €

Expenses

For the expenses related to this project the following expenses were identified:

- PV Plant: 200,000 € - this value will come from the members of the community, so it is not a UÉvora expense
- Management Software (IT tool): 10,000 € - paid by the project, so it is not a UÉvora expense
- PV Plant Operation and Maintenance (1% CAPEX): 2,000 €
- IT tool Operation and REC maintenance/management: 10,000 € - after the end of the project
- Discounts used in the University products/services: 275,195.44 € - if the discounts are 100% made in the University in the first 3 years of operation with a 20% interest rate per year (worst case scenario for the REC)

For the calculation of the projected expenses, a 3% for the inflation and 7% for the discount rate is assumed. The projected expenses can be seen on the following table.



Table 10 - Projected expenses.

Year	Expenses	Year	Expenses	Year	Expenses
0	0.00 €	9	15,657.28 €	18	20,429.20 €
1	87,660.00 €	10	16,127.00 €	19	21,042.07 €
2	93,713.80 €	11	16,610.81 €	20	21,673.33 €
3	111,116.16 €	12	17,109.13 €	21	22,323.53 €
4	13,506.11 €	13	17,622.40 €	22	22,993.24 €
5	13,911.29 €	14	18,151.08 €	23	23,683.04 €
6	14,328.63 €	15	18,695.61 €	24	24,393.53 €
7	14,758.49 €	16	19,256.48 €	25	25,125.34 €
8	15,201.24 €	17	19,834.17 €	Total	704,922.95 €

As can be seen on Table 10, in the first 3 years of operation it will have considerable expenses resulting of the use of the discount cards on UÉvora, being this the worst-case scenario (the bachelor study cycle is 3 years long). Having an extended partners' network will prove beneficial for the University so that the members won't use the entirety of the discounts in the University, saving money in that way.

Economic Analysis

Having projected the revenues and expenses of the project, the annual cash flow of the project was calculated.

Table 11 - Annual Cash Flow.

Year	Cash Flow	Year	Cash Flow	Year	Cash Flow
0	0.00 €	9	27,147.37 €	18	43,333.40 €
1	-57,623.70 €	10	28,615.63 €	19	45,607.38 €
2	-62,317.61 €	11	30,157.55 €	20	47,993.67 €
3	-78,298.51 €	12	31,776.66 €	21	50,497.65 €
4	20,797.37 €	13	33,476.69 €	22	53,124.92 €
5	21,945.28 €	14	35,261.53 €	23	55,881.37 €
6	23,151.35 €	15	37,135.25 €	24	58,773.16 €
7	24,418.39 €	16	39,102.13 €	25	61,806.73 €
8	25,749.37 €	17	41,166.62 €	Total	638,679.66 €

These results of accumulated cash flow can be observed in the following figure.



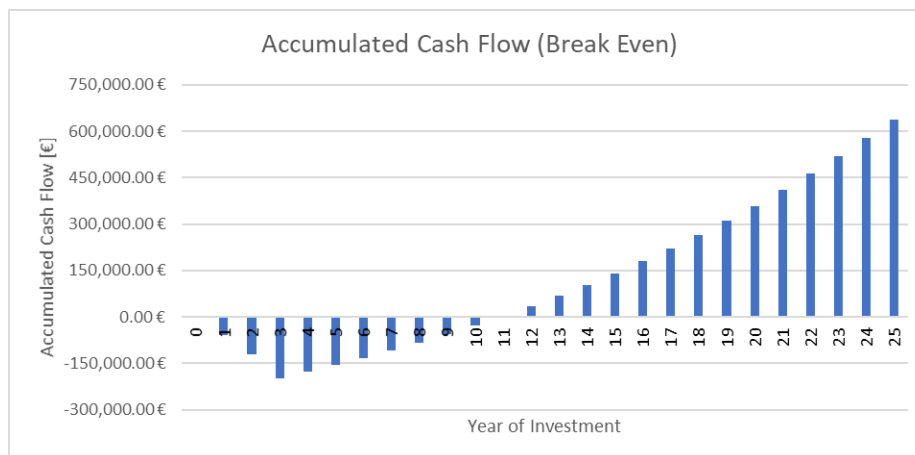


Figure 11 - Accumulated Cash Flow.

For the calculation of the economic indicators of Table 12, a discount rate of 7% was used.

Table 12 - Economic Indicators.

Net Present Value (NPV)	126,770.48 €
Total Life Cycle Cost (TLCC)	704,922.95 €
Payback Time of the Investment	10.88 years
Internal Rate of Refund (IRR)	5.23 %
Levelized Cost of Electricity (LCOE)	0.0962 €/kWh

The overall economic indicators point to a viable and profitable investment, supporting a sustainable REC. As a reminder, this economic analysis was taking into consideration the worst-case scenario for the University.

3.8. Timeline

Table 13 - Timeline for the UÉvora demo site.

Year	2021	2022												2023		
Month (cumulative)/Progress	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Business model development																
University internal approval																
Information and communication campaign																
Crowdfunding and development of the IT tool for management																
Infrastructure development and continuous monitoring																



3.9. SWOT Analysis

Table 14 - UÉvora SWOT Analysis.

Strengths	Opportunities
<ul style="list-style-type: none"> • Great value in the return of the investment • Citizens aware for the problems related with climate change • Tax advantages • Large space to install the PV Plant • Raise of electricity prices in the future 	<ul style="list-style-type: none"> • Simplified expansion of this business plan • Offering the opportunity to the community to invest in clean energy • Serving as a demonstrator for other universities and organizations in Portugal to replicate our business model
Weakness	Threats
<ul style="list-style-type: none"> • Target group not homogeneous (students, staff, researchers) • Difficulty in getting partners willing to offer discounts to the members of the community • The large number of target participants comes with a huge organizational task • Legal blocks regarding the exit of cash flow from the University 	<ul style="list-style-type: none"> • Not being able to engage the citizens and make them invest • New university administration not accepting the business model or taking a long time making the decision • Raise of PV Plant components price • Challenge to involve external partners to the discounts scheme

3.10. Risks

Regarding this business model we identified the following risks and assessed the possibility of occurrence and their impact on the project.

- Financing risk

This risk is associated with the failure of reaching the target sum for the 200 kW PV plant (200,000€). The students that we already approached show willingness to invest small amounts (20 €), so this risk is evaluated as medium possibility and medium impact.

The power of the PV plant will be flexible in case we fail to reach the sum needed for the 200 kW, adjusting the installed power according to the funding raised.

- PV plant incidents

Incidents may occur during the installation, maintenance or operation of the PV plant. These incidents could include theft of PV modules, or physical damage due to several reasons such as extreme weather (hail, strong winds, etc). This risk is considered low possibility and medium impact.

For this reason, there will be bought spare PV modules so that we can quickly switch them with the broken ones.

- Raise of material prices

With the raise of prices in raw materials, a raise of prices of the PV Plant components may occur and result in a raise of price for our PV Plant, being this risk evaluated as medium possibility and medium impact.

If the raise of prices occurs, we can increase the target sum of the crowdfunding or lower the installed power for our PV plant.



- New University Administration

In April 2022 the University of Évora had elections for the new Dean and administration of the University. The new Dean and administrator took office on the 10th of May, so there is a risk of delay in the internal approval of this business model and start of the crowdfunding process, or in the worst-case scenario, the rejection of the business plan. This risk is considered low possibility and medium impact.

As mitigation strategy, we will initiate as soon as possible the contacts with the university administration to present them the business model, if the business model ends up being rejected, we will redo it according to the suggestions made by the administration.



4. Demonstrator Site – Ljubljana, Slovenia

4.1. Opportunity

Our Solution

The demonstrator site in Ljubljana will be set up at Faculty of Electrical Engineering (FE), which is a member of University of Ljubljana (UL). The members of University of Ljubljana are spread out in many buildings across the city of Ljubljana. The Faculty of Electrical Engineering is situated at Tržaška cesta in Ljubljana and consists of four interconnected buildings with enough roof space for about 200 kW photovoltaic power plant.

The Faculty of Electrical Engineering hosts about 1,500 students who attend lectures at three different programs, from undergraduate, over postgraduate to the doctoral study programme. There are 350 staff members, mostly educational and research personnel, but also in management and supporting services. The University of Ljubljana consists of 26 members, with 40,000 students and 6,000 employees.

University of Ljubljana operates in more than 350 buildings, the majority of which (>90%) is older than 15 years and therefore not energy efficiency. In 2014 UL prepared Energy Strategy to increase energy efficiency. According to the plan 6% of buildings should be renewed annually. Energy management system was set up to monitor energy efficiency of the buildings, prepare annual reports and track progress. Based on increased climate change awareness, Paris Agreement and recent EU Green Deal a new and more ambitious strategy is being prepared.

Aurora activities will first focus on students and employees of Faculty of Electrical Engineering and based on lessons learnt activities can be spread to other UL members.

Market Size & Segments

At the end of 2021, there were a total of 17,919 photovoltaic power plants (PVPPs) in Slovenia. The total capacity of these PVPP is 467.20 MW. In 2021, the electricity produced from PVPP in Slovenia is 302 GWh, which represents a 2.1% to 2.4% share of all electricity produced^[1]. Installed power of PVPP per capita is 223 W/person.

Energy communities of citizens were formally introduced on 13 November 2021, when the Electricity Supply Act (ZOE) entered into force, which states in paragraph 2 of Article 24 that “the Energy Community is established as a cooperative by law, which governs cooperatives. Nevertheless, preparations were made for the establishment of energy communities of citizens even before this law entered into force of. Some examples of energy communities established before ZOE are listed here:

Luče Energy Community

The rural community in Luče is the first in Slovenia to become completely independent in its energy supply^[2]. From April 2020, the place with 400 inhabitants can cover all its electricity needs exclusively from renewable energy sources. The establishment of the Energy Community was encouraged through the COMPILE project (European Union's Horizon 2020 research and innovation program under the grant agreement N° 824424). Despite the weak connection to the grid, ten times more photovoltaic devices were successfully installed in the settlement than are usually allowed by the local grid operator. The energy community also includes the use of home and community batteries. To achieve this, the community has teamed up in an energy community of citizens. The COMPILE project was led by the Faculty of Electrical Engineering, University of Ljubljana.



The result of the COMPILE project confirms the thesis defined in the European Commission's directives on renewable energy sources and electricity that by 2050 almost half of all households in the EU could participate in the production of renewable energy sources, of which about 37% could be integrated into energy communities^[3].

Zavrate Energy Community

In the village of Zavrate, the villagers included in the community receive a 10 to 15% reduction in the electricity bill or up to a 50% reduction in electricity bills for users who offer their roofs to communities^[4]. Users can thus dispose of the entire amount of electricity produced by their power plant, including surpluses from the previous year, which they can transfer freely to other consumers anywhere in Slovenia or sell them. Advanced blockchain technology ensures business transparency and security.

Budanje Energy Community

Organized by the municipality, a 55.68 kW solar power plant was installed at the local primary school, which operates within the community of seven more houses. In addition to monthly savings in electricity costs, users will reduce their carbon footprint by 28,500 kg in one year, or 853 tons in 30 years, as the estimated lifespan of the power plant^[5].

[1] The 2.1% calculation includes the Croatian part of the electricity produced at the Krško Nuclear Power Plant (NEK). Without Croatia's share in the NEK, the share of photovoltaics would be 2.4%. Source: <http://pv.fe.uni-lj.si/> PV portal, Slovenski portal za fotovoltaike, Pregled slovenskega fotovoltaičnega trga v letu 2021 29.03.2022.

[2] <https://eusew-2021.prezly.com/prva-samozadostna-energetska-skupnost-v-sloveniji-orje-ledino-za-podezelska-obmocja-po-vsem-svetu-na-podrocju-vkljucevanja-energije-iz-obnovljivih-virov>

[3] <https://www.petrol.si/znanje-in-podpora/2019/clanki/prva-lokalna-energetska-skupnost-v-lucih-z-obnovljivimi-viri-energije-do-proznega-in-konkurenčnega-energetskega-sistema.html>

[4] <https://sonce.com/uradno-smo-zagnali-prvo-energetsko-100-odstotno-samooskrbno-vas/>

[5] <https://www.gen-i.si/novice-in-mediji/prva-samooskrbna-ove-skupnost-v-sloveniji/>

4.2. Legal Framework

Country Regulations

Directive (EU) 2019/944 on common rules for the internal market for electricity was implemented in the Electricity Supply Act (ZOOE).

The Slovenian Electricity Supply Act (ZOOE) stipulates that for the purpose of establishing an energy community of citizens, the Cooperatives Act applies (ZZad).

The implementation of the provisions on the energy community of citizens was carried out into Slovenian legislation in such a way that paragraph 2 of Article 24 of the Electricity Supply Act (ZOOE) states that "the Energy Community is established as a cooperative under the law governing cooperatives. The law governing cooperatives shall apply to them, unless otherwise provided by this law. The phrase "energy community of citizens" is used in this law only in two articles: paragraph 18 of Article 4 and the entire Article 24.

For everything else regarding the energy community of citizens, the Cooperatives Act (ZZad), which was adopted in 1992, is therefore relevant.



4.3. PV Power plant

Location

There is enough space on the Faculty of Electrical Engineering's horizontal roof for a PVPP with a capacity of around 200 kW depending on exact PV module power. Parts of the roof are already covered with different kinds of photovoltaic panels, which are being used for research purposes. The physical location of the PVPP is on the roof of four different faculty buildings.

This is an excellent location for a PVPP due to the ample amount of sunlight that shines on the site. There is also plenty of space for additional panels on facades if needed in the future. Installing a PVPP at this location will help to reduce the University of Ljubljana's carbon footprint and contribute to awareness of all stakeholders of the faculty on the production of electricity from renewable energy sources.

The Faculty of Electrical Engineering is the perfect place to install a PVPP due to its prominent location and its importance in educating students on renewable energy sources. Most important of all - students can see the power plant in action and learn from it directly.



Figure 12 - Building of Faculty of Electrical Engineering at University of Ljubljana with existing PV installations (bluish modules) added predicted new PV installations (black modules).

Installation details

The installation of the PVPP will proceed in phases taking into account the interest of participants and available funding. In the initial phase, a 39 kW power plant will be installed regardless of funding from the energy community. This section will be aimed to demonstrate the PVPP, raise awareness and increase interest in PV. In this section modules will be mostly installed under 10° inclination in east-west orientation (65° NE and 245° SW, exactly) to maximize available roof space. The whole construction will have a slightly different inclination to conform to the roofs (flat, 7° N, 7° S). Also, different module types (PERC, TOPCon, SHJ, IBC) will be installed. The variability will provide a lot of monitoring data regarding different orientation and different technologies, which will be made available to citizen scientists for research purposes.

Further expansion is possible on additional roofs (27 kW, 10° incl., E-W (-25°); 38 kW, 14° incl., 65°W and 115°; 87 kW different orientations)



4.4. Energy Community

Goals

Based on preliminary discussion with possible participants, raising energy awareness must be a major focus. By attracting and empowering citizens, we aim to engage them in setting up photovoltaic power plants. Young people and students are the most important since they are more likely to understand climate and energy crisis and at the same time, they need to secure their future. Furthermore, they can also influence older people (e.g., their parents) to invest in PVPP and therefore achieve a multiplicative effect. Our approach focuses on involving the public such as through campaigns or events where ideas for how one might go about doing so may be brainstormed together with others who share similar goals.

The energy sector is one of the most important industries in the world. It is responsible for providing the power that we need to live and work, and it is also a key part of the global economy. However, the energy sector can also have a negative impact on the environment and on society.

That is why it is important for the energy sector to have clear goals to be environmentally acceptable and to focus on social benefits. These goals should not be based solely on immediate profit but should also consider the need to protect our planet and to ensure that everyone has access to affordable energy, which combined maximizes the overall profit of the communities and environment.

The energy community can play a key role in achieving these goals. By working together, we can create a more sustainable future for ourselves and for coming generations.

Legal obstacle

At a meeting between AURORA project managers, the management of the Faculty of Electrical Engineering and a lawyer specializing in corporate law and legal affairs concerning renewable energy sources, it was found that the Article 10 of the Higher Education Act, which deals with the legal subjectivity of the university and its members, is unconstitutional. Article 10 of the law is currently the subject of a legal dispute and prevents members from establishing new legal entities. Furthermore, since the Faculty of Electrical Engineering and the University of Ljubljana are public institutions, they cannot establish or co-establish any new legal entity without the explicit approval of the Government of Slovenia. Therefore, the Faculty of Electrical Engineering or the University of Ljubljana are currently unable to form new legal entities.

Social obstacle

The crux of the problem is also the financial burden on students. Based on preliminary discussion with students, they are not yet in favour of financial investment in the energy community. On the other hand, employees at the faculty or university have significantly greater financial capabilities. However, if students participated only with symbolic financial contributions that would significantly rise the managing cost, and they would be very disproportionate compared to employees, resulting in financially very inhomogeneous community, which may be discouraging for employees in terms of votes. Furthermore, a symbolic contribution would result in minor absolute financial gains, which may be discouraging for students.



Informal communities

In order to overcome the legal and social obstacles and still raise energy awareness and encourage investment in photovoltaic power plants for energy independence, we plan to establish two informal communities: Student Energy Club (ŠEK) for students and Academic Energy Community (AES) for employees. The purpose of proposed communities is not to raise money for the investment, but rather to spread the awareness about renewable energy sources among students and faculty employees. AES would unite faculty interested in renewable energy sources, ŠEK would be open to all students. It is important to have two separate communities because it would allow for better coordination and ease the communication between equivalent members. The organized events will be shared between communities for better impact and to enable option for members of AES to learn from the members of ŠEK and vice versa.

The establishment of these two communities would not only raise awareness about renewable energy sources but would also help to develop an additional sense of community on our faculty. Virtually, the members of both communities will be able to buy the share of actual PVPP on the roof of Faculty of Electrical Engineering and virtually offset their carbon emissions through the Aurora App. This will plastically demonstrate the ratios between electricity production and consumption leading to energy independence and consequently further encourage the members to actually invest in PVPPs.

Legal form

Based on the Cooperatives Act (ZZad), it is possible to establish only one type of legal entity - a cooperative. This is a perfect legal form for communities where partners are equal, e.g., rural villages (reference: "Luče Energy Community" mentioned in chapter "Market Size & Segments" under 4.1. Opportunity). Nevertheless, in the case of very inhomogeneous partners with great fluctuations (students coming and leaving), the cooperative form becomes less suitable and complicated. There are other legal forms available to establish a form of energy community (not based on the cooperatives act) such as LLC or foundation. However, the University of Ljubljana is currently in a legal dispute regarding the double legal subjectivity of its members, and it is therefore not possible to form any legal entities at least until the dispute is resolved. Therefore, we have decided to emphasize the raising of awareness goal by forming informal communities, namely:

- *Akadska Energetska Skupnost* or **AES** (Academic Energy Community) and
- *Študentski Energetski Klub* or **ŠEK** (Student Energy Club).

By establishing AES and ŠEK, we will develop a network of interested participants, raise their energy awareness, and provide information on how to become energy independent. As soon as the legal dispute is resolved and if it allows the foundation of new legal entities, we will revise the possible options also to financially involve participants of AES and ŠEK. By that time, the members will already have virtual experience and will be more willing to invest.

In case of informal communities (AES & ŠEK) there is no formal basis to establish them.

Electricity Management

University electricity demand is usually low during weekends and holidays and over the nights because most people are at home. During working daytime hours there is an increased need for university-related operations. This increase very well corresponds to the predicted generation of the power plant with modules installed in a 10°east-west orientation. Detailed circumstances around May 1 are shown in Figure 13. The chart shows that with a proposed 200



kW solar system, all the generated electricity will be used on site. In the case of an unlikely surplus, it will go to the grid and will be sold to the electricity provider at a market price.

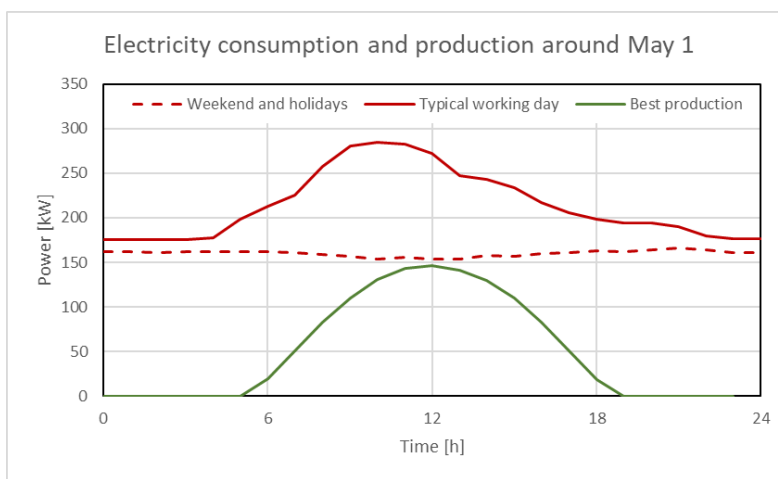


Figure 13 - Electricity consumption of Faculty of Electrical Engineering at University of Ljubljana and electricity production of proposed 200 kW PVPP.

Daily electricity consumption in 2021 is presented in Figure 14. The base consumption of 4 MWh per day is present throughout the year, with variable increases of 1.5 to 3 MWh, depending on the circumstances. 7 days periodicity is due to the working week, and the increase in June and the first half of July is due to air conditioning. The decrease in the second half of July and August is due to the summer holidays, and the increase from October until the last week of December is due to intense study semesters and shorter days. In total in 2021 1.9 GWh was consumed, out of which about 10% or 215 MWh can be offset by a planned 200 kW PVPP.

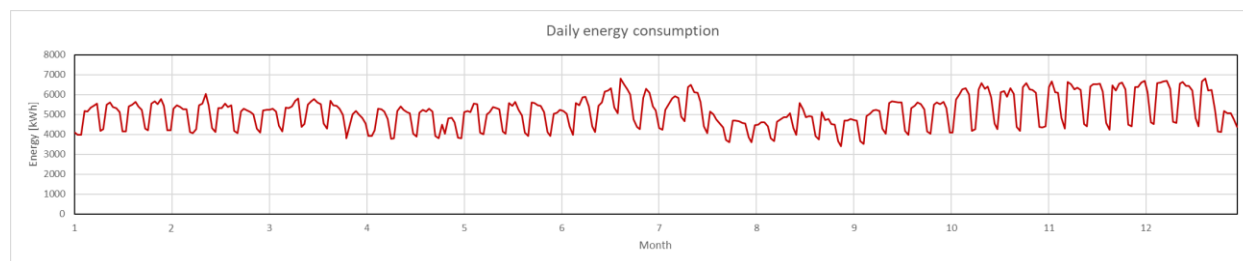


Figure 14 - Electricity consumption of Faculty of Electrical Engineering at University of Ljubljana and electricity production of proposed 200 kW PVPP.

Community Management

The Community Management of the Student Energy Club (ŠEK) and the Academic Energy Community (AES) will be defined in the founding documents or in the statute. At the Student Energy Club (ŠEK), these provisions will be looser, as fluctuations are expected among students - students graduate sooner or later and are no longer students. In the case of the Academic Energy Community (AES), the provisions may become much more specific.



Sustainability Strategy

Like the Community Management of the Student Energy Club (ŠEK) and the Academic Energy Community (AES), the Sustainability Strategy will be defined in the founding documents or the statute. The Sustainability Strategy does not provide the care for financial transactions as they are not foreseen.

4.5. Mobilisation

Engagement process

We are in the process of forming a Student Energy Club. This club will involve students who are aware of the long-term nature of energy decisions. Members of the Student Energy Club can be students of all faculties of the University of Ljubljana. We are also in the process of establishing an Academic Energy Community, whose members will be employees of the University of Ljubljana.

The first event of the Student Energy Club is the founding event. This event will be held as Sustainable Energy Day, which is part of the European Sustainable Energy Week. On June 15, 2022, the Student Energy Club will be presented at the renowned event SLO-PV 2022. This is the 8th consecutive biennial Slovenian photovoltaic conference. SLO-PV 2022 will also be implemented as Sustainable Energy Day, which is part of the European Sustainable Energy Week.

Sustainability

The Student Energy Club and Academic energy community is a proposed model for future cooperatives that want to involve both citizens, as well institutions. In this model, both citizens as well institutions would be involved with forming new co-ops for the purpose of making sustainable changes within an area or citywide level by utilizing cooperation skills amongst one another while promoting sustainability practices among participants at every level including homeowners who may not otherwise know what it means when you're talking about solar panels on your house!

4.6. Financial Plan

Financing Needed

The prices of PV power plants were decreasing in Slovenia until end of 2021, when a specific investment of 1 €/Wp was reached also for smaller power plants (<50 kW). However, due to the current energy crisis and disruptions in supply chains, prices in the field of photovoltaics are beginning to rise again. In the specific case of the demonstrator at UL, which will be built in units of a few 10 kW each and internally connected, the specific price is expected to be around 1.2 €/Wp + VAT.

Sources of Funds

Considering the current legal situation, we do not expect any financial resources from students or employees. Therefore, the main source of funds for the installation of PVPP will be the own funds of the Faculty of Electrical Engineering (University of Ljubljana).

The possibilities for donating funds are many and varied. The scope of the donation will need to be defined, but individuals or companies could make gifts as well - both now and at any time during the lifetime of the PVPP. Non-profits might also choose this path if their mission aligns nicely alongside ours - which is believed it does.



Identification of Stakeholders

Both the Student Energy Club (ŠEK) and the Academic Energy Community (AES) will keep records of their members. However, this will not be the shareholders of the investment in the solar power plant. The Faculty of Electrical Engineering is, at least initially, expected to be the main investor in PVPP.

Return of Investment

Given that this investment will not be financed by many investors but instead handled internally within the Faculty of Electrical Engineering, the return on investment is calculated virtually for the members of community.

The actual economics of proposed PVPP is representative for any entity where all the electricity produced by PVPP is consumed locally.

As pointed out in the Electricity Management chapter, the Faculty of Electrical Engineering, where PVPP will be installed, consumes the most electricity during the day. The production of electricity from PVPP will thus coincide with the demand of the facility on which PVPP will be installed. All of the electricity generated will be used on site.

At the beginning of 2022, the Faculty of Electrical Engineering was paying around 0.13 €/kWh for electricity and 0.04 €/kWh for a network fee summing up to 0.17 €/kWh. Since all the electricity produced by the PVPP will be self-consumed, that is the cost that the PVPP will offset. Due to the current energy crisis, the electricity price and the network fee are expected to increase, therefore in calculation each produced kWh in our PVPP and spent on-site is conservatively valued as 0.17€.

Due to currently fluctuating conditions on financial markets (zero interest rates, raising inflation) and unpredictable future, the Accumulated cash flow presented in Fig. 15 does not account for discount rate.

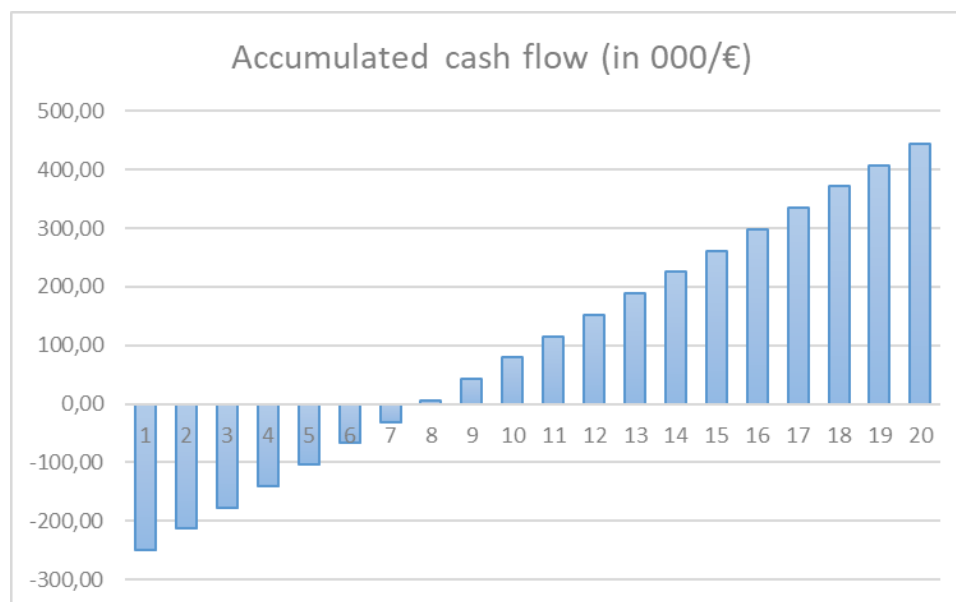


Figure 15 - Accumulated cash flow in 000 €.



Exit Strategy

The Faculty of Electrical Engineering (University) owns the facilities where PVPP will be installed and at the same time ensures electricity consumption for all or most production from its own PVPP, so there is no need to develop an exit strategy.

4.7. Forecast

Revenue

As the Faculty of Electrical Engineering will be the sole owner of PVPP and a consumer of all electricity thus produced, there is no need to make a profit. Each kWh produced in PVPP will be valued at the price paid by the Faculty of Electrical Engineering from the existing electricity supplier - that is 0.17 € (described in the Return of Investment chapter). The price thus determined makes it possible to calculate the return on investment in PVPP.

Expenses

Operating and maintenance costs are estimated at 2% of the value of the initial investment. These costs include:

- Annual insurance premium for the entire PVPP
- Possible repair / replacement of worn-out equipment (inverters)
- Possible cleaning of PV panels
- Internal accounting costs

4.8. Timeline

Timeline is set according to the Aurora project timeline.

Table 15 - Timeline for the UL demo site.

Year	2021	2022												2023		
Month (cumulative)/Progress	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Business model development																
Information and communication campaign																
Infrastructure development and continuous monitoring																



4.9. SWOT Analysis

Table 16 – UL SWOT Analysis.

Strengths	Opportunities
<ul style="list-style-type: none"> target groups of citizens are aware of the problems of the climate crisis legislation provides for Citizen energy communities 	<ul style="list-style-type: none"> The possibility of setting up a PVPP in a way that will be a model for other Citizen energy communities an opportunity to make students aware of the importance of sustainability and renewable energy sources
Weaknesses	Threats
<ul style="list-style-type: none"> organizing a larger number of citizens for investment is a big organizational task citizens are not a homogeneous group (employees, students, external actors) sophisticated legislation in the case of financial flows 	<ul style="list-style-type: none"> due to the inhomogeneity of the group (students versus employees) the inability to form a unified community due to the financial benefits of investing in PVPP, the need to pay taxes, complicates the situation of the individual

4.10. Risks

The following risks are identified and assessed according to the possibility of them occurring and their impact on the installation of PVPP.

- Legal risk

Immediately at the beginning of the project and even before the preparation of this business plan, we encountered a legal risk. In Slovenia, the operation of cooperatives has been supported by legislation for decades. There is also a legislation governing the functioning of citizens' energy communities (transposition of Directive (EU) 2019/944 on common rules for the internal market in electricity). In order to minimize legal risk, we hired an external expert - lawyer Lidija Kobe. The lawyer specializes in corporate law, including extensive experience in solving problems in the field of renewable energy.

Nevertheless, we encountered an insurmountable problem in the fact that the Faculty of Electrical Engineering or the University of Ljubljana currently cannot be the founder of a new legal entity or that it is necessary to demonstrate an urgent need, which must be approved by the Government of Slovenia. Due to such legislation, the Faculty of Electrical Engineering cannot participate in the newly created legal entity.

As a mitigation strategy we decided to form informal energy communities to pursue goals of Aurora, raise awareness and promote photovoltaics and to invest into PVPP by our own funds for demonstration purposes.



- Financing risk

We have already faced a financial risk. When researching the response of students regarding their willingness to invest in a PVPP at the Faculty of Electrical Engineering, we detected very little interest in financial investments, often connected with financial dependence of students.

There are significantly too few employees at the Faculty of Electrical Engineering or the University of Ljubljana for mass investment. Due to this, the Faculty of Electrical Engineering decided to carry out the investment in PVPP itself, and in parallel to carry out all possible promotional activities.

- PVPP damages

Damage to the PVPP can occur during installation or at any time later when the PVPP is already in operation. Damage can be caused by extreme natural factors (hail, extreme wind, icing, earthquake, ...). For all these cases, the investor will ensure PVPP with the insurance company.

- Prices

One of the potential risks is the change in prices used in this business plan. These are mainly:

- Price of PVPP installation
- The price of electricity in the future

As already mentioned in this business plan, over the last six months we have seen not only a halt in the decline in PVPP component prices but even an increase in them. The reason for the rise in prices is the mass interest of the population of all over Europe not only in Slovenia in setting up their own small PVPP, due to the war in Ukraine and the consequent increase in all energy sources.

Another risk is a change in the price of electricity. This is not only perceived risk but is already happening in extremely high percentages. Electricity price increase actually has positive effect on investment in PPP as the investments returns earlier. There is also a chance of prices falling, but due to current energy crisis and the need to ban fossil fuels, significant decrease is highly unlikely.

The increase in the price of PVPP components has a negative effect on the investment in PVPP, while the increase in the price of electricity has exactly the opposite effect and will bring significant savings to the investor - the Faculty of Electrical Engineering or the University of Ljubljana.



5. Demonstrator Site – Aarhus, Denmark

5.1. Opportunity

Our Solution

Aarhus University (AU) has set itself an ambitious climate goal: the university wishes to reduce its CO₂ emissions by 35% in 2025, and by 57% in 2030, both compared to a 2018 baseline, and the university aims to achieve carbon neutrality in 2040^[1]. To achieve this, the university sets detailed sub-goals under four focus areas (campus operations, procurement, transport and waste). Under the focus area of campus operations, one sub-goal states that AU aims to increase the proportion of sustainable energy in the university's energy consumption. Among many initiatives, AU plans to encourage climate-friendly behaviour among students and staff and give researchers and students the opportunity to use AU's campuses as a living lab. In order to fulfil the university's ambitious plans, concrete actions and activities must be implemented and this creates an excellent synergy with all the activities included within the AURORA project. In short, AU's climate goals and initiatives present great opportunities and potential for transforming the university community into an energy community.

At AU, the proposed structure for the energy community is “solar cell cooperative”, or “solcellelaug” in Danish. Cooperatives have a long history in Denmark, from dairy cooperatives in the early days, to private cooperative housing now, and the structure is well known by the citizens. There have also been successful examples of energy cooperatives in Denmark, e.g., Københavns Solcellelaug^[2], and Middelgrunden Vindmøllelaug^[3]. Moreover, more than 80% of the roughly 400 district heating suppliers in Denmark are organized as cooperatives^[4]. Both Københavns Solcellelaug and Middelgrunden Vindmøllelaug were established between the late 1990s and early 2000s with the aim to produce electricity from renewable sources such as solar cells and wind turbines and raise awareness of the technologies. Many existing successful examples of energy cooperatives in Denmark give us confidence and a pool of best practices and know-how to replicate similar bottom-up experience to establish an energy cooperative at AU thus transforming the university community into an energy community. On the other hand, in these previous examples of cooperatives, the shares were owned by individual participants and/or small companies. The AURORA project gives us the opportunity to extend that concept to involve a large public institution, i.e., a university, as part of the cooperative, together with students and employees in the institution.

[1] Aarhus University Climate Strategy 2025, https://auinstallation40.cs.au.dk/fileadmin/www.au.dk/om_au/KLIMASTRAT2020_DK_INDHOLD_v4_UK_v5.pdf, accessed on 22/03/2022

[2] <http://www.solcellelaug.dk/>

[3] <https://www.middelgrunden.dk/>

[4] Handbook for Energy Communities, 1st edition, Published 2020, ISBN 978-87-93053-06-9, Energiforum Sydhavn. https://kk.sites.itera.dk/apps/kk_pub2/pdf/2054_8548c61b05ec.pdf; accessed on 22/03/2022

Market Size & Segments

Aarhus University is a major Danish university with its main campus in Aarhus, which is the second-largest city in Denmark. Within the municipality live around 355,000 citizens, and as many as 27.5% of the population is between 18 and 29 years old^[5], thanks to the universities and folk high schools in the vicinity. According to AU's key figure report, in 2020, there are around 8,000 employees (calculated as full-time equivalent) and 38,000 students (including bachelor's, master's, PhD and part-time students) at the university^[6]. A few other organizations such as several AU spin-offs and externally funded research centres also sit on the AU campus, and subsequently, their staff and students are welcomed to participate in the energy cooperative.



As a university, the total electricity consumption of all the AU campuses across Denmark amounts to dozens of GWh^[5] per year. Currently, AU has an agreement with the electricity company Ørsted to purchase electricity based on a variable price, which is calculated as the sum of hourly electricity wholesale market price, grid tariffs, and taxes.

^[5] Befolkning i Aarhus Kommune,

https://ledelsesinformation.aarhuskommune.dk/aarhus-i-tal/default.aspx?doc=vfs://global/AARHUS-I-TAL/BEFOLKNING_I_TAL-Demografi-Demografi.xview; accessed on 23/03/2022

^[6] AU Key Statistics 2020,

https://i48.au.dk/fileadmin/www.international.au.dk/About_AU/Profile/About_AU/AU_Key_statistics_2020/AU_Key_Statistics_2020_UK_Final_010721.pdf; accessed on 22/03/222

^[7] Data from AU operations

5.2. Legal Framework

Country Regulations

Energy communities have existed in Denmark in forms such as cooperatives, associations, foundations, etc, long before the introduction of the EU directive on renewable energy community and citizen energy community. In 2019, the EU defined energy communities in its legislation, which was subsequently translated and incorporated into Danish law in the “Electricity Supply Act” and the “Act on the Promotion of Renewable Energy”. The legal definition of energy community in the Danish legislation requires that the members of the community comprise citizens, small businesses, or local authorities. Since a university does not fall under these categories, decision to create an energy community as defined in current legislation, would limit the participation of the University.

As a result of this, we adopt a different approach: using the Danish energy cooperative framework. This framework has existed in Denmark for years and generated many successful examples.

Process

The Handbook for Energy Communities^[8] provides a good reference on action plans to establish an energy community, which includes 10 steps. In the following table, we elaborate on these actions using the demonstrator in Aarhus as an example.

The fundamental ideas and objectives of the energy community should be defined and clarified before implementing the following action plan.

	Suggested action plan from the Handbook for Energy Communities	Aarhus demonstrator as an example
1.	Dialogue between initiators and potential local actors	It is important to identify and engage the potential local actors. In the case of the demonstrator in Aarhus, the AURORA project team acts as the initiator group, and potential local actors includes individual citizens, relevant departments at AU, and the building owner (detailed stakeholder analysis in section 5.4). We had several meetings with the different organizations, in addition to a public meeting with the potential participants. These dialogues and meetings helped us to convey the objectives of the cooperative and gather valuable feedback that has been subsequently incorporated into this business plan.



2.	Clarifying how many partners contribute to the founding of the energy community	Partners need to consider what resources they are able to contribute to supporting the further process, in terms of time and finance. Some resources are in other forms instead of cash, for example, roof space for the installation.
3.	Providing baseline for the existing energy supply	An analysis of the electricity demand for a full year is necessary. At the demonstrator at AU, we analysed the yearly electricity consumption of the buildings where the PV panels will potentially be installed. In addition, a more granulated hourly analysis was performed to better understand how much electricity produced by the PV panel installations would be consumed on-site.
4.	Setting out different scenarios for the extent of the energy community	Based on the handbook, this action focuses on setting out which partners should be involved, and which consumption levels and profiles are represented. Possible delimitations usually consider whether the community only involves households, or whether organizations such as public institutions and small businesses are included. The demonstrator at AU aims to engage not only the students and employees but also the university as a public institution. The consumption level and profile differ from an energy cooperative that involves only households. Based on our experience, this step involves additional legal analysis to ensure the participation of public institutions is acceptable according to the relevant legislation (also mentioned in point 8 below).
5.	Establishing an analytical framework for the technical composition	As AURORA has already decided to adopt solar cells at the early stage of the project, at the demonstrator in Aarhus we focused more on identifying potential solar cell technologies, outlining the different configurations, and exploring the requirement of roof space. For an energy cooperative in general, this step should first start with establishing the framework based on considerations of different renewable sources, for example, whether it is wind turbines or solar cells, or a combination of different renewable sources, followed by identification of technologies and configurations that correspond to various scenarios.
6.	Obtaining information on possible sources of funding for the investments	The energy cooperative should identify the major sources of funding and ways to access the funding. In addition, whether donations are acceptable by the cooperative should be discussed.
7.	Outlining the organizational framework	This step involves reviewing the legal forms. Specifically for the demonstrator in Aarhus, the review involves not only the Danish legislation for energy communities but also the law governing public institutions. This review also helps the energy community to decide which legal form it would take. This action may eventually lead to a set of statutes and registering the community as a legal entity.
8.	Calculating an “optimal” mix of energy production and the need for storage technologies	This action entails a preliminary technical and financial calculation of investment and operation costs. It helps the community to clarify the benefits and costs. At the demonstrator in Aarhus, we did not consider storage technologies in the plan and the surplus electricity will be sold to the grid. However, for other future energy communities, storage technologies could be considered to maximize self-consumption.
9.	Establishing an overall timeline and financing plan	Like any business development plan, setting out a timeline and financing plan helps to keep track of the progress. In the process to establish and realising the energy community, it might be required to adjust the technical ambitions according to funding and choose the best scenario. For the demonstrator in Aarhus, we anticipate the crowdfunding to be open for 2-3 months in the second half of 2022 (detailed short-term plan can be found in section 5.8).



10.	Implementation of the project with relevant contractors and technical advisors	As suggested in the Handbook, the final action in realizing the energy community could be divided into sub-phases, depending on the size of the community's technical ambitions and funding opportunities.
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Based on our experience with the demonstrator, these suggested actions are necessary in the process of creating an energy community, and some actions could be recursive. Some of the actions are re-visited when new information is made available, or as changes take place. Taking the demonstrator in Aarhus as an example, setting the baseline for the existing energy supply was repeated after discussions on potential installation site revealed that the cooperative would get access to part of the roof area instead of the entire space. The Handbook also points out that it is important in the process to base the actions within an initiator group, without losing touch with both the partners and end-users.

^[8] Handbook for Energy Communities, 1st edition, Published 2020, ISBN 978-87-93053-06-9, Energiforum Sydhavn. https://kk.sites.itera.dk/apps/kk_pub2/pdf/2054_8548c61b05ec.pdf; accessed on 22/03/2022

5.3. PV Power Plant

Location

The potential installation site will be a complex of buildings known as Nobelparken^[9], which lies at the northeast corner of the main campus of AU. Following local legislation, AU does not own any of the buildings where students and employees are located. In particular, the buildings at Nobelparken are owned by the company, Forskningsfondens Ejendomsselskab A/S (FEAS). These buildings were constructed after the 2000s and are therefore relatively newer compared to the other buildings on campus. Currently, the main tenants include a couple of schools under the Faculty of Arts. There is over 3,000 m² of roof space available for solar panel installation. It is worth mentioning that based on preliminary discussion with FEAS, the energy cooperative might not have access to the entire roof space, but only a part of it.

^[9] Nobelparken on Google Maps: <https://goo.gl/maps/7brM1Ycu1LpKhTKK6>

Installation details

The targeted installation capacity at the demonstrator at AU is 200 kW. It is noteworthy that the final installed capacity also depends on the funding raised through crowdfunding.

The potential installation site is a building complex in Nobelparken, which includes 3 blocks connected by intermediate steps with lower heights (Figure 16).

The preliminary design assumes that solar PV panels will be installed in each of the three blocks. The PV panels will be oriented 19° east (following the longest dimension) in the buildings due to the following reasons: (a) we have checked that the annual energy production will only be 1% lower than the south orientation, and (b) this will maximize the use of the rooftop space and ease the mechanical mounting. The PV panels will be mounted in landscape configuration and with a tilt angle of 20° to maximize annual electricity generation while minimizing wind loads.





Figure 16 - Three building blocks comprising part of the Nobelparken complex where the rooftop installation will be mounted.

At least one inverter per building block is foreseen. For the installation, we plan to use different technologies of monocrystalline solar cells including monofacial PERC, bifacial PERC and TOPCon technologies. By doing this, researchers could test and compare the performance of different solar cell technologies installed in the same environment. This also aligns with AU's initiative of encouraging researchers to use the campus as a "living lab".

5.4. Energy Community

Goals

First and foremost, the cooperative aims to increase the proportion of sustainable energy in AU's consumption and therefore reduce AU's carbon footprint. This aligns with AU's ambitious climate goal. The second goal for the cooperative is to demonstrate the bottom-up approach in the energy transition. We aim to empower and engage the citizens, especially young adults, in transforming the energy system. Finally, the cooperative aims to raise awareness of the technologies and change public perception of renewable energy infrastructure projects. There is a lot of debate about solar farm projects and their impacts on the population living close by. Through this community-based cooperative approach, we aim to show that it is possible to engage and benefit the local communities in solar infrastructure projects.

Identification of Stakeholders

As a result of AU not owning any buildings, the matrix of stakeholders becomes more complicated, in comparison to the other demonstrators. Apart from the various department in the university, the building owner is an important stakeholder in the energy cooperative at AU. We have identified the following stakeholders:

- AU facilities management

AU facilities management department has a high interest in the energy cooperative as they wish to have access to the clean electricity produced by the cooperative. On the other hand, they have a high influence on the cooperative, because it is with the AU facilities management department that the cooperative needs to negotiate and agree on the price of electricity produced by the installation and consumed by AU.



- Building owner FEAS

FEAS' interest in the energy cooperative can be attributed to 2 aspects: first, FEAS has a plan to install solar panels on the roofs of the buildings in Nobelparken so they are interested in observing the bottom-up approach and learning from the energy cooperative; second, in the event that AU ceases renting the buildings at Nobelparken, FEAS has an option to buy out all the shares from the cooperative (more to be elaborated under Exit Strategy). At the same time, FEAS has a high influence on the energy cooperative as the owner of the buildings where the solar panels will be installed.

- Consultant

To establish, operate and manage the energy cooperative, specialized knowledge and experience are required, for example, but not limited to, knowledge of legislation in Denmark, energy cooperative operation, etc. Therefore, a consultant is an important stakeholder in the energy cooperative. In AURORA, we engaged EBO Consult A/S (EBO Consult), who has tremendous experience with energy cooperatives in Denmark.

- AU procurement

AU procurement helps to re-negotiate the exclusive terms in the existing agreement with the electricity company Ørsted, and procurement department will be the department to sign the agreement with the cooperative, therefore having a high influence on the energy cooperative.

- AU departments residing at Nobelparken

The different departments residing at Nobelparken will pay the electricity bills from their operations budget, and it is important to them that the electricity price is reasonable. As a result, they have a relatively high influence on the cooperative.

- AU board of directors

The influence of the AU board of directors lies in the fact that they can approve whether AU can become an active member (i.e., shareholder) of the cooperative. In case this is not approved, AU will remain as a passive member of the cooperative, i.e., not owning shares, but consuming the electricity produced by the cooperative.

- AU Green Team

AU Green Team supports the work on AU's climate strategy and its implementation. The establishment and operation of an energy cooperative contribute to AU's climate goal in two folds: it contributes to the goal of 35% reduction of CO₂ emissions in 2030 compared to the 2015 baseline, and it encourages behavioural changes toward sustainability among AU students and employees. As a result, AU Green Team has a high interest in the energy cooperative. However, as their work mainly involves campus strategy and practices and the energy cooperative will be a separate entity, their influence on the energy cooperative is not as high.

- Interested participants

From the initial press release and news articles, there is a group of interested participants, who would potentially become members of the energy cooperative.

- General AU community

General AU community refers to the students and employees who are not aware or not interested in the energy cooperative now. We need to monitor their interest closely, as some may become interested cooperative members in the future.

Legal Form

The cooperative will be registered as an independent legal entity with limited liability. The statutes of the cooperative will be written, with help from the consultant, and discussed among the members. They will ensure democratic decisions



within the cooperatives (e.g. one vote per participant independent of the amounts of shares owned), open participation, independence and autonomy.

Documentation

An agreement has been signed with EBO Consult to provide help to write the following required documentation.

- a. Writing contract that describes the commitment of the company FEAS to rent the rooftop for 25 years.
- b. Writing the statutes of the energy community (articles of the association).
- c. Writing the tender for the installer of the solar rooftop system.
- d. Writing the prospect for all possible investors.
- e. Setting up the contract that establishes the price at which AU will be paying the electricity produced by the installation.
- f. Setting up the contract that the participants in the energy community will sign.
- g. Establishing a Management Agreement, which describes how EBO could take care of handling the payments of dividends to the shareowners every year. The initial duration of the Management Agreement will be for the initial 5 or 10 years.

Contracts

This will be done together with EBO Consult as described in previous sections.

Members of the Community

We foresee different types of memberships: active membership and passive membership. One main difference is that active members contribute financially to the cooperative, whereas passive members do not. To become a passive member, one is not required to invest in the cooperative. Subsequently, the passive member does not receive any economic returns from the revenue. The different membership and the rights associated with them will be drafted in the statutes of the cooperative.

There is no strict restriction on membership to the cooperative, though priority will be given to the AU community. We anticipate that members of the cooperative include but are not limited to students and employees of AU. Staff who are not directly hired by AU but work on the AU campus are also welcomed to become members of the cooperative. The building owner FEAS could become a member of the cooperative as a small and medium-sized enterprise (SME). Whether AU becomes an active member of the cooperative depends on approval from the board of directors.

Types of Participations

The main type of participation will be in-cash, i.e., members purchase shares to become co-owners of the cooperative. FEAS' participation is seen as in-kind, as the rent of the roof space is waived for the cooperative, and there is the option for FEAS to invest in the cooperative in cash. In addition, there is the possibility of donations, in which case, there will not be economic returns for the donors, and the use and scope of such fund shall be clearly defined in the articles of the cooperative.

Types of Shares

Since we aim to engage as many participants as possible, we set up a rule so that no one can take up 20% or more in the investment or the ownership of the cooperative. Furthermore, the number of shares owned by a member does not



affect the weightage of his/her vote. In the cooperative, each member has one vote, regardless of the number of shares he/she has.

Requirements

As the cooperative does not have any entry requirement based on one's studying or working status at AU, members have the option to keep their shares after graduating or leaving AU's workforce. It is also possible to sell the shares to other people, and the selling price should be adjusted accordingly every year, based on the difference between the initial share price and the returns the member has already received.

Electricity Management

Unlike residential housing, whose electricity demand usually increases during the evenings when most people are at home, the daily profile of electricity demand in a university matches that of the power generation from solar panels: when the solar panel generates electricity during the daytime, the electricity demand from the university is high. This means most of the electricity generated from the solar panels could be used on-site. Figure 17 below shows the electricity demand of the selected buildings at Nobelparken (using historical consumption data from 2018) in comparison to the electricity produced by the PV panels that are going to be installed, taking a typical workday in the summer as an example. Occasionally, the electricity produced is higher than the demand from these buildings, due to reduced activities at the university over weekends or during holidays. In this case, the surplus after meeting self-consumption needs will be sold to the grid.

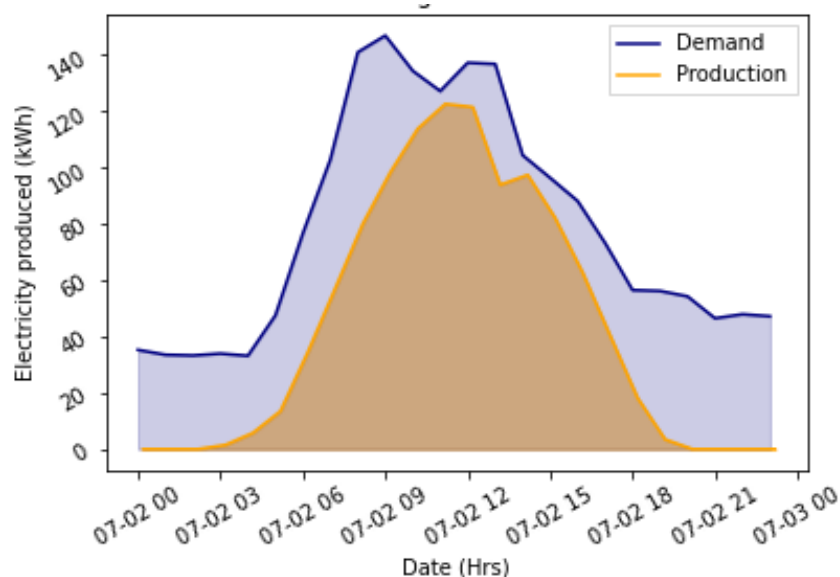


Figure 17 - Comparison between electricity consumption from selected buildings at Nobelparken and production from PV panel installation.

Based on our preliminary analysis: annually around 90% of the electricity generated from the solar installation will be used as self-consumption.



Sustainable Community Management

Following the previous examples in Denmark, the cooperative will have its own by-laws or statutes, elect a board of management, and hold annual general meetings. These are standard practices for a cooperative. The elected management will then be empowered by the cooperative to make decisions relevant to the operation and management of the cooperative. Some examples of relevant decisions include: choice of insurance to the panels, hiring of accountant company for annual financial reporting and auditing, engaging administrative support to distribute dividends to the members, etc.

5.5. Mobilization

Engagement process

Since the initial press release and news articles, we have gathered interest from close to 100 potential participants. The first public meeting was held with the potential participants on 10th March 2022, where we explained the rationale and shared the proposed cooperative structure. The team also received useful feedback from the community.

To further engage the community, we have set up accounts on major social media platforms: Facebook^[10], Instagram^[11] and Twitter^[12]. The team also set up a Google Group^[13], which will be used as a mailing list and forum so that everybody can contribute to meaningful and open discussions. All these means will be used to share updated information and report progress, to keep the interest of potential participants.

In order to further engage the wider community within and outside AU, we have reached out to various student organizations for collaboration. On the other hand, we will keep working with AU Green Network in sharing information about the cooperative and events.

Lastly, we plan to host multiple events open to the public to engage the community. In April 2022, two such events were held: an exhibition at the Open Citizens Day (24/04/2022) at the Steno Museum, where we demonstrated the technology and engaged children with solar-driven car competition. The second public event was held as a public discussion (25/04/2022) on the topic of the impact of cutting Russian gas. In the future, we aim to keep engaging the community through different workshops and public discussions on energy-related topics.

^[10] <https://www.facebook.com/AURORA.Aarhus>

^[11] <https://www.instagram.com/aurora.aarhus/>

^[12] https://twitter.com/AURORA_Aarhus

^[13] <https://groups.google.com/g/auroraaarhus>

Sustainability

By demonstrating the cooperative model involving public institutions as a “flagship”, we hope to encourage the formation of new local energy communities in Aarhus, and other cities in Denmark. The model proposed in this document should be used as a reference for future cooperatives that wish to involve both citizens and institutions. Organizations and communities who wish to replicate a similar structure in Denmark could become an “observer” of the cooperative. Along the way, we plan to share our experience and learning with the “observers”.

5.6. Financial Plan

Financing Needed

Based on Danish Energy Agency’s Technology Catalogue^[14] in 2020, the installed cost for solar panel systems in Denmark is around 8,400 kr/kWp (approximately 1.13 €/kWp). In January 2022, we sought unofficial quotations from



local contractors for 200 kW solar system at the potential site at Nobelparken. The estimated cost ranges between 1.37 million Danish kroner (DKK) to 1.49 million DKK (price before tax).

^[14] https://ens.dk/sites/ens.dk/files/Statistik/technology_data_catalogue_for_el_and_dh_-_0009.pdf, accessed on 22/01/2022. There is an updated version of the catalogue published in March 2022, where the estimated investment cost is lower than this value. We choose to use this number for a conservative preliminary economics analysis.

Sources of Funds

The main source of funds will be from investment from shareholders, i.e., through a crowdfunding approach. However, the possibility of donations is not completely ruled out. Donations could come from individuals, companies, or non-profit organizations. As mentioned, the scope of donation and its use will need to be clearly defined in the statutes of the cooperative.

Return of Investment

Members can purchase one or more shares of the cooperative, and the return of investment will be distributed back to them as a form of an annual dividend, depending on the revenue from the cooperative and the number of shares the members own.

Since the agreement on the price paid by AU for the electricity produced by the cooperative is not yet finalised, the exact ROI expected for the investment remains uncertain. Nevertheless, our preliminary analysis indicates that ROI can be between 4% and 8%.

Exit Strategy

As AU leases the buildings from FEAS, there is a need for an exit strategy, in the event that AU ceases renting the buildings at Nobelparken. Although Nobelparken is a potential installation site at the time of writing this document, the situation will be similar at a different installation site, because AU does not own any buildings. The options of in this Exit Strategy shall apply to all situations, regardless of the final installation site.

We see two options for the exit strategy when AU ceases renting the buildings from FEAS, and they should be executed in this following order as written below.

1. FEAS adds in their lease agreement a condition that the new tenant signs a separate agreement with the cooperative to consume and purchase electricity produced from the solar installation, or alternatively becoming a passive member of the cooperative. In this option, the cooperative stays as an independent legal entity and the investors can keep on holding their shares. This should always be pursued as the prioritised exit strategy.
2. FEAS takes over the solar installation. In this case, FEAS buys out all the shares of the cooperative from the other investors and becomes the sole owner of the installation. As a result of this, the cooperative ceases to exist. To become the sole owner of the installation, FEAS needs to pay the depreciated value of the installation and calculated profit loss to the shareholders.

5.7. Forecast

Revenue

Revenue of the cooperative comes from selling electricity that is produced by the PV installation to the AU departments residing at Nobelparken, or the new tenant at Nobelparken if option 1 in Exit Strategy is executed. There are two pricing options: fixed price, or variable price.



1. Fixed price: since it is in AU and the departments' interest to purchase electricity at a reasonable price, we proposed 1.20 kr/kWh (0.16€/kWh). The price is set based on an analysis of the average monthly electricity bills paid by these departments from 2016 to 2021. It is noteworthy this proposed price is lower than the historical lowest point during this period. A fixed price ensures the economic sustainability of the cooperative independent of external events (such as the undesirable Russian war which ironically would create higher benefits for the cooperative under a variable price agreement). On the other hand, it protects AU if the electricity price keeps rising.
2. Variable price: In this scenario, the price for the cooperative will be similar to that of the current contract with Ørsted (i.e., the average monthly spot price for electricity plus grid tariff). This option gives less "stability" to the cooperative and makes it challenging to estimate ROI for the shareowners. On the one hand, the cooperative will do economically well if the market price increases. On the other hand, if the market price reduces significantly due to the mass deployment of wind and solar systems in the future, it takes longer for the shareowners to recover their investment. It is also remarkable that this option removes the potential benefit for AU of having a fixed price contract, in case the electricity price increases in the future.

It is worth mentioning that at the time of writing this document, there is no agreement made yet regarding the choice of pricing options, but we expect this to be agreed upon within the coming weeks.

Expenses

For our preliminary analysis, we assumed 2% of initial investment cost as operation and maintenance (O&M) cost per year, which translates to 168 kr/kWp. The expenses include but are not limited to the following items:

- Insurance for the panels;
- Cost of engaging accountant firm;
- Saving for parts replacement (e.g. projected inverter replacement after 10 years).

5.8. Timeline

Table 17 below is a summary of the short-term timeline planned till early 2023. We would like to stress that the cooperative's lifetime shall exceed the project time of the project (3.5 years). We expect to use the first 3.5 years (aligning with the AURORA project timeline) to set up the energy cooperative and gather experiences and best practices, and the cooperative is expected to be independent of AURORA and function as any other cooperative after the AURORA project ends.

Table 17 - Timeline for the AU demo site.

	Year 1												Year 2			
Month	1*	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Business model development																
Information and communication campaign																
Cooperative formation and crowdfunding																
Infrastructure development and continuous monitoring																

*M1 refers to December 2021.



5.9. SWOT Analysis

Table 18 – AU SWOT Analysis.

Strengths	Opportunities
<ul style="list-style-type: none"> We chose the cooperative framework, which the Danish society is familiar with and feels closer to heart. We work with EBO Consult, who has successfully set up multiple energy cooperatives in Denmark and has extensive experience and knowledge of renewable energy projects with citizen involvement. Our approach is truly bottom-up, which gives the community a sense of ownership. 	<ul style="list-style-type: none"> AU has set itself an ambitious climate goal, and so has Denmark. To realise these goals, citizen empowerment and participation are considered important strategies. The Danish society is generally concerned about and participates actively in sustainability agenda such as energy conservation and transition to low-carbon options. Energy policy is well-rooted in the Danish energy transition; therefore, the format is easy to replicate outside AU and in other cities.
Weakness	Threats
<ul style="list-style-type: none"> We need to keep working on increasing public acceptance and awareness of solar technologies. Due to the weather and climate constraints, solar PV in Denmark produces around 900 kWh per installed kWp, so it takes relatively long to recover the initial investment cost in the cooperative. The location of installation is subjective to discussions with FEAS, unlike other energy cooperatives which may have higher decision power choosing the site of installation. 	<ul style="list-style-type: none"> AU has an existing 2-year agreement with Ørsted to purchase electricity, which started in January 2022. The agreement is exclusive, which means the term needs to be re-negotiated before the cooperative can deliver electricity to AU. The project team is working with the procurement department to re-negotiate the terms. FEAS is simultaneously developing their own business plan for solar panel installation on the roof of buildings in Nobelparken. This could mean the cooperative may not have access to the buildings at Nobelparken for the installation, but FEAS is willing to explore synergies with the cooperative.

5.10. Risks

Identification of Risks

The following risks are identified and evaluated based on the possibility of happening, and their impact on the energy cooperative.

- Legal risk

Though the structure of the cooperative is familiar to the Danish society, there is specific documentation and process to adopt for the formation and registration of the energy cooperative, especially with the involvement of a public institution. The project team has little knowledge on the specific legislation. This might lead to a delay in the formation of the cooperative. This risk associated with this is evaluated as medium possibility and high impact.

- Financing risk

There is also the risk of failing to raise the targeted sum to install 200 kW solar panels (roughly 1.5 million DKK). This risk is evaluated as medium possibility and medium impact.

- Incidents to the installation

The risks associated with operation and maintenance of the PV installations could include theft of components, or physical damage to the panels due to various reasons such as extreme weather. The risk is considered low possibility and medium impact.



- Pricing

One of the potential risks for the operation of the energy cooperative is the electricity price, which influences the stability of the cooperative. Electricity prices could be impacted by a few factors. For example, at the time of drafting this document, the Russian invasion of Ukraine has sparked discussions in the EU about cutting Russian gas, which will have an impact on the electricity price. Another factor impacting the electricity price could be the mass deployment of renewable energy infrastructure in the future, which may lead to a decrease in the price. This risk is evaluated as medium possibility and high impact.

- AU relocation

As AU leases buildings in Nobelparken from FEAS and consumes the electricity produced by the solar panels, naturally there is a risk to the cooperative if AU relocates. The risk is evaluated as low possibility and high impact.

Risk Mitigation Strategy

To handle the challenge of registering the energy cooperative with involvement from a public institution, we engaged an experienced consultant (EBO Consult) as the legal adviser. In fact, the decision to adopt cooperative as the structure for the community is consulted with EBO.

To mitigate the risk associated with financing, the cooperative will be flexible with the installed capacity. In other words, the installed capacity will be adjusted according to the size of the funding the cooperative is able to raise through crowdsourcing.

The risk associated with unexpected incidents to the installation can be mitigated by purchasing an insurance.

The risk associated with pricing could be avoided with a fixed price strategy, as described under section 5.7.

Lastly, the risk associated with relocation will be dealt with through the exit strategies, as described under section 5.6.



6. Demonstrator Site – Forest of Dean, United Kingdom

6.1. Opportunity

Our Solution

Forest Energy Community Initiative



Figure 18 – Forest Energy Community Initiative Logo.

AURORA creates the perfect opportunity to test the development and engagement of a community to ‘come together’ to take collegiate action on individual net zero carbon journeys.

Through Aurora we will provide a share offer for a PV locally installed PV Power Plant (PVPP) which is focused on the local market with ease of access.

This report sets out our current thinking. Stakeholder and community buy in is essential to ensure the best chance of success and learning for future projects. We therefore expect the project business model to change and evolve as the project develops.

With the current energy crisis, we have identified that there will be a need to have a broader offer than just carbon saving. We are therefore proposing that the PVPP will need to provide additional benefits which the community can see, such as supporting community services or other projects. For this reason, the solution will focus on a Power Plant installation on community accessible assets and services.

Market Size & Segments

The Forest of Dean has a population of 87,000 with 60% falling into the 16-64 age range and 25% over 65. The median age is 48. Mean gross annual pay for the period 2020-21 being £29,471 (35,300 €).

Between January-December 2020, it was estimated that there were 43,400 economically active people in the district, which represents 81.5% of the total district population of 16-64-year olds.

While the population continues to grow, within the community there is a marked population change towards an aging population. The graph below shows the number of males and females of different ages within the district. As can be seen, the graph is becoming ‘top heavy’ with the age groups between 45 and 75 growing larger than the younger generations.



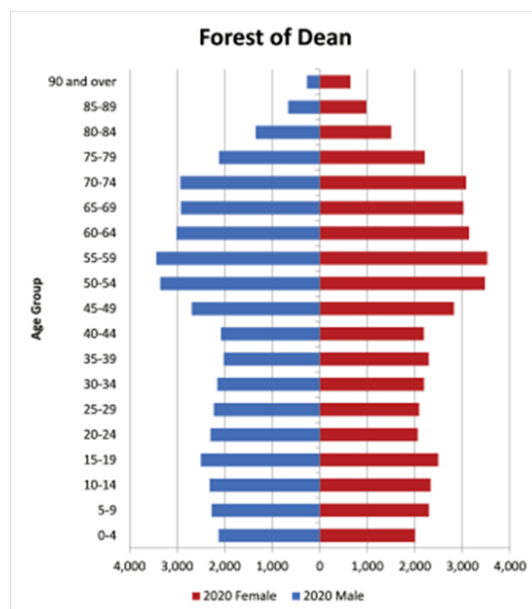


Figure 19 – Age groups distribution of FoDDC.

In 2011 (most recent data) out of a total figure of almost 30,000 economically active people, 15,524 of them live and work within the Forest of Dean District. This represents over half of the working population who are working and are living in the Forest of Dean District, but are out commuting to a place of work the majority by car. Whilst this data is dated, and there will have almost certainly been some change since the pandemic, it may well be that commuters could be a target group to offset locally their emissions and support local services.

45% of the population live in areas of 'average deprivation' with one area (Cinderford) identified as the most deprived and therefore may not be a focus for share offer but could represent a good opportunity to support community services.

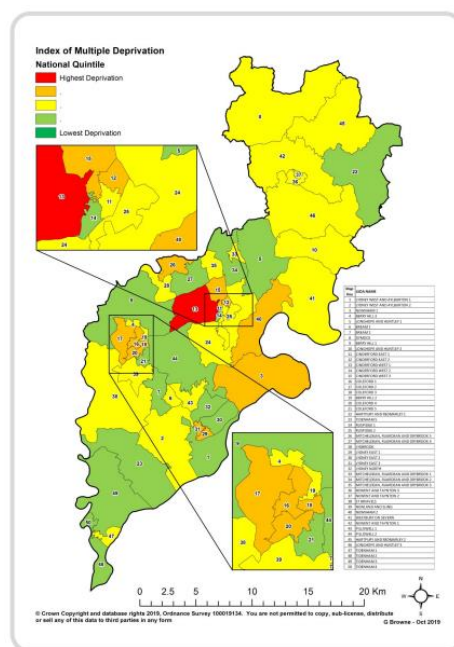


Figure 20 – Index of Multiple Deprivation National Quintile.



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101036418.

The project will use analysis form Britain Talks Climate <https://climateoutreach.org/britain-talks-climate/> to appeal to key sectors in the Forest of Dean.



Figure 21 – Climate Outreach logo.

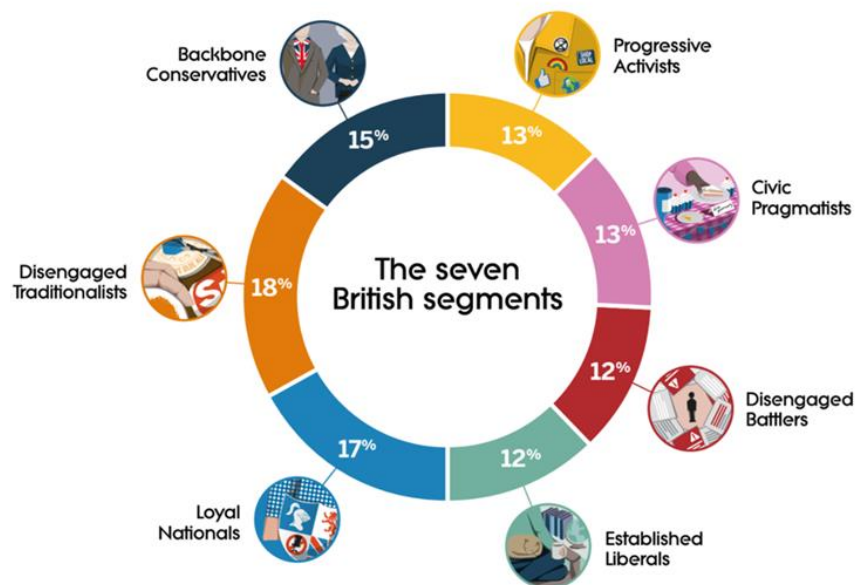


Figure 22 – The seven British segments.

Analysis suggests that 'backbone conservatives' and 'established liberals' will be key segments to engage within the Forest of Dean.

It is recommended that in engaging with *backbone conservatives*' key messages should include:

1. Build on well-established research on engaging audiences with firmly held conservative values, and animate them over battleground issues to do with rural life: for example, food standards that protect farmers' livelihoods and climate change-related weather effects.
2. Remove the signifiers of left-wing environmentalism without undermining the substance of the message.
3. Find and amplify genuine success stories around British leadership on the environment.

Similarly for *established liberals*

1. Motivated by arguments about economic and societal progress and opportunity
2. Use their comfortable and influential position in society to bolster the case for common sense,



3. Low-carbon solutions that build on positive steps already taken.

Therefore, from a commercial perspective, our main target audience will be the older population 40+ outside of the most deprived areas and geographically related to PVPP locations.

6.2. Legal Framework

Country Regulations

Energy generation

Energy Communities can own and operate energy generating assets in the UK by taking on a variety of legal forms which will be discussed in more detail in 6.4.

Energy generating assets can be legally operated in the UK on a rooftop owned by another party through a lease or license agreement. In the case of this project, the owner of the solar assets will be looking to secure a lease agreement with the owner of the rooftop. Lease agreements may be required with local Councils, schools, community services or private companies.

Energy supply

Energy will be supplied directly to the building hosting the installation using a Power Purchase Agreement (PPA), or similar, which will set out the price of supply. Any remaining electricity produced by the installation which cannot be used on-site will be exported to the grid. In the UK you can apply to receive the export tariff which is a payment made through a licensed electricity supplier if you meet the criteria outlined by Ofgem: https://www.ofgem.gov.uk/sites/default/files/docs/2020/02/seg_generator_guidance_-_final_for_publication.pdf. If only small amounts of energy are expected to be exported to the grid, this will be the mechanism for providing the installation owner with a financial return from energy produced and not used on site. However, if large amounts of energy are expected to be exported, a further PPA will be explored in order to secure a higher price for the sale of the excess electricity being generated.

Planning

Planning permission is required in the UK for all renewable energy installations that involve development. This may be granted either by a permitted development right (PDR) or by a planning application to the local planning authority. Development is defined in [section 55 of the Town and Country Planning Act](#).

Community Energy organisations need to consider impacts of different renewable technologies on the local landscape, ecology, environment and archaeology. However, rooftop solar PV is a tried and tested technology in the UK with low impact and in most cases permitted development will be granted.



Process

This will depend on the option we take. We are considering 3 potential options:

1. Establishing a new Community Benefit Society
2. Establishing a new node of the Big Solar Coop
3. Running a community municipal bond offer.

These options are described below.

We believe that the right legal form, business model or vehicle will be the one that overall best balances the benefits/risks to each of the key stakeholders involved (or potentially involved) in the process.

We need to explore further with key stakeholders as follows, before selecting the business model:

1. The community (which is described in more detail above, see sections 6.1).

It is the drive, commitment and enthusiasm of community members that shapes energy communities. We need to further explore the appetite and commitment; individual capacities and capabilities; the nature of involvement community members want to have (e.g., level of interest in being directors, volunteers, members, investors); and their underlying motivations and aspirations.

2. The Forest of Dean District Council.

This is a project being led by the Council and CSE. The Council have given their full support to the project, but as the project develops we will need to have more detailed and ongoing conversations with the Council and its elected members about the specifics of these options in order to help them understand and consider the exact nature of their role and participation going forward.

3. Landlords and Energy Users.

The participation of Forest of Dean landlords (like schools and community buildings) and their tenants (energy users) is fundamental to each of the models. Therefore, we need to understand more about their specific circumstances, wider goals and priorities for the initiative.



Table 19 – Business Model example 1.




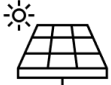






We're looking at three 'basic' options that could be useful and relevant to the Forest of Dean							
Example Business Model 1 – <i>Forst of Dean Community Energy (Community Benefit Society)</i>							
Process:						Potential benefits / beneficiaries:	
							A. Investors in community benefit organisations benefit from interest on their shares.
							B. Surplus income available to community for the development of future projects and/or community benefit.
1. Form a community benefit society (see legal forms detailed below).	2. Community benefit society organises agreement with council, school and leisure for use of roof space and sale of generated electricity.	3. Community benefit society runs a share offer for investment in solar arrays.	4. Solar installed on roof of the school and leisure centre owned by community benefit society	5. School and Leisure centre pay reduced rates for the use of electricity generated on their roofs.	6. Revenue is generated from sale of electricity to school, leisure centre and (excess) to the national grid.	 	C. the energy user (e.g., school and leisure centre) benefit from reduced cost of electricity.



Table 20 – Business Model example 2.

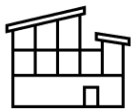
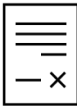









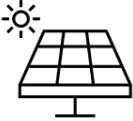
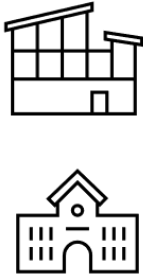




Example models 2: Forest of Dean, Big Solar Coop 'Cell'							
Process:						Potential beneficiaries/Benefits:	
							A. Big solar Coop's Community of investors benefit from interest on their shares.
1. Big Solar Coop assess the solar potential of the school and leisure centre roofs.	2. Building owners, the school and council (who own the leisure centre), enter into an agreement with the Big Solar Coop.	3. Big Solar Coop run a continuous share offer as part of a nationwide process.	4. Solar installed on roof of school and leisure centre by the Big Solar Coop.	5. School and Leisure centre pay reduced rates for the electricity generated on their roofs.	6. Revenue is generated from the sale of electricity to school, leisure centre and (excess) to the national grid.	 	B. the building user (e.g. school and leisure centre) benefit from carbon savings and reduced cost of electricity.
Potential for scaling-up roof top solar on public, commercial and community buildings in the Forest of Dean:							
Big Solar Coop could also train a 'cell' of volunteers to identify and assess other rooftops.	Volunteers/Big Solar Coop could approach other building owners in the Forest of Dean.	Additional buildings could easily be included in on-going share offers	More roofs with solar in the Forest of Dean.	Greater savings for schools, business other organisations in the FoD.			



Table 21 – Business Model example 3.

Example models 3: Forest of Dean Community Investment Bond						
Process:					Potential Benefits:	
						A. The council benefits from cheaper borrowing, ownership of solar and potential future income.
						B. Community investors benefit from interest on their bond.
1. Forest of Dean Council launches Community municipal bond.	2. Community member invest in bond.	3. Solar installed on roof of school and leisure centre.	4. Solar installed on roof of school and leisure centre. 5. School and Leisure centre pay reduced rates for the electricity generated on their roofs.	6. Revenue is generated from sale of electricity to school, leisure centre and (excess) to the national grid.		C. The energy user (e.g. school and leisure centre) benefit from carbon savings and reduced cost of electricity.

6.3. PV Power Plant

Location

The location(s) for the power plant remains flexible (April 2022). Discussions are ongoing with potential asset partners and to some degree they will have a view of the business models explored in this document.

For the reasons set out above the current focus for the installation of the power plant is on public buildings which support community services such as Schools, healthcare, town halls and leisure providers. The FoD is a rural district with approximately 50% of its population focused in one of its four market towns. The focus for location of the PVPP



will therefore be one of the market towns (Lydney, Coleford, Cinderford, Newent), on or near a public building and in a 'visible location' where communities can see the installation.

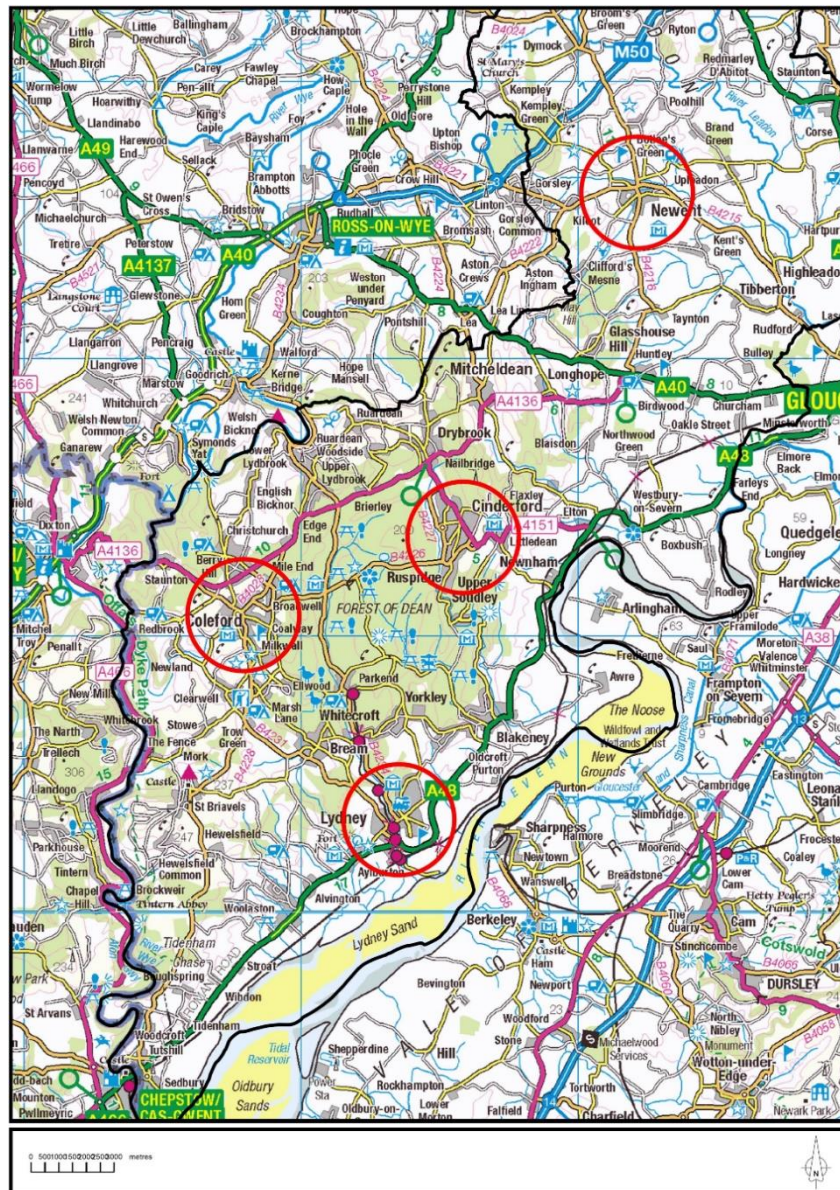


Figure 23 – Forest of Dean District Map.

Installation details

As set out above the location has not been set yet. By way of an example looking at a leisure centre facility in Lydney. This site has a high energy demand throughout the year with a swimming pool and sports facilities and there is roof capacity in the region of 200-300sqm (150-250 kW).



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101036418.



Figure 24 – Leisure centre in Lydney.

The Forest of Dean District Council has recently installed a 78 kW system, commercially, using 340 W Q.Peak Duo G9 panels (module) and Solis 110 kW (5G 3 Phase MPPT – DC) inverter. Once the site has been agreed design and installation will be subject to a procurement exercise.



Figure 25 – PV system already installed.



6.4. Energy Community

Goals

Our shared vision (FODDC and CSE) is to optimise the generation of clean local energy in the Forest of Dean and enable greater local participation in the transition to a low carbon energy system.

Through Aurora we will support a local investment vehicle to develop clean local energy projects, that actively involve and benefit local businesses, communities and organisations.

We want to see the project as a catalyst for further community energy projects in the Forest of Dean.

Legal Form

We will be consulting with key stakeholders on 3 basic options:

Table 24 – Business Model legal form options.

1. Summary of Potential Legal Entities	
<p>1. Co-operative Society</p> <p>This legal form is specifically for organisations that wish to be registered as a co-operative. It is suitable for organisations that wish to operate a business for the <u>benefit of its members</u> who come together to meet their common needs.</p> <p>Capital can be raised through issuing withdrawable shares to members. A profitable co-operative society <u>can pay dividends</u> to members based on the member relationship and/or interest on shares held in the co-operative.</p> <p>Key features:</p> <ul style="list-style-type: none"> • Registered with the Financial Conduct Authority • Has to be carrying on a business industry or trade <u>for the benefit of the members</u> • Created to meet the common social, economic and cultural needs of the members • People or organisations can be members through purchasing share capital • Only members can hold shares. • Members are only permitted to hold one vote regardless of how many shares they hold 	<p>2. Community Benefit Society</p> <p>The purpose of a community benefit society is to <u>serve the broader interests of the community</u>, in contrast to co-operative societies that serve the interests of members.</p> <p>Capital can be raised through issuing withdrawable shares to members – most commonly through a community share offer. A profitable community benefit society <u>can pay interest</u> on shares held in the co-operative.</p> <p>Key features:</p> <ul style="list-style-type: none"> • Registered with the Financial Conduct Authority • Has to be carrying on a business industry or trade <u>for the benefit of the community</u> • People or organisations can be members through purchasing share capital • Only members can hold shares. • Members are only permitted to hold one vote regardless of how many shares they hold. • <u>Profits cannot be distributed to members and must be retained by the society to further the objects.</u> • <u>Assets on dissolution must be distributed to another charity</u>

See: [5.2 Choosing your legal form | Co-operatives UK](#)



3. The local authority – Forest of Dean District Council

- Community Municipal Investments (CMIs), is a bond issued by local authorities through a crowdfunding platform giving residents the chance to support low-carbon projects, directly benefiting their own community.
- CMIs can be used to supplement, diversify or replace sources of borrowing to fund-specific infrastructure projects, or to refinance existing debt.

See: [Turning Words into Action](#) (PCAN); [Financing for Society](#) (University of Leeds); [West Berkshire Council](#) (2020); [Camden Council](#) (March 2021)

Documentation and contracts

Depending on the legal status we chose to pursue, this is the documentation that may need to be prepared:

1. Articles of association for the energy community/ Agreement with an existing Cooperative
2. Lease agreement with building owner
3. Power purchase agreement with energy users
4. Export tariff agreement with a licensed energy supplier
5. Power purchase agreement for energy exported (if a large amount of energy is exported)
6. Share offer documentation
7. Agreement with shareholders
8. Tender for solar PV installation
9. Contract with solar PV installer
10. Management contract for managing shares
11. Management contract for solar PV operations and maintenance

Members of the Community

The scheme will have wide appeal, with opportunities for individuals, community associations, local charities and potentially local promoters. Whilst the focus is on the establishment of the main scheme. The scheme will be designed to ensure it can be a catalyst for further measures.

The proposal will need to make a balance and 'discourage/redirect' those on lower incomes to more direct home energy conservation measures such as those supported through the local '[Warm and Well](#)' scheme. The Warm and Well scheme supports households where a household income is under £30,000 per annum, or someone in the household has a long-term health condition and the property has an Energy Performance Certificate (EPC) rating of D or below.



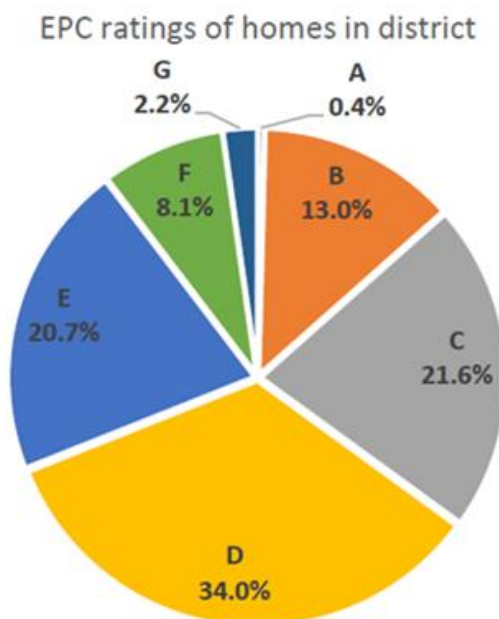


Figure 26 – Energy Performance Certificate rating for FoD homes.

Types of Participations

A range of different forms of participation are possible depending on the option selected.

Table 25 - Forms of participation – ownership of Solar PV.

Option 1 – Community Benefit Society	In this model the PV in the FoD will be owned by a locally controlled community benefit society.
Option 2 – Cooperative (using Big Solar Coop as an example)	In this model the PV will be owned by a national organisation along with PV installations in other parts of the county.
Option 3 – Municipal Bond	In this model the PV will be owned by the council.

Table 26 - Forms of Participation – Governance.

	FoDDC	Community Representatives	Building owners	Energy Users
Option 1 – Community Benefit Society	Could be part of a local board but would have a potential conflict of interest where/if the council is also a landlord (if expecting a rent).	Would need volunteers from the local community to become Directors of local society. As well as volunteers and members.	Contractual 'landlord' relationship with CBS – not directly involved with governance of the organisation.	Contractual 'consumer' relationship with CBS – not directly involved with governance of the organisation.



Option 2 – Cooperative (using Big Solar Coop as an example)	Unlikely to take a decision-making role in the organisation due to its national rather than FoD mandate (also still to have a Conflict of Interest).	Could potentially be directors in a national scheme. Most likely role as local volunteers or members.	Contractual 'landlord' relationship with Big Solar Coop – not directly involved with governance of the organisation.	Contractual 'consumer' relationship with national organisation – not directly involved with governance of the organisation.
Option 3 – Municipal Bond	Owners of the PV	No role for local community in governance	Contractual 'landlord' relationship with other landlords (e.g. schools if using their building for solar PV).	Contractual 'consumer' relationship with Council – not directly involved with governance of the organisation.

Table 27 - Forms of participation – Investment.

	FoDDC	Community Representatives	Building owners	Energy Users
Option 1 – Community Benefit Society	Could provide a loan/grant against agreed terms to support the organisation. Could potentially invest subject to management of Conflict of Interest.	Withdrawable shares – terms set locally including potential for lower investment threshold locally. Could also issue Bonds.	Could potentially invest subject to management of Conflict of Interest.	Could potentially invest subject to management of Conflict of Interest.
Option 2 – Cooperative (using Big Solar Coop as an example)	Withdrawable shares – terms set by Big Solar Coop. Potentially anyone could invest but they would be investing in a portfolio of projects across England (of which, at least one, would be based in the Forest of Dean).			
Option 3 – Municipal Bond	Investment in council led project – therefore council Investment unlikely to be possible or beneficial.	Investment via a fix term bond to the Council for an agreed period and return. Potentially anyone could invest including interested parties from outside of the Forest of Dean. Offer is investors only with all decisions being made by the Council.		



Types of Shares

Shares or Bonds

<https://www.uk.coop/start-new-co-op/start>

Bonds

Bonds are possible in options 1 and 2 and the only form of investment possible in option 3.

A bond is a loan agreement between an individual and an enterprise. Usually, the agreement will be that the enterprise promises to pay interest and to repay the capital to the bondholder on a set date. Bonds do not confer ownership or voting rights. They are a form of debt. Debt has to be repaid according to a pre-agreed schedule and normally carries a pre-arranged interest rate.

Community Shares

Community shares are a type of share capital, unique to co-operative and community benefit societies, that are ideally suited to the needs of community businesses. Community shares in societies are wholly different to share capital in companies, represented by two entirely separate and distinct bodies of corporate legislation; society law and company law.

Societies can issue a form of shares known as withdrawable share capital, which is unique to society law. Withdrawable share capital can be withdrawn from the society, subject to the society's rules and any conditions set out in a share offer document. Most societies have rules that give the board discretionary powers to refuse or suspend withdrawals if it is financially prudent to do so. This means withdrawable share capital is fully at risk. Members could lose some, or all, of the money they invest. But they also have the scope to withdraw some, or all, of their capital when they need it, subject to consent. Unlike with transferable shares, members don't have to find a willing buyer, or negotiate a price for their shares.

Withdrawable share capital places a responsibility on a society to manage its capital prudently. It needs to establish reserves to provide for withdrawals, or to attract new share capital from new or existing members to replace capital that is being withdrawn. Most new societies suspend withdrawals for an initial period, typically three or more years, so that they can build up reserves to finance withdrawals.

Voting rights in a society are normally attached to membership rather than share capital, with most societies adopting the co-operative principle of one-member-one-vote. Investment in share capital can be encouraged by offering a financial return on shares expressed as an interest rate, but the interest rate offered must be the minimum necessary to attract and retain the capital. Profits cannot be distributed in the form of a dividend on share capital.

Most societies choose to have an asset lock, similar to those found in charities and Community Interest Companies, which prevents any residual assets being distributed to members or subscribers in the event of the enterprise being wound-up. This means that members cannot benefit from the sale of the society or its assets.

Society law restricts a member's withdrawable shareholding in a society to £100,000, although this limit does not apply to societies investing in other societies, or to transferable share capital issued by a society. The purpose of this limit is to prevent a society being financially dependent upon members who can afford to invest larger amounts. It is good practice for smaller societies to limit shareholdings even further, to no more than 10% of the total share capital in the society.

Society law is suited to distributed ownership by hundreds, or even thousands, of members. Each member contributes a relatively modest amount of share capital and there is an established mechanism for withdrawing this share capital without the need for a stock market or the sale of the enterprise. Members have a democratic say, but their financial interests are restricted to a modest interest rate on capital and without the scope for capital gain.



Requirements

The requirements for investing in the energy community will be informed by the legal form chosen. We aim to keep the threshold level of investment low to enable many investors to participate. However, this will need to be balanced with the increased administrative cost of having an increased number of investors. Depending on the legal form we pursue, it may also be possible to make the investment threshold lower for those living in the Forest of Dean to incentivise local investment. With many forms of community energy group in the UK, it is possible to withdraw your shares, as described above. These rules around this will also be decided when choosing the legal entity from the forms described above.

Electricity Management

The building we are currently looking at is a school and leisure centre with high day time on-site usage. We are therefore expecting the majority of the electricity produced by the solar pv panels to be consumed on-site and paid for through a Power Purchase Agreement. We will be conducting further analysis of this rooftop and on-site electricity demand before the installation is confirmed. Any electricity that is not consumed on-site (for example during the school holidays) will be exported to the grid and will either be paid for via the export tariff or a Power Purchase Agreement as described previously.

Sustainable Community Management

As with existing energy communities in the UK, the organisation will need to abide by the rules laid out in their articles of association which vary between the different legal entities as described above. This will lay out how the board members are selected and replaced, how annual general meetings are to be run, management of finances etc.

6.5. Mobilization

Engagement process

Our engagement process starts with district wide strategic data evaluation, mapping and research. For the Forest Energy Community Initiative, we have developed an understanding of the district context in which this new project will be adding to, identifying strengths and existing activity. A needs assessment and gap analysis has informed us where the gaps in engagement are and where duplication of effort lies. Throughout the district a range of community-based approaches already exist including renewable energy and other general themed activities and the community animators delivering an ABCD (Asset Based Community Development) approach are from a range of both statutory and voluntary organisations. For example, the 500 kW Community Wind Turbine at St Briavels, commissioned in 2013 and operated by Resilient Energy Great Dunkilns <https://resilientenergy.co.uk/REGD/> and the 500 kW Community Wind Turbine at Alvington, commissioned in 2016 and operated by Resilient Energy Alvington Court Renewables <https://resilientenergy.co.uk/REACR/>

We intend to work collaboratively with existing Community Builders, Community Development Workers and Community Engagement Officers building and using a strength-based approach across the towns and villages of the district. Whilst our first PV power plant will inevitably be based in one single town location, our engagement approach will be to mobilise and empower people and communities from the entire district using a range of key messages with several distinct motivational reasons to take part.

We have recognised that community engagement activity is co-dependent on high quality information, communications, branding and promotion. Press releases, social media posts, the AURORA website and the emerging local website will enable us to engage effectively and share key messages. We will implement a range of engagement fora, for example the FODDC already runs a Planning Engagement Forum where groups, individuals and Town and Parish Councils can



be represented to play a key role in informing and advising the District Council as it continues to develop project plans. A further method of getting informal views from around our district will be focus group sessions and innovation cafés, with co-production and co-creation at the heart of the project. We will utilise online surveys using for example, SurveyMonkey or SmartSurvey, the local website newsletter sign up function will enable citizens to receive regular information and will inform our community of participation activities. Once our social media feeds are up and running, in addition to being key to engaging a wider audience and growing awareness of our project, a culture of welcoming commenting on posts and encouraging people to take part in online polls such as on Facebook will give an additional method for participation.

This will be a good initial start, however our aspiration and expectation is that we will move through the various levels of participation, engaging citizens to achieve co-creation, co-production and as in the example diagram below, community directed.

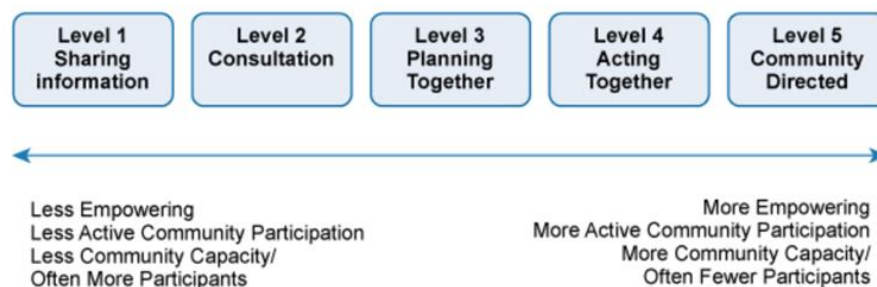


Figure 27 – Various levels of participation.

To move on with this journey towards a community led approach, our engagement plan includes comprehensive face to face engagement, informal conversations to build district wide awareness and public debate about the project. An analysis of key Forest of Dean events has found that engaging with mass audiences can be achieved at many annual events, festivals, fetes and shows. For example, the Forest Showcase Food Festival, Coleford Music Festival, Newent Onion Fayre, the Fiddle Fair in Coleford and a range of small, rural village summer fetes. Our engagement can also take the form of 'roadshow' style engagement at popular leisure and recreational centres and venues such as Forestry England visitor centres at Beechenhurst Lodge, Mallards Pike Lake and Symonds Yat Rock. In addition, pop-up stands at leisure centres and supermarkets in the main town have also been identified as a key activity. In respect of information dissemination and promotion, physical noticeboards at community centres and village halls can be utilised, and news articles can be published in parish and local community magazines both in hard copy and online.

A further feature of our engagement will be to identify key champions and ambassadors and to grow a network beyond the core project staff to engage with the community. Our engagement will include the hundreds of small voluntary and community sector organisations, ranging from community food growing projects, walking groups, lunch groups to craft and knitting groups. In our area we also have a voluntary sector local association which supports community action, called FVAF (Forest Voluntary Action Forum), Community Connectors Networks and Know Your Patch events and a Community Builders Network. In our main towns and in several villages, we have community cafés where engagement activity can take place including Lydney Harbour visitor attraction and community café, being particularly relevant due to its geographical proximity to the proposed PV power plant site at the Leisure Centre in Lydney. Our local district, town and parish councilors also have a key role to play in being ambassadors for this project.

Our engagement work in the first part of the project is intended to be preliminary activity to create the right conditions for the implementation phase of the energy community and the ownership, management and co-ordination of the chosen legal structure for community share offer in our PV power plant. We intend to move beyond the traditional



boundaries of Council led and controlled activities and anticipate our community share offer scheme will be set up with the ownership and decision-making firmly with the community as seen is the illustration below:

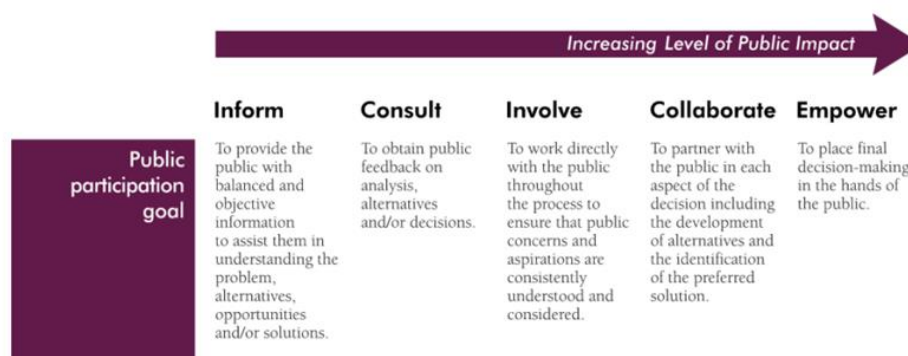


Figure 28 – Public participation goal and its level of public impact.

Sustainability

A key aspect of the project will be to kick start a local energy community. One of the key factors in evaluating the appropriate business model is 'growability' and the ability to develop new initiatives. It is proposed that the business model will have strong links to local Parish, Town and District Councils to ensure integration with community wide plans as well as climate emergency fora such as Forest of Dean Climate Action, Parish Council's Climate Action Group, Existing Local Community Groups (<https://resilientenergy.co.uk/REGD/>) and Severn and Wye Energy Agency.

6.6. Financial Plan

Financing Needed

Whilst detailed costs will not be available until detailed design stage recent experience suggests in the region of £1,200/kW (based on design, legal installation costs). We are aware of significant cost increases in the PV sector together with supply chain delays. In our project planning budget we are therefore allowing for a 25% inflationary/delivery costs and 30% contingency.

Table 28 – Indicative installations costs.

Indicative installation costs	£	€
200kwp installation @ £1200/kWp	£ 240,000	287,395 €
Supply chain and inflation @ 25%	£ 60,000	71,820 €
Contingency @ 30%	£ 90,000	107,730 €
Indicative total cost	£ 390,000	466,945 €

Ongoing management and maintenance costs of both the PVPP and share offer will be financed through share offer and return on investment.



Sources of Funds

The local share offer will be the main source of funding. We are currently exploring opportunities for public sector investment initially, to get the project installed sooner, which is then reduced as the share offer increases.

Identification of Stakeholders

Our stakeholder mapping has revealed a long list of stakeholders and we have grouped stakeholders into themes according to each project component using for example, mind maps. Our lists of stakeholders have been categorised in respect of PV power plant installation, community share offer business structure set up, energy monitoring app usage, and project governance, performance management and grant compliance.

Table 29 – List of stakeholders.

Key Partners	Organisations / Scheme promoters	Individuals / Potential share holders
1. Asset owners 2. Public sector /community services operators	3. Community leaders / Councils 4. Local business 5. Clubs and Societies	6. Local residents 7. Individuals from outside the area

We have also given careful thought to an identification of power and interest, to map stakeholders accordingly to see who are our champions and ambassadors who are valuable assets to the project, who our powerful opponents or 'blockers' may be and who are our potential audiences for developing from a subtle interest to be empowered to be involved in a greater capacity are. We have used the standard stakeholder mapping method as seen below for this purpose.



Figure 29 – Standard stakeholder mapping method used.

We also recognise that as the project develops and evolves, we will need to review and re-assess our stakeholder mapping as new stakeholders come on board in the delivery of the energy community in the Forest of Dean.



Return of Investment

The return on investment for members will be calculated through the financial model. As we are considering a community benefit society or cooperative legal structure, the level of investment must be set at the minimum level needed to attract the investment. We will be hoping to be able to offer a 2-5% return on investment for members.

Exit Strategy

As the Forest of Dean District Council may own the roof space of the solar pv installation, there may be a need for an ongoing relationship which will be set out in the lease agreement. Through this agreement terms will be set about the length of ownership and any transfer of ownership. For example, an asset lock is common for community benefit societies which commonly states that any transfer of assets must be to another community benefit organisation which also has an asset lock. This prevents solar installations being sold to private companies that are not bound to operate for the benefit of the local community.

As for the entity which owns the solar pv, both CSE and FoDDC would aim to work closely with the local people involved in this project, to develop the skills and capacity needed to continue delivering future projects in the Forest of Dean. We would hope that this group would operate independently from the council whilst maintaining a close and supportive relationship.

6.7. Forecast

Revenue

In section 6.6 we have provided a rough estimated cost of installation of £390,000.

The majority of the revenue will be generated by selling electricity to the building occupiers at an agreed price through a Power Purchase Agreement, or similar. Additional revenue may be generated from electricity which is not consumed onsite by collecting the export tariff or arranging an additional Power Purchase agreement. The unit cost for electricity will be negotiated through each Power Purchase Agreement.

Expenses

The expenses for this project may include:

- Insurance for the panels
- Cost of ongoing management of the community organisation, community shares, finances and accounting requirements
- Ongoing operations, depreciation and maintenance costs



6.8. Timeline

We are currently working to this estimated timeline

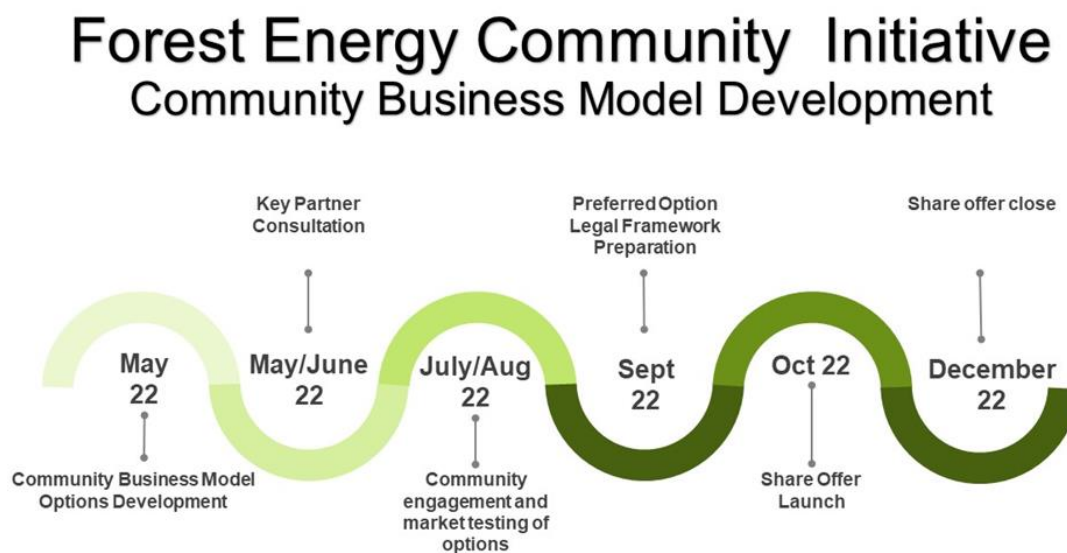


Figure 30 – Timeline for the FoDDC demo site.

6.9. SWOT Analysis

Table 30 – SWOT Analysis – Example Model 1.

Comparative SWOT analysis	
Example Model 1 - Forst of Dean Community Energy (Community Benefit Society)	
Strengths	Opportunities
<ul style="list-style-type: none"> • High levels of community leadership • Legal vehicle for potential further projects • Potential for CBF for community (although likely to be small given size of project) • Local ownership and control 	<ul style="list-style-type: none"> • Council could retain more control on the CBS as a custodian trustee*. • Could set a lower minimum level of investment for people living locally.
Weaknesses	Threats
<ul style="list-style-type: none"> • Requires additional administration (establishment and running of CBS). 	<ul style="list-style-type: none"> • Local people need to be willing and skilled to be directors of CBS. • Within timeframe of Aurora. • Need deliver aurora solar pv project.

*Custodian Trustee – has the power of veto.



Table 31 – SWOT Analysis – Example Model 2.

Comparative SWOT analysis	
Example models 2: Forest of Dean- Big Solar Coop ‘node’	
Strengths	Opportunities
<ul style="list-style-type: none"> • No need to set-up and administer a new legal entity • Experience of Sharenergy. • Shared responsibility for fundraising with Big Solar Coop. • Potential for training/support from Big Solar Coop. • Potentially less risk for investors – as investment as investment would be in portfolio of assets. 	<ul style="list-style-type: none"> • To train volunteers to identify latent potential for solar on the Forest of Dean community, commercial and public buildings. • Buy-back option after 5 years (at cost). • To localise the model – establish FoD node.
Weaknesses	Threats
<ul style="list-style-type: none"> • Exclusive focus on roof top solar. • No potential for community benefit fund. 	<ul style="list-style-type: none"> • No local governance and control – national model. • Set-up by an external actor.

Table 32 – SWOT Analysis – Example Model 3.

Comparative SWOT analysis	
Example Model 3 Forest of Dean Community Municipal Bond	
Strengths	Opportunities
<ul style="list-style-type: none"> • Time limited option – no ongoing cost or responsibilities. • Council maintains full control and ownership. 	<ul style="list-style-type: none"> • Develop a larger portfolio of projects for investment. • Raise the profile of the FoD council's climate emergency response
Weaknesses	Threats
<ul style="list-style-type: none"> • Limited opportunities for community leadership. • Limited local capacity development (outside of council). • One-off fundraising activity. 	<ul style="list-style-type: none"> • May be harder to attract investment than for a community-led initiative. • Relatively few examples of council's having done this at present – though many thinking about it, including Cotswolds. • Perception challenge? Shouldn't the council be doing this anyway?



6.10. Risks

Identification of Risks

Identification of risks is an ongoing process which we will continue to add to throughout the project delivery and added to the risk mitigation strategy below.

Risk Mitigation Strategy

Table 33 – Identification of risks and corresponding mitigation strategies.

Category	Risk	Likelihood rating	Impact rating	Mitigation actions
Technical	Grid connection capacity limits development size	3	2	Check with DNO, following site identification. Though if most generation is to be consumed on site impact is not likely to be significant
	Installed system/ equipment doesn't perform as expected	2	2	There might be two different things here. Equipment – warranties, guarantees. Performance – is always going to be subject to weather etc. Modelling will need to allow for some variations but solar is fairly well understood so should be quite accurate.
	Equipment supply risk: delays/unable to source as specified	4	4	Current UK market conditions would suggest this is highly likely Need to begin the tendering process and engagement with potential contractors in parallel with the dev of the organisation funding model.
Financial	Business model does not identify a viable project on selected building	3	4	Until further detailed work is done this remains a possibility and the impact would be significant. Keep under review at each stage.
	Insufficient return to attract investment	2	2	A significant proportion of investors are expected to be motivated for environmental reason and not just return on investment.
	Inability to pay return on shares	2	3	Detailed financial advice will be sort throughout business model development.



Building owners	Building owners/ occupiers decide not to go ahead with project	2	4	There are a range of properties in the project area owned by many public bodies and the Council is a project partner. Therefore, it is likely that an appropriate building(s) can be found.
	Building owner decides to proceed with project without community involvement	2	4	There are a range of properties in the project area owned by many public bodies and the Council is a project partner. Therefore, it is likely that an appropriate building(s) can be found.
	Lack of understanding/ time to understand legal agreements needed for project	3	4	This is a complex area and as soon as there is a preferred business model option. Detailed professional advice will be needed to draw up legal agreements.
	Change of building owner	1	2	Any agreements in place would transfer with buildings. There is some risk of this happening before legal agreements are in place, but overall considered low.
Installers	Unable to secure installers/	3	3	There is high demand for installers currently. We will commence procurement as soon as possible using established procurement processes
	Installer goes out of business	1	5	Through established procurement processes we will ensure due diligence of preferred supplier to minimise risk.
	Installation doesn't meet required standard	1	3	Use of external verifier to assess standard together with warranties will minimise risk.
Community	Objections from local residents	1	2	Considered unlikely and will be a consideration in building choice.
	Lack of interest in roles which are essential to run a community energy project	3	4	This could be a challenge. Stakeholder involvement in designing the business model will reduce likelihood of this happening



	Lack of ability/interest in investing	2	2	A significant proportion of investors are expected to be motivated for environmental reason and not just return on investment.
Organisation	Lack of skills or time to manage development project	2	3	Aurora project funding assists with the development of the project. Lead organisations are established and have skills/resources to support the project development
	Skills & knowledge concentrated in single person	2	2	Lead organisations are established and have skills/resources to support the project development. Project groups and shared file management ensure risks are reduced.
	Unable to keep up with regulation/policy changes affecting project	1	3	Projects leads are well connected to renewable industry and no changes are expected

6.11. Conclusion

The assessment indicates there is a viable option to deliver a community energy investment vehicle in the FOD. It is essential, to get the best offer with the highest chance of quick implementation, to undertake stakeholder engagement to develop a preferred investment vehicle. This may take some additional time initially but ultimately is expected to lead to a more successful energy community.

The co or added benefits around establishing a Community Energy Group which could develop further into new projects after Aurora is a real possibility and with a long-lasting impacts. Whilst one solution may deliver the project as proposed it is important to consider using the project to establish a longer lasting energy community. So, whilst one financial solution, such as the investment bond, could deliver the project the potential for long term benefits are not as significant as that utilising a community benefit society model.

It remains a challenging environment with energy price crisis, inflationary and supply pressures to obtain the investment necessary and deliver a PV power plant. It can be expected that individuals will have an increased interest in investing in their own energy efficiency rather than a community carbon reduction project. Through examining some of the local demographics we propose an additional project offer around reducing energy price risk to community services. Whilst no location has been set for the power plant as yet we propose that a key deciding factor to location will be the ability of the powerplant to support local community services such as schools, leisure or health care. In this way the project can provide an additional offer of supporting local services by reducing their risk to energy price rises.



7. Conclusion

Though there has been much debate on the subject, a bottom-up approach involving the common citizens is vital to combat climate change and to succeed in meeting the European Union's ambitious objectives of decarbonization and energy transition. The AURORA project intends to develop and implement an upgraded local community, as a local energy community. Five demonstrators were selected, and to this end, five business models were presented. These business models were developed in order to comply with the countries' legislation, national social-economic context and target citizens group, resulting in different approaches to reach a similar goal: to create and deploy a sustainable local energy community for a larger lifetime than the AURORA project encompasses. Although some difficulties arose along the development of these business models, regarding the specific national legislation compliance and acceptance by the Universities/county administration, solutions were found to meet the original goals, as proposed and defined in the AURORA proposal.

The development of five different demonstrators with different solutions and business models will maximize the demonstrative potential of local energy communities, strengthen links between them at a European level and lay the foundations for the exploitation, dissemination and replication phase to upgrade existing European communities up to true renewable energy communities with zero-emission citizens.

