Design of a Cookbook to Boost Energy Community Deployment Across Europe

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I declare that this document is an original work of my own authorship and that it fulfills all the requirements of the Code of Conduct and Good Practices of the Universidade de Lisboa.

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Abstract

Energy communities are gaining popularity as a strategy to support the energy transition by allowing citizens to take an active role in shaping their energy future by promoting local ownership, collective decision-making, and mutual benefit. Every energy community is different and must be designed to serve the needs of said community. On top of this customizable quality, the convoluted regulations across the European Member States render the creation of citizen-led ECs rather challenging. A literature review of the state-of-the-art tool repositories and one-stop-shops was carried out; concluding that there is a lack of interactive tools and resources that guide the user through each step of the process. Most one-stop-shops tend to list resources, failing to provide the user with a clear direction on what they should be doing and in what order. This paper presents the methodology to create a Cookbook, or roadmap, to help users at any stage in the EC creation process progress by providing them with user-friendly, interactive, and relevant tools. This was accomplished by conducting an extensive search to leverage existing tools and catalog them according to the applicable step. Missing steps will be developed by the project team. Once launched, this tool will facilitate the complex process to create an EC throughout the EU.

Keywords: Energy community, one-stop-shop, technical assistance

Abstract

As comunidades de energia estão a ganhar popularidade como estratégia de apoio à transição energética, permitindo que os cidadãos assumam um papel activo na definição do seu futuro energético, promovendo a apropriação local, a tomada de decisões colectivas e o benefício mútuo. Cada comunidade energética é diferente e deve ser concebida para servir as necessidades dessa comunidade. Para além desta qualidade personalizável, a regulamentação complexa dos Estados-Membros europeus torna a criação de CEs lideradas pelos cidadãos um desafio. Foi efectuada uma revisão bibliográfica sobre os repositórios de ferramentas e balcões únicos mais avançados, concluindo que há falta de ferramentas e recursos interactivos que orientem o utilizador em cada etapa do processo. A maioria dos one-stop-shops tende a listar recursos, não fornecendo ao utilizador uma orientação clara sobre o que deve fazer e em que ordem. Este documento apresenta a metodologia para criar um livro de receitas, ou roteiro, para ajudar os utilizadores em qualquer fase do processo de criação de CE a progredir, fornecendo-lhes ferramentas fáceis de utilizar, interactivas e relevantes. Isto foi conseguido através de uma pesquisa exaustiva para aproveitar as ferramentas existentes e catalogá-las de acordo com a etapa aplicável. As etapas em falta serão desenvolvidas pela equipa do projecto. Uma vez lançada, esta ferramenta facilitará o complexo processo de criação de um CE em toda a UE.

Palavras-chave:: Comunidade da energia, balcão único, assistência técnica

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List of Abbreviations

CEC Citizen Energy Community

DSO Distribution Service Operator

EC Energy Community

ECP Energy Community Platform

ECR Energy Community Repository

EU European Union

IEMD Internal Electricity Market Directive

KPI Key Performance Indicator

NPV Net present value

OM Operation & Maintenance

OSS One-Stop-Shop

PPA power purchase agreement

PV photovoltaic

p2p Peer-to-peer

REC Renewable Energy Community

RED II Renewable Energy Directive Recast

ROI Return on Investment

TAO Technical Assistance Office

TWh terawatt-hour

1 Introduction

1.1 Context and Justification of Study

This study aims to promote energy community (EC) deployment across the European Union (EU) by developing a "Cookbook", or a roadmap, for project promoters to use to overcome common barriers. There are currently more than 9000 active EC initiatives across Europe [1]. The European Commission defines two different legal constructs of ECs.

The Renewable Energy Directive (RED II) defines a **renewable energy community** (REC) as an autonomous legal entity based on open and voluntary participation effectively controlled by shareholders or members located in the proximity of the renewable energy project owned by the legal entity. The primary purpose is to provide environmental, economic, or social community benefits rather than financial profits [2].

The Internal Electricity Market Directive (IEMD) defines a **citizen energy community**(CEC) as a legal entity based on voluntary participation controlled by shareholders with the purpose to provide environmental, economic, or social community benefits rather than financial profits. With the main difference between the two types being that CECs may engage in a wider variety of energy services including: generation, distribution, supply, consumption, aggregation, energy storage, and energy efficiency services for their members [3]. Energy generation from CECs does not have to come from renewable sources, and the key members are not required to live within a certain proximity of the project.

The European Commission is encouraging the implementation of ECs to continue decentralizing the EU energy systems with the Clean Energy for all Europeans package along with the RED II and IEMD [4]. With these directives, the EU encourages the removal of national regulatory barriers. The efficiency and enthusiasm of the RED II transposition varies significantly across the Member States, this will be discussed later on.

Apart from regulatory hindrances, the development of an EC can be a confusing and overwhelming process due to the bottom-up nature. Community members and project promoters are not necessarily technical nor legal experts making certain steps of this process particularly difficult. A plethora of resources and tools exist but they are often rendered irrelevant or useless due to the specific country and type of project for which the resource was designed.

1.2 Problem and Research Objectives

Problem Statement: Many resources including guides, one-stop-shops (OSS), tools, and case studies exist to facilitate the deployment of energy communities across the EU. While these resources are helpful, they fail to provide a simplified, universal method to take the project promoters from start to finish. There is a need for an all-encompassing, user-friendly toolkit to help projects navigate from the formation of a group to the construction of the actual energy community.

To address this need, the following research objectives were defined to identify the features this tool must incorporate to ensure a user-friendly interface with meaningful content (for *every* user) spanning the entire life cycle of an EC.

Research Objectives

1. Extract best practices from past EC-related projects and incorporate these in the Cookbook.
2. Catalog existing tools useful at any step in the EC creation process.
3. Develop a toolkit to streamline the process of establishing an EC (EU-wide).
4. Brainstorm and implement innovative ways to add value and differentiate this toolkit from existing ones.

1.3 Structure of Thesis

This document provides an overview of energy communities' role in the energy transition and a description of the EU-funded LIFE-BECKON project (Section 2). Briefly, the BECKON project aims to promote energy communities in the EU by developing three different support mechanisms (a Cookbook, a capacity building program, and a one-stop-shop). Then, a literature review highlights the best practices and shortcomings of past EC-related projects to account for when designing the tool (Section 3). Next, the proposed solution is described in more detail with the methodology followed and the final results (Section 4). Then, wireframes of the tool are presented to illustrate the user interface and functionalities (Section 5). Finally, the paper concludes with an impact assessment, limitations, and next steps (Sections 6 & 7).

2 Energy Transition and Conceptual Framework

2.1 The Energy Transition

In 2015, the United Nations Member States adopted 17 sustainable energy goals with the intention to eradicate poverty, reduce inequalities, and restore the earth by 2030. Sustainable development goal 7 aims to ensure access to affordable, reliable, sustainable and modern energy [5]. Even though the global electricity access rate and global share of renewables in the final energy consumption are steadily rising, bottom-up initiatives are necessary to improve energy literacy effectively meet this goal at a community level.

Energy communities are democratically owned, by principle. This attribute drives transparent energy bills and contracts, enabling informed decision-making regarding when to consume (dynamic pricing) [4]. Historically, shareholders in energy communities do not expect the same degree of returns as typical investors, allowing more flexibility for financial schemes [6]. Energy communities also support local economies, increase social acceptance, and help reduce energy poverty.

This democratization boosts the local economy with community energy projects typically generating 2-8 times more local revenue than a project run by an external party [7]. Local projects are often more concerned with supplying energy at a fair price and stimulating the local economy [7]. Community energy achieves this by creating local jobs, taking advantage of the local supply chain, reducing energy bills, and helping money stay in the community. It strengthens communities, reduces energy poverty and enables people to cut their energy consumption. These benefits reduce potential local opposition to new renewable energy projects.

Local ownership of energy communities have shown to substantially improve social acceptance of renewable energy projects; causing an increase in deployed capacity and a decrease in cost [6]. A German case study showed that 60% of the interviewees held a negative stance towards wind turbines without local participation, compared to only 12% in the presence of local participation [6].

Energy poverty is also a pertinent issue affecting up to 25% of Europeans [7]. Energy poverty is defined as the inadequate access to energy services due to the combination of low household incomes and high energy expenses. A commonly used metric to determine energy poverty is if 10% of the total household income is spent on energy expenses, however, this percentage

can vary [8]. Under recent energy efficiency directives, Member States must give priority to the energy impoverished in their renovation strategies [4].

Energy communities can aid the energy impoverished by initiating social programs to deliver cheap energy to vulnerable households. The RED II directive declares that RECs provide opportunities to address energy poverty by helping to reduce consumption and by charging lower tariffs, however they do not supply any direction on how to implement these measures [2]. In a study of 71 energy communities only 35% offer lower tariffs than the market price, 41% offer energy efficiency services, and 27% offer lower share prices and membership fees for people experiencing energy poverty [9]. This is a result of the delay and inefficiency of the transposition of RED II into Member State's national energy and climate plans. Thus far, only Portugal, Spain, Italy, and Greece highlight RECs ability to address energy poverty [9].

A pioneering study at CE Delft determined that half of EU citizens – including local communities, schools and hospitals – could be producing their own renewable electricity by 2050, meeting 45% of the EU's energy demand [10]. With the electrification of the transport and heating sector, electricity demand will jump in the coming years. This study estimated by 2050, over 1500 TWh will be produced by households, energy collectives, small enterprises, and public entities. Eighty-three percent of EU households will contribute as energy citizens by producing renewable energy, providing demand services, or supplying energy storage [10]. This study was conducted assuming the national grid, DSOs, local markets, policy and regulatory frameworks continue developing at a pace to facilitate the wide-scale deployment of community energy. The LIFE-BECKON project aims to make this a reality by removing common barriers and smoothing the EC creation process.

2.2 RED II Transposition

Regarding energy communities, the Renewable Energy Directive recast (RED II) intends to remove regulatory and market barriers preventing widespread deployment of ECs throughout the EU. The primary purpose is to level the playing field for ECs by labeling them as non-commercial actors and enabling them to participate in the energy market [11]. This deadline for transposition into national law was mid-2021, but full implementation is still ongoing.

The COME-RES project facilitated this transposition process in the nine partner countries, noting that significant progress had been made regarding transposing definitions, rights, and

market activities but still lacked enabling frameworks (as of 2022) [12]. Their experience with their partner countries provided significant findings regarding governmental actions to be taken.

Governments need to be strict to ensure a full transposition including the enabling framework. Additionally, the RED II mandates that Member States assess the barriers and the potential for the development of RECs in their country. This information should inform the framework to maximize its efficacy. The RED II also implores that RECs be made accessible to all consumers, especially those experiencing energy poverty [2]. It encourages national and regional governments to establish advisory services or one-stop-shops [2]. The LIFE-BECKON project seeks to develop a One-Stop-Shop facilitating this framework to boost EC deployment.

2.3 BECKON as a Framework for Implementation

Simply stated, the project consists of developing various tools and platforms to foster initiatives from start to finish, all over the EU. The first, and primary focus of this paper, is the Energy Community Cookbook. The Cookbook will highlight the key steps and provide tools to bring an energy community from the ideation to the operational phase. This Cookbook will be as simple and efficient as possible to streamline the research process.

The Cookbook will be featured on the virtual One-Stop-Shop (OSS). Along with the Cookbook, the OSS will offer a database of tools, a matchmaking service to connect project promoters to investors, and training opportunities. The OSS will then form a part of the Technical Assistance Office (TAO). The TAO is a physical office that provides custom capacity building programs to kick-start EC deployment in that region, on top of general advising services.

By the end of the project and subsequent 5-year upscaling period, LIFE-BECKON expects to have incited investments exceeding 38 M€, to have saved 20 GWh/year of primary energy, to have added 12 GWh/year of renewable energy generation, and to have reduced greenhouse gas emissions by 4,500 tCO2/year [13].

Energy communities bring many benefits to local communities while simultaneously helping them decarbonize. However, due to an ever-changing legal environment across EU Member States, and the technologically complex nature of energy communities, deployment has been

relatively slow. Through this combination of services and tools that span different levels of interactivity, the LIFE-BECKON project will address and supply solutions to common obstacles felt by ECs in the EU. This framework will be deployed in three pilot TAOs: Sofia, Bulgaria; Copenhagen, Denmark; and Ávila, Spain. These sites were chosen because they represent different geographic conditions (rural/urban), different levels of market maturity, different regulatory environments, and different levels of citizen engagement.

Figure 1: Organization of BECKON Project

3 Literature Review: Common Barriers and Best Practices when Implementing Energy Communities

More than twenty key energy community initiatives in the European EC ecosystem were scrutinized for barriers and best practices. This in an imperative first step to ensure the successful creation of the One-Stop-Shop by employing advice and avoiding common pitfalls of similar previous projects. The most ubiquitous barriers were found to be low user engagement, low level of knowledge, and lacking regulatory frameworks.

These projects were chosen by searching the EU Cordis website for "energy community", "self-consumption", and "one-stop-shop". The Horizon 2020 interactive map was also used to identify projects of interest [13]. The objective, barriers faced, lessons learned, and engagement strategy were recorded for each project. This information was extracted by interviewing key project partners and combing through publicly available deliverables.

3.1 Description of Barriers

The different types of barriers were categorized as technical barriers, financial barriers, and participatory and user engagement barriers.

3.1.1 Technical Barriers

Distribution System Operator (DSO) Involvement: Most EC projects must interact with the local DSO some way or another. ECs are not profitable for the DSO, yet their cooperation is integral to the project. Multiple EU projects have faced issues addressing the complexity concerns of the DSO highlighted in Table 1.

Data Collection: Privacy concerns and improper installation and communication with the data provider can hinder the effective operation of an EC. Specific cases and best practices are listed in Table 2.

Table 1: Best Practices to overcome DSO barriers.

Project	Description	Barriers / Best Practices
UPSTAIRS	Creates flexible business models for OSS to facilitate EC creation	ECs are not cost effective for DSOs. They require more support.
MUSEGRIDS	Intertwines electricity and gas networks with mobility and community networks to create a Multi Utilities Smart Grid.	Experienced problems regarding a smooth interconnection of various networks due to a lack of regulation of grid coupling technologies. **Best Practice:** Assess local grid capabilities before project start, and include the DSO from the beginning.
REACT	Aims to achieve energy independence in island communities.	**Best Practice:** develop a minimum viable product to assess DSO capabilities. Include them from the beginning.

Table 2: Best Practices to overcome Data Collection barriers.

Project	Description	Barriers / Best Practices
HESTIA	Develops models and tools for demand response services.	**Best Practice:** to circumvent delays in data collection, use synthesized data in the meantime.
REACT	Aims to achieve energy independence in island communities.	**Best Practice:** To address energy consumption data concerns, be straightforward and upfront about how the data will be used and stored.

3.1.2 Financial and Operational Barriers

Market: The immaturity or lack of a market integrating and catering equally to each stakeholder causes miscommunications regarding responsibilities and cost bearing. Table 3 shows some examples of this.

Table 3: Best Practices to overcome Market barriers.

Project	Description	Barriers / Best Practices
Renaissance	Develops a bottom-up method to implement new business models for clean technologies on the community scale.	**Best Practice:** to mediate stakeholder objectives, use the Multi-Actor Multi-Criteria Analysis or a similar tool.
eNeuron	Develops tools to optimize multi-carrier energy systems	Experienced governance barriers such as: what party manages the Energy Hub and what party covers the investment. Multi carrier systems naturally involve many stakeholders (natural gas DSO, electricity DSO, and district heating and cooling).
IElectrix	Enables the connection of ECs to the grid by solving technical issues (peak load, voltage deviation, etc)	Customers must bear grid expansions costs, discouraging them to become active in the energy transition. Technical successes are not celebrated by the community.
REACT	Aims to achieve energy independence in island communities.	Experienced difficulties identifying the best business model even after modeling multiple value propositions due to the large number of stakeholders.

3.1.3 Participatory and User Engagement Barriers

Low engagement level: A lack of awareness and therefore motivation, has kept citizens stagnant as passive consumers. Table 4 shows how projects overcame this challenge.

Table 4: Best Practices to overcome low engagement.

Project	Description	Barriers / Best Practices
LIGHTNESS	Engages stakeholders, provides regulatory guidelines, and evaluates CEC benefits using digital twins.	**Best Practice:** from the beginning create the solution with community input and employ a feedback loop. Engagement strategies should be developed by experts in social science.
LocalRES	Develops tools to design and optimize the management of local energy systems.	**Best Practice:** Use evidence-based guidelines (collected statistics) to form engagement strategies (ie. At what time can local representatives participate?).
REACT	Aims to achieve energy independence in island communities.	People were skeptical and thought they project was selling a service, general public wariness towards the project. **Best Practice:** Use the municipality as a middleman. Be clear and realistic with outcomes to garner trust. Split recruiting into phases to capitalize on word of mouth.
UPSTAIRS	Creates flexible business models for OSS to facilitate EC creation	**Best Practice:** Create a sense of community amongst those joining the initiative to enhance participation.

Level of Knowledge: A low level of knowledge goes hand in hand with a low level of engagement. Many people unfamiliar with energy sharing were naturally opposed to the idea. Some examples of this are shown in Table 5.

3.1.4 Best Practices Learned from EU Projects

These valuable experiences from past projects accentuate which aspects of EC development must be addressed in the Cookbook. The Cookbook highlights DSO involvment from the initiation of the project. Stakeholder involvement strategies and tools are provided to ease controllable market barriers. Active engagement techniques are provided to include the local community throughout the entire process. The Cookbook provides very specific educational materials, but the OSS will host a Training Hub to help promote energy literacy in the public

Table 5: Best Practices to overcome low level of knowledge of given technologies.

Project	Description	Barriers / Best Practices
BECoop	Online platform for bioenergy tools and guides.	BECoop pilots in Poland and Greece reported low regulation and awareness of the benefits of bioenergy.
REACT	Aims to achieve energy independence in island communities.	Low smart grid familiarity in island communities, resulting in low willingness to provide flexibility services. **Best Practice:** Be sensitive to the demographic of the people and highlight financial, environmental, and community benefits.
CREATORS	Accelerates and supports initiatives throughout the lifecycle of an EC.	**Best Practice:** CREATORS offers a CES- as-a-Service (CESaaS) to support initiatives across all stages of an EC to help fill knowledge gaps.

and fill knowledge gaps.

3.2 Existing Database Analysis

Widely used databases were analyzed to note any areas of improvement and identify potential synergies between the established databases and BECKON's Cookbook. The goal is to provide the users with a very easy to use resource to guide them through their energy community journey. Industry-leading databases were analyzed below to help narrow the vision BECKON's Cookbook and One-Stop-Shop.

3.2.1 Energy Community Platform (ECP)

Description: The Energy Community Platform received funding from a variety of EU projects [14]. When visiting the website the user is asked to log in or sign up for free. Then, the user is asked to take the placement test to determine the stage of the EC. Once the stage of the EC is known, the user is directed to the tools corresponding to that stage. The

ECP is home to over one hundred tools. There is also a map of ECs in the EU and a list of experts and their contact information.

Capabilities/Features: The placement test is very valuable to help a user identify which steps they have yet to complete and helps tailor tools to their needs. The tools can be filtered by stage (inspiration, preparation, implementation, and operation), type of support (political, technical, financial, etc), EC activity (solar, storage, mobility, etc), language, and country.

Areas of Improvement: Many of the tools are labeled under two or three different stages, making it difficult to discern when each tool should be used. The ECP is also lacking a structure within each phase to guide the user. It also does not provide an equal level of depth and resources for each country so certain countries are left with only the dense general European reports. These long reports require the user to navigate to a different web page, download a report, and search for the desired information.

3.2.2 Energy Community Repository

Description: The Energy Community Repository is the EU's primary website for EC support [15]. It offers four different kinds of support: technical assistance, a toolbox, EU projects and initiatives, and One-Stop-Shops.

Capabilities/Features: Contingent on a successful application, the technical assistance offers direct assistance from experts on feasibility studies, business plans, developing a financing plan, etc. They also offer capacity building programs and peer-to-peer exchange. The toolbox offers 114 tools that can be filtered by subject or country, or searched by keywords. The EU Initiatives tab directs the user to relevant resources and ongoing projects. The One-stop-shops tab lists other platforms that could be of use to the user (including the previously mentioned Energy Community Platform). The Energy Community Repository also continually updates a map of all the ongoing Energy Community efforts in Europe. This year (2023), they expect to publish a tool compiling the existing legal frameworks and policies throughout the EU.

Areas of Improvement: As the name suggests, the ECR is a large collection of tools. The user must know exactly what they are looking for and then has to do a lot of work to find what resource will serve their purpose.

3.2.3 REScoop

Description: REScoop is a network of 1900 energy cooperatives with the goal to promote energy democracy and foster information sharing across energy cooperatives in Europe [16]. REScoop tracks the legal frameworks and national support schemes for RECs. They also have published various useful guides to help educate people on how to start an EC and gather interest in their community. It also offers several free online courses to help get an initiative off the ground.

Capabilities/Features: REScoop offers a variety of types support including community coaching, organizational development, advocacy, financing services, and a toolbox. The toolbox has over 140 tools and can be filtered by activities, audience, project, and the type of tool (report, video, tool, etc).

Areas of Improvement: The tools can not be filtered by country or language. There is no way to self-assess the status of the EC online.

3.2.4 Smart Cities Marketplace

Description: The Smart Cities Marketplace is found on the European Commission website with the purpose to catalyze the green transition in European cities.

Capabilities/Features: The marketplace has a matchmaking and a community forum for projects to find investors and provide a space for discussions amongst projects and experts.

Areas of Improvement: This website does not have many concrete tools to help with each stage of the EC design. The EC project already be developed to some degree to make use of this website.

3.2.5 Key Takeaways

After reviewing the existing platforms, it was determined that the placement test feature of the ECP substantially benefited the user to orient their actions. The tools in the BECKON OSS will also be divided into various phases, but these phases will not overlap like the ones in the ECP so the usefulness of the tool is not degraded. These phases will be broken down into individual steps to recommend more specific tools. The ECR would be more useful if

it could be filtered by language, country, stage, and specific step; these improvements will be made in the Cookbook. A matchmaking hub will be included to help with financing and other technical questions. The current organization methods of these resources requires the user to spend time sorting through reports and irrelevant tools. The Cookbook improve upon this by extracting information from the long, tedious reports, or the report will be cut down to solely pertinent information. The BECKON Cookbook aims to provide a more interactive guide rather than just a repository of tools (which it will also produce), to present a simple roadmap from the initial idea to the operation and maintenance of the community. There is no existing tool that can draw a straightforward step-by-step blueprint of how to found and run an energy community.

4 Cookbook Design Methodology and Implementation

The objective of the Cookbook is to provide energy community initiatives all over the EU with an efficient, user-friendly, interactive roadmap to guide them through every step of the process. To make the BECKON project more manageable, the Cookbook is tailored to ECs powered by solar photovoltaic (PV) generation. This allows the Cookbook to specialize in one technology thereby providing more specific tools while still maintaining applicability to the majority of EC initiatives. Unique to all other EC platforms, the Cookbook will include a feature to input information as the user moves along the roadmap. This information will be used to automatically generate documents that could be presented to potential investors or stakeholders. The following methodology was used to begin the development of the Cookbook.

1. Define the universal steps to create a PV-powered Energy Community for both the PV plant and the legal entity (financial, legal, participatory, etc). These steps were based on previous successful projects throughout Europe.

2. Assess existing resources that could be of use. Over 200 tools, documents, and resources were cataloged into a database to later be categorized by where they would be most applicable. These tools were sourced from a variety of established databases including the Energy Community Repository, the Energy Community Platform, Compile, Modelos SueloSolar, amongst others.

3. Link the tools to the corresponding step.

4. Perform a gap analysis to identify which steps are lacking tools.

5. Write a quick quiz to assess the stage of the initiative based on the milestones. This was inspired by the Energy Community Platform quiz.

6. Build the wireframe for the Cookbook (see Section 5). This was done using Miro.

The Cookbook development is considered finished when all steps for all EU countries have tools to allow the user to effectively accomplish each step.

4.1 Define the Steps

Firstly, the action steps to create an Energy Community were divided into two separate initiatives: establishing the EC as a legal entity (this entails more administrative tasks like legal, regulatory, and financial work), and the construction of the PV installation (more technically focused). Specific steps were outlined for each of these categories to be performed in parallel. To ensure both processes progress in tandem, the steps are grouped into four different stages: Initiation, Design, Implementation, and Operation. Fig.2 shows the basic tasks to accomplish at each stage for both the technical and administrative workflows. These steps will be explained further in the results section below.

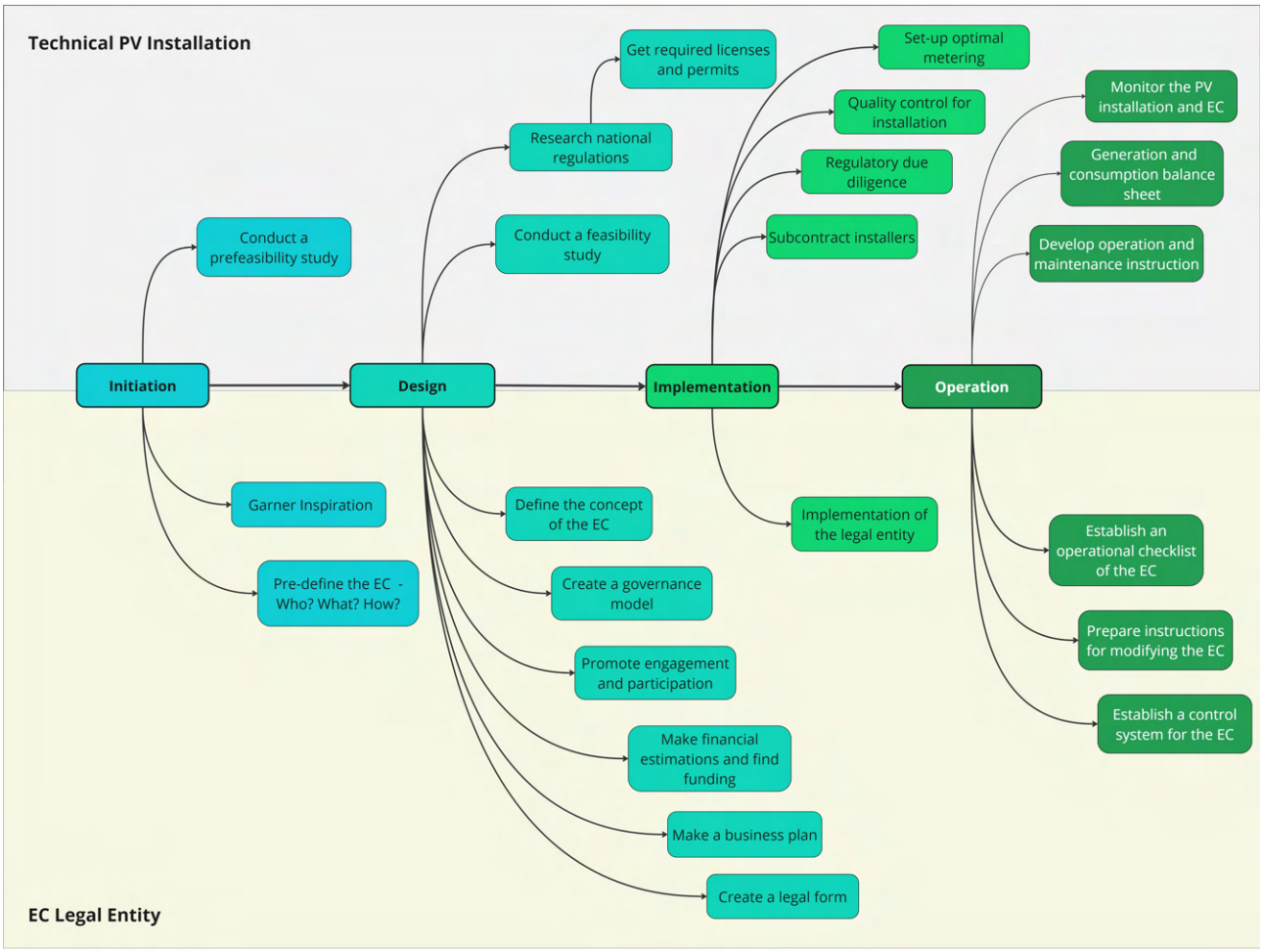
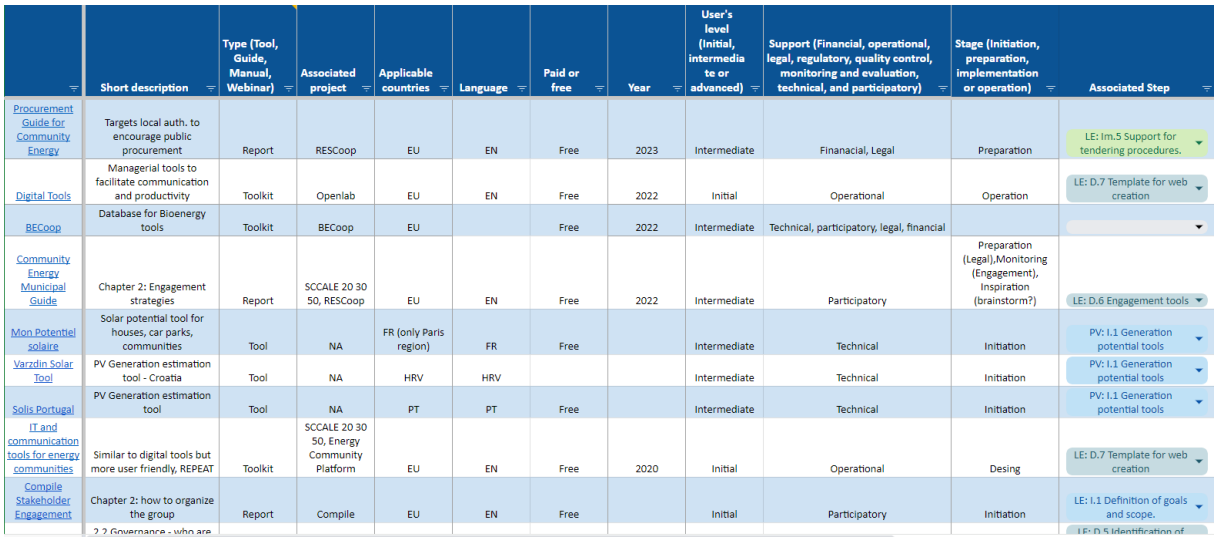


Figure 2: Steps for the technical PV installation (top) and to create the legal entity (bottom) throughout all four stages of EC development.

4.2 Assess Existing Resources and Bibliography Creation

Over 200 existing resources were assessed primarily but not exclusively from the EU Energy Community Repository, Energy Community Platform, Compile Project, and Modelos Suelo Solar. These resources will feed a large database of useful resources for users to browse a more extensive list of tools, featured on the Knowledge Hub of the OSS. This bibliography is not restricted to the previously defined steps. It will catalog all tools and resources that are handy for any stakeholder at any stage of the EC creation process. There are also tools available for individuals wanting to assess the energy efficiency of their home or install PV panels apart not involved in an EC. The bibliography will provide a description of the tool, the language, the applicable countries, date of last update and what type of support it offers. Tools and interactive resources were emphasized and prioritized over long, cumbersome reports. In the reports included, specific key chapters are noted to reduce the searching time for the user.

Fig.3 shows how the bibliography is set up. It lists the link to the tool, a short description explaining the contents and any particular chapters of interest, the type of tool (tool, guide, manual, webinar, etc.), the applicable countries, the language, if it is free, the type of support it provides (financial, operational, legal, regulatory, technical, etc.), and in what stage of EC development it is most useful. As of now it holds over 100 resources and will continue growing throughout the project.



	Short description	Type (Tool, Guide, Manual, Webinar)	Associated project	Applicable countries	Language	Paid or free	Year	User's level (Initial, intermediate or advanced)	Support (Financial, operational, legal, regulatory, quality control, monitoring and evaluation, technical, and participatory)	Stage (Initiation, preparation, implementation or operation)	Associated Step
Procurement Guide for Community Energy	Targets local auth. to encourage public procurement	Report	RESCoop	EU	EN	Free	2023	Intermediate	Financial, Legal	Preparation	LE: Im.5 Support for tendering procedures.
Digital Tools	Managerial tools to facilitate communication and productivity	Toolkit	Openlab	EU	EN	Free	2022	Initial	Operational	Operation	LE: D.7 Template for web creation
BECoop	Database for Bioenergy tools	Toolkit	BECoop	EU		Free	2022	Intermediate	Technical, participatory, legal, financial		
Community Energy Municipal Guide	Chapter 2: Engagement strategies	Report	SCCALE 20 30 50, RESCoop	EU	EN	Free	2022	Intermediate	Participatory	Preparation (Legal),Monitoring (Engagement), Inspiration (brainstorm?)	LE: D.6 Engagement tools
Mon Potentiel solaire	Solar potential tool for houses, car parks, communities	Tool	NA	FR (only Paris region)	FR	Free		Intermediate	Technical	Initiation	PV: I.1 Generation potential tools
Varzdin Solar Tool	PV Generation estimation tool - Croatia	Tool	NA	HRV	HRV			Intermediate	Technical	Initiation	PV: I.1 Generation potential tools
Solis Portugal	PV Generation estimation tool	Tool	NA	PT	PT	Free		Intermediate	Technical	Initiation	PV: I.1 Generation potential tools
IT and communication tools for energy communities	Similar to digital tools but more user friendly, REPEAT	Toolkit	SCCALE 20 30 50, Energy Community Platform	EU	EN	Free	2020	Initial	Operational	Desing	LE: D.7 Template for web creation
Compile Stakeholder Engagement	Chapter 2: how to organize the group	Report	Compile	EU	EN	Free		Initial	Participatory	Initiation	LE: I.1 Definition of goals and scope.
	2.2 Governance - who are										LE: D.5 Identification of

Figure 3: Screenshot of the Bibliography structure.

4.3 Assign to Steps and Gap Analysis.

After all the steps of the Cookbook were defined, the resources were categorized into each associated step. Each step was classified as having existing tools that serve the purpose, having existing tools that must be modified meet the needs of the step, or missing. The missing tools were noted and sent to all the project partners in an effort to locate existing tools as quickly as possible. In the case of nonexistent tools, the BECKON team will develop them. Some of the missing tools are less interactive and entirely depend on the location of the EC: for example, various templates, grid and regulatory checks, and legal framework assessments. The results section gives examples of existing tools and highlights which steps were lacking resources.

For the more region-specific tools, priority will be given Spain, Bulgaria, and Denmark (the pilot site locations), but the finished product will include resources for all EU Member States.

4.4 Results

In this section, the results of the Cookbook design are presented by defining and justifying each step in the Cookbook, describing the existing tools or the tools to be developed. The first section focuses on the technical steps to install the PV system and the second section addresses the administrative steps to create the legal entity.

4.4.1 PV Installation

Initiation: In the initiation phase, a prefeasibilty and feasibility study will be conducted to thoroughly flesh out the idea.

- **Conduct a prefeasibility study**. The initiation phase starts with a prefeasibility study to screen many potential solutions with the objective to identify the solution(s) best-aligned with the group's priorities. Key outcomes for each potential solution are whether the project is financially viable, if there are any insurmountable regulatory obstacles, what are the expected social and environmental impacts, and what are the associated risks [17].
  - **Estimate generation potential and consumption**. The balance of generation

and consumption is critical to sizing the PV system. The number of households interested in forming a part of the energy community shapes the consumption estimation which helps determine the size the PV system.

To help the user complete this step, tools to assess solar generation potential are linked here along with tools to estimate the consumption of the community for a given number of households connected. It is also important to assess the rooftop potential as the generation potential does not take into account which rooftops would be available for use [7]. While there are universal tools to estimate solar generation, there are many tools targeted to specific countries that are also linked here. These will only appear if they are applicable to the user's country.

- **Assess existing energy infrastructure.** In this step, it is recommended to contact the local DSO to understand how they can cooperate. The Clean Energy Package has made it possible for ECs to become DSOs or manage the network in their area of operation [18]. This is still relatively rare, but can incentivize private investments in the grid [18]. The more common option is to collaborate with the local DSO. Before making any investments in the distribution system, it is necessary to ensure the DSO can adequately integrate the EC. The REDII and IEMD directives explicitly emphasize that DSOs must cooperate to facilitate EC deployment [2][3]. Including the DSO from the beginning can be mutually beneficial with a smooth integration to the energy system in exchange for valuable flexibility services. This step does not demand any tools, but some background information could be useful to better guide the conversation with the DSO.

Design: In this stage, a feasibility study is carried out along with permitting and regulatory due diligence to prepare for implementation.

- **Conduct a feasibility study.** The project promoters will delve deeper into the most attractive outcome(s) from the prefeasibility study. The project starts to take shape in this stage. Specific resources are provided to dimension the PV system, balance the generation and consumption, and run a techno-economic analysis.
  - **Define expected key performance indicators (KPIs).** At this stage, the group should come together to agree upon their goals and expected KPIs. Examples of some common KPIs are investment, return on investment (ROI), prosumer profitability, community self-sufficiency, and grid impact [19]. At this step, a template to calculate common indicators like required investment, savings, and ROI

is attached to help determine the most attractive option from the prefeasibility study.

  - **Dimension technological selection.** With a list of available rooftops or space to install PV panels and an understanding of the grid constraints (peak power) the system can be designed. For this stage, the COMPILE ValueTool dimensions the PV system with the rooftop and location data for every building in the EC. However, this is only applicable to a few EU countries. For initiatives in other countries, a universally applicable Excel spreadsheet is available.
  - **Techno-economic analysis**. The techno-economic analysis provides a financial model for the proposed project specifications and is necessary to inform decisions. The National Renewable Energy Lab's (NREL) System Adviosry Model (SAM) tool is free and can run real-time simulations for all different types of technologies [20]. The high level of detail of this tool may be challenging for some less-experienced users. There are also a variety of Excel sheets and other programs that achieve this in a more user-friendly way at the cost of less detailed results.

- **License and permitting support.** Once the feasibility study is complete, the project must obtain the necessary licenses and permits to enable construction. At this step, the tool links various templates to obtain the required permitting for the installation. There are currently only templates for Spain. By the time this tool is published, there should be information for all EU Member States with a priority given to Bulgaria and Denmark. Most countries have their own processes in their own languages, making it particularly difficult to track down these tools; especially in countries where renewable energy adoption is low.

- **Supplementary Information.** For promoters lacking expertise in self-consumption regulation, the national regulatory framework is valuable knowledge to have. In the Cookbook, the regulatory status is summarized for each Member State. This information is extracted from long documents making it more manageable for the user.

Implementation: This stage will provide an overarching checklist to ensure the PV system is installed properly and legally.

- **Subcontract Installers.** As the project is approaching the construction phase, the EC will have to subcontract project installers. The Matchmaking platform on the OSS

can help locate trusted installers in that area. The Cookbook, however, provides a template to smooth the process of subcontracting installers. This template is under development by the BECKON team.

- **Quality control of installation process.** As all activities within a legal entity, it is imperative to establish a quality control strategy to ensure the safe and proper installation of the PV system. This quality control guideline will be created by the BECKON team.

- **Set-up optimal metering infrastructure.** The metering infrastructure in an EC is critical to guarantee a proper peer-to-peer(p2p) exchange and accurate self-consumption data. A tool to support the metering infrastructure has yet to be found. It may look like providing the user with educational material on the required capabilities of a household meter and the interaction with the control system.

Operation:

- **Operation and maintenance (O&M) instructions.** O&M is integral to ensure the EC runs smoothly and maximizes the lifespan of the PV system equipment. Attached to this step is a paper guiding the creation of and O&M strategy and a best practice guide for O&M of PV installations. The paper helps the user understand the different types of maintenance and decide whether they want to outsource it to a third party.

- **Generation and Consumption balance sheet.** During operation, it is necessary to know how much energy the community (and an individual) is producing versus consuming. This informs demand-response and flexibility services actions. The COMPILE project designed Compilot, a tool, to visualize consumption and generation data from a community to a household resolution. This allows the optimization of the energy bills for the entire community.

- **Monitoring of the PV installation and EC.** Monitoring the system allows the optimal operation mode. The EU Compile project produced a variety of technical tools to monitor the EC in terms of flexibility, stability, and security [21]. Self-consumption in the community (GridRule) and household energy usage should be optimized (HomeRule). These tools ensure the most financially and technologically efficient system management.

4.4.2 Legal Entity

Initiation: In the initiation phase of more administrative tasks, the team will discuss the questions: who, what, where, and why to better define the idea. These answers are fluid, but are necessary to talk about from the beginning to give the project direction. At this phase, communication within the group and with the public is very important.

- **Inspire.** Opinions towards renewable energy projects vary by country. To raise participation and spread enthusiasm across stakeholders, the team should educate themselves, and subsequently the public, on successful projects in their country and vocalize the benefits of such a project. Other than case studies, this step will also link the City Stories podcast and motivating webinars and videos.
- **Draft a business model.**
  - **Predefine initial goals, scope, and activities.** To start the journey to become a legal EC, the members should have an open discussion to align everyone's values and motivation for participating in the initiative. Since ECs are democratically operated, it is imperative to achieve a common understanding early on in the project. The Compile Stakeholder guide provides good discussion points to kick off the conversation [22].
  - **Pre-identify potential participants and main stakeholders.** Once the goals are broadly defined, the potentially interested members should be noted to grow the team. In order to spread awareness and excitement, tools and strategies to engage the public are given here. Additionally, stakeholders can have a significant impact on the value chain of the project. Various tools to map out the potential stakeholders are available in the Cookbook. One of these tools is an "Actor Tree" (Fig.4) to help narrow down exactly who the stakeholders are and which ones are worth spending more effort on [22]. These stakeholders are constantly changing so it is a good idea to update it once and awhile to make sure the right people are involved in the projects. Many tools like Fig.4 exist on paper, but would be much more useful to the user in a digital form. This is one of many examples of the existing tools that need a bit of effort to turn them into a useful resource.
  - **Pre-identify consumers and potential generation sites.** At this point, it is a good idea to investigate how many people are interested to refine the energy demand estimation. It is also a good way to evaluate how much rooftop space is

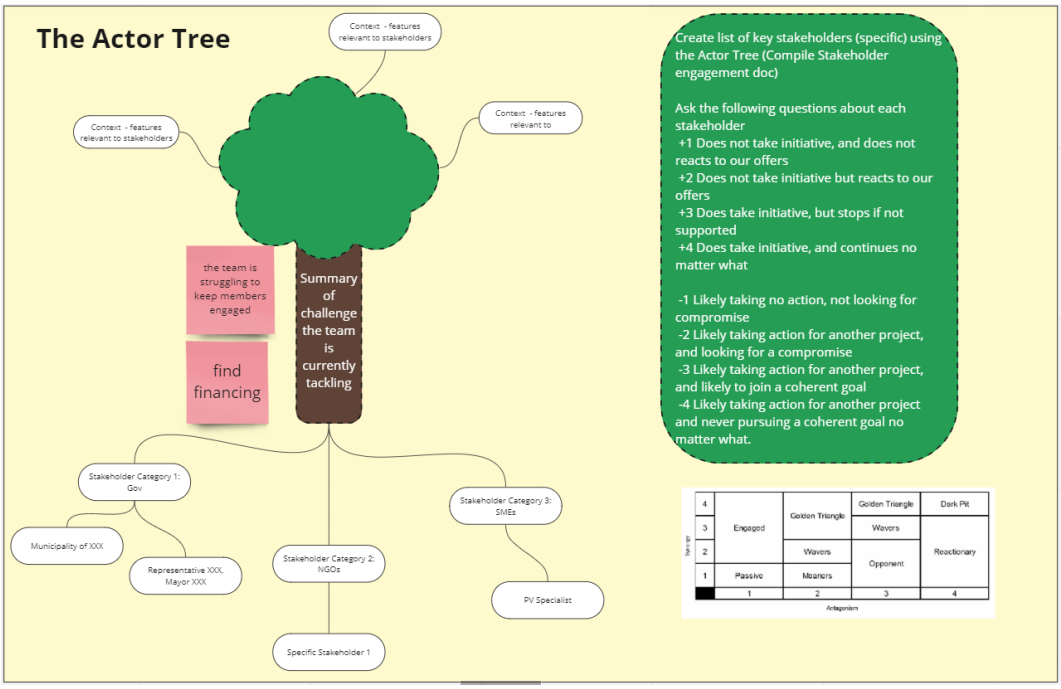


Figure 4: Digitization of Actor Tree stakeholder activity from [22].

currently available. If there is not enough residential rooftop space, other public rooftops or land can be investigated. The best way to accomplish this is still being discussed.

– **Evaluation of strengths and weaknesses.** Before starting the design stage, it is important to understand the environment and context of the project. A PESTEL (political, economic, social, technological, environmental, legal) analysis can help pinpoint external forces affecting the project [22]. Insights gained from the PESTEL analysis can feed into a SWOT (strength, weakness, opportunity, threat) analysis to thoroughly flesh out all of the market forces acting on the project [22].

Design:

- **Define the concept of the EC.** At this point, the users have a better idea of what their project will look like and must delegate roles and responsibilities to key participants.

  – **Define goal, scope, and purpose.** Upon entering the design phase, the previously defined goals, scope, and purpose should be revisited amongst the commu-

nity members. The Future Radar tool is an activity designed by Climate-KIC to roadmap the discrete actions required to reach a given goal [23].

  - **Identification of key actors and their roles and responsibilities.** The Compile Stakeholder Engagement Guide provides steps to identify the responsibilities and how to assign these to active members. Some of the main responsibilities mentioned are: project management, financing, administration /coordination, and communication [22].

- **Create a legal entity.** To legalize the EC, the team must choose a type of legal entity for their initiative. This decision is influenced by the foreseen actions and goals of the EC as well as the legal context in the respective country.

  - **Decide legal form.** Energy communities can take the legal form of an association, a cooperative, a partnership, a non-profit organisation or a small or medium-sized enterprise. Although it should be noted that certain countries promote specific types of legal entities for ECs. The BECKON team will develop a legal entity decision tool to help the user decide which type would be the best fit given the previously stated goals.

  - **Supplementary info: Legal context of ECs in each country.** In case the user wants to know more, an excerpt summarizing the legal context in each country will be available. Currently there is information pertaining to the transposition of the REDII and which legal forms are favored in most EU Member States.

- **Establish a governance model.** The governance model is critical to the democratic operation of the project.

  - **Write the statutes.** Once the legal entity is chosen, the statutes should be written with the help of a lawyer. This step will provide the user with instructions and templates to guide the process. Currently, there are templates available for each type of entity in Spain. The Cookbook will also link the user to the OSS Matchmaking platform if the user is in need of a lawyer.

  - **Guidelines for development of organizational process and institutional structure.** The governance structure should embody the 7 main principles of a cooperative being: 1 - open and voluntary membership, 2 -democratic member control, 3 - member economic participation, 4 - autonomy and independence, 5 - education, training and information, 6 - cooperation between cooperatives, and

7 - concern for community [24]. The Cookbook provides guides to implement a high-functioning governance structure.

- **Engagement and Participatory Processes.** Throughout the design phases, it is important to start engaging both the internal team, and the public in the project.
  - **Website creation.** To post progress updates and make announcements, the project needs a website. The Cookbook will provide a template to simplify the website creation. This is currently under development.
  - **Engage the team.** Reflecting the democratic core of an EC, the group should adopt participatory design processes to promote co-creation. The Cookbook will provide various best practices to achieve this.
  - **Engage the public.** This step goes hand in hand with the website creation. To gain new participants and support, it is important to communicate successes with the public. This can take the form of a website, newsletters, outreach events, etc. ECs are also a powerful channel to improve energy literacy in the local community to make people more aware of their energy habits and advise them on how to improve [7].
- **Financial Estimations.**
  - **Financial tool to estimate costs of the project and for each participant.** As the PV system is being designed, it is possible to estimate the total cost of the project and how much this will translate to for each individual participant. The CSOP calculator developed by the SCORE project can estimate the finances based on the number of households and the amount of money each house is willing to contribute to the project [25]. This tool takes the roof area, inflation rate, operational costs, and interest rate into account to calculate the loan and loan repayment period.
  - **Cost-benefit analysis based on current energy supply contracts and present/future opportunities.** The different contractual opportunities must be considered to determine the best fit for the project. The first option is a typical generation and supply contract including power purchase agreements (PPAs) and wholesale markets. The second option is collective investments in generation installations meaning consumers pay a fee to be part of an EC (usually with a PPA in place). The final option is collective self-consumption where electricity is sold to other community members [1]. A tool to compare these contractual

options does not currently exist. The BECKON team will develop a cost-benefit analysis tool.

  - **Economic and financial modelling.** For investors and key stakeholders, it is key to understand when they will receive a return on their investment. A detailed excel sheet is provided in the Cookbook. It makes more precise estimates on the amortization period and net present value (NPV) based on the initial investment needed, the income from electricity sales, loans, inflation, and taxes. This tool is in Spanish and will need to be translated. A small instruction to how the excel sheet works would be useful to the user.
  - **Identify financing sources for the EC and PV installation.** To aid the project find funding opportunities, the Cookbook offers excerpts for particular countries explaining ongoing initiatives. It also directs them to ECrowd!, a platform to publish projects to find funding. Additionally, the OSS Matchmaking platform allows the advertisement of projects to look for funding.

- **Finalize business plan.** From the past actions, the users have already completed the components of a business plan in a piece-wise manner. Here the user can find a template to put their business plan together, or they can generate the document automatically if they have uploaded their information to the platform.

- **Control.**

  - **Carry out a risk assessment.** A risk assessment is necessary to be aware of what could potentially occur to threaten the project. A template is attached here to weight the probability of an action with the severity. This tool will be embedded in the Cookbook with an existing example to help the team brainstorm specific risks for their initiative.
  - **Develop a monitoring and evaluation plan.** The BECKON team will develop a template to guide the creation of a monitoring and evaluation plan.

Implementation: The Implementation phase consists of administrative tasks like signing documents and developing procedures.

- **Implementation of the legal entity.**

  - **Sign the statutes.** Since the statutes were written in the last phase, now they need to be revised and signed. There is no tool for this step.

- **Sign the Founding Act.**(what is this called in English?). The Founding Act template will be uploaded to the Cookbook. Currently there is one for Spain, the BECKON team will need to look for or create templates for the other countries.
- **Develop tendering procedure.** The user needs support to launch a tender for the PV project. The Cookbook has a guide on which actors to engage, but is missing interactive, custom help.
- **Map of approved suppliers.** The BECKON team will develop a team of suppliers across the EU to help users find trustworthy sources. This will also be available on the Matchmaking platform of the OSS.

Operation: Most of the steps in the Operation phase are still under development by the BECKON team. These tasks are specific to the energy community and to the location.

- **Operation of the EC.**
  - **Operational checklist.** The users will be provided a preventative maintenance checklist and
  - **Financial balance sheet for income and expenditures.** The EC will need to keep track of their monthly income and expenditures. The BECKON team will create user-friendly Excel sheet tailored to ECs.
  - **Template to update the sharing coefficient.** The sharing coefficient represents the amount of energy a certain household will receive from the PV installation. This coefficient is fixed but can be updated to meet the consumers needs. To do this, the BECKON team will develop a template to change the coefficient.
- **Modification of the EC.** The Cookbook will provide the initiative with instructions for specific situations that occur when operating an EC. For example, the entrance of new participants or exit of existing participants requires a modification to the sharing coefficient. Instructions to expand the installation and terminate the EC will also be included. The BECKON team will create guidelines for these situations.
- **Control.**
  - **Quality control checklist for operation of an EC.** Quality control is a key activity to any business operation. This exact checklist will be developed from the best practices reported by successful EC projects.

- **Develop an Internal Monitoring Plan to track specific indicators.** A monitoring and evaluation plan is critical to keep the EC running smoothly. Some examples of indicators to track could be performance monitoring, data collection, dissemination methods.
- **Guide to perform an EC audit.** An EC audit should be performed every once in awhile to enhance both the technical and contractual maturity of the project. Maybe it would make more sense for the EC to expand the PV installation. Changing the contract could also benefit the community more than the current one. This guide will be developed by the BECKON team.

4.5 Placement Quiz

After the steps were defined, a placement quiz was written based off the main milestones from both the PV Installation process and the Legal Entity creation process. This idea came from the Energy Community Platform. Their quiz informs the user the stage of the initiative to filter their tools. The Cookbook tool goes one step further to check off the steps the user has already completed. Table 6 lists the milestones that must be completed in each stage for both the PV installation and the legal entity. The quiz starts by asking the location of the EC and if it is on an island to adequately filter the tools. The next User Experience section will delve into the how this quiz will work in practice.

Table 6: Milestones addressed in checklist

Stage	PV Installation	Legal Entity
Initiation	A pre-feasibility study has been conducted. A feasibility study has been conducted.	A group has been formed. A pre-business model has been created.
Design	A producer license is necessary and has been obtained. The project plan has been finalized.	The concept of the EC has been defined. A governance model has been created. A legal entity type has been chosen. The statutes have been written. A financial plan exists.
Implementation	A contractor has been signed. Construction has started. Construction has finished.	The statutes have been signed. The EC has been registered.
Operation	Has a control plan. A maintenance program is set up. New projects are in development.	Procedures have been developed for the modification of the EC. The governance structure is diverse. Has contributed the fundraising of other projects.

5 User Experience

Apart from the developing the back-end logic, the Cookbook must be developed from the user's perspective. Learning from past EC guide and OSS initiatives, the vision for this tool is a straightforward, easy to use roadmap. The intention is to avoid bulky reports and provide the user with exactly what they need without having to search for it. Interactive tools will be given priority over papers, assuming they provide equal value.

The BECKON Cookbook differentiates itself from other EC platforms by offering the capability to automatically generate useful documents for the user by inputting their progress as they work through the Cookbook. These documents would be a vision document to present to investors, a stakeholder mapping document, and finally, a business plan. No other existing tool provides this service to the user. Contrarily, if the user does not want to make use of this function, they can continue completing the steps without inputting their results.

To operate this Cookbook, the user will log in and be asked to take a placement quiz if it is their first time. This placement quiz will check off actions already completed. It is recommended that the phases are completed chronologically (initiation, design, implementation, operation), however, the steps in these sections can be completed in any order. Some steps will ask the user to input information to make use of the document generation function, but this is not mandatory.

5.1 Take the Quiz

The user will first be introduced to the Cookbook with a landing page shown in Fig.5. They will then be asked to complete a questionnaire to evaluate the status of the EC and filter the tools based on the location. This survey informs the Cookbook which steps the EC has already completed and therefore, should hide.

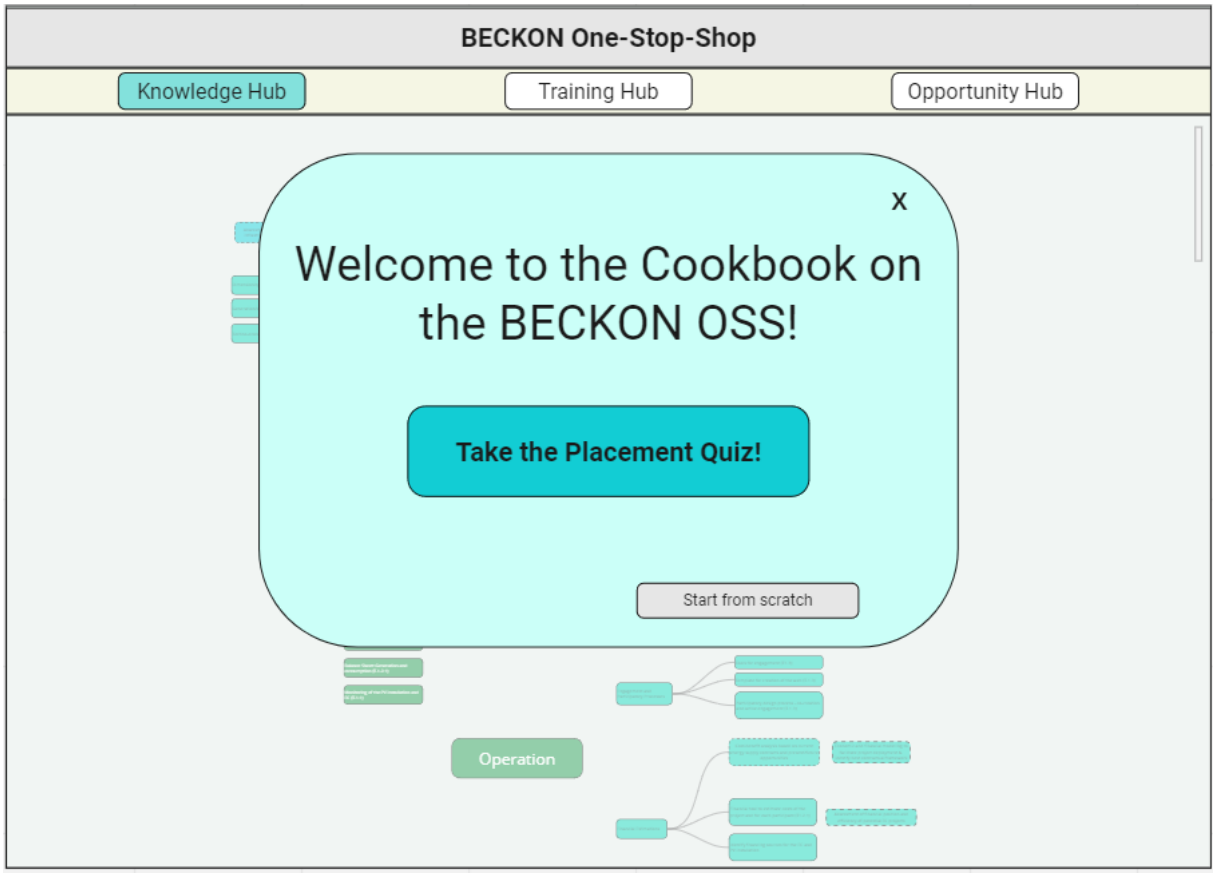


Figure 5: Wireframe for the splash page of the Cookbook.

If the user chooses not to take the placement quiz, or is starting a project from scratch, they will be directed to the entire Cookbook, illustrated in Fig.6.

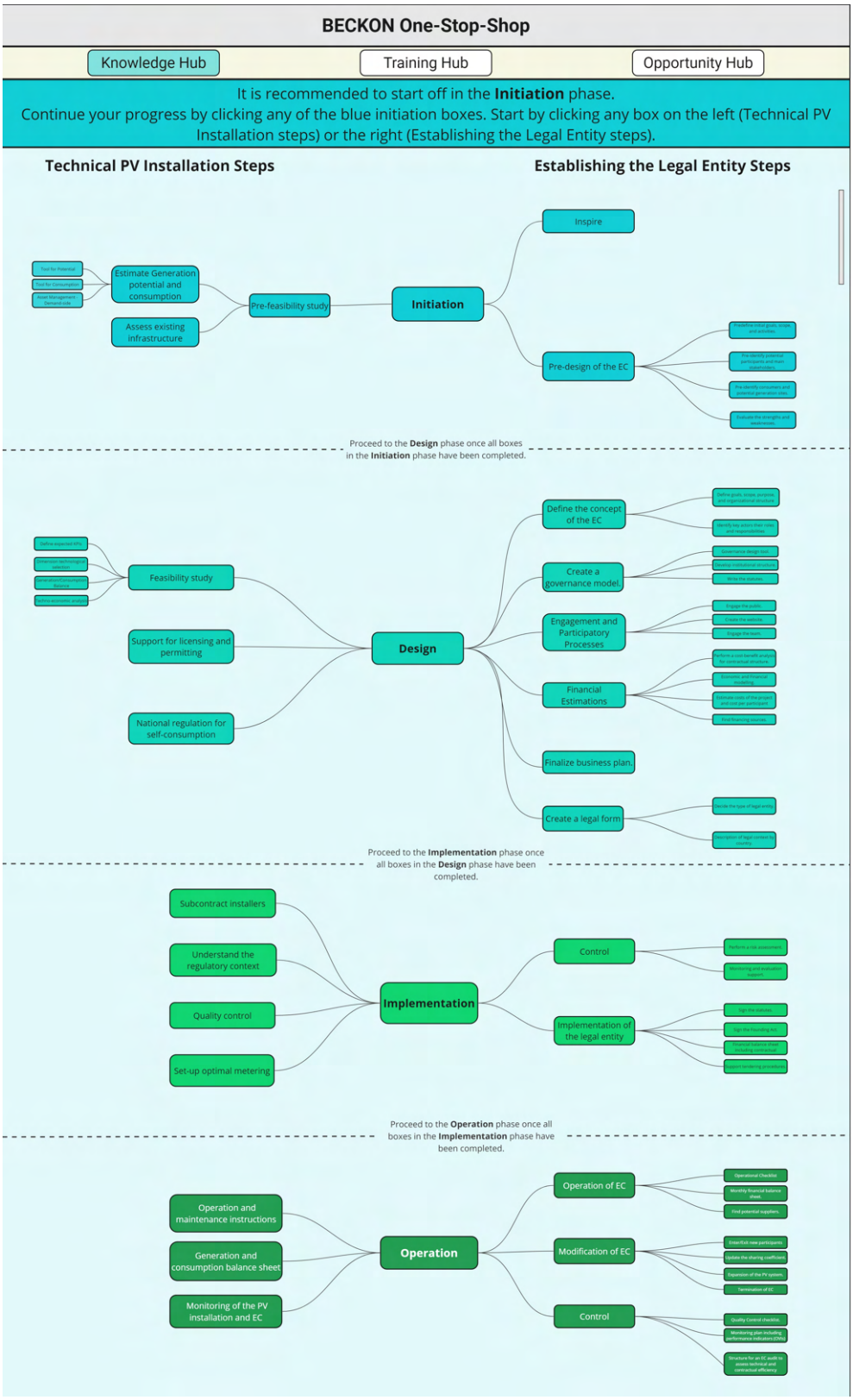


Figure 6: Entire Cookbook structure.

If they choose to take the placement quiz, the recommended option, they will see a window pop up, shown in Fig.7. This quiz is structured to ask a few main questions to place the user in the proper stage. The logic behind the quiz aims to minimize the questions the user has to answer. When the user indicates that they are in a certain stage, for example, that are in progress of registering the EC, they will be asked a series of more detailed questions to pinpoint what steps they need to complete. In total, a bank of approximately 20 questions based on the milestones listed in Table 6 compose the quiz, although most users will only answer a few questions.

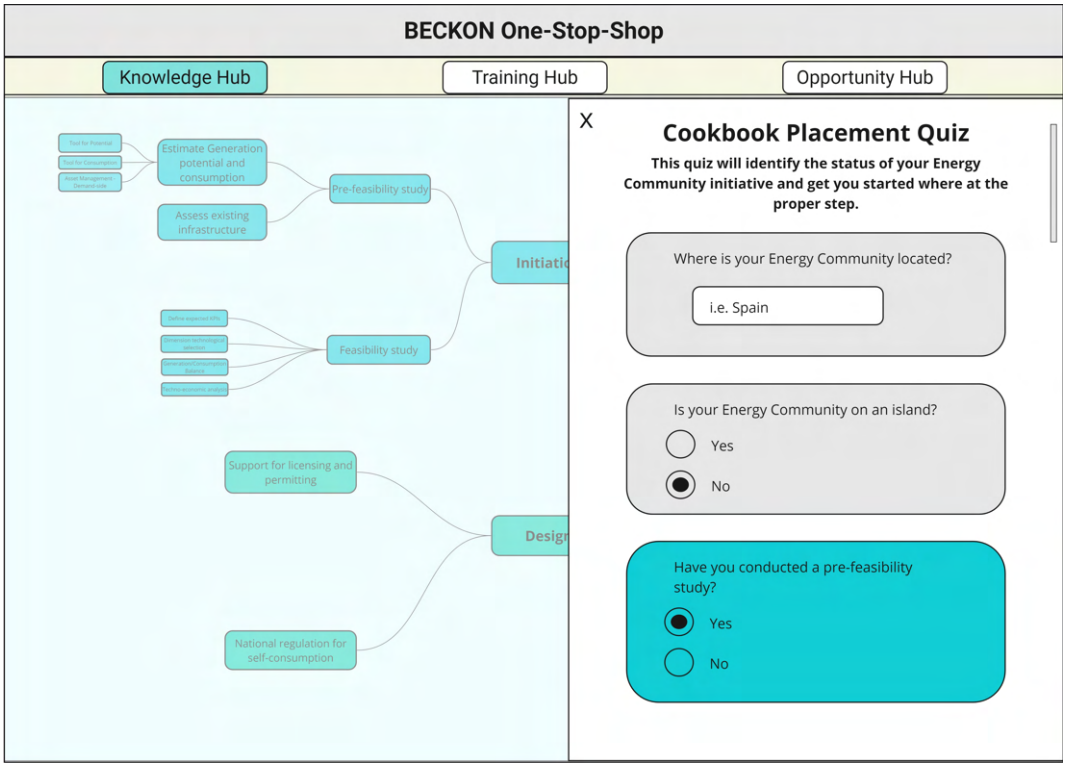


Figure 7: Placement quiz to determine the status of the EC. This quiz will cover all of the milestones referenced in the "Placement Quiz" section above.

After these questions are answered, the user will be directed to their personalized roadmap, see Fig.8. The completed steps will be shown in gray, however, the users can access the tools and materials associated with completed steps. It is recommended to complete all of the steps in the current stage before proceeding to the next one.

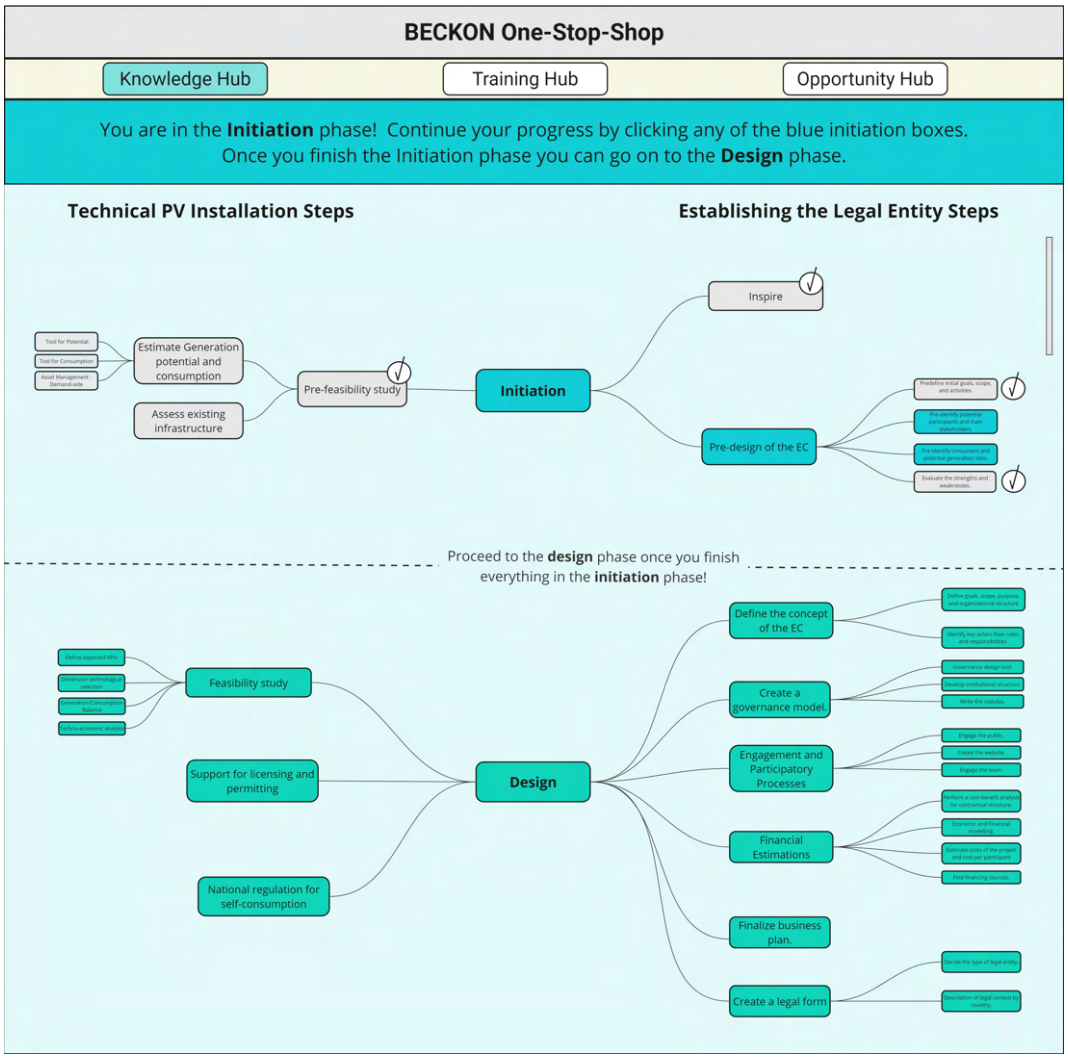
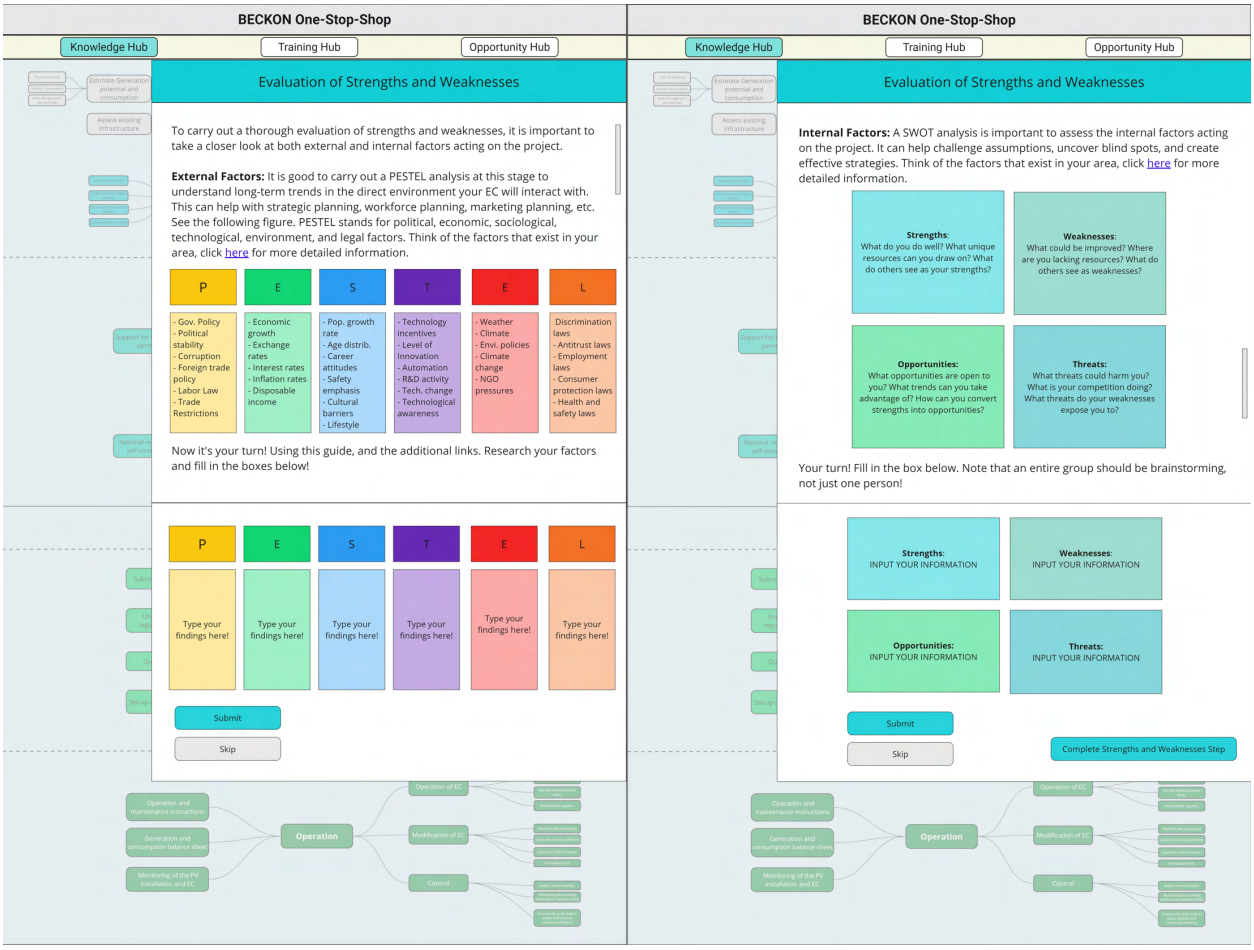


Figure 8: Sample results from the placement quiz.

5.2 Start the Journey

Once the project is placed in the appropriate stage, they can begin completing steps. The steps are split with the Technical PV Installation steps on the left side and the Legal Entity Creation steps on the right side. If the user clicks on a certain step, a window will appear with

the associated tools and resources. Fig.9 illustrates the user's view of the tools associated with the step "Evaluation of Strengths and Weaknesses". The user will first see a brief explanation of why the tool is important with additional links if the user wants to learn more. Then the tool structure is shown with examples, followed by textboxes for the user to input their own answers. This information is stored to later be used to generate specific documents. Fig.10 and Fig.11 show larger images of the strengths and weakness tools to improve the legibility of the content. Some steps are more interactive than others. The steps will be made as interactive as possible with this feature included to store information.



(a) External factors - PESTEL analysis. *(b) Internal factors - SWOT analysis.*

Figure 9: The resources associated with the Legal Entity: Evaluation of Strengths and Weaknesses step. Once both activities are completed, the user can submit their information and continue to another step.

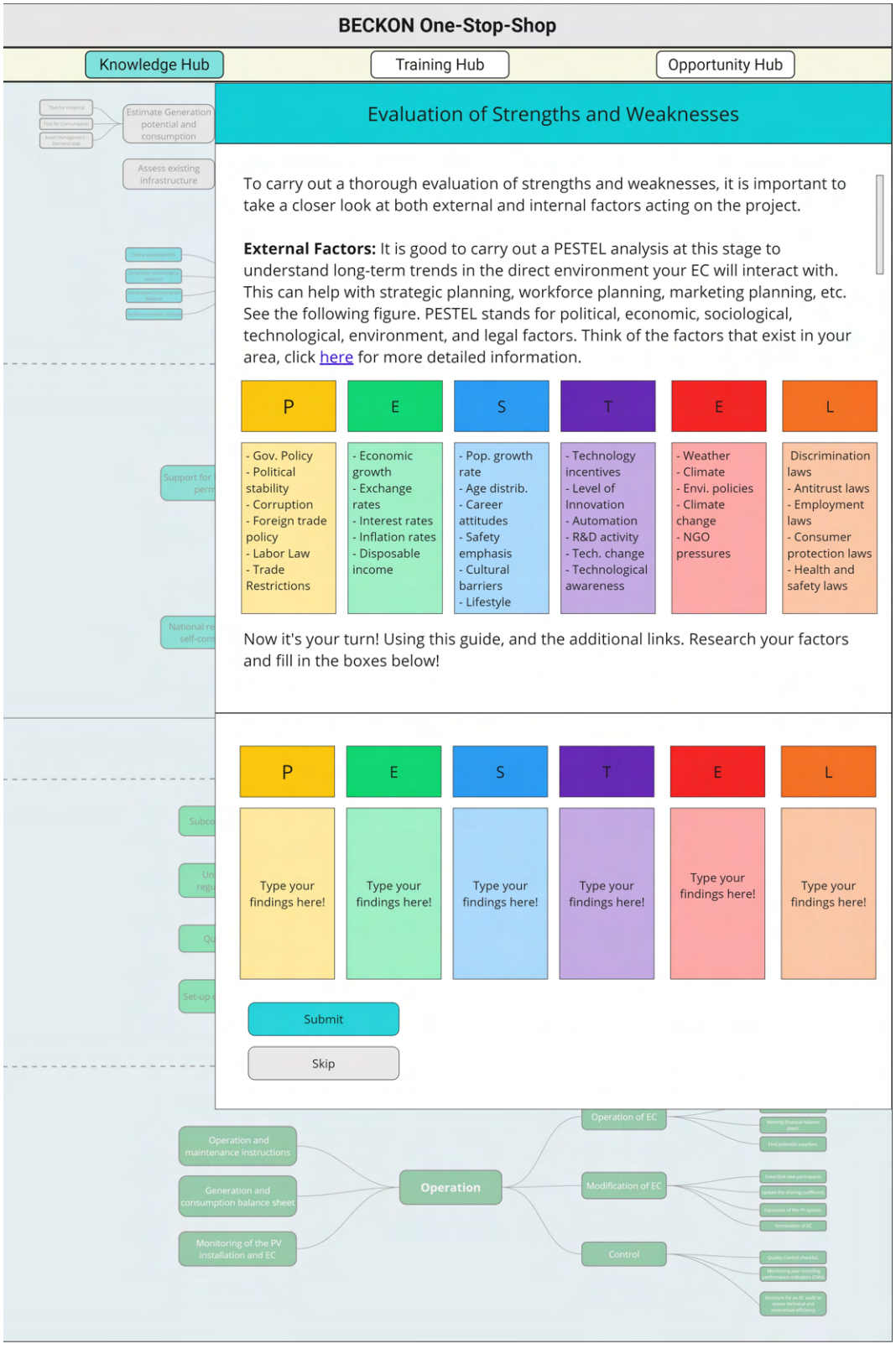


Figure 10: Resource to assess the external factors acting on the project.

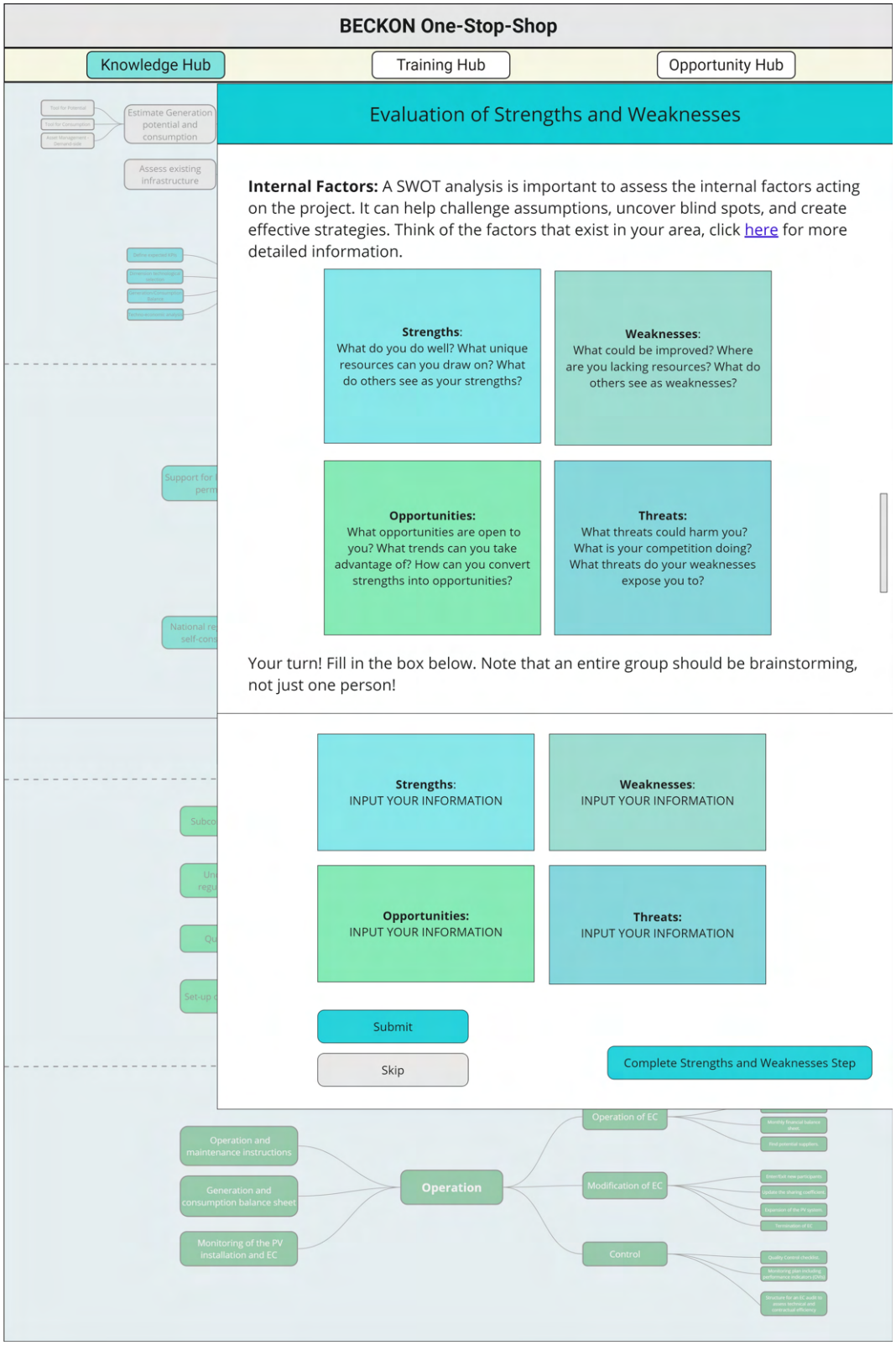


Figure 11: Resource to assess the internal factors acting on the project.

For the steps that are more informational than interactive, the desired information will be given in the most succinct manner possible. Fig.12 shows the implementation of the "National Regulatory Context for Self-consumption" step. Since this step is a part of the Technical PV Installation side, the window appears on the left. This is also part of the Design phase, so the Initiation phase should already be completed at this point. A quick description of the regulatory context in the country the user previously specified is given. If the user wants to learn more, pertinent resources are linked here. This is a valuable improvement from other existing Cookbooks and OSS's because the user does not have to dig through any hundred-page reports for information about their particular country.

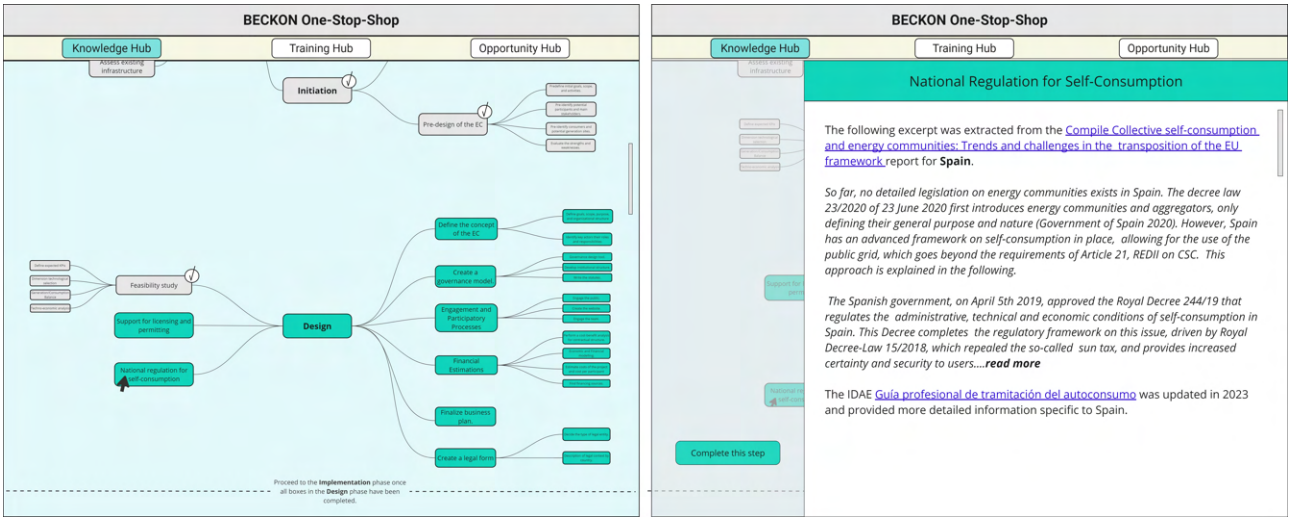


Figure 12: National self-consumption regulation for a given country (in this case, Spain).

Wireframes are already developed for steps with existing tools. The tools the BECKON team is developing will fit into this format to give the user an interactive and streamlined experience.

5.3 Unique Value Offering

As mentioned previously, the key feature that distinguishes the BECKON Cookbook from others is the ability to guide the user, take their results, and create personalized, professional documents for them. After completing the Design phase, the user will have completed all the main components of a business plan. From the Initiation and Design phases, the goals, scope, activities, participants, main stakeholders, strengths and weaknesses, governance model, and financial estimations will all feed directly into a business model template. They will all have

input boxes like in Fig.9.

This business model template is still under development. The vision is to weave the user's answers with known content like the benefits of choosing a certain legal entity. For example, in Fig.12, if the EC is in Spain, the Cookbook can automatically add a section to the business plan about the regulatory context in Spain. This can also be done when deciding the type of legal entity. The user just has to indicate the Cookbook what legal entity they have decided and the Cookbook will support that choice with the associated benefits of that legal form. This method is applicable to many of the less personal steps, like the chosen contractual framework. The synthesis of the personalized, "long-response", steps with the justification of the "multiple-choice" decisions saves the user an immense amount of time and provides them with a useful document to present to stakeholders and investors.

6 Next Steps

Now that the content and structure of the Cookbook has been drafted, it is important to understand how each piece of the BECKON project fit together. This section will describe how the Cookbook will be integrated into the OSS and what services can be found there. It will also describe how the TAOs will be implemented in the pilot areas.

6.1 Operations and Services in OSS

The OSS will be composed of a Knowledge Hub, Training Hub, and Opportunities Hub. These three hubs will provide tailored support to all users.

6.1.1 Knowledge Hub - Cookbook Integration into OSS

As seen in Fig.5, the Cookbook will form a part of the Knowledge Hub on the OSS. The Knowledge Hub will host a bibliography with useful resources along with the Cookbook. The Training Hub will include the educational materials produced in the Capacity Building effort, described below. The Opportunity Hub will directly interface with the Cookbook in the Knowledge Hub. Specific technical and financial experts in a given location are recommended at certain steps of the roadmap if extra support is necessary. Additionally, the Cookbook links to the Opportunity Hub to help the project find funding.

6.1.2 Training Hub - Capacity Building

To improve the awareness and familiarity of energy communities throughout Europe, it is necessary to launch a social outreach program. This capacity building program will equip project promoters (public authorities, energy agencies, local action groups, energy companies) with the knowledge they need to confidently lead an energy community initiative. A "train the trainers" approach will be employed starting at the three pilot sites to create a "ripple effect". The goal is to heighten community energy awareness amongst local stakeholders, thereby encouraging them to spread the enthusiasm across their region. This approach follows a Living Labs methodology; meaning the citizens are involved at all stages, and the program is constantly evolving to meet the citzens' needs. At this stage of the project, hun-

dreds of actors across the three different pilot sites have been surveyed or interviewed gain insights on how best to tailor the various resources to their needs [13].

Additionally, the capacity building program will include a series of interactive training sessions at the three pilot sites. These will include videos to complement the Cookbook, workshops to facilitate relationships across the value chain in each region, and webinars to support EC deployment. The recorded resources will be made available on the Training Hub of the OSS.

6.1.3 Opportunity Hub - Matchmaking Service

The matchmaking service serves three main purposes: to find experts, to find funding opportunities, and to network with other actors or EC initiatives. In this space, projects can publish a call for a certain type of expert, start a discussion about a challenge they're experiencing, or introduce their project to kick-start networking opportunities.

6.2 Implementation of Technical Assistance Office in the Field

The OSS (including the Cookbook and capacity building program) will be validated in three supramunicipal areas in Ávila, Spain; Sofia, Bulgaria; and Copenhagen, Denmark, covering a wide range of conditions, cultural aspects, and market maturities. This diversity is necessary to ensure the robustness of the tools, maintaining its applicability throughout the EU. The technical assistance offices will educate actors local to the three pilot areas.

In general, the TAO pilots will interact with the existing local energy office to launch a call for projects. The target is to assist between a minimum of ten, to a goal of 25 initiatives in each area. This assistance includes a Cookbook introduction session, a capacity building program throughout the area, and OSS engagement initiatives. The capacity building aims to reach 150 - 200 stakeholders in each pilot area, effectively training the trainers and filling knowledge gaps.

After the launch of the pilot TAOs, the effectiveness and quality of the support mechanisms (Cookbook, capacity building program, and OSS) will be evaluated for certain indicators such as ease of use, robustness of features, and areas of improvement. The validation of the tools' efficacy is the most important step to guarantee the lasting impact of the implemented

activities. The pilots' evaluation and feedback of the tools will incite corrective actions to strengthen the Cookbook, capacity building program, and/or the One-Stop-Shop. These improvements will be implemented prior to the replication and dissemination activities to capitalize on the lessons learned from the pilot sites.

7 Conclusions and Recommendations

Energy communities are gaining traction as an innovative approach to promote the energy transition, allowing citizens to take an active role in shaping their energy future by promoting local ownership, collective decision-making, and mutual benefit. While some national governments are being more proactive than others regarding the RED II transposition, tools need to be developed in tandem to support deployment as early as possible.

The Cookbook, along with the other support mechanisms BECKON is developing (capacity building program, OSS), must provide simple yet sufficient resources to walk project promoters or local action groups through every step of the EC creation process. While it is not always easy to find specific resources for each country, it's often these countries that need the extra support. Leveraging the BECKON network and the network of existing ECs in each country can help fill these gaps.

The Technical Assistance Offices will play a key role in validating the comprehensive support mechanisms and guaranteeing the quality before dissemination and replication. It is imperative that these TAOs report which steps and tools worked well for them, and which ones didn't. It would also be useful to receive feedback about what other types of document generation capabilities they would find useful.

7.1 Limitations and Future Research

The BECKON Consortium consists of eight parties. The size of this team led to frequent lengthy discussions over which steps should be included and which tools are the most valuable to the user. While this improved the quality of the Cookbook to some extent, many of these conversations ended inconclusively. The size of the team also caused significant communication errors with several people working on the same tasks without knowing it. On the other hand, the size of the group made it easier to find missing tools with most people having worked on related projects in the past.

This paper was also limited by the timeline of the LIFE-BECKON project. The OSS is scheduled to launch around July 2023, and the TAOs in November 2023. For that reason, this work has been purely theoretical albeit necessary work to enable the future steps.

The differing and constantly changing legislation such as the transposition of the RED II

and across the EU Member States has also made it challenging to provide adequate and tailored support to each country.

To continue this project, the BECKON team will have to design the missing tools stated in the Results section of the Cookbook Methodology. These tools must be designed around the needs of these users. Extra care should be taken with the financial tools, as those were reported as the most highly-sought after. Since there are a lot of tools to develop, priority should be given to the pilot sites (Spain, Bulgaria, and Denmark) for the country-specific resources. While the TAO is operating and validating the OSS in these countries, the team will have time to develop the tools for the rest of the countries.

Special attention should be given to the document generation feature of the tool. The BECKON team must hire a developer capable of implementing this type of feature that can store inputted data and then merge it into a document with predefined prompts.

This report sets the BECKON Cookbook up for success. These next steps are easily achievable and the roadmap is quite simple to follow.

7.2 LIFE-BECKON Impact Assessment

In the face of these challenges, the LIFE-BECKON project is expected to make a large impact in the EU energy community environment. Multiple different expected impacts were estimated for project end and for five years after the project. These expected impacts were based on realistic goals set by the team regarding number of initiatives supported, number of citizens engaged in community energy as a result of the project, investments triggered, primary energy savings, and GHG reduction.

Twenty-five EC initiatives will be supported between the three pilot areas. Fifteen more from different EU countries will receive support from the BECKON OSS platform. In the five years post project end, it is expected that each of the TAOs in the pilot areas will support 25 more bottom-up projects. The project consortium of eight partners will involve 30 public authorities across the EU, triggering a call for projects in each of these areas which is predicted to generate a pipeline of 300 projects (10 ECs per each call for projects). This sums to a total of 375 projects supported by the BECKON OSS within 5 years of the end of the project [13].

The pilot projects vary significantly in size. The Spanish pilot is expected to engage 100

citizens, the Bulgarian TAO predicts 330 citizens, and the Danish project expects to involve 2000 - 4000 citizens. The estimations are made as conservatively as possible; for that reason, it is assumed that the future 375 projects will engage 100 citizens each. This totals to 6830 citizens transforming from passive to active energy consumers as a result of the BECKON project [13].

This number of citizens engaged is used to estimate the approximate magnitude of sustainable investments induced by the project. By engaging more citizens investments will have to be made in PV panels, battery storage, and monitoring equipment to meet the electricity demand of the community sustainably. It was estimated that 7500€ per citizen to install a 5 kWp system (the typical power rating to meet the demand of a house). An estimated 1500€ is expected per citizen to install or upgrade the monitoring equipment to ensure a proper p2p exchange. A 10 kWh battery costs about 6000€. All of these components sum to a total estimated investment that an average of 15000 per citizen engaged in an EC initiative. Based on the previous estimations, this will sum to a total of 38.7 M€[13].

Primary energy consumption will also be reduced. The average energy consumption of an EU citizen is 6.5 MWh/year. BECKON's energy efficiency measures are expected to reduce primary energy consumption of EC participants by 20%. Assuming a 5 kWp PV system is installed on every participants rooftop (equalling 4.6 MWh/year) and their annual consumption is 5.2 MWh (20% less than average), each citizen is effectively saving 5.9 MWh of grid electricity consumption per year (4.8 MWh/year with the PV system and 1.3 MWh/year from the efficiency measures). Using a conservative conversion factor of 1.5 (the lowest average of the EU countries), this amounts to 60.45 GWh/year saved 5 years post-BECKON accounting for all involved citizens [26].

Primary energy savings can be easily converted into GHG emissions reductions. For every kWh of primary energy saved, 230.7 gCO2 equivalents are avoided. This tallies to 13,946 tCO2-eq/year emissions avoided as a direct result of the BECKON project.

While these metrics all contribute to achieving Sustainable Development Goal 7, the BECKON project simultaneously reduces a consumer's monthly energy bill. It is also predicted that these ECs will reduce energy poverty in certain areas, although these impacts have yet to be estimated.

7.3 Contribution to the BECKON Project

This impact is enabled by the work described in this report in which the prerequisite foundation to develop a robust yet simple roadmap to support EC projects from start to finish was presented. Identifying and justifying each mandatory step and the order in which it should be completed provides value to the user. This scheme provides the BECKON team with a framework to order the tools and further discuss the implementation of additional innovative capabilities. While the report showed a brief snapshot of the envisioned user interface, the team will further refine this to provide the best user experience. Next steps include determining which tools cataloged in the bibliography add the most value so as not to overwhelm the user with 10+ tools that accomplish the same goal. Once these decisions are made, the scheme can be sent to the developer and launched in the pilot areas.

This tool is designed provide an equal level of support for every EU country at each step of the EC creation process. This alone elevates this platform over existing ones. The roadmap format is also a novel feature, providing users with real guidance towards which tools they should be using at which stage. Finally, automatically creating useful business documents to present to investors goes above and beyond the existing databases that drown the user in a sea of tools. Based on these key features of the BECKON Cookbook, this tool will effectively fill the need mentioned in Section 1, thereby successfully boosting the deployment of successful ECs across the EU.

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