



Collective action Models for Energy Transition and Social Innovation

Defining Indicators for Collective Action Initiatives (CAIs) and Social Innovation (SI) in the Energy Transition

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Abbreviations and acronyms

CAI:	Collective Action Initiative
CE:	Community Energy
EC:	European Commission
ET:	Energy Transition
GHG:	Greenhouse Gas
SDGs:	Sustainable Development Goals
SI:	Social Innovation

Contribution history

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1 Introduction

The Brundtland Commission has defined sustainable development as ‘*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*’ (WCED 1987). Sustainable development is about improving the quality of life and wealth of people in a way that can be sustained socially, environmentally, and economically.

Collective Action Initiatives (CAIs) are considered as means to empower local communities and promote behaviours that are expected to have an aggregate effect on the energy transition and social innovations. According to the concept of sustainable development, CAIs are evaluated at the economic, environmental, and social level.

The aim of task 6.2 (WP6 COMETS) is to identify indicators and variables to evaluate the performance of CAIs and their contribution in the energy transition and social innovation at communities’ level. As CAIs are multidimensional initiatives, we have identified three key macro-areas of assessment: economics, environmental impact and social innovation. For each area, dimensions of performance are identified as well as a set of variables that could be potentially used to calculate or proxy them and indicators, when available.

This Report results from several activities and steps over time and within COMETS project. An initial set of variables and indicators has been produced through literature review, analysis and discussion among COMETS partners. This has led to the production of an internal interim report. The current report is the result of further analysis based on information and data gathered over time by the COMETS project on CAIs through: the Europe-wide inventory of CAIs in the energy sector (WP2), the survey to explore CAIs determinants in the energy sector (WP3) and national case studies (WP4). Figure 1 illustrate this process.

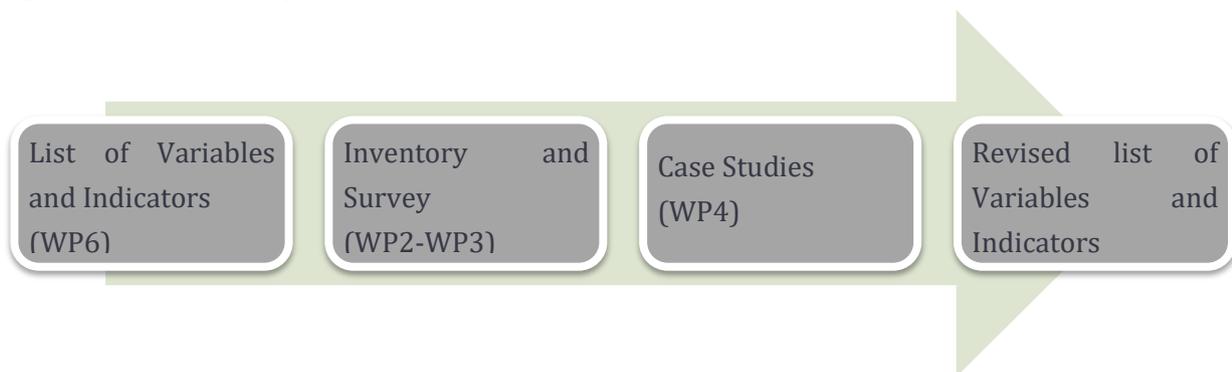


Figure 1. The process

The report proceed as follows. Section 2 recalls the definition of CAIs in the energy transition adopted in COMETS and presents some results from the survey, which further contribute to characterize CAIs and their activities in the energy transition and as social innovators. Section 3 connects our framework to Sustainable Development Goals (SDGs) and introduces some methodological elements. Section 4 identifies and describes dimensions of performance for each area (economics, environmental impact and social innovation) and the relative variables and indicators, when available. Section 5 concludes.

2 Defining Collective Action Initiatives (CAIs)

For the definition of indicators of the performance of CAIs, it is firstly essential to specify the typology of CAIs the project - and the present report - is referring to by reminding the definition of CAIs proposed and their boundaries. CAIs can be structured and characterized in many ways, focusing on different types of activities and delivering different combinations of outcomes. They can be local or have a broader geographical scope. This indeed has an impact on their organizational, financing, and economic structures. This heterogeneity has to be taken into account in characterising CAIs and, mostly, in developing a framework for their assessment.

To deal with this heterogeneity, as presented in the Report of deliverable 2.1., COMETS has proposed to describe and characterize CAIs along *explanatory dimensions*, including the dynamics of creation, the organizational structure, the financing, CAIs activities in the energy transition and wider social impact. These explanatory dimensions, that have been taken into account in the designing of the COMETS inventory that will be released in November 2021 (Deliverable 2.3), have already been operationalized in the COMETS survey. This process has provided further clarity on CAIs characterization and evidence to support the grouping of CAIs as proposed in Deliverable 2.1, i.e. two groups: (i) **community energy initiatives** and (ii) **other initiatives**. For each of these groups, we specify the essential characteristics.

a. Community energy initiatives (CE)

Community energy initiatives are the most known and studied CAIs. Citizens' participation is commonly identified as a major defining characteristic of such actions. Nonetheless, CEs encompass a wide range of initiatives, e.g., cooperatives for renewable energy deployment, green associations, collective purchasing of energy services, community or local authority led schemes for renewable energy implementation, community programs for energy poverty alleviation. Such heterogeneity in the sector has led to a variety of different definitions.

We focus here on the definition of CEs, commonly adopted in the literature (Walker et al., 2010; Seyfang et. al., 2013; Wirth, 2014; Yildiz et al., 2015), which identify them as those:

- implying a form of citizens ownership or financing of an energy project, and control over the initiatives (along the process dimension);
- where citizens directly benefit from the outcomes of the initiative (along the outcome dimension).

At least in principle these characteristics are in line with the definition provided by the two European directives which firstly provide a formal definition of energy communities: Citizen Energy Community (CEC) contained in Directive (EU) 2019/944 (recast Electricity Directive), and Renewable Energy Community (REC), contained in Directive (EU) 2018/2001 (the recast Renewable Energy Directive). In particular, they are defined as follows in the Directives:

- a 'Renewable Energy Community' means a legal entity:
 - o which, in accordance with the applicable national law, is based on open and voluntary participation, is autonomous, and is effectively controlled by shareholders or members that are located in the proximity of the renewable energy projects that are owned and developed by that legal entity;
 - o the shareholders or members of which are natural persons, SMEs or local authorities, including municipalities;

- the primary purpose of which is to provide environmental, economic or social community benefits for its shareholders or members or for the local areas where it operates, rather than financial profits;
- A 'Citizen Energy Community' means a legal entity that:
 - is based on voluntary and open participation and is effectively controlled by members or shareholders that are natural persons, local authorities, including municipalities, or small enterprises;
 - has for its primary purpose to provide environmental, economic or social community benefits to its members or shareholders or to the local areas where it operates rather than to generate financial profits; and
 - may engage in generation, including from renewable sources, distribution, supply, consumption, aggregation, energy storage, energy efficiency services or charging services for electric vehicles or provide other energy services to its members or shareholders.

We specifically refer to the new paradigms of citizens' engagement and involvement in energy initiatives (mostly renewable energy projects), which has begun appearing in Europe since late 2000s, facilitated and driven by the last decade's energy system liberalization and transition toward more decentralised energy systems (Yildiz et al., 2015; REN21, 2016). For these CE initiatives, COMETS proposes to characterize them along two *defining dimensions*: the outcome and the process dimension (Candelise and Ruggieri, 2017), as reported in Figure 2.

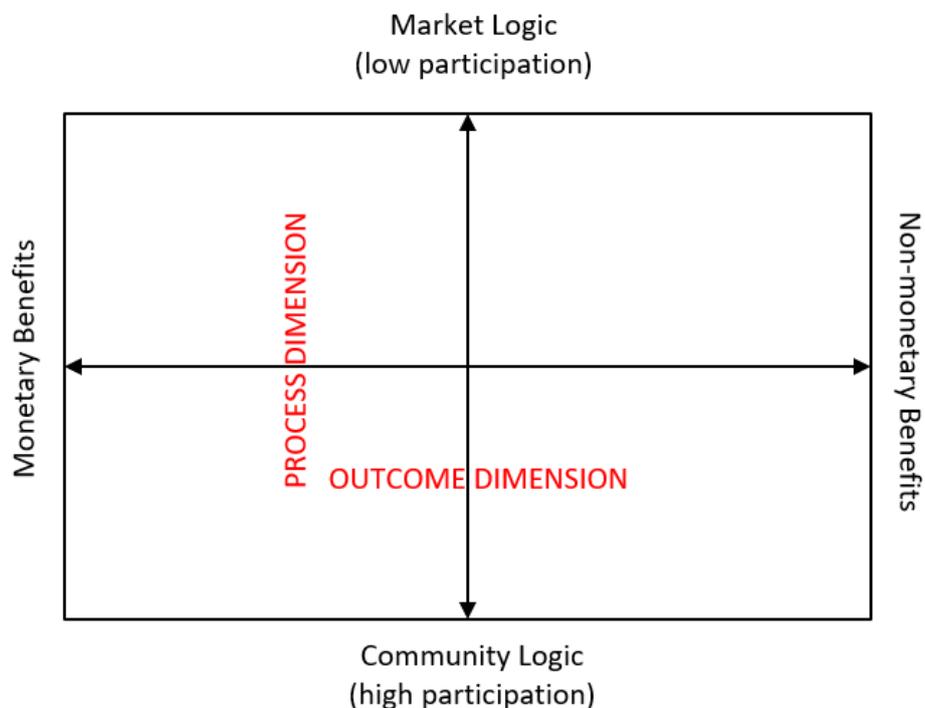


Figure 2: Identifying Dimensions of CAIs

The process dimension comprises a set of variables and elements which define how and why the CAI has been set up. In Figure 2, CE initiatives are characterized along the process dimension according to the degree of participatory and community logic behind the dynamics of the constitution, implementation, and governance of the initiatives.

Thus, in Figure 2, they can span from a prevalence of community logics in the process to a more market-based logic. This specific characterization of the process dimension accrues from both the assumption that participation of citizens in initiatives is a dimension of particular interest in the context of COMETS, but also from evidence from the CE initiatives, and the literature analyzing them, of different implementation models, characterized by various degrees of community logics.

The outcome dimension, instead, refers to the type of benefits offered. It is assumed in Figure 2 to span from monetary benefits (e.g., returns on investment or saving on electricity bills provided to members of initiatives) and non-monetary benefits (e.g., other energy services offered, education activities organized, etc). Similarly, as to the process dimension, the relative weight of different types of benefits delivered to the CE members, spanning from monetary to more community-oriented benefits, contributes to characterizing the typology of initiatives (from more community to more market-based logics).

As discussed above and also presented in the Report of deliverable 2.1., COMETS further describe and characterize CE initiatives along *explanatory dimensions*, including the dynamics of creation, the organizational structure, the financing, CAIs activities in the energy transition and wider social impact.

b. Other initiatives

The other initiatives are all those which do not fall in the definition of community energy above. Citizens do not own or finance them necessarily (e.g., associations, grassroots initiatives for climate change reduction or fuel poverty alleviation, ecovillages); and the objectives and the outcomes of the initiative do not significantly benefit their members and are often not limited to the energy domain, but can target a wider audience and can expand their focus on a “common cause” related to the environmental sustainability. Fall in this category initiatives such as the two Italian ecovillages described in deliverable 4.2: Villaggio Ecologico di Granara and LUMEN.

The Villaggio Ecologico di Granara starts on the initiative of a group of young adults inspired by ideals and endowed not only with technical competences, but also with a strong attitude towards the challenges of “appropriate technologies”. This group initiates the project in a sort of “waste land”, where they settle down, rebuilding the pre-existing abandoned (and ruined) buildings. The relationships with local authorities and actors are not a priority and are not intentionally sought, while they emerge as “relations of cordiality” over time, as long as the ecovillage’s activities display their positive impact on the territory (e.g., summer theatre festival). The most important alliances and networks of the ecovillage do not have a geographical basis, but are mostly those with the groups and initiatives the ecovillage share the same values. Later on, the ecovillage starts the so-called “Energy Project”. The energy theme, the energy production from renewable resources, and the energy self-sufficiency are core values and ideals of the initiative since its very beginning. The energy-related activities, in fact, start very soon, following a slow, but constant development path, which experiences a turning point, with a relevant upward change of scale, when the ecovillage builds a photovoltaic canopy, which strongly increases the CAI’s energy production.

Similarly to the Villaggio Ecologico di Granara, also the other ecovillage, LUMEN, settles in an abandoned place, starting the initiative with an even smaller group of founders/pioneers: a couple of young adults. This couple starts to revitalize the place without – as in the case of Villaggio Ecologico di Granara - the external support of any association, but with the simple contribution of a growing

number of people attracted by the initiative (which will eventually become a community), who populate the place with an ever increasing number of relations and activities. Like Granara, also LUMEN does not look for ties with the other local actors, at least at the beginning of their experience, when the initiative is looked and perceived by the locals with diffidence and suspicion. Later on, as soon as LUMEN opens its doors, through the “Festival NaturOlistica”, and starts its commitment in the management of the local administration and in several local environmental campaigns, the local inhabitants reduce their prejudice and suspicions on it. The energy theme is not central, but consistent with LUMEN’s primary goal, that is the promotion of health care through natural and sustainable methods. Even if LUMEN has not developed a specific energy project, the energy production, the reduction of energy consumption, the energy (and non-energy) self-sufficiency and the efficiency-driven renewal of buildings and plants are part of the activities gradually carried out by the ecovillage, in accordance with the principle “the right thing at the right time”.

The main differences between Energy communities and the two initiatives briefly described above refer to the activities and objectives that motivate and characterize the initiatives, both strongly connected with the role played by the energy domain in their development. While energy communities are, by definition, initiatives that aim at promoting alternative models of energy production/consumption able to foster the transition towards a more sustainable energy system, the activity of ecovillages in the energy domain is one of a wider pool of processes they engaged in. If for energy communities the shift to renewables, the affordability of energy and the empowerment of citizens can be considered the primary objectives, for ecovillages they are only part of the wider ambition of promoting an alternative and comprehensive socio-economic model that in addition of a change in the dominant market-based economic paradigm should affect more in-depth also households lifestyles and individuals values.

2.1 Characterizing CAIs, results from the WP3 survey

The survey was carried out from June to September 2020 and collected feedback from around 250 CAIs in the 6 COMETS EU countries, namely Belgium, Estonia, Italy, Poland, Spain and The Netherlands. A complete overview of the survey results has already been published (Lupi et al., 2021) and here some main results are presented that help in clarifying some basic features of what have defined as CAIs.

As for the origin of CAIs, figure 3 citizens are at the origin of the CAIs' formations and are among the initiative's prominent supporters country except in Poland, where municipalities have a leading role. Citizens' role is crucial in Belgium, the Netherlands, Italy that have a long history in CAIs' development (e.g., Belgium and the Netherlands) and recent legal and administrative premises to develop new initiatives (e.g., Italy and Spain). In particular, the community energy movement is rather large in the Netherlands, and energy cooperatives are several

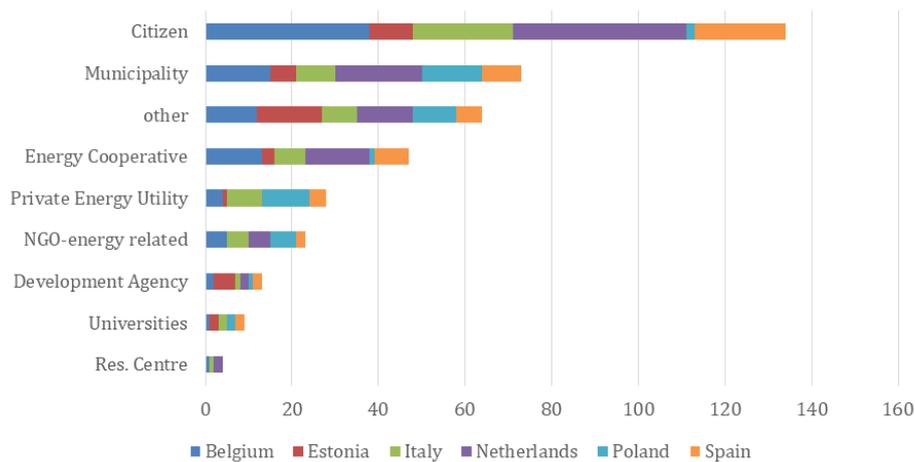


Figure 3: Origin of CAIs (Source: Lupi et al., 2021)

The active role of citizens is confirmed for what concerns the financing the first activity of CAIs., except for Poland where public grant are predominant, figure 4. In addition of citizens and public authorities another relevant actor in the funding step are banks, showing the ability of CAIs to leverage credit from private institutions.

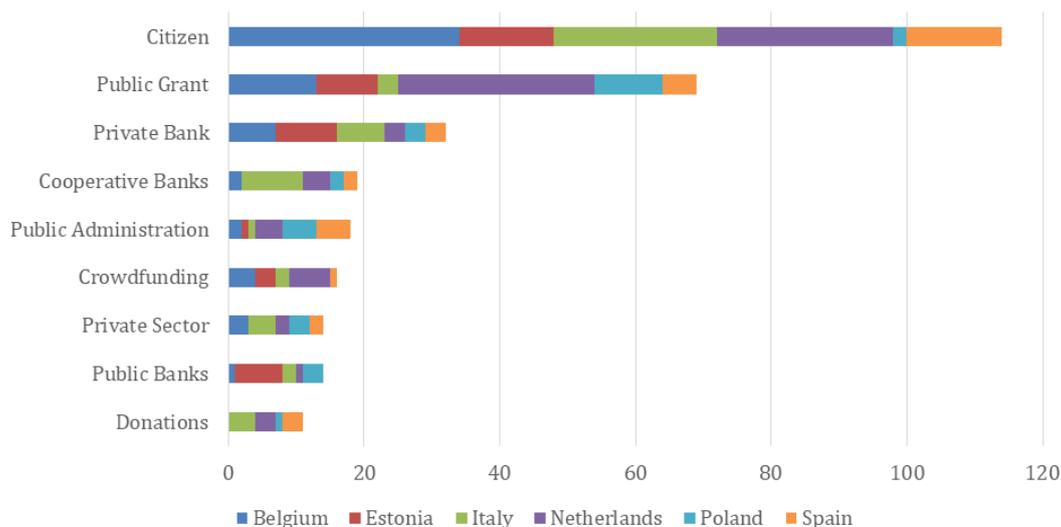


Figure 4: Initial investors (Source: Lupi et al., 2021)

The literature highlights that, as for the legal form, CAIs are mostly organized in cooperatives (see Huybrechts and Wilmars, 2014; Yildiz et al., 2015; Creamer et al., 2019; Rescoop, 2019;), a form believed to provide the best institutional framework for locally owned and participatory approaches to renewable energy projects (Candelise and Ruggieri, 2020).

Survey data (figure 5) confirm this evidence with 81% of Belgian CAIs, 60% of Italian, and 62% of Spanish respondents are cooperatives, such as the 88% of respondents from the Netherlands. Respondents from Poland cluster around limited-liability companies (llc) and foundations, plus 73% of respondents choosing another form called *energy cluster*. Energy clusters are promoted through agreements between several municipalities, together with an energy operator and an investor. In Estonia, 100% of respondents chose other because most of the Estonian initiatives are based on associations and already have a legal form. According to the law, it is mandatory to establish an

apartment association as a legal entity in Estonia. Creating a separate legal entity for renewable energy production or other energy-related activities is neither required (as the body already exists) nor economically justified.

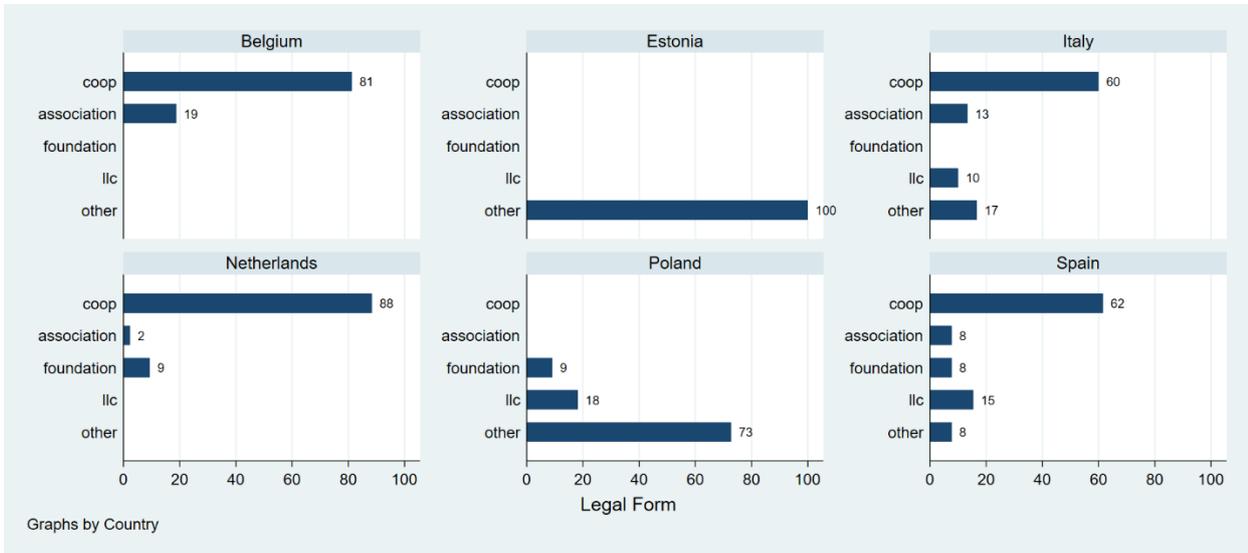


Figure 5: CAIs legal form (Source : Lupi et al., 2021)

In terms of size, proxied by the number of customers, figure 6 show that in the majority of the surveyed countries the distribution is skewed towards a medium-small size with Belgium and Netherlands having more than 80% of initiatives with less than 99 customers, Poland more than 70% and Estonia 100%. In Italy and Spain there are instead many relatively bigger initiatives. 1/3 of Italian CAIs and almost half of the Spanish fall in the class 100-999, 36% of the Italian and 7% of the Spanish fall in the class 1000-9999, and a relevant 13% of the Spanish initiatives are actually big organization with up to 50000 customers.

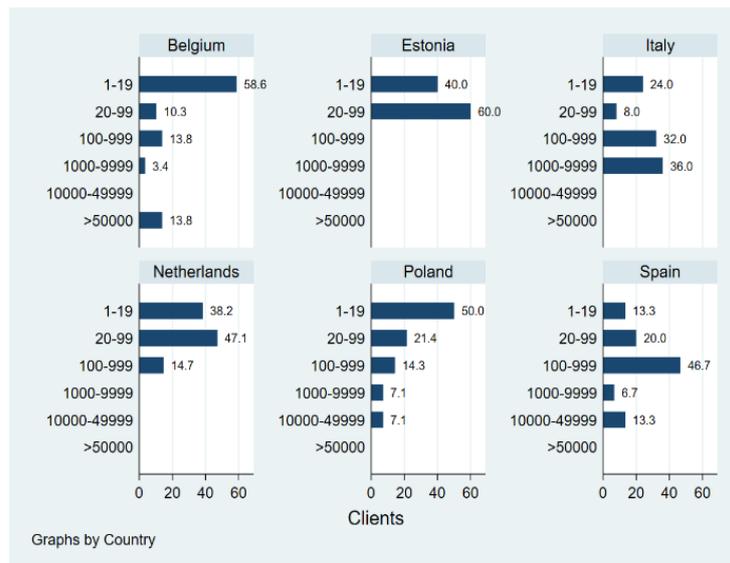


Figure 6: Number of customers (Source: Lupi et al., 2021)

Finally, a quick look to the activities to conclude this quick overview of the main CAIs' features as derived from COMETS survey.

Overall, as for the geographical scope, CAIs are mainly *local* initiatives, table 1. However, in all countries, there is a presence of *national* CAIs, except for Estonia. The urban category is relevant for Belgium, Estonia, the Netherlands, and Poland. Nevertheless, several CAIs are in rural areas, especially in Italy, the Netherlands, and Spain. The Regional option, which considers CAIs' activities located inside one region, is relevant for Belgium and Italy.

	Belgium	Estonia	Italy	Netherlands	Poland	Spain	Total
Rural area	3	4	8	18	5	9	47
Urban area	10	18	3	9	8	1	49
Local	27	7	11	26	7	9	70
Regional	22	0	11	7	8	5	53
National	16	0	8	8	2	4	38
International	1	2	1	2	1	1	8
other	4	0	1	6	3	4	18
Total	66	31	43	76	34	33	283
Total CAIs	41	23	32	45	22	24	187

Table 1: Geographical scope (Source: Lupi et al., 2021)

In order to qualify with respect to their role in the energy supply chain (ESC) the survey focused on activities such as generating renewable energy (RE), selling RE to consumers, operating an energy grid, and energy sharing activities, table 2 and figure 7. The results show that overall the majority of CAIs in all the countries declare to be engaged in generating and selling energy to customers but also the sharing of energy seems to be quite diffused, especially in Belgium. It is worth to notice that in Italy around 20% of the surveyed CAIs are engaged in the operating energy grid.

These results should not be surprising. Since several CAIs' activities are related to hydroelectric, wind, and, mostly, photovoltaic (PV) plants, the generation of energy is likely to be the primary activity of CAIs.

	Belgium	Estonia	Italy	Netherlands	Poland	Spain	Total
Generation of RE	32	20	24	36	10	10	132
Sell RE to Consumers	11	2	13	13	5	5	49
Operate and energy grid	4	0	8	2	1	2	17
Energy Sharing	11	3	6	7	2	12	41
Other	42	19	24	29	7	14	135
No Activity	5	3	7	7	9	3	34
Total	105	47	82	94	34	46	408
Total CAIs	44	25	36	47	22	24	198

Table 2: Energy-related activities (Source: Lupi et al., 2021)

In Belgium, 36% of CAIs perform generation of renewable energy. In Estonia, 52% of CAIs perform production and generation of renewable energy plus other activities, while 8% of the sample do both generation of renewable energy and sell the energy to customers. In Italy, 20% of respondents declare that they do not perform any of the ESC activities mentioned but a similar share declare that they operate an energy grid. 17% of CAIs perform production and generation of renewable energy, 8% of the sample do both renewable energy generation and sell the energy to customers. Almost 50% of CAIs in the Netherlands perform generation and production of renewable energy; 8% of the sample, instead, do both renewable energy generation and sell the energy to customers. In Poland, 40% of respondents declare that they do not perform any of the ESC activities mentioned. 14% of the sample

perform both generation of renewable energy and sell the energy to customers. There is no clear trend in Spain, even though renewables and energy sharing activities are the most selected options.

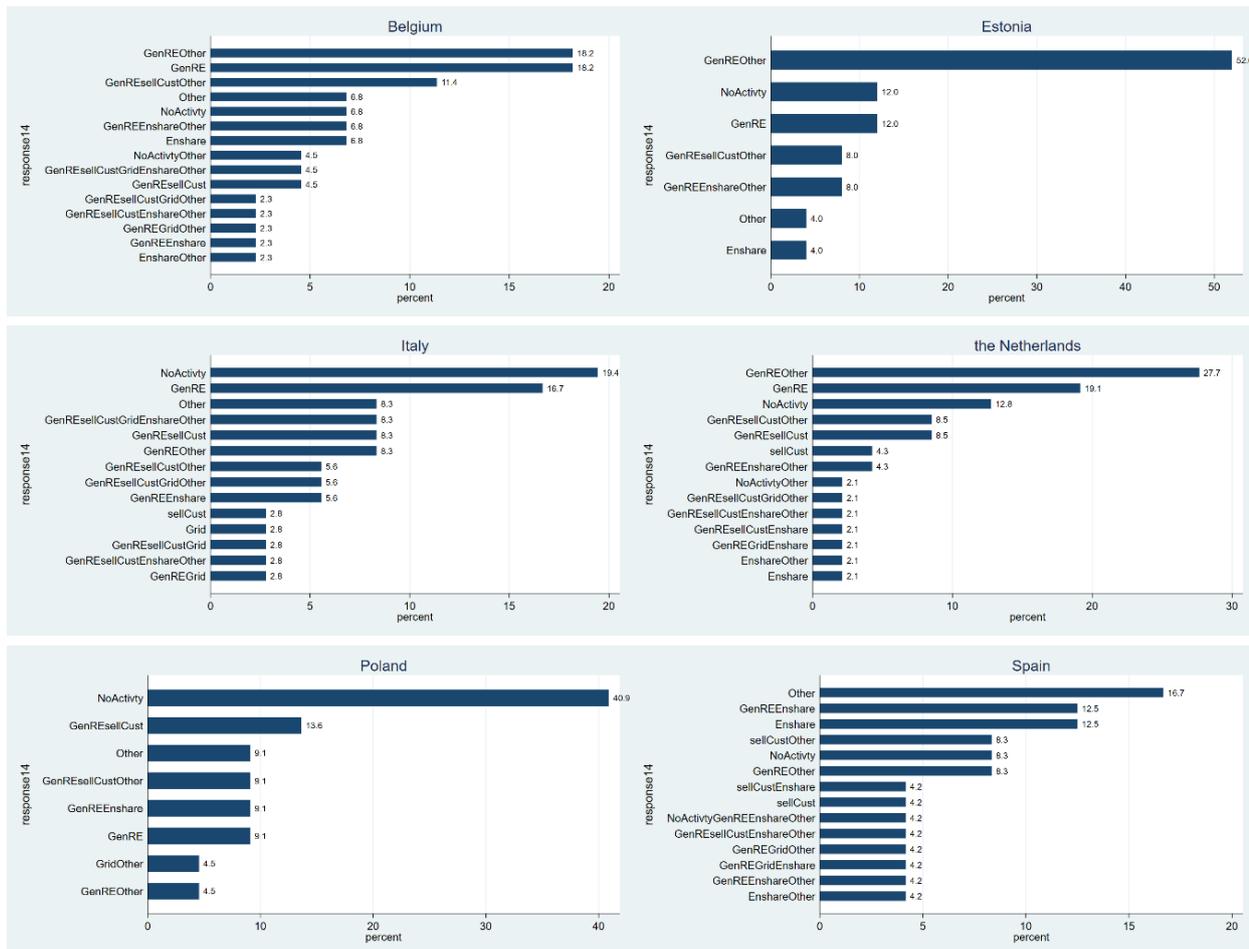


Figure 7 – Energy-related activities : combination by country (Source: Lupi et al., 2021)

Given this heterogeneity we propose to split the CAIs landscape into two groups (i) community energy initiatives and (ii) other initiatives on the basis of a qualitative difference in their premises, objectives and activities that could not have been grasped by the survey. For each of these groups, a qualitative description of the essential characteristics and some examples are provided in the following.

2.2 Broader consideration on social impacts of CAIs

Concepts such as participation and community, in narrower and more general sense, are essential aspects for the COMETS project. On the one hand, CAIs offer a physical/virtual space and opportunities for socialization and networking among members and participants. At the local level (mainly for local CEs), these conditions strengthen the relationships among members of the same community. At the national level (national CEs and others), besides the impossibility of sharing the same location, members and participants share the same ideals, scope and targets, feelings which translate in the creation of groups, working and acting together. Moreover, they could have social functions aimed at promoting social inclusion in general, or targeting vulnerable groups which may have difficulties, for example, in accessing electricity.

The project also focuses on the social issues of the energy transition. In particular, as reported in (Padovan et al., 2019), CAIs might have significant effects at two levels. First of all, such experiences

could reshape the population attitudes and values regarding the transition towards renewables. Secondly, initiatives like CEs, are structured ways to enhance, in principle, the energy transition directly involving citizens, at different levels. The project aims at evaluating if data support this evidence. As anticipated above, the outputs of relevance for social innovation are empowerment and social values, increasing trust inside communities, guaranteeing access to energy to the whole population, raising the acceptance of renewables, and the awareness of sustainable practices, promoting democratization, and inclusive processes, facing gender issues. Social innovation is therefore one of the critical areas of interest of the project that represent a crucial dimension for assessing CAIs performance. Some questions have been therefore defined in the survey in order to proxy to proxy its measurement.

In terms of what we called *Social Objectives of CAIs*, table 3, *social inclusion of all genders* and *promote local projects* seem to be the most diffused among CAIs with the exception of Estonian and Polish CAIs that are less concerned with these issues. The empowerment of women and youth are relatively higher respectively in Spain and Italy.

As for Energy Poverty, figure 8, that is one of the priority of the European Green Deal, it is perceived by the vast majority of CAIs as an issue they are actively dealing with but with quite relevant differences among the countries. If Estonia, Italy and Poland almost all the CAIs are concerned with Energy Poverty (respectively 96%, 85% and 76% of the respondents), this share is consistently reduced in Belgium, the Netherlands and Spain (respectively 70%, 62% and 54%).

	Belgium	Estonia	Italy	Netherlands	Poland	Spain	Total
Reduce Unemployment	1	0	1	2	1	2	7
Empower women	0	0	3	1	0	11	15
Social inclusion genders	8	0	4	2	1	10	25
Social inclusion elderly	4	0	2	2	1	5	14
Empower youth	4	0	7	4	3	7	25
Multiculturalism	3	0	2	1	2	5	13
Local projects	23	5	17	30	7	14	96
Support individuals-groups	6	0	3	4	2	2	17
NoActivity	16	15	9	18	12	1	71
other	4	5	3	2	2	1	17
Total	69	25	51	66	31	58	300
Total CAIs	43	25	32	46	20	23	189

Table 3: Social objectives of CAIs (Source: Lupi et al., 2021)

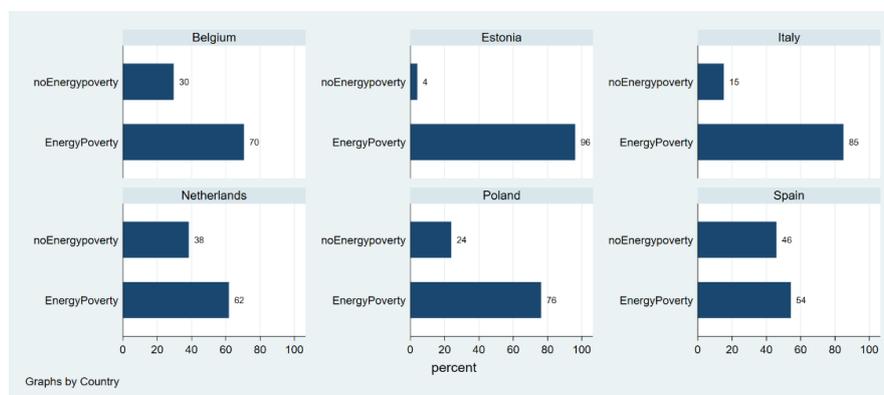


Figure 8: CAIs concerned with Energy Poverty (Source: Lupi et al., 2021)

Finally, as an overall proxy of the social attitude of CAIs, the management of the eventual profits was investigated. The majority of CAIs declare not to make profits, especially in Poland and Estonia, due to the prevalence of CAIs in such countries (e.g., energy clusters and apartment associations). Conversely,

if profits arise from CAIs' activities in Belgium, Italy, Spain, and the Netherlands, these are distributed to investors and/or reinvested in the initiative assets.

	Belgium	Estonia	Italy	Netherlands	Poland	Spain	Total
No Profits	14	15	10	13	10	10	72
Distrib.toInvestors	21	5	10	18	3	2	59
Reinvest. Initiative Assets	18	4	9	19	6	9	65
Other activities	5	0	3	5	1	8	22
Other activities (community)	8	1	10	19	2	6	46
Other activities (energy transition)	14	0	5	16	0	5	40
Other activities (social)	4	1	8	3	0	4	20
other	6	1	3	3	2	3	18
Total	90	27	58	96	24	47	342
Total CAIs	44	25	32	47	21	24	193

Table 4: Distribution of profits (Source: Lupi et al., 2021)

3 Definition of variables and indicators

3.1 CAIs and Sustainable Development Goals (SDGs)

The Sustainable Development Goals (UN, 2015) were adopted by the United Nations in 2015 as a starting point to work towards global sustainability up to 2030. The goals were classified into four pillars, e.g., economic, environmental, social, and institutional (IAEA, 2015). In our framework we consider three key dimensions as well, the economic, the environmental, and the social innovation to identify drivers and variables needed in order to build performance indicators specific for CAIs. The institutional area will be addressed in future steps of the project. Table 5 summarizes the SDGs.

SDGs	GOALS
SDG1	No Poverty
SDG2	Zero hunger
SDG3	Good Health and Well-being
SDG4	Quality education
SDG5	Gender Equality
SDG6	Clean water and sanitation
SDG7	Affordable and Clean Energy
SDG8	Decent Work and Economic Growth
SDG9	Industry, Innovation and Infrastructures
SDG10	Reduced Inequality
SDG11	Sustainable Cities and Communities
SDG12	Responsible Consumption and Production
SDG13	Climate Action
SDG14	Life Below Water
SDG15	Life on Land
SDG16	Peace, Justice and Strong Institutions
SDG17	Partnerships to achieve the Goals

Table 5: Sustainable Development Goals (Source: UN)

The seventeen SDGs cover areas which are strongly tied to CAIs' activities. In what follows we highlight some links between SDGs and CAIs. SDG11 is directly concerned with *sustainable cities and communities*. Some of the other goals address areas in which CAIs have or might have impacts which would be interesting to assess, including SDG1 and SDG2, *livelihoods* and *food provision*; SDG3, *health*

and *well-being*; SDG4 and SDG5, *education and gender inequality*; SDG7 and SDG9, *renewable energy and innovative technologies*; SDG12, *sustainable behaviours*, SDG13, *climate change*, SDG14 and SDG15, *ecosystem protection and enhancement* and SDG16 and SDG17, *social and institutional innovation* for effective partnership and inclusive governance (wiki.ecolise.eu, 2019).

The overlap between many of the SDGs and the aims and efforts of CAIs suggests the potential for the SDGs to link bottom-up local action of communities with government interventions towards sustainability and vice-versa. CAIs have a long history across Europe and could be studied as extant vehicles to implement SDGs.

3.2 Methodology

In this section, we describe the performance dimensions identified and the main features of the variables and the indicators proposed. Following the guidelines set by the European Commission (EC, 2014), it is essential to choose measures that are clear, simple, and easy to compute. The pool of variables and indicators are divided by area of interest. We provide definitions, and, when possible, we suggest how to calculate indicators through examples applied to the CAIs under study. Besides quantitative variables and indicators, we also propose to collect qualitative information. When a quantitative measure is selected, a unit of measure is reported. If the variable/indicator is qualitative, a range or a binary criterion to be applied to the survey is chosen, such as Yes/No. Finally, when possible, we already highlight if the data needed are available or need to be gathered. In doing so, we use the traffic-light colors. In the following is described the methodology, defining the information collected and to be specified for each variable. Table 6 reports the information to be collected in describing variables.

Areas and performance dimensions

In our context, we identify three primary areas of interest: economics, environmental impact and social innovation. For each area, a series of performance dimensions is identified as well as some indicators and variables available to evaluate them.

Definitions

We report an explanation for each variable and indicator considered. Moreover, we propose the geographical disaggregation level, e.g., country, province, and the perspective at which the variable is considered, e.g. CAI or member/participant, level. Given the interdisciplinarity of this project, both micro and macro, qualitative, and quantitative variables and indicators are collected. When describing the variables/indicators, we highlight, if possible, why it is relevant in our context.

Unit of Measure

When a variable is quantitative it is expressed in a specific unit of measure. When the variable is qualitative unit of measure is marked as NA.

Types of CAIs

For each variable, we report if it is suitable to evaluate the performance of community energies, other initiatives, or both.

Reference Literature

Some variables, as well as indicators, are taken from the literature (like for SDGs) and adapted to our context of analysis.

Data Availability

We highlight, with the traffic-light colours, which data are available and which data are not available. Green means that data can be found easily; yellow shows that there might be some difficulties in finding the data required; finally, red highlights the severe complexity in finding the variable considered. The aspect of data availability is relevant and further considerations will be done along the project duration.

Variables					
Define the Area	Description	Unit of measure	Type of CAI	References	Availability

Table 6: Steps to define variables

4 The Multidimensionality of CAIs

We defined CAIs in Section 2 to delimit the boundaries of our investigations. Though CAIs are different in terms of underlying motivations, functioning, and outcomes, the criteria we selected give us the possibility to pick some initiatives and to exclude others.

Nevertheless, we still find several differences among the CAIs selected: some are community energies or solidarity purchasing groups, which are more oriented towards profits and in delivering monetary benefits to their members. Others, instead, resemble social movements and incorporate ethical values related to political activism. For some CAIs, environmental awareness and the reduction of the environmental impacts of individuals/society are the main objectives, while others are more focused on the increase in social cohesion and local engagement.

The aim of this report is to identify indicators and variables to evaluate the performance of CAIs and their contribution in the energy transition and social innovation at communities' level. Given the multidimensionality of such initiatives, we identified three key macro-areas: economics, environmental impact and social innovation. For each area, dimensions of performance are identified as well as a set of variables that could be potentially used to calculate or proxy them and a set of indicators, when available. In the next sections, dimensions of performance, variables and indicators available are presented and discussed for each area. It must be stressed that the lists are not intended to be fully comprehensive of all the possible variables and indicators of performance of CAIs.

4.1 Economics

As presented in section 2 and more widely discussed in the report of Deliverable 3.3(Lupi et al 2021). CAIs selected in the COMETS project are heterogeneous in their activities and aim at delivering various services along the energy supply chain to members, participants, and the local/national communities. Some CAIs invest in renewables (PV plants, Wind, Hydropower, etc.) and/or energy efficiency measures to lower the dependence of communities on fossil fuels. Other selected initiatives are aiming at delivering services such as bike-sharing, car-sharing, audits, environmental campaigns, public education, training, and cultural opportunities. The COMETS project aims at estimating the economic performance of CAIs in operating their activities and in delivering their services, while also considering economic implications for its members and the possible economic spillovers/externalities in the wider community.

Note that a few works highlight that, in the medium run, the services offered by CAIs could generate negative economic externalities. For example, Dooling (2009) and Tornaghi (2014) showed that some initiatives may promote ecological gentrification, by increasing the value of poorer inner-city areas. Due to CAIs, the price of housing and other services can increase, negatively affecting low-income residents. Moreover, we cannot exclude potential negative economic impacts of CAIs. For example, members and participants may incur direct/indirect costs such as periodical membership fees, project operation costs, maintenance, and management duties. Direct participation means that people need to devote a certain amount of their time contributing to the initiative, through voluntary work, which is a "double" cost, in terms of reduction of spare time and wage loss.

In general, all initiatives face internal economic issues and provide external (direct/indirect) economic effects. The internal economic and financial performance of CAIs is crucial in terms of chances to

survive. Moreover, the effectiveness of their activities, the financial conditions and management and their ability to deliver their services are also measures of their internal performance. Another possible perspective in the economic assessment is what CAIs can deliver in terms of economic benefits to their members or participants as well as to the broader community.

Therefore, we distinguish between (i) *the internal economic conditions and challenges faced by CAIs*, e.g., assessment of the economic activity, or the necessity of specific skills and resources to survive and compete in the market, and (ii) *the external economic effects induced by CAIs* at the participant/member as well as at the wider community level. We consider this dichotomy in our framework, highlighting variables and indicator to evaluate the internal/external economic conditions and effects at CAIs/members/participants' or community levels.

We define "*member*" as a citizen who has an active role in the CAI, investing in it, directly benefits from his/her investment and/or being involved in the decision-making process at different levels. A "*participant*" is someone who contributes (economically or with his time and skills) to a specific cause promoted by associations, non-profit organizations, grass-roots initiatives, etc., but without influence on e.g. the use of funds collected or which project to finance or any involvement in the decision making processes and without direct economic benefits.

We identify five economic dimensions of performance:

1. CAI lifetime and sustainability - under this dimension the lifetime of the CAI is assessed as an indication of the success and sustainability of the initiative over time.
2. Scale of activity – under this dimension fall a set of variables which defines the scale of the activity under different dimensions (geographical, number of members, service provided etc.).
3. CAIs internal economic performance – variables and indicators are provided to assess economic performance of the CAI.
4. Economic impact on members – includes variables and indicators that can be used to assess economic implications (costs, benefits) for members.
5. Wider economic impacts on the community, including spillovers and redistribution effects.

The following section 4.1.1 presents a set of possible variables for the first four economic performance dimensions, while three indicators to assess wider economic impacts are presented in the indicators section 4.1.2.

4.1.1. Economic Variables

VARIABLES	DEF.	UNIT	TYPE	REFERENCES	AVAILABILITY
Year of creation	1	Year	BOTH		G
Year of removal	2	Year	BOTH		G
Activities	3	NA	BOTH		Y
Location/address of CAI (headquarter)	4	GPS coordinates, address	BOTH		G
The Scale of economic activity	5	Nuts level	BOTH		G
Number of employees	6	N. of FTE	BOTH	-	Y
Number of members	7	N	BOTH		Y
Total revenues	8	€	BOTH	-	G
Fees/Subscriptions/Memberships	9	€	BOTH	-	R
Banks' financing	10	NA	BOTH	-	Y
Public grants and incentives	11	NA	BOTH	-	G
Sales of services	12	NA	BOTH	-	G
Sales of goods	13	NA	BOTH		G
Tangible Assets	14	?	CE	-	G
Price of one quota	15	€	CE	Bauwens (2016)	G
The average investment in the initiative	16	€	CE	Bauwens (2019)	Y
The average return on the investment	17	%	CE	Candelise and Ruggieri (2017); Bauwens (2019)	Y

Table 7: Economic variables

a. CAI lifetime and sustainability

1. Year of creation of CAIs

This variable is useful to place CAIs in the policy, economic, and country-level context, and to analyse and understand conditions that have affected their development. For example, whether the national or EU policy framework has played a role in the CAIs start-up and progress could be understood.

2. Year of removal of CAIs

This variable is relevant in order to assess the lifetime of the CAIs as well as the potential conditions and causes of success or failure, e.g. by contextualising the date of removal with changes in the policy framework (for ex. removal of incentives relevant for the economics of the CAIs, such as tax credits) or by merely assessing the duration of the initiative itself and the implications in terms of socio-economic and environmental impacts.

b. Scale of activity

3. Activities

A qualitative entry composed by several elements and variables describing the activities of the CAIs both along the energy supply chain and wider environmental, social activities. These variables characterizing CAIs activities fall within one of the explanatory dimensions identified in the report of deliverable 2.1 and applied in the analysis of the survey in deliverable 3.3, as already introduced and discussed in Section 2. For a more detailed description, please refer to the report of Deliverable 3.3.

4. Location of CAIs

This variable helps to investigate the geographical spread of a CAI around it. It is derived from the registered address. The variable is useful to analyse the locality of activities (e.g., PV installation units) relative to the headquarters. The locality also allows to study the recruiting area of members.

5. The scale of economic activity

A distinctive feature of CAIs is the scale of their activity, e.g., national vs. local. We investigate the dimension of the geographical area covered and the number of people that benefit from the initiative itself. This information is useful to gauge the outreach potential of the initiative and could contribute to the understanding of which CAIs can survive across years, given the country in which they are located and the specific political and cultural context they face. Various sources of information can be used to indicate the scale of CAI activities. For CAIs that engage in energy production through operation of production facilities, which is the most common activity among CAIs, the spread of the production facilities can indicate the scale of activity. Information on the location of production facilities is readily available in most countries, either centralized (e.g Marktstammdatenregister for Germany, Hieropgewekt for Netherlands) or reported on the websites of individual CAIs. CAIs also occasionally indicate the intended scale of their activities in their statutes, for example in Germany.

6. Number of employees

Number of people employed by the initiative as a proxy of the dimension of the initiative and its ability to recruit professional staff to support the activities.

7. Number of members

Number of members as a proxy of the size and outreach potential of the initiative.

c. CAI economic performance

8. Total revenues

Total revenues of the CAI. This information is relevant to evaluate the economic performance of CAIs. The point is to understand if the initiative is solid and able to face external shocks, such as a decrease of members or financing sources or unexpected low incomes, e.g. due to low solar radiation in a year, without compromising the activity of the CAI.

9. Fees/Subscriptions/Memberships

Total gain from fees, subscriptions and memberships. Relevant to build indicators. This information needs to be surveyed.

10. Bank's Financing

This variable shows if the CAIs benefit from external support by banks. The possibility to collect funds from the private sector may condition the existence of CAIs, especially when the initiative has to start, and a significant amount of money is needed to set up the project. Available from the yearly balance sheets. Some evidence of ability to get credit from private banks available also in results of WP3 survey, in deliverable 3.3.

11. Public grants and incentives

Public funds and incentives collected by the initiatives. This could be relevant information to assess which conditions have contributed to the implementation as well as to the economic sustainability over time of the initiative. For example, evidence from analysis of WP3 survey in deliverable 3.3 Report shows a significant role of public grants in supporting financing of CAIs in several surveyed countries.

12. Sales of services

This variable could be of interest to understand other possibilities for CAIs to get funds.

13. Sales of Goods

This variable could be of interest to understand other possibilities for CAIs to get funds.

14. Tangible Assets

The amount of equipment owned by CE. Variables are total amount of equipment (in terms of type, capacities, charging points, grid & network infrastructure), data of purchase of equipment, type of equipment (e.g., Original Equipment Manufacturer), location of equipment and cost of equipment (primary and or secondary market prices). Related to the equipment are also production data (e.g., kWh of electricity produced and/or sold at the markets).

For formalized CAIs (that are required to register as legal entity under national law) data required for the variables 1-14 above are commonly available in regular financial statements. However, the degree of accessibility of such financial statements varies greatly from country to country. In Germany, for

example, financial statements of cooperatives tend to be available in national business registers free of charge, while in other countries such documents need to be purchased.

d. Economic impact on members

15. Price of one quota

The amount required to participate in the initiative, if ownership or financing is implied (mainly in the case of CEs). This variable could be further broken down to know the amount needed to buy a share of the CE (in case of ownership) or to finance the CE through loan. These variables map the forms of economic participation in the CAIs selected by the project. Such information could be used, e.g. to understand how financing CE initiatives impact the income level of members. This information is available usually from the rules and regulations of the CAI, mainly if they are legally defined as cooperatives. However, if loan agreements are a requirement of investments/activities of the CAI, this is not always directly accessible. Also note that some CAIs offer quotas in various denominations and quota can be purchased as multiples of denominations.

16. The average investment in the initiative

This variable gives information on the average amount invested by members and participants. It can be used to study how the economic involvement of members and participants change through time and, for example, at the CEs level, how the investment of members changes according to differences in the initiative considered, e.g., local vs. national. This information is sometimes hard to get. Usually it is accessible only by survey of the CAI. However, notice that some CAI/COOP report this to show that the investments are evenly spread.

17. The average return on the investment

This variable shows the (average) return on investment for members. It reports the external monetary benefits offered by the initiative. Investigating whether the presence of such incentives condition the involvement through time of members and pushes more citizens to join the initiative, is a question the project might want to address. Notice that at least for many COOPs, we have the yearly balance sheets. From this, we can compute the yield paid to members for each year.

4.1.2 Indicators of Economic Performance

We propose here some indicators to assess economic performance of CAIs. In particular, one indicator of CAI internal economic performance called *revenue concentration index* and one indicator of economic impact on members, *bill saving* which are applicable mainly to CE initiatives. We also consider three potential indicators of wider economic impact, which could be used for all types of CAIs: *jobs creation*, *equity and justice/redistribution effects* and *economic spillovers*.

- Revenue concentration Index

This indicator investigates the ability of CAIs to maintain financial capacity over time (Bowman, 2011). This is relevant to understand if CAIs can survive and to be effective in pursuing their objectives. Usually, CAIs can account for different sources of funding. We adopt an economic concept such as the Herfindahl Index¹ to measure the concentration of funding sources in the portfolio of CAIs.

$$\text{Revenue Concentration Index} = \sum_j \left(\frac{\text{Revenue}}{\text{Total Revenues}} \right)^2$$

For each initiative, “the square of the (percentage) share that each revenue source represents to total revenue” is summed to produce the index. We obtain a revenue concentration measure that captures both the number of revenue sources and the extent of revenue dispersion (TESS project, 2016a). The j sources are the variables related to internal and external sources of funding such as *fees/subscriptions/memberships, sales of services and goods, public grants*, etc., which constitute the revenues of CAIs. If the CAI has equal revenue from many sources the value of the index is close to zero; if the revenues come from a single source, the index will be equal to one. The initiative is considered financially sustainable when its concentration index is close to zero (Abraham 2003).

- Bill Savings

Previous literature on motivation to invest in CAIs (Bergman and Eyre, 2011; Sauter and Watson, 2007), highlights how many CE initiatives offer discounts to bills for CE members to increase the involvement of citizens. Using the variable *price of one quota*, and knowing the average discount provided by specific initiatives, we can compute an indicator representing the *bill savings* for members.

$$\text{Bill Savings} = (p \times s_{\%})$$

The price of one quota p is multiplied by the expected saving per year $s_{\%}$. Nevertheless, this indicator is quite specific only to certain types of CAIs, mainly CEs. In particular, it applies to CEs where members purchase their electricity/heat from the CAI itself. If this is not the case, members just get the yearly yield from the CE as a normal business activity.

- Jobs Creation

This indicator investigates if CAIs are engines promoting the creation of jobs (Bauwens 2016). We can consider *the number of employees involved* in CAIs, transformed into full-time equivalents.²

¹ The Herfindahl index is a measure of the size of firms in relation to the industry and an indicator of the amount of competition among them. See Rhoades, 1993.

² Full-time equivalent, sometimes abbreviated as FTE, is a unit to measure employed persons in a way that makes them comparable although they may work a different number of hours per week. For example, a part-time worker employed for 20 hours a week where full-time work consists of 40 hours, is counted as 0.5 FTE (EU, 2017).

$$\text{Jobs} = \frac{\sum \text{hours worked per member/participant}}{40 \text{ hours}},$$

where the denominator, i.e., 40 hours, is chosen to convert the time spent in CAIs in full-time jobs.

- Equity and justice/Redistribution Effect

Some contributions in the literature (see Adams and Bell, 2015), highlight the redistribution impacts of CAIs. In particular, CAIs could help in maximizing 'localization' of economic benefits accruing from investment in renewables and other services, ensuring equal and fair redistribution of benefits/revenues resulting from the deployment of low carbon technologies. Suitable quantitative or qualitative indicator needs to be identified. One possible quantitative indicator could probably be constructed using the difference between the local average income and the national average income. The logic would be that a CAI might keep value circulating in a poorer area, compared to the national average, and that this would have positive distributional effects.

- Economic Spillovers of CAIs

This indicator measures the economic value of tangible and intangible services offered by CAIs. CAIs may offer (discounted) products to their members, such as insurance, bank services, magazine, and books. Besides the direct benefits for members, other initiatives indirectly benefit the whole society. Here the question is to identify economic spillovers through, firstly, determining which kind of services and products are offered by CAIs.

A method developed by the New Economics Foundation (NEF, 2019), could be adapted to our evaluation framework. In particular, we are referring to the *Local Multiplier 3 (LM3)*. LM3 is a method to measure the local economic impact of organizations in the economy. The 'multiplier' is an economics concept and is defined as "*the money that enters an economy has a multiplier effect on that economy based on the way people spend and re-spend money*". More re-spending in the local economy means a higher multiplier effect because more income is generated. The indicators could be constructed using data already available plus collecting additional information through the inventory and the survey. We will refine these indicators in the next steps of the project.

4.2 Environmental dimension

The transition to a low-carbon economy is recognized as a crucial need in contemporary societies. Greenhouse Gases (GHGs) from burning fossil fuels pollute the atmosphere and generate dangerous and unpredictable increases in temperature, leading to climate-change. The resulting climate damages and the disastrous effects on ecosystems and biodiversity are widely documented, and solutions to mitigate climate change and adaptation measures are under investigation.

CAIs, and CEs in particular, offer members clean energy (solar, wind, hydro, bioenergy), so they can be seen as vehicles to promote renewables at local level. Moreover, on November 30th, 2016, the European Commission (EC) presented a package of measures called “Clean Energy for All Europeans”, which pursue three main goals, (i) energy efficiency, (ii) leadership of the EU in renewable energy, (iii) empowering households, business and energy communities. A formal definition of energy communities and a recognition of their role in Europe as actors in the energy transition is provided by the Directive (EU) 2019/944 (recast Electricity Directive) and Directive (EU) 2018/2001 (the recast Renewable Energy Directive).

One of the COMETS project goals is quantifying the European-wide aggregate contribution of CAIs to the energy transition at national and European levels, by investigating their evolution and scaling up and studying implications in terms of reduction of GHG emissions and of potential other environmental impacts. In what follows, we propose a methodology to make a GHGs assessment of CAIs. Then, as for the economic area, we list some variables and outline some indicators which can be useful to evaluate the performance of CAIs in abating GHGs.

The TESS project (TESS project, 2016b) developed a framework for the GHG accounting of CAIs. The GHG Protocol provided the guidance for the quantification of CO₂ or GHGs emissions-reduction of CAIs for project accounting (Greenhalg et al., 2005). We build upon this methodology and, in what follows, we propose further variables/indicators to be considered. Following the TESS project (2016b), we provide an overview of the GHG activities relevant to CAIs. The TESS project developed the concept of the quantification of GHG emissions reduction for several actions of CAIs reported in Table 5.

Domain	Activity	Service/Product provided
Transport	Transportation of Goods	Sustainable Transport of light weight goods
	Provision of Transport to Persons	Sustainable personal transport
Food	Provision of Food	Provision of locally grown organic produce
	Provision of Infrastructure for Local Food Markets	Provision of locally grown organic produce
	Redistribution of Food	Saving food from businesses and avoiding food waste at home
	Provision of Meals	Provision of vegetarian and/or vegan meals
Goods and Materials	Repairing, Reusing, Upcycling	Repair, reuse or upcycle of goods and materials
	Recycling	Recycle of materials
Energy	Provision of Heat	Provision of heat from more sustainable energy sources
	Provision of Electricity	Provision of electricity from more sustainable energy sources

Table 8: Activities of CAIs: quantification of the GHG emissions reductions. Source: TESS (2016b)

For the time being, we describe this methodology applied to the CAIs which provide electricity from renewable sources. Ideally, we can use the same method for other types of CAIs, aiming at offering different kinds of services.

Looking at Table 8 (TESS project, 2016b), we focus on two types of CAIs' activities: (i) provision of heat and (ii) provision of electricity. Applying the methodology, a baseline scenario is identified, i.e., a scenario that accounts for all emissions that would be generated in the absence of CEs' activities, which is compared with the resulting activities of CEs.

Moreover, we report the variables and indicators which could be used to evaluate the performance of CAIs in decreasing GHGs. As before, we keep the division between the members/participants level and the CAIs level. The reason is that, besides the overall ecological impact of CAIs, it is crucial to investigate the CO₂ contributions at the individual (member/participant) level.

4.2.1 List of Environmental Variables (CO₂ assessment of CAIs)

VARIABLES	DEF.	UNIT	TYPE	REFERENCES	AVAILABILITY
Members/Participants					
Per-capita heating demand of different heating sources	21	kWh	CE	TESS (2016b)	G
Emission Factors for Heat	22	Kg CO ₂ /kWh	CE	DEFRA (2015)	G
Estimated number of beneficiaries	23	Numb.	BOTH	CE	G
Average space heating consumption	24	kWh/person	CE	ENTRANZE 2013; Eurostat 2014	G
CAIs					
Average national electricity mix	26	-	CE	EUROSTAT (2015)	G
Renewable electricity source	27	kWh	BOTH	EC (2015)	G
Renewable energy produced	28	kWh	CE	EC (2015)	G
Emission Factors for energy sources	29	Kg CO ₂ /kWh	CE	IPCC (2011)	G
Installed capacity (PV plants, Eolic)	30	kWp	CE	-	G

Table 9: Environmental variables

18. Per-capita heating demand of different heating sources

19. Emission Factors for Heat Energy

20. Estimated number of beneficiaries

21. Average space heating consumption

Variables 18-21 are needed to compute the heating indicator. We report the data sources in Table 9.

22. Average national electricity mix

23. Renewable electricity source

24. Renewable energy produced

25. Emission Factors for energy sources

Variables 22-25 are needed to calculate the Electricity indicator. We report the data source in Table 9.

26. Installed capacity (kW)

Relevant to assess the size of the activity, at least for the CAIs that use renewables.

4.2.2 Indicators of CO₂ Impacts of CAIs

These indicators are useful to compute the impact of CAIs in terms of CO₂. They can also be adjusted to measure the CO₂ impact at member/participants level. The *heating*, *electricity*, and *avoided CO₂* indicators are applied to CEs. We also suggest some broader indicators, i.e., air pollution, which can be used to CAIs in general.

- Heating

We build an indicator to quantify the GHG emissions from heating buildings. The space heating consumption per building is calculated to capture the demand per person. The result is then multiplied by the corresponding EF for the respective fuel used for the generation of heat (gas, electricity, oil, etc.). We assume the national average of fuel mixes for heating.

Regarding CAIs, we assume that the number of members (CEs), satisfy their total heat demand through renewables sources. The average heating consumption per member and country is multiplied with the corresponding EF of the renewable energy source. Then, we compute a baseline scenario and the activity scenario for emissions of CAIs as follows:

$$\begin{aligned} \text{Baseline}_E &= \sum_i^n N_i * h_i * EF_i \\ \text{CAI}_E &= \sum_i^n N_j * h_j * EF_j \\ \text{Indicator}_E &= \text{Baseline}_E - \text{CAI}_E \end{aligned}$$

Where $Baseline_E$ and CAI_E represent the baseline and CAI emissions, respectively, in kgCO₂; $N_{i,j}$ represent the number of people provided with heat energy for each type of energy, and i, j are citizen not belonging to CAI and member of CAIs, respectively; h is the average heat energy consumed by one person for type of heat energy, in kWh; EF is the emission factor for each type of heat energy, in kg CO₂/kWh. The difference between the two scenarios gives the final indicator. It provides the amount of emissions saved (if positive) or additionally produced (if negative) by CAIs.

- Electricity

CAIs providing electricity using renewables (like solar and wind) are expected to decrease emissions compared to the business as usual national mix. Regarding renewables, the emissions due to the production of facilities should be taken into account for the computation.

The baseline scenario is computed, multiplying the share of the energy source for the generation of electricity by the emission factors for each energy source. The emissions from CAIs are obtained multiplying the electricity generated by the CAI by the emission factor of the renewable source considered. As before:

$$Baseline_E = \sum_i^n en_i * EF_i$$

$$CAI_E = \sum_j^n en_j * EF_j$$

$$Indicator_E = Baseline_E - CAI_E$$

Where $Baseline_E$ and CAI_E represent the baseline and CAI emissions, respectively, in kgCO₂; en is the national electric energy produced by energy source i, j ; EF is the emission factor per electrical energy produced by energy source, in kg CO₂/kWh. The difference between the two scenarios gives the final indicator. It provides the amount of emissions saved (if positive) or additionally produced (if negative) by CAIs.

- Avoided CO₂

This indicator computes the CO₂ emissions avoided by each plant installed by CEs. To calculate it, we need data on the kWh production of the plant and the factor emission of the electricity mix specific for each country in which CEs are analyzed. For example, in the case of a CE implementing a renewable plant in Italy: we consider the factor emission of the electric mix for Italy (Minister of the Environment, ISPRA), which is 0.531 kgCO₂/kW_{el}³. Each kWh produced by the plant avoids the emission of 0.53 kgCO₂/kW_{el}. Suppose we have a plant in Milan producing 1167.4 kWh/yearly.

³ The equivalent of 2.56 kWh is burned in the form of fossil fuels to produce 1 kWh of electricity, and consequently, about 0.53 kg of carbon dioxide is emitted into the air.

$$\text{Avoided CO}_2 = 1167.4 \frac{\text{kWh}}{\text{yr}} \times 0.53 \frac{\text{kgCO}_2}{\text{kW}_{el}} = \frac{619\text{kgCO}_2}{\text{yr}}$$

Considering that a PV plant has a life span of 30 years

$$\text{Avoided CO}_{2_{30\text{yr}}} = 619\text{kgCO}_2 \times 30\text{yr} = 18596 \text{ kgCO}_2$$

4.3 Social Innovation

As already stated in (Padovan et al., 2019), this project investigates social innovation processes, conditions, and outcomes. Hubert et al. (2010) consider social innovations "*as new ideas (products, services, and models) that simultaneously meet social needs and create new social relationships or collaborations. In other words, they are innovations that are not only good for society but also enhance society's capacity to act*".

The concept of social innovation identifies innovations, which do not create new technologies or products, but changes in attitudes, behaviour, social practices, and organizations' forms (Neumeier, 2010; TESS, 2016). Previous literature tries to select both qualitative and quantitative methodologies to assess the outcomes of social innovation (Seyfang and Smith, 2007, 2010; Cajaiba-Santana, 2014; Reeves et al., 2013). However, social innovation and its impacts are intangible, and so, often difficult to be identified and evaluated. As such quantitative assessment and data availability are more of an issue compared to the other areas. Moreover, survey based methodologies tend to be the mostly appropriated to collect information and data on social innovation. Indeed COMETS WP3 survey has included several questions on social impacts of CAIs, but rather than providing a quantitative or qualitative measure of them it mainly highlights how these are objectives commonly shared among European CAIs. For a more detailed description, please refer to the report of Deliverable 3.3 (Lupi et al. 2021).

We identify several dimensions to be considered in the effort of assessing performance of CAIs in delivering social innovation through their action and activities. They are summarised in the table 7 and discussed in the following section. When possible we suggest possible variables and indicators that could be used to provide a quantitative or qualitative assessment of some dimensions or of some aspects of them.

4.3.1 Social Innovation dimension

DIMENSION	REFERENCES	AVAILABILITY
Participation and engagement	Bauwens et al., (2016) Candelise & Ruggieri (2020)	Mainly survey based

Trust	Walker, Devine-Wright et al. ,(2010); van der Schoor and Scholtens (2015); Monitor.coop	Mainly survey based
Social inclusion	Hewitt et al. (2019)	Mainly survey based
RE access	UNDESA (2019); IAEA (2005)	Mainly survey based
Green habits	-	Mainly survey based
Energy Poverty	(UN 2015)	Mainly survey based
Social Acceptance of Renewables	-	Mainly survey based
Energy Context	-	Mainly survey based
Governance	Hewitt et al. (2019)	Mainly survey based
Partnership	Oteman et al. (2017)	Mainly survey based
Resilience	Binder et al. (2017)	Mainly survey based

Table 10: Social Innovation dimension

A. Members participation and engagement

This dimension investigates if CAIs are social vehicles enabling the active participation of citizens/members. The effort is to find measures to quantify the “level of participation” in different initiatives and, if possible, to compare the trends across years. Needed information has to be gained via survey in most cases.

A quantitative variable which could be used to assess performance of CAIs in achieving high levels of participation is the percentage of ownership/equity of the initiative detained by the members (see for example Candelise and Ruggieri, 2020). This variable applies mainly to CE initiatives (as defined in this report), and it could be used as a proxy of the success of those initiatives in engaging citizens. The higher this %, the more successful the initiative has been in involving members and, in turn, in redistributing the economic benefits of the initiative among them.

Occasionally, information can be found on member participation and engagement in annual general meetings. Formalized CAIs such as cooperatives often require at least one general meeting per year and require formal protocol in such meetings. In Germany, for example, CAIs may publish these meeting minutes, which also include the number of members that joined, as well voting outcomes for specific decisions (for, against, abstentions). These values can be compared to the total member number for each year, respectively.

A proxy for this dimension could be the number of the CAI's members involved in project management activities or the difference between the amount of the CAI's members engaged in project management (PM) activities in the early period of CAI and those involved in PM activities at the end period of the CAI. This proxy could also be used at the CAI level, measuring the ability of the CAI to empower the whole community where CAI is located, allowing citizens to take part in its PM activities. Moreover, it could be of interest to explore the preliminary level of social participation in decision-making processes before the constitution of CAI. To this end, the number of CAI members usually involved in the local city council can be used as a proxy.

To measure the extent of the engagement, an engagement rate indicator can be defined:

$$\text{Engagement Rate} = \frac{n.\text{of members (volunteers)}_{t+1} - n.\text{of members (volunteers)}_t}{n.\text{of members (volunteers)}_t}$$

The indicator can be computed at the CE level, considering the change in *members* across years. It can also be calculated for other types of initiatives if we pick the number of *volunteers* involved in CAIs. Another option is to measure members participating at yearly meetings in relation to total membership numbers.

B. Trust

Contributions in the literature (in particular on CEs) often point out the relevance of “trust” among members, both as an enabling condition for CAIs and as a result of CAIs activities. Assessing the direction of causality (e.g., is trust enabling CAIs and are CAIs creating trust) would be important to assess whether CAIs have a direct positive impact on trust. However, direction of causality is quite difficult to assess both because the definition of trust can change considerably according to the context and because it would require a quite detailed, possibly context dependent and survey-based analysis.

One possible way could be to compare levels of trust in CAIs of different ages. For example, a CAI that has only existed for 1 or 2 years versus one that has existed for 10 years, and whose membership has been relatively stagnant in the last few years. This should probably be done for CAIs which are similar in terms of activities and context of implementation.

Proposed proxies that could be evaluated to assess the level of trust within a CAI are:

- the discussion in yearly meetings;
- the stability of the board: if the board composition is frequently changed, this can be a very democratic CAI, but possibly indicative of internal quarrels.

- If there are any internal leadership elections with multiple lists or opposing candidates, that could seem a sign of internal conflict since those events are rare in smoothly functioning CAIs.

One other idea for assessing trust is to look into the meeting minutes for general assemblies and find the percentages that "no" votes received on motions.

C. Social Inclusion

This dimension aims at assessing the ability of CAIs to be inclusive and to involve a wide range of stakeholders, including representation of gender and minorities. A set of variables have been identified under this dimension, as follows.

VARIABLES	DEF.	UNIT	TYPE	REF.	AVAILABILITY
Number of males/females involved in CAIs	27	%	BOTH	Fraune (2015), Van Veelen (2018)	Y
The average income of people involved in CAIs	28	€	CE	Bauwens & Defourny (2017)	Mainly based survey
The average education of people involved in CAIs	29	%	CE	-	Mainly based survey
The average age of people involved in CAIs	30	Years	BOTH	Van Veelen (2018)	Mainly based survey

Table 11: Social Inclusion variables

27. Number of males and females involved in CAIs

These variables map the gender distribution of people involved in CAIs. Potentially useful for demographic description and assessment, and to study gender and equality issues. Mapping the gender distribution of members/participants can be difficult due to a lack of data availability. In the case of formally structured CAIs, such as cooperatives or associations, only Swedish and Danish CAIs publish full member lists, which can be used to assess gender ratios. For these two countries the information is available in a standardized way in the national business registries. Information on the members of the steering bodies of CAIs (board of directors, advisory board, etc) is more readily available in other countries, however not in a standardized way. Information on the composition of the board (male/female) can potentially be used as a proxy for better-structured initiatives. Smaller initiatives, less structured, and relying more on the direct participation of citizens/members can be surveyed.

28. The average income of people involved in CAI

This variable is interesting from a socio-economic point of view. It helps in creating and defining a profile of CAI members. It is interesting to understand if CAI members belong to medium-high average income or if the average income of members is heterogeneous. As mentioned in respect to the gender

ratio of people involved in CAIs, information on individual members/participants is rarely available. This includes information on income. Survey based studies have been conducted by, for instance Bauwens & Defoury (2017). Given the fact that CAIs are commonly active on a local/regional level (REF), average household income values for specific administrative regions can be used as a proxy. The COMETS consortium applied this approach in two exemplary studies for the cases of Germany and Italy (Wierling et al., 2020; Wierling et al. 2021). The price of one share in the CAI (see economic indicators) may also indicate who can afford to become a member, with higher shares being unaffordable to low-income households.

29. Average Education of people involved in CAI

This variable shows the percentage of graduates among members. It is interesting from a socio-economic point of view. CAIs, CEs initiatives, in particular, have always relied on specific skills of founders/members. It may be of interest to show the level of education of people participating in CAIs is medium-high on average. COMETS may further explore this evidence and expand the knowledge to a broader audience. Except for data collection through surveys, information on the members of a CAI's steering bodies can be used. In a number of countries (e.g. Germany, Sweden, Denmark) CAIs commonly report occupation as well as titles (Dr., Prof, etc.) of the steering body members.

30. Average age of people involved in CAI

This variable shows the age distribution inside CAIs. This information is relevant from a socio-economic point of view. Collecting evidence on how and if CAIs can attract different age groups could be connected with their ability to survive and to engage the majority of the society in such projects. Data on dates of birth is available for members of Swedish and Danish CAIs. For other countries, a direct survey should collect this data. Qualitative studies on this matter have been conducted for instance by Van Veelen (2018). An investigation into the case of Sweden and Denmark can be found in Wierling et al. (2020)

D. RE access

CAIs (CEs in particular), are considered as initiatives facilitating access to renewables. A proxy variable for it could be the number or the share of CAI's members with access to renewable energy sources, e.g., number/share of members with a PV installation, with a 'green bill,' etc.

E. Green Habits

Finding (qualitative) measures to understand if CAIs promote a "green behavioral change at the society level". Survey based analysis can support information gathering. For example, analysis of results of WP3 survey in report of Deliverable 3.3 (Lupi et al 2021) shows that CAIs surveyed engage in environmental care activities (ECA), in knowledge and skills creation (K&S), and civil society mobilization activities (CSM).

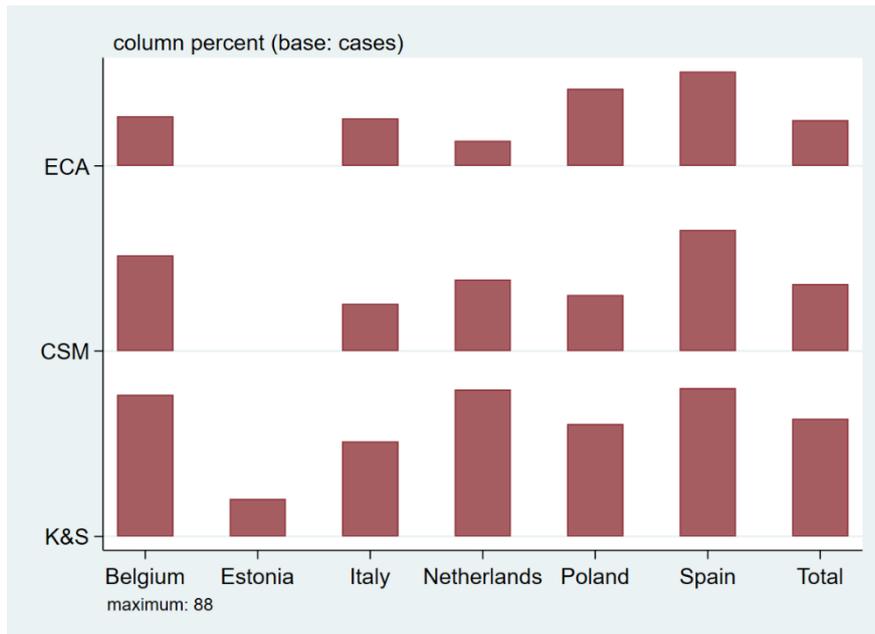


Figure 9: Distribution of energy-related activities at large (Source Lupi et al, 2021)

Figure 9 shows that except for Estonia, CAIs perform at least one of these education and mobilization activities at large in all countries.

F. Energy poverty

This social innovation dimension is useful to understand the impact of CAIs on fuel poverty. As an example, schemes led by local authorities and community energy groups could help in easing access to energy in impoverished areas. The Sustainable Development Goals framework could be used to select appropriate variables/indicators. Qualitative information could be collected through the survey. Information on energy poverty objectives of CAIs have been indeed gathered through the WP3 survey, as already discussed in Section 2, for a more details see report of Deliverable 3.3(Lupi et al. 2021). Additionally, in cases where CAIs sell their own energy, either directly or through associated retailers (e.g Bürgerwerke in Germany, Enercoop in France), energy prices can be compared to prices of incumbent energy providers.

G. Social Acceptance of Renewables

This dimension investigates if CAIs could be seen as a means to increase the acceptance of renewables among citizens. Needed information has to be queried from the survey. In the case of Germany, the database on petitions and referenda, run by the University of Wuppertal, includes petitions for or against renewable energy projects. This can be mapped in comparison to the location of CAIs to check for local co-occurrences. Another measure of this variable, or rather its absence, is the existence/persistence of public opposition to renewable energy development projects, even when the CAI is involved.

H. The Energy context

This dimension aims at understanding the pre-conditions at the infrastructural level in territories where CAIs developed. A proxy could be the number of energy infrastructures already operating before the constitution of CAIs. In the French case, mixed economy companies are frequently attached to the departmental energy syndicate and some of these have specific focus on either developing renewable energy infrastructure, facilitating citizen appropriation of the energy transition, or both. The presence and activities of such institutional actors and their posture toward renewable energy CAIs can be measured qualitatively.

I. Governance

A dimension including information about the structure of governance in order to gauge the level of representativeness and democracy within a CAI. These type of information can be gathered through surveys, for example information about governance is included in the COMETS WP3 survey and analysis, for a more details see report of Deliverable 3.3 (Lupi et al. 2021). Information of interest includes the voting system (collegial, direct voting on all major decisions, one person = one vote, etc.), the existence/number of committees and working groups, oversight structures, and other formalized practices to ensure good governance. The management structures can either be prescribed by national law or defined individually by each CAI in their statutes, depending on the chosen legal form. In addition, these structures can be compared to established best practices published by associations serving as networks of CEs.

J. Partnership

A dimension identifying the kinds of partnership set up by the CAI (e.g., private-public partnership, collaborations with academic institutions or local schools, etc.) in order to assess wider societal impacts of CAIs activities or, viceversa, the level of influence they receive from the external context. Information on formal partnerships, such as subsidiaries or umbrella organizations or members of steering bodies also representing other business entities can often be found in national business registers (e.g. Northdata for Germany). Information on less formal partnerships is often available on CAI websites. This indicator can also include information about the degree of involvement of the CAI in regional or national level networks and other organizations that mutualize resources between CAIs, as well as collaborations with other CAIs on projects.

K. Resilience

The dimension deals with CAIs' contribution to the resilience of the energy transition process. It could be built upon the Activities and Partnership indicators, producing a final quali/quantitative assessment or potentially an index. The resilience index should rely on resilience's core characteristics, such as diversity and connectivity. It could be captured respectively by the number/type of activities and partnerships.

5 Conclusions

This report aims at evaluating collective action initiatives (CAIs) to understand their performance in the energy transition and social innovation. The introduction and the first section of this report describe the objectives of the COMETS project and recall the definition of CAIs and defining characteristics. This is essential to define the boundaries of our study and to understand which types of CAIs the project is focused on.

We connect our framework to the concept of sustainable development and, in particular, to Sustainable Development Goals (SDGs). Then, we propose a straightforward methodology which defines dimensions of performance of CAIs and identifies a set of potential variables and indicators to assess them.

CAIs are heterogeneous and multidimensional, meaning that they affect several aspects of our society. To deal with this heterogeneity COMETS has proposed to describe and characterize CAIs along *explanatory dimensions* (including the dynamics of creation, the organizational structure, the financing, CAIs activities in the energy transition and wider social impact) which have been taken into account in the design of COMETS inventory as well as in the COMETS survey. This effort has allowed to better characterise CAIs along the different dimensions and provides the backbone structure to account for CAIs heterogeneity in developing the framework for their performance assessment.

Given the multidimensionality of CAI, three key macro-areas of assessment are defined: economics, environmental impact and social innovation. For each area, dimensions of performance are identified and discussed. A set of variables that could be potentially used to calculate or proxy the different dimensions have been presented and discussed, including some indicators, when available.

The list of determinants, variables and indicators provided in this report is not intended to be fully comprehensive of all the possible variables and indicators of performance of CAIs. Further analysis and evolution of this report are possibly delivered in the future steps of COMETS projects, along with a progressive advancement of the other WPs, in particular WP2, the Europe-wide inventory of CAIs in the energy sector.

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