The contribution of collective prosumers to the energy transition in Europe - Preliminary estimates at European and country-level from the COMETS inventory

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Abstract

We present preliminary estimates for the contribution of collective prosumers to the energy transition across Europe. Drawing from the COMETS inventory, we report country-level and EU-level aggregates for current total numbers of initiatives and their historic evolution, the fields of engagement, the number of people involved, renewable capacities installed, number of projects administered, and total funds invested. Currently, at least two million citizens across Europe collectively engage in more than 8400 energy communities, realizing a minimum of 13000 projects and investing at least 2.6 billion EUR.

Introduction

The successful transition of national energy systems from fossil-fuel based systems to renewable-based systems benefits from the engagement of citizens in transformation processes in various ways. Across Europe, citizens form different types of collective action initiatives (CAI) to invest in renewable energy projects, to ramp up renewable capacities, or to motivate and support others in participating. In these ways, citizens act as pioneers and explorers of the necessary system changes. They test the practicability of technical and legislative solutions, experiment for the benefit of the local community, serve as partners to public authorities in transition initiatives, identify new business models, and, most importantly, they partake in the discussions about the shape of the future energy system.

Case studies of CAI have been carried out in many countries. However, aggregate quantitative information is largely lacking (c.f. Wierling et al. 2018, Berka et al. 2018). As a response to these missing aggregates, this paper presents the first systematic insights and aggregates, drawing from an inventory that has been compiled over the last 3 years, as part of the EU funded project "COMETS - Collective Action Models for the Energy Transition and Social Innovation" (05/2019-04/2022). We report preliminary country-level and EU-level aggregates for current total numbers of initiatives and their historic evolution, fields of engagement, number of people involved, renewable capacities installed, number of projects administered, and total funds invested. The focus of the paper is on CAIs with legal registration. Projects without legal registration are also recorded if possible, but no systematic search has been made.

It is important to note that this paper presents preliminary estimates only. A final update and open publication of the inventory on collective action initiatives in the energy transition is planned for Spring 2022.

Context

Members and associated countries of the European Union are currently implementing EU Directives 2018/2001 and 2019/944 which define the terms "Renewable energy community" and "Citizen energy community", respectively. Both legal terms also outline the space for what we

operationalize in the COMETS inventory as collective action initiatives (CAI). While some differences between these three concepts exist, the important points are that:

- Members participate voluntarily and have full control over their initiatives (e.g., following the 'One-member, one-vote' rule as is common among energy cooperatives),
- The initiative benefits the local community (socially, environmentally, and/or economically).

The focus of the paper is on collective action initiatives that engage in the sustainable energy transition. This means that we compile data on citizen-led energy projects that involve renewable energy, energy saving, sustainable energy consulting, and services. We do not cover initiatives that solely engage with fossil-fuels (e.g., gas or conventional heating networks).

Materials and methods

The results are based on the COMETS inventory on collective action initiatives in the energy transition. The data has been compiled over the last 3 years, as part of the COMETS project. Main data sources include national business and trade registries, web pages of initiatives and network associations, annual reports, and media coverage. Current publications on the COMETS database include Wierling et al. 2018, Wierling et al. 2020, Wierling et al. 2021 a, Wierling et al. 2021 b (submitted), Beck 2021, Schwanitz et al. 2021 (submitted). These papers provide further information on data collection methods and sources. A final update with comprehensive documentation of the inventory on collective action initiatives in the energy transition is planned for Spring 2022. The data will be open access.

Preliminary results

European-level results

Currently, at least two million¹ citizens across Europe collectively engage in more than 8400 energy communities², realizing a minimum of 13000 projects³ since the year 2000. Pioneering the installation of renewable capacities in Denmark and other countries, they support the energy transition and contribute to the competitiveness of renewable energy technologies in various ways. Energy communities raise technology awareness and acceptance, promote energy efficiency, produce and distribute renewable-based electricity, provide services around e-mobility, and run energy consulting services. They experiment innovatively with business models and self-sufficiency concepts for the benefit of local communities.

Fig. 1 details the number of initiatives and projects per country. Differences across countries can be explained by the strength of governmental support and incentives schemes, historic path dependencies of the energy system, and social and technological preferences. Current total renewable capacities installed by citizen-led energy projects in Europe can be estimated at least as high as 6.3 GW⁴, contributing up to 7% to the nationally installed capacities⁵. The lion's share is

¹ Based on numbers from 15 countries. Information is missing for CYP, LUX, SLV; NOR; IRE, ITA, HUN, LVA, ROM, PRT, ESP, GRC, MLT, BGR, LIE, SVK.

² Based on numbers from CAIs from 28 countries, missing information for CYP, LIE, and SLK.

³ Based on numbers for 19 countries, missing information for LUX, IRE, BGR, CYP, GRC, ESP, PRT, ROM, SLK, HUN, LVA, LIE.

⁴ Based on numbers from 18 countries, excluding terminated projects. Missing information for LUX, BGR, CYP, GRC, HUN, IRE, LVA, LIE, PRT, ROM, SLK, CHE, ESP.

⁵ Using the Belgium estimate (highest value).

taken by solar PV (~50%)⁶, followed by onshore wind (~10%).⁷ A conservative estimate of the total invested finances amounts to at least 2.6 billion EUR.⁸

The continuation and extension of energy communities in Europe depends on favorable legislative and financial incentives as well as on the competitiveness of technologies that are accessible to citizens. The latter is in particular the case for granular renewable technologies, such as roof-top solar, small- to medium-size wind and solar parks, heat pumps in private and cooperative housing, micro hydro, biomass furnaces, and biogas installations.

The European level aggregates are preliminary, rough estimates based on the current state of the COMETS database. Country-level results below have been aggregated for this purpose (see following tables). In case no data was available, the contribution of that country to the total estimate was not accounted for. Therefore, the estimates can be seen as conservative, lower estimates.

Fig. 1: Collective action initiatives in Europe (8431). The figure presents preliminary estimates based on the COMETS database. Shown are the number of initiatives in a country. The color code for the countries shows the civil society participation index of the Varieties of Democracies Project VDEM (Coppedge et al. 2021).

⁶ Based on data from 12 countries, not counting terminated and planned initiatives as well as initiatives that do not have their primary focus on the energy sector (e.g., agricultural initiatives).

⁷ Counting the contribution from seven countries, excluding terminated and planned initiatives as well as initiatives not having a primary focus on the energy sector.

⁸ Estimate based on data from 10 countries.

Preliminary country-level results

Austria

Essential information	Quantitative estimate	Notes
Current total number of initiatives	282 cooperatives	Typical forms: cooperatives, associations.
Historical evolution of number of initiatives	Slow increase since late 1980s.	Wierling et al. 2018
Field of engagement	95% of coops are active in district heating with biomass.	Early engagement in wind energy, solar PV only emerging.
Number of people involved	>564	Min. # of members per CAI: 2
Renewable capacities installed	Wind (~400-500 MW)	No update yet available. Estimate for 2010 based on Wierling et al. 2018. No aggregate data for heating yet.
Number of projects	>282	Assuming 1 project per CAI.
Total funds invested	n/a	n/a

Belgium

Essential information	Quantitative estimate	Notes
Current total number of initiatives	90	We expect about 20 more initiatives to be added to the database. The most common forms are 3 types of cooperatives.
Historical evolution of number of initiatives	Peak in 2017, strong recent development.	Good governmental support, but a variety of regional specifications.
Field of engagement	Solar PV (11%), wind (88%), heat, others.	Estimate based on installed capacities.
Number of people involved	~120000; one big with ~60.000.	Typical size: <600, few >1000 members.
Renewable capacities installed	Solar PV: 39 MW (7% of national installed PV), wind (7% of nationally installed capacities): 330 MW.	Based on the COMETS database.
Number of projects administered	576	Database entries.
Total funds invested	n/a	Upcoming.

Croatia

Essential information	Quantitative estimate	Notes
Current total number of initiatives	~ 10	Total number based on an interview with Edo Jerkic from ZEJ in 2019. 8 cooperatives in the COMETS database.
Historical evolution of number of initiatives	Starting in 2013, so far peak 2018.	The United Nations Development Program initiated "Energy cooperatives in Croatia" in 2013. The sector is expected to grow.

Field of engagement	1 wind farm operated by a cooperative bank, 3 PV systems.	Based on a presentation from Jerkic 2016. A variety of single projects as testbeds (e.g., wind, rooftop solar PV, biomass/biogas for heating, e-mobility, crowdfunding, consultation).
Number of people involved	~1300	Information on members only available for two cooperatives: ZEZ (18 members) and ZEF (1200); a cooperative for ethical financing. Estimate based on the smaller CAI as the more representative one.
Renewable capacities installed	<10.5 MW (thereof: 10.3 MW wind)	+ up to ~50 MW planned/feasibility study stage. Estimates are based on COMETS database entries.
Number of projects	8-10 (2016)	Jerkic (2016).
Total funds invested	63800 EUR (PV), 21.74 million EUR (wind)	Number from two initiatives where investments are known.

Czech Republic

Essential information	Quantitative estimate	Notes
Current total number of initiatives	35 (potentially up to 110).	Mostly agricultural, housing, and construction coops.
Historical evolution of number of initiatives	Peaks in the 1950s and 90s. 2 new coops after 2000.	Implementing EU Directives on its way.
Field of engagement	Biomass/biogas (82%), solar thermal (11%), solar PV (5%).	Agricultural/housing/construction cooperatives. 1 planned windpark.
Number of people involved	17000 (up to 53000).	Upper estimate based on one share per member.
Renewable capacities installed	Heat: 21 MW (potentially up to 67 MW), electricity: 22 MW (potentially up to 69 MW).	Capacity from planned wind park not included.
Number of projects	35 (potentially up to 110).	Typically 1 project per CAI.
Total funds invested	< 15.5 million EUR (potentially up to 48,6 million EUR).	Estimated from shares. CAIs have a secondary focus to be financed, thus the estimate is upper limit.

Denmark

Essential information	Quantitative estimate	Notes
Current total number of initiatives	130	Just 12 % of the former 1109 wind coops exist (Wierling et al., 2018).
Historical evolution of number of initiatives	Two waves of foundation of wind cooperatives in Denmark (1985–1992 and 1998–2002). Strong decrease from 2002.	Change in FIT from 2002 and beginning of commercial offshore wind investments. Coops driving onshore wind were not able to continue with offshore wind.
Field of engagement	Onshore wind, solar PV, others.	Private data restrictions.

Number of people involved	5000-0.5 million	Domination of smaller coops, 5-200 members.
Renewable capacities installed	Wind (340-600 MW)	~15-40% of turbines are/were owned by coops.
Number of projects	Around 1109.	Assuming one project per initiative.
Total funds invested	Up to 400 million EUR.	Rough estimate. Figures missing.

Estonia

Essential information	Quantitative estimate	Notes
Current total number of initiatives	131	96% apartment associations, 1 ecovillage, 1 NPO, other business).
Historical evolution of number of initiatives	n/a	Emerging sector. Establishment of support programs under development.
Field of engagement	Solar PV, solar thermal.	Installed on apartment houses.
Number of people involved	393-1300	Assumption: 3-10 units per apartment house with one member per unit.
Renewable capacities installed	2740-6550 kW	Based on the average size of solar PV installations in housing coops (20-50 kWp).
Number of projects	137 production units.	Database entries
Total funds invested	~1-1.4 mill EUR.	Estimate: subsidized reconstruction and investment grants.

Finland

Essential information	Quantitative estimate	Notes
Current number of initiatives	77 entries (potentially: 80-120).	Cooperatives are the most common form
Historical evolution of number of initiatives	Few new CAIs after 2010.	Earliest cooperatives established in 1918 (electricity grid operation).
Field of engagement	Heating (biomass, oil): ~47 %; el-distribution: ~20 %; Hydropower: ~9 %; Wind, solar-PV, consulting.	Based on database entries.
Number of people involved	112000 (potentially up to 117000).	Only four cooperatives with member information. Between 50-103420 members. Estimate based on categorization of CAIs along yearly turnover, assuming higher turnover indicates larger member numbers.
Renewable capacities installed	Electricity: 32-133 MW (potentially up to 210 MW); heat: 137-367 MW (up to 560 MW).	Low estimate excludes outliers, high estimate includes all. Not included: 29 TWh/a RE-based heat and electricity from the largest coop (~15% of national RE production).
Number of projects	150 (potentially up to 240).	Assumption: 3 projects/CAI and 65% of CAIs being active in energy production (based on collected data). Largest coop as outlier.
Total funds invested	n/a	Only information on turnover available.

France

Essential information	Quantitative estimate	Notes
Current total number of initiatives	347 (primary focus on energy market, excluding CAI engaged in general in energy transition)	Many legal forms in France, incl. citizen energy projects, associations, Local Distribution Companies, coops.
Historical evolution of initiatives	New CAI creations peaked in 2018, declining in 2019 & 2020.	Reductions in FiT, possible COVID-19 effect.
Field of engagement	Solar PV (54%), energy education (46%), onshore wind (8%), microhydro (3%), biomass (3%), biogas (2%).	Almost all productive CAIs specialize in one technology, and many participate as well in education and consciousness raising.
Number of people involved	~130,000 (thereof about: 55,000 Enercoop, 40,000 la Nef Cooperative Bank, 18,000 currently producing CAIs, 8,000 other and developing CAIs, 7,000 local distribution companies, 2,000 mobility).	Figure based on representative sample of each category with mean taken from second and third quartiles and applied to all CAIs with no membership number available. Figure excludes ~100 associations, most with no listed member figures.
Renewable capacities installed	~205 MW installed, ~210 MW planned identified (ca. 0.35 % of French installed RE capacity).	Based on units in the COMETS database. Excluding 5 units without data.
Number of projects	~760 installed, ~200 planned installments identified	Based on units in the database, aggregates are assumed to have 3 units.
Total funds invested	154-176 million EUR (thereof: 33 MEUR PV, 96 MEUR wind, 10 MEUR biogas, 9 MEUR wood, 9 MEUR heat, hydro 6 MEUR hydro).	Low estimate excludes units with unknown ownership. High estimate assumes equal shares. Solar PV (biogas) estimates from IEA country reports (ADEME figures) if n/a. Other technologies are means of investment cost..

Germany

Essential information	Quantitative estimate	Notes
Current total number of initiatives	1550 coops with primary purpose 'energy transition (ET)', up to 3012-3434 associations owning RE production units or engaging in ET.	Typical legal forms: coops, associations. Majority of associations do not have a primary focus on energy transition.
Historical evolution of number of initiatives	Peak in 2014, ⅔ continue investments thereafter.	Change in FiT. Associations started to engage in ET since around 2000 and recently.
Field of engagement	Solar PV (81%), onshore wind (13%), hydro (0.6%), biomass (4.8%); associations: majority solar PV.	Numbers are based on coop projects with primary focus on energy transition.
Number of people involved	Energy coops: ~300.000	Unspecified for associations which may range between 7 to several hundred of members.
Renewable capacities installed	Up to 3 GW; Solar PV: 600-848 MWp.; wind: 1-1.9 GW; hydro: 6.4 MW, biomass/heat: 110 MW; altogether ~2-3% of national capacities (thereof: solar PV 1.2-1.7%; wind: 3.5%).	Based on Wierling et al. 2021 and COMETS database updates.
Number of projects	~4530 (ca. 3672 PV projects, 597 wind, 28 hydro, biomass: 216), associations:	Estimate from coops with primary purpose on energy transition;

	~ 4129 PV projects; 6 wind turbines and 159 storage projects. Total number of projects (primary & secondary focus): ~10000.	Indication of size/complexity: Wind farm projects may differ between 1-36 turbines.
Total funds invested	Coops: ~0.8 billion EUR; associations: ~0.36 billion EUR	~0.36 billion EUR (thereof: solar PV ~0.35 billion EUR, storage ~0.005 billion EUR, wind <0.001 billion EUR).

Great Britain

Essential information	Quantitative estimate	Notes
Current total number of initiatives	363	Forms: initiatives registered under the Co-op and Community Benefit Societies Act.
Historical evolution of number of initiatives	First wave 2010-2015, declined from 2016. Recently a new increase.	Mirroring FIT changes.
Field of engagement	Wind (14%), solar PV (40%), hydro (16%); energy consulting (20%).	Based on Wierling et al. 2018.
Number of people involved	~17000	300-750 members per CAI. New initiatives tend to have minimum numbers.
Renewable capacities installed	Total: 150 MWp.	Wierling et al. 2018
Number of projects	~2800	New initiatives start with just one project. Later 5-10 projects per CAI.
Total funds invested	800000 GBP/CAI, total: 290.4 million GBP (~339 million EUR).	From Wierling et al. 2018, based on 49 coops revealing this information.

Italy

Essential information	Quantitative estimate	Notes
Current total number of initiatives	82	Coops are the common legal form.
Historical evolution of initiatives	Few new CAI since 2011.	Depending on FIT.
Field of engagement	Solar PV (94%)	Some hydro projects from historical energy coops. 94% with primary focus on solar.
Number of people involved	n/a	n/a
Renewable capacities installed	Solar PV (11 MWp)	Estimate from Wierling et al. 2021
Number of projects	64	Solar PV projects
Total funds invested	n/a	n/a

Lithuania

Essential information	Quantitative estimate	Notes
Number of initiatives	8	Housing associations.
Historical evolution of number of initiatives	n/a	Emerging topic.
Field of engagement	n/a	Renovating heating in housing (various technologies, incl. geothermals, solar PV, biomass).
Number of people	160	Members of housing and village associations.
Renewable capacities installed	Solar (17 kWp), wind (250 kW)	Estimate based on BSR database (Co2mmunity 2021).
Number of projects	8	Assuming at least one project/CAI.
Total funds invested	~0.4 Million EUR	Solar (~17,000 EUR, estimate based on capacity), wind (~0.4 million EUR from BSR database).

Luxembourg

Essential information	Quantitative estimate	Notes
Current total number of initiatives	4	Identified coops related to energy transition
Historical evolution of number of initiatives	Emerging sector.	
Field of engagement	Solar PV, wood pellet heating, Onshore Wind	
Number of people involved	n/a	No data
Renewable capacities installed	Solar PV (60 kWp), heating (777000 kWh), wind (no data)	Ownership for wind is unclear.
Number of projects administered	7	Database entries
Total funds invested	208000	Only reported and realized investments.

Netherlands

Essential information	Quantitative estimate	Notes
Current total number of initiatives	1001 +/- 5%	Energy cooperatives, foundations, associations with primary purpose 'energy transition'. Main source: Hier Opgewekt (2021)
Historical evolution of number of initiatives	Ca. since 2015 (focus on wind), peak in 2018, recently many new initiatives.	Based on the COMETS database. See also Hufen & Koppenjan (2015), Boon & Dieperink (2014)
Field of engagement	Solar PV (92 %), wind (8 %).	Solar PV is also established on water. Another field of engagement is also energy coaching, here not included in the statistics.

Number of people involved	~120,000	Based on estimates obtained from a subset of 280 CAI for which membership numbers are known. About 12 outliers with members >500 are excluded from the sample, but included in the final estimate.
Renewable capacities installed	Solar PV 140- 205 MW, (up to 270 MW with planned projects); wind 237- 264 MW (up to 1884 MW with planned projects).	Low estimates: realized projects until end of 2020, crowdfunding projects excluded, no ownership assumed for projects with unclear ownership share. High estimates: realized projects until end of 2020, includes crowdfunding, 100% ownership assumed for projects with unclear ownership share. Brackets show high estimate including planned projects)
Number of projects administered	~1442 total (thereof: 940 realized, 473 planned, 14 wind repowering, 15 planned but never realized).	Based on the COMETS database.
Total funds invested	Estimate 1: PV: 224 - 329 million Euro Wind: 390 - 431 million	<Estimate for PV from Hier Opgewekt (2021): 2012-2020: 180-200 billion EUR invested. Based on PV solar capacity estimate of 166 MWp (300 EUR per panel/275 Wp). Estimate 1 (PV): Based on system prices for installation of 10 Panels, including costs for modules, installation, converters and VAT. Datasource for prices: Milieu Centraal (2021). Estimate 1 (Wind): based on average price of 2000 EUR/kw until 2013, 1500 EUR/kw thereafter. Excludes planned projects. Datasource for prices: Paardenkooper (2015), Madlener et al. (2019).

Norway

Essential information	Quantitative estimate	Notes
Current total number of initiatives	~30 (2018)	Local Energy Communities. Driven by property developers and distribution network operators. Data is fully anonymized.
Historical evolution of number of initiatives	Recent developments, still in their infancy.	
Field of engagement	Under development.	Solar PV, energy efficiency, end-user flexibility, security of supply, grid investments. Lack of data.
People involved	N/A	
Renewable capacities installed	~100 kWp	Based on limited information of 3 projects.
Number of projects	5 implemented, 25 concepts	Based on information from the NVE report 2018.
Total funds invested	N/A	

Poland

Essential information	Quantitative estimate	Notes
Current total number of initiatives	~112	45 housing cooperatives , 66 energy clusters, 1 energy cooperative. Government prefers energy clusters.

Historical evolution of number of initiatives	Emerging sector.	Implementation of EU Directives ongoing.
Field of engagement	Solar PV, biogas, housing cooperatives, energy clusters	Limited data.
People involved	~784	Assuming minimum 7 members.
Renewable capacities installed	Housing PV: 0.045-1.8 MW Energy clusters (PV, biogas, other): 150 MW	From Schwanitz et al. 2021. Assuming average apartment/ house installations of 10-40 kW.
Number of projects	At least 112.	Assuming a project per initiative.
Total funds invested	n/a	

Slovenia

Essential information	Quantitative estimate	Notes
Current total number of initiatives	7	COMETS database. Common legal form: limited liability coop (z.o.o.).
Historical evolution of number of initiatives	n/a	Recent developments, still in their infancy.
Field of engagement	Solar PV (~100%), wind	Recent activities.
Number of people	n/a	
Renewable capacities installed	~60 kW	Based on the number of total kW/prod. units.
Number of projects	7	Assuming at least 1 project/CAI.
Total funds invested	n/a	

Sweden

Essential information	Quantitative estimate	Notes
Current total number of initiatives	312 CAIs (incl. liquidated, ~10%). Additionally, 32 ecovillages.	COMETS database. Number for eco-villages from Magnusson & Palm 2019. Legal forms: different types of associations/coops.
Historical evolution of number of initiatives	1990-2010 expansion phase, boom in wind coops. Since 2015 growth in solar PV.	Favourable legislation (e.g., high CO2 tax, RE subsidies). Change in taxes in 2009 led to a halt in wind coop and retreat of investors.
Field of engagement	Wind (38%), solar PV (10%), hydro (7%), electricity trading (13%), heat/wood (11%), distribution (10%)	Housing cooperatives often engage in electricity trading (consumption).
Number of people involved	~0.08-0.1 million (2018). One coop with 52000, smallest with 20 members.	Based on the sum of database entries. Does not include eco-villages.
Renewable capacities installed	Solar PV: 1.2-13.1 MW, wind: 153.8-244.6 MW, hydro: ~6.4 MW, other (biomass, solar thermal) up to 2.9 MW. Total capacity installed: ~165-267MW.	Estimate based database (excluding terminated). Depending on ownership shares, 0% (100%) assumed if no information available for lower (upper) estimate.

Number of projects	~311 projects realized, out of which 272 are wind.	Based on database entries. No information about plans.
Total funds invested	n/a	

Switzerland

Essential information	Quantitative estimate	Notes
Current total number of initiatives	291	Few more to Holstenkamp 2018. Typical legal forms: traditional and modern cooperatives.
Historical evolution of number of initiatives	Steady development, three waves since 1890' (2. 1980', 3. 2010').	Historic 'electra', recent ones often with 'solar' or 'energy' in the name. Since 2016, more often joint purchasing / do-it-yourself coops have been founded.
Field of engagement	Solar PV (33%), hydro (7-10 cases), wind (1-3 cases), biogas (1), heat (19%), distribution.	About 20% engage broader, i.e. beyond the installation project.
Number of people involved	137640, thereof two bigger ones with 67000 members.	Typical size: 50-150 members. Based on database entries. Traditional elektras in rural areas.
Renewable capacities installed	Upcoming.	Installations with 50-100 kW (most), up to 350 kW (few), >1000 kW (few). Method based on rule of thumb to convert: Solar: 1000 kWh/kWp. wind: 30-40% efficiency x 8640 for kWh; hydro: 8000.
Number of projects administered	1200-1500	Typically, 4-5 projects per CAI. Estimate based on CAI number.
Total funds invested	~263 million EUR	About 20% of solar coops have financial info. Estimate based on extrapolation to all.

Energy communities/collective action initiatives in the energy transition:

Bulgaria: High financial and administrative barriers to start citizen-led initiatives. An interesting example is the attempt to explore options for forming a cross-border coop between Burgas in Bulgaria and Nis in Serbia to co-own PV systems (supported by H2020 project mPower, 2018-2022). Alleviation of energy poverty is an important motivation for establishing community energy initiatives.

Cyprus: Currently no initiative. However, the implementation of EU Directives is on its way and it is expected that a few energy communities are established soon (Cyprus Energy Agency 2021). Consulting material (in Greek language) is available to support potential initiatives.

Greece: Under construction. Unclear what forms qualify as CAI. About 50 candidates.

Hungary: Two community projects identified: 1 ecovillage (biomass) and 1 crowdfunding PV project (planning stage, 30 kWp). Administrative and technical barriers towards financial sustainability. Legislative barriers for wind energy (12 km from settlement rule, banning almost the whole country) and community energy as a whole as prosumers are not allowed to be energy suppliers (electricity has to be sold to grid with low revenue). Strong focus on nuclear power development in cooperation with Russia. EU frameworks are implemented with the minimum requirements (in progress). Little information available.

Ireland: About 20 initiatives. Database entries under construction.

Latvia: 3 housing associations. They renovate heat pump systems, improving energy efficiency through reduction by about 50%. Implementation of EU Directives ongoing.

Liechtenstein: Under construction.

Malta: One active RE cooperative, but information is limited. The first national, communal PV farm has started operation: 997 kWp, 366 crowdfunding applicants to provide rooftops were accepted to the project (Energy and water agency Malta 2021). The requirement for a start capital of 0.1 million EUR is seen as a barrier (Cooperatives Europe 2015).

Portugal: Under construction. 1 CAI known.

Romania: High legal and financial barriers for citizens to engage. High centralization of legislative and executive powers makes it difficult for local parties to participate. State of Implementation of EU Directives. One cooperative was established in 2019.

Slovakia: Implementation of EU Directives ongoing. High financial and administrative barriers. Negative investment experiences from the 1990 still hamper interest from citizens.

Spain: About 20 CAIs. Entries under construction.

Summary

We present preliminary estimates for the contribution of collective prosumers to the energy transition across Europe. Drawing from the COMETS inventory, we report country-level and EU-level aggregates. Aggregating to the European level, we estimate that:

- Currently, at least two million citizens across Europe collectively engage in at least 8431 energy communities that have their primary focus on the energy sector, realizing a minimum of 13000 projects (since 2000).
- Differences across countries can be explained by a) the strength of governmental support and incentives schemes, b) historic path dependencies of the energy system, and c) social and technological preferences.
- Current total renewable capacities installed by citizen-led energy projects in Europe can be estimated at least as high as 6.3 GW, contributing up to 7% to the nationally installed capacities. Solar PV contributes half of the capacities, followed by onshore wind (10%).
- A conservative estimate of the total invested finances amounts to 2.6 billion EUR.

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