Renewable Energy Communities

What is the impact of Renewable Energy Communities on the electricity system and is it an effective strategy in the Energy transition?

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Introduction - Utopia or Reality?

We invite you to imagine a Utopia where groups of like minded people come together to generate and use renewable energies created in their own backyard. Where a collective effort, turns into social returns, environmental returns and economic returns. This is no dream state, but a reality for a very small cohort of people.. these are renewable energy communities. As best romantisized by Greenpeace & Friends of the Earth (2018) "socially fair energy transformation means **we put renewable energy into the hands of communities and people** – taking back power from the fossil fuel industry…which act at the expense of people and the planet". In December 2015, world leaders came together agreeing to adopt a cohesive strategy to combat the demise of our planet - the Paris Agreement. The aim being to reduce emission outputs to keep our planet well below 2 degrees For this to occur three tactical strategies were layed out for the Energy sector, the need to reduce energy consumption, enable a low carbon energy mix and imporve energy efficiency. Renewable Energy Communities (REC) are seen as highly comlpimentary to contribute to the energy transition, however the potential of REC are far from being fully realised, and their future is uncertain (Capellán-Pérez et al., 2018; Gorroño-Albizu et al., 2019; Hufen, 2015; Proka, 2018; Seyfang et al., 2014). In this report, we aim to explore how, 1) effective adoption has been and 2) whether energy consumption is likley to change on more agglomerated scales, 3) the shortcomings and policy recommendations, and 4) Technological potential. Although this report discusses the Renewable Energy Community concept as a whole, we take a special lens on French adoptions and limitations.

1. Community Motivation & Background

1.1 Energy Communities Explained

The concept of energy communities are very heterogenous, in terms of organisational models and legal forms. But explicitly it must involve a citizen, public and private actor, who both produce, sell and consume energy, which is then shared within the community and can be sold back to the grid. The notion of community also must be precised, as it should involve a group, in the decision-making process and the benefit sharing is at the limitation of geographical area. Currently, there are 3,500 renewable energy co-operatives in Europe and it is estimated by 2050, 45% of EU citizens will produce their own energy (Greenpeace EU, 2018). The notion of collective participation within this concept can involve all of the following: energy production, energy efficiency, energy literacy, collective energy buying, electric mobility too (Walker and Devine-Wright, 2008). This begins to unviel how simultaneously, specific and vague this notion is.

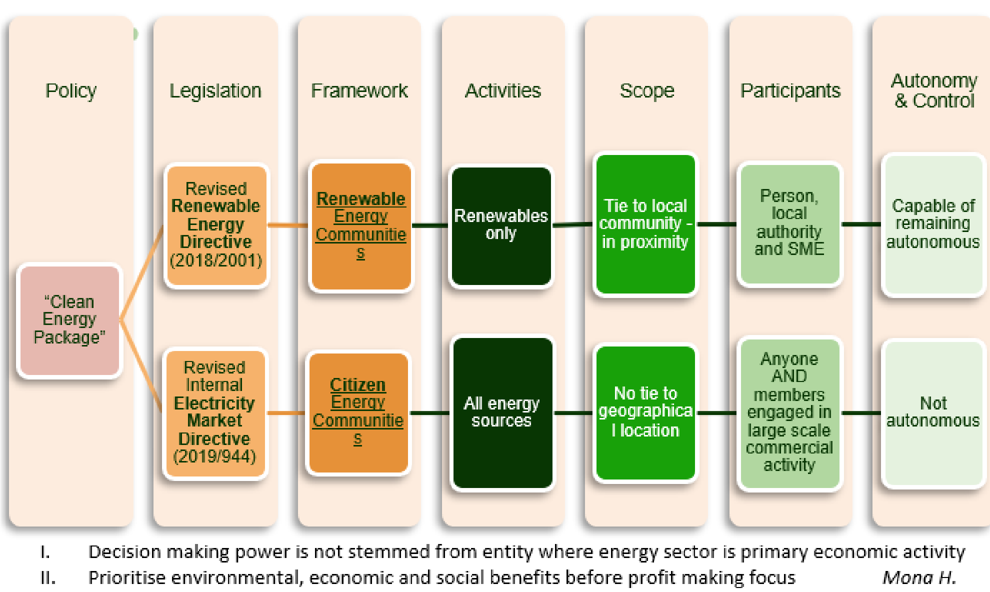
> ***"By 2050 45% EU citizens could*** *produce their own energy"*

In more technical terms, energy communities can be understood as a way to 'organise' collective energy actions around open, democratic participation and governance, accompanied by the provision of benefits for the members or the local community (Roberts et al., 2019). In practice these communities will likely stay connected to the grid, unless it is a small island or in remote areas, and this transition experience must be done in a way to gain real savings and value for members/customers. The objective is to ensue a shift in consumer behaviour, changing traditionally passive consumer, to become active energy prosumers and co-owners of renewable energy facilities (Van Der Schoor et al., 2016).

To understand the historical pre-requisits to get to this stage, acknowledgment must be given to Stephen Littlechild who in 1996, pushed for the liberlization of the energy markets in Europe and the regulation of private market players, debundling the horizontal integration of the Energy industry. What followed was a cascade of "pro-competition" incentives and reforms such as decarbonizatoin agendas in 2001 & 2009 (Pollit, 2018). Essentialy energy communities can play a key role in facilitating the decentralising of the energy system and the local operation of renewable energy (Caramizaru & Uihlein, 2020). The EU pushed France to liberalize its energy market for three decades, and that liberalisation was complete in 2007. However, France's electricity market remains, ranked among the most centralised in Europe. Indeed, the historical national electricity incumbent, EDF, leads on both the market and grid levels (Poupeau, 2020). The French electricity mix that is characterised by low carbon intensity owing to the dominance of nuclear energy and secondarily hydroelectricity is also unique in the EU, all these factors contribute to slower adoption of renewable energy communites in France.

1.2 European Political Push

In order to bring to life to notions of the 2015 Paris agreement, the European Commission assembled, to draft up a proposition, which would later serve as a framework to urge member states to implement within their own countries, through laws and organizations. The output was the commission's "**Clean Energy for All Europeans Package",** which confirms the prominent role prosumers, and their collective forms can play on the future of the energy system. The EU framework established in 2018 & 2019, are first and foremost legal frameworks, insighting laws to enable citizens to set up these community arrangements (Caramizaru & Uihlein, 2020). There are two formal definitions of energy communities: '**citizen energy communities'** which is included in the revised Internal Electricity Market Directive (EU) 2019/944, and **'renewable energy communities'** ,which is included in the revised Renewable Energy Directive (EU) 2018/2001. Although similar in ideology these two types of communities must be carefully disentangled to truly see the nuances. Regarding decision-making power, both community strands have similarities, in that power mustn't stem from the entity where the energy sector is the primary economic activity. In other words an existing wind turbine farm out in the Atlantic Ocean, already monetizing energy generated, cannot be deemed a community. Secondly, incentives cannot be profit optimizing, in other words, the motivation must be purely for the betterment of the planet.



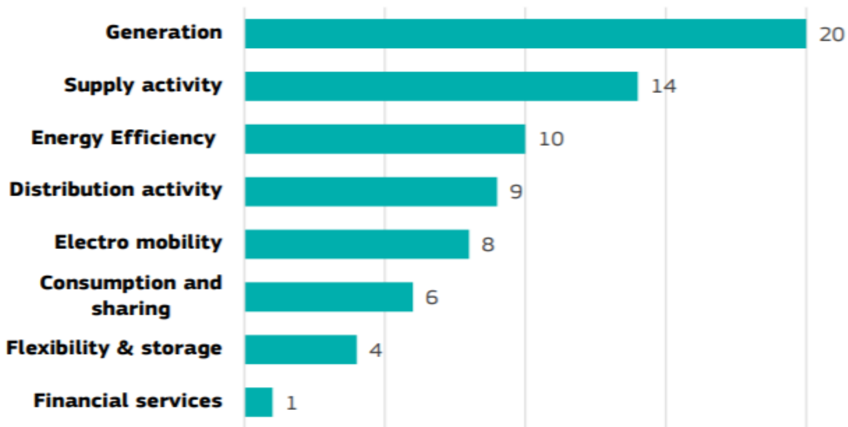
Figures 1. Disentanglement of Energy Community according to EU definition.

Source: European Parliament & Council of the European Union, 2018

Renewable Energy Communities differ primarily, because energy generation can solely be from Renewables sources, where as Citizen Energy Communities (CEC) can use any form of resources inc, fossil fuels. The notion of CEC exists primarily to support the electricity decentralization ideology, rather than to push the renewable agenda. The other important nuance, includes the definition of geographical area, REC's are tied to their community proximity, whereas theoretically CEC's can be on polar ends of a country. Participation also differs, unlike REC, CEC's can be of much larger scale nearing commercial size – but the decision making still cannot stem from members, who's primary source of economic activity is energy. Although we have simplified this breakdown, the European commission's document can be confusing to navigate. In fact as best critiqued by Heldeweg, et al., (2020) "It's **considerably difficult to define** who decentralized **actors such as renewable energy communities really are**.. Due to the **heterogeneity of sector..** It undermines the analysis". He claims that the lack of simplification around the policy overcomplicates the model, so to disincentivize effectiveness of this project. He further states that this scheme is yet to have impact due to the ambiguity.

We would rebut this, by leaning on a deep dive carried out by Caramizaru & Uihlein, (2020), which evaluates a sample of 24 renewable energy communities in Europe. Findings cumulated by these co-operatives, revealed 58% of the electricity generated, was being returned to the grid. The graph (left) showcases the breadth of energy conservation activity currently taking place. Undoubtably, the impacts would be larger, once achieving critical mass, however these small steps should not be shrugged off.

Figure 2 Overview of activities corresponding to the 24 case studies

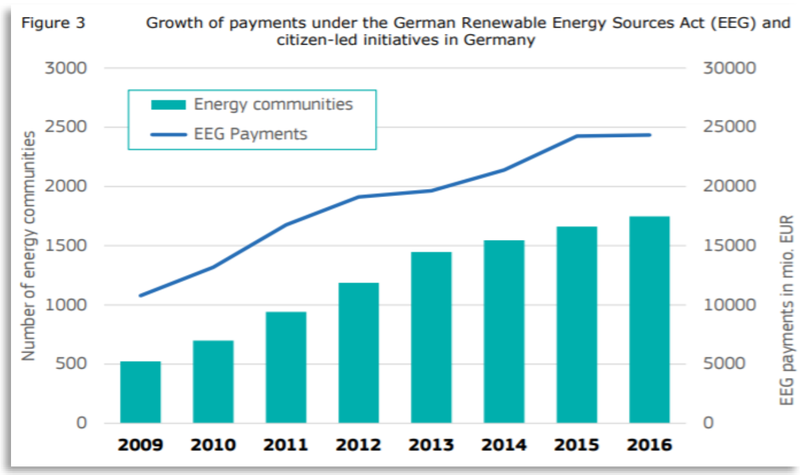


Source: JRC based on the case studies, 2019

1.3 Actors and Organizations

At present many of these Energy Communities need exogenous support from the governments or NGO's. The primary energy co-operative/NGO is called Ecopower or REScoop and was established in Belgium around a kitchen table in 1991. The organization originated from a co-housing project in 1985, when a watermill was collectively bought, then in 2003 following the liberalization of the electricity market in Belgium, the general assembly of this co-operative became energy suppliers of the region of Flanders. Many other local scale networks started popping up especially in Nordic countries around the late 80's, roughly around 150-300 were estimated to be established in this time (Derk. Et al., 2013*)*. However, some key actors namely REScoop, Energie Partagee (EPA) and Enercoop, became more involved lobbyists, on the behalf of energy communities, as they believed there was a lack of mention of citizen involvement in the EU energy system, where an existing "blind spot" existed and regulations were lagging behind. The primary role of these associations today outside lobbying, is to pprovide a mechanism of solidarity to budding communities, from education on consumption, or assisting vulnerable people with revenue from selling energy to grid, they help out in any way possible to get projects started and provide a network to connect communities (REScoop, 2021). This is an interesting example of how a global niche who share common knowledge and goals can become a locus of social innovations in the form on new practices and behaviours, pushing for change at a governmental level.

Despite the great potential of energy communities, unfortunately the economic model **still requires government intervention. The most common public policy is a feed-in tariffs (FITs)** (Herbes et al., 2017), this is the most popular incentive scheme, adopted in most of Europe, the U.S and Japan. Essentially they enable renewable communities to contribute back to the grid at above-market price. The graph below illustrates the positive correlation between these payments and the growth of citizen-led communities in Germany. Similarity in England, the governments removal of FIT's in 2016 significantly impacted number of new energy co-operatives (Vernay & Sebi, 2020). An example of a combined NGO and government aid initiative in the Netherlands, is coined the "Green Deal" . Firstly, the national government provides financial help through tax deduction for research and development called the MKB+ (midden en kleinbedrijf—small and medium business), Secondly, the government helps as a mediator in matchmaking & negotiating in community projects, connecting them to NGO's. And finally, it reduces unnecessary administrative burden and other legal obstacles. Sometimes governments go as far as to actually starting the community's projects themselves. In France, on top of a FIT, there is a dedicated incentive (called a "participatory bonus"), which includes bonus grants, between 1 and 3 euro pr MWh, these are awarded to participants who finance a certain threshold of capital/ equity for a minimum of 3 years. A downfall identified was that it effectively leverages citizen investments for renewable projects, but did not encourage citizen involvement or appropriation (Sebi, 2020). As best said by Tews (2018), all the above highlights, how many projects could not emerge without government aid and supporting organisations.



1.4 In Practice

To truly understand the heterogeneity of Energy communities, it is necessary to delve into some real cases. Here we will implore how they differ, downfalls and respective benefits. The cherry picked selection below showcase the varying models, these energy communities can take.

1.4.1 – Case 1 Texel – Netherland

Case 1: TEXEL Netherlands – is one of the most studied, largest renewable communities within the literature, the Dutch island of Texel is located in the North Sea and the inhabitants are called "Texelaars". This island, has a community of 14,000 people, where 1/3 are members of the renewable energy co-operative and another 1/3 are customers. Founded since 2007, a person can become a member for 50 euros a year, which allows them shares of the company, a discount on energy prices and a vote in the annual assembly. The Texel Energy co-operative generates energy through solar energy, biomass and ‘anaerobic digestion’, with intentions to expand. The main driver in effectiveness for this organization is the “local culture”, the Texelaars, have a strong sense of independence and strong historical and local identity. (N. Frantzeskaki et al. 2013). There is tension here in the interpretation of for-profit, non-profit and not-for profit. With the strategy to deal with government legislation is active ignorance, in fact they “doubt the usefulness of government involvement and facilitation” all together. This completely negates the argument above made by Tews (2018) claiming projects would not occur without the aid of government funding. Texel does not lean on governmental support because they want to operate on their own accord, overtly claiming “we were not that bothered by laws and regulations”.

1.4.2 – Case 2 Urgha and Udny – Scotland

Urgha and Udny Community are Wind Turbine communities and are representative of successful endeavors in the face of “unfriendly institutional landscape”. Urgha is a community set up by the North Harris Community Trust, North Harris is a sparsely populated area consisting of 700 inhabitants. Initially the community members created a recycling center, however due to the lack of support from the local municipalities, a 10KW wind turbine was erected to run the plant. This turbine generates enough electricity for the entire community and the surplus is fed back into the grid, generating 4K pounds of added revenue p/y. The main challenge here was the financing, in fact, the fund went bust during the erection of the turbine, and banks were too risk averse to lend to the co-operation. Eventually once they managed to receive a grant fund, the clauses in sighted the exclusion to benefit from feed-in-tariffs (Frantzeskaki et al. 2013). Udny in Scotland went through a similar procedure, however with more support from local authority, the primary issue was still around gaining funding, a grant given to the community had to be declined due to the co-operative already receiving favorable bank loans. Hence the major difficulties for these groups to strive, stem from rigidities of regulations and financing.

1.4.3 – Case 3 Amsterdam Zuid

A unique case is the houseboat neighborhood in Amsterdam Zuid, which has 50 members. Four local people started the project in 2008, when they wanted to buy solar PVs on their own, but they got an offer from a supplier that, in case they bought PVs in large quantities, they could get them at a reduced price. The initial residents were motivated to draw in new members and the project became a big success. Therefore, the collective procurement was repeated in the two following years (Dóci et al., 2015b, p. 88). On the one hand, old, mostly lower educated working-class residents moved to the house-boats neighborhood in the 60s and 70s, because they did not want to fit in the framework provided by mainstream society. On the other hand, the community also includes a second generation, rather wealthy intellectuals that could afford to live in luxury house-boats in the capital of the Netherlands. This example shows the heterogeneity of members and reinforced that financial benefits played an important role in the establishment. An argument for effectiveness is that heterogeneity is a prerequisite for these communities to have the potential for scaling up (Seyfang & Smith, 2007).

1.4.4 – Case 4 Darebin – Melbourne Australia

To get a more 360 view, we will also examine a case in Melbourne Australia. The Darebin City Council wanted to make solar power more accessible to low income elderly residents through the ‘Solar Saver program’ – the first of its kind in Australia enabling households to install solar PV systems and pay them off through Council rates, interest free over 10 years. The primary incentive was to target heat-stress vulnerable households which elderly live in, to provide a low-cost energy source and efficiency advice, substantially decreasing the cost of cooling in summer. These services were provided at minimal financial risk to the households while ensuring a high level of quality and care. In 2015, the Council committed a further $1 million to the Solar Saver program and is considering opening the program to non-pensioners, renters, pensioners and small businesses (Darebin Solar Saver, 2015). However unlike the other “community” examples of Europe, these member do not have any autonomy, decision making power, nor do they make added gains by contributing back to the grid, however they save significantly on energy bills.

1.4.5 – Case 5 – Hikari - Lyon Confluence France

Finally, we will examine a more modern interpretation of a Community in the first energy positive small island in Europe- Hikary in Lyon. It consists of a combination of Office space + 36 apartments + 4 villas. The project was designed to demonstrate the introduction of energy saving technologies to new and existing houses, and the construction and evaluation of IT-based PV generation management system, EV car sharing system. It is a primary example of how a system supporting effective and efficient city planning, through management of real time energy usage data of the city, can bring about some important implications (Chinomiya, 2017). This is a special case and potentially a peak into the future, with the integration of Japanese smart technology, the notion of a traditional "community" is removed, as the building consortium is being managed by a computer "brain". The notion here is that Automation is taking over Autonomy.

1.5 – Comparative discussion

These 5 very heterogenous cases from all over the world, further highlight the difficulties in defining, regulating, promoting and spreading the concept of renewable energy communities (REC). We will analyse the differences in these cases in alignment with the primary definitions of a Renewable Energy Community as earlier provided by Commission's "**Clean Energy for All Europeans Package"** outline.

- Capable of remaining autonomous - Decision making power of the entity should not be the energy sector is the primary economic activity.
- Tie to proximity of local community
- Prioritize environmental, economic, and social benefits before profit making.

Clause 1. Is the most contentious among almost all the above cases. It appears that the Scottish (Urgha and Udny) and Amsterdam cases were the only community models that complied with the autonomous factor. The "exemplar community" case of Texel, no longer aligns with clause 1. On the basis that 'TexelEnergie', has become an energy generating business, where by decision making power, sits in the same realm where energy sector is the primary economic activity. Their mission statement on the website claims that they want to make all of the Netherlands use sustainable energy as fast as possible through the supply of clean energy (TexelEnergie, 2020). In the Melbourne case similarly to Lyon, the notion of community autonomy is completely removed, on the basis that the local government, controls decisions around the running of renewable activity.

The Clause 2. Proximity appears to be unanimously accepted amongst all explored cases; however, a remark is the discrepancies in institutional and cultural contexts. Even upon further literary reviews, there appears to be strong convergence and collective citizen participation more so in Nordic countries, namely Netherlands. Interestingly, Derk. Et al., (2013). attributes this to a history of collective citizen efforts to fight the threat of the sea, which over the centuries aggregated to formal organization and a strong corporatist culture. Another perspective, is the collective heterogeneity within the demographic composition, unlike the Australian example for example, the involvement of a wide range of wages & ages, creates a more unified sense of niche community microcosm.

Figures 4. Amsterdam Houseboat community boasting collective Solar energy for 50 pp

Finally, regarding Clause 3. Based on an interview study carried out to examine behavioral motivations of REC by Doci et al., they found these communities were mostly unified with the aim to protect the environment. From a social POV, it was found people who played an active role within the cooperatives, found it a good opportunity to get closer to neighbors and invoke more creative projects with them, newcomers found it helped significantly to integrate. However, the baseline finding was that people expected financial benefits as a pivotal feature in choosing to adopt collective renewable energy lifestyle.

Vernay & Sebi (2020), have researched extensively every existing French Renewable energy community and have managed to categorize them into four pillars of organizational structures.

- **Type-1 "citizen PV clusters**" - typically correspond to small solar roof-top projects initiated by local activists often in collaboration with local public actors such as mayors. These are under the same investment to save costs but also to spread the risks of individual operations. These clustered projects can generate installed capacity up to 1 MW and 40 Shareholders and up to 500 participants.
  - This links best to the Amsterdam Boat communit.
- **Type-2 "wind farm projects**" - They recruit between 200 and 800 citizens and generate capacity ranging from 2 to 18 MW. These CREPs focus on using wind projects to strengthen local economies and local identity (EPV EnR citoyennes, 2019). They communicate returns on investment of between 4% and 6%. These projects require a long incubation time and depend heavily on the support of local authorities (departmental and regional) to finance all the upfront investments (e.g. environmental and technical studies). Beyond energy production, these communities also emphasize education, sensitizing residents to the potential of local renewable energy and energy savings
  - The Texel Energy case is best fit.
- **Type-3 "small projects by public local actors"** of CREP corresponds to communities that have small production capacities (i.e. they can benefit from FITs) and more strongly emphasize profitability. The category includes mini-hydro projects, We find small solar farm projects initiated by local public actors, for instance elected officials (e.g. a mayor), who are willing to implement renewable energy communities in their regions in association with local citizens.
  - The Scottish Wind Communities (Urgha and Udny) are best fit for this type.
- **Type-4 "large Scale investment"** of CREP corresponds to big projects, such as wind and solar PV farms or wood-chip district heating. ake large-scale investments and carry heavy administrative. projects take the form of public–private partnerships with majority public involvement (51% to 85% of the capital), known as "societes d'´economie mixte" (SEM).
  - This Australian housing project is best fit for this type.

We believe the Renewable Community categories proposed by Vernay & Sebi (2020), to be comprehensive and all encompassing. This enriches the literature by aiding in structuring the heterogeneity of these community constructs, which can help for policy improvements.

2. Decentralised Energy Communities and Eco-innovation

2.1 Primary Pros and Cons

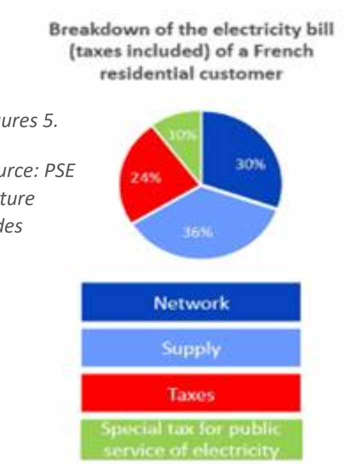
Pros:
A decentralised system has greater public involvement and control, people are conscious about their consumption behaviours as they decide how electricity is produced, making them more aware of their carbon footprint. Off-grid suppliers lean toward renewable energy sources enabling market economies to be more efficient. The reasons for this inclination is that renewable energy sources are economical, and offer uniform and long lasting supply for all geographical areas. Apart from abundant supply it is easy to maintain short distance transmission and distribution infrastructure. (IEA 2011). This shift to renewable energy sources reduces the emission of carbon dioxide and other harmful gases that degenerate the quality of the environment.

Additionally, smaller scale grids can be set up as viable businesses using local investments. This will aid in building the local economy and improve the skill levels and employment opportunities in the local populations, who may be employed in the construction and maintenance of the decentralized systems. (Bacon and Kojima 2016)

Cons:
These communities lead to loss of tax revenue. The pie chart in Figure 1 shows the electricity bill breakdown of a French residential customer, 24% of the bill is taxed. These taxes will be forgone in a decentralised system.

Figures 5.

Source: PSE lecture slides



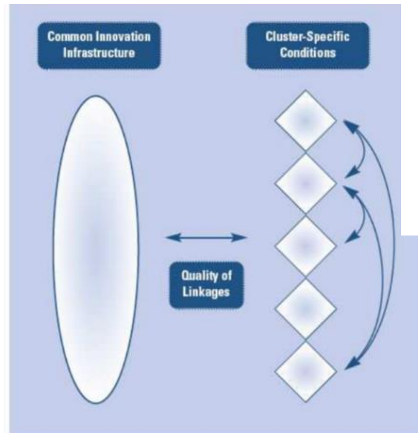
The financial expenditure needed to set up a decentralised plant is high, increasing the cost of electricity in regions with low demand, often rural areas. Funding and information provided to these off-grid (decentralised) communities are limited, due to being smaller scale and newer enterprises, as opposed to grid companies that are well-established with strong existing ties to government representatives and financial institutions. Another downside to decentralised electric systems is the mismatch between hourly curves of generation, typically for solar, as more electricity is generated during the day, forcing the need for battery energy storage. Inadequate disposal of these batteries poses a significant environmental hazard. (Alstone et al., 2015)

2.1 Eco-innovation

Eco-innovation involves adopting new production processes, management and business methods, to considerably reduce the risks to the environment. This approach automatically draws all the actors (producers and consumers) towards a renewable lifestyle. Clustered communities have better linkage promoting eco-innovation as opposed to general umbrellas (Karunathilake, H et al 2019).

Demand for energy innovation arises out of scarcity of resources, an escalation in energy consumption and uncompromising environmental regulations. Some of the examples of eco-innovation in the energy sector include, using energy-saving light bulbs, re-using lost energy through cogeneration and switching to clean fossil fuels (E.g. Clean coal). A good example for eco-innovation at community level in France is Agrivoltaics. It involves co-developing the same area for solar energy generation and agriculture. Solar panels are placed above the plants to provide shade and the energy generated is used for irrigation. Leftover energy is transferred back to the grid (Dupraz, C et al 2011).

An interesting academic parallel, to have a deeper understanding on the effectiveness of clustering communities, is developed by Park., et al., (2017). This explores how conglomerates of likeminded people from diverse backgrounds, when broken up into smaller groups, stimulate more innovation, this phenomenon is also coined "Cluster specific Conditions". Further explored by S. Barsoumian, A Severin (2011), Cluster promotion and policy is being more and more facilitated by the European commission. An important link between innovation and clusters is made stating "Genuinely open innovation requires brokerage, intermediaries and networks in which all players can participate on an equal basis. Internationally competitive clusters play a vital role in bringing together – physically and virtually … the exchange knowledge and ideas.". This further reiterates the importance of having a decentralized autonomous "community" construct as a driving force of the energy transition. If policies continue to be implemented solely on a national level, there would be an opportunity cost, of untapped human innovation potential.



Figures 6.

Clusters Promote innovation

Source: Park. et al.,

3. Risk Analysis and Global Lens

3.1 PEST Analysis

This analysis factors in political, economic, social and technical risks for energy:

Political risk is mainly linked to changes in regulation. Different parties have different agendas. Taking the United States: The Republican Party wants to kill the Clean Power Plan, use more coal and ease nuclear restrictions. It pushes the idea that environmental problems can be solved by the development of new technology, instead of moving to the use cleaner sources. The democratic party wants to get fifty percent of electricity from clean energy sources within a decade and install half a billion solar panels in four years to generate enough renewable energy to power every home in the country. Once an energy policy is adopted, it takes approximately ten years to be implemented and come into fruition for us to see any significant results. Parties changing every four years and slashing their predecessors' efforts and plans prevents us from making any progress in either direction.

Non-renewable energies are tied to the volatile raw material and fuel markets. Economic fluctuations like inflation, interest and exchange rates, even for short periods, can fluctuate the production of non-renewable energy in great amounts. This however has a smaller effect on renewable energy production. The capital costs of renewable energy production are high, but with the provision of incentives like low taxation and easy access to investments, these costs can be overcome making it the most economical solution in the long run.

Socio-economic factors play a major role in setting energy trends. If people are informed of the factors deteriorating the environmental quality, there will be a conscious change in behaviour. The scepticism about climate change is in decline. It is being acknowledged as a real problem, creating a motivation for change, there is an increase in community activities to produce clean energy. E.g. By 2012, community groups in Germany owned 34% of installed renewable capacity.

Lastly, technology plays a crucial role, new technologies are being developed to make methods more reliable and efficient. With technological progress a day when all the energy problems are solved doesn't have to be a fairy-tale. Fusion energy cannot be produced on a large scale today, but with advancements the world's energy needs could be met using fusion power.

3.2 Global Lens

This section provides an overview of the energy communities across the world and emphasis on how governments are supporting them. Energy communities are more prominent in Europe than the rest of the world. Asian countries like China and South Korea have it in their agenda for the coming years. Figure 2 shows the number of community energy initiatives taken up by EU countries.

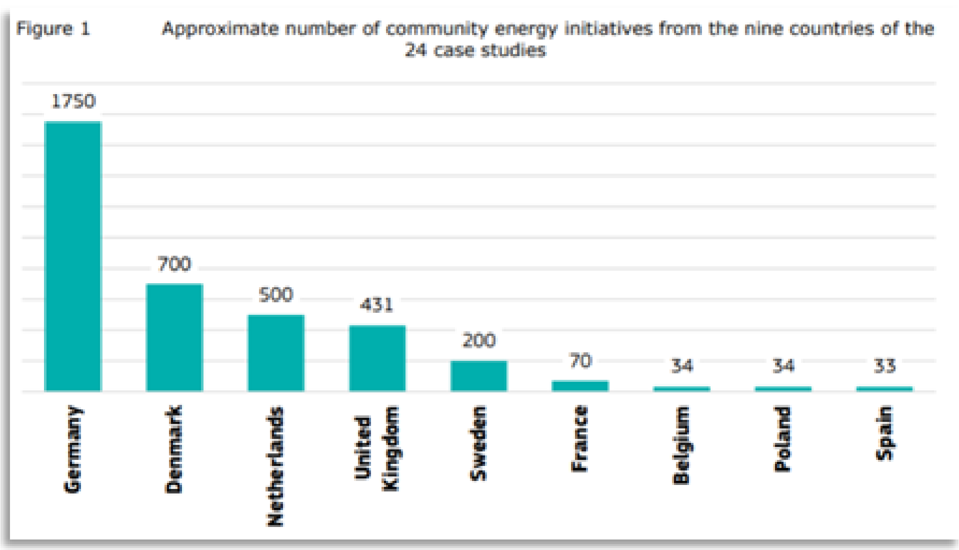


Figure 7
Source: Caramizaru & Uihlein (2020)

One of China's main goals in developing renewable energy has been to supply off-grid electricity to more than two million rural households that do not currently have access to electricity. It views renewable energy as a potentially lucrative economic opportunity, particularly in the global market for clean technologies. In 2009 China exported more than 90% of the photovoltaic cells that it produced. This however suggests governmental control as opposed to community autonomy, which is not unexpected from China.

In the United States, California, Illinois, Ohio, Massachusetts, New Jersey, New York, and Rhode Island authorised Community Choice Aggregation (CCA) legislation. CCAs are programs that allow local government to purchase power on behalf of their residents and business from an alternate supplier while continuing to receive transmission and distribution service from their existing utility service provider. This helps communities shift to green power and they will have more control over their electricity sources resulting to lower cost of electricity. (Environmental Protection Agency, 2020)

In London, the Mayor, Sadiq Khan, has made civic energy a crucial pillar of his 2050 strategy. He has set up a dedicated Community Energy Fund with the objective of increasing local solar capacity to 2 GW. He also assured that by 2025 a quarter of London’s energy will be supplied from decentralised sources.

The Victorian Government in Australia is abetting the development and enforcement of community renewable energy projects. The Traditional Owner Renewable Energy Program (TOREP) will enable the traditional owners to determine how they want to be part of this energy transition. The government wants them to be part of the planning and uptake of renewable energy generation and storage and the reduction of greenhouse gas emissions, delivering social and economic benefits to the Aboriginal Victorians. Each Traditional Owner Corporation (TOC) is eligible for up to $100,000 in funding to formulate plans and aspirations within the renewable energy sector and build a long-term legacy to feed into self-determination processes.

In the city of Gent, Belgium, the municipality provides support to citizens to invest in renewable energy and energy efficiency. The government has partnered with the local cooperative Energent, to provide technical assistance to citizens with clean energy generation. Cities can also benefit from the skillset of energy cooperatives to help define strategies.

4. The future of Energy Communities

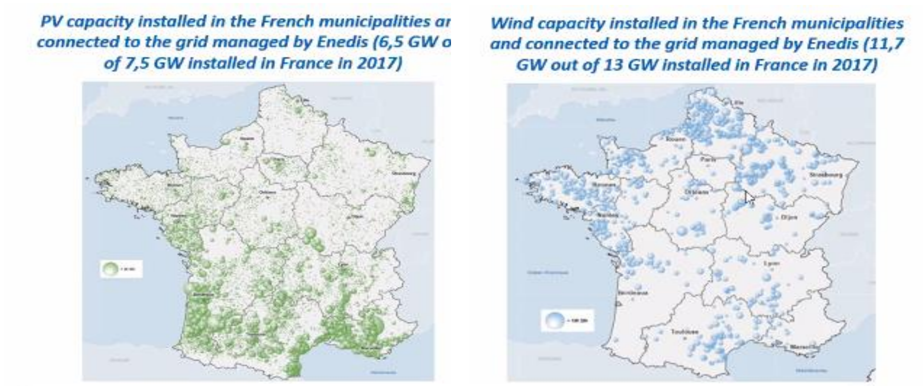
4.1 Shortcomings of French Adoption

As discussed in Part 1, a big component of the establishment of these communities is a sense of collective drive. A primary issue in France is the lack of sufficient membership to organize such communal endeavors. In defense for France, it was one of the last markets to fully liberalize the energy market, this prior extreme centralization results in very low citizen involvement, as people believe they have no role to play in that system (Devine-Wright, 2007), hence the French are behind their European counterparts. Unlike the Dutch communities seen on the canals of Amsterdam or Texel island, in France there is a serious lack of willingness to participate (Vernay & Sebi, 2020). Setting up communities take time, knowledge, and effort. The technical capabilities need to be advanced, requiring service providers for electrical engineering or opportunity assessment studies, securing grid connections, finding insurance providers, organizing and following installations, monitoring plants and performing maintenance activities, in a regulatory framework which is relatively confusing to disentangle, it is a big ask.

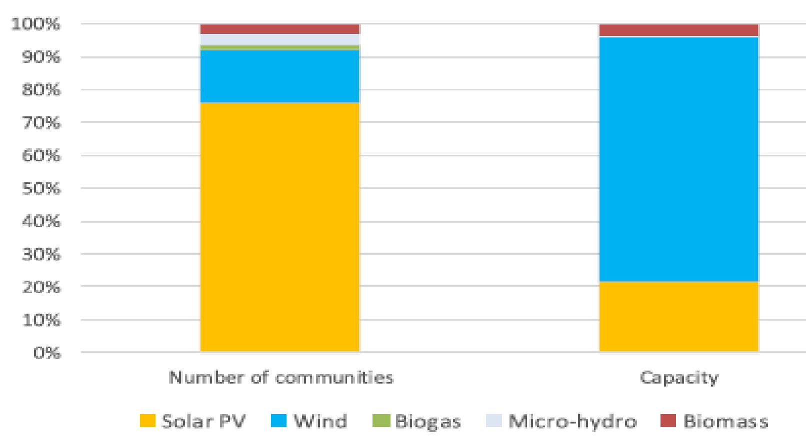
Additionally, France has a relatively low carbon intensity relative to our European counterparts – 8%, due largely to the nuclear energy share. Hence intrinsic motivation to fight against a polluting supremacy is lacking, compared to their Dutch neighbors, that still use a predominantly “Grey” energy mix: natural gas (42%), oil (37%), coal (11%), (IEA, 2018), there is a lack of climate urgency. Stronger anti-nuclear sentiments have shifted significantly from the 70’s, in a study carried out by Beccia (2020), it appears that as French people get more educated on the matter, negative perception is dropping, which is why Nuclear usage does not induce mass action.

Finally, from a geographical point of view, there are major biophysical limitations, which make France a more complicated case, the expertise required to best harness the renewable potential of a region differs significantly between the north and south of the country. The large majority (76%) of REC’s in France have solar power plants, but wind plants represent the majority of installed capacity - 64%. Due to the limitations of the hourly curves of generation for renewable energy consumption, majority of these projects still require interconnection at the national grid level. However, local energy allocation can decrease ‘peak demand’ due to the increased consciousness developed from shifted energy consumption. Establishing whether the decrease in peak demand is lowering overall utility is unexplored in literature but can be assumed. Finally, in France connecting to the grid can vary between 1000 € and several tens of thousands of euros and this has a very important impact on the economic feasibility of a project, especially in rural areas where the grid has lower capacity. some REC claim that ENEDIS is still acting in a bias manner, making it difficult for smaller player to integrate, especially through grid prices and reluctance to share digestible information for non-professional actors (Sebi, 2020). These market organizational and geographical barriers, all play a large role in the adoption of REC in France.

Figures 8. PV and Wind Capacity constraints in France Source: Enedis



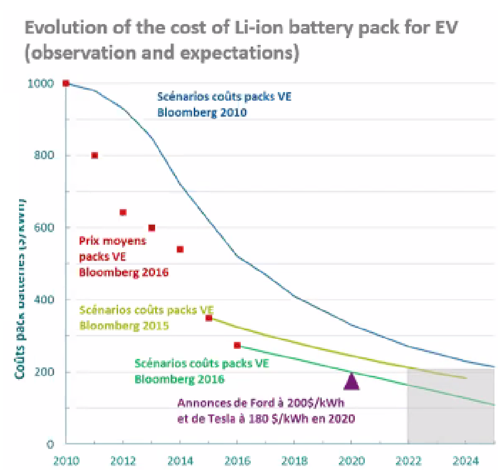
Figures 9. Distribution of REC by technology in number of projects (left) and installed energy capacity (right) Source EPA



4.2 Technological Advances

Figure 10.

Source: PSE lecture slides



The most promising new technological advancement that is set to disrupt the renewable energy market is Green Hydrogen. The European Union intends to invest $430 billion in this by 2030, to help achieve the green deal goals. Essentially, this energy form, is hydrogen created from renewable energy instead of fossil fuels. Scientifically speaking, this is produced through the electrolysis of water, leaving nothing but oxygen as a by-product, it's when an electric current from wind or solar, is used to split water into hydrogen and oxygen, which results in pollutant-free hydrogen, called green hydrogen. The rapidly declining cost of renewable energy is one reason for the growing interest in green hydrogen. (Cho, R., 2021). The fantastic opportunity here, is that when comparing KG by KG, hydrogen contains almost three times as much energy as fossil fuel. Since Green hydrogen is more expensive (€3. 50 to €6 p/kg) than grey hydrogen (€1.50 p/kg) and Blue (€2.5 p/kg) (van Renssen, S., 2020), an interesting opportunity could be created for renewable energy communities and it's believed to be "Catalyst to decentralization of the system". The primary benefit here is that electricity does not need to be put back into national grids to gain revenue, it can be produced on site and sold directly to any buyer. Storage wise, it can be easily stockpiled in large quantities for long durations of time and even stored in existing gas pipelines. By removing the institutional/ market barriers and offering higher prices for this electricity source, it could motivate a new wave of renewable energy communities. Again however, technical expertise is still the primary downfall, which act as a very high barrier to entry.

The most easily adoptable technological advancement is battery storage capabilities. The rise in EV vehicles is driving down the price of lithium-ion battery production. Renewable energy generators will be able to increase revenues that would have otherwise been lost owing to curtailment, and this will significantly ease the off-grid transition to truly cut ties to the grid dependency (IRENA, 2019). The interesting transportation and cost incentives seen in green hydrogen and lithium-battery capacity are both advancements, that if made accessible enough, will have a major positive influence on Renewable Energy Communities.

4.3 Digitization of REC

As seen in the Lyon Confluence example, one of the most effective ways to run a renewable energy community, is to remove a certain human element, which simply cannot outperform the automation and analytical capabilities of digital programming. The Hikari building uses: windows that are operated by a central system to maximises sunlight, the walls are covered by PV, EV car sharing is made available, the building charges EV's and energy data collection devices are installed in the complex to visualise and correct energy consumption in real time. (i.e. auto sensing rooms for heating and light). The overall savings from this, resulted in net positive returns of electricity back to the grid (Chinomiya, 2017). Finally, crypto-trading and blockchain are on the forefront of this conversation. From a technical perspective a modular blockchain-based software platform can be created for extending the features of cryptocurrency exchanges to the renewable energy earket, including a robo-advisor which will suggest prosumers the bestselling strategy. Blockchain technology shows a lot of promise in boosting the growth of renewable energy production. (Mannaro, K., et al. 2018). The primary focus is to take out the centralized institution and promote a P2P trading scheme, where owners will sell their produce to other consumers on a local low-voltage distribution system. Currently there are already developments in the U.S, Australia and Switzerland, but not many European countries as of yet (Ableitner, L.,et al, 2019). Collective effort and motivation to transition to clean energy can lack within the mass population, so by taking away barriers through technological advances, renewable energy communities can be made more attractive.

Fig. 1 The electricity market is experiencing a shift to more distributed energy generation and an increasing share of prosumers supplying their own energy

Figure 11.

P2P trading blockchain benefit

Source: Mannaro, K., et al. 2018

5. Cost and Benefit for REC

To deepen this discussion, we explore how an analysis could be conducted for a purely decentralized community (a remote town in Western Australia for example), using PV technology and comparing it to a diesel generator. Primarily, we must understand all costs involved, this is referred to as levelized cost of energy (LCOE) and captures the total lifetime costs and provides a comparable financial metric in dollars per unit of energy ($/MWh), that enables comparison between technologies. Using the cost breakdown as stated below, for a scenario with an 80%/20% debt to equity ratio, total costs per $/MWH of a standard PV set up, would come to $136 for fixed costs and $14.5 variable costs. A Solar PV panel with 6hrs Storage would cost, $230 for fixed costs, and $49.3 variable costs (these exclude generation management). Interestingly, when compared against a Diesel generator at standard fuel prices, fixed costs are at $99 and variable costs are $447. Diesel generation LCOE is highly sensitive to changes in forecast diesel price but only marginally sensitive to changes in WACC, in contrast to solar LCOE which is sensitive to WACC. (Byrnes, L., et al., 2016). Now Costs have been identified, some constraints and assumption must be laid out, such as, no land costs, electricity tariff increases annually at a conservative rate, 'buyback' prices are assumed to be constant at $0.50/kWh over the lifetime of project etc.

Total costs	$TOC(t)_j = Fuel(t)_r + O\&M(t)_r + CM(t)_r + EL(t)_r - RE(t)_r$
Fixed and Variable operating and maintenance costs	O&M(t) j = VOM$(t)_j$+ FOM$(t)_j$ Where: VOM$(t+1)_j^E)_j$= VOC_t * SO$(t)_j$ * CPI($(t)_C$ incorporates the initial cost of construction VOC_j per MW, increasing by CPI($(t)_C$ incorporating the sent out energy SO$(t)_j$ $VOC(t)_{j\ j}^E = VOC(t)_j * E$ FOM $(t+1)_j^E = FOM_t * CPI(t)_C$ FOM $(t)_j^E = FOM_t$ * E
Technology depletion costs	$CM(t)_{j\ j}^E = \left(\frac{CF_j^E * Capex_j^E * CPI(t)_C}{Life_j} *\right)$
Fuel cost	$Fuel(t)_j^E = \left(\frac{(HR_j * E) * CF_j^E * FC(t)_j}{1000}\right) * SO(t)_j^E * CPI(t)_C$
Capital Costs	$Capex_j$
Capacity Factor	CF_j^E
Sent Out Energy	SO$(t)_j$ = $\left(\frac{size_j * CF_j * 8760 * (1-Aux_j)}{1000}\right)$ Where, the revenue inflation rate to output generated of the sent out energy is: SOR$(t)_j$= SO($(t)_j$* CPI($(t)_r$
Carbon Emissions Liability	EL$(t)_j$= SO$(t)_j$* $EIF_j * C_t *$ CPI$(t)_r$ * CL_j Where: EIF_j = the emissions intensity of any generation technology CL_j = the emissions liability C_t = the carbon price at time t
Payments under renewable energy scheme	$RE(t)_j$= SO$(t)_j$* $REC_t *$ CPI$(t)_r$ * REE_j Where: REC_t = the renewable energy certificate price at time t REE_j = {0,1} which reflects a generation types eligibility under the Federal Government Scheme

Table 3: LCOE Parameters

In this case, the reference scenario is based on a situation using a diesel generator, so evidently when fuel prices are higher, the net benefits of renewable energy options seem comparatively higher. Additionally, depending on the financing structure, different outcomes are to be expected, for this discussion we have chosen an 80/20 debt to equity ratio, however in a scenario at 70% capital grant, the net benefit outcome is more interesting. The PV option with 6hr battery did not meet the Net Benefit equilibrium, however the simple PV technology did. The shortfall in this analysis, is the limited breadth of 'benefits' included, whereby financial benefits from installation of renewable energy source alone were considered, as opposed to the plethora of additional benefits, which are harder to monetize.

Net Benefit	Scenario 1		
	20 kW	262 kW	
		Photovoltaic	
Community Perspective	$31,674	-$422,343	
Utility Perspective (low fuel scenario)	$136,052	$1,509,018	
Utility Perspective (base fuel scenario)	$215,583	$2,471,338	$
Utility Perspective (high fuel scenario)	$309,614	$3,609,110	$

Figure 12 & 13. Benefits & Costs of Renewable Community
Source: Byrnes, L., et al., 2016

To build on the existing literature, we suggest the following theoretical framework for how the Byrnes, L., et al., (2016)'s CBA analysis can be enriched, through a more comprehensive inclusion of benefits.

Benefit Category	**Benefit**	**Description**	**Monetization strategy**
Network and Transmission	Network efficiency	Localizing the production of energy and locating closer to consumption area will reduce the chances of loses in transmission.	Transmission savings in $
Reliability and efficient usage	Household Efficiency	When people take interest in energy production, they use it wisely, which lowers electricity bills and increases carbon savings.	Carbon offset Effects from behavioral changes in $
	Energy Security	Fluctuation in fossil fuel prices will not affect the prices of renewable energy.	$ value of reliability from stable predictions
Economy and Community	Economic Gains	Community energy initiatives create employment opportunities strengthening the local economy. These communities attract investments and higher economic activity.	Employment multiplier and Community agglomeration effects of added stimulus in $ (Can take from Urban Economics)
	Community building	Empowers communities in collective decision making and self-governing.	Social Benefits and human interaction in $ (Can take from Urban Economics)
	Autonomy	Giving people greater control over their expenditure on energy, reduces dependence on big and impersonal companies.	User cost saving from not connecting to grid (fee/charges) $
Environment	Reducing Emissions	The promotion of communal environmental preservation by limiting harmful emissions.	Reduction in Co2, OECD, 2020, values at $86

Figure 14. Benefit extension Renewable Community

6. Final thoughts and Conclusion

The Increase in energy communities has led to manoeuvres toward off-grid clean energy generation and is said to play a central role in energy transition. Its long-term benefits outweigh the deterrent of short-run costs of initial set up and establishment. Beyond the pronounced reduction of greenhouse gas emissions, communities can blossom with cheaper energy, economic expansion, self-sufficiency, eco-innovation and cohesion. The political, economic, social, and technological blockades preventing the shift to cleaner energy sources, can be ranked in the following:

1. Access to and understanding of information i.e Salience and expertise
2. Follow through/ effort & motivation from parties
3. Administrative & Governance barriers
4. Access to capital
5. Institutional barriers
6. Regional/Cultural barriers

local and national governments should focus on drafting future policy implementations to smooth these barriers, prioritising specifically on salience and technical expertise. Perhaps through widespread educational campaigns starting as early as teenage years, and prioritizing grants and scholarships for university courses focused on the establishment of renewable communities. Moreover, even a large-scale communication campaign, integrating educational TV episodes after the evening news, would spread awareness and desirability. The wide-spread comprehension of decentralisation is crucial, for this concept to reach critical mass, and once the comprehension of the concept is established, motivation will follow.

Although there is still a long way to go, through the adoption of new technologies and smart advancements, a paradigm can be shifted, to enable organisations of these communities to require less human effort. This paired with convincing cost-benefit analysis, highlighting the long-term financial gains, are instrumental to help draw citizens to become prosumers. As of 2019, in France alone, 37% of renewable energy communities were under development. With a further governmental push, who knows, the Utopic ideal of "45% of EU citizens producing their own energy", may indeed become a reality.

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Thank You

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