



Renewable energy cooperatives: Facilitating the energy transition at the Port of Rotterdam

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ABSTRACT

Renewable energy cooperatives (RECs) are an important element of the European energy transition. Allowing citizens and companies to invest in renewable energy and thereby become independent power producers has advanced the acceptance of renewable energy among the population, accelerating the move toward a more decentralized and sustainable power supply. We investigate how a REC could be designed to increase renewable energy deployment at the Port of Rotterdam. Based on a progressive case study conducted among a wide array of stakeholders at the Port and across Europe, we have found 14 specific characteristics a REC should embody to facilitate the energy transition at the Port. Based on these results, we present an action plan with concrete recommendations on how a successful cooperative could be launched at the Port. The results of this research can serve as a guide for stakeholders in any industrial cluster interested in driving the energy transition through a REC.

1. Introduction

The beginning of the energy transition from unsustainable to renewable energy sources can be seen as one of the most promising global developments in recent history that is solving the wicked problem of sustainable energy supply (Ketter et al., 2016a). Renewable energies offer two major benefits. First, they are relatively clean; second, they can be used in a decentralized manner (Robyns et al., 2012). While the first benefit is widely known, the latter rarely receives the attention it deserves. In fact, decentralization has played a crucial role in the energy transition, as private households and companies invested in solar systems for self-consumption to decrease their energy bills (Braun et al., 2009). This is leading to a more diverse energy industry and to a “democratization” of energy supply (Kaphengst and Velten, 2014). This democratization brings new players to energy markets, in addition to the conventional energy corporations. One of the most visible ongoing developments is the emergence of Renewable Energy Cooperatives (RECs) (Fridgen et al., 2018). Based on the well-known concept of cooperatives, which emerged in Europe in the 19th century (Bonus, 1994), RECs give individual citizens and companies outside the energy industry the opportunity to on the one hand bundle resources and become renewable power producers, and on the other hand participate in

cooperative energy consumption. Through the increasing international acceptance of renewable energy resources, RECs have gained ground in many countries. For instance, the European Federation of Renewable Energy Cooperatives (Rescoop) currently counts 1240 RECs within its federation and a total of 650,000 European citizens as members.¹

Given the remarkable success of this phenomenon in driving the energy transition, it is expedient to find out how to expand RECs to industrial zones. Hence, in this paper we focus on the following research question:

What are the critical success factors in setting up an industrial REC so that it can have a significant impact in reducing CO₂ emissions and energy costs? Therefore, together with the Center for Future Energy Business of Erasmus University Rotterdam, we analyze what characteristics such a cooperative would have to contain to help the Port of Rotterdam, one of Europe's major industrial clusters and a macro-economic power house, in achieving its own energy transition. Based on these results, we give practical recommendations of how a REC should be set up in order to facilitate the energy transition at the port.

The reason why the Port of Rotterdam - the largest port in Europe - was chosen as research setting, is that the companies located there have an immense combined electricity demand, which according to the port authorities sums up to approximately 10–20% of the entire Dutch

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¹ <https://www.rescoop.eu/> (accessed 07.02.2018).

electricity consumption. Energy is the main cost factor for many companies at the Port, which is why the port community is looking for ways to decrease energy costs. An important challenge the Port is facing with regards to energy, is to make better use of synergies and common interests of companies located within its industrial park. For instance, while installing more decentralized and renewable power plants could be beneficial for the port community, their full benefit can only be harvested if companies aggregate their resources and better coordinate their energy consumption patterns. Our research intends to lay out guidelines to set up a REC as an entity that can help addressing the challenge of making better use of synergies regarding energy within an industrial cluster.

This paper is organized as follows. In Section 2 we present relevant literature. Section 3 outlines the methodology of the research this publication is based on. Section 4 presents the results that have been generated. In Section 5 we lay out a possible plan of action for building, managing, and sustaining a REC at the Port. Finally, in Section 6 we summarize and suggest ideas for future research.

2. Related work

2.1. (Renewable energy) cooperatives

Cooperatives are organizations enabling economic collaboration among individual actors. Some authors define the founding of the Rochdale Equitable Pioneers Society in England in 1844 as the birth of modern cooperatives (Pezzini and Ambiorix, 2006). Subsequently, the International Cooperative Alliance has evolved as the predominant authority on the matter. According to this non-governmental organization, a cooperative should be defined as follows:

A co-operative is an autonomous association of persons united voluntarily to meet their common economic, social, and cultural needs and aspirations through a jointly owned and democratically-controlled enterprise.

Interestingly, most recent publications on cooperatives refer to renewable energy cooperatives. To understand why energy cooperatives are gaining in importance and why this refers mainly to RECs, it is useful to look at the history of German energy cooperatives, whose origins trace back to the end of the 19th century (Stier, 1999). In that time, due to insufficient grid infrastructure, local actors formed energy cooperatives to organize electricity production and distribution networks (Holstenkamp, 2012; Flieger, 2012). This shows that, while energy cooperatives were already partly investing in renewable energies (hydropower), they originally emerged mainly out of the desire to provide basic energy infrastructure.

After the Second World War, extended economic growth led to a dramatic increase in electricity demand. Since individual energy cooperatives often lacked the resources to meet this demand, they declined in importance and gave way to bigger, national energy companies (Stier, 1999). Another reason was that the public administration favored a centralized approach to energy supply (Holstenkamp and Radtke, 2017). Consequently, the dominant energy infrastructure in Germany (and globally), has been organized in a central manner, often through state owned companies (Stier, 1999)

However, since decentralized energy systems offer several important economic and technical advantages over centralized systems, a decentralized energy supply emerged over the last decades. Among other things, this led to more active participation of individual energy consumers and to the development of the now highly popular term “prosumer” (Luo et al., 2014), a neologism composed of the words consumer and producer (of energy).

The rising popularity of energy cooperatives and their strong association with renewable energies can thus be explained by two factors: first, renewable sources such as solar and wind are diffuse – it is difficult to concentrate them into large power plants. This leads to

decentralization and to active involvement of property owners who are willing to invest in these resources. Second, small producers of sustainable energy have no market power, and may find the cost of installing and maintaining the necessary equipment burdensome. A cooperative can increase the value and reduce the cost of renewable resources for individual producers, aside from the social benefits that may accrue.

RECs are often classified by their purpose (Yildiz, 2013):

- *Energy consumption cooperatives* help organizing bundled and well-coordinated energy purchases for its members. Through such cooperatives, peak demand can be optimized and better prices on the spot market due to larger purchase quantities can be achieved.
- *Energy production cooperatives*, the most common form of RECs, enable a group of persons to produce and sell energy together.
- *Energy service provider cooperatives* act as service providers for a group of already existing energy providers and cooperatives. Their purpose is to bundle resources for activities such as energy purchase and sales. Energy related service providers often also offer consultancy services.

2.2. How RECs facilitate the deployment of renewable energies

Walker (2008) suggests several reasons why RECs facilitate the deployment of renewable energies: first, they lead to a higher local acceptance of the technical installations. Second, RECs lead to lower energy costs and in some cases a more reliable energy supply for their members. Third, Walker argues that RECs help their members achieve ethical and environmental commitments, since it allows them to invest in a more sustainable energy supply, often by procuring sustainable electricity for their own consumption. Finally, RECs enable its members to perform load management (coordinating energy demand and supply), which can lead to significant cost benefits as well (Rieger et al., 2016). Other authors mention the benefit that financial barriers to the deployment of renewables can be overcome through RECs (Morris and Pehnt, 2012). Furthermore, Yildiz (2013) names lower danger of opportunistic behavior as one of the main benefits offered by RECs. The author argues that by giving ownership of their business activities to their members, cooperatives can be a beneficial organizational structure, since they reduce opportunistic behavior of the agents and thereby transaction costs.

As a community of energy consumers and producers, RECs can also facilitate the energy transition through their capability to act as power brokers among their members (Mono, 2018). In fact, in countries where the energy transition has already profoundly shifted the energy landscape, integrating renewables into the existing energy system has become a bigger challenge than increasing the amount of renewable power plants (Brunns et al., 2012). The current system design of “central power stations serving large populations of customers is breaking down” (Collins and Ketter, 2014), which is why the research community is busy developing means to create “smart markets” (Bichler et al., 2010). Meeting this task will require large scale measures that include providing “efficient price signals that motivate sustainable energy consumption as well as a better real-time alignment of energy demand and supply” (Ketter et al., 2013).

2.3. RECs as strategic alliances

The concept of cooperative organizations can be linked to the concept of strategic alliances, which offers interesting implications for the theory on RECs. Varadarajan and Cunningham (1995) define strategic alliances as a “manifestation of interorganizational cooperative strategies [which] entails the pooling of specific resources [...] in order to achieve common goals as well as goals specific to the individual partners.” In fact, RECs composed of companies can also be seen as interorganizational endeavors aiming to pool resources. In most cases, an industrial cooperative would not lead to an all-inclusive cooperative

behavior of its members – companies can be competitors – but to a pooling of specific resources (i.e. bargaining power). Nevertheless, by decreasing the energy costs and improving the image of companies within a certain industrial cluster, a REC would strengthen the competitive advantage of its entire business community. This relates to the final elements of Varadarajan and Cunningham's definition, as achieving improved competitive advantage towards other clusters is clearly a common goal of the companies, while decreasing energy costs by i.e. buying local solar energy, generating additional income by i.e. renting roof space or investing in sustainable assets would be goals specific to certain individual companies, depending on their properties (high energy consumers or warehouses owning large roofs etc.).

Also Parkhe (1993) definition of strategic alliances, which the author describes as “relatively enduring interfirm cooperative arrangements [...] that use resources and/or governance structures from autonomous organizations, for the joint accomplishment of individual goals linked to the corporate mission of each sponsoring firm” fits the concept of cooperatives composed of companies.

Having established that a REC that is composed of companies could constitute a strategic alliance, the following implications can be deduced.

According to Varadarajan and Cunningham (1995), the strength of linkages companies form within a strategic alliance can range from complete integration of the entirety of a firm's functional areas towards cooperative action that is “limited in scope to a single functional area and value creation activity”. Furthermore, the authors conclude that the main reasons why companies enter strategic alliances are market uncertainty, drive for increased efficiency, resource dependency, skill and resource heterogeneity and imperfect factor markets. Viewing these elements in the light of renewable energies at an industrial cluster such as the Port of Rotterdam, the following can be inferred: first, since the current Dutch renewable energy regulations do not provide fixed feed-in tariffs, they do not offer strong securities for investments in renewables and it is unclear when and how this situation might change. Therefore, market uncertainty is witnessed. Second, due to high energy prices and increased expectations by consumers, Dutch companies have a strong drive for increased energy efficiency (Ecofys, 2012). Third, with regards to electricity, companies at the Port are resource dependent, since they rely on external energy providers. Fourth, companies at the port are specialized in many different areas and do not necessarily own knowledge in the field of renewable energies, therefore there is a skill and resource heterogeneity. Finally, as mentioned by the Port Authorities, there is an immense potential for solar energy, that is not yet used; a clear sign for an imperfect factor market. It can thus be concluded that each motivating element fits the case analyzed by this research.

Analyzing strategic alliances from a resource dependency theory perspective, Das and Teng (2000) name the ability to pool resources as an important motivational factor for the formation of a strategic alliance. According to the authors, companies enter alliances because they see a significant potential for value creation when they pool their resources together. The authors further stress that if the resources to be pooled are imperfectly mobile (e.g. roofs) and imitable (e.g. bargaining power regarding electricity consumption), they offer more potential of value creation through cooperation.

2.4. Clusters – a fertile ground for cooperatives

In a visionary article on competition in a globalized world, Porter (1998) introduces the concept of clusters, which he defines as “geographic concentrations of interconnected companies and institutions in a particular field”. Porter argues that, since companies can nowadays source globally, competitive advantage is shifting from having access to certain inputs to making more productive use of the resources a firm sources. Consequentially, the “immediate business environment outside companies plays a vital role”. Emphasizing that competitive advantage

is increasingly achieved through greater productivity, Porter argues that companies must achieve sophistication in the way they produce goods and services, which in turn is highly dependent on the local business environment they act in. Therefore, executives should expand their focus of attention from matters internal to their firm and to their industry towards the situation of their cluster, because “a vibrant cluster can help any company in any industry compete in the most sophisticated ways, using the most advanced, relevant skills and technologies”, such as renewable energies. According to Porter, one of the main benefits clusters offer to their members is that they allow “each member to benefit, as if it had greater scale or as if it had joined with other formally”.

Furthermore, in a more recent study on the economic performance of industry clusters, Delgado et al. (2014) show that new industries emerge more easily in “strong regional clusters”. Additionally, the authors show that clusters facilitate new business formations (Delgado et al., 2010), since they build up an environment of trust and beneficial interdependence among companies located in close proximity. Finally, Zhang and Wang (2014) show that especially in the case of energy, inter-firm collaboration to reduce energy procurement related carbon emissions can lead to a better economic performance of each company involved.

3. Methodology

To investigate how a REC would have to be designed to increase renewable energy deployment within an industrial cluster such as the Port of Rotterdam, we apply the progressive case study approach. This research methodology was developed by Steenhuis and Bruijn (2006) and — due to its empirical mix of case study and grounded theory approach — allows for practical research in a field where data must be gathered from scratch. Since at the time of the research no REC is established yet at the Port of Rotterdam, the progressive case study is a highly fitting method to gather data on how a REC should be designed to be successful. Based on this method, we apply a two-phase research process design as depicted in Fig. 1. The aim of this research design is to identify specific characteristics a REC would have to contain to facilitate the energy transition at the Port of Rotterdam.

Phase I is composed of two steps. After preparatory desk research on recent developments regarding energy cooperatives, the first step contains two case studies. German RECs constituted the first study population. German RECs have been chosen as the starting point for this research for two reasons: first, they are at the forefront of the contemporary energy cooperative movement and second, the cooperative environment in Germany is comparable to the one in the Netherlands (Schenk, 2013). Consequently, analyzing German RECs lead to a rich pool of information that could be well transferred and compared to the Dutch REC movement. Furthermore, due to the researcher's working experience in the German solar energy industry, he had good access to the German REC network. The study population for the second case was Dutch RECs. The Netherlands have been chosen as a research location to enable the researcher to gather information that is specific to the environment of the Port. As a rule regarding the study populations of case 1 and 2, cooperatives had to have companies (juridical persons) or their CEOs among its members and own renewable energy power plants to qualify for the study. Additionally, interviewees should be founding members of the cooperatives. Apart from these similarities, the researcher sought to interview a heterogeneous group of RECs. For instance, regarding the type of technologies used, business models applied, and years of existence the cooperatives vary. Throughout both case studies, nine founding members or managing directors of existing RECs and an industry expert are interviewed. The interviewees are selected based on their full decision-making power within their institutions and their ample knowledge of the field. A list of interviewees can be found in the Appendix. The interviews are semi-structured, to give the interviewee enough space to elaborate on his answers, while at

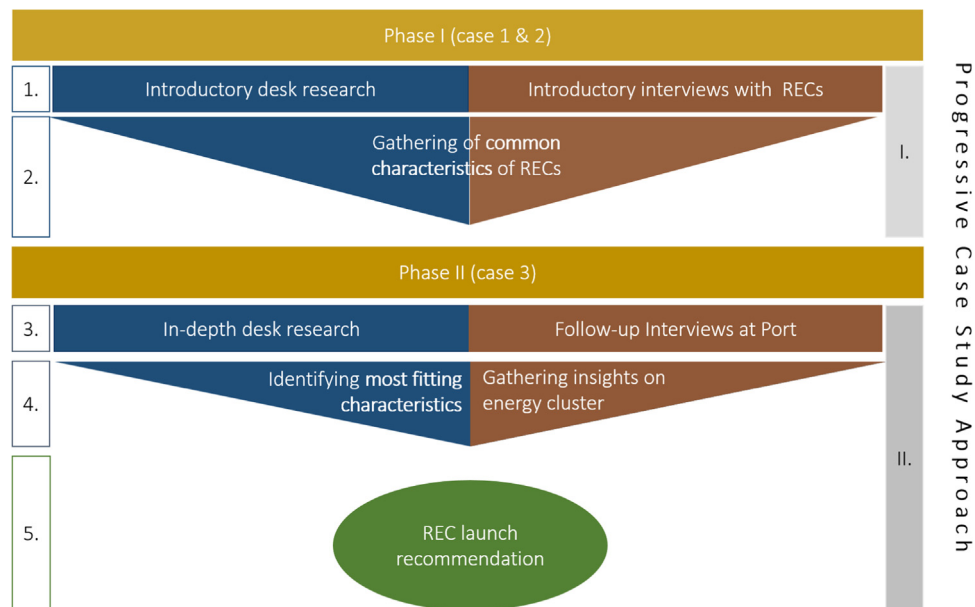


Fig. 1. Progressive Case Study research framework.

the same time making sure that all necessary elements are addressed. Interviewees are asked about the legal structures, business models, *raison d'être* and organizational designs of RECs and the issues they are facing. In the second step of Phase I, we progressively identify and gather common characteristics of RECs from the two first case studies. To identify the characteristics we make use of descriptive coding, assigning a certain label to each answer of the interviewee by summarizing its main idea (Saldaña, 2015). Each label, in turn, refers to a certain characteristic, which receives a point each time it is mentioned. This allows us to rank the characteristics throughout the research process and thereby confirm which proposed characteristic would be suitable for a REC within the specific setting of the Port.

The second phase aims at identifying those characteristics of a REC that fit the purpose of facilitating renewable energy deployment at the Port of Rotterdam. To achieve this, three additional research steps are taken. In the third step, a third case study is conducted aiming at investigating the opinion of decision-makers within companies and other crucial stakeholders at the Port on the matter of renewable energy and collaboration through energy cooperatives. For this 8 interviews are conducted with CEOs and project managers of companies at the Port, the strategist of the Port Authorities, researchers of Erasmus University and a manager of an Investment Fund. All interviewees were selected based on their high level of insight in the energy market at the Port and their involvement in the decision making processes concerning the future of its energy supply. In addition, this case study contains in-depth research regarding the legal prerequisites a REC at the Port would have to fulfill to be effective as well as possible business models it would have to put in place.

Hence, the first two case studies aim at identifying characteristics of RECs that are then confronted in the third case with the Port environment.

In the fourth step we identify the most fitting characteristics a REC would have to possess to be successful at the Port. Finally, based on these results, in the fifth step we propose a REC design and provide practical implementation recommendations.

4. Results

We describe three types of results to paint the full picture of this research: *confirmed characteristics*, *rejected characteristics* and *potential characteristics*.

4.1. Confirmed characteristics

The first is *confirmed characteristics*, which are characteristics that have been identified as crucial by the interviewees of research phase I and confirmed by those in Phase II. This means that these characteristics have been named by many interviewees throughout the three case studies.

Mix of financial and societal targets: Our research indicates that most importantly, the cooperative's mission should be composed of a mix of financial and societal targets. The port community will identify itself with an organization that on the one hand wants to achieve higher levels of sustainability within the Port and on the other hand aims at helping its members to save (or earn) money.

Professionalism: Since the REC would be composed mainly of companies, it would have to be managed professionally. Companies at the Port will only be willing to invest time and money in an organization that presents itself as a highly professional institution, since this conveys an image of confidence and efficiency.

Specific starting project: To convince companies to join the cooperative, they first must understand its *raison d'être*. Consequently, the REC would have to present a concrete starting project, which would help potential members to understand how the cooperative would operate and what risks and benefits would be involved. This specific starting project would have to be easy to understand and easily realizable.

Membership fee: A professionally managed REC has to finance salaries, an office and other expenses. To be able to do this, it should charge a reasonable membership fee. This would motivate new members to actively participate (since they paid for it) and it would set a professional environment from the beginning.

Separate legal entity: the REC's organizational design should make it a separate legal entity that functions independently from its members. Thereby, a company could become a member without having to worry too much about the cooperatives' operations, while keeping full control over its decisions.

Address trust challenge actively: Companies at the Port are careful

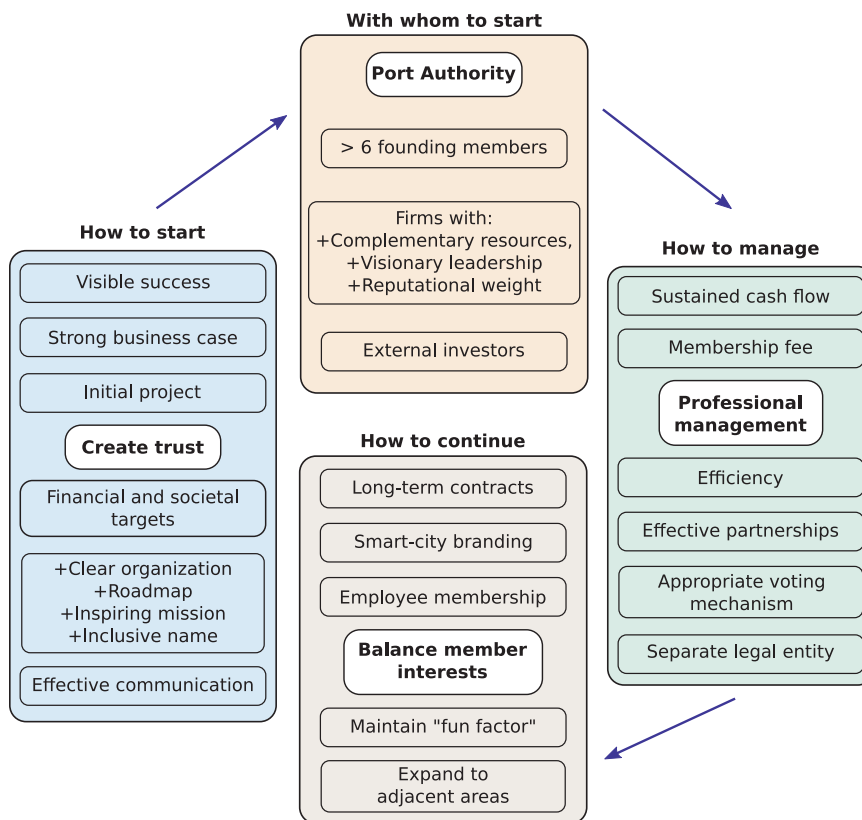


Fig. 2. Action plan for launching a cooperative.

about the information they share, and are reluctant to engage in extensive collaboration. Consequently, the REC would have to address this trust challenge actively, for instance, by presenting a specific starting project that is easy to implement and does not require intrusive sharing of information. Successfully realizing a starting project would show the members that they can work together, count on each other and thereby build up confidence.

Clear organizational structure and roadmap: For similar reasons the cooperative must have a clear organizational structure and roadmap from the beginning.

Intensive communication with stakeholders: The REC would have to engage in constant and professional communication with all stakeholders to explain the benefits of membership to potential members, and to maintain good relationships with administrative bodies and the civil society of the Port area.

4.2. Rejected characteristics

We call the second type of results *rejected characteristics*. These are characteristics that have been named by many interviewees in Phase I but were deemed as unsuitable for the Port environment by many interviewees in Phase II, or vice versa. Consequently, these characteristics have a high pertinence, but show conflicting results between the two research phases. We focus on the rejected characteristics due to their high pertinence. We will consider them when recommending an action plan on how to launch the REC.

One man, one vote: The one man one vote rule is recommended by four out of nine respondents of Phase I and no interviewee advised against establishing such a voting mechanism. Interviewees stated that even in a REC with only companies as members, this rule should be upheld. However,

respondents of the second research phase clearly rejected it.

External investors: Respondents of the first phase clearly discarded the idea of allowing external investors access to the projects of the cooperative. Hence, if confirmed, the characteristic would have been to keep external investors out. However, interviewees of the second phase are more open to the idea.

4.3. Potential characteristics

The third type of results concerns *potential characteristics* that we identify. These are characteristics of RECs that were not mentioned in research phase I but which were named repeatedly by the stakeholders interviewed in Phase II.

Strong business case: By far the most important potential characteristic named by the port community is that the REC should present a strong business case. All companies interviewed state that they would join the REC given that its business case is sufficiently compelling, meaning that it offers competitive returns on investment that are proportional to the risks involved.

Employee membership: Many interviewees confirm that it would be a good idea to allow employees of members access to the cooperative.

Large scale: The REC should start with a large number of founding members.

Matchmaker: The REC should act as matchmaker between companies by pooling complementary resources.

Efficiency: The cooperative should convey an image of efficiency and make sure to achieve results quickly and on a regular basis, to keep up the motivation of its members.

Partner with existing firms: The REC should consider partnering with firms that already have significant knowledge in the

energy sector and, if possible, also with doing business at the Port. Thereby the cooperative can outsource the implementation of cooperative projects and focus on its core mission, which is enabling cooperation.

5. Action plan

Based on the 14 identified (confirmed and potential) characteristics of RECs and on some valuable additional insights (including the rejected characteristics) that we gained throughout the process, we have formulated an action plan on how to launch a REC at the Port of Rotterdam. This plan, depicted in Fig. 2, can serve as blueprint for energy economists, consultants, civil servants and entrepreneurs who want to apply the powerful tool of RECs to design effective policies and empower the energy transition within an industrial cluster.

Fig. 2 shows that the results of our research can be classified into four steps of the launching process: how to start, with whom to start, how to manage (once started), how to continue (in the future).

5.1. How to start

Intensive communication: Before the official launch of the REC at the Port, the founders of the cooperative should prepare well. We show that intensive communication with relevant stakeholders is required before the launch. Companies that could be potential founders should be identified and then motivated to join the project by explaining them the benefits of the REC. Once they are inclined to become founding members, an agreement regarding the following topics has to be reached before the launch:

Inspiring mission: The cooperative's mission should be composed of a mix of financial and societal targets. It is important that it is conveyed clearly by the founders that the organization's aim is to build a more sustainable business environment and to enable its members to earn money by cooperating on energy matters at the same time. The business community should develop the feeling that a new era begins where affordable and green electricity becomes the norm.

Inclusive name: Additionally, the cooperative should receive a name that conveys a feeling of inclusion and unity. The name should show that the goal of the cooperative is to unify the resources of the entire business to create a more sustainable and financially attractive electricity procurement system for all parties involved.

Create trust: The REC must convey a feeling of trust among the business community. We show that companies at the Port will question the cooperative's effectiveness as well as its ability to handle sensitive data. To overcome these two barriers, the cooperative must address this trust challenge actively from the start.

To prove its effectiveness, the REC should initiate its public appearance by presenting a strong and simple business case. Given that in the beginning, companies will not be willing to invest a lot of time in the project, such a business case must contain a specific starting project that is easy to understand (simple and compelling financial calculations) and through which the mission of the cooperative becomes clear immediately. Additionally, the first project should be easy to implement, so that fast success can be generated and made visible, which would send a strong message of effectiveness. We recommend a simple roof renting scheme to jointly operate a solar system as cooperative on the roof of a member and sell the solar energy directly to members that are located in close proximity to the rented roof.

Rebutting the second objection will be more difficult, since a certain period of successful cooperation has to pass before companies will be convinced enough to share data with the cooperative. Consequently, the first step should be to engage companies as members, even if at first

they are not willing to share data on, for instance, energy consumption. To achieve this, a clear organizational structure and roadmap should be presented showing potential members that their participation will not force them to disclose sensitive information and that cooperation can be started on a simple level. Additionally, becoming a member should not force companies to invest in projects that the cooperative develops. This is common practice among professionally organized RECs and lowers the entrance barrier significantly.

5.2. With whom to start

Port Authorities: One of the most important characteristics of the REC should be that it is fully supported by the Port Authority. In fact, the Authority should be one of the most active founding members of the cooperative. This will increase significantly the trust of potential members into the REC as well as its awareness level among the port community.

Visionary Leadership: Furthermore, founding companies should have a visionary leadership. This will give them the necessary perseverance to confront the skepticism they will encounter and to navigate the cooperative through the rough waters of its founding. Founding members must believe that higher profitability can be achieved through cooperation, even if this goes against the conventional Machiavellian conception of rivalry and competitive advantage. Additionally, according to Varadarajan and Cunningham (1995), it will be easier to convince companies with visionary leadership to become founding members of the REC. The authors state that top management attitudes affect a firm's propensity to cooperate, since trust among top level management will help to share knowledge and resources with other companies. Finally, founders of the cooperative (i.e. the people organizing the launch, not the founding members) should possess an entrepreneurial spirit, since they will have to conceive creative yet robust business cases that will have to be defended against the above-mentioned skepticism of the Port community.

Large size and external investors: Even though studying the two cases in phase I has shown that most RECs of the study population have been founded by six entities or less, in the case of the Port it seems that a different approach is necessary. Many interviewees of phase II stated that energy at the Port is a topic that must be addressed on a large scale and therefore there should be many participants. Consequently, it should be considered to launch the REC with a larger number than six founding members. Still, it should be made sure that the initial size does not become too big so that the cooperative is still able to remain agile in the beginning. Additionally, one of the founding members should be a company with a certain representational weight among the business community, since this will convey a feeling of security to smaller companies, which will attract new members. Finally, since the aim is to achieve large scale changes within the Port area, which will require high initial investments, the cooperative should remain open to external investors (i.e. investment funds specialized in renewable energies) to finance projects.

Matchmaker and resource pooling: The cooperative should act as a matchmaker between companies whose demand for and supply of resources is complementary. Consequently, the REC should start its existence by inviting companies with such complementary resources to join and to engage in prosuming activities. This will make it easier for the cooperative to present a strong business case since it will identify untapped resources and make them available where they have the highest economical value. The ability to act as matchmaker and to pool resources will be a crucial element of the REC's

raison d'être. Valuable lessons on how to achieve efficient matchmaking, for instance by sending the right price signals to the right parties, can be learned from the insights gained through Power TAC (Ketter et al., 2013, 2016b)

5.3. How to manage

Efficiency and professionalism: A REC at the Port of Rotterdam must be managed efficiently to gain the trust of the Port community. Resources must be spent in such a way that maximum impact is reached, projects must be executed fast and effectively and a strategic marketing campaign must be put into place to establish the REC as an accepted and valued member of the Port community. Achieving this goal requires a professional management. Most RECs are managed by its members and on a voluntary basis. This would not work for an industrial REC at the Port. At least one FTE must be employed from the beginning. In the beginning, the REC will not generate positive cash flows, therefore a membership fee should be collected from new members to finance the overhead of the cooperative. It would have to be decided whether a one-time fee or a yearly fee should be charged. Additionally, it would have to be decided whether the cooperative should differentiate among members. Furthermore, the cooperative should make sure to design its business cases in such a way that a sustained cash flow is generated that flows back into the cooperative so that after a certain time, the REC would be able to finance itself. Finally, to keep the organizational structure lean and membership fees low, the cooperative should always focus on its core capabilities and mission, which is organizing cooperation regarding energy matters. Therefore, other activities, such as project development and project implementation should be outsourced to existing firms.

Separate legal entity: The cooperative must be set up as an impartial entity so that no member has to fear that the cooperative follows the interest of a certain stakeholder. Therefore, the REC must be set up as a legal entity that operates separately from but is nevertheless owned and controlled by its members. Additionally, creating a separate legal entity avoids issues of cartel building, since companies would not collaborate with each other directly, but via a commonly owned, third party that has been set up with the official purpose to facilitate collaboration on energy matters (Neumann, 1977). Finally, creating a separate legal entity would help building a compelling story and presenting a clear organizational structure to potential members, as explained above.

Smart voting mechanism: Most cooperatives apply the one man one vote voting mechanism - one of the seven cooperative principles - which allocates one vote to each member, independent of this member's importance within the organization. Even though many interviewees, especially those of phase I, claimed that this characteristic is crucial, many others stated that applying such a rule within an industrial cooperative would not work. Those supporting the rule argue that it creates a feeling of trust and familiarity among members, which is one of the most rudimentary aspects of a cooperative. Those arguing against it state that companies are used to systems, where more investment of time and money leads automatically to more influence within an organization and that they would not want to engage in a cooperative that functions otherwise. Not applying the one man one vote rule, would clearly deviate from the cooperative principles. However, we show that in the case of a REC at the Port of Rotterdam, this rule might have to be modified and we suggest that the voting mechanism should eventually

evolve out of a negotiation process of the founding members.

5.4. How to continue

Successfully launching the cooperative is only half the work. If a real change of the energy supply of the Port is to be achieved, a REC would have to operate for a long time. Based on the results of this thesis, certain recommendations can be given on how to achieve this goal.

Keep the "fun factor" alive: Next to financial benefits, being part of a progressive movement that creates a better future will be one of the main motivating elements for companies to join the cooperative. This feeling of being part of a revolution that creates a smarter and more sustainable business environment must be held up by the cooperative. This means that a constant feeling of progress and innovativeness must be created, triggering the kind of out of the box (yet realistic) thinking that motivated companies to join in the first place. We show that allowing employees access to the cooperative could contribute to this feeling significantly. As long as this does not disturb the efficient functioning of the REC, giving employees the option to invest (maybe even to vote) in projects of the cooperative, could spur a feeling of advancement in which all stakeholders at the Port are involved. Consequently, the Port's energy supply would not only become more sustainable, its profits would also remain local, fitting the purpose of decentralization. Additionally, successful RECs enhance the social cohesion of its members (Pezzini and Ambiorix, 2006) which can lead to the creation of "a vibrant cluster, which can help any company in any industry compete in the most sophisticated ways" (Porter, 1998).

Right balance between the interests of its members: We show that the REC should act as matchmaker between parties with complementary resources. While creating such synergies will certainly constitute the backbone of the cooperative's business cases, it also bears an important challenge. Since members will have different resources, they will also have diverging interests. Therefore, to enable continuous success and growth, the cooperative must put effort in finding the right balance between the interests of its members. Fortunately, research has shown that cooperatives are a highly effective mean to "handle conflicting interests of different stakeholders" (Rieger et al., 2016). A regular dialogue with all stakeholders will be as important as full transparency. When expanding into adjacent areas, the cooperative must make sure to not engage in activities that might harm some of its members. Members of the REC must at all times be assured that the cooperative strives to achieve the best solution for all types of members, independent of their interests and resources.

Finally, keeping an atmosphere of mutual trust will also require offering financing parties, internal as well as external, security regarding their investments. This can best be achieved by signing long term contracts whenever possible and by focusing on business cases that offer the possibility to create sustained cash flows for the cooperative.

Brand as smart city initiative: Launching a REC at the Port of Rotterdam has the potential of fundamentally changing the energy system of one of the major ports and industrial hubs of the world. Therefore, the project might gain a level of importance, which could elevate its impact beyond the Port

area. For this reason we propose to brand the REC as a smart city initiative, rather than as energy cooperative. By calling cooperative behavior to create a more sustainable future a smart city initiative, we imply that cities of the future should be composed of decentralized and smart ecosystems, where with the help of big data, consumers become prosumers and the individual can assume more responsibility for his actions.

6. Conclusions and policy implications

To sum up, we have presented 14 characteristics and additional insights that can serve as a road map to set up and successfully expand a REC at the Port of Rotterdam. Once the first renewable energy systems are installed, with the help of smart business models, the financial situation of the REC will improve steadily and with these funds, it should be able to expand its staff to increase its impact. Thereby it will hopefully one day successfully lead the energy transition at the Port.

This road map can serve as inspiration and guidance for policy makers to design regulations that facilitate the successful implementation of RECs within other industrial clusters. We pose that the action plan outlined above can serve as orientation for any agglomeration of industries (i.e. Rhein-Ruhr cluster in Germany) wanting to make use of synergies in energy demand and supply and to push the energy transition by means of a REC.

Setting up RECs within an industrial cluster is a relatively new application of the concept of RECs and therefore little data is available for this specific setting. This is why it is necessary to find ways to research its implications beyond the analysis of already existing data. The

progressive case study approach provided a powerful methodological tool to collect data on a yet unstudied topic and to continuously test the collected data throughout the process. The main weakness of this approach is that the researcher had to collect and interpret the information on his own, which left room for bias. While this risk has been remedied as much as possible through triangulation and validation techniques (Steenhuis and Bruijn, 2006), the results have to be seen as the fruit of an exploratory work that can serve as a foundation for future research.

Based on the research it can be expected that companies whose energy costs are their major cost factor and companies that can benefit from producing and/or selling energy will become members of the cooperative. Also the Port Authorities have shown interest in becoming a member, since facilitating collaboration (on energy matters) within the port is one of their goals. Once the energy cooperative will be launched at the Port, there will be data available on its impact on the harbor's energy system. Consequently, we see potential for future research in measuring the impact of a REC at the Port on renewable energy deployment. Additionally, analyzing alternative forms of organizations, for instance joint ventures of companies with complementary resources, can be an interesting topic for future research. Researching other industrial zones and energy clusters that have a similar synergistic potential could be an additional topic for future research. It would be interesting to analyze how cooperation is managed in these zones and what generalizable lessons about cooperation in industrial zones can be learned. Finally, this study could be a good starting point for research comparing industrial with community owned RECs.

Appendix A. Detailed list of interviewees, Case 1 and 2

Interview No.	Case	Organization	Country, founded	Position of interviewee	Technologies used
1	1	Energy Cooperative Heidelberg	Germany, 2010	Co-founder	Solar and Wind
2	1	Energy Cooperative Helmetal	Germany, 2013	Co-founder	Solar, Wind, Biomass
3	1	Energy Cooperative Odenwald	Germany, 2009	Co-founder Managing Director	Solar, Wind, CHP
4	1	Energy Cooperative Köln (Energiegewinner EG)	Germany, 2010	Co-founder and Managing Director	Solar
5	1	Energy Cooperative Heilbronn-Franken	Germany, 2010	Co-founder Managing Director	Solar
6	1	Energy Cooperative Heidelberg	Germany, 2010	Co-founder and Managing Director	Solar and Wind
7	2	Energy Cooperative Amsterdam South (Zuiderlicht)	Netherlands, 2013	Co-founder Managing Director	Solar and Wind
8	2	Science Broadcasting	Netherlands	Industry Expert	–
9	2	Energy Cooperative Lochem	Netherlands, 2010	Co-founder and Managing Director	Solar
10	2	Energy Cooperative Amsterdam North (NDSM)	Netherlands, 2012	Managing Director	Wind

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