



# USING COLLABORATIVE MANAGEMENT IN INDUSTRIAL CLUSTERS – CASE STUDY OF ITALIAN ENERGY CLUSTER

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**ABSTRACT**

In the current industrial scenarios those involved in production and services distribution are called to deal with a plurality of stakeholders, considering different interests, readings and positions. This paper exploits the concept of collaboration in this fast changes and flexible scenario by describing the characteristics of collaboration among enterprises and their scope. In this context, the purpose of all managers to maximize utility, to save cost or to minimize of transaction costs is hard to be reached. Under this prospective, to collaborate with other firms is a logical way to work and to pursue the previous objectives. The purpose of this paper is to define all the aspects of collaboration, mainly among enterprises, and the reasons that can drive a manager to stipulate a collaboration agreement. Two different ways, through collaboration can rise, have been described: collaboration induced by external body (top-down collaboration) or born in a spontaneous way (bottom-up). The management of the collaboration and the identification of key performance indicators, able to control the development of the network system, is addressed by exploiting the Italian network contract and the case study of the energy cluster.

**KEYWORDS**

collaboration, collaborative networks, collaborative economy, network contract, energy cluster.

## Introduction

Fast technological change, short product life cycles and markets that extend beyond national boundaries are the characteristics of production and services systems [1]. In this context, the purpose of all managers to maximize utility, to save cost or to minimize transaction costs is hard to be reached. Under this prospective, to collaborate with other firms is a logical way to work and to pursue the previous objectives. It is very frequent and desirable that companies collaborate in the exercise of their activity, putting in common aspects and resources or sharing strategies to improve competitiveness and their outcomes. The world “Collaboration” can be declined into different ways by putting in evidence different aspects that a collaborative action between two or

more individuals can generate. The first meaning of collaboration is to participate together with others in a job by working-together [2]. This can happen only under the condition that all the members of the collaborative action share the same purpose that cannot be reached individually by the members of the collaborative agreement, or, at least, not at the same conditions. As a consequence, collaboration is a positive form to work together in order to help each other to obtain mutual benefit where each single organization preserve its autonomy, integrity and identity in order to be free to interrupt the collaboration in every moment [3]. If the first element of collaboration is to share the same objective, in practice, collaboration involves an exchange of information and products, to take common strategic decision, to share resources, to enhance each oth-

er's capacity for mutual benefit, to share risks, responsibilities and rewards [4]. The management of resources in a common way and sharing risks helps to act towards a sustainable future where every company of the supply chain collaborate by sharing information [5], joining planning activities, integrating process, in order to support all the phases from the designing and production of a product to the final disposal and recycling [2]. Collaboration opens also to the possibility to have longer perspectives of life of the organizations thanks to sustain that all the actors that decide to collaborate can guarantee each other [6]. In this paper, Sec. 2 is dedicated to introducing the concept of Collaboration and to classify the different characteristics of a collaborative relationship and different purposes of the members of the collaboration. The purpose of this paper is to exploit the characteristics of collaboration, to identify the main objectives of a collaborative agreement considering the Italian case of the network contract and the case study of an energy cluster. In Sec. 3 the concept of cluster is introduced with a focus on the different kind of collaborative clusters in Europe. Section 4 analyzes how collaboration can introduce benefit, in terms of efficiency and robustness, for a cluster. In Sec. 5 the Italian network contract is introduced and an analysis about the characteristics of the network contract stipulated is given. In Sec. 6, an example is provided. In Sec. 7, conclusion and some future prospective are presented.

## **Characteristics and expectations of collaboration**

The analysis of several examples of stories of collaboration among enterprises underlined how, to have a successful collaboration, it is important to define a congruent and fair set of rules that must be clear and respected by all the members of the collaborative agreement. Each member must know the boundaries of its collaboration in terms of a clear definition of the duties, the responsibilities and the autonomy. Having a common purpose is important in order to feel as part of a community where members mutually trust each other, communication is clear, transparent and efficient.

In [7], the author measures the relative strengths of each determinants that influence the choice of a member to join or not a collaborative partnership with other members. For collaboration, it is highly important to feel as a member of a community with trust among all members, trend affinity, reduction of costs, high service/product quality and utility.

When two or more companies coordinate their aims, expectations and resources in the collaboration process they give rise to a system that can be called a Collaborative Network (CN) of enterprise since all the members have connected each other by links that give to the structure the characteristics of a network. Among the enterprises of the network, there is an exchange of products and information in accordance with the collaboration agreement. Collaboration can be virtual when it is characterized by an exchange of information, resources and skills among independent organizations supported by a computer network, in order to respond to business opportunities [8]. One of the main challenges in virtual organization is the lack of appropriate definitions, formal models and tools that can support in the management of virtual organizations [9]. The main characteristics for the VO are the temporary nature and the distribution of operations in independent but interdependent organizations with their own aim, behavior and culture. This requires important coordination abilities in order to reach the common objectives by respecting the identity and the creation of trust and a collaborative atmosphere [10].

### **Collaboration expectations**

Like in every context where interactions among different members are the main characteristics of the systems, in a collaborative network it is of primary importance the management of relationships in order to be sure that every member is free to give his proper contribute to the common objective [11]. The network coordinator is customer-focused, with consciousness about the market requirements in order to identify the right strategy to put in act. When we think about joint ventures, strategic alliances, collaboration in a supply-chain, research consortia or channel of distribution network [12–14], we are classifying different natures that a collaborative agreement among members can have. In this short classification of collaborations, we can find different motivations and impacts for networking [15, 16]:

- (1) grow the enterprise;
- (2) develop the skills and resources needed to transfer innovations quickly to commercial success;
- (3) achieve the operating efficiencies in order to offer value to customers;
- (4) increase flexibility to face with the rapidly changing and intensely competitive marketplace.

The growth of an enterprise can be measured by considering different indicators such as the increasing of the employment, with important impact on the growth of the economy and the society of a State, the growth of sales and turnover that outline the im-

fact of the enterprise on the economic growth and competitiveness, profitability [17]. Other measures of firm growth that could be used are market share, return on capital employed, measures of productivity, personal development of management and employees, technology innovation, and professional recognition [18].

Collaboration has also an important impact on the growth of knowledge and skills of the employers of an enterprise. Much wider is collaboration, higher is the growth of knowledge. A study conducted by [19] emphasizes that networks are crucial for management of complex knowledge. An important component of a firm's human resource management should be not only to track the knowledge base of its employees, but also to understand their participation in key interpersonal networks that span regional and firm boundaries. A firm could learn more from its environment by encouraging external collaborative links rather than merely opening divisions close to "hi-tech" clusters with a hope that knowledge gains would follow on their own. Collaboration with research or formation institute is crucial also in the innovation process to be always updated with new technologies and new needs [20].

Product innovation is an important objective for every enterprise. In order to be more and more competitive and to stay behind the evolution of requirements from customers and changing lifestyles, collaboration with different actors is of primarily importance for the innovation process. Suppliers have the right knowledge about components or parts that can be critical for the development of a new product and their collaboration can allow firms to incorporate the expertise and different perspective.

Another important actor for collaboration for the improving of product quality and for innovation is customers. Very often, as customers of products or services, happens that we receive requests of feedback about the product that we have bought or the service that we have used. When we decide to answer, we are agreeing to a collaboration request from our supplier. This kind of collaboration is not formally defined, but requires an exchange of information and reciprocal trust, two of the requisites for a collaborative relationship highlighted previously. Collaboration with customers has a positive impact on product innovation performance: not only provides benefits in identifying market opportunities for technology development and new ideas but also reduces the likelihood of poor design in the early stages of development and increase the chances of new product development and success [21, 22].

Vertical collaboration (with clients and suppliers) allows a firm to gain considerable knowledge about new technologies, markets and process improvements and has a more significant impact on both product and process innovation.

A not so frequent type of collaborative network is collaboration with competitors to share technological knowledge and skills with each other in order to support the innovation process. The synergistic effect on solving common problems is an important contribute to overcome the limits of all the enterprises when risks of collaboration are not too high. Large firms may be less flexible but have resources potential to develop inventions into products or processes, while small enterprises are more flexible to market requirements but need resources and skills they cannot produce internally [23]. Given that resources and capabilities are needed to innovate successfully, and that these are not always available inside the firm and cannot be obtained efficiently in the market, collaboration offers a good solution to the problem [24, 25].

Technological collaboration, its continuity and the diversity of partners affect positively on product innovation. This finding follows in the [6, 27, 28]. While collaboration plays an important role in generating new products, its role in achieving innovations with a greater degree of novelty is even more central.

In [29], the authors exploited the potential impact that different partners (clients, suppliers, ROs, and competitors) may have on the degree of novelty of product innovation. Their results show how diversity in the make-up of collaborative networks favors innovation novelty more than collaboration with a single type of partner does. Being integrated in a heterogeneous network promotes access to diverse sources of information and enables firms to transfer and apply that knowledge. When this happens, firms find themselves in a better position to achieve more novel innovations.

This request of innovative and more customized products requires a high degree of flexibility both in the characteristics of the product / service offered and in the lead times. This request for flexibility seems to correspond to a wider trend of increasing flexibility in the labor market.

This phenomenon can be particularly observed in the collaborative platforms that intermediate works between individuals on line and that represent another way to apply collaboration among individuals or enterprises. An entire economy is emerging around the exchange of goods and services between individuals instead of from business to consumer. This is redefining market relationships between tradition-

al sellers and buyers, expanding models of transaction and consumption, and impacting business models and ecosystems. We refer to this trend as the Collaborative Economy, defined as initiatives based on horizontal networks and participation of a community. It is built on “distribution power and trust” within communities as opposed to centralized institutions [30].

The advent of the collaborative economy, in combination with artificial intelligence, big data and 3D printing, makes something like a fourth industrial revolution [31]. At the same time, it is unlikely to bring a big jump in the way in which work is performed anytime soon, especially in light of the fact that a large majority of users only rely on it for additional income and not as a substitute for a full-time occupation [32].

## Collaborative clusters

The great interest of the European Commission for the agglomeration of micro, small and mid-enterprises reflects into two strong promotion and investment initiatives: on the one hand, investing, through the ICI-SME program, in small and medium-sized companies with a high technological content; on the other hand, investing, in various Horizon 2020 programs, in SME Cluster.

This effort by the European Commission finds different answers according to the European regions and the industrial system developed in them.

With reference to the development of SME Clusters, two ways of aggregating SMEs can be identified: either aggregations promoted and financed by a regional public body or by bid enterprises, that means “top-down” aggregations, or aggregations created by autonomous agreements between a group of companies (“bottom-up” ones).

It can not be said that bottom-up collaboration is better or worse than top-down collaboration because it depends on the relationships between companies and the existence of a leader in the cluster. In the case of the existence of a leader, top-down collaboration is necessary, in the case of requests from several companies where collaboration is managed without real imbalances or struggles on market shares, the bottom-up is the only way to create an efficient district.

Each one of the two typical approaches to aggregate SMEs can be associated to groups of European countries: usually, top-down aggregations of SMEs are promoted in France, Germany and Ireland, while bottom-up aggregations characterize the cluster types in U.K. and Italy.

In U.K., experience in enterprise clustering has a long tradition, starting from end Nineteen century, when Alfred Marshall [33] presented a first description of geographical concentrations of specialized industrial companies. According to the Marshall’s approach, if a concentration of enterprises is autonomously created, it would attract other companies in a cluster that would gradually be transformed into a supply chain. Therefore, complementary companies have the interest to aggregate together, without any government promotion, but only for the need to strengthen their commercial position, facilitate innovation, and satisfy the demand of market [34].

Similar to the U.K. situation it can be seen the Italian evolution in time of SME aggregations. Development of “industrial districts” has found in Italy the ideal conditions for its affirmation until late sixties, at the same time as the first major crisis of the large enterprises, mainly in the automotive and steel industry. At the same time, there was a growing process of small-scale enterprises, originally of artisan type, strongly rooted in the traditional production of narrow geographical areas, which gradually reached significant market shares in niche productions. Soon small and medium-sized enterprises recognized the agreement to make cooperation agreements: this gave rise to the Italian way of autonomous clustering, generating “industrial districts”, i.e. networked organizations of SMEs, operating as a cognitive, relational and competitive environment whose internal vitality and external effectiveness depend the partner SMEs [35].

Differently from the U.K. experience, the French industrial system is characterized by the tradition of supporting the emergence of cluster or networks through government funded projects, thus creating “pôles de compétitivité” [36]. These poles could have inside major enterprises, SMEs, research laboratories and training institutes, and could be dedicated to different sectors as emerging technological fields (nanotechnologies, biotechnologies, environmental technologies, etc.) or more mature (automotive, aeronautics, etc.). In terms of management, the main decisions are all concentrated in the management group, a proper juridical entity including industrial, scientific and academia personalities as well as members of the regional government.

The clustering approach in Germany makes evidence of some similarities with the French line of poles of competitiveness. Indeed, “clusters” in Germany means “Competence Networks”, that are groups of enterprises created by regional government initiatives, in the form of “top-down externally-

started networks”, with managers nominated by the public promoter and with an evolution strongly dependent on public funding. Competence networks cover about 70% of the total.

Some similarities with the two above countries can be found in Ireland, where a very large quantity of foreign investment in the 1990’s gave rise to a manufacturing system dominated by large multinational companies, attracted to Ireland by a competitive corporation for tax system. Irish SMEs were stimulated to participate in networks through outsourcing contracts with these multinational companies, who played the role of SME aggregator by linking SMEs to themselves; therefore, giving rise to “rings” of SMEs all oriented towards the leading companies. Also, in this case (denoted “hub-and-spoke” cluster), all decisions are in the hands of the leading enterprises.

Except in the last case, where SMEs are operating each one competing with the others, in the previously outlined types of clusters a reasonable cooperation among partner SMEs should be necessary in order to improve the cluster efficiency (i.e., utilization of the SMEs capacity) and effectiveness (i.e. ability to satisfy the demand).

However, a relevant question is still open: could the cluster performance be improved by an effective collaboration among SMEs?

Using the collaboration definitions in the previous section, if an SME network wants to have “great capacity for innovation and communication” it should be composed of SMEs that operate not only in close collaboration, but with a common purpose and with common enthusiasm.

This consideration is suggesting another question: which type of SMEs aggregation, either top-down or bottom-up, is more efficient in increasing cluster performance?

In theory, an autonomous aggregation of SMEs, obtained by an agreement freely and independently signed by the SMEs themselves, presents the two conditions necessary to encourage collaboration between companies: (a) the formation of the cluster bottom-up, obtained from the aggregation of companies that know each other and have assessed that they can work together efficiently; (b) the management structure of a bottom-up cluster, generally consisting of a management committee, with representatives of all companies, and with a cluster manager chosen by the committee, often via election. Even in industrial practice, these two conditions are the basis for the success of many bottom-up clusters.

Depending on the European countries, a higher percentage of clusters generated by the regional government (top-down) or driven by local collaboration

needs (bottom-up) can be found. Contributions can be obtained in the creation of clusters by regional governments, both for the one and the other type of organization.

## **Formalization of collaboration**

One more question needs to be asked: is a collaborative bottom-up cluster sufficiently robust, i.e. capable of surviving to demand crisis?

A collaborative cluster can survive a crisis if a mutual aid relationship is implemented among companies, that is, if, in the face of a crisis, the stronger companies offer some form of help to the weakest. In this case, the robustness of the autonomously created and collaborative cluster becomes equal, if not greater, than that of a top-down cluster, in which the strength of the leading company or the support of the public body is often invoked by the cluster to overcome the crisis [37]. The bottom-up type clusters, constituted by autonomous aggregation, like those in general originated in U.K. and in Italy, base their strength on collaboration and mutual assistance, while top-down clusters, formed on the pressure of large companies in production or finance, or public bodies, in France, Germany and Ireland, are aggregations whose survival depends on the promoter entity.

One of the requirements of collaboration is a joint planning activity in order to minimize the resources required to complete all manufacturing operations and maximize the profit for the whole network of enterprises. These objective functions can be modelled by an Aggregate Planning (AP) model with the goal to implement a long-term win-win relationship and information flow of all the participating companies in the network [38, 39].

By clarifying the concept of effective collaboration between SMEs of a cluster, it is possible to discuss some sub-problems, obtained through approximations of the general problem, to find out whether or how the collaboration between SMEs is justified. Some types of sub-problems are discussed below.

1st type: Maximize SME average utilization:

- with respect to average workload assignments to SME;
- In the case of constant demand;
- In the presence of graph constraints.

This sub-problem is addressed in terms of constrained Linear Programming (LP) problem [40], the solution of which does not induces SMEs to collaborate but favor the most efficient.

2nd type: Maximize SME average utilization on the mid-term time horizon:

- with respect to workload assignments to SME, varying over time;
- with graph constraints in terms of production flows and storage capacity of SMEs;
- with the hypothesis of variable demand to be satisfied.

This second sub-problem, for a linear supply chain, is often dealt by using dynamic optimization techniques [41]. The main result is to avoid the emergence of bottlenecks within the future time horizon. However, even in this case, collaboration between SMEs is not clearly justified.

Since the solution to this sub-problem is a productive plan for the medium-term, cases where a collaborative situation can be forced by the cluster management center can occur.

3rd type: Maximize the estimated average utilization on mid-term time horizon AND Minimize the maximum difference between workloads assigned to two SMEs:

- with respect to workload assignments to SMEs, which vary over time;
- with graphic constraints in terms of production flows and storage capacities for SMEs;
- in the hypothesis of variable demand, to be satisfied.

This third sub-problem is a multi-objective constrained dynamic optimization.

The approach adopted by the authors to obtain a solution line is based on two steps:

1st step: transform the problem into the following:

- Min Max [Difference Between Workloads Assigned to two SMEs];
- with a threshold constraint on the minimum utilization of different SMEs, depending on their production capacity and so that they can be violated;
- with the remaining relational constraints related to the graph of interactions in the SMEs network.

2nd step: Analyze how the different constraints, considered one at a time, act on the cost indicator.

Note that, since the indicator that measures the imbalance between workloads assigned to SMEs is a measure of the collaboration strategy between the same SMEs, the analysis of the effect of constraints on it may explain different behaviors.

The third type of problem is the complete formalization of a collaboration problem to maximize the use and minimize the difference between the loads assigned to the companies. These are the two objectives that specify the concept of collaboration. When companies interact with each other on the basis of these two cases, it can be said that collaboration increases efficiency and productivity of the cluster.

The most interesting can be seen in the case of persistent low demand: by balancing workloads to SMEs, in the presence of the thresholds of minimum utilization of each of them, there is a behavior of mutual support that, by preventing individualism, promotes mutual trust.

From research developed by the authors and from the data of ASSORETIPMI, an association of enterprise network (<http://www.retipmi.it/pmi/>), this behavior is often found in clusters of micro-enterprises in the Italian manufacturing sector [11].

The models introduced represents a formalization of the collaboration objectives that can introduce the modeling of collaborative clusters based on the nature of the final goal. In next section the Italian Network contract is analyzed by considering official data related to all the network contracts stipulated from 2009 to 2017.

### **Management of a collaborative cluster: the Italian network contract**

In Italy, the problem of the management of a cluster has been faced with the introduction, in the Italian law of a new typology of business contract, named "Network contract" (Law 99 of July 23rd 2009, published under number 136 in the Ordinary supplement of the Gazzetta Ufficiale on July 31st 2009).

This formal agreement among two or more enterprises has the objective to define the specific activities that the enterprise want to jointly perform in order to reach their common objective, to increase their mutual innovation capacity and competitiveness in the market. Having a common scope to pursue is an essential and strict requirement for the stipulation of the network contract. It is also important to identify the economic or production activities interested by collaboration and a set of key performance indicators (KPI) useful to measure the effectiveness of the collaboration in order to help the actors of the contract to decide to renew the agreement after the end of the temporal duration of the contract. It is important to underline that collaboration, in this case, is also defined by a temporal limit that act as a constraint in the achievement of the common goal [42]. The firms are also free to establish entry and exit rules, and resolute conditions for the network.

From 2009 until 2017, 4318 network contracts were signed, involving 23352 companies (data source: <http://contrattidirete.registroimprese.it/reti/>).

By analyzing all SME network contracts, it is possible to see that industry and services are the most present sectors with a global 70% of network contracts (Fig. 1).

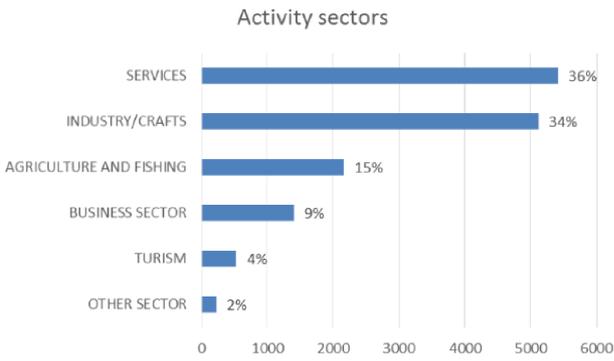


Fig. 1. Activity sectors of network contracts.

The reason of an important presence of enterprises working in these sectors and, on the contrary, the poor presence of enterprises coming from the agriculture and tourism sectors can be understandable from the analysis of the common goals that drive enterprises to collaborate (Fig. 2). Neglecting the typical goal of expanding markets, present in the 38% of signed contracts, the aim of SMEs is to collaborate in order to increase their innovation strength (17%) such to increase production capacity (20%) and their ability to compete (15%). These objectives are easier to be reached in the industrial service sectors. Although, some critical aspects should be underlined: only 7% of contracts are devoted to improving quality and certifications and a small 3% to share know-how and skills, the typical aspect of modern sharing economy.

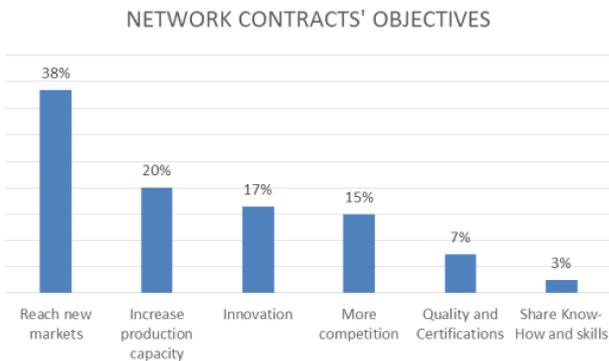


Fig. 2. Goals of the network contracts.

In the industrial district, it is common to find districts with a high number of enterprises because, usually, there is not a formal agreement that specify rights, duties, and that formalize the relationships among the enterprises. In the network contract, the average number of enterprises for each network is less than 5 with the 26% of network contracts with 3 enterprises (Fig. 3). This is an important evidence that when relationships are formalized, the effort to cultivate them is so strong that it is not possible to

have a high number of partners to interact with, also because the management activity would be more critical.

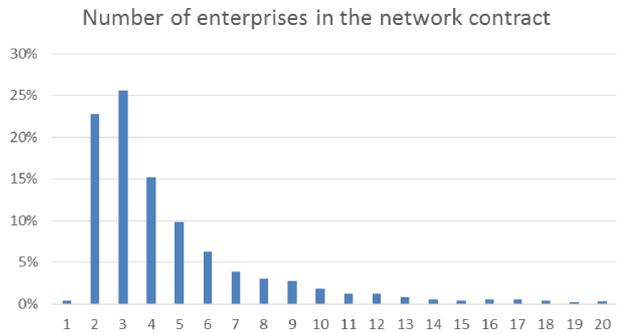


Fig. 3. Number of enterprises in network contracts.

Even if the network contract is thought also to push collaboration among enterprises from different territorial area, an analysis on the regions where the enterprises work shows that more than the 70% of network contracts is constituted by enterprises coming from the same region (Fig. 4).

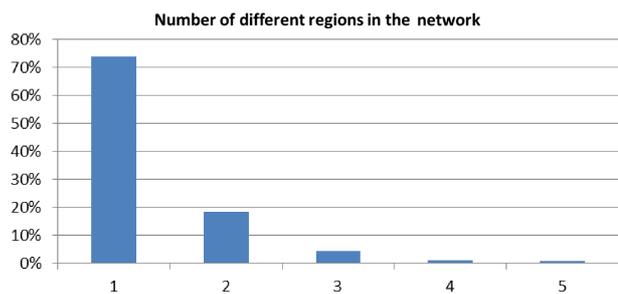


Fig. 4. Number of different regions in the network.

Even if the regulation and the above data are referred on Italian situation, some other European countries are approaching the autonomous creation of networks and clusters in similar way, thus enlarging the possibilities of aggregations among enterprises, research centers and agencies.

### Collaborative energy cluster: management and control

Collaboration is an important opportunity for enterprises that have the necessity to collaborate also to overcome difficulties related to the availability of services essential for their survival. This is the case of enterprises located in isolated areas, far from the industrial concentration, where the access to services, among them the energy network, is difficult. The Energy Cluster is an aggregation of associations, enterprises, universities, knowledge and research centers, specialized bodies and public administrations with

the aim to develop research, innovation and training projects on energy production and on energy saving in production systems.

Figure 5 provides a simplified scheme of an Energy Cluster where all the typical components (i.e. individual SMEs and/or "Usual" Clusters of SMEs) of this type of Cluster are represented:

- Cluster-internal producers of energy, using renewable sources, as wind mills, farms with biomass, solar cell fields, etc.
- Cluster-internal users of energy, typically with low efficiency and then waste of energy, as individual industrial small enterprises (manufacturing SMEs), networks of industrial SMEs and isolated small villages;
- An external National/Regional energy producers/provider, i.e. the energy distribution network

connecting all users & producers, whose owner could be different from the energy producer/provider above mentioned.

The energy distribution network is characterized by two elements:

- A set of Data Collection & Energy Flow Control Blocks, i.e. devices located in some links of the energy network with the task of measuring the energy flow at that point.
- The number of DCEFC Blocks and their locations should be such to allow the measurement time by time of the energy flow.
- An ICT Energy Network Management System, such to connect all DCEFC Blocks into a virtual network, by which the accurate estimation of the energy flows both produced and absorbed by the Cluster components, can be obtained.

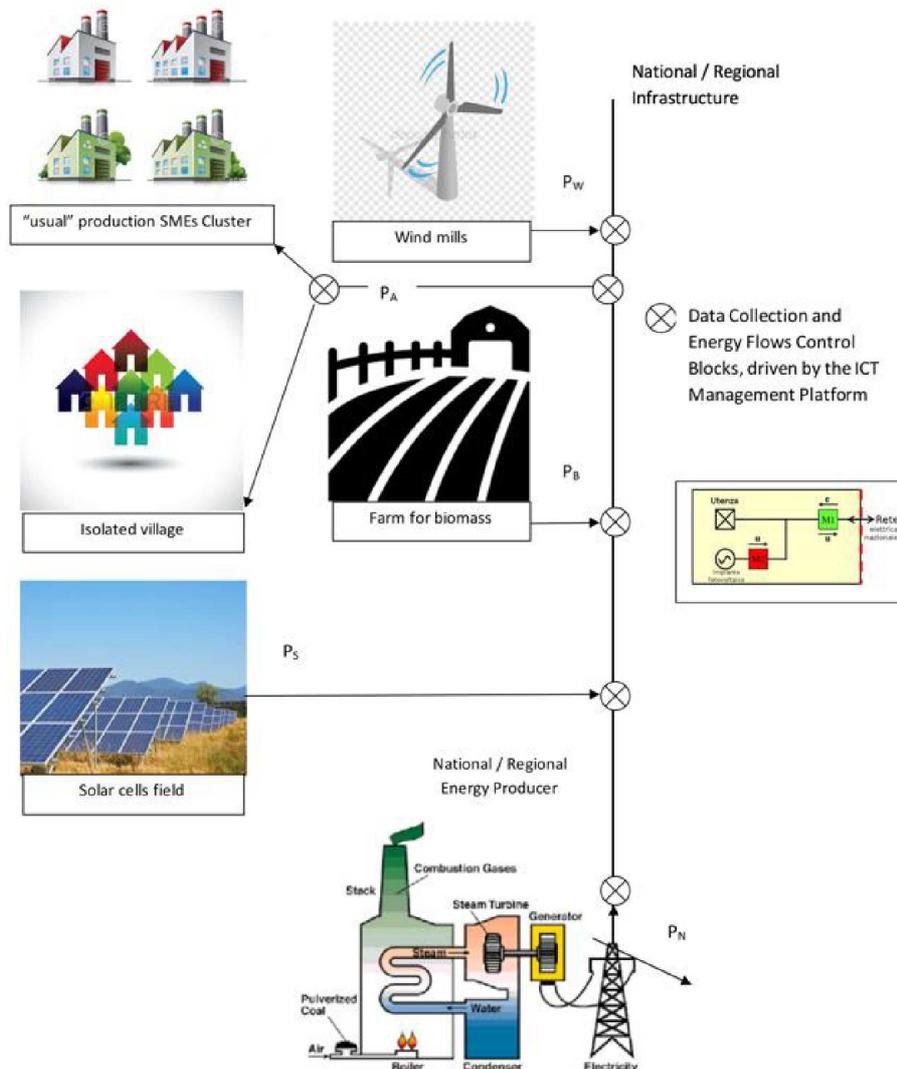


Fig. 5. Scheme of a collaborative energy cluster.

The management of any business relation among the Cluster Components during operation is the job of the Energy Cluster Management Committee, composed by representatives of all Cluster Components. It is constituted at the stipulation of the Collaborative Cluster Agreement, stating all conditions and rules to be member of the Cluster itself. This Committee has to manage all organizational issues in the Cluster, and manage the business interaction with the external National/Regional energy provider, as well as with the infrastructure owner.

The core of the management system is the graph-based model by which the estimation of the energy flows from/to any Cluster Component is done, by using the large amount of data collected.

The normal operation condition of the energy cluster is

$$PA = PW + PB + PS + PN, \quad (1)$$

where PA is energy necessary to the SMEs cluster and the village, PW is energy produces by wind mills, PB is energy produced by biomass, PS is solar energy, and PN is energy bought from the National/Regional Energy Producer (PN).

The objective is to minimize PN and this can be reached in three different ways that represent the basic governance rules:

- by improving the efficiency of the production processes in the “usual” SME Cluster (this means that the objective is to Minimize PA);
- by balancing, in time, the utilization of internal electrical power (re. Collaboration goal): Minimize  $PA - (PW + PB + PS)$ ;
- by controlling the Energy exchange with the National/Regional Infrastructure: Maximize  $(PW + PB + PS)$ .

A Collaboration Cluster Management Agreement is necessary for the management of the cluster. The basic elements of the agreement are:

- The common scope/goal;
- Investments and activities for implementing the common goal;
- Common funds;
- Management body composed by the cluster components’ representatives;
- Rules to manage energy flows;
- Business models, for managing internally and exchanges with external energy producer.

The management of the cluster is performed through an architecture that consists of

- Data collection and storage;
- Energy flows balance/unbalance evaluation (time by time);

- Energy production control;
- Energy exchange versus external.

At the ‘governance level’, the objective is to design (i) the management agreement, (ii) the Business Model rules and (iii) the managerial committee missions. The definition of these governance elements aims at implementing a transparent and shared collaboration protocol, then ensuring the efficient day-to-day operational functioning of the Cluster. These governance aspects are crucial to ensure the success of the associated Business Model.

The ‘regulation level’ addresses the ICT needs of an automatic control procedure to regulate the energy consumption and production flows within the Cluster. Here, the objective is first to develop an estimation methodology to evaluate in real-time the balance or imbalance situations of energy exchanges, then to build an energy control procedure easily applicable to the energy-using and -producing Cluster nodes.

The ‘data level’ is the required basis for the regulation level. The objective is to develop the ICT solutions for the data collection and storage required at each real node of the energy cluster, and to organize a Big Data, for an easy implementation of the decentralized, automatic control procedure mentioned above.

In practice, an Energy Efficient Collaborative Cluster is a superstructure that overlaps with a set of components, i.e. individual SMEs, energy users and producers of energy from renewable sources, or traditional cluster SMEs (thus only energy users).

This superstructure has the objective of organizing and managing an efficient collaboration between producers and users, and its implementation has a special utility in the case of SME aggregation, and even villages, in particularly isolated areas.

This type of local grid for the Italian energy system is an innovation (unlike what happens in France) because the energy distribution infrastructure is unique and totally interconnected, so local producers of electricity from alternative energy sell their product to the national distributor.

## Conclusions

In this paper, we have exploited the collaboration concept among enterprises by highlighting the main characteristic of a collaborative relationship: common scope, trust, exchange of information, skills and resources. Collaboration can arise in a piloted way (top-down collaboration), introduced by some administrative body or in a spontaneous way (bottom-up). The main objective of collaboration is to reach

the common goal that all the actors have identified and that is the aim of the collaboration agreement. To reach this purpose it is important to manage the collaborative activity and to identify key performance indicators that are able to control the development of the network system. After a fast view on the European situation about clusters, we have introduced the characteristics of the Italian network contract, a formal way to manage the collaboration agreement and to be sure that all the members of the agreement can give their contribution to the final common goal. Among the collaborative systems, the Collaborative Energy Cluster has been introduced. The objectives of collaboration can be of different kind: innovation, new market to enter in, increasing of production capacities and the sharing of new skills, all these purposes can be modeled by an objective function to be optimized, as in the Collaborative Energy Cluster application. The management of this kind of SMEs aggregation requires a collaborative approach to reduce waste by the user companies and manage the energy production.

This also reduces the purchase of energy from domestic producers by introducing savings that are a clear measure of the effectiveness of collaborative management. The collaborative behavior described is also interesting under the view of the emerging Collaborative Economy or Sharing Economy that is changing the behavior of customers and is generating new competition for providers and producers. The drivers that guide Collaborative Economy are of different nature and must be considered and studied in order to understand the future challenges of the traditional production and service systems. The first driver is the requirement of sustainability. There is growing awareness about the environmental impact of our consumption habits, so a reduction of costs corresponds to a reduction of waste in terms of energy, inventories, low quality products. This requires important efforts on the process optimization and production planning not only at the level of each enterprise but as whole system. The lack of resources requires a global management and a global optimization. Another driver, already seen in this paper, is the latent desire to interact with others, both to be stronger in crisis periods and to learn from others and improve the performances. The Collaborative Economy permits, also, to access to technologies without the requirement of ownership by facilitating a match between demand and supplier that otherwise is not possible. Many start-ups in the Collaborative Economy are mobile-driven. The rise of smartphone adoption means that customers can increasingly offer or locate goods and services anytime, anywhere. Col-

laborative economy represents a new challenge for the future and can change the organization and the structure of collaborative clusters.

In Italy, the problem of the management of a cluster has been faced with the introduction, in the Italian law of a new typology of business contract, named "Network contract" (Law 99 of July 23rd 2009, published under number 136 in the Ordinary supplement of the Gazzetta Ufficiale on July 31st 2009). As an example of collaborative cluster, the case of the Energy Cluster is considered. The objective of collaboration is given by the necessity to supply energy to the enterprises belonging to the cluster also in conditions of difficulties in isolated places where the access to the public network is not easy and to reduce energy costs by optimizing the energy network and the energy distribution. The considered case study can be modeled through a flow network with sources and wells where it is important to optimize the flows. This is an important challenge for isolated areas but also for the reduction of the environment impact on industrialized countries. The open point is the management of this kind of network with different types of physical "components", i.e. industrial SME belonging to different industrial sectors, isolated villages, rural areas, all with weak or non-existing smart grid connections and with energy-related infrastructures, products and services.

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