The Management of Risks Related to Innovation and Technologies

Application to the Ecosystem of Renewable Energy

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Abstract- **Energy is a strategic sector in France. The concept of energy transition has favored the development of renewable energies. In the traditional energy model, a few large groups, resulting into an oligopoly situation, control the market. Systems based on renewable energies, on the other hand, can be deployed in a decentralized way. The concept of Renewable Energy Ecosystem (REE) is then relevant in order to think about the transition. This emerging ecosystem relies heavily on innovation, including start-ups. However, the risks posed by innovation and technology are significant; they favor start-up failures and limit the investments of venture capitalists and business angels in the ecosystem. We propose the principles of a risk assessment approach related to innovation, which takes into consideration the characteristics of the ecosystem, the role of economic models, and finally, the role of digital in accelerating the energy transition.**

Keywords- Ecosystems; Renewable Energies; Ecosystem Model; Risk indicators; Evaluation of Innovation.

I. INTRODUCTION

In 2015, the energy sector represented 2.0% of the Produit Intérieur Brut (PIB) [English: Gross Domestic Product] in France, and the energy bill represented 1.8% of PIB. In 2015, primary energy consumption (at the production level) was 47.6% of fossil fuels (of which 30.1% was petroleum products, 14.2% natural gas, and 3.3% coal) and 42.5% of non-renewable primary electricity (nuclear + pumping production - electricity exporter balance). Electricity accounted for 24.7% of the final energy consumption in France in 2015. The electricity produced in 2016 comes 72.3% from nuclear energy, 17.8% from renewable sources (mainly hydroelectric generation), and 11.1% and 8.6% from fossil thermal power plants. In fact, France's energy bill in the third quarter of 2016 amounted to 31.4 billion Euros according to the general commission for sustainable development [1].

Synthetically, the reserves of oil and natural gas are limited, while, due to demographic and economic factors, the consumption of oil, gas and coal will always be higher in the future as compared to today's consumption. The energy transition, largely based on renewable energies, is therefore imperative. Nevertheless, many experts estimate that it will be possible to cover only 30% to 40% of the needs with the help of renewable energies by 2050 if an energy transaction is taken into consideration.

Innovation, especially on the technological level, appears to be a determining factor in the competitiveness of renewable energies. According to a recent study by Irena (International Renewable Energy Agency), "All renewable technologies will be competitive with fossil fuels in 2020" [3]. Also, it must be added to the dimension cost, the non-cost competitiveness factors, such as quality, innovation, technological level, reliability, services, etc. This paper is structured as follows. In Sections II and III, we present the situation of renewable energy in France, and recall the concepts of ecosystems, business models and innovation. Sections IV and V are dedicated to the explanation of the hypothesis and the elaborated research model. We conclude in Section VI with discussions and perspectives.

II. RENEWABLE ENERGY

At the turn of the 2000s, many countries are engaged in the energy transition sector. This is one of the components of the ecological transition. The latter results from technical developments, prices, and the availability of energy resources. It also depends on the political will of governments, populations, and businesses, willing to reduce the negative effects of this sector on the environment. In France by 2050, the objective is to cut the greenhouse gas emission by 4 to 5%, and reduce by 2025 the share of nuclear energy to 50% of the French electricity production. This is done by developing renewable energies and seeking all forms of energy efficiency and therefore energy savings.

Renewable energies (RE) are energy sources whose natural renewal is fast enough that they are considered inexhaustible at the human time scale. Their renewable nature depends partly on the speed at which the source is consumed and on the other hand on the rate at which it regenerates. Renewable energies are divided into hydropower, wind, solar, biomass, biogas, renewable urban waste, geothermal energy, and marine renewable energies.

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Primary production of renewable energy has been steadily increasing since the mid-2000s, particularly with the development of wind power, photovoltaics, biofuels and biogas. In the third quarter of 2016, the electricity produced in France by the renewable energy sector in one year equals 95 TWh. This volume covers 20.1% of the country's consumption. This share is up to 6.6% in 2015 by the same time of the year. According to the reports, renewable energy accounts for about 12% of final energy consumption (at the consumer level) in 2015 [1].

The energy sector is organized in France around a limited number of very large companies. In fact, TOTAL is the main player in the French oil sector, and the first French market capitalization on February 27, 2014, and EDF, by far the leading producer, carrier, distributor and supplier of electricity in France, and finally, ORANO for the nuclear professions. These companies are at the heart of a first ecosystem of energy production. The recent opening to competition driven by the European Union and the diffusion of the concept of energy transition has forced these major groups to invest in the field of renewable energies. Renewable energies have thus become for some of these players an investment priority [4].

III. ECOSYSTEMS, BUSINESS MODELS AND INNOVATION

Our first hypothesis is that the current and traditional actors of energy represent the first classical ecosystem, we will call it the Energy Ecosystem (EE). Next to this EE, a second ecosystem is being articulated, more specifically focusing on the renewable energies, as a clean and partly emerging segment, the "Renewable Energy Ecosystem" (REE). The EE/REE dynamic is the factor of complexity of the field of analysis.

First, the concept of business ecosystem is now well known, notably through its introduction by the work of Moore [5]. In particular, this concept was defined as "All the relations between heterogeneous actors guided by the promotion of a common resource and an ideology that drives the development of shared competencies (ecosystem skills) [6].

Specific work on the concept of the ecosystem applied to renewable energies is still rare. Yet the various reports of the International Energy Agency show that 2016 was a tipping point in the sense that investments in renewable energy, especially electricity, exceeded those made in coal, oil and gas [7]. Renewable energies thus become a massive investment deployment sector underpinned by important innovations. Renewable energies have benefited in 2016 from a series of technical advances that promise to make sustainable energy more and more efficient and affordable (artificial photosynthesis, CO2 storage, etc.).

Our second hypothesis is that this sector or, rather, this ecosystem in the phase of creation, relies largely on innovation, especially technological innovation. In the field of renewable energies, a large number of startups are currently developing. In fact, the Observatory of French start-up cleantech has observed 952 start-up companies cumulated since the creation of the Observatory in 2011. The studies conducted by the Observatory confirm the importance of belonging to an ecosystem. As a result, 62% of start-ups belong to a competitiveness cluster, 32% to an incubator and 27% to an accelerator [8]. New financing methods are unfolding strongly, like crowdfunding (or crowdfunding), which tends to show that the ecosystem of renewable energies has different characteristics from the traditional energy ecosystem. This creates complex networks, linking renewable energy start-ups with major groups in addition to citizens and other stakeholders.

IV. A EXPLORATORY MODEL FOR RISK EVALUATION

"In our model (see figure 1)," innovation plays the role of intermediate variable between the REE, as it tends to be structured today, and the desired performance by investors (or dependent variable), which can be societal, ecological, technological and financial. To set the stakes, the RE fundraisers collected by French cleantech companies during the year 2017 amounted to € 529 million, according to GreenUnivers. Our research problem is articulated around the innovation risk evaluation of the renewable energy ecosystem (REE), in particular the risk factors related to the dynamic of this ecosystem from its structuration and innovation point of view.

Our contribution is the proposition of a risk evaluation system for both business angels and venture capitalist of this ecosystem, based on risk indicators related to innovation; assessment of risks through models inspired by dependability, and finally through management measures that tend to improve the control of these risks.

Our third hypothesis is that there is a link between failures of innovations in start-ups and the notion of economic model. It is customary to share the risks of innovation in current theories [9] in three fields of uncertainty; the human need (desirability), technology (feasibility) and economic potential (viability).

Recent work that examines companies' performance in terms of their business model and the ecosystem structure to which they belong, shows that the business model / business ecosystem pair is a significant determinant of profitability [10].

As pointed out in the introduction of a special issue of Industrial Economics Review devoted to the links between business model, business ecosystem and innovation: "The use of the model of business as an independent variable has a significant link to the performance of the business [11]. It is therefore an important element in predicting the success of a business in a given ecosystem. Stability of the ecosystem (and the economic environment in general) is an important determinant of business survival [12].

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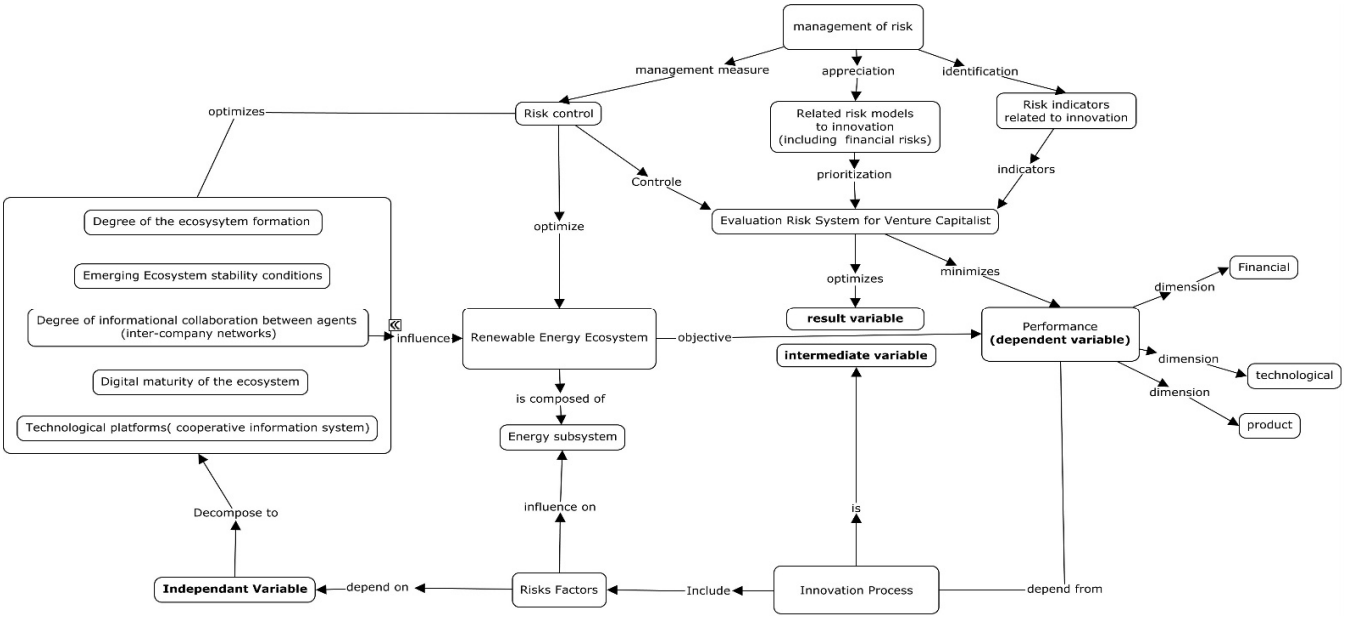

Figure 1. Research model

A large number of failures could be avoided if the company paid more attention to stakeholders and to the interactions between the company and its ecosystem. To the still too introverted view of the risks associated with a business model, new dimensions must therefore be added, especially those related to both the increasingly open nature of innovations in ecosystems and the consideration of value sharing within the value network in the ecosystem [13].

Many risk factors can explain the failure of companies in the renewable energy ecosystem. However, by focusing on the relation between the components of the innovation, and on identifying sub-variables related to technology, it is possible to identify an independent variable to explore. In fact, the relation between these components can lead to a presentation of a business model on one hand, and the structural and dynamic characteristics of a business ecosystem on the other hand. As a result, it is possible to identify a dependent variable composed of three risk classes and six sub-variable classes. The first class of risks regroup the sub-variables related to the ecosystem and covers: 1) the formation degree of the ecosystem 2) stability 3) state of inter-company networks. The second class of risk concerns the economic model, knowing that it depends strongly on the concerned energetic sub-system such as (solar, hydraulic, wind, etc.). Finally, the third class gathers the sub-variables related to the digital, its function and deployment within the ecosystem. The two-identified variables are the digital maturity of the ecosystem and the quality of platform responsible of the collaboration and the cooperation between the different agents.

V. TAKING THE DIGITAL IN CONSIDERATION IN ACCELERATING THE ENERGETIC TRANSITION

We do not tackle all the risk factors in this short paper, rather, we limit our study to what the concept “digital maturity of the ecosystem” covers. In fact, the problematic of digital maturity takes part in the problematic of digital transformation. Based on the Annual Conference of the Renewable Energies Union (SER) that was held on 8 February 2018, energy transition is now based on positive trends, such as the cost of renewable technologies that continue to decline dramatically, and the solar system that gets anchored permanently in the French landscape. In addition, innovation is a crucial factor in this transition and takes many forms. However, in the time when the acceleration of the energy transition will take place through the digital world, these positive trends do not consider digitalization as an essential way to achieve the objective of the energy transition at the best cost.

In one of the first reference books on digital transformation [14], the authors propose a model of digital transformation. This very thorough study of the strategy of 400 major global groups, such as Nike and Pernod Ricard in France, gives the keys to a successful digital transformation in terms of business models, management, customer experience, leadership, and the mobilization of employees. The main conclusion of this study is that thanks to digital technologies, higher level of profits, productivity, and performance, the masters of digital exist but they are rare. The proposed approach consist in diagnosing the digital maturity of the company based on its digital capacities (both managerial and digital), and then realign its competitive strategy according to its digital maturity in order to be able to plan for the energetic transformation within the company. The second variable related to digital, which is not tackled here, considers the ecosystem of renewable energies as a new digital ecosystem. While some companies tend to integrate the next generation of ecosystem, others are designing platforms themselves and creating their own ecosystems to position themselves at the center. In most of the studied ecosystems, the platforms have rapidly became the central hubs of ecosystems that are themselves more and more digital. Providing platforms or participating in existing offers is a strategic alternative, but it is also, from our risk perspective, a structuring and stabilizing factor of the ecosystem or, on the contrary, a new factor of risk, which

will have to be taken into account. A significant example is energy-purchasing platforms that are gaining importance, especially in fuel oil where the risk of uberization is real with actors such as fioulmarket.

VI. DISCUSSION AND PERSPECTIVES

Until now, limited studies have been undertaken, linking the performance of companies to their business model and the ecosystem structure to which they belong. These studies focus on the value proposition (innovation, target customer segments), its architecture (the ecosystem) and the model of incomes (value distribution mechanisms).

However, these models seem less suitable for emerging ecosystems such as the ecosystem of renewable energies (REE), which is articulated less around dominant firms and more around eco-citizen dynamics, start-ups. Second characteristic, this REE maintains a strong dependence on technological innovation, unlike other ecosystems more sensitive to non-technological innovations. Therefore, the question of risk management induced by innovation is crucial, while it is not taken in to consideration in these models. Thirdly, the actors of the REE do not seem to place the digital transformation at the heart of the energy transition and the decentralization of the productive model, whereas industry specialists consider that the acceleration of the energy transition will be done through digital technology.

We recall that the fundraising of renewable energies are 529 Million euros in 2017 and that the transaction market in the renewable energy sector is dynamic. In fact, in France, in the first semester of 2017, 19 transactions were initiated for a total value of 1.2 billion euros [15]. As a result, investors expect to be secure against technological challenges in order to increase the volume of transactions in the renewable energy sector, and thus accelerate the progress of the market towards the energy transition. The framework outlined here aims to develop a more integrated approach explicitly taking into account, besides the business model and the ecosystem, the risks related to innovation within the REE as well as the place of the digital in accelerating the energy transition.

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