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Types of business-models: evidence for an empirically derived typology based on energy and industrial diversification indicators. The case of photovoltaic

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Abstract

Thanh Thao PHAM LISIS, CNRS, ESIEE Paris, INRA, UPEM, Université Paris-Est, 77454 Marne-La-Vallée, France Year of enrolment: 2014 (april); Expected final date: June 2017. thanhthao.pham@esiee.fr This study deals with one specific technology whose commercial age started in 1954: solar photovoltaic cells. As photovoltaic technology matures, it has the potential of moving out of its niche market position, thereby capturing an increasing, significant share of the rising world community's electricity demand. We argue that what is new and of interest in the photovoltaic case is that despite the industry's maturity, the industry still encompasses, in numerous countries, a large number of actors, mainly new entrants, in the downstream, mainly decentralized generation chain. All these actors struggle in the photovoltaic market to strive to success. The similarities end here: while some entrants benefit from generous state help, others struggle with political turmoil (stop-and-go policies); while some still face losses, others achieve great profits; while some are specialized, others are diversified; and so on so forth. These entrants also vary widely in terms of strategy and subsequently business-model, as business-model is a reflection of the realized strategy of one's firm. In other words, this population appears to be heterogeneous. At first glance, the global value chains literature only addresses the upstream situation. As a result, it lets the downstream segment of photovoltaic value chain with no explanation as to why the market is characterized by modularity, instability, and diversity. It follows that little is known about the role of smaller firms in the emergence of a new market, mainly because prior global value chains research focused essentially on unipolar chains governance. That means that these scholars studying global value chain only investigated the power exercised by lead firms (i.e., a handful of companies determining the division of labor) in mature industries (such as automobile, apparel, and vegetable). In other words, this literature pays scant attention to both multipolar governance and niche markets. It is unfortunate because these smaller firms are crucial in both job creation and the deployment of some markets. It is particularly true in the photovoltaic market. Hence, looking at this issue from the standpoint of business-model should allow us to deepen our understanding of this diversity of actors. This article aims at investigating this proliferation of actors in the downstream segment of the photovoltaic value chain. For this purpose, this paper attempts to highlight commonalities and divergences between business-models through the elaboration of a typology. This will provide a clearer picture of the observed abundance of actors in the downstream segment of the photovoltaic

value chain. An emphasis is placed on French-based SMEs. Following interviews with representatives (e.g. CEOs, founders, directors) of SMEs operating in the French decentralized production system and local communities, we propose a typology of business-models: 1) 'the photovoltaic specialized-based business-model' (BM1), which designates a business-model that focuses solely on photovoltaic; 2) 'the energy-based business-model' (BM2), which is implemented by companies specialized in energies, including (but not solely) solar energy; 3) 'the complementary function-based business-model' (BM3), which is set up by diversified companies from mature industries that integrate photovoltaic panels into another structure; and 4) 'the general-purpose technologies business-model' (BM4), which is built on technologies not specific to one market or industry. Based on two criteria – energy and industrial diversification -, it is possible to build our typology around a two by two matrix. A further step was to test the typology quantitatively. It provides the statistical robustness for our typology. We examined the business-model of 187 firms, derived from a listing provided by two significant French professional associations, Syndicat des Energies Renouvelables and Enerplan, at the date of September 2014. They are distributed as follows: 57 companies for the BM1, 45 for the BM2, 72 for the BM3 and 13 for the BM4. Preliminary results show that companies occupying the same quadrant often share the same characteristics. Among them are: their position in the photovoltaic value chain, their customer segmentation, their revenue stream and model. Conversely, there are no (or limited) commonalities as for their value proposition, the role of partner network, their size and profitability. As for their key activity and resources; it entails further work.

Jelcodes:M20,M2

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1. Introduction

The two last decades have witnessed the strong enthusiasm for business-model and strategy concepts, from academics, practitioners, and investors. Yet these notions remain unclear. Indeed, as noticed Magretta (2002, p. 91;92), strategy and business-model are two terms that are often stretched to mean everything – and end up meaning nothing. Furthermore, their ties remain blurred.

There is indeed a strong relationship between these two notions. "In simple competitive situations, there is a one-to-one mapping between strategy and business model, which makes it difficult to separate the two notions" (Casadesus-Masanell and Ricart, 2010, p. 195). However, this overlap is unfortunate when there are significant contingencies on which a well-designed strategy must be based. In this situation, the two concepts differ (Casadesus-Masanell and Ricart, 2010, p. 195). For further distinctions between strategy and business-model, see for example Casadesus-Masanell and Ricart (2010, p. 205) and Chesbrough and Rosenbloom (2002, p. 535). Based on the assertion of Casadesus-Masanell and Ricart (2010) for whom business-model is a reflection of the realized strategy, our focus is on the business-model.

As noticed Teece (2010, p. 176), "there are a plethora of business model possibilities." Yet, Teece suggests that as some dominant features could be observed, they are only the variation of a generic business-model. This paper attempts to test this theory and thus to identify the generic business-models in question.

For this purpose, the photovoltaic industry is of particular interest as it encompasses a large number of actors, mainly new entrants, in the downstream generation chain. The downstream segment includes the following activities: system manufacturing, Balance of System (BOS) component manufacturing, project development, and installation and maintenance. The differences between these firms go far beyond their size. They include notably their strategy, and therefore their business-model (Casadesus-Masanell and Ricart, 2010). Hence, in this paper we highlight commonalities and divergences between business-models, through a typology, in order to identify generic business-model and subsequently, to get a clearer picture of the observed abundance of actors in the downstream segment of the photovoltaic value chain. In undertaking this analysis, the paper draws upon interviews and a database of 117 analyzed companies. An emphasis is placed on SMEs and the French situation. Aware of context and industry specificities, we use the German case to achieve generalization, to some extent, of our taxonomy.

The paper is organized as follows. Section 2 presents the business-model concept. Section 3 outlines the business-model components that will help us define a generic business-model and what distinguish one from another. The following section exposes the methodology used to construct the typology (section 4). In this section, explanations will be provided on how we investigate the focal phenomenon. Specifically, the section exposes a framework, which identifies the two factors determining which business model a company "naturally" adopts. In sections 5 to 8, to ensure the comprehensiveness of our typology, as well as its relevance for real-life contexts, we elicited descriptions of these business-model categories along with the various business-model elements described in section 3. For each quadrant, we pull strands together and conclude on what define each generic business-model. This chapter finishes with a conclusion in section 9.

2. The static and transformational perspectives of business-model

Business-model is a relatively recent term, traced back to 1954 with the work of Peter Drucker 'The Practice of Management'. The book found a larger readership in the mid-90s coinciding with the Internet boom and e-commerce (Chesbrough and Rosenbloom, 2002; Demil and Lecocq, 2010; Magretta, 2002; Teece, 2010; Zott et al., 2011). Other factors include "the emerging knowledge economy, [...] the outsourcing and offshoring of many business activities and the restructuring of the financial services industry around the world" (Teece, 2010,

p. 174). There was an increasing interest of business-model construct since then (Zott et al., 2011). This trend keeps going on, as evidenced by the numerous academic conferences and management workshops (e.g. EGOS, EURAM and R&D Management) and, special issues on business-model and business-model innovation (e.g. Long Range Planning in 2010, M@n@gement in 2010, International Journal of Innovation Management in 2013, R&D Management in 2014, Strategic Entrepreneurial Journal in 2013 and 2015).

Even though numerous contributors propose their own definition of business-model, no consensus has yet emerged. Succinctly defined, business-model refers to "stories that explain how enterprises work" (Magretta, 2002, p. 87). A more accurate definition of business-model would be for example “the logic of the firm, the way it operates and how it creates value for its stakeholders” (Casadesus-Masanell and Ricart, 2010). In other words, business-model defines "how the enterprise creates and delivers value to customers, and then converts payments received to profits" (Teece, 2010, p. 173). Hence, a business-model should answer the following questions: "Who is the customer and what does the customer value?" and "What is the underlying economic logic that explains how we can deliver value to customers at an appropriate cost?" (Drucker, 1954). But not all firms are doing so in the same way. Here, academics focus on companies’ description through their business-model. That is what Demil and Lecocq (2010, p. 227) named the static perspective. Demil and Lecocq (2010, p. 227) depict the static approach "as a blueprint for the coherence between core business model components."

A contrary perspective, i.e. the transformational one, matches with the business-model innovation definition (Demil and Lecocq, 2010, p. 227). Researchers use the concept “as a tool to address change and innovation in the organization, or in the model itself” (Demil and Lecocq, 2010, p. 227). Indeed, founding a good business-model is a trial and error process, and as such “requires progressive refinements to create internal consistency and/or to adapt to its environment” (Demil and Lecocq, 2010; Sosna et al., 2010; Teece, 2010). Consistently with the lack of definitional clarity for business-model, the same applies to business-model innovation. For example, Markides (2006, p. 20) defines it as "the discovery of a fundamentally different business model in an existing business." Others focus on the business-model components such as Yunus et al. (2010), for whom “business model innovation is about generating new sources of

profit by finding novel value proposition/value constellation combinations." In the same vein, Gambardella and McGahan (2010) point out that "in this conceptualization, business-model innovation occurs when a firm adopts a novel approach to commercializing its underlying assets." Some business-model innovation definitions are based on the value creation. As a case in point, Osterwalder et al. (2010) suggest that business-model innovation is about creating value, for companies, for customers, and society". Kaplan (2012) underlines the superiority of the new business-model as "a better way to create, deliver and capture value."

For sure, the lack of consensus on the definition of what a business-model and, by extension, a business-model innovation are, entails further work. While we do not intend to contribute to the clarification of this term, for the purpose of our work, we opt for the definition provided by Teece (2010): a business-model has to depict the mechanisms that help companies to link two dimensions of firm activity (e.g. value creation and value capture) in order to create and sustain a competitive advantage. These two dimensions measure the coherence of a business-model (Casadesus-Masanell and Ricart, 2010, p. 200)[1]. On the one hand, value proposition "provide the volume and structure of revenues." On the other hand, value capture (i.e. the internal and external organizations) "provide the volume and structure of costs." The difference results in margins. Both sides are composed of business-model components. These business-model elements, also called 'building blocks,' are articulated in a way "to produce a proposition that can generate value for consumers and thus for the organization" (Demil and Lecocq, 2010). Hence, to describe in details companies and therefore identifying a generic business-model, we have to analyze their business-model components. The following section is dedicated to the description of these components.

[1] This point is of interest particularly in basic investment research and in the production of scientific knowledge (Teece, 2010, p. 185). As spillovers are too large, and as strong intellectual property protection for scientific knowledge is nearly impossible to satisfy, it is hard to profit from discovery. That explains why few firms invest in basic knowledge.

3. Variety of business model elements

All the definitions quoted in the previous sub-section have the following three elements as common threads, while they may be named differently according to the authors: (1) value proposition, (2) revenue model and (3) internal infrastructure. As such they are "considered to be the most basic and important elements of business models" (Chesbrough, 2010; Chesbrough and Rosenbloom, 2002; Johnson et al., 2008; Teece, 2010). Yet, the business-model literature does not restrict the list of its components to these three dimensions. Far from it. The list goes on and on. As already noticed Dmitriev et al. (2014, p. 308), "the variety of elements identified reflects the multi-dimensional nature of business models in the literature." In addition to the three previous quoted elements, we will introduce the most frequently identified components through a quick analysis of scholarly papers taken from three special issues (Long Range Planning in 2010, M@n@gement in 2010, R&D Management in 2014) and of a few additional seminal papers (Chesbrough and Rosenbloom, 2002; Johnson et al., 2008; Magretta, 2002; Osterwalder et al., 2010). It is possible to gather them into either value creation or value capture side of business-model.

3.1. Value creation

As for value creation, it deals with the way a company generates value for its customers. Here, two business-model components are of interest: value proposition and customer segmentation.

3.1.1. Value proposition

Value proposition identifies *what the offering is.* Chesbrough and Rosenbloom (2002, p. 533) define value proposition as the value created for a specific customer segment by the offering based on technology. The offering could be delivered in the form of products or services (Demil and Lecocq, 2010, p. 231), and could be quantitative or qualitative (Osterwalder et al., 2010, p. 23). Some values created for a customer segment are (Osterwalder et al., 2010, pp. 23–25): newness, performance, customization, 'getting the job done,' design, brand/status, price, cost reduction, risk reduction, accessibility, convenience/usability.

3.1.2. Target market segment or market segmentation.

The offering aims at serving different groups of customer (e.g. people or organizations, large or small) who may not belong to the same customer segment. As such the question asked here is "*to whom is the offer addressed?*" To be part of the same customer segment, customers should share common needs, behaviors, or other attributes (Osterwalder et al., 2010, p. 20). Thus, customer groups belong to separate segments, notably when a company needs to use different distribution channels or propose a distinct offer. As such this component is of particular importance as value propositions, distribution channels, customer relationships and revenue models are designed according to the customer segments the company aims.

Below are five examples of customer segmentation (Osterwalder et al., 2010, p. 21):

- Mass market. The company makes no distinction between different customer segments. They form one large group who has broadly similar needs and problems. It is the case for example in the customer electronic sector.
- Niche market. The company identifies and target specific and specialized customer segments. It may create a dependent situation. It is common in supplier-buyer relationships. It is true notably for car part manufacturers who have a dependent status from major automobile manufacturers.
- Segmented. The company distinguishes different market segments with similar but varying needs and problems. The retail arm of a bank who distinguishes the normal from wealthy clients exemplifies this situation.
- Diversified. When a company targets two or more unrelated customer segments with very different needs and problems, it operates a diversified customer business-model.
- Multi-sided platforms (or multi-sided markets). Two or more interdependent customer segments are served. That means that companies may propose offers to various kind of customers (e.g. end-consumers, suppliers, complementators, competitors or sponsors) (Demil and Lecocq, 2010, p. 231). A free newspaper company is illustrative, as it serves in the same time, advertisers and readers.

3.2. Value capture

As stressed Chesbrough and Rosenbloom (2002, p. 534) and Teece (2010), creating value is not sufficient for a firm to profit from its business-model. Then, ***value capture*** (or value appropriation), i.e. *how the firm captures some of this value as profit*, must be considered. It is achieved through a combination of components. While barriers to imitating business-model developed by Teece (2010)are of utmost importance, they are out of our scope.

3.2.1. Revenue model (or profit formula)

Revenues are generated through one or more revenue streams (Hamermesh et al., 2002, p. 3). Their relative size and importance of each revenue stream account for determining the type of revenue streams underlying a business-model. Below are the different possibilities:

- Single stream. One product or service provides the largest part of the revenues.
- Multiple streams. More than one product or services generate substantial revenues, enough to have a meaningful impact on profitability.
- Interdependent. The sale of one or several products or services should "stimulate revenues from another set of products or services." It is the case of razors and razor blades, and of printers and printer cartridges.
- Loss leader. It is a particular case of multiple streams. While they are profitable altogether, they are not profitable separately. Indeed, here, one or several products or services are sold at a loss. These loss leaders aim at driving traffic to spur other purchases.

Having said this, we still do not know how a company generates revenues. That is where revenue model comes into play. Indeed, revenue models answer to the question: "*what is the source of each revenue streams?*" As such they reflect how "revenue streams can be manifested in a business-model" (Hamermesh et al., 2002, p. 3). Specifically, revenue model refers to a mechanism of pricing and charging money (Chesbrough and Rosenbloom, 2002; Johnson et al., 2008; Zott and Amit, 2010). Such mechanism determines "how and per which unit of products or services money can be charged" (e.g. per pack or per unit for a product, per hour

for a service). Hereafter are some examples of such mechanisms provided in Hamermesh et al. (2002) and Osterwalder et al. (2010):

- Volume or unit-based (or asset sale). A company sells a product or service at a fixed price per unit. It is the most widely understood revenue stream. It is true for example in retail operations such as in a restaurant, clothing shop or beauty parlor.
- Usage fee. Here, the company derives revenues from using a particular service. The fee is growing with the use of a service. A prime example is the number of hotel nights or the number of minutes spent on the phone.
- Advertising. It designates fees for advertising a particular product, service, or brand. Usually, the fee is not paid by end-users. At worst, they only pay a fraction "of the true value of the product or service." Notably, network television stations and content-based websites use this revenue model.
- Licensing and syndication. It occurs when a company gives customers permission to use protected intellectual property in exchange for licensing or syndication fees. It is usually observable in the media industry for copyright and in the technology sector for patents.
- Brokerage or transaction fees. The company generates revenues by intermediation services aiming at facilitating the transaction performed on behalf of two or more parties. The customer pays a fixed fee or a percentage of the transaction's total value. Credit card providers, brokerage firms, auction houses and real estate agents are good examples.
- Lending/renting/leasing. During a fixed period, a company grants to another the exclusive right to use a particular asset. In contrast to the above revenue streams for which there is a one-time payment, this one results in recurring revenues.
- Subscription/ Membership fees. Revenues are derived from the sale of continuous access to a product or service. This revenue stream also provides recurring revenues to the company as customers pay a fixed amount at regular intervals

3.2.2. Key activities

To create and offer a value proposition, reach markets, maintain customer relationships, and earn revenues, a company has to undertake some key activities (Osterwalder et al., 2010, p. 36). These activities could be classified as follow:

- Production activities. They deal with designing, making, and delivering a product in substantial quantities and/or of superior quality. It is the main activity for manufacturing firms.
- Problem-solving. It is about to propose new solutions to individual customer problems. It is particularly appropriate for service organizations, including consultancy firms and hospitals.
- Platform/network activities. It is the case when a platform is a key resource in the company's business-model. The platform could be a network, matchmaking platforms, software or brands. These activities relate to platform management, service provisioning, and platform promotion.

3.2.3. Key resources

Key resources are as crucial as key activities (Osterwalder et al., 2010, p. 35). Below are the four categories:

- Physical resources. The category encompasses machines, buildings, vehicles and distribution systems. These assets are mainly capital-intensive.
- Intellectual resources. They include patents, proprietary knowledge, copyrights, and brands. "Intellectual resources are difficult to develop but when successfully created may offer substantial value."
- Human resources. While they are used in every company, they are particularly significant in knowledge-intensive and creative industries, such as biotechnologies.
- Financial resources. Some business-model uses financial resources and/or guarantees as leverage. For example, they could be cash, lines of credit, or stock option pool.

Interestingly, a company could mobilize the resources through its internal (i.e. owned or leased by the enterprise) or external network (i.e. acquired from key partners).

3.2.4. Internal value chain structure or infrastructure or organizational structure

This component designates what is needed "to create and distribute the offering, and determine the complementary assets needed to support the firm's position in this chain" (Chesbrough and Rosenbloom, 2002, p. 33). It encompasses value chain of activities and value

network (Demil and Lecocq, 2010, p. 231).

3.2.5. *Partner or value network*

The partnership endeavors to make the business-model work. It could involve different actors: non-competitors (i.e. strategic alliances), competitors (i.e. coopetition), suppliers and buyers (Chesbrough and Rosenbloom, 2002, p. 534; Osterwalder et al., 2010, p. 38). The objectives for creating alliance include (Osterwalder et al., 2010, p. 39):

- Optimizing and achieving economy of scale: as it is unusual to possess all resources or perform every activity by itself, this partnership aims at optimizing the allocation of resources and activities, and consequently reducing costs. It often involves outsourcing or sharing infrastructure.
- Reducing risk and uncertainty: when companies face uncertainty, they could set up a partnership. Sometimes they could be competitors in one area while cooperating in another.
- Acquiring particular resources and activities: some companies "extend their own capabilities by relying on other firms to furnish particular resources or perform certain activities." The purpose could be to acquire knowledge, licenses, or access to customers.
- Developing new businesses (i.e. joint ventures).

4. Methodology

4.1. Data collection

Our study involved two distinct phases. The procedures for the two phases of this study are discussed.

1. Phase 1: Conducting interviews.

According to Eisenhardt and Graebner (2007, p. 28), interviews are often the primary data source when research "moves away from everyday phenomena." Thus our first source of data is interviews with actors of photovoltaic market development. Our typology was induced

from 16 interviews with representatives of SMEs operating in the French decentralized production system (eight CEO or founders, three directors, four managers and one commercial engineer) and three representatives of local communities (two project managers and one director). The profile of the companies and the interviewees vary widely.

The interviews were semi-structured, consistent with the exploratory nature of our study, and made face-to-face or on the phone. This type of interview offers to the interviewee the advantage of answering freely to the questions. Although a framework of questions has been determined in advance, we have not ruled out introducing certain freedom in order not to disrupt the natural flow of the conversation. This first step enables us to work on a draft of the classification and to observe preliminary dominant features.

2. Phase 2: Testing quantitatively the typology.

A further step was to test the typology quantitatively. It will provide the statistical robustness for our typology. We examined business-model of 276 firms, derived from a listing provided by two significant French professional associations, *Syndicat des Energies Renouvelables* and *Enerplan,* at the date of September 2014. Yet, to be part of the final sample, we establish a protocol of selection that excludes:

- Firms that do not have direct activities in the photovoltaic industry (e.g. companies producing thermal solar or producing solar energy only for their own consumption are not selected). Following this first screening, 28 enterprises were pulled out from the initial list of companies.
- Firms that do not operate at least partially in the downstream part of the photovoltaic value chain (system manufacturing, BOS component manufacturing, project development, and installation and maintenance). 61 more companies were rejected from our panel.
- Firms with less than ten employees as very small businesses do not have a business-model. 69 enterprises are excluded from our final panel.

After these two screenings, 117 companies composed our final list. They have to be allocated through the typology. To examine the proposed typology quantitatively, a questionnaire was constructed. Specifically, for each firm, we determined a series of yes/no answer questions:

1. Is it involved in other energies?
2. Is it involved in other industries?
3. Does it propose general-purpose technology?

For answering, we collected a great variety of information obtained from the companies' website as well as ORBIS database, press releases, and press articles. Data collection includes but is not limited to qualitative data, encompassing legal status, CEO name, reference shareholders name, internal organization, and activities. We also employ quantitative data such as year of foundation, the number of employees, turnover, and operating profit. Besides, the possible limiting factors in drawing on materials that we may face are availability and confidentiality.

Consistent with our desire to provide a typology that goes beyond national borders, we validated this result with Photovoltaik. It is a German magazine whose headquarter is in Berlin, Germany.

4.2. Constructing a business-model typology

Relying on business-model and diversification literature, we developed a model of a generic or ideal business-model. Rather than constituting prescriptive criteria, this typology describes "ideal-types" of firms and consequently is a tool for our research to put the seeming chaos of social reality in order. These business-models are 'ideal types' in that they are based on certain elements and characteristics common to most cases of each category. By no means, it corresponds to all of the features of any one particular case. To distinguish these business-models, we combine two criteria:

1. Energy diversification: we are interested to know whether the firm operates in the photovoltaic market only or in the energy market in general.
2. Industrial diversification: we are interested to know whether the company operates in energy market solely or not.

Having discussed the two criteria, it is now possible to present our matrix that focuses on the firm's activity scope. In line with other popular strategy models such as the product-market growth matrix (Ansoff, 1957), the BCG Growth-Share matrix and the regimes of appropriability matrix (Teece, 1986), we propose to build our typology around a two by two matrix.

Specifically, four 'ideal' business-models present in the decentralized production derive from the intersection of these two criteria: the photovoltaic specialized-based business model (BM1); the energy sources-based business-model (BM2); the complementary function-based business-model (BM3); and the general-purpose technologies business-model (BM4). The matrix chart below presents these four generic (or ideal-types of) business-models observed in the photovoltaic downstream and decentralized industry. These types are mutually exclusive and jointly exhaustive. We acknowledge that this is by no means the only way to classify business-models.

As a result, the 117 companies are distributed as follows: 27 companies for the BM1, 21 for the BM2, 57 for the BM3 and 12 for the BM4.

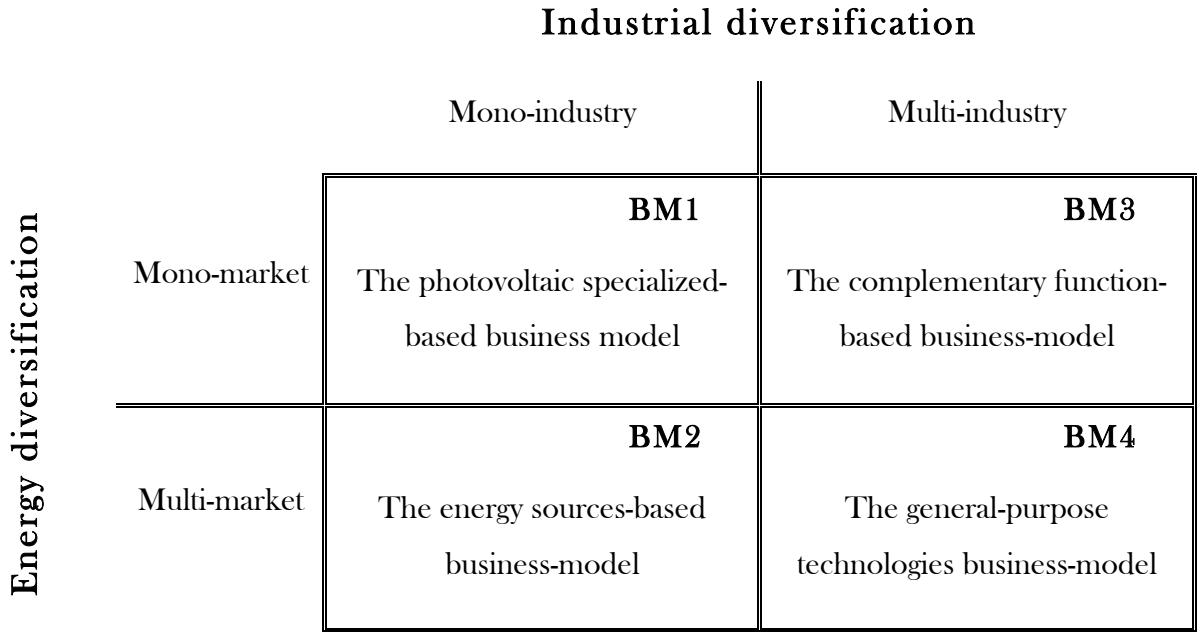

Figure 1: What is your business-model?

Source: Author

While the differentiating factors will be developed in the following sections, they are summarized in the table below.

	BM1	BM2	BM3	BM4
Common photovoltaic value chain	Not specific	Not specific	System manufacturing	BOS components
Activities in common		Platform (brand)	Production	Production
Value proposition	Not specific	Not specific	Not specific	Not specific
Customer segmentation	Mass	Segmented	Niche	Diversified
Revenue streams	Single	Multiple	Multiple	Multiple
Power producer (project owner)	Yes	Yes	No	No
Partner network	Important			Not/less important
Operating profit	Loss		Profitable	Profitable

Table 1: Differentiating factors

Source: Author

5. First quadrant: The photovoltaic specialized-based business-model (BM1)

The photovoltaic specialized-based business-model designates business-model implemented by companies that focus solely on photovoltaic (BM1). 27 of the 117 companies of our panel, approximately 23%, apply this kind of business-model.

Following are the key features of our first generic business-model:

1. Operating profit: Most of these businesses are hemorrhaging money. Indeed, by 2010, they were on the verge of collapse. As for the survivors, they face an uphill battle to produce profits. Indeed, their operating profit was negative even in 2014, indicating their difficulty to make profit thanks to its sole activity.
2. It seems that the partner network is of utmost importance for their survival (or development). For example, their partners (including the parent company) could broaden the extent of their geographical scope.
3. All the companies of the BM1 opt for a mass market as customer segmentation. It could be induced by the fact that they try to address their offer as many people as possible.
4. Their activity varies throughout the downstream part of the photovoltaic value chain: operations and installation; system manufacturing; and project development.

For illustrating the diversity of cases in the BM1, we describe the business-model of three companies positioning in the different parts of the value chain.

5.1. System manufacturing: the case of FranceWatts

Based in the department of Seine-Maritime (Barentin near Rouen), FranceWatts was created in 2009 by a group of investors, including Jean-Francois Marteau, the CEO of Gautier de Pavilly SAS, a carpentry company. The company is positioned in the 'system manufacturing' part of the photovoltaic value chain as it develops and manufactures photovoltaic modules and integration systems (key activities: production). Thus, its unique activity generates a single revenue stream through a volume based revenue model.

Its photovoltaic solutions are various: photovoltaic tile, large roof, superimposition, railing, cladding, shading, off-grid solutions, penthouse, veranda, carport, roof-terrace, and bi-glass. The corporation aims at meeting any application for residential, farms, communities, commercial and social landlord. The applications comply with some national, European and international certifications promoting the traceability and security of the proposed panels: BIPV, IEC, and ISO certifications. Furthermore, the applications are aesthetic and bespoke unframed laminated photovoltaic panels. The corporation considers itself a craftsman firm of the photovoltaic market (value proposition: customization, design, newness, risk reduction,

convenience). Its solution variety enables FranceWatts to target a mass market as its customers are non-specific installers (customer segmentation: mass market).

As for its history, due to the financial loss following the moratorium, in 2014 the firm was closed down and restarted from new by liquidating all liabilities and was acquired by Gautier de Pavilly SAS (about 140 employees). This acquisition benefited to FranceWatts as Gautier SAS can boast a 130-year expertise in building (key partner). The same year (in 2014), FranceWatts acquired the assets of Batisolar, specialized in architectural integration of photovoltaic glass products into a building. These assets aim at reinforcing what FranceWatts already has regarding qualified employees, materials, and certifications (key resources).

5.2. Operations and management: the case of Gensun

To cite a different example, GenSun was created in 2007 by Michel Erbs, who hold experience in managing major technological projects. It is a Montpellier-based company positioned in two segments of the downstream photovoltaic value chain: Operation and maintenance, and project development. Specifically, it is specialized in the development, construction, operation, supervision and maintenance of photovoltaic plants of all sizes. Specifically, GenSun offers to its clients the supervision under QOS, allied with a preventive and curative maintenance of the installations. Such offer aims at guarantying optimum efficiency (and consequently optimum return on their investment) throughout the entire lifetime of their plants (key activities: production and platform).

GenSun may work on various projects on behalf of its clients, i.e. power producers: on regular roof, flat rooftop with crystalline silicon or thin films, or ground-mounted power plants, with or without solar trackers. So the company targets a broad public (customer segmentation: mass market). At first sight, nothing, in particular, distinguishes GenSun's offer from its competitors (value proposition), except its geographic accessibility. Indeed, GenSun owns five agencies in France (Montpellier, Aix-en-Provence, Toulouse, Pau and Pessac) and four subsidies abroad (Portugal and India).

One point is of particular interest: most of its income comes from only activity, i.e. single revenue streams, through subscription fee from supervision and maintenance services (revenue model). According to the deputy CEO, Brian Boulanger, GenSun considers its core activity as uncertain, especially after the French moratorium. Thus as compensation for this

inconvenience, the firm diversifies its revenue sources with maintenance contracts. In other words, maintenance activity enables to recoup part of the investment. Furthermore thanks to the acquisition of juwi EnR by Neoen, Gensun retrieves juwi EnR solar park and, hence, sharply increases its solar park maintenance to 300MW. It is equivalent to a multiplication by ten over one year. As such the maintenance activity becomes its core activity.

Besides, its parent company, Neoen, the third largest renewable energy producer in France, after EDF and Engie, plays a significant role in the business expansion (partner network). Thanks to the knowledge and activity of Neoen in the Central and South of America markets, Gensun expects to expand its activities in these regions.

5.3. Project development: the case of kiloWattsol

Set up in 2007, kiloWattsol is a spin-off of ENTPE (Ecole Nationale des Travaux Publics de l'Etat) and LASH (Laboratoire des Sciences de l'Habitat). Specifically, it was founded by Xavier Daval, the former European Director of OK International, a world leading manufacturer of tools for the electronics industry, a subsidiary of Dover Corp (DOV NYSE), and by Dominique Dumortier, professor at ENTPE Engineering School and one of the leading European specialists in daylight and solar radiation characterization, and modeling.

kiloWattsol is a leading European independent technical advisor (photovoltaic value chain: project development). In the panel, kiloWattsol is one of the rare companies providing services exclusively. On the basis of internally developed software, the company offers high-quality expertise, notably for important clients for sizeable projects (key activity: platform activity).

It has an expanding global portfolio of operations in countries such as Burkina Faso, Turkey, Japan, Thailand, the United States and Italy. The year 2015 alone, 300 projects were assessed cumulating over 1GWc. Their size varies from 100kWc on rooftop to the biggest worldwide projects. Most of its clients are banks and investment funds. To a lesser extent project developers or installers also ask for their services. Also, some companies having its own internal technical advisor service request counter-expertise (customer segmentation: mass market).

The firm is competing with roughly 50 independent technical advisors based in France. What differentiates the company from its competitors are its solid experience in portfolio assessment, its methodology been audited by Moody's and the accreditation from the major banks financing photovoltaic projects. Furthermore, kiloWattsol was twice winner of the national prize for innovative businesses (in 2007 and 2008) from the French Ministry of Higher Education and Research, funded by Oséo. As a final point, it should be noted that the corporation has been selected to join the Incubator of EM-Lyon, one of Europe's finest Business Schools.

In addition to its brand, its value proposition includes newness, brand, risk reduction and "getting the job done," as the company aims at reducing the level of incertitude in pricing risk and at determining the project's return on investment. Hereafter are two examples of its offers:

- Risk assessment. Siemens Bank and Commerzbank mandated KiloWattsol in 2012 for doing a risk assessment of disconnection for the San Martino and Pietralba photovoltaic plants (4 MWp), located on the French island of Corsica.
- Capacity audit: in 2012, Dutch Infrastructure Fund (DIF), the Finsterwalde II and III power plant owner, commissioned kiloWattsol to assess the power plant's future yield for its remaining lifetime. The survey took into account the specific climatic conditions of the location to be as close as possible to the reality.

While it is feasible to offer a wide variety of services based on the software, we can consider that kiloWattsol generate revenues from a unique revenue stream based on a volume-based mechanism (revenue model) from the generation of surveys.

To meet the expectations of its international clientele, its team speaks six languages: English, French, German, Dutch, Spanish and Romanian. The profile of its team member is varied. It encompasses Ph.D. and engineers. As such the enterprise relies on intellectual (as for its software) and human resources.

As for its partner network, we do not have any information.

6. Second quadrant: the energy-based business-model (BM2)

The energy-based business-model is implemented by companies specialized in energies, including (but not solely) solar energy (BM2). It is worthwhile noting that the 21 companies

have different backgrounds. Yet it is possible to establish two distinct profiles. An example for each is provided in the following subsections.

Yet, few general trends could be observed:

1. Their business-model lies on segmented customer segmentation.
2. They all operate in the 'operation and maintenance' segment photovoltaic value chain. Interestingly, numerous companies become a project owner, that is, acquired an energy plant. It is a way to guarantee a part of their revenues.
3. Revenue model. Revenues are derived from multiple revenue streams, whose the main mechanism is volume or unit-based. Subscription fees are rather marginal. Yet, as well as the companies in the BM1, they do not generate profits through their activities.
4. Building a strong brand is a significant pillar for their development. As such a platform activity is a common thread.

6.1. Pure clean energies offer: the case of Arkolia Energies

Firstly, some firms initially operate in a clean energy market and then diversify its offer to other renewable energy markets. For sure, they owe their present survival not least to the fact they were capable of diversifying their activity into other renewable energies. Such a decision was made possible by using the company' core competencies to enter into these markets. A case in point is Montpellier-based Arkolia Energies.

Arkolia Energies is a 42-person, Montpellier-based firm founded in 2008 by Laurent Bonhomme, a former banker, specialized in real estate market, and Jean-Sébastien Bessière, a former financial auditor and corporate financing advisor.

It is involved in package building, investment project, and operation and maintenance of power plants (key activities: production and platform as for the brand). As such it operates in 'operations and maintenance' and 'project development' segments of the photovoltaic value chain.

Historically, the company is involved in the production of electricity through solar. Soon after the French moratorium, in 2011 it extended its energy sources to methanization, wind power, and biomass. What differentiates the company from its competitors are its multi-energies approach and its significant methanization activity supported by R&D, which became

over the years the cornerstone of Arkolia Energies development, contributing to building their brand (value proposition: brand, convenience of the multi-energy offer, newness).

As for photovoltaic, Arkolia Energies targets farm building (its initial application), warehouses, solar shade structures, offices, industrial or commercial buildings on behalf of farmers, landowner, industrials, investors, or local communities. These various market segments have similar yet different needs and problems. As such, its offering goes to segmented markets (customer segmentation).

Having said this the company has two revenue streams based on one revenue model to generate €50 million in 2015:

1. Volume-based revenue model 1. The company is a project developer of clean energy power plants. The company has developed a portfolio of more than 373 MWc of photovoltaic rooftop and shade structure. In 2015, this sole activity generated €44 million, equivalent to 90% of its €50 million of annual total revenue.
2. Volume-based revenue model 2. Since 2011, the company also diversifies its revenue sources in the photovoltaic in becoming a project owner. The resale of electricity generates €6 million of turnover in 2015. They are majority owner at 51% of four large ground-mounted photovoltaic power plants, named Arkolia Solar Park (ASP), for a total of €75M and 70MW in 2015[2]. Depending on the projects, the remaining 49% belongs to Groupe Caisse des Dépot, Green City Energy or Acofi. In other words, its partners bring the needed money to the projects. The latest project inauguration owned partly by the enterprise, i.e. the 4th of Arkolia Energies, dates back to June 2016. This solar plant requires a €16 million of investment. Located in the city Soler (near Perpignan, in Pyrénées-Orientales), at the time of writing, it is the largest French solar plant on trackers. Based on 60 000 photovoltaic modules and 2 500 trackers, this 45-hectare solar farm is capable of powering 15,3 MWc for 24 GWh of annual production. It is equivalent to powering the 7 000 households of the city.

[2]

As for the maintenance of its clients' photovoltaic plants, this activity generates little monetary value. As such it has very limited impact on Arkolia Energies' profitability. Thus it could not be considered as a revenue stream.

To be sure, its activity is based on some key resources: financial (for its owned plants, coming from the company itself and its partners), human (for the R&D and commercials) and intellectual (R&D).

Furthermore, the founders' background may have an impact on their ease to convince financial partners in sharing the adventure and the risk associated. Thus, its partner network (for acquiring particular resources, i.e. financial, and reducing risk) is crucial for its activity of power producer. The founders consider that this activity is a proof of their expertise in financial engineering and project funding.

6.2. General energy offer: the case of BP Solar – ApexEnergies

Secondly and finally, some energy firms not having their main economic activity in clean energies move at least partially into them. As for example, BP and Total opted to acquire solar plant, and Eon chose to get rid of its traditional energy production sources to deftly towards a more sustainable source, including solar energy. That is why, instead of limiting this second business-model solely to renewable energy sources, we prefer to enlarge it to include firms operating in the energy industry in general. The study of BP Solar-Apex Energies will help us gaining understanding of this situation.

Created in 1981, BP Solar, a former fully owned subsidiary of British Petroleum (BP), one of the top oil and gas multinationals, was a photovoltaic cells manufacturer and installer. In 1999, to penetrate the French market, BP Solar acquired Apex Energies, created in 1991, and therefore is the oldest company in the panel. Following the decision of BP to stop its solar activity worldwide, BP Solar closed in December 2011. In France, five former employees decided to buy up the French solar business to gain back independence. The company is still operating under the name of Apex Energies. In 2015 it employed 28 persons and generated sales of €6,2 millions.

The company's key activity has evolved from photovoltaic cell manufacturer and installer to mainly nowadays become a solar photovoltaic energy producer and thus, operating in the 'operation and maintenance' and 'project development' segments of the photovoltaic value chain (key activities: platform as for its brand and, production).

Based on its strong brand, due to its parent company, the company bases its offer on three business areas (value proposition):

1. *Development and construction.* The company designs and builds grid-connected and off-grid photovoltaic plants. It has installed more than 600 on-grid and 5 000 off-grid plants in France and the overseas departments. It began to extend its operations to reach Europe since 2014 (mainly Italy) and Mexico since 2015. Self-production is also proposed for businesses, communities, and individuals. The installations total 455 KWc over 72 solar plants.

   The following project exemplifies this business activity. 31,2KWp will be produced in the industrial area named Sables de l'Etang Salé, with a storage system. It should provide with the energy security needed at least for the computer server. The overflow is for self-consumption. The data center is based on heavy energy use, as its energy consumption is up to 25% of the building. The project plans to include shade structure and shelters to recharge the electric service vehicles.
2. *Operations and maintenance.* As for operations or asset management, it is its core activity, be it as project owner or operator for its clients. To the date of writing those lines, the company exploits more than 24MWp of photovoltaic energy, including 15MWp held in equity. It aims at exploiting 40 MWc as project owner by 2018. It is possible through external growth. Indeed, the firm is highly active in the second-hand market for photovoltaic plants. This strategy allows a quick growth of its solar park. Thanks to the operation of its own solar plants, it guarantees a significant level of revenues.

   Turning to the maintenance activity, in 2015, the company increased its supervision and monitoring performance for its 7000 clients, through the acquisition of the software company S4E specialized in energy. Specifically,

PVSoft software allows remote monitoring for small photovoltaic installations. This software is the first not to be dedicated to large photovoltaic plants.

3. *And investment and financing*. Apex Energies proposes a service for auditing solar plants, technically, financially, administratively, and legally. They are appointed by acquirers, investors or, plant builders. Over 350 solar plants are analyzed annually.

   The Thézan project is a telling example of its financing role. Apex Energies was the unique investor in this project, located in the land of the former landfill site of Crès de Laouzino. It involves 9 408 photovoltaic panels installed over 4,5 hectares. It should cover three times the energy consumption of Thézan-des-Corbières village. Installed on trackers, a part of the land could be used as a grazing ground.

Besides, its photovoltaic solutions encompass sloping roofs with or without building integration, terrace roofs with all types of waterproofing, ground plants, and parking shelters. Its offers address various types of clients, including investors, industrials, local communities, farmers, and individuals. These customer groups have more or less the same needs and problems. As such Apex Energies serves segment markets (customer segmentation).

Having said this, the company generates revenue through the activities dedicated to its clients and as project owner. Thus, it constitutes four revenue streams based on the volume-based mechanism regarding the development and construction of photovoltaic plants, the sales of its own power plants and, the investment and financing activities; and on the subscription mechanism regarding the maintenance of photovoltaic plants of its clients.

Based on these pieces of information, we could assert that for running its business, Apex Energies relies certainly on its brand, as formerly owned by BP, and on intellectual and human (concerning the software development), financial (as project owner) resources.

As for its partner network, we do not have any information.

7. Third quadrant: the complementary function-based business-model (BM3)

This business-model category is set up by diversified companies whose core

competencies come from mature industries and integrate photovoltaic panels into another structure (BM3). Specifically, these firms, building upon the knowledge they gained in other industries, propose new services as a complement to their traditional offer. In other words, the photovoltaic industry is also appealing for companies occupying originally other industries. Indeed some firms from other industries still see a market opportunity despite the moratorium. These companies include among others builders of car park shelters with photovoltaic shade panels, roof covering companies that install photovoltaic roof tiles and electrical installation firms proposing an electrical installation of solar modules. It is not an exhaustive list. Far from it.

Below are the main characteristics of the 57 BM3-companies:

1. Customer segmentation. They target niche market as they propose specialized offer and thus target specific customers.
2. Operating profit. BM3 companies are profitable. Yet it is not always possible to know the contribution part of their solar activity.
3. Revenue model. Revenues are derived from multiple streams based on volume-based mechanisms.
4. Photovoltaic value chain. They are primarily system manufacturer. Some are more integrated as they also install their system and thus operate also in 'operation and maintenance.'

7.1. GagnePark

A prime example is GagnePark. Located in Lyon, GagnePark was founded in December 2006 by Montauroux Group. In 2014, it employed more than 25 persons (they were 12 in 2009) and generated €14 millions of sales.

Gagnepark operates in 'operation and maintenance' and 'system manufacturing' segments of the photovoltaic value chain. Specifically, it offers to its clients the conception, the engineering and the construction of parking lots (key activity: production).

The company targets industrials requiring parking lots for their employees or their clients, such as large supermarkets and commercial centers. Among its customers are Carrefour Group, Auchan and EFFIA Stationnement. Considering the specificities of its clients, it is possible to say that GagnePark targets a niche market (customer segmentation).

Broadly speaking, backed by its brand, Gagnepark proposes to its clients new patented solutions combined with mass customization (value proposition). What makes its patents so unique is that it allows a simplified and rapid on-site assembly procedure and a customization of its solutions. Specifically, it offers non-standardized products, enabling it to reap advantages of economies of scale and to deliver a custom product in taking account of the willing of its clients and the characteristics of the land and budget (i.e. mass customization).

Besides, the company generates revenues from two revenue streams based on a volume-based mechanism (revenue model):

1. Volume-based revenue model 1: *Parking construction*. It is its originating business line. The company undertakes R&D programs aiming at patenting innovative solution for construction systems. The GAGNEPARK® construction process for multi-storey parking lots is illustrative. As of 2014, a total of 26 multi-storey parking lots were built up over more than 250 000 square meters, equivalent to more than 10 000 parking spaces.
2. Volume-based revenue model 2: *photovoltaic shade structures*. Quickly after its first successes, its clients asked Gagnepark to diversify its offer to include photovoltaic. Then, backed by its research and experienced on parking construction, in 2008 the firm satisfies its existing customers by extending its offerings to photovoltaic shade structure (or carports). Solar photovoltaic panels are installed on a shade structure. The power generated is either resold or self-consumed. R&D endeavors are also significant in its solar activity: the firm had patented its building system under the name of "OMBRAPARK." It is applicable, for example, to single-storey or terrace level of multi-storey parking lots. As of 2015, this patented building system based upon its expertness in parking solutions was implemented to over 280 000m2, cumulating 50MWc and 16,500 car parking spaces. At the time of writing, its latest photovoltaic project dates back to January 2016 with the 13,5 MWc shade structure of the Walon-Riversaltes solar plants.

   Yet, since the decree of 2010, its solar activity has been halved. Indeed in 2009-2010, regarding sales, more than 50% of its activity was dedicated to its solar activity. At the time of writing, it is reduced to 20%. However, the company still makes a multi-thousand euro investment each year in R&D focused on building

system and added in 2012 a new solar activity: *solar-powered shelters* (i.e. for charging electric vehicles).

For proposing these solutions, Gagnepark relies on its machines for producing parking lots, on human and intellectual resources for R&D (key resources). All are internal resources. As far as we know, it does not build partner network.

7.2. Imerys

Imerys is another illustrative example of a firm that initially operated in a mature industry but subsequently decided to enter the photovoltaic market.

Created in 2008, Imerys Toiture, the French leader in innovative clay tiles, is a joint venture between EDF ENR and Imerys Terre Cuite, the French leader of terracotta tiles and bricks.

The company is one of the rare system manufacturers in France, which develops photovoltaic roof tiles (key activity: production). In addition to its traditional clay tiles activity, it operates in the photovoltaic building integrated rooftop market for residential and industrial applications, especially for production and installation (photovoltaic value chain: 'operation and maintenance' and 'system manufacturing').

Specifically, it proposes this alternative to photovoltaic panels installed on top of a roof. The installation process is rather identical to its original core competences, even though the photovoltaic roof tiles are a bit bigger. Thus, by taking the place of clay tiles, photovoltaic roof tiles intend to ensure the tightness of the roof. Furthermore, it is also argued that it preserves integrity and aesthetics: the used installation process and the colors (i.e. slate-grey and silver) enable the tiles to disappear in the roof. It aims at being highly aesthetics and waterproof. Furthermore, the photovoltaic roof tiles aim at being easy to use for installers. To sum up, the values proposed by Imerys Toiture are newness, performance, risk reduction, brand, design, and usability. One remarkable project was to install photovoltaic panels on the sailboat 'Green.' The panels will provide green energy to the boat during the competition Transat Bakerly, linking Saint-Malo, to Plymouth and, to New York in 2016. This offering targets three independent customer segments: photovoltaic roof tiles and normal roof tiles installers and energy producers (customer segmentation: niche markets). As such its activity generates sales through three single revenue streams based on the volume-based revenue model.

Besides, its strategy of development goes through external growth. In 2016 alone, the firm bought the photovoltaic and thermal power activities of SAG Group (under the name of Ecoscience) and has secured a majority share in the capital of LUXOL, specialized in the making of photovoltaic tiles. These acquisitions extended the offer. Specifically, as of the time of writing, Imerys Toiture offers photovoltaic tiles (EVOLU'KIT), energy storage kit (STOCK-IT) and thermal power tiles for self-consumption. Thus, Imerys Toiture relies heavily on its machines for its tiles, be they photovoltaic or not, on intellectual and human resources as for the R&D for photovoltaic tiles (key resources).

7.3. Marchegay

Our last example deals with Marchegay. Founded in 1948 in Vendée, the company bears the name of its founder, Roland Marchegay. As for its story after 10 years of belonging to Richel, a French group specialized in greenhouses, specifically in 2011, it bought backs its independence to become SAS Marchegay Technologies.

Initially, the company was focused on the construction of frames and metal structures and then focused on glass greenhouses (key activity: production). Its diversification to the solar industry started in 2007. In 2012, a fourth activity rounded out the range of its offer by promoting the building of quality greenhouses, facades, and sustainable buildings. In 2015, 105 persons were employed by the firm and operated over 30 countries. After going to receivership in 2015, the photovoltaic activity has been sold to Dome Solar, and the other activities were acquired by MTECH SAS, by decision of the Commercial Court. The remaining of this section is dedicated to Marchegay SAS before May 2015.

Focusing on its solar activity, the company designs, builds and installs roof integrated photovoltaic panels (photovoltaic value chain: system manufacturer and, operation and maintenance). It offers to its clients, energy producers and installers of photovoltaic roofs and shade structure (customer segmentation: niche markets) various innovative, adaptable, designed and low-risk solutions (value proposition: risk reduction; customization; design; usability; newness). Indeed, their systems are CSTB (Pass Innovation, ATEC or ATEX) or New Technologies Investigations (ETN) Certified and satisfy all integration criteria of the CEIAB. Hence, it is possible to say that certifications are one of their main strengths. Furthermore,

installers from other companies can easily install the roof integrated photovoltaic panels. The applications are various, encompassing the residential, agricultural, tertiary and industrial industries.

Two solutions are proposed and generated revenues through a volume-based mechanism (revenue model):

1. Volume-based revenue model 1: *photovoltaic roofs and shade structures.* Far from being the only one, Marchegay proposes photovoltaic roofs and shade structures with a power input of 33kWc, either for 7 or 13 parking spaces. The modules could be crystalline, laminated, or double glass, depending on the client's wish.
2. Volume-based revenue model 2: *photovoltaic hangars.* What differentiates Marchegay from its competitors is that it proposes photovoltaic hangars. They are used exclusively for agricultural storage, with a capacity either of 36kWc or 100 kWc. Concerning this market segment, Marchegay undertakes the integration system. They are commonly called Heliossytems. They are particularly known for the speed at which it can be installed, in particular HELIOS B^2, under technical advice (Avis Technique n°021/13-33). Its Easy Clip system and user-friendly system (for installers) make them interesting. HELIOS RC3 is specific to solar shade structure. Here is something else too: the Helios RP+ system is compatible for integration on a greenhouse. As far as we know Marchegay is one of the rare, if it is not the only one, to offer this solution.

Based on this information it is possible to say that, in addition to its physical assets, notably machines, the company relies heavily on human and intellectual resources to provide patents (key resources). As for its partner network, we do not have any information.

8. Fourth quadrant: the general-purpose technologies business model (BM4)

Conversely to the other business-models that focus solely or at least mainly on a dedicated technology, the fourth business-model of our categorization is built up on technologies that are deployed in different downstream markets. Indeed, the general-purpose

technologies business-model designs companies proposing products not specific to one market or industry.

Chiavari and Tam (2011, p. 35) acknowledge the important role of generic and general purpose technologies in the development of renewable energy research, development and demonstration. As such governments are encouraged to allocate public funding on these technologies, including energy storage and grid management (Johnstone et al., 2010). "One general consequence of the rise in these intermediate technology markets has been an increase in downstream product-market competition" (Gambardella and McGahan, 2010:264).

Having said this, while the 12 companies vary widely in terms of profitability, the number of employees or geographic scope, there are some common threads:

1. Their customer segmentation is diversified.
2. They all operate in the BOS segment of the value chain.

Previously Saft Power Systems Group, AEG Power Solutions, to cite an example, is a transnational corporation specialized in energy conversion, belonging to 3W Power Holdings S.A. Specifically, it is a designer and provider of power supply systems and service for various industries (key activity: production). Not only does it aim at customers operating in industrial, infrastructure and telecommunications markets, such as transportation and petrochemical companies, but also in the renewable energy markets. Thus it aims at serving groups of customers with different needs and problems (customer segmentation: diversified markets).

As for the solar market, it deals with all activities connected to energy management, such as power inverter and energy storage (*photovoltaic* value chain: BOS components). Their products aim at supporting "integration of the renewable energies into the grid, solutions for energy storage and solar solutions." It proposes for example central hybrid power, energy storage, solar inverters, power supply modules inverters and monitoring services for solar power plant, utility scale applications, off-grid for photovoltaic technologies based on silicon or concentrated solar power. Their solutions are claimed to be customizable, cost-effective, reliable, efficient, designed, innovative and of quality (value proposition).

The company generates sales from multiple revenues streams through a volume-based mechanism (revenue stream and revenue model).

For sure, this activity diversification and production requires substantial financial, human and intellectual resources.

As for its partner network, we do not have any information.

9. Conclusions and further developments

At first sight, the population of actors in the photovoltaic industry, especially in the decentralized, downstream part of the value chain appears to be heterogeneous. Yet, based on two criteria – energy and industrial diversification -, it is possible to classify firms into four 'ideal' or generic business-models: the photovoltaic specialized-based business-model (BM1); the energy-based business-model (BM2); the complementary function-based business-model (BM3); and the general-purpose technologies business-model (BM4). Further differentiating factors have been identified. Indeed, each quadrant presents some specificities. Among them we could quote: their position in the photovoltaic value chain, their customer segmentation, their revenue stream and model. Conversely, there are no (or limited) commonalities as for their size and their profitability.

As we have classified an important number of companies, reflecting an indisputable variety of actors in the photovoltaic industry, into four categories, it is possible to say that there are not infinite possibilities of business-model in an industry. Thus, it confirms the statement of Teece (2010), for who the multitude of business-models in an industry are variations of generic business-models.

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