The innovator's struggle to assemble environmental concerns to economic worth

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Table of contents

Introduction

Key message

All three business ventures Lifelink, Infarm and BioBooster have proven to be somewhat radical innovations that upset existing user competences and market valuations. The three business ventures stem from the ambitious business vision of GNB to realize Grundfos's long term mission to become a world leading supplier of clean water solutions. The critical point addressed in this report is that radical innovations require extraordinary investments and types of work in the "external environment" to be able to claim value on the products.

Indeed, while radical innovations may seem obvious and relevant from the innovator's point of view, to other stakeholders they may suffer from the liability of newness (Stinchcombe, 1965). Such liability of newness may exist because technological discontinuities break away from established standards and norms of valuation associated with existing solutions to certain problems. Thus, technological discontinuities result in products with very different *cost and performance characteristics compared to existing* products (Anderson and Tushman, 1990:607).[1] In this report we use the term *qualities* to refer to the particular mix of price/cost and performance characteristics (technical, environmental, etc.). It is this mix of characteristic that allows users and stakeholders to make calculations and judgments on competing solutions (Callon and Muniesa, 2005).

This is highly relevant for clean-tech innovations as they are not only radical in the technical sense, but in the sense that they offer completely different qualities of cost and performance. They are *clean-tech* in the sense that their performance attempts to reduce the disutilities (negative externalities) related to the performance of existing technoeconomic solutions, by reducing environmentally damaging emissions, reducing the use of limited natural resources, improving work conditions for labour, etc.

Many companies that initiate sustainable innovation by acting upon the disutilities and concerns stemming from existing technoeconomic solutions face the surprising challenge that innovation is not only about making new or improved technologies, but as much about challenging and transforming the lock-in of existing technologies and solutions in our societies. Clean-tech solutions and innovations are not entering a vacuum or empty space, but a space already occupied by the cost and performance of existing solutions.

The relevance of the new clean-tech solution to the user is not pre-given, but stems from its ability to demonstrate a *cost and performance difference*. The business model provides the innovator with a tool to explicate the new cost and performance characteristics, but this is only a starting point. Realizing the innovation is not done by justifying the business case, but requires that the new value propositions are translated into new or modified user valuation frames. This extends the innovator's work to involve both the user and the network of stakeholders and regulations that configures the user.

[1] The founding father of innovation as creative destruction J. Schumpeter stated that in rare and irregular intervals innovations occur, that "command a decisive cost or quality advantage and strike not at the margins of profits and the outputs of the existing firms, but at their foundations and very lives" (Schumpeter, 1942:84).

Consequently, this report states that the managerial work involved in clean-tech innovation is not only to make a new technological design and show the business case, but to address the series of challenges associated with unlocking existing solutions and overcoming attempts to destroy the new solution, while demonstrating new and different cost and performance qualities. This implies getting disutilities accepted as legitimate qualities of the product, finding methods for demonstrating and calculating its worth, and developing new knowledge and practices (routines) of use, regulation and evaluation. All these elements are part of making a new market valuation frame, and they must be established before profit can be claimed on clean-tech innovations.

The managerial implication from this study is that the innovation journey (van de Ven et al, 1999) is not predictable since it does not unfold in some preexisting regulatory, stakeholder and market context, nor does it follow a linear, cumulative sequence. Instead, the success of an innovation and its value depend on the capacity to manage an unpredictable innovation journey, i.e. to work in non-linear processes in which the innovator seeks to assemble stakes and their holders in networks of associations. The report concludes by sketching an approach to "managing with informed unpredictability".

Theoretical perspective

This report adopts a theoretical perspective that builds upon new insights in entrepreneurship and economic sociology regarding the construction of opportunities and markets.

Opportunities have to be created

How do opportunities become visible to the innovator and how are they realized? In many occasions the approach to entrepreneurship and opportunities builds upon the so-called "discovery" perspective. Here opportunities are treated as objective phenomena "out there" waiting to be discovered by entrepreneurs with special skills or experience to "see" them (Shane and Venkataraman, 1997). This perspective portrays the opportunity as already existing and waiting to be discovered; the discovery process is subjective, but the "window" can only be seen by a few. Consequently entrepreneurs are able to gather information about the existing opportunity that will make the prediction of the future more probable.

This report adopts an alternative perspective according to which opportunities have to be created by the entrepreneur (Alvarez and Barney, 2007). The "creation" perspective portrays opportunities as the outcome of entrepreneurs' work to enact and create their environment (Garud and Karnøe, 2001). This means that there is not a pre-given environment "out there" visible to the entrepreneur; the environment becomes visible "in the company/for the entrepreneur" through the work of representation. The work of representation creates the business opportunity and makes it visible in the business case through a process of construction, whereby the entrepreneur enacts, collects and arranges data (e.g., regulations, assumptions about user problems), and makes calculations (e.g., estimated price/cost structures) to form a view of the world. It is the entrepreneurial challenge to bring the reality represented "in the business case" into a reality "out there in the environment", by creating the conditions where the customer will pay for this product.

"Stakes" and "holders" must be assembled

This approach to entrepreneurship opens for a view where the external environment and the market are also seen as not pre-given, but created and assembled. Stakeholder theory, which emphasizes the critical role of stakeholders in a firm's environment, provides a way to overcome the abstractedness of the term "environment" (Freeman, 1984, 2010). However, despite the value of recognizing the role of stakeholders in making up the external environment, it is a limitation of much stakeholder analysis that it tends to see the identities, interests and positions of stakeholders as pre-given and static. This provides limited understanding of how the firm and its stakeholders can co-evolve and become assembled as a new network supporting the new product. When it comes to innovation of new products, both stakes and their holders are emergent; hence, assembling the stakes and holders is a critical job for the innovator.

The qualities of the good must be framed

The market environment can be seen as a space where the bundle of qualities which define a good makes it comparable with a finite list of other goods. The qualities refer to price/cost and performance (technical, environmental, quality, etc.). It is these qualities that allow users and stakeholders to make calculations and comparisons (Callon and Muniesa, 2005). Some of these qualities may be inscribed in regulations and standards that frame the particular product market. An important part of sustainable and clean-tech innovations is to establish facts and agreement between the involved calculative actors.

This brings stakeholders into the core of establishing the new bundle of qualities. Indeed, what qualities are to be taken into account and how they are to be valued, is not given "in the market" and may be controversial. In addition, the attributed qualities may change, resulting in a market process of continuous qualification-requalification involving stakeholders (see how the nuclear power industry worked to establish itself with the quality "emission free" as opposed to "unsafe and costly", (Garud, Karnøe, and Gehman, 2011)).

Therefore, the outcome of this market process is a not a final state of closure, but a temporary stability of the qualities of the good, making it, for a while, a tradable good in the market (Callon, Meadel, and Rabeharisoa, 2002; Callon and Muniesa, 2005). The qualification-requalification process, i.e. the modification of the list of qualities, is at the heart of economic competition. Moreover, this work of establishing the qualities of goods is not traditional marketing work, and is especially critical for radical innovation in the clean-tech sector. It involves stakes and holders, rules and regulations, scientific facts, calculative devices, and user valuations that happen to make the user buy some product or service.

The "frames" through which products are qualified and valued are outcomes of work, and must be established, maintained and upgraded in the lifetime of the technology, and that requires multiple actors and blurred boundaries to politics (Fligstein, 2001; Callon and Caliskan, 2009). The history of Edison's centralized power system overtaking the centralized gas-system, as well as the history of adding wind power to the electricity system, clearly demonstrates the struggle and negotiations involved in framing a market environment that fits the technology compared to fitting the technology into a pre-existing market environment

(Granovetter and McGuire, 1998, Karnøe and Garud, 2012). Like all radical new technologies, clean-tech innovations may suffer from the liability of newness, but they may undergo a transformation to become normalized into technical standards, routines and skills in production, use and regulation, and even extend into the future by socialization, expectations and identity formation.

The resources behind the innovator's competitive market position must be constructed

The resourced based view (RBV) has gained prominence by rightly demonstrating that competitive advantage may be explained and managed by identifying the unique bundle of resources behind a product's success (Barney, 1991). Resources are productive assets to a firm, and a firm's competitive advantage is based upon the ability to develop and bundle resources in unique ways that produce extraordinary returns. For example the competitive position of Swiss watch-maker Swatch may be represented as a bundle of resources such as technical miniaturization, simplification of components in the watch, and mass production capacity, combined with a strong brand that jointly create something that the customer values.

By stressing how building internal company strengths can lead to competitive position vis-à-vis competitors, RBV has distanced itself from the predominant view of adapting to the external environment put forward by Porter's industry analysis (Porter, 1985). While RBV may be a useful guide for companies when they identify the unique resources behind an already established competitive position in a market, the framework is not adequate for innovations, as it is causally ambiguous for the manager what can be a resource, and s/he is most likely only to determine valuable resources retrospectively (Clegg et al., 2011:96-97).

However, there is another danger built into the RBV. By stating the critical role of resources behind competitive advantage, the rhetoric of the RBV vocabulary comes to depict resources as almost pre-given, or relatively easy to develop. Thus, the RBV may easily come to confuse the identification of the needed resources to make the innovation successful with the process of constructing the unique resources in order to obtain a competitive advantage. This is due to the tautology built into the theory, which insists on "unique resources as the basis for competitive advantage", while downplaying the process that generated these resources.[2]

The innovator's struggle to qualify the product and assemble resources for economic worth

In this report we adopt the perspective that economic resources are critical but not pre-existing: they are outcomes of organizing processes. As innovation economist Michel Callon stated: "economics does not begin with the *allocation* of scarce resources, but rather with their *localization* or location (renting)" (Callon, 1991:152). In our view the localization of resources involves managerial processes of assembling (organizing), bringing together heterogeneous elements such as people, things/prototypes, machines, calculative demonstrations, meanings, and stabilizing their association to become competences and value chains, as well as framing the market for the claimed qualities of the product.

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[2] Sillince (2006:803), "There is thus a self-fulfilling aspect to the resources based theory. The theory states that competitive advantage follows from valuable, rare and non-imitable and non-substitutable resources. Rationalizations constructed after the alleged success has happened look for self-serving instances of this."

Thus, in order to have a successful innovation or product launch, the innovator needs to assemble a network around its product. The success of the innovation is dependent on building the product qualities into alliances with stakeholders (Akrich, Callon, and Latour, 2002). The heterogeneous elements that compose an innovation are not born associated, and the innovator has to bring together supposedly disinterested actors, stakes and misfit technological components. This work requires maintenance and even shifting tactics, because the involved elements may be "active" and move around in unpredictable ways. Crucial then is the capacity to manage an unpredictable innovation journey, i.e. to work in non-linear processes in which the innovator seeks to assemble the new stakes and their holders in networks of associations.

Cases and methods

This report studies the three GNB business ventures Infarm, Lifelink and BioBooster.

Infarm offers solutions for handling animal manure in agriculture. Grundfos New Business invested in the start-up in 2004 and subsequently became its unique shareholder. At the time of investing, Infarm was starting to commercialize a slurry acidification system (the NH4+ system) that allowed decreasing ammonia emissions from pig and cattle farms. Since then, the company has developed a second product (the Smellfighter), which is an ozone-based slurry treatment system that reduces odour nuisances. Infarm has continuously attempted to demonstrate the environmental and economic value of these two products to a wide array of partners, ranging from regulators and NGOs to farmers' associations.

Lifelink's system provides clean water to small communities in disadvantaged areas in developing countries (e.g., Kenya). The system combines Grundfos SQFlex pump, solar panels, and a mobile banking technology. The innovativeness of Lifelink's solution lies in its business model. The value proposition ("safe water" and "safe money") rests upon a network of partners (government, NGOs, banks, and telecom companies) and a revenue model based upon Lifelink's payment system.

BioBooster offers a wastewater treatment solution for the industrial and municipal sectors. It started around 2003 with the PBR (Pressurizes Bacteria Reactor) technology, and shifted in 2006 to the MBR (Membrane Bio-reactor) technology. PBR allowed "industrializing" waste water treatment by packaging the whole waste-water plant in containers. However, it could only provide pre-treatment water quality (that can go to municipal waste water plants), whereas the new MBR technology can clean water to such a standard that it can be recycled in nature or re-used by industry. The system can be used for industrial waste water treatment as well as in municipal sewer systems where it replaces the need for further centralization (connecting small local waste water plants with pipelines to large centralized plants).

Data on these three projects has been collected through interviews with three types of actors: the team of Grundfos New Business, the managers and employees of the three new ventures, and their stakeholders (e.g., customers, users, competitors, technical and commercial partners, relevant policy makers, investors, consultants). Interviews were supplemented with the analysis of internal and external documents that were produced throughout the development of the new ventures (e.g., business plans, internal reports, Powerpoint presentations, press articles).

Section1. Clean-tech innovation: introducing discontinuities in dominant designs and established practices

Discontinuous innovation and dominant designs

To further understand the challenges associated with clean-tech as radical innovation, we build upon two central concepts from technology studies: "dominant design" and "discontinuities" (Anderson and Tushman, 1990; Utterback, 1998). This framework combines technical change with the underlying knowledge and competences that become associated with the design, manufacturing, use and regulation of any technology. Technological advance can be depicted in the following way: an era of ferment, when new technological discontinuities are introduced, is followed by an era of incremental change within a dominant design, until new discontinuities are introduced, for example by disruptive innovations (Christensen and Raynor, 2003).

Dominant design refers to the gradual reduction of variation in models and designs as standards emerge. The dynamics of technological change for products such as typewriters, Tetra-Pack'ings, computers, automobiles, sewer systems, three-bladed wind turbines and smart phones for example demonstrates that innovation becomes more incremental for periods of time, while the knowledge and competencies of users, producers, regulators and scientists become more convergent, deepened and specialized to serve the "needs" of that particular technology. Competition is within the class of dominant designs, and may also include established brands and story-telling. The performance of new technologies is relatively poor and crude when introduced, and realizing the depicted potential of the new technology is not automatic, but an outcome of subsequent investments and learning processes in the incremental phase.

While this may be great to know for the innovator, it is more worrying that technology studies show that there is no guarantee that a "new and better" technology wins. Research shows that it is only known in retrospect which of the alternative designs eventually becomes the dominant design that reduces variation and uncertainty in a product class, and becomes the industry standard difficult to dislodge. The conclusion is that the emergence of dominant designs is an outcome of complementary assets, user interaction, and regulation in a process that is subject to "the social or political dynamics of compromise and accommodation between actors of unequal influence, [and therefore] these standards cannot be known in advance" (Anderson and Tushman, 1990: 617).

However, even if this model points to the role of social and political dynamics, it tends to downplay and black-box the processes associated with "getting social and political dynamics" on the innovators side. Technology and the resources that make it up rarely develop in a linear and predictable manner within a stable social and industrial context. As mentioned above, this report builds upon studies that see resources, qualities, and stakes and their holders as outcomes of the actions of individuals, social movements, organizations, and calculative instruments that work to shape the momentum from eras of ferment that may lead to new dominant designs and trajectories (Callon, 1991; Garud and Rappa, 1994; Akrich et al, 2002; Rao, 2009; Karnøe and Garud, 2012).

Lock-in and the challenge of unlocking existing technological solutions

Mostly, innovation is done to serve an imagined need. Nevertheless, radical innovations cannot be understood as fitting into a vacuum or empty space of a need. It is critical that the innovator explicitly addresses *the already existing designs and solutions* that solve the problem for the user.

We use the concept of lock-in as a way to direct the innovator's attention to the existing solutions, and the "switching cost" (the cost of work) of altering the support for the existing solutions (Callon, 1991; Unruh, 2002). This is useful in order to understand why it is not enough that the innovator offers a technically better product (as the perspective of technological determinism would suggest): that a new mousetrap is better is not sufficient, because there are already mousetraps out there doing a good job in catching mice.

The concept of lock-in addresses the point that markets do not, in a textbook manner, automatically shift to new products. More importantly, the reason for this slow or no switching is that existing designs and solutions must be seen as locked-in by a mix of heterogeneous resources such as technical standards and organizational routines, and supported by interests of entrenched actors and governing societal institutions, associated with a specific economic domain of activity (e.g., producing and consuming electricity and, in the cases we study here, treating waste water; supplying water in Africa, removing ammonia and smell from farms).

Table 1: Sources of lock-in for existing technological systems

Sources of lock-in

Lock-in source	Examples
Technological	Dominant design, standard technological architectures and components, compatibility
Organizational	Routines, training, departmentalization, customer-supplier relations
Industrial	Industry standards, technological inter-relatedness, co-specialized assets
Societal	System socialization, adaptation of preferences and expectations
Institutional	Government policy intervention, legal frameworks, departments/ministries

Source: Unruh (2002)

Table 1 presents the sources for lock-in for existing technological systems (Unruh 2002). It is important to note that the sources of lock-in entail heterogeneous elements. For example "technological" refers to dominant designs and standard technological architectures for components that fit each other. "Organizational" refers to routines of work and management as well as skills and competencies, and "value chain relations to customers and suppliers. While these two lock-in sources may be similar to Michael Porter's (1985) value chain, the three other lock-in sources extend the value chain to include "industrial", '"societal", and "institutional" sources. In this way the lock-in concept adds other layers of embeddedness to the more narrow focus on the economic and technical interfaces in the value chain analysis. "Industrial" refers to industry standards, technological inter-relatedness and co-specialized assets, such as the Intel-chip and the Microsoft software in modern PC's, which for a time dominate the pattern of technological development. "Societal" refers to so-called soft parameters such as socialization and normalization of adapted preferences and future expectations (for example, the normalization of the internal combustion engine). Finally, "institutionalization" refers to how norms, standards, tariffs and subsidies for existing technologies become inscribed in governmental policies and regulations, legal frameworks, and specific competencies and responsibilities of different ministries, such as emissions standards for animal production, or subsidies for fossil fuel.

Lock-in stems from the complex interactions of these many different elements, and it is difficult to un-lock them all in one sweeping move. Lock-in reminds the innovator that markets do not in a text-book manner automatically shift to new products. Rather, it is important for the innovator to understand that the starting point for the new innovation most often is the existing lock-in, and that it is maintained by the interacting heterogeneous elements that tend to preserve and favour the existing solutions in complex, almost self-reinforcing interactions.

Sustainable and clean-tech innovations typically attempt to reduce the disutilities of existing solutions by reducing environmentally damaging emissions and the use of limited natural resources, or improving work conditions, etc. Therefore the challenges for sustainable clean-tech innovation go beyond the lack of science and technologies. Companies that enact concerns and initiate sustainable innovation face the surprising challenge that innovation is not only about making new or improved technologies, but as much about unlocking the lock-in of existing technologies and solutions to user problems.

The difficulty is that they must prove both the innovation's net positive economic effect as well as social and environmental effects outside the lock-in. Unlocking, involves the demonstration of these qualities not only in the business case, but in the concrete practice of potential users and other involved stakeholders. The innovator's work of unlocking displaces existing practices, interests, and revenue streams for individuals, corporations and even state budgets.

Mapping the degree of lock-in

A relevant starting point for managing the innovation journey is to map and assess the degree of lock-in for the existing technological systems or solutions that the clean-tech innovation is replacing. Table 2 gives a brief illustration of this for Infarm, Lifelink and BioBooster. The description is not exhaustive, but provides a few examples of lock-in sources for each case.

Table 2: Lock-in sources and unlocking challenges in the cases of Infarm, LifeLink and BioBooster

	Infarm	Life-Link	BioBooster
Technological (e.g., dominant design)	Manure tank and land area, chemical air cleaning in closed stables	Hand-pump, electrical pump	Centralized sewer and wastewater systems based on long pipelines
Organizational (e.g., routines)	Farmers used to existing solutions	People used to pick up water from river	Wastewater engineers trained in centralization paradigm; pay-back time in decision making routine
Industrial (e.g., co-specialized assets)	Infarm is of low disturbance to existing solutions (farm, tank, land)	Lifelink is of low disturbance to existing solutions (e.g., re-use boreholes)	BioBooster is of high disturbance for the municipal segment (does not fit into the paradigm for wastewater treatment) Lower disturbance for the industry segment (replaces pipelines to municipal system)
Societal (e.g., user preferences)	Existing solutions are "normalized", agriculture emissions are a "hot cause", farmers are in a difficult economic situation	Existing solutions are "normalized" for users, but access to clean water is a "hot cause" for potential donors	Existing solutions are "normalized" for users, wastewater treatment is not a "hot cause"
Institutional (e.g., regulation)	Environmental regulation supports Infarm and other emission reducing systems	"Safe money" is in line with government's fight against corruption, at least officially...	Regulation about the local preservation of water might support BioBooster

If we look at Infarm, and ask if there is some lock-in on existing solutions for manure treatment the answer is "yes – there are several". There is the traditional solution of the "manure tank + land area", and there is chemical air-cleaning in closed stables. In terms of work routines and skills, farmers are used to existing solutions, but in terms of industry standards Infarm is only a minor disturbance to the existing solution. In terms of societal preferences, existing solutions are at the moment "normalized", manure is not a "hot cause", and farmers in difficult economic situation. Existing regulation supports Infarm, but the distribution across several ministries (environment, agriculture) makes concerted action difficult.

For Lifelink there are also alternatives: water from river, hand pumps, electrical pumps. Regarding work routines people are used to pick up water from the river, and simply using a mix of solutions. Lifelink does not disturbing industrial standards of existing water systems, and may re-use boreholes, but it is likely to disturb the so-called water-mafia, which may raise active resistance. Regarding societal preferences, it seems that existing solutions are "normalized"; yet, access to clean water and corruption alleviation are "hot causes" for NGOs and international aid organizations, which are potential donors. With respect to governmental policies, it cannot be assumed that the "safe money" quality of Lifelink will be wholeheartedly supported as corruption is not a problem for all.

Regarding the industrialized wastewater treatment by BioBooster, there is a dominant design in the existing solution with centralized sewer and waste water systems based on long pipelines. Two types of working routines may be a source of lock-in: the first one relates to training (municipal wastewater engineers are trained in the centralization paradigm); the second one relates to investment decision procedures in the industrial segment (the pay-back time for the BioBooster was compared to other investments that increased production efficiency). Regarding industry standards, BioBooster does not fit into the municipal segment paradigm for wastewater treatment, as it replaces pipelines to municipal system; it fits the industry segment better, as they have some experience with local solutions. Regarding societal preferences, the existing solutions are "normalized", and there is only a moderate public "hot cause" to support the technology shift. However, politically new concerns like "preserve water locally" will be inscribed in groundwater regulations from 2015, and this will support BioBooster. Indeed, due to the up-coming water treatment regulation that emphasizes keeping water locally, the discourse is shifting from centralization to decentralization.

The conclusion is that, even if the degree of lock-in varies, all three GNB ventures must challenge existing solutions that are protected by efficiencies in the existing value chain and revenue streams, as well as supported by interests of entrenched actors and institutions.

Unlocking strategies

The innovator must look at a combination of different interacting *factors for unlocking* existing solutions. Clearly, to offer a new technological solution is critical, but in order to claim profit from the business case, it is still required that the innovator acts on the different lock-in sources.

A first step, as explained above, is to map the degree of lock-in and hence to determine how discontinuous the innovation is. The clean-tech entrepreneur must assess novelty and continuity on different dimensions:

- The need for new technology standards,
- The need for new knowledge and skills of the users,
- The need for new infrastructures,
- The need for new societal norms and evaluative criteria,
- The need for new regulations.

In this regard it is useful to think about different *technical strategies for unlocking*: end-of-pipe, continuity or discontinuity[3] (Unruh, 2002). The underlying dimension for this definition is the degree to which the *technical components and their integration in the technological system remain unchanged when adding the new solution*. The end-of-pipe strategy has the least impact on the existing technological system. The continuity strategy changes some components, but leaves as many components and infrastructures as possible unchanged. The discontinuity strategy abandons and replaces central components and infrastructure of the existing technological system.

[3] The strategies continuous versus discontinuous are scale dependent as subsystems within a technological system may be discontinuous while the system's level is continuity (for example, BioBooster may disrupt part of but not replace the whole centralized sewer and wastewater system).

Table 3: Strategies for unlocking the existing technological system

	Infarm	Lifelink	BioBooster
End-of-Pipe	Yes	No	No
Continuity	Yes – but change need for land area and tank roofing	Yes, solar pump, re-use boreholes, and use existing payment system	Yes – for the industry segment
Discontinuity	No	No – not technically	Yes – for the municipal segment

The continuity strategy transforms the systems by taking advantage of existing infrastructures and governance systems, such as when Edison's electrical system re-used existing gas transmission pipelines and meter systems. Discontinuity refers to the abandonment of the existing system.[4] Both strategies can each be associated with radical innovations: for example, Infarm is a continuous (or even end of pipe) and nonetheless radical innovation. Lifelink is technically continuous as it attempts to build upon many technical elements in the existing water supply systems and payment systems for mobile phones. The decentral BioBooster solution is discontinuous in that it disrupts the municipality centralization paradigm with connecting small towns to centralized plants with pipelines; by contrast, it appears as a continuous innovation for the industry segment.

[4] From a lock-in perspective, the radicality of a clean-tech/sustainable innovation can be defined by the number of existing associations that need to be re-worked (cut or transformed) and the number of new associations that need to be built.

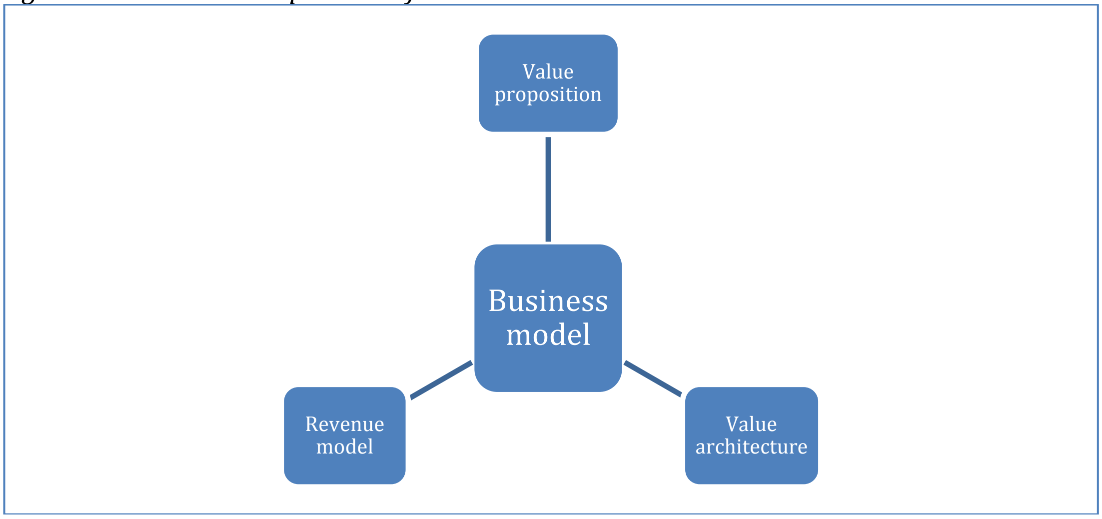
Section 2. New business models and "valuation frames"

Technological and business model innovation

As compared with technology entrepreneurs, clean-tech or social entrepreneurs face a twofold challenge: they have to innovate in technologies and business models as well. If key success factors and caveats for technological innovation are well understood today, much less is known about business model innovation. What does it take to design new business models and put them into practice? What factors should business model innovators pay attention too? Are there any recipes that they can rely on?

A business model can be defined as the combination of three main components: a value proposition, a value architecture, and a revenue model (Doganova and Eyquem-Renault 2009). The first component deals with the following questions: what do customers/users value in the company's offer? How does this offer solve a problem that they encounter, or meet an unsatisfied need? The second component refers to the network of partners and channels which make it possible to actually deliver the value proposition to customers/users. The third component translates the value proposition delivered to customers/users, within in a given architecture, into a steady flow of income that accrues to the innovator (figure 1).

Figure 1: The three components of a business model



The business model concept emphasizes the links between these three components. In particular, the value proposition of a new business model can only be realized within a particular value architecture. We can note this close interdependence between the value proposition and the value architecture of a business model in all three GNB ventures.

Lifelink's value proposition is to provide an affordable, sustainable and corruption-free source of clean water to a set of customers/users from the bottom of the pyramid (BOP). However, water cleanliness and "safe money" (i.e., alleviating corruption) may not be taken into account by consumers who, due to persistent lack of water, have been used to fetching water from the nearby river and seeing collected funds disappear in the pockets of corrupted water committees. Moreover, sustainability is neglected by NGOs who install water pumps in the timeframe of a project without ensuring their maintenance over time. Finally, safe money is not a positive quality for all, because it puts a threat on those who have been profiting from corruption. To ensure that all the claimed product qualities are taken into account when the Lifelink system is assessed (or, in other words, to ensure that Lifelink's value proposition is realized to its full potential), a wide set of heterogeneous actors has to be enrolled: the people who consume the water, but also governmental and non-governmental organizations, donors, consultants, technical partners, investors. One main challenge in recruiting these actors and aligning them into a stabilized value architecture lies in the potential divergence (or even conflict) between their expectations and evaluation routines.

Infarm's value proposition is to provide farmers with a solution that allows them to reduce their ammonia emissions, obtain an environmental permit, expand their farm, and achieve a higher nitrogen yield. Its claimed qualities go beyond the ones according to which emission-reducing systems are generally assessed. Indeed, ammonia emissions are considered as externalities that are to be internalized through the establishment of regulation, which takes the form of an environmental permit. The additional yield-related benefits of an acidification system such as Infarm's may not taken into account in the calculation of its worth, as regulation focuses exclusively on the reduction of ammonia emissions, and farmers tend to view the installation of the system exclusively in terms of compliance with regulation. To realize its value proposition, Infarm claims not only environmental (ammonia emissions reduction) but also economic (achieve a higher nitrogen yield) qualities; this requires building and handling a complex network of actors who often happen to be in conflict: regulatory bodies and NGOs on the one hand, and individual farmers, farmer associations and consultants on the other hand.

BioBooster's original value proposition to the industry segment departed in the existing surcharges for wastewater treatment, which provided a business case for BioBooster's pre-treatment of water before it went to the public waste water system. BioBooster's value proposition to the municipal segment took advantage of structural reforms of municipalities that initially called for more centralization through investments in new pipelines. BioBooster offered a decentralized, flexible, and modularized solution that saved money on expensive pipelines, and expansion of centralized plants not operating below capacity level. To make sure that the claimed qualities become realized for the industry segment, BioBooster did not have to address a complex set of different actors, but was faced with calculative routines for allocating investments among alternatives for increasing efficiency. Even if surcharges were relevant, the investment in BioBooster competed against investments that increased internal production efficiency that had a higher return. However, the new value proposition combines the economic surcharge issue with the sustainability "water foot print" issue. This is seen as an emerging "hot cause" and major global companies like Coke, Nestlé, Carlsberg, etc. cannot deplete large water resources in their production; it is expected that this CSR trend will encourage large retailers to request their suppliers produce in a sustainable manner. This value proposition requires specific handling by the innovator to turn the issue into a stable value architecture. The decentralization value proposition for the municipal segment took advantage of the unexpected water regulation that stated that water must be preserved locally to protect groundwater and water level in small rivers and streams. However, the decentralization proposition requires a paradigm shift and consequently the building of a new value architecture, and BioBooster must work to align a wide range of actors (municipalities, professional associations, research experts, consults, etc.).

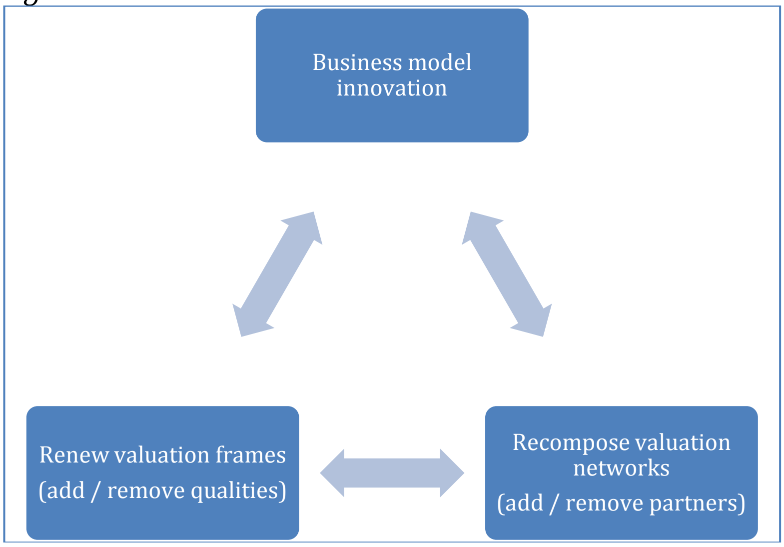
Valuation frames and networks

All three GNB ventures deal with business model innovation. Their value propositions include product qualities that are not necessarily accepted or taken into account. Some of these qualities are economic: they relate to top line growth, or to cost-savings and efficiency improvements that contribute to the bottom line. Others are non-economic: they relate to a product's environmental friendliness, or to the social benefits that it may generate. The challenge that GNB ventures face is the following: How to invent business models that value both the economic and the non-economic qualities of new goods?

Combining and ranking "economic value" and "social values" is not an easy task (Stark 2009). Not only do they have idiosyncratic logics of valuation, but their management has generally been delegated to different actors: economic value falls into the realm of companies and markets, while social values pertain to norms, government, and regulation. This separation left social values and disutilities outside markets, and the boundary was seen as "natural state of markets". Their new combination within novel "sustainable" business models thus requires not only mixing economic and social dimensions in the value proposition, but also adding new types of partners (e.g., government, NGOs, associations) in the value architecture.

To conceive of this twofold challenge in business model innovation, we introduce the notions of "valuation frame" and "valuation network". Our argument is the following (figure 2): adding new qualities (that is, qualities of a product that are currently not taken into account in the calculation of its value) calls for adding new partners (e.g., alliances with user associations, governmental and non-governmental organizations); in other words, renewing *valuation frames* entails recomposing *valuation networks*.

Figure 2: Two dimensions in business model innovation



The notion of "valuation frame" helps to understand how market actors qualify goods and calculate their worth. It refers to the boundary established between the qualities of a product or service that will be taken into account in the calculation of its worth, and those that will be left unconsidered (Callon 1998). This boundary is taken for granted and hardly noticed in everyday economic exchanges, but it becomes visible when "market rebels" (Rao 2009) shed new light on qualities that lie within or beyond it. The mobilization of "concerned groups" (Callon and Rabeharisoa 2008) can reveal "externalities"- that is, qualities external to the dominant valuation frame – and shift the ranking of qualities that induce market participants to take them into account. If these externalities are negative (e.g., when the manufacturing of a product causes pollution), taking them into account reduces the value of goods. If they are positive (e.g., when trading coffee in a "fair" way helps growers to make a decent living), taking them into account increases the value of goods.

Valuation frames are recomposed through the invention of new business models which grant value to qualities that have hitherto been unaccounted for. Promoters of the fair trade business model, for example, succeeded in making consumers care not only about the taste of coffee, but also about the people who grow that coffee; the inclusion of this new quality within the valuation frame justified a higher price. Conversely, the low cost airlines business model experimented with the extent to which travelers care about the possibility to buy a ticket in a physical setting, to choose one's seat, or to have food and drinks for free; it turned out that these qualities could easily be taken out of the valuation frame, to design a service that could be delivered at a significantly reduced price.[5]

Challenging the existence and ranking of qualities in dominant valuation frames is likely to trigger *controversies*. The attempt to include an externality in the valuation frame through which a good is assessed raises (at least) two questions. First, is there a link between the good and the external quality (e.g., does fair trade coffee really

[5] Let us note that most examples of business model innovation are in the consumer markets, while Infarm and BioBooster have addressed industrial markets (Lifelink has moved from consumer to government markets).

improves the living of growers)? Second, is the external quality positive or negative, and for whom? Such controversies can also be observed when entrepreneurs propose radically innovative business models, and valuation frames have to be invented from scratch. That was the case, for example, after Amazon's debut on Wall Street in the 1990's. A sharp controversy between analysts developed over the value of this new venture (Beunza and Garud 2007). The discussions opposed two competing valuation frames, composed of internally consistent categories, analogies and key metrics. One categorized Amazon as an "internet company", compared it to Dell, and measured its value through revenues, while the other categorized Amazon as a "book retailer", compared it to Barnes&Noble, and measured its value through profits. This divergence had crucial practical consequences: the frames that analysts used to assess Amazon led them to value its stock at very different prices.

All three GNB ventures attempted to renew established valuation frames, because their value propositions included qualities that were not necessarily taken into account by the relevant stakeholders. Established valuation frames were too narrow to realize the full potential of Lifelink's value proposition: for example, users did not always care about the cleanliness of water, while NGOs and donor organizations did not always pay attention to the problem of maintenance and the sustainability of water systems. Therefore, it is the valuation frame through which water systems are assessed that Lifelink attempted to renew, in particular through building alliances with new actors. A similar observation can be made for Infarm: interestingly, in this case, it is the "non-economic" quality of the product that was included in the dominant valuation frame (Infarm's system reduces emissions and hence enables farmers to comply with regulation), and the main challenge for the new venture was to include "economic" qualities back into this frame (Infarm's system allows farm expansion and higher nitrogen yield). Here again, the renewal of valuation frames hinged upon the recomposition of valuation networks. Infarm's task was all the more difficult as the "economic" and "environmental" qualities of products in the agriculture market are distributed across different institutions (the ministry of agriculture, for the former, and the ministry of the environment, for the latter) which have their own – and not necessarily overlapping – requirements, regulations and methods of calculation. Finally, for BioBooster, both the industry and municipal segment required a shift of the valuation frame to make sure that "non-economic" qualities like preserving water locally or reducing the water footprint are taken into account when the system is assessed.

Section3. From public issues to market opportunities

Three moments: issues, facts and worth

In order to realize the full value proposition of their business models (which, as mentioned above combine "economic" and "non-economic" qualities), clean-tech entrepreneurs can build on public issues, such as pollution in agriculture (Infarm), access to water (Lifelink) and water footprint (BioBooster). However, the existence of public issues does not mean that there is a market opportunity that the innovator will be able to exploit. Our analysis of the innovation journeys of Lifelink, Infarm and BioBooster highlights three key "moments" in the move from public issues to market opportunities: building issues, constructing facts, and demonstrating worth. Table 4 summarizes the key variables at play in each of these three moments.

Table 4. Key variables in building issues, facts, and worth

	Issues	Facts	Worth
Question	What concerns do product qualities relate to?	Are product qualities backed up with data and measures?	Do users and customers value product qualities?
Examples	Access to water (LL) Ammonia emissions (IF) Water footprint (BB)	How long does a system function without maintenance? (LL) How much acid does a system consume? (IF) How much energy does a system consume? (BB)	Is the product valued for its productivity or regulation-related benefits? (IF) Do users "remember" that the water is clean? (LL) How can costs be decreased? (BB)
Key variables	Do concerned groups exist? How extended and structured are they? To whom do they relate? Does the new venture want to relate to them?	Controversies stemming from uncertainty (science) and collective action (user involvement in the production of data)	Value "maintenance" Cost parameters: calculation methods, incremental R&D

Issues

Issues are similar to the "hot causes" that energize people by arousing their anger or pride (Rao 2009); yet, they are not limited to one particular actor (activists) or to one particular mechanism (emotions). Issues are not of psychological, but of political nature; and they can mobilize a wide range of actors whose definition depends on the issue at stake (e.g., government, user associations, neighbors).

We can identify such issues in all three projects. In the case of Lifelink, the main issue - *access to water* – is able to mobilize actors as diverse as rural communities, local ministries, NGOs, foreign governments and international donor organizations. As the project unfolds, new issues, namely corruption and sustainability, become visible. Their associated concerned groups, however, are much less extended and structured. It then becomes part of the innovator's work not only to identify concerned groups, but also to build and maintain them.

The case of Infarm allows contrasting these two configurations. There are two main issues that Infarm has attempted to deal with: *ammonia emissions* and *smell*. Around the issue of emissions reduction, a clearly identified and firmly structured concerned group is already in place. The only uncertainty here is to identify all of its members (including less obvious actors such as NGOs that watch over the strict application of regulation) and to nurture good relationships (which may be a very complex task, as shown by the example of the farmers' association). By contrast, no concerned group exists for the issue of smell. There are concerned individuals, as those who live or simply pass nearby a farm, but no collective action is organized. Instead, it is up to the innovator to organize collective action, by mobilizing individuals, aligning their interests and grouping them together. Regarding BioBooster, the concern for *preserving water locally* has already been translated into the future market frame by regulations (by some labeled as a "license to operate"). However, regarding the *water footprint* of various food process industries, it seems to be the innovator's challenge to organize collective action around this issue.

Facts

Yet, an issue does not make a market opportunity. Issues need to be transformed into opportunities, and this transformation work involves two other important moments – in the vocabulary adopted here, constructing facts and demonstrating worth. Transforming issues into facts means providing the sometimes vague issues that people care for with a clearly articulated definition and a solid numerical backup. Let us take the sustainability of water systems for example: evidence that the water pumps installed by NGOs on a project basis are not sustainable due to the lack of maintenance exists, but it is scattered around; people seem to "know" that there is such a problem, but there are no solid statistics. In such a situation, any anecdote providing the opposite evidence (and we have heard such anecdotes circulating in Kenya) can come to destabilize the innovator's claim, and the sustainability-related quality of the innovation cannot be firmly translated into a numeric value (e.g., "the Lifelink system appears to be more expensive than other solutions, but when its price is divided by its functioning duration, its average cost per year becomes much lower than that of competing solutions").

In a similar way, the transformation of smell from a public issue into a market opportunity requires measurement and statistical evidence. Nevertheless, the production of numbers is a necessary but not sufficient condition for concerns to become facts. In other words, facts may backfire, and raise new issues. Infarm's experience with the issue of ammonia emissions reduction illustrates this point. The inscription of numbers measuring the benefits (the amount of emissions reduced) and costs (the price that farmers have to pay) of Infarm's system on the Technology list triggered controversies. That was due to three main reasons. The first one has to do with publicity: as the qualities of the product were translated in a single number that could easily circulate across various spaces, new actors were able to get hold of it and contest its validity. The second one has to do with uncertainty: measuring ammonia emissions or smell is a complex process in which different scientific models and experimental protocols (with potentially divergent conclusions) can be used. The third one has to do with collective action: assessing the costs of the system (e.g., acid consumption) requires the cooperation of farmers, who can then take advantage of the intermediary information that they have come to possess, to put forward an alternative calculation that leads to a different final result (e.g., the system is more expensive because it has a higher acid consumption).

For BioBooster's municipal segment, controversies were not strong, but the delayed numeric values on performance parameters from Bjerregrav Test site fostered some initial story-telling about operational problems, which could leak from the focus group to other organizations in the Danish waste water cluster. The focus group members were all positive to BioBooster and had high expectations, but needed numbers to overcome such stories.

Let us emphasize that controversies are not "pathological". They are inescapable and inherent to any innovator's endeavor to challenge established valuation frames. Mobilizing science to produce solid numbers and measures is not necessarily enough to turn concerns into stabilized facts, because science "in action" does not preclude controversies – rather, it is nurtured by them (Latour 1987). Moreover, by embarking on real-scale ("in-vivo") experimentation, and including users in the process of devising or testing ideas for new products and services (von Hippel 2005), open innovation strategies (Chesbrough 2003) simultaneously enable them to intervene in the design of these products and services, and in the calculation of their benefits and costs. Paradoxically, such collaboration comes at the price of potential controversies. Therefore, entrepreneurs should be prepared for handling them – all the more so when technological innovation is combined with business model innovation and uncertainty increases.

Worth

Controversies over the value of goods remind us that establishing facts is not the end of the clean-tech innovation process. The production of numbers can turn facts back into issues, as concerned groups engage in the collection of counter-evidence. But even when the entrepreneur succeeds in cooling contestation and stabilizing a series of facts around the new product or service, a last challenge remains: to demonstrate the product's worth, to transform it into a good that users/customers value.

This challenge was particularly salient in the case of Infarm. As regulation is a key element of Infarm's value proposition (farmers buy the product in order to obtain an environmental permit), attention was focused on enrolling one central actor: government. However, reliance on government as a central partner bears several risks. First, it imposes to the project the slower pace of ministries and the rigid format of regulatory instruments (e.g., the Technology list). Second, it removes resources from managing the product users (farmers) to managing the product "prescribers" (ministries). Third, and may be most importantly, a business model centered on regulation may introduce a conflicting relationship between the new venture and its customers. For example, some farmers viewed the emissions reduction system as a burden imposed by regulation, and not as something valuable (for instance, as a means to achieve higher nitrogen yield). Some even had the impression that Infarm was "double-dealing": pushing for tougher regulation, which farmers resented and resisted, in order to increase sales. This situation created a sense of uneasiness both on the side of the company's employees and of its product users.

In the case of Lifelink, great emphasis has been put on ensuring that the water system is of worth to users and customers. The installation of each system starts with a community mobilization process, as part of which even the price that users are ready to pay for water is put into discussion and jointly agreed upon. Anthropologists have been involved both in mobilizing communities and, in some cases, in follow-up monitoring and evaluation activities after the installation. When the need to distinguish users (villages) from customers (donors) and opt for a semi-commercial business model became clear, a person dedicated to the management of customer organizations and with experience of their specific expectations and procedures was hired. In spite of all these efforts, that the Lifelink system becomes and remains valuable is not guaranteed, especially when it comes to its users. Our on-site observations in user communities have shown indeed that the attachment between villagers and the water system needs to be continuously sustained, because people tend to "forget", for example, that the water is clean and does not need to be boiled, or that it is cheaper, or that a given price has been agreed upon during the community mobilization process, or even that the pump exists.

A key variable when it comes to ensuring that the innovation is of worth for its customers and users relates to the issue of cost. BioBooster illustrates the point that the performance of new technologies is relatively poor and crude when introduced, and realizing the depicted potential of the new technology requires subsequent investments and learning processes in the incremental phase (improvements in disc design to avoid clogging, and, very importantly, reduction of energy consumption to bring down operation costs). Indeed, the system performs much better in 2011 than in 2008 in terms of cost and technical processing of waste. Moreover, the case of BioBooster shows that it is important for the innovator to work from the premise that the calculative process of establishing the cost of a system is not an exact science, but is sensitive to the use of different calculative methods.

A check-list

The three key moments that we have identified in the movement from public issues to market opportunities – issues, facts, and worth – are neither exclusive, nor sequential. As we have mentioned above, controversies may "heat up" a "cold" fact and turn it back into an issue. Moreover, none of the three moments corresponds to a state that a good should reach for a market opportunity to be created. A successful clean-tech/social innovation is one that *at the same time is an issue, of fact, and of worth as well.* It becomes a good with an established valuation frame that allow stakeholders to relate to the good simultaneously in terms of *care* (the emotional activity of praising), of *numbers* (the scientific activity of measuring), and of *economic value* (the calculative activity of pricing).

It is therefore impossible to organize these three moments in a linear sequence that clean-tech/social entrepreneurs should follow. What we propose, instead, is a check-list (figure 3) that can serve as a guide to the entrepreneur throughout the innovation project. When applied in the beginning, the check-list should provide a sense of how radical the project is, that is, which elements are already in place and which ones have to be built from scratch (e.g., do groups concerned by the issue at stake already exist?). When applied at intermediary stages, it should visualize the progress accomplished, and it should keep efforts focused on all three fronts: concerns, facts, and worth (e.g., even if numerical evidence supports the product's benefits, do users and customers view it as valuable?).

Figure 3. A check-list

Concerns	Facts	Worth
☐ Is there an issue?	☐ To what extent is the issue quantified?	☐ What are the qualities of the product?
☐ How visible is it?	☐ Are there measurement standards set?	☐ What are the valuation frames of users / customers?
☐ Who is concerned by it?	☐ What kind of numbers are considered by stakeholders?	☐ How can external qualities be included in the valuation frame?
☐ Are concerned groups organized?	☐ Who produces these numbers?	☐ How are the product's costs calculated?
☐ How extended are they?	☐ How stabilized or controversial are measurement methods and numbers?	☐ Can the value of the product be sustained over time?

Section 4. Stakeholders

Key actors

Building issues, facts and worth is a collective activity in which take part various actors with whom the innovator must establish and maintain collaborations. The analysis of the cases of Lifelink, Infarm and BioBooster allows distinguishing a set of key actors.

Users

Unsurprisingly, users are a key stakeholder to be taken into account. Conceiving of users as a homogeneous group may be misleading, though. Indeed, in all three projects users appear as a multi-layered set of individual "cases" whose expectations and interests may be divergent, or even conflicting.

Lifelink's users, for example, are composed of: the individuals (mainly women) who take water from the system for their own consumption, the water committees which make purchasing decisions and manage the system, the entrepreneurs who take water to resell it further away at a higher price, etc. Infarm's users are all farmers, but they differ as to the animals that they breed and as to the size and prosperity of their farm; they are accompanied by consultants who may formulate varying prescriptions; they are represented by farmer associations who pursue their own objectives and are themselves composed of heterogeneous organizational units (e.g., their directors vs. their R&D teams); they are governed and attended by different ministries (namely, the ministry of environment vs. the ministry of agriculture) who have idiosyncratic missions and procedures. BioBooster's users in the industry segment are composed of people from the specific company, but it is a heterogeneous set as those who use the system, those who pay for it, and those who are concerned by the issue that it addresses are not necessarily grouped in the same person or organizational unit (e.g., production department or CSR department?). Another reason for user heterogeneity is related to site specificity: treating waste water from juice, milk or fish-oil production is not the same process, as BioBooster learnt at its expense. In the municipality segment, the BioBooster user ranges from the mayor (who may want a "green city") to the engineers in the wastewater treatment unit (who may defend the centralization paradigm).

All these examples lead to a key challenge for the innovator. Who are the relevant spokespersons to talk to? What are the representative figures (both in terms of average portraits of users and numbers) to include in the business modeling process? There is no uniform answer to these questions. Their formulation, however, should as a continuous warning to the innovator: ensuring the collaboration of a subset of users does not mean that one "has users on her side".

Governmental organizations

A second type of stakeholders that play a crucial part in clean-tech/social entrepreneurship consists in governmental organizations, which range from local municipalities through national governments to international bodies. There are several ways in which they bear in the innovation process. First, they produce regulation and set standards. This role is particularly salient in the case of Infarm: the environmental permit and the Technology list are established and managed by the Danish government; the European Commission is active in setting environmental standards that directly impact the market of solutions for ammonia emissions reduction in particular. It can also be observed in the case of Lifelink, through the reforms introduced by the Water Act in Kenya and the standards provided by the World Health Organization in regard to the quality of water.

Second, governmental organizations ensure the application of regulation and the everyday management of related systems. Local municipalities, which are in charge of delivering environmental permits to farmers, have an indirect impact on Infarm's sales through the extent of scrutiny with which they examine farmers' applications. In Kenya, water service boards and water companies hold the power to decide upon, and the mandate to manage, water systems.

Third, governmental organizations dispose of funds to foster clean-tech/social innovations and can therefore be an important source of complementary funding and subsidies. This role is particularly salient in the case of Lifelink, which has benefited, more or less directly, from the financial and other support of organizations such as Danida, IFU, the Danish Embassy in Kenya, as well as international donors. It can also be observed in the case of Infarm and BioBooster, where publicly subsidized research projects have been a part of the technological development process.

Non-governmental organizations

The role of non-governmental organizations mirrors the one played by their organizational counterparts. Two types of positioning can be distinguished. First, NGOs may act as an extension of official political action, in particular by supporting the application of regulation. This is the case of the Ecological Council, which has turned out to be an unexpected ally of Infarm by contesting the unjustified delivery of environmental permits for systems that do not achieve the required ammonia emissions reduction.

Second, NGOs may act as a substitute for official political action, by moving into domains that governments have left out of their scope. In this respect, they participate to amplifying and building issues, which they simultaneously attempt to address. From here stems the ambivalence of NGOs' relationship to private clean-tech/social entrepreneurship projects. On the one hand, NGOs may facilitate the entrepreneur's efforts by making visible issues (such as ammonia emissions reduction, in the case of Infarm, or access to water and corruption alleviation, in the case of Lifelink) and increasing public awareness. On the other hand, when NGOs step into the operational management of the solutions addressing these issues, they may turn into potential competitors to the entrepreneur. This is clearly visible for Lifelink, which positions itself precisely as providing a remedy to the sustainability-related drawbacks (due to the lack of maintenance) of water pumps installed as part of projects managed by NGOs.

Moreover, some NGOs position themselves as the missing link between governments and their people. Here, the role of NGOs lies in mobilizing and training communities - which also happen to be the users that clean-tech/social entrepreneurs target. This is certainly most visible for organizations such as the Red Cross which become a crucial mediator between Lifelink and its user communities: it facilitates their encounter (help Lifelink find suitable communities) and maintains their attachment (namely, through training on the importance of clean water, hand washing, etc.). An equivalent to this mediating role does not seem to exist in "developed countries" (in the case of Infarm, we can observe that the Ecological council and farmers' associations might be able to play such a mediating role; however, they confine their intervention to regulation and are not active in mobilizing or training).

Academia

The crucial role of science for innovation has been established in the literature. We can observe, indeed, that in the three GNB projects, collaboration with universities and academic figures has been important for the development of new technologies and business models. What we would like to highlight here is a complementary role of science, which is much less documented: a key mechanism in the chain translating issues, fact and worth. As mentioned above, turning concerns into facts requires the production of numbers (e.g., measures, statistical evidence). Universities intervene here both through the collection of data on a national or international scale and through the setting of measurement standards. Quantification enables valuation to proceed: the benefits and costs of a new product can then be calculated and compared to those of alternative solutions. But numbers also lay themselves open to contestation: a tentatively established fact may thus be turned back into an issue if scientific controversies arise.

Emergent concerned groups

The stakeholders outlined above – users, governmental and non-governmental organizations, academia – have relatively stable identities, functions and interests, as part of which they might come to embrace the issues that clean-tech/social entrepreneurs address. Another (and quite different) type of actors that the entrepreneur has to take into account consists in "emergent concerned groups" (Callon and Rabeharisoa 2008)[6].

There are two types of concerned groups. "Orphan groups" form in situations of lock-in, when actors that are excluded from the market partner together to explore alternative worlds. The examples of Linux (von Krogh and von Hippel 2003) and wind turbines (Karnøe and Garud, 2012) illustrate this notion[7]. "Affected groups" form as a result of overflowing, or externalities, instead of exclusion. A typical example is that of neighbor's associations fighting against local pollution. They might have been a precious ally for the Smellfighter, but Infarm would have had to take part in their very formation, because there were no pre-existing organized collectives.

One can see how complex the task of the innovator may become here: not only does she need to identify the relevant stakeholders, understand their interests and

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[6] "A group is qualified as concerned when its formation is strongly contingent on the existence of issues shared by its members. Initially, there may well have been no particular relations between the members of the still inchoate group. Then, owing to the activities of some of them and to the publicity given to difficulties that first seem to be individual, they gradually move closer to one another as they share their emotions and develop common actions. Provided they become visible and explicit, issues then serve to link up and to bind the members of the group." (Callon and Rabeharisoa 2008, p.243)

[7] The whole idea of a "BOP market" could be envisaged through the lens of orphan groups, because it is defined as a set of potential consumers who are excluded from the consumption of goods that they cannot afford; the difference, though, is that orphan groups form endogenously, while the definition of segments such as "BOP" is imposed from the outside and is not necessarily integrated by those that it is supposed to describe.

seek for their cooperation, but also to build, sometimes from scratch, the groups that will hold a stake in her venture.

Stakeholders' roles in three moments

While the analysis of Lifelink, Infarm and BioBooster's journeys allows us to identify a set of key actors, it also highlights that the identity of these actors, their role and the timing of their intervention in the innovation process are specific to each project and hence cannot be defined in advance. Nevertheless, a list of "usual suspects" and their expected contributions can be sketched and used for the management of future projects – not as a recipe to apply evenly to any case, but rather in the manner of the check-list proposed above. The following table lists the five types of key actors described above and indicates their salient roles in the three moments in the process of transforming issues into market opportunities (the role that appears as most salient is in bold).

Table 5. The role of stakeholders in building issues, facts, and worth

	Issues	Facts	Worth
Users	Express concerns, buy in	Generate data on product's benefits and costs	**Value product's qualities**
Governmental organizations	**	**Establish and enforce regulation and standards**	Reduce the cost of the product for users through subsidies
Non-governmental organizations	**Raise public awareness**	Monitor the application of regulation	Sustain the product's value for users over time
Academia	Contest numbers	**Produce numbers**	**
Emergent concerned groups	**Articulate issues and bring individuals together**	Produce numbers	**

Section 5. The challenge of stabilizing valuation frames and networks

Clean-tech/social innovation challenges established valuation frames. Qualities that have been hitherto considered as external to the valuation frame (the so-called "externalities") are to be taken back into it. Business models that combine "economic value" and "social values" are to be invented. Issues are to be translated into facts and into worth. This process, which transforms public issues into market opportunities, is a collective endeavor: it involves the cooperation of various actors ranging from users, through governmental and non-governmental organizations and academia, to emergent concerned groups. The renewal of valuation frames implies the renewal of valuation networks.

Controversies and the problem of stabilization: a dynamics of framing and overflowing

We have seen that quantification plays a crucial role in clean-tech/social entrepreneurship. For the publicly shared concern about the environmental sustainability of agriculture to become operational in economic terms, ammonia emissions reductions and incurred costs must be translated in the numbers exposed in the tables of the Technology list. In a similar way, the maintenance and health-related benefits of installing Lifelink in Kenyan villages must be backed up with statistical evidence and weighed against the additional financial effort that the water system requires from those who acquire it. For BioBooster the Bjerregrav test-site may provide a measurement system that can make performance on relevant operational parameters of cost and water quality visible to stakeholders, and for the industry segment this is critical for the CSR-parameter and the 'water footprint' to be visible to stakeholders.

But we have also seen that the quantification of cost and worth is a double-edged sword. Even if the innovator "has science on her side", controversies are likely to follow from quantification, because it makes transparent the black box of claims and calculations. Even if a valuation network that realizes the full value of an innovation, taking into account both its economic and social value, has been put into place, attacks might come from unexpected counter-calculations, put forward by users who judge that, to put it simply, they are paying too much (farmer associations in the case of Infarm, donors and their consultants in the case of Lifelink, and competing pay-back times on investments in the industry segment for BioBooster).

The clean-tech/social entrepreneur is thus faced with a major challenge: how to stabilize the valuation frames and networks that she has committed such a great effort to build? How to deal with controversies? How to discipline stakeholders and their competing calculations? How to demonstrate the value of the innovation, and inscribe it into numbers that will be taken for granted, or at least not vociferously contested?

A useful lens to conceive of this dynamics is the concept of framing/overflowing (Callon 1998). Framing is a pre-requisite to economic exchange, because calculations can only be performed if the goods and agents involved in them are framed: "a clear and precise boundary must be drawn between the relations that the agents will take into account and which will serve in their calculations and those which will be thrown out of the calculation as such" (p. 16). However, framing is never complete, because any frame is subject to overflowing. For example, it is through framing its property rights by means of a patent that a company simultaneously discloses its results, which can then be taken up by other companies (be it to copy or to contest them).

It is by framing the benefits and costs of its ammonia emissions reduction system in the Technology list that Infarm lends itself to the contestation of farmers' associations. The same holds for BioBooster and the measurements from Bjerregrav. In the case of Lifelink, the "blackbox" frames the interactions between users and the water system; yet, this is also a source of overflowing: those who do not have a key fob, or find it too difficult to handle, switch back to cash exchange with the pump attendant, and the price of the jerrycan of water escapes from the control of the social entrepreneur.

In their analysis of projects carried out as part of the Wharton Societal Wealth Program, Thompson and MacMillan (2010) refer to such overflowing as "second order effects". They insist that social entrepreneurs should try to anticipate the positive and negative second order effects of the success of their efforts and be alert to their emergence. One example is a project that used modern linear programming from the USA to calculate optimal feed mixes, and sell this high quality, lower cost animal feed in North West Zambia, a region that suffered from huge unemployment and malnutrition after local copper mines shut down. The project's success generated both positive and negative second order effects. The "bonuses" related to the ripple effect of the project on the broader feed market: growth in activity, new entries, and higher quality standards. But as the project expanded, the entrepreneurs were faced with a problem: what to do with the excess production of chicken feathers which could not be recycled? Potential environmental damage is certainly an issue for any production activity, but it becomes crucial for clean-tech/social ventures: if such externalities are not taken into account by the innovator and are then made visible by concerned groups or other stakeholders, the whole value of the new venture, which heavily relies on a social component, may crumble down.

What all these examples show us is that there is no straightforward way to close controversies and to discipline stakeholders and their calculations. Such an attempt may even be dangerous, because it entails the risk to position the innovator as an enemy to her stakeholders, instead of their partner (as it happened it the case of Infarm). Does this mean that there is nothing to do to prepare oneself to navigate in the uncertainties of clean-tech/social innovation? We believe that such a preparation lies in cultivating an open attitude to controversies and in exploring the sources of the unpredictability of stakeholders.

Sources of stakeholders' unpredictability

As shown in the master thesis that Malou Berggreen Jakobsen (2011) devoted to the case of Lifelink, product qualities and stakeholders may shift from an asset to a liability, and vice-versa, depending on the context in which they come to be embedded. The unpredictable behavior of stakeholders is due to the fact that they are not abstract figures endowed with given set of attributes (the ones that stakeholder analysis methods usually retain include: interests, power, influence, etc.), but evolve in idiosyncratic and complex networks. A careful examination of these networks may thus shed light on the potential sources of stakeholders' unpredictability.

Users

Let us consider users. Innovation textbooks advise the entrepreneur to start by identifying "a customer with a compelling reason to buy". However, in the field of clean-tech/social entrepreneurship, the targeted user often does not have a clearly defined "need": she may not share the concern (e.g., sustainability) that the entrepreneur intends to build on, or she may consider it as an externality, i.e. an issue that other actors (e.g., government) should take care of and support financially. We then believe that it may be more relevant to conceive of the user not as an individual who experiences a certain need, but as a network which is embedded in a physical setting and which is composed of a set of actors, technical devices and valuation metrics. This whole network should be mastered if the clean-tech/social innovation is to succeed.

It is in the case of Lifelink that we can observe the most elaborate effort to master the user network. The original payment system provides indeed a solid frame that contains the interactions between the water system, the user, the community, the company and the donors. Yet, as solid as it may be, this frame does not prevent overflowing. Unexpected problems may arise at any node of the network. The Lifelink system is coupled to an existing borehole; but are there enough boreholes that meet the standards that the innovator has chosen to comply with in regard to the quality of water? It is installed on a parcel of land; what if those who own or operate this parcel all of a sudden decide that they have a legitimate right to take water for free? In order to use the water system, villagers need a key fob and a mobile phone; are key fobs supply and mobile connectivity ensured? They also need to keep in mind that water cleanliness is important for health and that the water collected through the Lifelink system is indeed clean; is the visibility of this message maintained over time? The excess money collected through the payment system is supposed to accrue to the community; how is this made clear to both users and donors? All these questions may appear as insignificant operational details, but it is on their answers that hinges the realization of Lifelink's claimed value.

Infarm's user network is no less complex. The benefits of the ammonia emissions reduction system are fully realized when not only the stable, but also the storage tank and the field are taken into account: indeed, it exempts farmers from covering the tank and it allows them to save on nitrogen. Keeping the system's potential risks and operational costs down requires farmers to adopt certain practices which they do not necessarily follow. The valuation frame through which farmers and their consultants assess the benefits and costs of Infarm's system is materialized in the Technology list which only considers certain product qualities (e.g., its format does not make visible the greater nitrogen yield from the slurry applied to the field), along the lines of which it makes the NH4+ acidification system comparable to other ammonia emissions reduction solutions. The results of this comparison, and hence the worth granted to Infarm's product, depend on the valuation frame used, on the practices adopted by farmers, and on the number of farm components (stable, tank, field) considered. All these parameters should therefore be acted upon and monitored throughout the innovation process.

BioBoosters user network also turned out to be more complex than anticipated. The designers expected that the wastewater from users in different industries like dairies, fish-oil, and slaughterhouses were relatively similar. However, the specific materiality of wastewater became a costly surprise, because the biological and chemical differences led to poorer operation and higher costs. Thus, the BioBooster system had to be re-designed and adapted to the situation of the specific user.

Other stakeholders

Another source of users' unpredictability lies in the instability of their spokespersons. As mentioned above, the label "users" covers a multi-layered set of individual cases that the innovator can hardly attend in their singularity. Hence the need to identify relevant representatives: average portraits and numbers that characterize the group, as well as organizations (such as farmers' associations in the example of Infarm) that defend its interests and have the capability to mobilize. However, the relevance of these representatives cannot be taken for granted, and the innovator should carefully examine the ones that she should rely on.

Representativeness is also at stake when it comes to governmental organizations. While ministries are supposed to defend the interests of those whom they represent, other agendas may also influence the attitudes that they are likely to adopt and the decisions that they are likely to make. They are subject to divergent - and potentially conflicting – imperatives, namely because they struggle to meet the demands of different groups of voters. Whether, for example, stricter environmental regulation is pushed forward and enacted thus depends on a number of parameters that reach far beyond the innovation in question. Moreover, the same group of users may be linked to different ministries (e.g., the ministry of environment vs. the ministry of agriculture, in the example of Infarm) that are caught in a dynamics of relationships the politics of which can hardly be mastered by the innovator. Finally, the interests of organizations do not necessarily coincide with those of their members: in the example of Lifelink, the imperative to fight corruption is not necessarily verified on the level of the individuals with which the innovator has to interact. For BioBooster the imperative to preserve water locally is not yet a standard across municipalities and ministries, and some favor local jobs higher than preserving water locally.

As to NGOs, a major source of unpredictability lies in their reputation sensitivity. When faced with clean-tech/social entrepreneurs, NGOs are caught in a dilemma: they tend to share the concerns that the entrepreneur attempts to address (e.g., reducing emissions, improving access to water, alleviating corruption, care for 'preserving water locally'), but they sometimes feel uncomfortable about collaborating with corporations. This issue may certainly sound as an unsolvable problem, which simply adds to the series of incompatibilities between NGOs and companies (relative, for example, to their very different ways of working and time constraints). Nevertheless, we believe that there are means to address it. For example, it indicates that when an established company engages in a clean-tech/social innovation project, it may be more appropriate to spin off the project and create a new venture (a start-up) that is clearly separate. As noted by Malou Berggreen Jakobsen in her thesis, being associated to a large corporation such as Grundfos may be a valuable social resource, but it may also turn from an asset into a liability. Whether the new venture is externalized or kept internal, extreme transparency on the project's accountability, and profits in particular, appears as an important condition to secure the stable enrolment of NGOs.

Finally, let us consider the other two types of stakeholders that have been identified above: academia and emergent concerned groups. While science is often viewed as a machine that delivers objective uncontested truths, which can provide neutral grounds for action, sociologists have shown that controversies are an inherent part of it. Scientists may disagree among themselves, and in addition other stakeholders may contest the truthfulness of scientific results, especially when the production of numbers relies on the cooperation of various actors (e.g., experimentations involving test-farms and farmer associations, in the case of Infarm; statistical evidence on the indirect impact of clean water sources, in the case of Lifelink; for BioBooster statistical evidence is critical but we did not have access to the data-sets from Bjerregrav). As to emergent concerned groups, they are unpredictable by definition, because they do not possess pre-given identity and interests, but form in response to the issues constructed or amplified by the innovator.

Mismatch between valuation frames

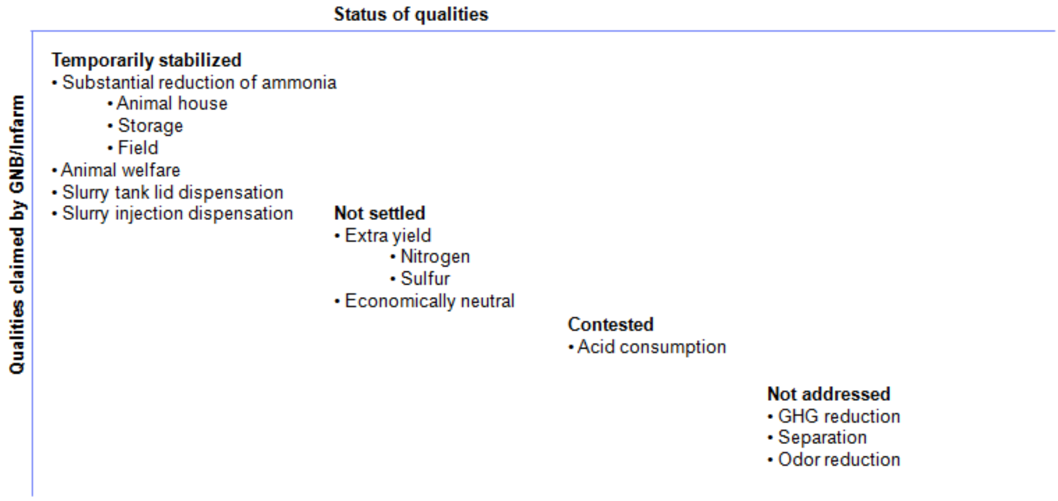
One that is likely to cause overflows, and which is relevant for all types of stakeholders, is the potential mismatch between the valuation frame imposed by the innovation and the one adopted by its stakeholders. Two forms of mismatch can be observed. In the first configuration, the valuation frame of the innovation encompasses the frames of several stakeholders. For example, Infarm's system combines two qualities (emissions reduction and yield increase) that are taken care of by two different stakeholders (ministry of environment and ministry of agriculture). As a consequence, none of these stakeholders can realize the full value of the innovation. This configuration is typical for clean-tech/social entrepreneurship, whose very specificity is to propose business models that integrate economic value and social values which, as we mentioned above, have typically been distributed across different actors.

In the second configuration, the initial valuation frame of the innovation turns out to be too narrow. For example, as Lifelink's system is implemented in practice and encounters an increasing number of actors and their own valuation frames, unexpected qualities start to emerge: what was initially thought of as a source of clean water turns out to be an instrument to fight corruption; is interpreted as a means to address gender issues; is linked to the problem of sanitation. The emergence of these new values comes as a pleasant surprise to the innovator, who can then include them in her marketing discourse to enroll new partners. But it also entails costs, because realizing some of these values in practice may require further technical development (e.g., make it possible to have several water points).

Degrees of stabilization of product qualities

One major consequence of stakeholders' unpredictability is the varying degree of stabilization of the product's qualities. Depending on the point in time and on the alliances, some of the qualities claimed by the innovator will be more or less agreed upon or, on the contrary, contested by stakeholders. The status od product quality should therefore be monitored on a regular basis. Figure 4 illustrates the monitoring tool proposed in the master thesis that Zeinab Al-Asfoor and Roman Graber (2011) devoted to the case of Infarm. It lists all the qualities claimed by the innovator for a given product, and groups them in four categories according to their degree of stabilization: temporarily stabilized, not settled, contested, and not addressed.

Figure 4: A tool for monitoring the degree of stabilization of product qualities



Source: Al-Asfoor and Graber (2011)

Given the high uncertainty inherent to the process of radical innovation, the difficulty to combine "economic" and "social" values in one business model, and the varying sources of stakeholders' unpredictability, the degree of stabilization of product qualities should be continuously put into discussion. The main value of the mapping tool presented here does not lie in the accuracy of its representation, but in the collective discussion that it is able to instrument. It will be most useful when leveraged in "forums" (such as the focus groups implemented by BioBooster) involving representatives of different stakeholders.

Section 6. Recommendations

Strategies

Continuity vs. discontinuity

Clean-tech products face the challenge of unlocking established solutions. The innovator may choose from a set of unlocking strategies which differ in their degree of continuity and have specific requirements in terms of alliances. On one extreme lies the strategy of continuity: the new product is inserted into an existing value chain, without challenging the dominant technological design and valuation frame. This requires building alliances with the holders of complementary assets. On the other extreme lies the strategy of discontinuity: the new product sketches a new value chain, and contests the dominant technological designs and valuation frames. Making alliances with the holders of complementary assets may not make any sense then, because their assets may no longer be complementary in the new value chain. Instead, the innovator's allies may turn out to be on the side of "market rebels" (Rao 2009). The choice of strategy (in terms of continuity vs. discontinuity) depends on a number of factors, including the degree of lock-in, the need for complementary assets, and the strength of the issue that mobilizes market rebels. However, in these innovation journeys there is no simple formula that makes issues and allies behave in a predictable manner.

Key stakeholders

Clean-tech/social entrepreneurship involves a process of transforming public issues into market opportunities. This process requires the enrolment of various stakeholders: users, policy makers, NGOs, academia, as well as other concerned groups whose composition is specific to the issue being addressed (e.g., farmers' neighbors). While all these actors are likely to play a part in the innovation process, their importance varies with the type of strategy chosen by the entrepreneurs. Three types of strategies, which we propose to label *regulation*, *sponsorship* and *awareness*, are presented in the following table.

Table 6: Three types of strategies

	Key actors	Key moments	Key challenges
Regulation	National governments	Facts	- Value proposition - Controversies over numbers
Sponsorship	- NGOs - International governmental organizations	Issues	- Value architecture - Controversies over intents
Awareness	Consumers	Worth	- Revenue model - Competing signs of value

These strategies differ by the types of stakeholders on which they tend to focus. The choice of key stakeholders has consequences as to the moments (building issues, constructing facts, demonstrating worth) that will be most crucial for the success of the strategy, to the devices through which calculations of value will be performed, and to the main challenges that the entrepreneurs will be likely to face.

The central moment within a regulation-based strategy is the construction of facts: backing product qualities with measures and statistical evidence, which will be codified in standards (such as the Technology list in the case of Infarm, and, for BioBooster, the standards for preserving water locally that will appear in 2015). The key challenge that such a strategy raises is twofold: handling the controversies that measures and numbers might trigger, and ensuring that the business model's value proposition is not reduced to a constraint imposed by regulation (a burden of which customers will be willing to get rid).

In a sponsorship-based strategy, the entrepreneurs attempt to enroll non-governmental and international organizations by acting upon their concerns. The match between the product's qualities and the sponsors' concerns is of great importance here, and hence mission statements and procurement guidelines become a key device (as in the case of Lifelink). The controversies that entrepreneurs have to deal with then bear over intents, rather than over numbers: how to make sure, and make clear, that the company is not making profit "on the expense of" the products' users? Another challenge raised by a sponsorship-based strategy is the complexity of the value architecture that has to be put in place.

A third type of strategy attempts to raise the awareness of end users and consumers (as in the case of BioBooster's approach to municipalities and industry users). A key moment here is the demonstration of the worth of the product. As in the example of fair trade coffee, a higher price may be compensated by the consideration of a quality (e.g., the producers' living and working conditions) that had hitherto remained outside the valuation frame. Signage (e.g., a logo) maintains the visibility of this newly valued quality. The key challenge raised by an awareness-based strategy stems from its revenue model: how to ensure that consumers continue to value these additional qualities and to be ready to pay a higher price?

Processes

Tools for business model innovation

Clean-tech/social entrepreneurship implies technological innovation and business model innovation as well. While the uncertainty inherent to business model innovation is higher, its processes and tools are much less understood. In a recent paper, Henry Chesbrough (2010) puts forward three distinctive characteristics of business model innovation which are worth recalling here: mapping, experimentation, and effectuation. A first tool for trying out new business models is that of *mapping*: construct maps of the envisaged business models to explicate their underlying processes and to make simulations. But mapping is not enough: business model innovation requires an organizational process of *experimentation*. When designing experiments with new business models, notes Chesbrough, entrepreneurs should find a balance between the fidelity of the experiment (the extent to which the experimental conditions are representative of the larger market) and its cost, and they should be careful about distinguishing "failures" from "mistakes" (the former occur when the hoped-for outcome is not achieved, while latter occur when an experiment is poorly designed and does not yield any learning). The process of business model innovation pertains to *effectuation*: rather than analyzing the environment as if it was pre-given, entrepreneurs take actions that generate learning and enact new opportunities.

In-vivo experimentation

Such an experimental approach is appropriate for innovation processes with uncertainties regarding the working of the technical design as well as the working of user needs. Indeed, all three cases show that "the user" is highly varying (site-specific physical network of farmers and their manure, of wastewater in different industries, and in public sewer-waste water systems) and rather unpredictable (as illustrated by the episode with the priest diverting the Lifelink system installed in a Kenyan community).

Coming to know more about the user than the assumptions of the design team puts in-vivo experimentation into a prominent role in the innovation process. *In-vivo experimentation extends the confined in-vitro lab experiments to the "outside" real life and real scale practices of those associated with the new innovation* (Callon and Muniesa, 2007)*.* In-vivo experimentation activates learning by allowing testing the innovator's assumptions and hypotheses against the users' real scale experience. Bringing the new technology in real scale situations of use and market assessment is crucial, because it is most likely that the innovation cannot build upon the existing technical infrastructure, user skills and valuation frames (in terms of price as well as accepted disutilities). Further, experimentation is not limited to economic actors, but involves a large number of heterogeneous agents, including industry associations, scientists from many disciplines, politicians, NGOs, activists, and other concerned groups.

The central point is that the unknown unknowns cannot be known in advance, and the knowledge about the working and acceptance of the technological solution only emerges through the very *in-vitro and in-vivo experimental actions* associated with bringing the new sustainable innovation into being. This implies extending the lab to include more stakeholders in order to "finish" the technology. The notion of experimentation suggests that there are only outcomes of the actions, and that failures are not pathological. The learning from outcomes may require new evaluation criteria. GNB's approach to learning – which is already present in their tools – may thus need to be extended.

Gain for the innovator - Managing innovation journeys with informed unpredictability

This report has argued that a central part of the innovation management work for sustainable innovation is to unlock existing solutions and to overcome set-backs in the technical design work, attempts to destroy the new products, and unpredictable moves by stakeholders. It is in this context that the innovator must assemble new economic worth by getting disutilities accepted as legitimate qualities of the product, finding methods for demonstrating and calculating its worth, and developing new knowledge and practices (routines) of use, regulation and evaluation.

In short, to claim the economic profit of a clean-tech innovation is basically an outcome of struggles to change valuation frames and transform valuation networks. This requires a management appraoch that combines a systemic view of the different elements in a business model with a non-linear attitude to how the elements become assembled. We label this approach "managing innovation journeys with informed unpredictability". It rests on the idea that while initial innovation requires design work and learning in the internal lab, it is only by extending the internal lab that the innovator enters a process of experimental inquiry that facilitates the development of knowledge about varying users and emergent issues. While business planning rests upon data and assumptions, it is only through action that the entrepreneur can be informed about the reality she intervenes in: *Informed means being able to act upon issues as they are articulated in innovation journeys even if they are unpredictable and the response is to be crafted.*

It should be emphasized that the three key moments of the innovation process that we have identified in the move from public issues to market opportunities – concerns, facts, and worth – are neither exclusive, nor sequential. As we have mentioned above, controversies may “heat up” a “cold” fact and turn it back into an issue. Moreover, none of the three moments corresponds to a state that a good should reach for a market opportunity to be created. A successful clean-tech/social innovation is one that combines issues, facts, and worth as well.

We have pointed at the complex task of the innovator to assemble worth for sustainable innovations. Not only does she need to identify the relevant stakeholders, understand their interests and seek for their cooperation, but also to build, sometimes from scratch, the groups that will hold a stake in her venture. To associate “stakes” and “holders” in re-composed valuation networks is critical to construct a willingness to pay.

While assumptions of managerial control often are based upon linearity and predictable sequences, we stress the importance to abandon the idea explicitly. It is better for management to be prepared for uncertainty and unpredictability, rather than expecting linear processes and be surprised if the journey unfolds otherwise. What we propose for management, instead, is preparing to be in control/not-in-control at the same time by accepting the uncertainty and unpredictability of the innovation journey. *We suggest that such a basic preparation for managing non-linear processes is combined with mundane check-lists (management tools) to be worked with.* The dimensions articulated in the checklist stimulate ongoing real-time mapping, discussions and reflections that raise awareness and can inform management earlier during the unpredictable innovation journey. Successful innovation journeys is an outcome of early addressing and temporarily reducing unpredictability of design, actions and responses in the valuation network, while accepting that new issues, overflows and controversies will be fostered by the very attempt to stabilize the association of stakes and holders.

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