4-16-2011

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Abstract
Sustainability needs to be tightly woven into the thinking of every senior executive if we are to develop a sustainable society. Furthermore, those companies seek to gain from meeting the needs of such a society need to forefront sustainability in all of their planning and product development. With this in mind, we have taken the business model generation canvas and developed a layer to stimulate Energy Informatics thinking. Business model generation is a technique to capture the essential features of an organization's business. It addresses such issues as value proposition, sources of costs and revenues, partnerships, and customers in a concise and graphical manner. Osterwalder and Pigneur's book has quickly become an international best seller because the technique is powerful and collectively engaging. We have taken the business model generation canvas and created a group collaborative version on Cacoo, which is web-based software for creating diagrams collaboratively. One of the features of Cacoo is the ability to create layers, so we have augmented our initial two-layer model of a blank canvas and key questions, with a layer containing questions to provoke Energy Informatics thinking and a layer containing examples of the application of Energy Informatics. Our goal is to use the workshop to discuss the content of each of these layers. Specifically, we would like participants to address the following questions: Do we have good questions for each segment of the canvas? Should there be several canvases for different audiences? What are some good Energy Informatics examples to stimulate thinking? The resulting canvas will be made publicly available to advance the development of Green IS.

Keywords: Energy Informatics, Business Model Generation, Framework, Sustainability

Introduction

The global climate is changing; temperature and sea levels are rising, glaciers are retreating, occurrences of extreme weather events are increasing, and the scientifically recognized culprit is human-induced emissions of heat-trapping gases (Karl, Melillo, & Peterson, 2009). In 2009, the U.S. Department of Defense classified global warming as a national security threat due to the prospect of dealing with the effects of violent storms, drought, mass migration, and pandemics (Broder, 2009), not to mention America's heavy dependence on foreign energy sources. For example, the U.S. imported 51 percent of the oil it consumed in 2009 (Energy Information Administration, 2009). It is clear that we cannot continue to live as we do now. It is our responsibility, as a society, to learn to live and conduct our lives in a sustainable manner for the sake of humanity. What does this mean for business? Sir Richard Branson puts it best, "Business is the force of change. Business is essential to solving the climate crisis, because this is what business is best at: innovating, changing, addressing risks, searching for opportunities. There is no more vital task." Through the study of Energy Informatics (Watson, Boudreau, & Chen, 2010), which focuses on analyzing, designing, and implementing systems to increase the efficiency of energy demand and supply systems, and through the application of business modeling (Osterwalder & Pigneur, 2010), our goal is to provide business leaders with an energy efficiency oriented framework to allow them to become a force for transforming their organizations into sustainable enterprises.

Energy Informatics

To understand the Energy Informatics concept as it relates to organizations, it is important to first understand the premise the concept is based on:

$$Energy + Information < Energy$$

The idea is simple and can easily be applied to other resources. To show the linkage between the concept and information systems, we have included the Energy Informatics Framework (Figure 1). The framework incorporates the following three energy system technologies as defined by Watson, Boudreau et al. (2010):

- *Sensor network*: A set of spatially distributed devices that reports the status of a flow network.
- *Flow network*: A movement of continuous matter (e.g., electricity, oil, air, and water) or discrete objects (e.g., cars, packages, containers, people) through a set of connected components (e.g., an electricity grid or a road system).
- *Sensitized object*: A physical good that can sense and report data about its usage and whose status may be controlled remotely.
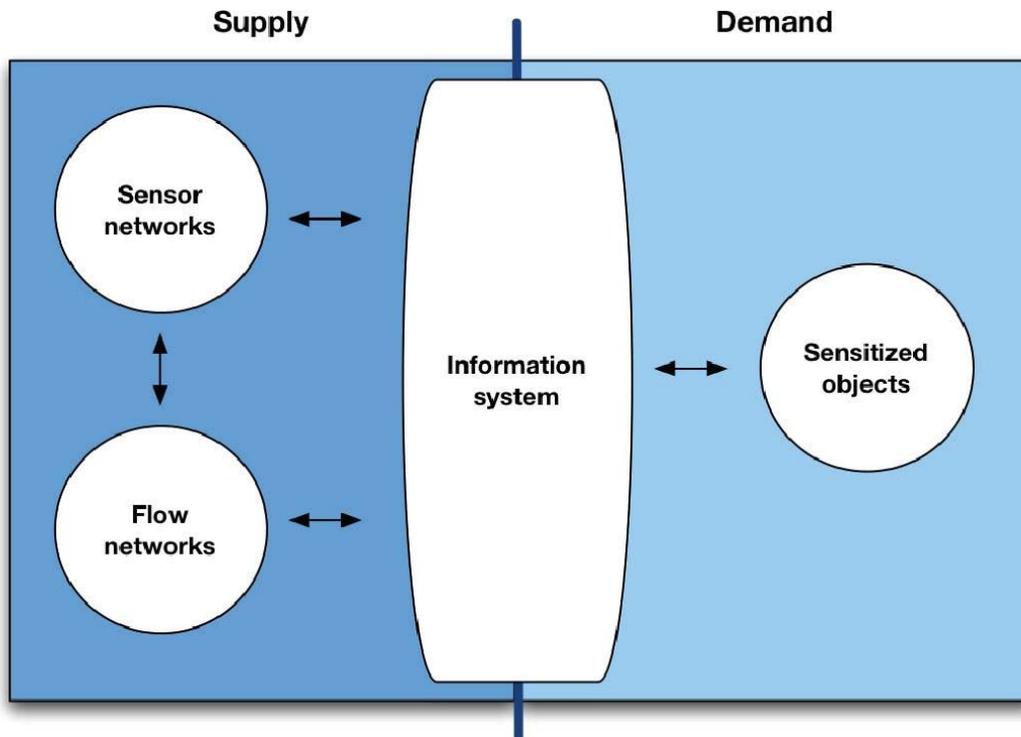
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Figure 1. Energy Informatics Framework (Richard T. Watson, et al., 2010)
An information system integrates the three energy system technologies to create a complete solution while accounting for the interdependencies between supply and demand. The goal of Energy Informatics is to reduce energy consumption through the use of information systems with the intent to advance ecological sustainability.

Business Model Generation

Before business leaders can begin the journey of transforming their organizations into sustainable enterprises, it is essential that they understand the fundamentals of their current business. A business with an unclear strategy or a poorly communicated model of how it creates value needs to first make explicit its business model, so it has a firm foundation for moving towards sustainability and sharing its plan for a new future. "Business models are at heart, stories that explain how enterprises work. Like a good story, a robust business model contains precisely delineated characters, plausible motivations, and a plot that turns on an insight about value" (Magretta, 2002). Utilizing Osterwalder & Pigneur's business model canvas, an organization can be modeled using building blocks as represented in Figure 2.

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Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
Who are our Key Partners? Who are our key suppliers? Which Key Resources are we acquiring from partners? Which Key Activities do partners perform?	What Key Activities do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue streams?	What value do we deliver to the customer? Which one of our customer's problems are we helping to solve? What bundles of products and services are we offering to each Customer Segment? Which customer needs are we satisfying?	What type of relationship does each of our Customer Segments expect us to establish and maintain with them? Which ones have we established? How are they integrated with the rest of our business model? How costly are they?	For whom are we creating value? Who are our most important customers?
	Key Resources What Key Resources do our Value Propositions require? Our Distribution Channels? Customer Relationships? Revenue Streams?		**Channels** Through which Channels do our Customer Segments want to be reached? How are we reaching them now? How are our Channels integrated? Which ones work best? Which ones are most cost-efficient? How are we integrating them with customer routines?	

Cost Structure	Revenue Streams
What are the most important costs inherent in our business model? Which Key Resources are most expensive? Which Key Activities are most expensive?	For what value are our customers really willing to pay? For what do they currently pay? How are they currently paying? How would they prefer to pay? How much does each Revenue Stream contribute to overall revenues?

Figure 2. Business Model Canvas[1] (Osterwalder & Pigneur, 2010).

Within each block, business leaders need to answer a series of questions about the organization to identify how it creates, delivers, and captures value (Osterwalder & Pigneur, 2010). These questions can be viewed in Figure 2.

Think of a business model as a blueprint for understanding how an organization creates value. Once this is understood, business leaders can apply the Energy Informatics framework to their model and begin creating ecological sustainable business value.

Energy Informatics Layer

We have developed an Energy Informatics layer (Figure 3) to supplement the business model canvas, with the intent of helping business leaders recognize potential opportunities for reducing energy consumption. The Energy Informatics layer is composed of the same building blocks as Osterwalder & Pigneur's business model, but contains generalized, non-industry specific questions that can be used to assess current capabilities and to gain a better understanding of how the Energy Informatics framework can be leveraged within an organization. These questions look at both external and internal aspects. Once this is understood, business leaders can incorporate

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[1] This canvas can be viewed using Cacoo, an online drawing tool, and can be downloaded and modified online at http://tinyurl.com/EI-BModel

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the generated ideas into the overall organizational strategy and begin the process of creating ecological sustainable business value.

Key Partners	Key Activities	Value Propositions	Customer Relationships	Customer Segments
Which business units need to be involved? Who are the championing executives? Who are key suppliers? Who are key customers?	How will data be collected? How will data be analyzed? Who is empowered to make changes related to energy efficiency?	How do we reduce energy consumption in our organization? How do we reduce energy consumption for our customers? How do we reduce energy consumption in our supply chain?	How will increasing ecological sustainability affect customer relationships?	Who are our high energy users? Which products require more energy to produce? Which processes use more energy? Which business units require more energy?
	Key Resources What skills do we currently have? What skills do we need to acquire? Do we have sensor network design and implementation capabilities? Do we have personnel with expertise in mathematical optimization?		**Channels** How will we cooperate to jointly reduce energy use with channel partners? How will awareness of energy-related initiatives be communicated to customers? How will awareness of energy-related initiatives be communicated to suppliers?	

Cost Structure	Revenue Streams
What investments will need to be made?	How much can we save through reduction in energy consumption? How much can we increase revenue through the marketing of greener products or services?

Figure 3. Energy Informatics Business Model Canvas[2]

Questions

The following sections will go into detail regarding the specific Energy Informatics questions we have developed for each of Osterwalder & Pigneur's building blocks. This is our initial set of questions and we expect to elaborate them based on the basis of experience gained from application and insights from our colleagues.

Customer Segments

The customer segment questions are designed to help an organization understand where and how it is using energy in relation to its customers and the products and services they buy. This should be viewed from a business unit perspective down to the specific parts of individual processes. This will allow an organization to identify areas of concern and opportunities for improvement. As a result, we arrived at the following questions:

- Who are our high energy users?
- Which products require more energy to produce?
- Which processes use more energy?
- Which business units require more energy?

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[2] This canvas can be viewed using Cacoo, an online drawing tool, and can be downloaded and modified online at http://tinyurl.com/EI-BModel.

Value Propositions

The value proposition questions assist an organization in understanding how it will reduce energy consumption. Once an organization understands the segments where energy curtailment opportunities exist, its business leaders need to develop proposals to reduce energy use. It is critical to understand both the explicit and implicit value that will be derived from reducing the current energy consumption before changes are made. The pertinent questions are:

- How do we reduce energy consumption in our organization?
- How do we reduce energy consumption for our customers?
- How do we reduce energy consumption in our supply chain?

Channels

The channel questions help an organization think through the process of gaining support and enhancing awareness of Energy Informatics related initiatives. After the value propositions are fully understood, business leaders need to plan how they will gain support for approval of their initiatives. In addition, they need to consider how they will communicate their initiatives to the organization, customers and suppliers. The key questions are:

- How will we cooperate to jointly reduce energy use with channel partners?
- How will awareness of energy-related initiatives be communicated to customers?
- How will awareness of energy-related initiatives be communicated to suppliers?

Customer Relationships

The customer relationship question stimulates an organization to think through the potential advantages and disadvantages related to becoming more ecologically sustainable. How will customers react as the firm becomes more sustainable? What premium will customers pay, if any, for sustainable products? A critical issue is:

- How will increasing ecological sustainability affect customer relationships?

Revenue Streams

The revenue stream questions guide an organization in understanding how revenue can be enhanced through ecological sustainability. These questions will allow an organization to investigate potential revenue streams that can be exploited through a reduction in energy consumption. Some important questions are:

- How much can we save through reduction in energy consumption?
- How much can we increase revenue through the marketing of greener products or services?

Key Resources

The key resource questions help organizations assess their current capabilities with regards to personnel skills and network capabilities. This assessment is necessary to

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understand what can be accomplished with current resources and what resources are lacking within an organization. Significant assessment questions include:

- What skills do we currently have?
- What skills do we need to acquire?
- Do we have sensor network design and implementation capabilities?
- Do we have personnel with expertise in mathematical optimization?

Key Activities

The key activity questions address some of the important actions that will be necessary for successful Energy Informatics related projects. These questions concern how data related to reducing energy will be collected; this can be through sensor networks or with existing systems. When firms collect large volumes of data, it will also be necessary to have resources to effectively and efficiently analyze this data. As well as the capacity for business analytics, the firm also needs to, empower personnel to make decisions based on the results of the analysis. Relevant issues are:

- How will data be collected?
- How will data be analyzed?
- Who is empowered to make changes related to energy efficiency?

Key Partners

The key partner questions enable an organization to understand who needs to be engaged for project success. These questions will help business leaders make sure the necessary groups or individuals are involved and fully understand the intent of the energy-related projects. It is also important to understand the support each of these groups or individuals is willing to provide. Important questions include:

- Which business units need to be involved?
- Who are the championing executives?
- Who are key suppliers?
- Who are key customers?

Cost Structure

The cost structure question focuses on evaluating potential investments that will need to be made. These investments can include training of existing personnel, hiring of new employees, and technology-related investments. The relevant question is:

- What investments will need to be made?

Industry Application

By incorporating the energy informatics framework and the idea of reducing energy into its business model, an organization can realize environmental and financial benefits. To illustrate this point, we provide examples of benefits UPS has received from incorporating Energy Informatics into its business model. The following benefits are from a telematics project at UPS (Watson, Boudreau, Li, & Levis, 2010):

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- Reduction in fuel consumption through optimization of routes and minimization of idling times.
- Reduction in replacement parts by switching from a condition-based maintenance plan to a schedule-based plan.
- Increased information to enhance the ability of mechanics to fix vehicles and better predict when equipment needs to be serviced, which decreases the likelihood of replacing the wrong part or equipment breaking down while in service.
- Increased safety through monitoring of driving habits. This includes speed, direction, seat belt usage, and locking of compartments.

While these benefits are specific to UPS and the transportation industry, it should be clear that significant gains can be obtained by incorporating Energy Informatics into an organization's business model.

Action Steps for Business Leaders

Executives interested in applying Energy Informatics thinking in their enterprise need to consider the following steps:

1. Demonstrate understanding of your organization's current business model by populating the blocks in Osterwalder & Pigneur's business model canvas.

2. Use the Energy Informatics questions to explore potential opportunities within your current business model.

3. Gain support and create awareness with regards to Energy Informatics initiatives within the organization and with key partners.

4. Become a force for transforming your organization and its supply chain into a sustainable set of enterprises.

Conclusion

Frameworks are highly useful for managers (Argyres & McGahan, 2002), and we have merged a business planning framework (Osterwalder & Pigneur, 2010) with one for Energy Informatics (Richard T. Watson, et al., 2010) to provide a stimulus for organizations to plan systematically and comprehensively for energy reduction. This is, however, the beginning of our efforts in this area. The initial set of questions to provoke thinking need the refinement and polishing that comes from the rough and tumble of application to critical problems. We need also to document a set of case studies to accompany each cell of the framework. As we frequently learn by modeling the behavior of others (Bandura, 1977), we need at least one case in each cell to support such learning.

Building a sustainable society is the challenge of this century, and enterprises will need considerable help in reconfiguring themselves to meet civilization's summons for

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sustainability. The first step is for each business to understand its current configuration and then use this as a launching pad for reinvention. The intent of this contribution is to provide some intellectual energy for such a launch by providing organizations with a framework for energy reduction.

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