Green Business Model Innovation in Symbiosis Business Value Networks: Bridging Green Business Model Innovation to Different Green Symbiosis Business Value Networks with Future Wireless Technologies

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Abstract

Societies all over the globe push to greening businesses and their business models on all Green Business Model Parameters. However, they are challenged to find efficiency in green business models innovation and to jump to the next step of "the Green Wall" – greening their businesses.

There is therefore a growing interest to investigate Green Business Model Innovation (GBMI) in Symbiosis Business Value Networks. The profitability and achievement of other values seems in Green Symbiosis Business Value Networks (GSBVN) to be much higher than classical GBMI isolated to single business model innovation. In this context the GSBVN seems to be a promising initiative and new strategic way to go – to increase transformation of business models into green business models. The GSBVNs seem by nature to be built for greening our society and business operations.

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Our hypothesis is that GSBVN could potentially achieve better results and effects on "the triple bottom line"combined with future wireless technologies and advanced sensor technologies. As 5G and beyond technologies offer better network solutions "the Green Wall"challenges can be overcome because sensoring, measurement, calculations and monitoring the green business models and GBMI in the terms of monetary and nonmonetary values can be performed in much more detail, in real-time and for the entire lifetime of all the GSBVN business models. Fundamentally, security, strong network constructions and trust are core to GSBVNs growth. Embedding Future Wireless Networks (FWNs) and advanced sensor technologies seems to be able to make this become even easier, and a promising way to achieve the green business model goals of the GSBVNs and the surrounding society.

There is lack of studies regarding the potential and initiatives of GBMI in GSBVN. This paper tries to fill some part of this gap by presenting some initial studies on (i) How can green business model innovation in symbiosis be defined? and (ii) How can Future Wireless Technologies support and value the innovation and evolvement of Green Business Models in Symbiosis Business Value Networks.

The paper seeks to unwrap different GSBVNs' approaches, origins, and views. The paper ends up with discussing the role future wireless technologies can play in designing, reconfiguring, developing and operating GSBVNs.

Keywords: Green symbiosis business value networks, green business models, green business model innovation approach, green business model technologies, future wireless technology, advanced sensor technologies.

1 Introduction – What is Green Business Symbiosis Value Networks?

"No business model is an island" [1] – neither is a green business or a local business community that aim at a green economy. In this context, an increasing focus has been on Symbiosis Business Networks, Helix Networks [2–4] and latest Symbiosis Business Value Networks [5, 6] that focus on becoming green – Green Symbiosis Business Value Networks (GSBVNs). The potential contribution of Industrial Symbiosis Networks (ISN) [7] in fostering environmental innovation – Green Business Model Innovation (GBMI) – at the local, regional, and even global level, seems to be very high

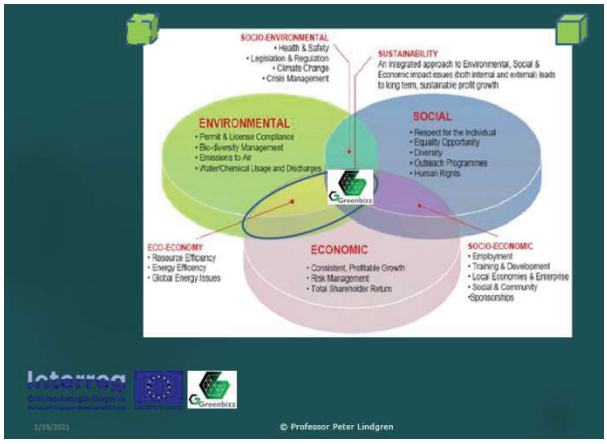

Figure 1 The environmental, economic and social dimension related to TO BE and AS IS green business models [11].

and promising. Drawing on literature from innovation studies and innovation in spatial proximity, we outline three factors that are important for the GBMI process and identify where the effects from GSBVN can be explored. The research was based on primary case studies at Sotenäs Symbiosis Network (SSN), Sweden [8, 9] and Greenlab in Skive, Denmark [10] to provide primary examples of effects and impacts of Green Business Models (GBM) and GBMI in GSBVNs. The implications of this inquiry are discussed in terms of design, reconfiguration, and development [11] of GSBVNs and links further to research into the GBMI effects and challenges of these GSBVNs on the GBM parameters.

The green wall [11] refers to an upper limit to going green. Green here pertains to the concept of GBM's. The term *green* is often interchangeably used as sustainable [12, 13] and circular [14, 23]; however we propose it can be somewhat different and part of sustainable and circular as shown in the Figure 1.

This means that sustainable and circular BMs could sometimes not be equal to GBMs. According to Čekanavičius, Bazytė and Dičmonaitė [7], a Green Business with its BM's commits to environmental sustainability, uses renewable resources, and minimizes the negative environmental impact of its operations. Green Businesses according to Karagülle [15] are environmentally friendly, use organic and natural products, and practice tight restrictions on emissions. However, we argue that there is often a limit by going green,

which is the same as hitting a wall or a ceiling – the Green Wall. The Green Wall can be caused by different challenges and barriers at all levels of Business Model Innovation (BMI). Consequently, business sometimes cannot be any greener until certain rule sets or dimensions in the Business Model Ecosystems (BMES) [16] change – e.g. political, technical, economic, social systems, business. These limits can be called a Green Wall.

On the one hand, it is of utmost importance that more BMES's and businesses adopt green practices and operations in the present time. On the other hand, it is also critical to understand boundary conditions – Green Walls – in which businesses innovate and operate that can hamper adoption of GBM and GBMI practices.

The paper analyzes the GSBVNs through the "lenses" of the BM relation axiom [17] and relates it to Future Wireless Networks (FWN) and beyond technology setup together with the economic parameters, cost, earning of the GBMs, the GBM environmental parameter [11] and the social economic parameters [18, 19]. Together with this, we analyze the GSBVNs' BMs' entire value stream processes and relations from cradle to cradle and grave. All BMs in the GSBVNs have to be considered to really identify and deeply understand the degree of green and types of relations of the GBMs. Only by doing this deep study the potential of and challenges of the GSBVN's reconfiguring AS IS BMs and/or designing TO BE BMs into GBMs can be understood and measured.

2 Research Design and Methology to Symbiosis Business Value Network Related to Green Business and Green Business Models

In this context cross interdisciplinary research methods and combined research approaches with preference can be used. Combining e.g. engineering-, accounting-, ethical-, technical- and strategic analysis of GBM approaches help to fully measure and account for the entire monetary and nonmonetary value and cost of GBM's and GBMI's operations. This work is highly necessary to create more clarity and reduce investment mistakes in GBMs and GBMI embedded with FWN technologies.

These days governments and businesses are experimenting and investing heavily in GSBVNs to find new ways to become greener [7–10], sustainable [11] and reach a green circular economy [12, 20, 21, 24]. Many Businesses are engaged in "greening" their business but define the term

green in very different ways [13]. Some use large resources to find a way to become green. Some even invest in looking like a green business – Greenwashing [27]. But

- What is a Symbiosis Business Value Network related to GBMI actually?
- How can a Symbiosis Business Value Network related to GBMI be measured with support of FWN and advanced sensor technologies?
- How can a business and society value from such Green Symbiosis Business Value Networks?

3 Towards a Classification of a Symbiosis Business Value Network Related to Green Business and Green Business Models

The transition towards a green economy requires a systemic change, where regions play a vital role. In Sotenäs, Sweden and Skive, Denmark, municipal GSBVN were implemented first on a regional level but now also on an international GBMI level. The regional development support program and strategy emphasizes a GBMI value network economy as a key feature. In practice, a GSBVN economy strategy was set up through a road map process involving stakeholders from local government, businesses, and academia. The strategies at SSN and Greenlab aimed to strengthen GSBVN BMI design, reconfiguration, and development in real-world systems through identified goals. The goals focused on closing both technical and biological loops, as well as promoting green energy technologies, radical and disruptive GBMs and demonstration sites. This illustrates a move towards a GSBVN BMI economy supported through regional, national, and international multi business model innovation (MBMI) strategy and advanced technology implementation. Furthermore, opportunities and challenges related to the transition towards the GSBVN and BMI are in this paper presented via two case studies of local GSBVNs, where biogas, fertilizer, green energy, protein, food and many more business models are produced from green and blue bio and recycling sidestreams, residual heat, sewage sludge and other types of 'waste'.

New advanced technologies such as these are shown to create more GBMs and opportunities at the interface of material, energy cycles and other resource cycles even where their implementation faces radical and disruptive MBMI financing challenges. New types of regulations have also been innovated to support the implementation of effective GSBVN emerging from new solutions, new advanced technologies, new BMs. This was needed

to safeguard the environment, human and social health, and business sustainability (green and business economic parameters in symbiosis) when closing the GSBVNs innovation loops. The regional GSBVN innovation economy strategy was described and the case of the two industrial symbiosis networks are recognized as transferable and good practices at a European level. Further they are already inspiration to at least two new GSBVNs to be established in near future in Hirtshals and Esbjerg, Denmark. A MBMI approach is shown to be crucial to continuous innovation and development towards a GBM ecosystem society.

4 Green Symbiosis Business Value Network Cases

The following GSBVN cases are elected as examples of classifying the different types of these different approaches, and some of the challenges [14] related to GSBVNs. The exact numbers and details are kept anonymous due to confidentially issues.

4.1 Sotenäs Symbiosis Network

The Sotenäs Symbiosis Network (SSN) [8, 9] is an industrial and social symbiosis network in Sotenäs municipality, Sweden. The SSN is a GSBVN's built on top of an existing business establishment with four established businesses – Orkla, Lerøy, Marenor and Klevs Gård as seen in Figure 2.

Just recently a private biogas plant, Renahav, was established primarily using the organic sidestreams from three of the businesses to produce biogas. The biogas is today used for energy and heat purposes in two of the existing businesses – a circular GBM approach. Two more startup businesses Smögenlax and Swedish Algae Factory are now being connected to Renahav

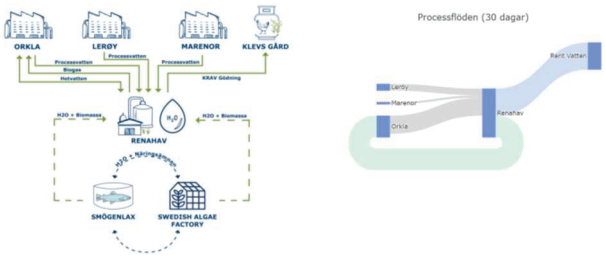

Figure 2 The environmental dimension related to TO BE and AS IS Green Business Models in SSN GSBVN [8, 9].

Figure 3 SSNGSBVN [8, 9].

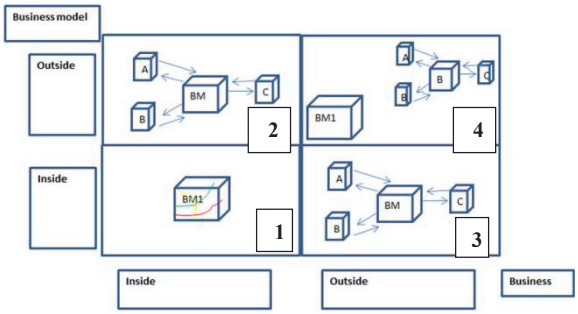

Figure 4 Relation axiom perspectives [17].

and the existing GSBVN to deliver more organic resources to Renahav and thereby increase energy production and other BMs. The latest businesses adding to the GSBVN were strategically elected to be sure they would add value to the SSN. In Figure 3 a picture of the existing SSN is shown.

SSN offers different BMs within the GSBVN both between businesses inside the GSBVN and also to other BMEs outside SSN. In the lenses of Figure 4 it is possible to see SSN and later Greenlab's BMs mapped in a Relation Axiom [17] perspective.

SSN have built up several related BMs and intend to implement more TO BE BM in the next coming years as indicated in Figures 2, 3, 7 and 8. SSN intends to invest in green renewable energy technology and GBMs but

also digital twin technology and advanced sensor technology. The businesses in SSN will amongst others reuse side streams from fish breeding and production inside the SSN GSBVN and to map in realtime GBM's value flows between the different businesses inside and outside the GSBVN. This will enable SSN to map all GBMs and BMs on all BM dimensions, and BMI layers in close to realtime. This requires advanced sensor technology, large computer power and advanced FWN technologies to adapt, process and distribute data. Further with embedding digital twin technologies it will be possible for SSN to make different scenarios of upcoming design, reconfiguration, and development of SSN. Greenlab is working with the same technologies.

SSN focus is on very advanced technical and MBMI solution by attracting some of the worlds most experienced businesses and researchers within energy technology, wireless sensor technologies, and land-based fish production. SSN wants to continuously increase the value of SSN and attract value to the GSBVN – and thereby valuing businesses within the symbiosis network.

4.2 Greenlab Skive

Greenlab in Skive, Denmark [10] was established as one of the world's first truly green industrial business park. Greenlab Skive was established on a green field beside a large waste storage and handling place. In Figure 5 it

Figure 5 Pictures from the GSBVN initial meeting on establishing Greenlab Skive.

Figure 6 Greenlab Skive.

is possible to see the different business representatives in 2017 overviewing the technical, business, and physical proposed installation of the Greenlab GSBVN.

Greenlab Skive generates today sustainable energy, and supply it to the businesses located in the GSBVN and nearby areas. Greenlab transforms manure into Biogas that is upgraded and delivered to the central gas pipe in Jutland, Denmark placed just beside the Greenlab GSBVN. Greenlab is a GSBVN design based on a "planned from scratch approach", which according to Chertow [19] is one of the riskiest ways to design GSBVNs.

Greenlab aims to develop the GSBVN itself primarily into a green and circular energy park. They want to be a technology enabler and a national research facility. Greenlab wants to specialize in accelerating research and technology to scale – particularly in energy technologies. Greenlab's vision is to transform the way green energy is produced, converted, stored, and applied, and aims to act like a test bed for theories in practice and looks for viable green solutions to the world's biggest challenges. In Figure 6, a picture of the established Greenlab Skive in 2022 is shown. All businesses except one business were "recruited" to establish themselfves within the symbiosis network.

Other examples of Symbiosis Business Value Networks exist like e.g. Kalundborg Symbiosis, Denmark [28, 29], Kwinna, Australia [30], Jväiskylä, Finland [31], Händelö, Sweden [32]. However, the degree of focus on green varies.

5 Green Symbiosis Business Value Network and Future Wireless Network Technologies

FWN Technologies embedded into these GSBVNs will enable both the individual businesses and the GSBVN to monitor and measure the technology and BMs much closer and deeper. One example to this is shown in Figure 7 as a GBM example, and as a part of SSN, focusing and zooming in on the business Renahav in the GSBVN – quadrant 3 Figure 4.

In the sketch and actual picture of the online value stream from Renahavs advanced wireless networks system, it is possible to overview in real-time not just in detail the complete biogas value proposition stream internal Renahav, but also all value streams coming in an out from Renahav on all BM dimensions and BMI layer. This gives a unique detailed and real-time visual view of technologies, BMs, value streams, etc, related to each individual business unit.

Advanced FWN and sensor technologies can monitor the technologies and BMs in real-time and enable:

- sensoring of product and service technologies input and output quality, status, content, upcoming status, potential and impact on the BMs
- sensoring of production technologies and future status to operate preventive maintenance on production technologies
- sensoring process and process technologies

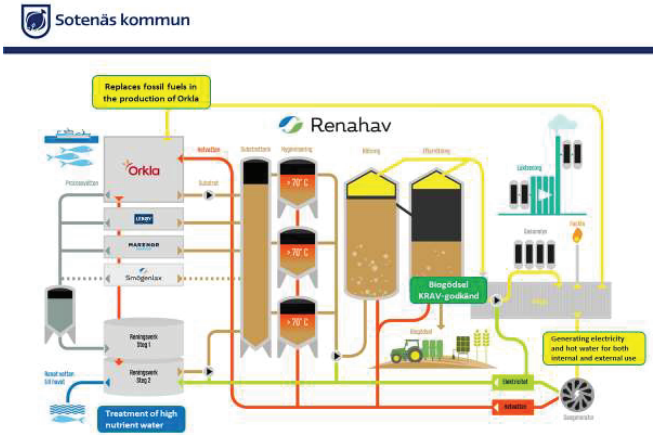

Figure 7 GSBVN mapping with focus on the privately owned biogas plant Renahav, Sotenäs Sweden.

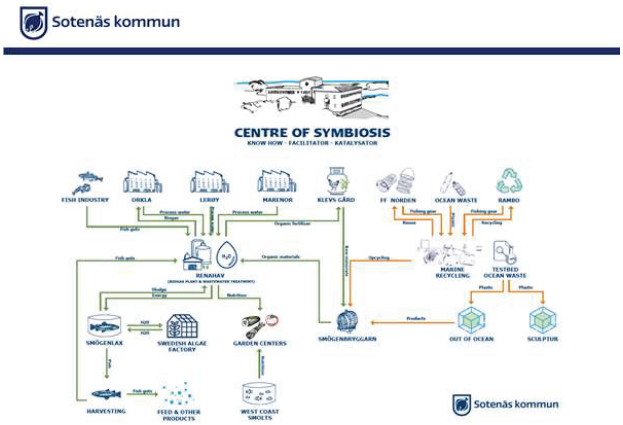

Figure 8 SSN GSBVN BMs measure on related businesses and technologies.

Advanced FWN and sensor technologies can monitor in realtime:

- business models
- business model dimensions
- business model components

This, on economic and GBM parameter perspectives in the GSBVN, can make a better decision platform to management of Renahav as seen in Figure 9 but also SSN. These data points give possibilities to feed digital twin models of the business and even all business BMs in the GSBVN to make it possible to propose reconfigurations and design of BMs at business levels and simulate and run these in a digital twin version before implementing them. Thus, different BMI scenarios can be simulated for the GSBVN at all BMI levels for one business and for the whole GSBVN.

In Figure 9, an online realtime monitoring is shown with the Renahav business in focus. Here, it is possible to see data of the "value formulas" – "other values" – as M3 of used process water, M3 of substrate, M3 of produced biogas, M3 of heatwater taking into the plant, producing or sending out to other businesses' BMs.

The value formulas of the different BMs can also be expressed in a monetary and/or in other non-monetary form. The monetary value can be added and shown in real-time as a second layer on the business' BMs and generate data for turnover, cost and earning measurements both overall for the business and in detail of all BMs included in Renahav business. In Figure 10, a model of this is shown for an anonymous green business outside SSN and Greenlab.

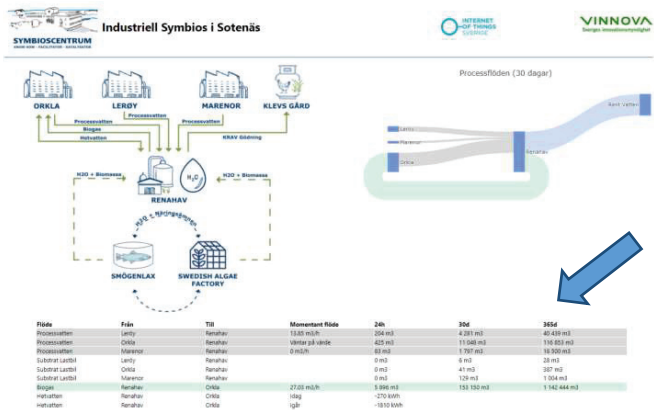

Figure 9 GSBVN BMs measure on other values.

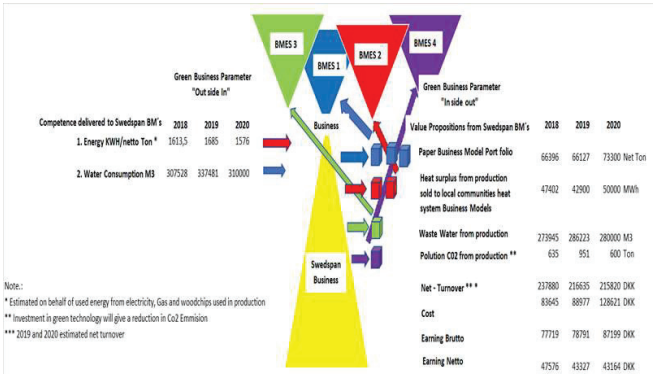

Figure 10 Sketch model of green parameter stream model combined with turnover, cost, earning and of an anonymous business.

The business economic parameters have not yet been fully implemented in realtime in SSN, Greenlab and Renahav business but are under development and implementation.

6 Discussion and Reflection on Results

SSN and Greenlab are established based on different backgrounds, circumstances, and GSBVN platforms, which have influenced "the "raw material" available, possible value stream and businesses to build the GSVBN on. The strategic innovation and development for the two different GSBVN are

very much dependent on the platform and rules set for the GSBVN. The measurement of the two GSBVN are, at the moment possible and prepared for measurement on environmental and economic parameters. However, it seems possible with FWN and advanced sensor technologies [25, 26] also to measure other parameters as social parameters as indicated in Figure 1. However, this is more difficult and could fall into heavy GDPR restrictions and challenges – but it is possible.

The model for the GSBVN could also be increased with measurements on network, user, and customer measurements. That would enable measurement on the entire GSBVN both inside and outside the GSBVN. It only depends on how open the different businesses want to be with their BMs. In the two GSBVNs the businesses in most cases are still operating with closed BMs so it is not possible, e.g., to see all business value formula calculations. In the future this could be changed.

Energy seems to be core in both GSBVNs we studied but also to many other GSBVNs. Energy seems to be connecting all businesses and a biogas plant like Renahav in SSN and EON in Greenlab relates and connects many of the businesses. In Greenlab, Skive EON's biogas plant was the first business to be established, where Renahav came later in the process of SSN.

Waste as a resource seems to be more and more important. In both cases the GSBVN is very much concerned about which businesses can be attracted to use the residuals from the GSBVN's businesses. Waste is in fact not used as a term anymore but considered as a resource.

There were several risks observed in GSBVN's establishment. These are also commented on by Chertow [16], saying that GSBVN designed from "greenfield", with strong government subsidies, seems to have less success than those developed based on existing established businesses or from "greenfield" with high initial engagement and interest of businesses. Further the GSBVNs' facilitators and coordinators have to be very careful in the process of determining and picking new businesses to join the GSBVN. The businesses have to value the GSBVN and its duty to collaborate, and not operate as stand alone businesses. Otherwise, the GSBVN could fall apart or move in a wrong direction.

7 Conclusion

The Green Symbiosis Business Value Networks (GSBVN)s is often much easier to relate and embed with Future Wireless Technologies as many of the businesses are strategically chosen or have chosen to be part of the

GSBVN. Further they have a business model structure, where they are often strongly related and value each other's BMs via strategic relations. Many of the businesses operate with open business models (BMs), or partly open BMs, which enables more insight in each other's BMs.

The effects and impacts on the green transformation seem therefore often to be much higher than classical green, sustainable, and circular business model innovation networks that are not "living"strategically in symbiosis with each other.

Green business model innovation in symbiosis can be setup in many different ways. GSBVN focuses on the environmental green parameters of BMs, whereas general Symbiosis Business Value Network focuses on other or also on other parameters than green.

Future Wireless Technologies and advanced sensor technologies can support and value the innovation and evolvement of GBMI in GSBVN's. Future Wireless Networks (FWNs) and advanced sensor technologies can take these to the next and higher level of green – climbing the Green Wall.

The paper tired to unwrap different GSBVN approaches, their origins, views, and challenges. Different GSBVN approaches and their success criteria for GBMI related to Symbiosis Business Value Networks were presented and the paper discussed the role FWN technologies that it can play in operating GBMs in GSBVN.

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