A Scoping Review and Framework of Green Business Models Related to Future Wireless Technology: Bridging Green Business Models to Future Wireless Technology

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Received 05 August 2020; Accepted 01 September 2020;
Publication 12 February 2021

Abstract

There is a growing interest on the profitability and value of Green Business and Green Business Models related to our societies strong push to greening our businesses due to climate change and environmental challenges. Regulation on businesses is everyday getting tighter on different topics of green. Energy and water consumption, type of energy used, greenhouse emissions, waste, use of materials and resources, recycling of materials, collaboration types and latest fulfillment of UN's 17 world goals. All topics are more or less being related to the term green and in this case green economy, green business, green business models and green technology are seen as solutions to fulfill the green goals and deals.

In this context many business have endeavored willingly or unwillingly to become and adapt the term green. Studies have shown that business however often find it difficult transforming into green. When users and customers and even competitors are not always loyal to those green business offerings and standards a green business and green business model concept have then it becomes even worse to trust and act on the green business vision.

Journal of NBICT, Vol. 1, 329–362.
doi: 10.13052/nbjict1902-097X.2020.015

Knowledge and awareness for green business model within the business model communities lacks. Systematic ways and taxonomies to classify and use the term "green" gives the motivation for the study. In this context the paper commence presenting a literature study on the term green business model and relates this to projects on green business and case studies on green business models. The overall research questions discussed are

1. How have and can green business model be defined?
2. How can Future Wireless Technology enhance the evolvement of Green Business Modelling and green business transformation?

The paper seeks to unwrap the different approaches, origin and views available on the term Green Business Model. The paper verifies their success criteria for classifying a green business model and discuss the role wireless technologies plays and can play in operating Green Business Models. The paper ends by proposing a framework to classify the degree of green related to business models.

Keywords: Green business models, green business model approach, green business model technologies, 5G, 6G, future wireless technology.

1 Introduction – What is Green Business?

The "greenness" of a business and business model (BM) – inspired by Kleinert 1991 [1] – does not really start in any single demonstration of concern to produce an environmentally kindly business model – CO2 neutral, paper over plastic or recycling of materials as examples. Rather, it is embodied in a business and its entire value networks willingness to innovate continually with the life cycles of their business models in the aim to become green and make their business models green – now and in their entire lifecycle. The real green businesses involved are those looking behind the counter of terms as energy consumption, energy type used, material, pollution, waste, recycling of material e.g. that, according to their own and collaborative partners – , their users, customers, network partners, employees and other collaboration partners – figures. Those figures that these partners never see or have difficulties to see.

The costs of maintaining processes of BM's that are not green were as can be seen, already in 1991 claimed [1] and mentioned. Later in 2012 [2] ultimately proved as higher than costs of working towards a green business model (GBM) – or costs to eliminate or change the black BM components

[22] into green components. At worst, the exercise of creating, capturing, delivering, receiving and consuming data for the purpose of eliminating or changing "the black components" of a BM e.g. pollution and Co2 were claimed to help unearth the costs of production and the technologies invested in the manufacturing of the BM.

Borrowed from the United Nations Environment Programme (UNEP) definition [3][4] it was described that green business are those that

> "contribute substantially to preserving or restoring environmental quality by
>
> **… reducing energy, materials and water consumption**
>
> **… decarbonize the economy and minimize or altogether avoid generation of all forms of waste and pollution.**

Green Businesses supplying GBM's are defined as ranging from **clean technology** businesses, **green building construction businesses, Green Business education and Green materials recovery businesses**. Green business can also include BM's in traditional Business Model Ecosystems (BMES) [22] with **businesses that have significantly greener processes or operations than BMES standards**.

Some also include **local food production** to the UNEP definition, as those businesses growing an urban food system central to the development of Green City visions for sustainable economy. Local food was here defined **as all food and beverage (including wine) produced and consumed within a predefined local area** e.g. in this case Vancover, Canada – British Columbia [5].

In other words the term green has and is taken into anything and is now very fussy and context defined.

"No business is an island" [6] – neither is a green business or a local area in a green economy.. It is in other words necessary to analyze the entire value network chain of a business and its value and cost streams. Together with this analyze the BM's entire value stream process and relations from cradle to grave. All BM's in the value network have to be considered to really identify and understand the degree of green and types of green business models. Only by doing this the amounts of potential transforming a BM (AS IS BM) or creating a BM (TO BE BM) into a Green BM can be understood and measured. Our analysis indicates in this context that a cross interdisciplinary research method and combined approached with preference can be used. Combining e.g. engineering-, accounting-, ethical, technical and strategic

analytical approaches to fully account for the entire values and cost of green BM's operations and intended operations including more advanced realtime controlling, treatment and measuring of emissions, pollution, water, waste, ressources e.g. discharges is will value the knowledge of GBM. This work is highly necessary to commence to create clearness and reduce investment mistakes.

Citizens globally state that the climate and environmental problems influence directly their daily life. Lattest "the lock down" caused by the Covid 19 pandemic showed how our global activities impact our environment as an example with the sky turning blue again in Delphi, India and many other places [7] making it possible to people to see monuments in distance again – and breath without inhaling smog. These examples increase motivation of users and customers of business models to demand green business models of all types of businesses in all kind of business model processes. Further they want to buy Green Business Models (GBM) that can be documented green – not just said to be green.

Governments and businesses are therefore together in these years investing heavily in becoming green [8]. Green Technology [2], Green Economy [2], Green Smart Cities [5] and Green Business Models [2] are all topics and major investment objectives in this context. Many Businesses are engaged in "greening" their business and they define the term green in many different ways as reducing environmental pollution, optimizing the usage of natural resources, increasing energy efficiency, changing energy consumption to green energy and supporting a new engine of green economy and green growth. Many businesses in general want to support the green mission where as other businesses are pulled into or forced to become green. Some use enormous resources to find a way to become green – or look like a green business. But

> What is a Green Business Model actually? How can a green business model be measured?
>
> How can a business profit – or value from such Green Business Models?

2 Towards a Clafficification of a Green Business and Business Models

The green economy was originally said to aim at reducing pollution [1], reducing environmental risks and ecological scarcities for sustainable

development without degrading the environment. The UNEP Green Economy Report [3] argued that a green economy must not only be effective and efficient – but also fair. Fairness implies recognizing global and country level equity dimensions, particularly in assuring transition to an economy that is low-carbon, resource effective and efficient – and socially inclusive [4]. UNEP's definition of a green economy is one that results in improved human well- being and social equity, while at the same time significantly reducing environmental risks and ecological scarcities. **A green economy** can be thought of as one which is **low carbon, resource efficient** and **socially inclusive**. A green economy is one whose growth in income and employment is driven by public and private investments, collaboration and partnership as in models like **triple helix** [9]

> a set of interactions between academia the university, industry and government, to foster economic and social development, as described in concepts such as the knowledge economy and knowledge society
>
> **quadruple helix** [10]
>
> adds a fourth component to the triple helix framework of interactions between university, industry and government: the public, consisting of civil society and the media.
>
> **Quinto helix** [11]
>
> adds as fifth helix the natural environment and views the natural environments of society and the economy as drivers for knowledge production and innovation. Thus, defining socio-ecological opportunities for the knowledge society and knowledge economy, such as innovation to address sustainable development, including climate change.

Green Economy and Green Businesses reduce carbon emissions and **pollution**, **enhance energy and resource efficiency**, and **prevent the loss of biodiversity and ecosystem services**. These investments need to be catalyzed and supported by targeted public expenditure, policy reforms and regulation changes and these development path intend to **maintain, enhance and rebuild natural capital** as a critical economic asset and source of public benefits.

GBM's have – as can be seen in the above mention discussion and in Table 1 – taken very different approaches in literature and practice related

Table 1 Green business model approach

	Approach and Green Business Model Projects	
Green Business Model Approaches	Approach	Green Business Model Projects Studied in this Paper
Energy	Reduction of energy consumption or changing energy consumption to more renewable types of energy More table copya	(ECSMV)(SET II) (Greenbizz))
CO2	reducing CO2	(ECSMV)(SET II),(Greenbizz), (Climatorium)
Material and resource	Reduction of material and resource use	(SET II), (ECSMV), (CIRCit)
Water and waste water	Reduction of water consumption and production of waste water	(SET II), (ECSMV)
Circular Economy	Recycling material, cradle to cradle principle, reeducing use of material and resources in the whole life cycle of a green business model	(SET II), (ECSMV), (CIRCit)
Environmental	Reduction of pollution from chemicals,reduction of noise	(ECSMV), (GREENBIZZ), (SET II, (Monica)
Triple Helix,Quanto Helix and Quinto Helix	Stakeholder Approach	(Climatorium), (ECSMV), (Greenbizz)
The Greenest City	Environmental quality by ... reducing energy, materials and water consumption ... decarbonize the economy and minimize or altogether avoid generation of all forms of waste and pollution. ... clean technology businesses, green building construction businesses, green education and materials recovery businesses. ... BM's in traditional sectors with businesses that have significantly greener processes or operations than industry standards. .... Local food production, urban farming	Vancover – The Greenest City
UN 17 World Goals	UN 17 World Goals Approach	(Climatorium)

to the term Green. Many terms of Green have also over time been increased by their approach and domain – beginning with just pollution and in some sense reducing CO2 emission [1] to include also UN17 world goals and local food production. Today Energy Approach – reducing energy consumption, changing to renewable types of energy and the CO2 Approach – reducing CO2 in both literature study and practice are the top approaches. Material and resource approach – reducing material and resource use, Water and waste water approach together with Circular Economy approach – recycling material, cradle to cradle principle and use of resources in the entire life cycle of a green business model are second most used approaches. Environmental Approach - Reducing Pollution – as example chemical spill, oil spill, air polution, smell polution, radioactivity and noise have for a long time been topics whereas wireless frequencies, background noise, indoor climate supporting biodiversity is upcoming topics. Focus is to protect humans, species and plants and Triple Helix, Quanto Helix and Quinto Helix methods and processes are used as models to support stakeholders to become more green. The UN 17 World Goals approach was found in our study to be the most broad Green Business Model Approach addressing many topics that questions the use of the term green and motivates the use of other colors for some of the above mentioned approaches. However, they are new approaches that are important and upcoming top of the list of green business model discussion and focus.

Ecosystem services [12] is another term used in the green business model discussion, which have a more process and recycling and regenerating perspective – said to benefits to humans and species gifted by the natural environment – and from healthy ecosystems. Such ecosystems are mentioned as e.g. agroecosystems, forest ecosystems, grassland ecosystems and aquatic ecosystems. These ecosystems, functioning in relationship, offer such things like natural pollination of crops, clean air, extreme weather mitigation, human mental and physical well-being. Collectively, these benefits are known as 'ecosystem services', and are integral to the provisioning of clean drinking water, the decomposition of waste water and wastes, resilience and productivity of business model ecosystems [13] together with reduction of C02 and increase use of green energy. This raises another question

> How can Green Business Model Ecosystems embedded with advanced wireless technologies be built to support these visions?

Ecosystem services are classically grouped into four categories: **provisioning**, such as the production of food and water; **regulating**, such as

the control of climate and disease; **supporting**, such as nutrient cycles and oxygen production; and **cultural**, such as spiritual and recreational benefits. The ecosystem service approach introduce the time, process, supporting and cultural perspective of Green Business Models meaning that a green business model cannot be "termed" just on a specific time perspective but has to be "termed" as on its impact over time and with different cultural benefits.

Many ecosystem services are in the latest BM theory and practice being valuated as with money and other values in order to draw equivalent comparisons to human engineered infrastructure and services. The term Green can as seen above have a manifold of approaches, measurements, viewpoints and definitions. The term Green seems therefore to be treated as **context based** and have over time evolved into many different topics and areas related to different practioners, authors and political groups defintions and motivations of the term green. Several of these – we found – were even based on feelings of what is green and this can even variate from one culture to another. Our litterature search covering more than 6000 articles on Green Business Models – both white and grey litterature [14] – shows some of the main approaches and topics to the term green and green business models.

3 Green Business Model Project

The Green Business Model approaches studied includes 7 projects and case examples taken from existing Business Model Ecosystems (BMES) [13]:
SETII [15] – Skandinavisk Elektrisk Transport System – sponsored 2019 by EU Interreg-program for Eastersee- Kattegat-Skagerrak 2 mio. euro for a 3 year Multi Business Model Innovation Project. SETS-project aims at reducing noice and particle emission from Nordic harbors and the maritime transport sector by electricfying 8 habours in Denmark, Norway and Sweden. The consortium seek to develop solutions, tools and methods, that will enable the harbors and see transportation in the region to become more environmental friendly. Best practices and solutions within battery technology will be the output of the project together with report on operation demands to the future technology solutions from the transport- and service sector. Individual electrifying plans and strategies on how to implement the solutions within the individual harbors on new green business models and how to finance these will be developed and presented. The partners in the SETII – project are:
Energycity Frederikshavn, Aarhus University, Skagen Habour, Frederikshavn Habour, Hirtshals Habour, Sotenäs Municipality, Kungshamn Habour, University of South-East–Norway, Larvik Harbour, Moss Habour, Arendal og Grenland Habour.

ECSMV [16] – aims as seen in Table 1 at increasing Energy effectiveness and CO2-savings in SME businesses in Central Region Denmark. ECSMV has a budget of 5.5 Mio EUR. The partners in the ECSMV – project are Ringkøbing-Skjern, Aarhus and Skive Municipalities.

Figure 1 Green Business Model Approaches in ECSMV project.

GREENBIZZ [17] – aims at increasing the use of Green Energy by 10% in Startups and SME's in the Interreg. KASK- region in Norway, Sweden and Denmark.

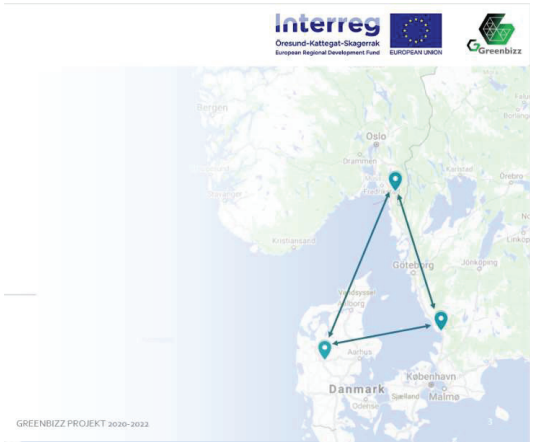

Figure 2 Green Business Model Approaches in GreenBizz project.

GREENBIZZ will help businesses to develop GBM's based on a new green Multi Business Model and Technology platform, which will provide continuously quantitative and qualitative data on businesses CO2 impact and Green Business Model Innovation performance. GREENBIZZ has a budget of 3.1 mio. EUR and is funded by EU by 2.1 Mio. EUR. 1.1 mio. EUR comes from private and business finance sources. The partners in the GREENBIZZ –

project are: CGC – Aarhus University, Denmark, Chalmers University, Sweden, Høgskolan Østfold, Norway and actors from municipalities and local Business Service Organizations, Energy consultancies. About 2000 SME will be screened and (60 of these will be elected for detailed Green Multi business model Innovation process and implementation.

CLIMATORIUM [18] is a forum and one of Denmark's "big bet" on tackling climate change. It is manifested with an advanced building for knowledge, education, innovation and development projects within utility services and climate change.

Figure 3 Climatorium Main Building in Lemvig, Denmark.

The aims is that Climatorium will be a new international climate center located on Denmarks west coast, facing the North Sea. The $7.9 million building will be a key part of the Central Region Denmarks's Coast to Coast Climate Challenge, a six-year- long climate awareness initiative that's being carried out by the region's government and several private and public organizations – like the local utility business Lemvig Water. The initial budget for Climatorium is 0,376 Mio. EUR but it is a part of the Coast to Coast project sponsored by EU LIFE- program with about 7 mio. EUR. and a total budget of 12 mio. EUR. These budget is exclusive investment for the Climatorium buildings.

Monica [19] – aims at demonstrating how cities can use IoT technologies to support the management of security and (un)wanted sound at large, open-air cultural and sporting events which attract and affect many people.

Figure 4 Monica – enhancing sound experience and control noice.

Hereby addressing a different dimension of the term Green – namely noise and sound. Cities involved were Bonn, Copenhagen, Hamburg, Leeds, Lyon, Torino. 29 partners from nine different countries form the MONICA consortium, representing a multitude of specialists from different disciplines. Monica had a overall budget of 17.3 EUR with EU contribution of 14.8 EUR.

CIRCit [20] is a 31/2-year research project, spanning the five Nordic countries, Denmark, Norway, Finland, Iceland and Sweden. Using a number of action research methods, CIRCit's objective was to support the Nordic industry to discover and implement the opportunities of Circular Economy, through the development, testing and implementation of science-based tools. Circit project spans six circular economy focus areas:

- Circular economy sustainability screening
- Circular economy business modelling
- Circular product design and development
- Smart circular economy
- Closing the loop for a circular economy
- Collaborating and networking for a circular economy

Circit is part of the Nordic Green Growth Research and Innovation Programme funded by NordForsk, Nordic Energy Research and Nordic Innovation. Total Budget of 3 Mio EUR.

4 Green Business Model Projects Related to Green Business Model Classification

Most Green Business Model projects and frameworks is based on "sustainable objectives", i.e. objectives that do not reduce the opportunities of future generations – Business Model Ecosystem/society perspective – but what about the business and its business models?

GBM's should be organized in "sustainable" ways, using means and methods that do not reduce the survival and opportunities of future generations, the global environment and not least the businesses. Quintuple Helix Green Business Model Approach aims at supporting this vision of synergy and symbiosis, whereas many GBM approaches up to know have addresses only part of the vision and part of the total group of stakeholders and their interest.

Green Business Models is in this form intend not to be based on dominance and aggregation of some groups of stakeholders because this will lead to imbalance in the Businesses and Business Model Ecosystems of future

generations. Green business Models is in the new form based on (open) cooperation, sharing and coopetition, where openness has to be defined in more detail by the collaborating partners. Sharing and sharing green business can be at various levels: sharing value propositions, customers, suppliers, data, common digital interfaces (APIs), services, symbiosis, multi Business Model Innovation (MBMI) and many other things.

In our literature and project review above we found 9 Green Business Model Approaches as seen in Table 1 and related comments. These are however not related to the generic construction of the Business Model [21], the levels of Multi Business Model Innovation (MBMI) [22], the viewpoints of the Business Model [22] and the full fillment of a business model value circles [22]. Many of the approaches do not have any background in business model theory and communities. They just added the term business model to the term green. As we consider that any business model – either green, blue

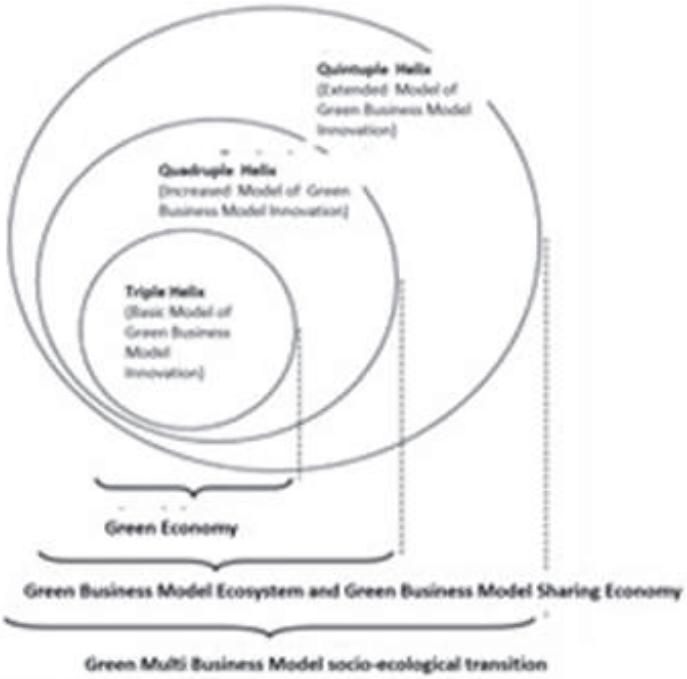

Figure 5 Triple, quadruple and quintuple helix approach related to Green Multi Business Model Innovation inspired by Carayannis, Elias G et al. [11].

or red – have the same generic BM construction the measurement of How green a Business Model is? has to be related to

1. each of the 7 Business Model dimensions
2. to each of the 7 Multi Business Model Innovation levels.
3. to the 7 viewpoints of the Business Model
4. to the fulfillment of a Business Model

4.1 The Green Business Models 7 Dimensions

We propose firstly that any Green BM – like all other BM's – consists fundamentally of seven dimensions – no more. Seven BM dimensions where the 7 dimensions – relations – that bind all other dimensions and components together and enable creation, capturing, delivering, receiving and consumption of the values that lie outside the Green BM and bind the Green BM together with other BMs – the multi business model Approach [xx]. We illustrate a Green BM (GBM) in Figure 6 and the questions in relation to each individual BM's dimensions characteristics and logic in Table 6. Each BM dimension can be split into small BM dimension components – the smallest level of a BM. With the above mentioned it is now possible to draw up the first part of the classification of How Green a BM is as seen in Table 2.

4.2 The 7 Green Multi Business Model Innovation levels

"A basic platform" to analyze GBM's and GMBMI at 7 different MBMI levels is shown in Figure 6.

As can be seen focus on just one BM related to GBMI would be too simple and would lack basic and critical information on GBMI. It would not be possible to understand and give the full view of GBMI range, GBM construction and impact of GBMI in BMES – just focusing on one GBM. Further the models shows that GBM's can have different degree of green and work together with BM's of different colors. In other words we hardly find any businesses in our research that have pure GBM's and are green "from component level to time level". This challenges the business that want to be green but also opens up potential for continuous GBM improvement, GBM innovation and GBM learning. The GMBMI level approach give a new generic definition and language of GBM's, typologies of GBM's and impacts of GBM's. In this case a classification of how greeen a GBM and GMBMI process are could potentially add and value the GBM and GMBMI vokabularium and discussion. All 7 MBMI levels of any GBM's as seen in

Table 2 Green business model dimensions

	Green Business Model Questions and Measurements Parameters Related to Green Business Model Dimensions	
Green Business Model Dimensions	Green Business Model Dimension Questions	Green Business Model Dimensions Measurements
Green Value Proposition (GVP) Value proposition/s (products, services and processes) that the BM offers or intend to offer (Physical, Digital, Virtual GVP)	"What Green Value Propositions Do the BM Provide?"	tangible and/or intangible green value proposition. green products, green services and/or green value proposition processes of green product and green services. values of green relations.
Green User and Customers (GCU) Customer/s and Users (users, customers that the BM serves – (Physical, Digital, Virtual).	"Who does the BM Serve with Green Value Proposition?"	Green users and/or customers
Value Chain Functions [Internal] (GVC) (physical, digital, virtual)	"What Green Value Chain Functions Do the BM carried out and have?" (GVC)	Green primary and secondary Value Chain Functions as Green inbound and outbound transport and logistics, Green operations, Green Sales and Marketing Green Administration and Financing Green procurement, Green Multi Business Model Innovation
Competences (GC) Competences (technology, HR, organizational systems, culture) that translate business ' inputs into value for customers, users, network (outputs). (Physical, digital, Virtual)	"What are the BM's Competences?" (C)	Green product and service materials Green Production technologies Green Production Processes technologies Green skilled employees Green Organizational Systems Green Culture
Network (GN) – (suppliers and others (Physical, digital, virtual network)	"What is the BM's Network?" (N)	Green suppliers and network partners
Value Formula (GVF) (Profit formulae and other value formulae. (physical, digital, virtual)	"What are the BM's Value Formulae?" (VF)	Green profit and other values
Relations (GR) physical, digital and virtual relations	"What are the BM's Relations?" (R)	Green Relations

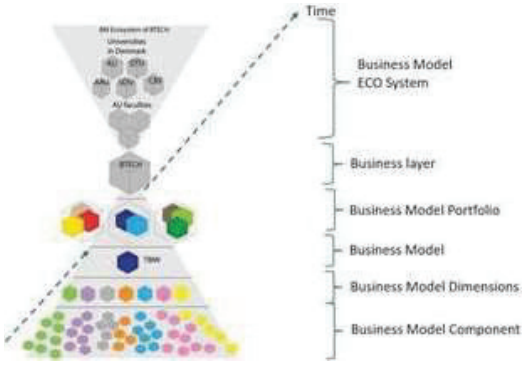

Figure 6 7 Different Green Multi Business Model Innovation (GMBMI) Levels inspired by Lindgren 2018 [8].

Figure 6 must however be understood thoroughly to communicate, work, innovate and classify precisely the degree of green of a GBM and GMBMI process. In this context our research adapt the concept that GMBMI is about change and GMBMI is "the tree of all Green Business Model innovation". However, we propose that their could be other types – or color – of MBMI, where GMBMI is just a part of. This approach helps to place GBM and GMBMI in the context of sustainable BM and BMI that is a much larger research area as indicated by Pieroni et al. 2019 [37]. It seams as if sustainable business models, circular business models and GBM's are overlapping each other and due to Pieronies model Figure 7 is interlinked.

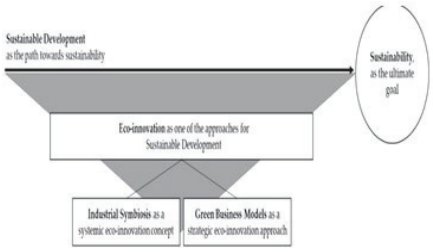

Figure 7 Sustainble business development, eco-innovation, industrial symbiosis and green business models adapted from pieronies model 2019 [37].

Further we adapt the proposed concept [13, 22], that any GBM and BMES is related to seven dimensions – value proposition, user and/or customer, value chain functions [internal], competence, network, relations, value formulae – and these can be changed incrementally, radically and Disruptive.

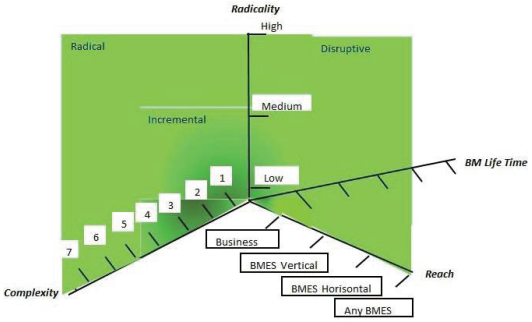

Figure 8 A four dimensional GMBMI framework Inspired by Lindgren 2020 [24].

Table 3 Green business model dimensions

Green Multi Business Model Innovation Levels	GMBMI Level Description [21]
BM Dimension Component Level	Each BM dimension can be divided into "smaller parts", which we call BM component level
BM Dimension Level	Each BM can be dived into 7 BM dimensions
BM Level	Each Businesses have one or more BM's – TO BE BM's and/or AS IS BM's
BM Portfolio Level	Each Businesses can group BM's into one or more BM portfolios – TO BE BM's and/or AS IS BM's
Business Level	Each Businesses have one or more Core BM's – TO BE BM's and/or AS IS BM's
Business Model Ecosystem Level	Each Businesses participate in one or more BMES's – TO BE BMES's and/or AS IS BMES's
Business Model process Level	Each BM follows a Business Model Process or have a BM lifecycle from cradle to grave – from TO BE BM's and/or to AS IS BM's

The paper proposes that BM change into green can be on the seven different levels from the most detailed level – BM Dimension component to the BM dimensions, BM, BM portfolio, Business, BMES layer and BM/BMES Process level as seen in Figure 8 and Table 3.

GMBMI can happen, when a business changes on any of the 7 MBMI layers and canbe measured related to the

– **radicallity of green**) – defined as **degree that the BM's dimensions are changed** into green (incremental or radical) [8]

- **Complexity of green** – defined as how many **dimensions ofeach BM are changed** into green
- **Reach of green** – defined as **the impact of the change** of green has to the business, vertical- and Horisontal BMES or the world
- **Time** – define as **the life cycle** of the GBM from cradle to Grave

As seen in Figure 9 the degree of green increases when the business innovate green on the scales of complexity, radicality, reach and BM Life Time.

Related to the measurement of complexity, if all BM dimensions are changed Green at all BM dimensions components, then the BM could be classify as a Radical GBM. In other words it is fully green to the business but the greenes of the BM and become disruptive related to the degree of "external impact" – the GBM's impact on the vertical, horizontal or any BMES is also full green. This can however not be realized without the GBM interacting with other BM – the Multi Business Model approach. The relations to other BM's outside the BM in focus will enable green value propositions to flow into other BM's and make them greener.

Radicality and complexity – Figure 9 – however mainly take the viewpoint from the business side – inside out perspective. If all BM dimensions are changed green then the BM is totally changed – meaning it could be classified as being in the disruptive green zone. Dependent on its impact on vertical, horizontal and any BMES – it could be classified as **disruptive green**. The **green impact** on the **reach** axis as seen in Figure 9 – green to whom becomes hereby very important related to defining and measuring how green the BM is and the degree of impact that the green BM and GMBMI in the business has. It is taking us to the viewpoint of "from outside – in" and "outside – out" impact of green – or GBM's. It is measuring the change in existing BM's – "AS IS BM" and also "TO BE BM" – related to the **green to the business**, **green to vertical BMES**, **green to horizontal BMES** and **green to any BMES – green to the world**. In this case clearly the green to the vertical BMES, green to horizontal BMES and green to any BMES – falls into range **having impact (AS IS BM) or potential impact (TO BE BM) outside the business**. The disruptiveness of "the greening" correlates with how many of the 7 BMES dimensions in the BMES in focus is changed or gets and impact. As a BMES have 7 BMES Dimensions the change can still fall in the range of incremental and radical GBM and GMBMI as the change to green can have limit or no impact to any BMES. However clearly and firstly it can be defined that the – green impact to any BMES would definitely

fall in the range of Disruptive GBM and Disruptive GMBMI, if the GBM and the output of the GMBMI process is green to the entire world.

4.3 The Seven Viewpoints of Green Business Model

Any BM and thereby also a GBM can be seen from different viewpoints [22]. This means that "the greenness" of a GBM can theoretically be judged from each of the 7 BM dimensions viewpoints. As an example the business could judge that its BM is green – but the customers or users not – as they do not see or consider the BM to be green. This takes the GBM discussion into a whole new dimension that complicates the discussion and degree of green even more. The latest discussion on GBM seems e.g. to push to a continuous GMBMI approach, where BM's continuously have to change into becoming more green and has to be seen from different viewpoints in relations with other BM's. If the GBM's cannot fulfill this requirement they will not be considered as green – or even loose their green business certificate.

In this discussion the viewpoints come into perspective – as

Who should judge how green a BM is?

From which viewpoint should a GBM be judged?

We choose not to discuss this approach further in this paper but acknowledge that this is a major topic in the discussion of GBM.

4.4 The Fullfillment of a Green Business Model Business Circle

A BM is not a business model if it have not or cannot fulfilled the total business circle – neither a GBM. What it means is quiet simple.

> **A GBM that has or cannot "invoice" a user/customer for a GBM and have not received the money or other values for the GBM is not a GBM.**

Many businesses, governments, users and customers **wants** to have GBM's but if they do not **demand** them and if they do not "pay" for the GBM's value proposition then there are no GBM's. There are no business.

In this respect, another distinction has to be made between sustainability based BM's and BMES's like clean energy BMES and sustainability leadership and management that aims to integrate sustainability aspects into the regular operations of the individual business. The former can undoubtedly be very attractive: global new investment in clean energy alone has increased

tremendously. The latter refers to whether a business operates in a sustainable way or not, i.e. minimizes its social and environmental impact within the constraints of the technological and MBMI possibilities in the BMES it belongs to. Clarification of the relation between sustainability performance and economic value creation is however difficult – but necessary. The link between sustainability performance and economic value creation is however often indirect and hard to quantify.

We choose also not to discuss this approach further in this paper but refer to discussion and basis of any business [38].

5 Green Business Modelling Related to Use and the Role of Wireless Technology

Those Businesses and BMES intending to embed 5G and 6G technologies into their GBM's face challenges:

> How to generate profit, ROI and other values from their GBM's and GBM technology Investments?

Investments in GBM and related to this advanced green technologies are large. Until now there has been a limited number of customers willing to pay for GBM and 5G soon 6G – but many users want to try the GBM, 5G and 6G. However users do not pay – customers do – and as discussed above there is no GBM if nobody pays or are willing to pay.

Many organizations and political people claim that the business will come – but it is still difficult to document and find the profitable GBM cases. It can be that some claim that the GBM will have a green impact to the society and will create an impact on environment but many cases show that it does not create a profit or other values to the business – yet. GBM 's do – in most cases – not create a sustainable business economically. They might gain a cost reduction temporally and be advantage to invest in when subsidies are received – but they have to be sustainable economically on long term basis. This still have to be proven.

Businesses therefore have to commenced to focus more on creating and capturing GBM's that give a profit or other values that can be "exchanged" to profit to convince investors, that GBM's are and can be profitable and can value the business. In this context the paper studied some elected cases from the projects shown in Table 1. The cases do not give a full picture of GBM and GMBMI but shows the work with GBM's – however up to now

in most cases with a limited focus on Green Technologies – the competence dimension in the BM. The cases also shows that basically the **GBM have a different construction on value formula than conventional BM's** and that **GBM's focus in general more on other values than on profit. GBM's are therefore potential and often well constructed to take advantage of the multi business model approach.** Herein lays maybe the reason why conventional business modelling mindsets and approaches find it difficult to develop and operate GBM's [25].

Speakers at the WWRF 44 conference in June 2020 in Copenhagen, Denmark [26] – documented although heavy investments in GBM's and Green Wireless Technology. According to sources in Silicon Valley much Venture capital are now ready to invest in GBM's, if businesses can verify GBM's profitability. Our research shows that GBM's are related to large business potentials when combined with wireless technologies – but they also have major challenges. Some speakers at WWRF 44 even proposed to leave 5G and 6G and go one or two step back – to focus more on 2,5 [27] and 3 G technologies [28] especially in rural areas – to connect the unconnected – and make them or enable them to become Green by a simpler wireless technology generation and by the very first moment they become connected.

6 Green Business Model Cases

The following GBM cases are elected as examples of classifying Green Business Model projects to verify the different types of GBM, GBM approaches and some of the challenges related to GBM, MGBMI and future wireless technologies. The case businesses names is kept anonymous due to confidentially issues.

6.1 The FG Hotel Case – incremental Green Business Modelling at Business Model Dimension Level

Hotel FG offers different BM's within the Hotel BMES in Region Central Denmark. Hotel FG has a focus on becoming green and offering GBM's. Hotel FG has a turnover of about 10 mio. EUR and employs about 50 employees. Hotel FG offers high quality BM's in the medium and high-end customer segment. Hotel FG have built up several BM's and intend to implement a TO BE GBM in autumn 2020. FG intend to invest in green energy technology (a Convex system) that will reuse heat from rooms inside the Hotel and hereby reduce energy consumption by 723887 KWH and reduce C02 emmision by

92 ton. Hotel FG focused on a technical solution and thereby only part of the competence BM dimension in the GBM's framework. Hotel FG choose this solution to reduce energy consumption, cost saving, reduce CO2 and placed the investment in 2019 because the activity hereby could be support by a subsidy. Subsidy was a major motivation to implementing GBM's and FG show hereby that they are most interested in the value formula dimensions cost component related to Green Business Modelling.

6.2 The Swedspan Case – Incremental GBM Innovation at Business and Business Model Dimension Level

Swedspan A/S BM's is based on all kinds of recycling paper materials. Swedspan A/S has a strong focus on green economy, circular economy, green production, reduction of water consumption and waste. Swedspan has a turnover of about 20 mio. EUR and employs about 100 employees. Swedspan A/S produces by order high quality products to the european industry. Swedspan A/S have build up several quality systems so all products can meet precise, measureable and well defined quality demands. Swedspan A/S continuesly invest in greener and more sustainable technologies – the competence BM dimension. Swedspan A/S has further in 2019 finish a large rebuild of the production and installed software to manage recycling production. Production capacity is expected to increase by 2021 10 – 12 %, which means that energy consumption and CO2 emission is expected to raise if Swedspan A/S do not invest heavily in new green technology. In Table 4 some of the key figures related to the GBM measurements made by Swedspan A/S are shown.

Swedspan A/S focus on becoming green on more BM Dimensions as seen in Table 4. Energy consumption will be reduced, local supply of heat to the municipalities small towns will be increased, CO2 emission will be reduced and water consumption too. However, as can be seen CO2 emmision

Table 4 Swedspan A/S

	Yearly Figures within Swedspan A/S			
Green Business Model Approaches	2018	2019	2020 Budget	2021 Goal
Specific Energy Consumption kwh/netto ton	1613,5	1685	1576	1450
Supply af heat in MWh to local community	74402	72900	80000	84000
CO2 emmision from production ton	1235	1951	1600	1650
Water consumption m2	407528	437481	410000	400000

is expected to rise in 2021 due to business growth, increased production and expected political change in emission calculation from government side. In Denmark the carbon footprint calculation related to renewable energy sources are politically decided each year – latest calculation is from 2018 [23]. This means that the business on some GBM parameters will turn or are more green, but on others as e.g. the CO2 parameter in Table 2 will turn less green. If they use an renewable energy source that is not political prioritized positively related to CO2 and subsidies a paradox turns up related to the GBM. In some cases it could hereby be more preferable to increase green electricity and even water consumption, with out ngetting Swedsspan less green.

Another issue is that GBM's impact on CO2 e.g. is measured in absolute numbers – ton of CO2 reduction. In relative measurements more can however be produced with less resources and less "carbon foodprint" from the business. However, this is not valued in the emission calculation. Further the measurements on Energy Consumption, CO2, water consumption, waste water production are all calculated and visualized for the individual business – not for the business entire vertical Business Model Ecosystem [3] (suppliers, users, customers and other businesses). All business models that are included and contribute to the business model are not taken into the green calculation – so a case of "green washing" [29] can easily be established – and the business can still be classified as green. It means that some businesses can be considered having GBM's, where as suppliers at the same time might supply raw material produced with e.g. "black energy". Customers might buy GBM's to be combined with "black" BM's. Case of Green Washing is continuously coming up in the GBM BMES debate where businesses by buying CO2 quotes can be allowed to do CO2 emmision. Swedspan A/S is not using this practice but it shows that the classification of GBM's becomes even more complex when Green is considered for the whole value network.

Another example is windmill's that are generally considered being GBM's as they are producing green energy. Many wings from windmills have to be taken down, brought to shore by ship and transported to deposition [30]. Recycling is often not possible as the material used for the wings cannot be recycled yet because it contains a mix of materials and used materials. Further the heavy steel towers, gears and nacelles are produced with much energy consumption – often "black Energy" – which makes the Lifecycle analysis (LCA) in a CO2 and material recycling perspective very hard to classify as green over time – from cradle to grave for a windmill. In other words – Is the BM and the outcome green electricity from windmills really green?

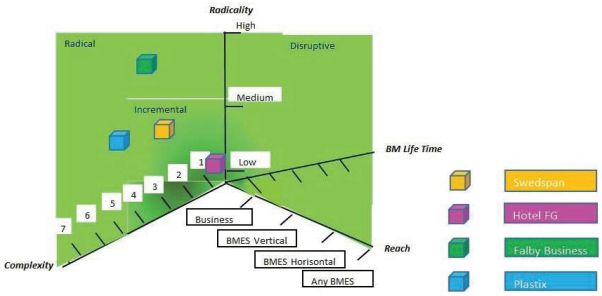

Figure 9 Swedspan A/S, Hotel FG, Falby and Plastix degree of Green Business Modelling.

The implementation of Hotel FG's and Swedspan A/S's Green TO BE BM have yet not economically been evaluated and classified related to GBM. However, it is with our new GBM framework possible to classify the GBM as in the area of incremental TO BE Green Business modelling as seen in Figure 9. Hotel FG and Swedspans A/S GBM is changing only 1–2 BM Dimensions and only incremental. The GBM's might be new to the businesses but not new to vertical and horizontal BMES or the world. Both Businesses are changing green at more Business Model innovation levels as seen in Figure 10.

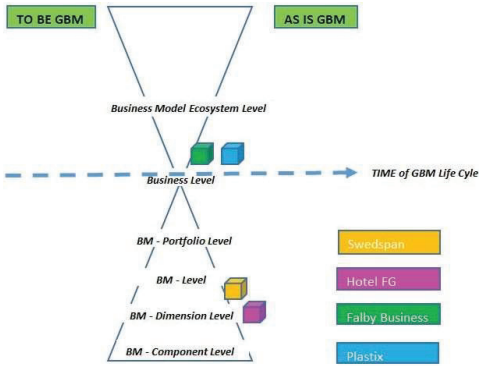

Figure 10 Swedspan A/S, Hotel FG, Falby and Plastix Green Business Modelling at Business Model Innovation levels.

At Business level Swedspan A/S performance is more radical GBM Innovation performance than Hotel FG and Falby and Plastix described beneath even more.

6.3 The Falby – Indian Yarn Case – Radical Green Business Modelling at Business and Business Modelling Level

Energy consumption, waste, waste water production and use of water are often very high in Yarn Manufacturing BMES's. However a Danish Design Business has through a close collaboration with Indian Yarn Manufacturer and leading Retailers in Europe build a production concept that have reduced e.g. water consumption from 1000 l water pr. unit of yarn to now 1 l water.

Figure 11 Yarn production from cradle to shop.

As more and more leading retailers demands GBM's and their retail brand gets dependent on being green they are now pushing the design business together with the Indian yarn business to be and document that they are green and produce green BM's. At the moment very few GBM certificates exist within the Yarn BMES however more consultancy business are or want to introduce these GBM certificates. The challenge is however that the measurements are not at the moment established with advanced continuous monitoring technology enabling real time monitoring. The measurements could be done by advanced use of wireless technologies and embedded devices (Sensors) in yarn products, production and along yarn business manufacturing processes and value networks – "cradle to grave". However this is challenging as the investment are high, risk of brake down in the system is possible along the long value network chain and wireless technologies are still in their very beginning phase. Further, the BM's along the yarn value network will then be an open business model value network and possible to see for any that have access to this. They will potentially also be open to those involved and in potential risk to be hacked. Therefore a monitoring and quality security system must be established to measure but also protect the green yarn BM value network and collaboration. The challenge is however that the cost of establishing such GBM's monitoring system will be very high compared to the unit price of the yarn. In other words there is a strong demand for such wireless technology solution but system cost has to be degreased pr. unit. Further the energy consumption of these devices and systems to run the GBM system has big concern. They have to be calculated and the expectation is that the energy consumption will be high – and this has to be decreased.

The Falby – India Yarn Case shows a Radical GBMI at business level as Falby, Indian and retailer businesses are changing to a full or partly commitment to become green at the business level. It can be argued that Falby and Indian Business change to become green in their entire businesses were as the retailers RE, HN and LI only have a small part of their BM's that are changed to green. Further the BM's at RE, HN and LI retailers are mostly green on competence dimension but hardly on other BM dimensions. Falby and Indian Yarn businesses BM's have more BM dimensions that are green.

6.4 The Plastix Case – Radical and Disruptive Green Business Modelling

Plastix provide sustainable BM solutions for cleaner environments and cleaner oceans. Plastix in Lemvig, Denmark transform fishing nets, fibres and rigid plastic waste fractions into high quality plastics raw materials. Plastix have the fishermen bring broken and used fishing nets from sea to harbor and to recycling.

Figure 12 Green business modelling with plastic.

Harbor provide storage facilities and Plastix technology transforms an extensive disposal/deposit problem – discarded fishing nets and other post-use plastic waste fractions – into valuable recycled HDPE and PP plastics raw materials. Plastix creativity for solutions derives from the imagination, designs, Business Model innovation, strategies and collective implementation methodologies that meet the diverse needs of customers and networks that want to buy and supply green BM's. Through the use of advanced technology Plastix provide treatment methods that have the ability to effectively recycle plastics and metals from net and trawl without downgrading the quality and thereby loose valuable resources. With recycling technology, the used maritime materials can be recycled 100% in a closed loop. Plastic waste and recycling of plastic will create horizontal and maybe diversified new BMES, which will need and be able to take advantage of future wireless technology BM's development. One large challenge is documentation of the plastic. As fishing nets contains a mix of different plastics, these different

plastic fragments have to be sorted, which today is done manually with high resource consumption and labor costs. Advanced wireless technology can support identification and sorting different plastic types. Then Plastix will be able to come closer to producing 100 % documented clean plastix. This will enable Plastix to enter the BMES's for water pipes and other plastic BMES that due to strict EU standards requires clean plastic.

The Plastix case show a business that are built on recycling waste materials, have develop technology that can recycle waste and supply BMES that demands BM's made from waste. The Plastix case show a radical and disruptive Green Business and Green Business Modelling approach as Plastix is working on all levels of the Multi Business Model Innovation levels on "greening" BM's components, dimensions, Business models, portfolios, business, BMEs and processes. Plastics and Falby – as mentioned above – have a major impact on both vertical and horizontal BMES – but maybe not to the world.

7 Discussion and Reflection on Results

The **different parameters measured related to GMBM Innovation** as seen in Figure 1 includes a large variety of parameters that need measurement related to classifying Green. This means that it actually today is possible to any business, city, country or society to claim that they are green, become green or define their own green definition of BM's – and to innovate GBMs. Politically and economically, this is probably not the intension and not optimal as we then have different "language" and terminology on green. How can we then talk about GBM together? When we define it differently. It will in the upcoming years probably be adjusted, so it is possible more precisely to characterize a BM on **a common agreed scale of green**. Here wireless technology can play a central role as most green classification today is made "by hand" and "by man". At the moment the term Green related to Business Modelling is very blurred and exstremely context based, however several consultancy businesses have made green certifications [31–34]. Green Business Certification provides third-party credentialing and verification for rating systems relating to green business modelling – but on a business level as seen in Figure 10. Many of these consultancy businesses and certification systems have their origin from building, technical and engineering construction BMES, which means that not all businesses can be measured and fits the Green Business Model Certification framework. Further they do have their origin from business model understanding, theory and praxis.

Absolute measurement and relative measurements of GBM's raises a challenge to the definition of GBM's. How green is the BM if it is produced as one of a kind or as mass production with low energy consumption pr. unit, relative low impact on CO2 pr. unit and low resource (material, water) consumption pr. unit?

Life Cycle assessments of a GBM have been discussed in many publication – and taken into consideration as the tool to measure green. However the tool is measuring mostly single products from cradle to grave. Life-cycle assessment or life cycle assessment (LCA, also known as life-cycle analysis) is a methodology for assessing primarily environmental impacts associated with all the stages of the life-cycle of a business model product, process and now also service business models. BM's environmental impacts are assessed from raw material extraction and processing (cradle), through the BM's creation, capturing, delivering, receiving and consumption, to the recycling or final disposal of the business model composing it (grave). An LCA study involves classically a thorough inventory of the energy and materials that are required across the BMES value network of BM's. It calculates the corresponding emissions to the environment – thus assessing cumulative operational AS IS BM and potential TO BE BM environmental impacts. The aim is to document and improve the overall environmental profile of the BM. Procedures for conducting LCAs for products are included in the 14000 series of environmental management standards of the International Organisation for Standardization (ISO), in particular, in ISO 14040 and ISO 14044. However there is still not LCA's for BM's. Criticisms have been leveled against the LCA approach, both in general and specific cases, e.g., in the consistency of the methodology, particularly with regard to system boundaries. Service BM's are now also measured but few cases have until now been seen. However, a major trend in GBM innovation is to transform businesses physical product based BM's to include all kind of GBM's. There are two main types of LCA Attributional LCAs seek to attribute the burdens associated with the production and use of a business model, at a point in time, typically in the recent past. Consequential LCAs seek to identify the environmental consequences of a decision or a proposed change in a system at a certain time and study, and thus are oriented to the future and require that BMES and economic implications take into account. A second type of LCA, termed "social LCA" is under development This type is a distinct approach focus on the potential social implications and impacts of a Business Model. Social Life Cycle Assessment (SLCA) identify and assess potential social impacts along the lifecycle of a Business Model and is framed by the UNEP/SETAC's

Guidelines for social life cycle assessment of business models.[32] The tool builds on the ISO 26000:2010 Guidelines for Social Responsibility and the Global Reporting Initiative (GRI) Guidelines.[33] Some widely recognized procedures for LCA are included in the ISO 14000 series of environmental management standards, in particular, ISO 14040 and 14044 [33, 34].

Multi Business model approach related to other GBM approaches was seen in Monica project [19] related to Noise cancelation, attendees security and Green. However this increase the term GBM into other areas than energy, CO2, use of material and resources, water consumption, waste, environment pollution other than chemicals. The term GBM then begin to touch upon UN 17 world goals as seen in Table 1 [35, 36] – and then GBM becomes even more fuzzy.

Wireless technology related to GBM Innovation seems at the moment very little actively used and covered in the cases and projects we studied. Our impression is that this is not unfamiliar to the wireless technology society as most GBM origins from other line of BMES. Monica used advanced wireless technology to support green business modelling but in areas of GBM innovation and Green Business Modelling monitoring and measurement not a top priority for green community, society, businesses and projects.

8 Conclusion

Many businesses feel high pressure to build more GBM's from more and more key stakeholders. Customers, Users, suppliers and even employees are today top vote getters when the CEO's in businesses are asked which stakeholders would be most influential on how they manage green BM's. Businesses are facing " a world of GREEN MULTI BUSINESS MODEL INNOVATION". Businesses entering GMBMI have to fundamentally convert business practice into new ways of doing business – in these cases Future Wireless Technologies can play an important and supporting role. Green Business Model Transformation can help/drive Future wireless Technologies into sustainable business models but also GBM's in general.

A disruption to previous MBMI and MBMI processes is the outcome of GBM and GMBMI. Businesses are forced to leave their "Business Model comfort zone" and existing BMES – and develop more radical and disruptive BM's – to become GREEN. However, there is still great fussiness on what is green and what is a GBM. The architecture of 5G and 6G wireless technologies combined with a MBMI Brain and advanced Multi Business Model Innovation technologies are perfect platforms and "partners" to evolve

"the new era of green business modelling" – new archetypes of GBM's and make GBM's finally profitable.

Businesses and society need to rethink and act differently to innovating GBM. As today it is context based, what is defined as GBM. The context spans from pollution, energy consumption, energy types, waste, material used, recycling, circular economy and latest UN 17 goals. Every business and everybody have their own definition and too many business models define themselves as GBM's.

Analyzing these GBM's carefully shows that most are just "greening" on one or very few BM dimensions and components. Further very few have really changed their Business BM's into green and therefor the impact on their business, BMES and the world is still small. Becoming green means turning to more Radical GBM's and even Disruptive GBM's and reach out to not just vertical BMES but also Horizontal and Diversified Green BMES. Business might have to leave existing BMES to impact and enter other vertical or horizontal GREEN BMES or even create new Disruptive GREEN BMES. They have to find the GBM's and combine these with future Wireless technologies – that can be vehicles and the platform to achieve and really monitor GBM's.

The papers project and case examples shows a variety of GBM and GMBMI work and what success criteria they try to achieve related to Green Business Modelling. GBM seems to be a perfect platform for increase MBMI as GBM seems to be dependent on a MBMI approach.

Acknowledgment

The paper acknowledge the EU Interreg Kask, ØKS and Horison 2020 for sponsoring the Green Business Model research.

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