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Tiivistelmä

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Vihreän talouden, bio- ja kiertotalouden huomioiminen akateemisessa tutkimuksessa ja politiikan teossa on tärkeä keino kestävän kehityksen edistämisessä (D'Amato et al. 2017). Se on myös tärkeä teema ja väline politiikan teossa (Lithido & Righnini 2013). Tätä varten tarvitaan tehokkaita ja monipuolisia menetelmiä ja työkaluja (esim. indikaattoreita), jotta voidaan kerätä tietoa Suomen biotalousstrategian (2014), vihreän talouden ja kestävämmän tulevaisuuden saavuttamisesta. Suomen biotalousstrategian (2014) mukaan erityisesti maaseudun kehitys nähdään yhtenä tärkeimmistä biotalouden edistämisen ajureista, mikä johtuu pääasiassa maaseutualueilla tuotetun biomassan kysynnän kasvusta ja linkittymisestä maaseutualueiden kehittymiseen. Vihreän talouden mittaamiseen käytettävä indikaattoreita on vielä vähän, ne ovat kapea-alaisia eivätkä skaalaudu hyvin. Tämä koskee erityisesti paikallista tasoa. Edellisessä "Vihreän talouden kestävä ja hajautettu toimintamalli" -hankkeessa tehtiin alustavia vihreän talouden toimintamalleja, indikaattoreita ja tiekarttoja lappilaisiin maaseutukyliin, Saijaan ja Hämeenkylään. (Timonen ym. 2017). Tässä hankkeessa jatkettiin työtä uudenlaisen biotalouden mallin luomiseksi. Tämä toteutettiin täydentämällä vihreän talouden mallia kohti biokaasun tuotantomallia huomioimalla uudenlaiset mekanismit (elintarviketeollisuus ja uudentyyppiset energialähteet) sekä etsimällä monipuolisia markkinointimahdollisuuksia ja uusia liiketoimintamahdollisuuksia. Tämän mallinnuksen tärkeänä osana oli kehittää aiempaan hankkeeseen liittyviä energia- ja elintarvikealan indikaattoreita, täydentää niitä matkailujärjestelmällä ja lopulta integroida ne kokonaisvaltaisempaan symbioosiajatteluun. Vihreän talouden mallinnuksen tarkoituksena on kestävän ekosysteemipalvelujen hyödyntämisen avulla edistää case-alueiden biotaloutta. Hajautettu, kestävä ja kilpailukykyinen lähestymistapa kohti vihreää taloutta perustuu verkostoajatteluun ja luonnonvarojen kestävään käyttöön.

Tässä hankkeessa sektorikohtaiset analyysit (jotka aloitettiin jo edellisessä projektissa) vietiin pidemmälle kohti symbioosimallinnusta. Biotalous ei voi perustua pelkästään sektorikohtaiseen taloudelliseen analyysiin (elintarvikkeet, energia tai matkailu), vaan sen on oltava rajat ylittävää, laajempaa tarkastelua eri sektoreiden kysynnän ja yrittäjyyden osalta yhdistettynä erilaisiin biotalouden vaatimuksiin. Monimarkkina-symbioosi ja liiketoimintamallinnus johtavat biotaloudellisiin liiketoimintamalleihin, kun niitä kehitetään yhdessä toimijoiden kanssa ja täydennetään vihreän talouden indikaattoreilla. Indikaattorien avulla saadaan näkökulma kokonaisvaltaiseen kestävyyteen. Liiketoimintamallit tukevat nykyisen hallitusohjelman keskeisiä tavoitteita ja keinoja, kuten ravinteiden kierrätystä, työllisyyttä ja yrittäjyyttä, kannattavia elintarviketuotantoja, kiertotaloutta, lyhyitä ketjuja ja jakelukanavia sekä uusia liiketoimintamalleja.

Vihreän talouden indikaattorit esitetään paikallistason indikaattoreina, jotka perustuvat Lapin aluetason ominaisuuksiin. Näiden indikaattoreiden tarkoituksena on mitata ja todentaa vihreän talouden siirtymäprosessia (nykytilanteesta kohti tavoitetilaa) alueella. Energia- ja elintarvikeindikaattoreiden osalta tiedonkeruu ja arviointi tehtiin jo edellisessä hankkeessa. Tässä hankkeessa kehitimme näitä indikaattoreita edelleen tarkastelemalla niitä kolmen vihreän talouden paradigman avulla: resurssitehokkuuden, ekosysteemien resilienssin ja sosiaalinen tasa-arvoisuuden. Koska vihreä talous on kestävän kehityksen käsite, on kaikilla näillä paradigmoilla ekologisia, taloudellisia ja sosiaalisia vaikutuksia. Matkailun indikaattoreiden kehittäminen on vielä alkutekijöissä ja indikaattoreiden arvojen laskeminen haastavaa tai mahdotonta, koska paikallistasolta puuttuu tarvittavaa tietoa, immateriaalisten hyötyjen arvottaminen on haastavaa ja subjektiivista (virkistyspalveluiden käyttöön liittyvä

koettu hyvinvointi) ja luontoon perustuvat matkailukäsitteet ja tulkinnat ovat moninaiset. "Kestävän matkailun" saavuttaminen onkin jatkuva prosessi, joka edellyttää jatkuvaa vaikutusten seurantaa ja tarvittavien ehkäisevien ja/tai korjaavien toimenpiteiden käyttöönottoa.

Järjestelmätason indikaattoreiden lisäksi esitämme sosiodemografisia indikaattoreita, jotka esittävät aluetason väestörakenteen nykytilaa ja potentiaalia. Sosiodemografisten indikaattoreiden muutokset heijastavat järjestelmätason indikaattoreiden muutoksia, koska vihreän kasvun voi korreloida järjestelmä- ja aluetasolla.

Symbioosin indikaattoreiden kehittämistyö oli haastavaa energian ja elintarvikejärjestelmien välisten synergioiden sekä matkailujärjestelmien ja ekosysteemien raja-alueiden välisten mittaamisten osalta. Tässä hankkeessa tehtiin alustava ehdotus näistä indikaattoreista. Ensimmäisessä vaiheessa kehitettiin indikaattoreita, jotka mittaavat ekologista materiaalia, energiaa ja palvelualojen välisiä eroja. Hankkeessa esitettiin ideoita ja toimintamalleja, miten uutta energiaa käytetään ja tietoa siirretään kyläyhteisöön. Tämä osoittautui haastavaksi tehtäväksi. Lisäksi yhdessä kyläläisten kanssa tutkittiin ruuan jatkokäsittelyä ja energiantuotantoa sekä symbioosin mahdollisuuksia. Merkittävät muutokset tekniikassa edellyttävät, että yhteisö saa uutta tietoa luotettavasta lähteestä, hankkii tämän tiedon, muuntaa prosessit ja luo uusia tuotteita tai palveluita, kuten Lund (2014) todisti omassa Choice Awareness -teoriassaan. Kyläläisten huolenaihe kylän tulevaisuudesta ja kylän selviytymisestä on motivoinut heitä yhteisiin kokouksiin ja keskusteluihin. Mahdollinen siirtyminen fossiilisesta energiasta itse tuotettuun bioenergiaan on avannut kyläläisille mahdollisuuksia laajempaan yritystoimintaan. Kestävyys on ollut ajattelutapa tuotteiden tai palveluiden luomisen ja kylän liiketoimintaprosessien suunnittelun pohjalla. Tavoitteena on ollut lisätä raaka-aineiden arvoa ja kierrättää sivuvirtapään virtoja takaisin ekosysteemiin. Kestävät symbioosit ovat yhteinen liiketoimintapohjainen ja asiakaslähtöinen malli eri toimijoille sekä matkailun ja energiantuotannon kehittämiseen maaseudulla. Kiitämme Hämeenkylän, Saijan ja Tanhuan kyläläisiä heidän kärsivällisyydestään ja osallistumisestaan projektiin.

Asiasanat: Vihreä talous, indikaattorit, symbioosit, liiketoimintamallit, swot-analyysi, bioenergia, luontomatkailu, ekoturismi, kaskadi-ajattelu, biotalous, energiakylä

Abstract

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The green economy, bioeconomy and circular economy have become mainstream topics in academia and policy making as key sustainability avenues (D'Amato et al. 2017) and as some of the key themes and most important tools for policymaking (Lithido & Righnini 2013). There is a need for effective and versatile methods and tools (e.g. indicators) to collect data to help the move towards a Finnish bioeconomy strategy (2014), and to achieve a green Economy and more sustainable future. According to the Finnish Bioeconomy Strategy (2014) especially rural development is seen as one of the most important drivers of the bioeconomy because of the increasing demand for biomass produced mainly in rural areas and relating to the development of those rural areas. However, the amount, quality and scalability of indicators for measuring the *green economy* is still new, and narrow, focusing mainly on a local level.

In the previous "Sustainable and Decentralised Operating Model for Green Economy" project, a formulation of preliminary green economy operational models, indicators and road maps for Saija and Hämeenkylä rural villages in Lapland were carried out (Timonen et al. 2017). In this project the work was continued, creating a model for a new type of bioeconomy. This was done by complementing the green economy model and biogas production model with new mechanisms (including the food sector and new types of energy) and in finding multi market and business opportunities. An important part of this modelling was to further develop the energy and food sector indicators started in the previous project and complement these with a tourism system and finally integrate these into a more comprehensive symbiosis. The purpose of modelling the green economy in this study is to promote the bioeconomy of the case areas, among others, through the sustainable exploitation of ecosystem services. A decentralised, sustainable and competitive approach to the transition to a green economy is based on network thinking and the sustainable use of natural resources now and in the future.

In this project, sector specific analyses (that were also started in the previous project) were taken further to create a form of symbiosis modelling. Bioeconomics cannot be based solely on sector-specific economic analysis (food, energy or tourism), but must cross borders into different sectors of demand and entrepreneurship, combined with the different demands of the bioeconomy.

Multi market symbiosis and businesses modelling will lead to bioeconomy-based business models, by developing them together with the actors and supplementing them with indicators of the green economy, providing a perspective on overall sustainability. Business models are the key project measures of current government programmes (e.g. for nutrient recycling, employment and entrepreneurship, profitable food production, circular economy, short chains and distribution channels, new business models).

Green economy indicators are presented as local level indicators based on a regional scale for Lapland. The aim these indicators is to measure and verify the green economy transition process in the area and therefore these indicators are eventually meant to be utilised for the whole period of the green economy transition process (e.g. from the present time to the target state). For energy and food indicators, the data collection and assessment was already done in the previous project. In this project we developed these indicators further by reflecting them in meeting the green economy framework with three green economy paradigms (resource efficiency, ecosystem resilience and social equity). In addition, as the green economy is a sustainability concept, all of these paradigms will have ecological, economic and social consequences. For the preliminary development work on tourism indicators, many of the actual indicator calculations were not done or were not yet possible due to the lack of local data, the immaterial nature of the services, subjective perception and also multiple different nature based tourism concepts and interpretations. Achieving “sustainable tourism” is a continuous process and it requires constant monitoring of impacts, introducing the necessary preventive and/or corrective measures whenever necessary. In addition to system level indicators, we present the socio-demographic indicators presenting the overall area level baseline for human and demographic potential and these are to be reflected in the changes in system-level indicators though there might be some correlations to be found between green growth on the system level and area level.

The preliminary work for developing symbiosis indicators was challenging for measuring synergies between energy and food systems, as well as tourism and the ecosystem boundaries, and in this project a preliminary proposal for these measuring indicators was done. The first step achieved during this development work was to develop indicators measuring the ecological material, energy and service flows between the sectors involved.

Presenting the ideas and operating models for the use of new forms of energy and transferring this knowledge to the village community was a challenging task. Major changes in technology alone require that the community receives new information from a trusted source, in addition to acquiring this knowledge, reorganising numerous processes, and creating new products or services as Lund (2014) testified in his own Choice Awareness theory. In our current study it was notable that the villagers' concerns about the future of the village and the survival of the village have motivated them to join meetings and discussions. The possible transition from fossil-based energy to self-produced bioenergy has also opened business opportunities for the villagers. Sustainability has been the driving theme for village meetings and planning new products, services and businesses. The aim has been to reduce the village's capital outflow. The first step is to establish a bioenergy plant and start producing bioenergy from local raw materials and to satisfy the internal need for energy. Energy self-sufficiency is the first major contributor to the changing future image of the village. In the next step, raw materials and products from these areas will be further processed with their own energy. Bio energy production is also a key point when building a sustainable symbiosis for various actors both in tourism and farming in rural areas. We thank the villagers of Hämeenkylä, Saija and Tanhua for their patience and participation in the project.

Key words: green economy, indicators, symbiosis, business models, SWOT analysis, bioenergy, nature tourism, ecotourism, cascading thinking, energy village

Content

1. Introduction

The green economy, the bioeconomy and the circular economy have become mainstream concepts in academia and policy making are key sustainability avenues (D'Amato et al. 2017) and are some of the key themes and most important current tools for policymaking (Litido & Righnini 2013). A number of international organisations have discussed issues related to the transition to a green economy (EC 2017, UNEP 2011, OECD 2014). In 2008, UNEP launched the “Green Economy Initiative to Get the Global Markets Back to Work”, aiming to mobilise and re-focus the global economy (Lenuta 2013). In addition, the green economy has become a central issue since the 2012 UN Conference on Sustainable Development in Rio de Janeiro (Rio+20) (UN 2012). The European Environment Agency (2016) has stated that, “The green economy can refer to sectors, topics, principles or policies”.

However, there is no general agreed definition of the green economy and the concept of the green economy is contested, even though the term is widely known and broad (Speck & Zoboli 2017). For example, according to D'Amato et al. (2017), the green economy acknowledges the underpinning role of all ecological processes and is more inclusive of some aspects of social dimensions at the local level than the bioeconomy and circular economy. In addition, the amount, quality and scalability of indicators for measuring the *green economy* are still new and narrow, especially on the local level.

There is a need for effective and versatile methods and tools (e.g. indicators) to collect data on moving towards the Finnish Bioeconomy Strategy (2014), and a green Economy and for achieving a more sustainable future. According to Finnish Bioeconomy Strategy (2014) rural development is especially seen as one of the most important drivers of the bioeconomy because of the increasing demand for biomass produced mainly in rural areas and relating to the development these areas.

The regional scale is a good level of governance for planning, coordinating and assessing actions towards sustainable development (Mascarenhas et al., 2010). There are several studies which have reviewed sustainability indicators at the rural level (e.g. Marsden 2003; Bryant and Granjon 2009; Cocklin et al. 2002) and at the community-based level (e.g. Valentin and Spangenberg 2000; Boyd and Charles 2006; Lu et al. 2017).

In the previous "Sustainable and Decentralised Operating Model for Green Economy" project (Timonen et al 20017), a formulation of preliminary green economy operational models, indicators and road maps for the rural villages of Saija and Hämeenkylä, in Lapland, were carried out (Timonen et al. 2017). The project provided a positive iteration programme for the regions by launching local pilot projects and development processes for the village-level bioeconomy. One of the further research needs was to further develop system-level green economy indicators, including more comprehensive social dimension and to complement energy and food system indicators with a tourism system. A further development need was also to create of a new type of bioeconomy network model to measure and explore synergies between energy and food systems and the use and storage potential of new types of energy in a local farm/village context, as well as synergies between the tourism system and area ecosystem boundaries. In addition, in the previous project (Timonen et al. 2017, pp. 41-43) a model of a bioeconomy-based Agro Centre and the rural Agrohub network were initiated and presented. The Agro Centre is a consortium of industries which is operated in a virtual-physical manner locally, in a defined geographic area. It is formed by competent people, farms and companies working in a symbiosis where the connecting factor is mutually owned energy production. The raw materials for energy production at the very basic level are manure and grass from farms and woodchips from local forest owners. Agrohub, on the other hand, serves as a meeting point for different kinds of resource providers and users, creating new business perspectives and supporting the thematic Platforms (European Commission 2018) and Arctic Smartness Cluster projects (Regional Council of Lapland). The green economy model and its new structures (Agrohub), open data and the advancement of digitalisation will in the future create the basis for future work on new indicators.

In this follow up project, we bring together the preliminary work started in the last project and continue the work in creating a model of a new type of economy for the bioeconomy. This is done by extending a model of the green economy to include a biogas production with new mechanisms (food sector and new types of energy), and finding multi market and business opportunities for the new bioeconomy. An important part of this modelling is to further develop the energy and food sector indicators started in the previous project and also to complement these with the tourism ecosystem and finally to integrate these into a more comprehensive symbiosis. In the previous project, we developed the Agro Centre and Agrohub model concepts, in which we locally created business models to develop the business network in the villages and their related rural areas. The Agrohub model further demonstrates the implementation of new business models and consortiums for different industries. The symbiosis of business models for energy and food systems were based on the digital Agrohub model (Timonen et al. 2017, pp. 91).

We thank the Ministry of Agriculture and Forestry for financing this project and we are grateful for the valuable comments by the project’s steering group: chair Liisa Saarenmaa (Ministry of Agriculture and Forestry), Jukka Teräs (Nordregio), Mika Riipi (Regional council of Lapland), Hannu Linjakumpu (Centre for Economic Development, Transport and the Environment, Liisa Saarnilehto (Ministry of the Environment) and Mika Aalto (Ministry of Economic Affairs and Employment).

2. Objectives

This project promotes the rural bioeconomy by reducing the use of fossil fuel purchases and by supplementing them with self-sustained renewable energy production. In addition, the project promotes the increased self-sufficiency of food production in the area.

The aim is to carry out development work based on findings already made in previous case villages (Tanhua, Saija, Hämeenkylä) and to obtain information to form a basis for decision making and design for the development of the case villages **Saija** and **Nellim**. More specifically, the aim of the project is to continue to pursue the aims of the previous project that launched a development process in the village of **Saija**. Firstly, to promote the rural economy by reducing the use of fossil fuel purchases and replacing fossil fuels with self-sustained renewable energy production. Secondly, to increase self-sustained energy, and thirdly to promote the self-sufficiency of food production in the area. The aim of this project was also to begin new promotion work in the village of **Nellim** where a responsible tourism concept was integrated as part of the local area ecosystem and network.

The aim is to continue developing a green ecosystem approach model. The purpose of green economy modelling is to promote the bioeconomy of case areas, among others, through the sustainable exploitation of ecosystem services. A decentralised, sustainable and competitive approach to the transition to a green economy is based on networking and the sustainable use of natural resources now and in the future. For this reason, a partial objective of developing the model was to create sustainability-based green economy indicators for modelling and validating the effectiveness of the desired target from an economic, ecological, and social point of view, and to take these further for a new perspective on bioeconomy symbiosis.

2.1. Green economy framework

In this project, a more profound green economy theory is presented and taken further compared to the previous project. In the theory section, the theory of ecosystem services is extended as part of the green economy concept framework. Integrating a reference framework of ecosystem services into decision-making is a new, comprehensive approach to sustainable interaction between society and nature. From the standpoint of sustainability, it is also important to identify and to monitor the factors that influence the supply of ecosystem services, as well as to define pressures and threats to ecosystem services. Similarly, the impacts of chosen policies and the measures must be measurable and monitored.

In the previous project the sustainable use of production services was an important contributory factor, but the maintenance and regulatory services, which are cogenerated by several ecosystems, are highly challenging to quantify. Measuring cultural services, such as recreational services and their welfare effects, becomes quantitative, qualitative and subjective.

2.2. Green economy indicators

A partial objective of developing a green economy model was to create sustainability-based, green economy indicators for modelling and validating the effectiveness of the desired target; the green economy transition process. In this project, indicators were used to verify the inner potential of the village and the achievement of the vision of the village, i.e. the achievement of the target population, by measuring the growth of the green economy.

A part of this objective, is to present the indicator selection process and the selection criteria. The indicators were classified in three sustainability dimensions (ecological, economic and social), and each indicator had to meet one of the green economy paradigms: resource efficiency, ecosystem resilience or social equity.

The focus of this project was on developing energy and food system indicators from the previous project to meeting the green economy framework and the three paradigms mentioned above. Further the project aimed to complement these with indicators for a responsible tourism system, taking into account not only economic growth, but also ecological sustainability, socio-cultural experiences and well-being.

As a basis for the indicator selection process, the ecosystem framework is to be used as far as possible to identify the potential of renewable resources in the case village. The aim is examine the region's energy, food and tourism sector ecosystem services and explore their potential from the ecological, economic and social point of view. In particular the project examines using renewables for fossil fuel substitution and utilising tourism as cultural services instead of material provisioning ecosystem services. The aim of the ecological perspective indicators is to generate information on alternative product processes and resource potential and assess their sustainable use for the region over the longer term to secure economic growth. The indicators aim to look at the region's self-sufficiency and how the economic potential of the sustainable utilisation of ecosystem services and renewable resources can be increased. The potential of new, value-added products and exports (more refined products) is also evaluated. The social objective of the project is to develop social capital indicators such as "trust" towards the development of green economy plans, and "know-how" to raise awareness of the development potential of the area. The social dimension objective was also to develop indicators that reflect the direct impacts of the energy, food and tourism sectors in terms of increases in employment, food security, well-being and social equity. In addition to these energy, food and tourism sector indicators, we also looked at socio-demographic indicators (population, education, human capital, and GDP).

2.3. Agro-ecological symbiosis modelling

A decentralised, sustainable and competitive approach to the transition to a green economy is based on networking and the sustainable use of natural resources, both now and in the future. In this project, a sector specific analysis (that was also started in previous project) was taken further to include symbiosis modelling. Bioeconomics cannot be based solely on sector-specific economic analyses (food, energy or tourism), but must span different demand and entrepreneurship sectors, combined with the varying demands of the bioeconomy.

2.3.1. Measurement of symbiosis

Here the aim is to take the green economy system level indicators (chapter 2.2.) towards the symbiosis and networking perspective. This can be seen as "scalability" from the company level to the local and regional level. This was done in the project by assessing energy and material flows in the system and their reciprocal effects. The symbiosis measurement used in this project measured the synergies between energy and food systems by evaluating the potential supply volumes meeting the area demand. The symbiosis measurement also assessed synergies between the tourism system (e.g. tourism entrepreneurs) and the local ecosystem by evaluating tourism demand and supply in the context of sustainability and ecosystem boundaries. The indicators for symbiosis also took into account the potential of *new* material flows as new value-added products and exports (fewer but more refined products), i.e. information on market-driven tourism-driven demand. This reveals the new opportunities and potential generated by market-based or demand-based approaches.

2.3.2. Complementary mechanisms (e.g. new food and energy sources)

In the Saija-case the aim was to find complementary mechanisms and production methods for food and energy production (a new smart farm) and to understand the potential for the overall exploitation of farm resources. The case included the following elements:

- Examining the village's potential for food and energy production and determining how surplus energy, food and other outputs can be converted into new products or services.
- Finding the potential for synergies in exploiting side streams of food production and exploring the their suitability for the manufacture of other products, e.g. reindeer husbandry and spice components. Incompatible side streams are directed directly to production or recycled as bioenergy raw materials.
- Exploring opportunities for utilising side streams (e.g. processing residues) of municipal energy production, such their use as nutrients in the production of raw materials.
- Exploring new sources of energy independent of biomass, which could be used in the village's own energy production (e.g. solar and hydrogen).

In the Nellim- area case the focus was to find complementary mechanisms regarding tourism and the Inari area:

- To determine the market-based tourism needs of the Nellim case and explore new market opportunities for tourism and
- To explore new types of food and energy production opportunities to meet the needs of tourists from the point of view of regional resources.

2.3.3. Multi market symbiosis and business modelling

The multi market symbiosis and businesses modelling led to the creation of bioeconomy-based business models, which were developed together with the actors involved. These were supplemented with the indicators of the green economy and provided a perspective on the overall sustainability. Business models are the key project measures of the prevailing Finnish government (2015-2018) programme (e.g. on nutrient recycling, employment and entrepreneurship, profitable food production, circular economy, short chains and distribution channels, new business models). The specific aims of this project were:

- To evaluate the creation of multi-market symbiosis of biomass business in the region and its activities.
- To develop and find new business through complementary mechanisms for food and energy production, in case areas, and create business models.
- To find means through the Agrohub model to get new products into new markets in the bioeconomy and to utilise authenticity-preserving short chains and new distribution channels.
- To increase food sovereignty in the area and increase the added value of downstream products by directing them to, for example, the global digital market (e.g. Amazon.com).

The overall aim of the project was also to find viable, new earning models for farms and rural businesses. The review is based on the opportunities created by the public/private actor approach, such as public demand for new forms of potential and public, non-profit business.

3. Theory

In this chapter, we present the green economy concept and its three paradigms: resource efficiency, ecosystem resilience and social equity. Resource efficiency is the idea of cascading thinking behind the concept; ecosystem resilience is based on the ecosystem service framework and social equity is relevant to all ecological, economic and social aspects.

After this, we present the concept of agro ecological symbiosis as a new kind of bioeconomy where sector specific analyses are used to a cross-sectorial analyses of different entrepreneurship sectors with numerous supply and demand flows and leading to new bioeconomy-based business models.

3.1. Green economy concept

There is no generally agreed definition of the green economy and the concept of the green economy is contested even though the term "green economy" is widely known (Speck and Zoboli 2017). The concept is contested by slightly different definitions (UNEP 2011; United Nations 2012; OECD 2015; Loiseau et al. 2016; Seppälä et al. 2016). The most widely used and authoritative green economy definition comes from UNEP (2011) in which they state: "A Green economy results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities." The same source sums up that in its simplest expression, the green economy can be thought of as one which is low carbon, resource efficient and socially inclusive.

According to the OECD (2015), green growth fosters economic growth which ensures that natural assets will continue to provide resources and environmental services which are vital to human well-being. According to Seppälä (2016), the green economy means changing in a new direction towards ***economic growth*** which at the same time guarantees functional ecosystems (providing ecosystem services alongside resource efficiency, renewable energy production and decarbonisation), well-being and social equity.

The green economy concept acts as an 'umbrella' concept and includes elements from the circular economy and bioeconomy, e.g. eco-efficiency and renewables, and also some additional ideas such as nature-based solutions. However, the green economy acknowledges the underpinning role of all ecological processes and is more inclusive of some social dimensions at the local level, whereas the circular economy and bioeconomy are mainly resource-focused. All three concepts remain, indeed, limited in questioning economic growth (D'Amato et al. 2017).

The central theme in the green economy is emphasising the values of nature: nature is considered to produce natural capital itself and is not considered merely as a raw material stock. According to the green economy premise (UNEP 2011), nature provides fundamental benefits for *the economy* and *society*, which are often invisible or disregarded (D'Amato et al. 2017). Economies cannot function without nature – our life support system. However, all that sustains us are finite resources. Unless we learn to value them properly, we risk destroying the natural ecosystems upon which all life depends.

According to Speck and Zoboli (2017), there are three commonly accepted green economy paradigms: improving resource efficiency, ensuring ecosystem resilience and enhancing social equity. Therefore, in this study, we perceive the green economy concept to be divided between these three paradigms.

3.1.1. Resource efficiency

Resource efficiency has no commonly accepted definition (Huysman et al. 2015). According to the ECN (2013): "Resource efficiency is a way to deliver more with less (natural resources). It increases aggregate economic value through more productive use of resources, taking their whole life cycle into account." The European Commission state that: "Resource efficiency means using the Earth´s limited resources in a sustainable manner while minimising impacts on the environment. It allows us to create more with less and to deliver greater value with less input," (EC 2017).

The circular economy is based on resource efficiency. According to the Ellen MacArthur Foundation (2015), the circular economy means "…one that is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times, distinguishing between technical and biological cycles," and "a circular economy addresses mounting resource-related challenges for business and economies, and could generate growth, create jobs, and reduce environmental impacts, including carbon emissions," (Ellen MacArthur Foundation 2015).

One concept used to depict the efficiency of resource use is called cascading use (Figure 1) and it means reusing resources in a hierarchical order (Sirkin and ten Houten 1994): energy production is the least favoured option (after disposal as waste) and industrial utilisation and recycling of material (utilising side flows) for more added value products is favoured and recommended over energy use. However, there are some exceptions, and according to Rytteri and Lukkarinen (2014), for example, following a strict cascading principle could problematically limit the use of biomass energy in sparsely populated rural areas with decentralised energy production.

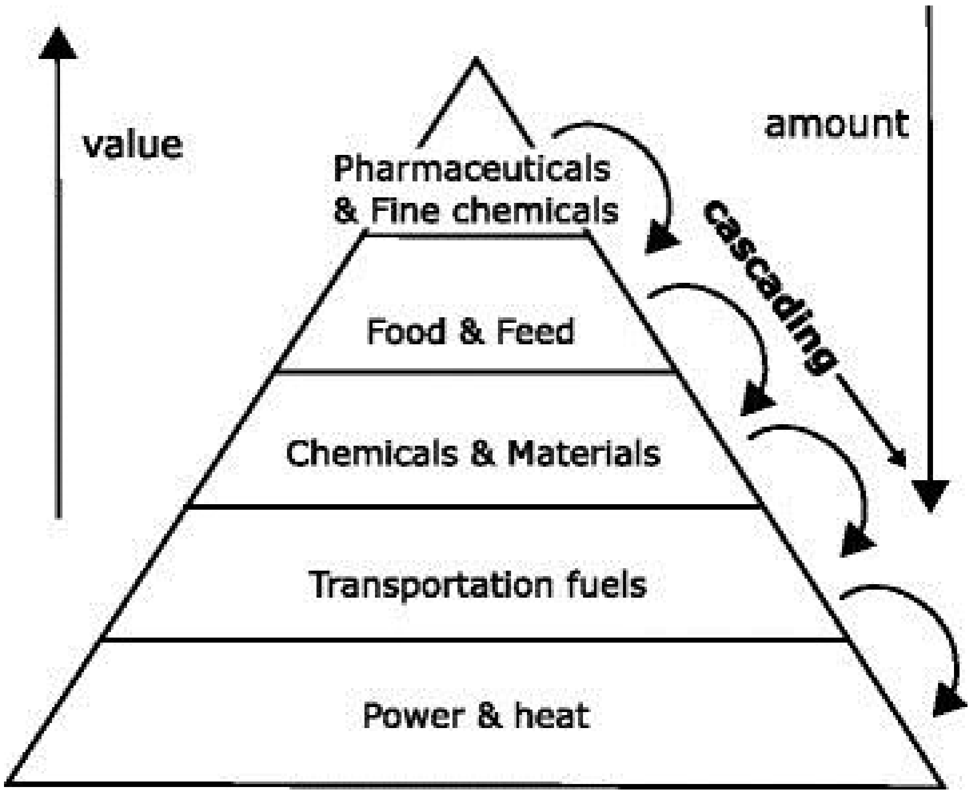

Figure 1. The cascading use of biomass (Source: http://agriforvalor.eu/article/The-cascading-usage-of-biomass-23). The background for cascading use is the concern over the sustainability of natural resource use and the circular economy, for example, aims to achieve neutrality from environmental impacts. The sustainable utilisation of renewables reflects resource efficiency as one paradigm of the green economy. It is thought that forestry and the agriculture can play a fundamental role in providing bio-based substitutes for non-renewables (Ollikainen 2014, Roos and Stendahl 2015).

From an economic viewpoint, with efficient resource use, more can be produced with less, that is, production can be increased. A carbon neutral circular economy and resource efficiency safeguard natural ecosystem services (Mickwitz et al. 2014), which have a wide spectrum of ecological, economic and social impacts (Millennium Ecosystem Assessment 2005).

3.1.2. Ecosystem resilience

Resilience has numerous levels of meaning, from the metaphorical to the specific (Carpentier et al. 2001). According to Gunderson (2000), "Resilience in ecological systems is the amount of disturbance that a system can absorb without changing stability domains." The concept of a social-ecological system is central to resilience thinking. It emphasises the "humans-in-nature" perspective which means that ecosystems are integrated with human society (Resilience Alliance 2010). Furthermore, the diversity and responsiveness of the industrial structure strengthens regional resilience, i.e. the ability to adjust to changing situations and economic disruption (Karppinen and Vähäsantanen, 2015).

Resilience in ecosystems is defined as "a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables," (Holling 1973). Resilience is defined as the ability of a system subject to disturbance to retain its essential structure, function, and feedbacks (Walker and Salt 2006) and return to its pre-disturbance state. The notion of resilience for a system with multiple equilibria focuses on the magnitude of disturbance the system can absorb without shifting to a new equilibrium (Walker et al. 2004). This form of resilience is referred to as "ecological resilience" (Holling 1996). Productive ecosystems are necessary for the supply of ecosystem services. Ecosystems that lack resilience are vulnerable to disturbances that can lead to reductions in the supply of ecosystem services. Some ecosystem services are valuable precisely because they increase the resilience of social-ecological systems. Ecosystem services cannot be used beyond the natural **resilience.** The environment needs diversity to work productively, otherwise its capacity to generate ecosystem services and recover from disruption will be reduced, resulting in an increase in vulnerability to climate change and natural disasters.

The **ecological carrying capacity** is the maximum number of a particular species that a specific ecosystem can sustainably support. The human carrying capacity is viewed as the areas of land that support a population and it is viewed as the maximum load (rate of resource harvesting and waste generation) that can be sustained indefinitely without reducing the productivity and functioning of ecosystems wherever those ecosystems are. The carrying capacity is the ability to produce desired outputs (i.e., goods and services) from a limited resource base (i.e., inputs or resources) while at the same time maintaining desired quality levels in this resource base. It provides physical limits as the maximum rate of resource usage and discharge of waste that can be sustained for economic development in the region.

The carrying capacity depends on several aspects: resources, interaction, habitat, economic conditions and policies. Resources (biological or non-biological) influence the number of species in the habitat based on the current conditions and interaction (physical, chemical, biological) between the resources and the processes involved in the conversion/production of the resources for a desired output with residuals and waste in the environment. (Ramachandra et al 2014.) The aim of increasing the carrying capacity is to adjust/increase the ability of the natural environment (Ramachandra et al. 2014), hence it is linked to the concept of resilience. For example, humans can exceed their local carrying capacity by several means including trade to import resources. The estimation of the carrying capacity dimensions concern a) the stock of available resources to sustain rates of resource use in production, b) the capacity of the environmental media to assimilate waste and residuals from production and consumption, c) the capacity of infrastructure resources (e.g., distribution and delivery systems) to handle the flow of goods and services and resources used in production and d) the effect of both resource use and production outputs on the quality of life (Ramachandra et al 2014).

An ecosystem services perspective provides a useful framework to consider the use of biomass resources for various goals, provided that the utilisation is realised within the boundaries of sustainability (compare Carpenter et al. 2009; Craig and Ruhl 2010). There are many definitions of ecosystem services to be found in the literature (La Notte et al. 2017). According to the Millennium Ecosystem Assessment (2005), ecosystem services are material and immaterial benefits provided by nature and valuated by humankind. In other words, they are immaterial services (cultural, regulating and supporting services) that generate material services (provisioning services): for example, photosynthesis is a basic supporting process which creates new biomass and is takes part in the water cycle of the earth. Harrington et al. (2010) defines ecosystem services as "benefits that humans recognise as obtained from ecosystems that support, directly or indirectly, their survival and quality of life." According to the Millennium Ecosystem Assessment (2005), ecosystem services provide us with immediate and indirect benefits, e.g. food, energy, carbon sinks, biodiversity, and photosynthesis. According to Saastamoinen et al. (2014), supporting services create a basis for the other main categories (provisional, regulating and cultural services) and act as indirect services in the production of other final ecosystem services, or are partly categorised as regulating and supporting services. The socio-economic factors (e.g. population demography and industrial structure) of an area in turn have indirect *social effects,* e.g. the well-being of the residents.

The sustainable utilisation of ecosystem services maintains ecosystem resilience. In order to secure ecosystem services, markets should be created for them. Creating markets for ecosystem services that have no markets is a good way to get involved in decision making (Kniivilä 2013). The sustainable use of an ecosystem, e.g. of its provisioning services, secures its ability to function (regulating and supporting services), which in turn secures the production, productivity and economy of (cultural and provisioning) the ecosystem services (Millennium Ecosystem Assessment 2005) (Figure 2).

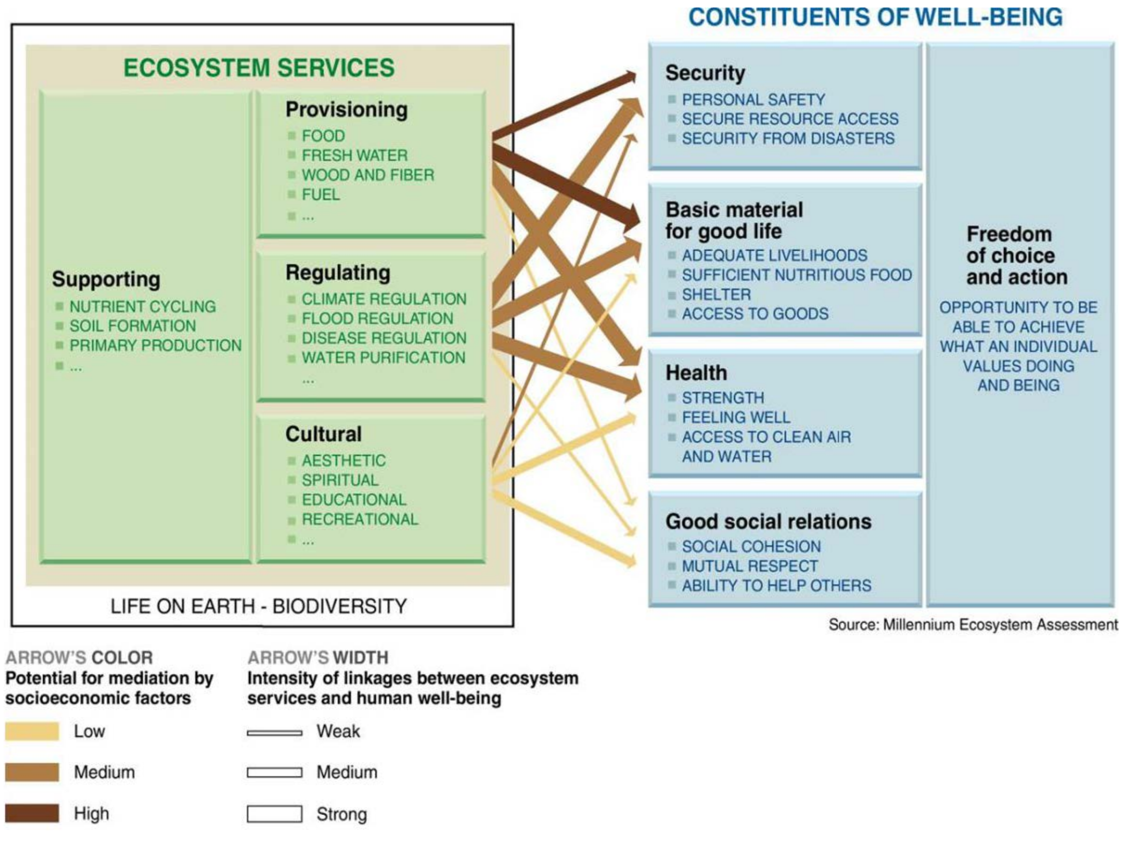

Figure 2. Ecosystem services and well-being (Millennium Ecosystem Assessment 2005).

3.1.3. Social equity

There are several different definitions of social equity, but they all refer to fairness and justice. According to Falk et al. (1993), “Equity derives from a concept of social justice. It represents a belief that there are some things which people should have, that there are basic needs that should be fulfilled, that burdens and rewards should not be spread too divergently across the community, and that policy should be directed with impartiality, fairness and justice towards these ends.” Beder (2000) states that it is agreed that equity implies a need for fairness, in the distribution of gains and losses, and the entitlement of everyone to an acceptable quality and standard of living. Social equity may also be pointed more towards ecological, economic or social aspects. For example, social equity can mean equal accessibility to resources in an area, which on the other hand has many direct or indirect impacts on society’s economy and well-being. Cai (2008) states that social equity implies fair access to resources and livelihoods. The ethical values shared by society reflect the concept of fairness and the economic values associated with resource uses. Equity as a concept is fundamental to sustainable development. The Brundtland Commission's (World Commission 1990) definition of sustainable development is based on intergenerational equity meaning it consists of a form of 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'.

According to Millennium Ecosystem Assessment (2005), accessibility and its different forms may be the reason why low human well-being occurs even though people live in environmental-resource-rich areas. Further changes in the equity structure of societies can have impacts on ecosystem services, e.g. those who have better access to capital have more opportunities to participate in capital and technologically intensive development. Well-being cannot be considered in isolation from the natural environment. Secure rights to environmental resources (e.g. land, water, trees) is an important dimension of well-being that reduces vulnerability, which also has instrumental value enhancing a person’s freedom to be and to do (Millennium Ecosystem Assessment, 2005).

In addition, Jones (2009) states that people should be treated as equals. Equity refers to a minimum level of income and environmental quality below which nobody should fall. In the community context this means that everyone should have equal access to community resources and opportunities.

3.2. The agro ecological symbiosis concept

The definition of symbiosis depends on the context in which it is used. In biology it refers to the close coexistence between two or more species of organisms (Lahti and Rönkä 2006), or to “the relationship between species that both parties benefit from," (Tirri et al 2001).

According to Chertow (2000, 2007), “*industrial symbiosis (IS)* engages traditionally separate industries in a collective approach to secure a competitive advantage involving the physical exchange of materials, energy, water and by-products.” The starting point for industrial symbiosis is cooperation and the synergistic potential of geographic proximity (Chertow, 2007). Lombardi and Layborn (2012) expand the definition by stating that: “IS engages diverse organisations in a network to foster eco-innovation and long-term culture change. Creating and sharing knowledge through the network yields mutually profitable transactions for novel sourcing of required inputs, value-added destinations for non-product outputs, and improved business and technical processes.” Kurup and Stehlik (2009) emphasise the social aspect, e.g. the relationship between partners of different industries enables sharing information, risks and benefits, thus reducing barriers such as lack of communication, or commercial confidentiality.

Chertow (2007) points out that at least three different entities must be involved in exchanging at least two different resources to be counted as a basic type of industrial symbiosis. Furthermore, the opportunities to exchange resources may concern a) by-product reuse, e.g. the exchange of firm-specific materials between two or more parties for use as substitutes for commercial products or raw materials, b) utility/ infrastructure sharing, which refers to shared use and management of commonly used resources such as energy, water, and wastewater, and c) the joint provision of services, e.g. supporting activities like fire suppression, transportation, and food provision.

Corporate symbiosis is a concrete tool for transforming the economy into a circular economy. According to the Myssy project (Oulun ammattikorkeakoulu 2018) by the Oulu University of Applied Sciences, symbiosis is the combination of several companies, where complementary companies produce added value by effectively utilising the partners' raw materials, technology, services and energy. In corporate symbioses, companies can also cooperate in the acquisition of labour and to sell products.

In practice, enterprise symbiosis appears as an entity or chain of several companies where companies utilise each other and create value for each other. Companies can achieve symbiosis from the use of raw materials through efficiency, technology and service or energy generation. Consequently, it can be expected that corporate symbioses will be strong in a circular economy as the waste generated by on company or production outflows can be utilised as the main raw material for another company. This would also make it easier to utilise the financial benefits of side streams and to improve the usability of processes.

A key factor in *enterprise symbiosis* is to expand the focus of economic utilisation from one product/service to many products/services. Usually, the term "industrial symbiosis" is used in English, although this can also be applied to public services and to the social and welfare industry (Marchi at al. 2017). In essence, corporate symbiosis has focused on wider utilisation of materials, increased business cooperation and strengthening the regional economy. In general, according to Marchi et al (2017), business symbiosis is focused on 1) utilising waste/by-streams through another company/process, 2) sharing infrastructure and services between different companies/business campuses, and 3) co-operation between companies, e.g. in design, experimentation and the production of services. In the same report Marchi et al. (2017) proposed to extend the industrial symbiosis concept to public sector activities as it would best promote cooperation between private companies and public service providers.

VTT (2015) highlighted the root cause of industrial/corporate symbiosis when companies are under increasing pressure to improve their resource efficiency and reduce waste costs. Therefore, we need to look at the material flows and processes of companies in a new way. Pohjakallio (2017) raised the interaction and trust between people and businesses at the heart of industrial symbiosis. Trust is considered an essential asset for a well-functioning industrial ecosystem (Schwarz and Steininger, 1997; Baas, 2008; Gibbs and Deutz, 2005; Sterr and Ott, 2004; Chertow et al., 2008; Dlouhá et al., 2013).

The most central feature is diversity and operational efficiency (Sagarin, 2013). The more complex the ecosystem is the stronger and more durable it is. The same thinking works in corporate symbiosis, i.e. a more economically sustainable environment requires a symbiotic relationship between companies and the ability to move from single product/service thinking to multiple product/service thinking, i.e. to see economic entities. Enterprise symbioses are then created to solve a problem or create potential (Mallette and Goddard, 2018).

Korhonen et al. (2002) emphasise that the material and energy flow structures vary and depend on the context and situational factors which are distinct for the region and for the industrial system in question. Hence it is difficult to establish universal design principles for regional industrial networks that are naturally different from each other.

Centralised and decentralised networks become symbiotic when there is a common will between people and businesses to solve a problem or take advantage of an opportunity. The number of participants in this group is often varied, but they often share a common intent and engage in common ventures. A symbiosis sometimes arises from unlikely partners. A common problem or target may combine the enterprises although immediate benefits are not visible but are expected at some time I the future.

In the networking process, it is essential that he actors find an area of common benefit (Virtanen 1999). In addition, networks reveal resources that have not yet been harnessed for utilisation. Agro ecological symbiosis (AES) is a model where food production is arranged in a mode of industrial ecology and industrial symbiosis. The Finnish pilot AES project aimed to achieve localised, energy and nutrient self-sufficient food systems connecting different stakeholders in the process. The project results have led to achievements in combining food processing, biogas production and cooperation between different stakeholders which in turn will lead to more sustainable localised food systems and create new jobs in rural areas and communities. (Koppelonmäki et al. 2016).

3.3. Symbiosis business modelling

A business model is a conceptual tool to help understand how a firm does business and can be used for analysis, comparison and performance assessment, management, communication, and innovation (Osterwalder and Pigneur, 2005). Lindgren and Rasmussen's Business Model Cube offers a model to understand value chain functions in primary and secondary level. It makes it possible to connect a company's network and process to form new kinds of relations. The generic dimensions for their multi business model include: value proposition, customers, value chain, competence, network and network partners, relations and value formulas (Lindgren and Rasmussen, 2013). This model makes it possible to build up a symbiosis business model.

Why are business models are important? New business models create new value. In particular, business models are new ways to create value and provided new kind of business. (Bock and George, 2018). A business model depicts the design of transactions, structure and governance to create business through the exploitation of business opportunities (Amit and Zott 2012).

The business model is a plan by which a company creates earnings and value for itself. A symbiosis business model creates earning and value for company itself, but also for other company at the same time. In symbiosis business models, sustainability is also a common way of thinking, and is relevant for creating products or services, planning business processes, pursuing financial or seeking financial results, etc. The goal is to recycle the primary raw materials, after adding value in the symbiosis, back into the ecosystem. Sustainable development, responsible business and corporate responsibility and corporate social responsibility are all the terms used by companies in symbiosis (Juutinen and Steiner 2010).

Innovative business models often follow from a significant change in large-scale infrastructure. Changes in technological, social and legal frameworks lead to new value creation opportunities. Innovative business models, in networks, are also models where the network seeks jointly to create cost-savings. Participants in a network could consist of households, primary producers, other resource producers, or side-stream owners. In a symbiosis, the partners are interlinked. The goal is to create new earnings sustainably and create a new value by using raw materials and natural capital sustainably.

The focus of this project is on rural areas, housing, sustainable food production, energy production, and new bio-based production. Small factories can be sustainable in a symbiosis. This business model builds sustainability socially, economically, and ecologically from bottom to top, and expands when the symbiosis units are networked. The key requirement for resilience is met in these models at the source of the process, where the generated side streams or waste are recycled symbiotically among other companies. On the other hand, industrial symbiosis attempts to reduce its emissions in accordance with its business model and to streamline its operational processes in order to obtain reduced emissions.

A successful partnership will help each company to expand its capabilities and to identify new opportunities for collaboration outside the current stage of development. According to Echavarria (2016), this is founded on the collaboration of individuals, groups and companies building value together, embedded as part of a larger ecosystem of business actors

The literature presents various perspectives on business models: Margretta (2002), Amit and Zott (2012) and Beattie and Smith (2013) describe business models as a holistic description of 'how a firm does business' and Teece (2017) states that a business model articulates how the company will convert resources and capabilities into economic value. It is nothing less than the organisational and financial 'architecture' of a business and includes implicit assumptions about customers, their needs, and the behaviour of revenues, costs and competitors (Teece, 2017). More specifically, Osterwalder and Pigneur (2010) and Osterwalder et al. (2005) describe a business model as a series of elements: the value proposition (product/service offering, customer segments, and customer relationships), activities, resources, partners, distribution channels (i.e. value creation and delivery), cost structure, and revenue model (i.e. value capture). Based on a wide range of literature, Richardson (2008) proposes a consolidated view of the components of a business models as: the value proposition (i.e. the offer and the target customer segment), the value creation and delivery system, and the value capture system. Amit and Zott (2012) take an activity- based perspective, including the selection of activities ('what'), the activity system structure ('how'), and who performs the activities ('who') (Bocken et al 2014).

"Eco-innovations, eco-efficiency and corporate social responsibility practices define much of the current industrial sustainability agenda. While important, they are insufficient in themselves to deliver the holistic changes necessary to achieve long-term social and environmental sustainability. How can we encourage corporate innovation that significantly changes the way companies operate to ensure greater sustainability? Sustainable business models (SBM) incorporate a triple bottom line approach and consider a wide range of stakeholder interests, including the environment and society. They are important in driving and implementing corporate innovation for sustainability and they can help embed sustainability into business purpose and processes and serve as a key driver of competitive advantage. The features of a route a sustainable economy (Jackson, 2009) might consist of the following:

- A system that encourages minimising consumption, or imposes personal and institutional caps or quotas on energy, goods, water, etc.;
- A system designed to maximise societal and environmental benefit, rather than prioritising economic growth;
- A closed – loop system where nothing is allowed to be wasted or discarded into the environment, which reuses, repairs, and remakes in preference to recycling;
- A system that emphasis delivery of functionality and experience, rather than product ownership
- A system designed to provide fulfilling, rewarding work experiences for all and that enhances human creativity/skills;
- A system built on collaboration and sharing, rather than aggressive competition.

These types of changes require a fundamental shift in the purpose of business and almost every aspect of how it is conducted. "Business model innovation offers a potential approach to deliver the required change through re-conceptualising the purpose of the firm and the value creating logic," (Bocken et al. 2014).

Understanding of sustainable business models and the options available for the innovation for sustainable business models and sustainability seem limited at present. To tackle the pressing challenges of a sustainable future, innovations need to introduce change at the core of the business model to tackle unsustainability at its source, rather than as an add-on to counteract the negative outcomes of business. The level of ambition for business model innovations needs to be high and focused on maximising societal and environmental benefits, rather than economic gain alone.

Boon and Ludeke-Freud (2013) describe a sustainable business model as follows: "The archetypes are classified in higher order groupings, which describe the main type of business model innovation: technological, social, and organisational oriented innovations."

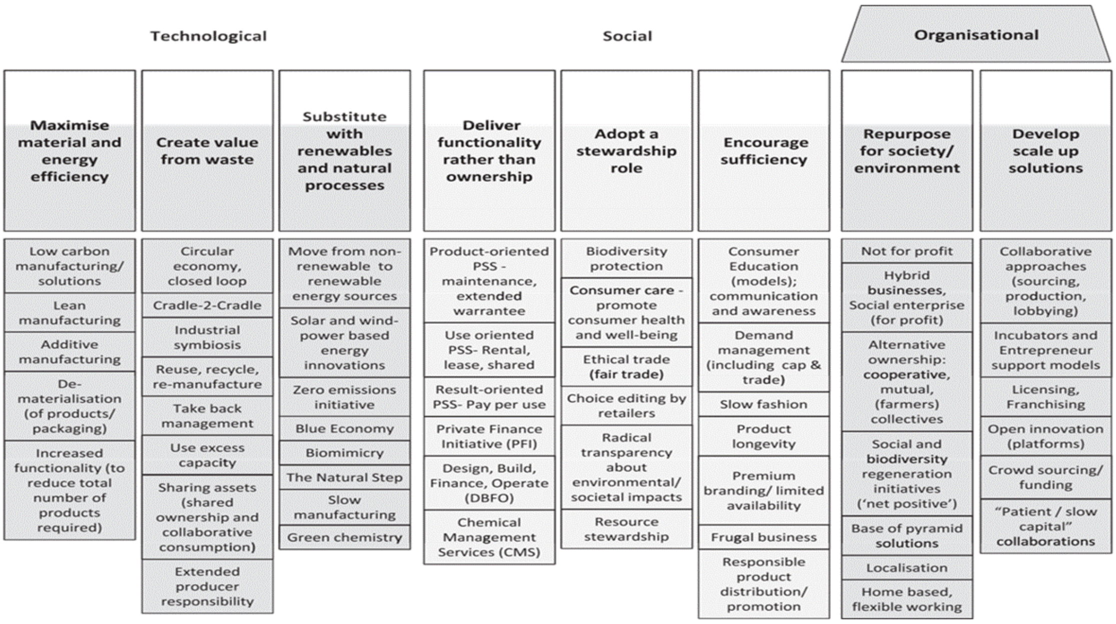

Figure 3. The sustainable business model archetypes (Boon and Ludeke-Freund 2013).

Another great tool for thinking about sustainability, specifically in the context of business model innovations, is the business model innovation grid (see Figure 4), produced by researchers at the Centre for Industrial Sustainability at the University of Cambridge and supported by Plan C, the Flanders-based network promoting the sustainable use of materials. The grid in figure above (see Figure 3) suggests sustainability innovation across three broad impacts areas by Boon and Ludeke-Freund (2013).

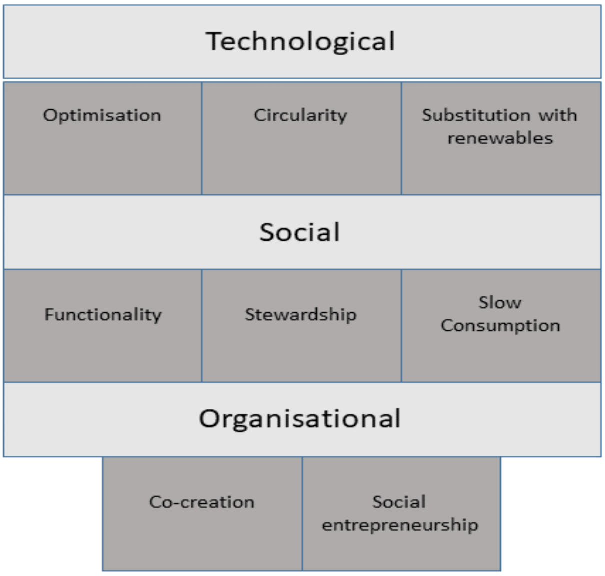

Figure 4. Business model innovation grid development by the Centre for Industrial Sustainability at the University of Cambridge and Plan C, Bocken et al, 2014.

A business model is a design that ties together resources, transactions and value creation. Business model analysis is the best indicator of whether an organisation is viable. Business models must be tested as we do not always know why some business models work and others do not. There is always a high risk in modelling new innovations. Business models are not required to be nice, rather they reflect the norms and values of the socio-economic context. (Bock and George, 2018).

Industrial clusters are one model which can be used to build business symbiosis at the regional level. Ganguly (2016) present new industry groups which maximise the knowledge harvest and best practice exchange (see Figure 5).

Figure 5. Industry Clusters, Ganguly. P. (2016).

We see more and more divides between organisations, and industries are crumbling with the Internet and digital technologies. We see companies are no longer restricted to their own fields of specialisation as they keep adding features and services to their products and are stepping into other industries. The Internet of Things (IoT) is a classic example of how for the order delivery service to a customer, companies are cutting across multiple industries (Ganguly 2016). Sensors and real time monitoring are rapidly changing functions and influencing behaviour in business and normal life.

According to Ganguly (2016), operational excellence, connection experience, asset utilisation and business models are encouraging companies to network at the next level. This is a new way of developing business efficiency and connections and using resource assets. The digital operating environment creates the foundation for communal activities both in industry as well as in the emergence of a community of rural residents and businesses. By combining the potential of the future with the latent resource of solid co-operation through the concept of action behind a common goal, more potential can be utilised and this creates a new kind of vitality. Intelligent behaviour and business can be coupled with an intelligent digital environment.

Ganguly (2016) bring forth the importance of connections and state, “To move to the next maturity level companies and symbiosis partners have to optimise their operations and resources. In parallel they have to maximise the gains from business executions either perfecting or eliminating waste and by introducing new and enhanced business models for existing operations.” They also go on further to say, “The better the connection experience delivered the better chances are that the organisation will be able to unlock the hidden potential. Having direct bearing on brand value, shareholder expectation, revenue and margins,” (Ganguly 2016) (see Figure 6).

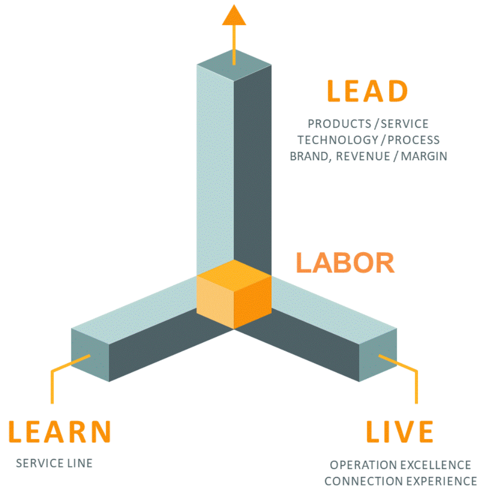

Figure 6. **Three dimensional movement along the themes of lead, labour, live and learn, Ganguly (2016) edited by Siitonen.** The live theme means that connections are strengthened and striving for excellence in every sphere of activity. The labour theme means a total connection experience with minimum uncertainty and maximum quality. The learn theme refers to continuous innovation with impact and value for connections. The lead theme means the best in class service driven through technology, to deliver the greatest value to the connections and establish higher brand recognition**.**

We have noticed the same in the business cases in the villages that we studied. Transformation tools include knowledge, connections, confidence in capital and resources. They make it possible to optimise business operations in a sustainable way. Businesses need to identify an opportunity for improvement in sustainability. In order to benefit from collaboration, they will have to accept a change of the business model. They need to understand which points will cause pain, but also the potential and value of sustainability. This should be followed up by sampling or prototyping their ideas. They further focus a long-term business model.

4. Materials and methods

In this chapter, we present the data collection and methodologies used in developing the green economy indicators and symbiosis modelling. In the previous "Sustainable and Decentralised Operating Model for Green Economy" project (Timonen at al. 2017), the green economy operational models, indicators and road maps for Saija and Hämeenkylä were formulated as preliminary work for this follow up project.

4.1. Area description (Luke)

The case villages examined in this project and report are Saija and Nellim. Saija is located in eastern Lapland, about 40 km north of Salla, near the Savukoski border (Figure 7). Nellim is located near the south-eastern corner of Lake Inari, close to the Russian border. The area has traditionally been inhabited by Inari Sámi. Logging in the 1920s and 1930s brought Finns to the area and after the Second World War, Nellim was inhabited by evacuees from Petsamo (Skolts). Thus, Nellim became a meeting point for three cultures and is part of the Skolt area.

There is a large reservoir of unutilised natural resources that hold great potential for local utilisation in the local area. In other words, the local habitants live close to their own renewable resources regarding energy production and raw materials. In addition, the fossil energy demand is significant and is sold and exported to Lapland areas elsewhere. Rural development is one of the most important drivers of the bioeconomy due to the increasing demand for biomass produced mainly in rural areas and this relates clearly to the development of rural areas. However, there is a risk that the use of renewable resources will be unsustainable and stakeholders with specific interests may dominate the development processes, not necessarily contributing to the public good by utilising ecosystem services in unsustainable ways in the name of the bioeconomy. Resource utilisation must take into account the special characteristics of the Lapland region, such as its plentiful resources, arctic conditions, delicate ecosystems and sparsely populated rural areas where many distinctive problems exist (e.g. migration). The region is also characterised by a shrinking population but increasing number of jobs to be filled.

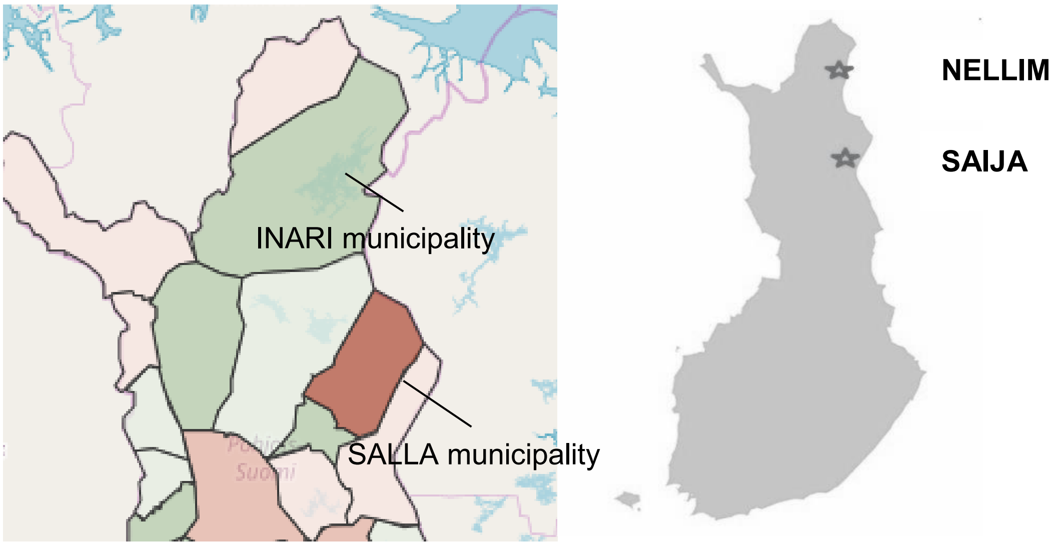

Figure 7. The villages of Saija and Nellim are located in northern Finland. Nellim is part of the Inari unicipality. Saija belongs to the Salla municipality.

Tourism is growing significantly in Lapland, and grew by 9% in 2017 compared to the previous year (Visit Finland 2018) and it has become more international and the season has expanded greatly. The number of tourism visitors is growing globally at 7% annually (UNWTO 2017) and international tourism receipts grew by 5% in 2017 (UNWTO 2018). Although tourism to Lapland is largely based on nature and the utilisation of the nature, it does not necessarily take into account nature's well-being. Tourism has often been followed by the disposable culture, meaning that the impacts of the tourism on the local environment have not played a major role in the business. Today, however, the growing popularity of eco/nature-based tourism partly due to increased awareness of environmental aspects such as climate change is challenging the earlier business models. More attention is being paid to the carbon footprint of tourism, especially due to the cost of air travel. This will be a key challenge for technological change.

4.2. Data from the previous project (cases Saija, Hämeenkylä, Tanhua)

The base work was started with the five villages in the previous project: Hämeenkylä, Saija, Tanhua, Kelujärvi and Puolakkavaara (Timonen et al 2017). However, of these five villages Kelujärvi and Puolakkavaara and Tanhua have decided to leave the project. The villages in Sodankylä (Kelujärvi and Puolakkavaara) are different from the others. These villages were influenced politically and by the effects of measures taken by the municipality's own competing projects. Among the participants there were a lot of municipal employees or operators in the administration. On the other hand, farmers in the Sodankylä villages did not participate in our meetings. This shows how important the attitudes of the local people are in the early stages of attempting to achieve far-reaching actions, and strong individuals had a major influence on decisions affecting the whole village. Compared to Hämeenkylä, in the villages of Saija and Tanhua the attitude was completely different. On pages 26 – 27 in the table there are descriptions of the processes in each village during the previous project and this project. Information about bioenergy and its potential was presented to the villagers in several meetings in the villages. By holding so many meetings with the villagers, we wanted to compare the attitudes, understanding and different factors of different villagers, farm owners, and entrepreneurs and to determine whether the information given was sufficient to influence the villagers to make decisions towards adopting the use of bioenergy.

This study utilising these experiences, results and the material collected (e.g. capital flows) in these previous projects (Timonen et al. 2017 & Kitti et al. 2014). For example, the socio-economic calculation in Table 1 shows that the capital outflow (normal fossil energy purchases per year) is over 1M€ in Hämeenkylä and 655,000€ in Saija. This means that the average resident in Saija uses 4,123€ for energy, in other words they spend 42% of their overall consumption on buying fossil energy and processed food per year outside the area (Timonen et al. 2017, pp 67 pic. 35). At the same time, the villagers live among sufficient natural raw materials to be able to produce and refine self-sufficient renewable energy, as well as to be able to produce local food beyond their own needs. In the village of Saija, the price of a hybrid bioenergy plant investment was 1.3 million € based on one offer. Currently they spend 0.7 M € per year on fossil-based energy. A socio-economic calculation for the repayment period of the new energy plant would only be 3 years if the village used the same amount of energy it has purchased up to now as fossil energy (see Table 1).

In the previous project, the profitability calculations of the biomass system were made, but it was necessary to extend this to the modelling of the economic, environmental and social impact assessment of the whole region and the new bioeconomic network. In addition to the profitability calculations and capital outflow, from a financial perspective, it is good to look at the formation of capital gains in the area, especially where the money goes and where it goes from?

Saija and Hämeenkylä had used to work together and wanted to do their utmost to prevent migration and to prevent the villages becoming deserted. Previously, there were no concrete measures for the business development of the whole village. Due to the last project efforts, for the first time, each villager was considered individually and together at the same time. Tanhua was the middle of these two examples. Willingness to develop the village occurred, but the demographic structure did not allow long-term development measures. The village also has extensive knowledge that would have enabled further development. It is quite likely that developments will take place, but over a longer period of time and on a smaller scale than envisioned in the original project. In Tanhua there was a negative, even grim, view of the future by all the villagers. It was seen that there was no long-term future.

Table 1. Socio-economic calculations for a hybrid bioenergy plant in Saija and Hämeenkylä (Timonen et al, 2017).

	Hämeenkylä	Saija
Fossil energy purchases per year	1 066 183 €	655 611 €
Investment of hybrid power plant	1 730 000 €	1 279 000 €
The Plant's annual operating expenses	259 623 €	152 472 €
Investment + annual expences - fossil energy purchases, 1 st full year of operation	923 440 €	775 861 €
Fossil energy purchases per year	1 066 183 €	655 611 €
The first year`s deficit	923 440 €	775 861 €
The Plant's annual operating expenses	259 623 €	152 472 €
Investment + annual expences - fossil energy purchases, second full year of operation	166 880 €	272 722 €
Fossil energy purchases per year	1 066 183 €	655 611 €
The deficit of the second year	166 880 €	272 722 €
The Plant's annual operating expenses	259 623 €	152 472 €
Investment + annual expences - fossil energy purchases, The surplus after three full years of operation	689 680 €	230 417 €
The village's annual energy needs	8161 MWh	4952 MWh
The Hybrid Plant's annual energy production demand for the internal market	9844 MWh	6528 MWh

ProAgria Lappi

In the above-mentioned interesting reasons have been found to influence the advancement of bioeconomy. A mutual vision of how the future of the village could be and the increased awareness of the bioeconomy can be seen as drivers for the villages to take more action for the future.

The main findings of the previous project were that there was significant capital flight from the villages and at the same time large amounts of biological raw material resources in the villages. Changing the use of fossil energy to the use and production of bioenergy was found to be the easiest way to improve the village's vitality and investment capability in the previous project (Timonen et al. 2017).

The findings collected in both the previous project and in this project were introduced into an adjusted open innovation process. Chesbrough (2006) states that: "Open innovation is the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively. Open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology. Open Innovation processes combine internal and external ideas into architectures and systems," (Chesbrough 2006).

4.3. SWOT –analyses

A SWOT analysis was conducted as part of the current project. The SWOT analysis highlighted the strengths and potential of the region and its companies, as well as possible threats and weaknesses. The analysis was done with sustainability indicators. The SWOT was divided into five areas (politics, the economy, social aspects, technology, legislation, and the environment) according to PESTLE (UCF 2018). The case villages Saija and Nellim were explored separately. The preliminary resource mapping of the energy and food system and the selected indicators measure the strengths and weaknesses of the present state and the potential and threats of the future revealed by the SWOT. The complete SWOT matrixes are to found in Appendixes (1-2).

4.3.1. Saija SWOT

A SWOT analysis for the village of Saija was carried out from an internal market point of view of the village. Utilising the perspective of cascading thinking, we are building energy production from ecosystem services (production side streams) on a pyramid basis to create the foundation and the potential for producing higher value-added products.

Politics and legislation

- Strengths: The present policy guidance aims towards the utilisation of renewable energy and regional development. There are opportunites to get financial support for development projects concerning renewable energy utilisation. In general, the aim of the current policy making is to make good decisions and promote the equality of people, e.g. by focusing on regional development and enabling living and working opportunities in all areas.
- Weaknesses: The short-term focus in policy making is a weakness; the next election period may not have/continue the same development programmes and financial support especially concerning policy guidance on natural products, energy policy, and fertiliser disposal. This question especially concerns land use in Lapland's context. Furthermore, the participation of local people should be made easily accessible and close to them. There is a need for novel methods and processes that empower local people to participate in decision making. There is not funding for farms for innovation and product development. Some restrictions for funding are on energy production for farms and farm-based networks or symbiosis. The value of real estate collateral is much lower in rural areas than in cities and making loans more challenging.
- Opportunities: The Finnish civil service culture is largely open and easily approachable. The civil service strives to make good decisions and to engage in good basic processes to encourage inclusion. This enables participation and it is easy to contact politicians. Furthermore, it is possible to change politics by raising awareness of important topics and educate decision makers about bottle necks that obstruct development.
- Threats: EU policy, which smooths out the different regions, while emphasising the special features of the regions. This creates contradictions in the policy making. Additionally, basic processes for participatory planning exist but practices do not allow and utilise large-scale participation due to lack of time and money. Competition for raw materials. Inspection fees for food

companies and, in general, public authorities are burdened by small and medium-sized businesses and restrict competition. National and local interpretation of legislation. The ability of large industry to influence legislation.

Economy

- Strengths: Seed money for financing renewable energy utilisation is available. For planning and making an investment in energy and food processing it is possible to get support up to 30-40% of the costs according to the local support system in Lapland.
- Weaknesses: Due to the location, there is low collateral value for investments. Hence, it is challenging to get investors for projects requiring large funding. Further Business Finland (the Finnish Funding Agency for Technology and Investments) does not support farming, leaving projects in farm contexts without funding opportunities. In addition, there are only a few big grocery trade operators, in Finland, whose own brands compete with small enterprise brands making competition challenging. Increasing public expenditure as part of public funding may lead to reduced funding possibilities for enterprises.
- Opportunities: Big cowshed investments enable increasing raw material production and increasing the funding support for investment will provide more opportunities to increase new investments in energy production and further processing. Also, new business opportunities will provide new jobs and better living conditions in the area. The job opportunities will enable young people to stay and raise families in the area. The smart farming (Smart Akis 2016) concept means that farms should produce high-grade and pure specialty food products for international markets. This allows farms to become export-driven, fast, and flexible players in the market.
- Threats: There is no public funding for innovation, production development or investments in farming; it will not be possible to proceed with the energy plant plans. The financing support is a key element for proceeding with the plans. Also, the raw material availability is an essential question. Further what would happen if wood chip use for energy production is prohibited? What raw material would be able to compensate it? From the demographic perspective the threats concern the decline in population. This will affect the municipality’s potential to support the village. Different interpretations of legislation locally and between different authorities cause additional costs.

Social

- Strengths: There are about 80 households with 160 people in the village. 12 households have children, of which 3 have small children. Saia’s occupational dependency ratio is 1.1, referring to the ratio between working-aged (18-65 years) and non-working people. There are 20 jobs in the village and agriculture is the main livelihood, alongside reindeer husbandry. The village has a food processing company with an innovative and active engagement in business development. The co-operation is also shown by the fact that village reindeer owners sell meat to the village's own processor company. There is strong knowledge of food processing in the village. A historic house in the village (Saijan-Pirtti) has been renovated by local people. The village has an active village association, which organises several village events a year. One example is the world's smallest jazz festival called Saijazz. In addition, the village publishes its own magazine, the Saijan Sanomat. There is also an active hunting club in the village. A nationally important landscape area was established in the village based on a decision by the Lapland Environment Center and the village has actively participated in the planning and management of the area. There have been several village development projects and the tradition of co-operation and collaboration is strong in the village. In addition, some individuals have good network connections related to business life and the restaurant sector.
- Weaknesses: The active village association is powered by a few people whose time and effort is limited to development projects. There is a threat of fatigue in voluntary development work. In the village, there would be a need for a “village secretary”, who could handle issues related to

development projects. Business activities in the village are based on a few individual actors, and the business structure is not versatile (mainly agriculture and reindeer husbandry). The skills needed for a new type of business may not be found inside the village. The village of Saija has a financial dependency ratio of 1.8, which means there are 1.8 unemployed or people out of the workforce per one employed person. In the long run, this kind of development is not sustainable.

- Opportunities: The village has young people and potential returnees. Young people have a desire for entrepreneurship and village development. New business opportunities will be opened with the energy sector, especially in food processing and production. Thanks to the village development plans, it is possible to increase cooperation within the village.
  In the village of Saija more than 80% of the 18-85-year-olds have completed a college, a vocational, a lower university, or a higher university degree. Most of them have a professional degree. There is potential for increasing knowledge in the village at least in the sense that the village is inhabited by an educated population. New business opportunities require new skills; matching these needs and training opportunities will allow expansion of the knowledge base and resources within the village. With an innovative entrepreneur, it will be possible to expand business activities and cooperate within the village.
- Threats: Saija's population growth has been declining. The number of the working-age population is almost the same as the number of children and elderly people, but the number of unemployed and inactive is almost double the number of people employed. If there is no job creation or opportunities in the future, young people cannot stay in the area, thus working possibilities also enable living opportunities. Possible novel job creation requires extending current knowledge and the existence of training opportunities in line with the needs of new business opportunities. If the supply and demand for education do not match, the local labour force/entrepreneur resource cannot be utilised.

Technology

- Strengths: Basic technology exists for the renewable energy utilisation and there is strong development work in warehousing technology. Resources exist (financial) and expertise is available in Finland, and people are ready to move towards renewable energy generation. In addition, there are trustworthy experiments abroad which give credibility to the implementation of novel technologies. Furthermore, the active farming in the village enables raw material production and active, enthusiastic actors are utilising novel technologies
- Weaknesses: There is lack of competence for utilising novel technologies (e.g. digestion plant or hydrogen expertise). Also there is an incomplete understanding of resources, their potential for utilisation and requirements of the funding base. There are also difficulties in combining the various forms of technology (hybrids). Furthermore, a lack of standards and control systems is slowing down the implementation of new technology systems
- Opportunities: In general, technological development is an opportunity and a key element for renewable energy utilisation. It is possible to use different technologies to separate resources utilisation. Moreover with technological innovations it may be possible to utilise more resources, for example, through the separation of bio materials from processing residues/raw materials, as well as processing, merchandising, and processing of fertiliser and its enrichment. Using a low carbon and circular economy and seeking means of symbiosis, especially from the point of view of the circular economy, will enable the utilisation potential of digitalisation, platforms, artificial intelligence, robotics and automation in rural areas. Courage and new funding will be required to introduce new business models.
- Threats: Competition between different technologies, applications and platforms, which utilise different resources that may not be compatible. The cost of purchasing equipment and machines may be too high and machines may be too large for small field plots or small production facilities. The use of old technology may lead to lost competitiveness.

Environmental

- Strengths: Saija's forest resources are large. The Saija Land Register Village has a forest area of about 16,000 ha and an annual growth of about 35,000 cubic meters. The current fragmented private forestry ownership has guaranteed balance in its utilisation. Saija also has important groundwater areas.
- Weaknesses: Saija is part of Lapland's sensitive ecosystem and its special characteristics have to be taken into account when using available raw materials for economic purposes.
- Opportunities: Sustainable forestry is considered a major opportunity due to the large forest resources according to the villagers. Forest-related side streams cover self-sufficient biogas production and overall there are many opportunities for developing biogas facilities. Raw materials consists of forestry side streams (energy wood and side streams account for approximately 25% of total tree growth, i.e. about 8,700 cubic meters per year). In the future there may be opportunities to produce zero emission energy; hydrogen and solar energy.
- Threats: What will happen to biodiversity or nutrient and water circulation (Saija is an important groundwater area) if these areas are to be exploited? Further there is a threat that the landscape value and the importance of recreation are not sufficiently taken into account as part of the forest or field ecosystem.

4.3.2. Nellim SWOT

The SWOT for the village of Nellim was carried out from an export perspective where the buyers are tourists that come to the area. Nature tourism is practiced in the area and the aim is to strive towards green ecotourism. In the case of the village of Nellim, according to cascading thinking, we are going to build higher value-added ecosystem service products (cultural services) from the top of the pyramid. Hence the perspective differs from the village of Saija.

In the Nellim case and the Inari area, information was collected concerning the demand for market-based tourism generated in the Nellim-case study (a wilderness hotel). The aim was to identify new opportunities and potential that would be created by the global market and the needs of global tourists (concerning services, souvenirs, etc.) and how these would be met by new types of food and energy production.

Here are the data for scoping local features, natural resources, goals, objectives and targets and enabling local participation in workshops. Workshops were held inside the Nellim wilderness hotel area together with experts, and the Nellim wilderness hotel entrepreneur was also interviewed. Area residents were not yet involved because Stage 1 included only a company perspective. An Interview and meeting between experts and entrepreneurs was also held.

Nellim is one of the villages which the Skolt Sámi, who are an indigenous population of the Kola Peninsula, inhabited when their original residential area was divided and most of the living area was lost in World War II. The Skolt Sami people had to move from their earlier living in Petsamo after the war and to move to the area called Skolt Sámi. The area is controlled by the Finnish Government (Sami museum 2003). Keväjärvi, Nellim and Sevettijärvi are the villages in this area. At present, there are about 600 Skolt Sámi in Finland, of whom approximately 400 live in the Skolt area (Saami Nuett 2018) (Figure 8).

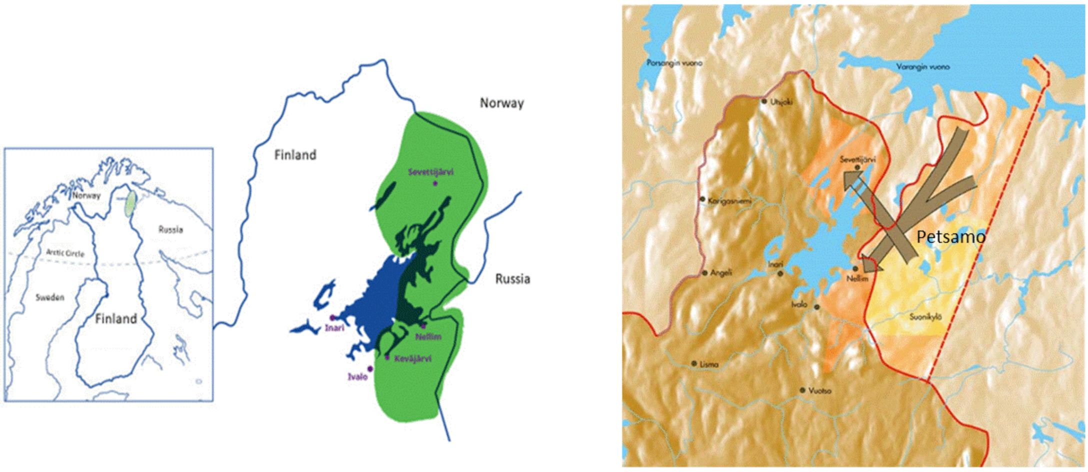

Figure 8. Original residential area and current living areas of the Skolt Sámi, Sami Museum (2003).

The Law on the Skolt Sámi settlement (Finlex 1995) defined the rights of the Skolt Sámi to land and waters in their new home regions after the settlement and was further to improve the Skolts' living conditions and the development of small-scale entrepreneurial activity in the Skolts' residential area. There was no return to their old lifestyle and to earlier migration patterns. The Skolt Sámi used to move between their traditional family areas – between winter, spring, summer and autumn places (Saami museum 2009). The early Skolt Sámi way of living defined the locations in the settlement period and they were situated far away from the municipality centre. The Skolt Sámi newcomers were looked down on by both the other Sámi groups and by the Finnish population. It was not until the 1970s that the self-esteem of the Skolt Sámi began to grow stronger. There were not many jobs in the region and the Sámi had to go to work elsewhere. Now the tourist centre employs the inhabitants of the village either by hiring them for work or by buying raw materials from them for the production of food and using their skills and cultural traditions for tourism entertainment.

Politics and Legislation

- Strengths: Policy guidance on granting financial support to Skolts in the Skolt Sámi areas (60/40 support and government guaranteed loan). Nellim is one of the Skolt areas and people have received funding for development from the government. The municipal business policy in the Inari area supports local entrepreneurs. In general, the aim of policy making is to make good decisions and promote the equality of people, e.g. focusing on regional development and enabling living and working opportunities in all areas. Business opportunities influence to politic decisions.
- Weaknesses: Support for Skolt public funding has been undergoing change in the Skolt area. From the entrepreneur's point of view many of the weaknesses relate to labour law. The logic of improving workplace policy benefits is not always the most beneficial either from the workers' or the entrepreneurs' point of view. The basic aim is to reduce working hours, even though many employees would be willing to work more. Concerning labour law, opportunities for local agreements should be explored. The bottlenecks of work security/legislation need to be explored in order to make progress. It is a challenge to get the workforce to move from the town to the countryside. The utilisation of highly valued and much admired snag wood is difficult. Most snag wood in Finland is protected, at the moment.
- Opportunities: The Finnish civil service culture, its openness, easy approach, and desire to make good decisions and basic processes encourage inclusion. This enables participation and it is easy to contact politicians. Furthermore, it is possible to change politics by raising awareness of im-

portant topics and educate decision-makers about the bottlenecks that obstruct the development. There would be business opportunities for snag wood collection and utilisation.
- Threats: Climate change and various consequences due to policy development. Inari Lake agreement between Russia and Finland (Ympäristö 2018e). Prohibition of the use of natural ecosystems in tourism.

Economy

- Strengths: Seed funding has existed in the area; basic investments came to Nellim from the Skolt financing (60%) and rest (40%) was a state granted loan. Historically, as a result of wars the Skolts moved from Petsamo to Nellim and the state granted loans to support their settlement. Otherwise funding is available from the rural ERDF funding. Local entrepreneurs have the capacity to take risks, which is an important factor for development and growth. Furthermore, the whole company business is built on a customer-based approach and customer wishes are taken into consideration. All the visiting packages are sold in advance and the investments for new buildings are made after that. Support services are the right size (small restaurant, group travel - not single night stays). In addition, they have several tour operators and they do not sell on an exclusive basis. The value of place/experience is being gradually improved based on customer feedback. The marketing area is global.
- Weaknesses: Lack of capital and financial resources (there are no venture capitalists in rural areas) prohibit development. This is the general problem in rural areas. Strong public funding is needed to support development and investment, as private capital does not exist in sparsely populated areas. This is especially important for tourism construction and bio-energy investments that would serve capital-intensive industries.
- Opportunities: Enter new businesses into subcontractors provide short chains for food based on local production. Opportunities exist in improving authenticity and increasing added value gradually building up a local brand and benefiting the local environment. The Arctic Ocean Railway (Liikennevirasto 2018), now in the preliminary study phase could, when implemented, make it easier for the arrival of customers in Nellim.
- Threats: The business infrastructure cannot attract investments and is in danger of losing authenticity. The pricing monopoly of international companies and their competition methods are biased against fair competition. New, external owners may have very different understanding of sustainable business in the Arctic area.

Social

- Strengths: The entrepreneurs family (from the wifes side) originates from the village, so local people feel the company is run by the “village’s own daughter". Over the years, the company has employed a lot of local and regional labour, including those who have not had experience in the tourism business. In the case of the tourism programme services, the company uses local businesses (dog sledding, reindeer programme) and local reindeer herding activities to share the tourism business's values. Owners of the company have good national and international networks that have developed over the long term. The entrepreneurs’ previous experience with restaurant and guiding services has also created these networks.
- Weaknesses: The lack of professional skills prevents the recruitment of local people. The short season complicates the recruitment of local people throughout the year. There is no real co-operation with other major tourist entrepreneurs in the region.
- Opportunities: The business has the potential to grow so that it keeps the legitimacy of the business from the point of view of local residents. Specific tailor-made training enables qualified staff (e.g. batch guides) and also allows the use of a local labour force. There are opportunities and a willingness to use local products (e.g. food), if only the supply can be increased. It is possible to extend the season with the help of new networks, thus enabling the recruitment/full-year hiring of new employees. At its core, it is possible to increase the use of local businesses (e.g. tourist programme services and food).

- Threats: Will the legitimacy of a company remain when it grows or will it become encompassed by envy? There is also a threat to the availability of skilled personnel as the business grows. With the change of generations of reindeer herders, the values and perspectives may change and create conflicts with tourism companies. The understanding/willingness of local residents to understand the needs and desires of the tourist centre's customers are key actors for the provision of programme services and, above all, the development of operations. Problems and ambiguities in the activities of other touristic entrepreneurs may also be reflected in activities, such as services whose actors speak only Finnish and the services are provided by local people.

Technology

- Strengths: Long tradition of using bioenergy. Positive attitude towards the use of renewable energy and hybrid technology solutions. Furthermore, the active farming in the village enables raw material production and active, enthusiastic actors will be able to utilise novel technologies.
- Weaknesses: Technology is not available to small companies. If the resort wants its own bioenergy plant, there is no technology ready for a small business. Operative safety is challenged by extreme weather conditions in the winter.
- Opportunities- In general, technological development is a possibility and a key element for renewable energy utilisation. It is possible to use different technologies to separate resources utilisation. Moreover with technological innovations it is possible to utilise more resources, for example due to the separation of bio materials from processing residues/raw materials, or by further processing, or merchandising, and the processing of fertiliser and its enrichment.
- Threats: Competition between different technologies, especially in bioenergy is a risk. Superior global digital platforms may conquer the market and bias the competition. The security of electricity distribution is challenged by climatic conditions. Problems with international transport companies may arise, for example, in exceptional circumstances such as the impact of volcanic eruptions on air traffic. Misconceptions, slandering or stealing the brand on social media are also potential risks.

Environmental

- Strengths- The natural resource base in Lapland is huge. There are lots of provisioning and cultural ecosystem services: the forest, berries, the wilderness, game animals, firewood and industrial wood. The environment is unique. The Nellim area has landscape value as well as self-sufficient energy and food production in neighbouring areas.
- Weaknesses- The region is a sensitive Arctic environment. Lapland is a very sparsely populated area. Nellim is off the map. In the summer, there is little activity and guests typically only stay for one night. People cannot easily get to Nellim (there are mainly Finns in the summer and foreigners in the winter).
- Opportunities- Entrepreneurs intend to expand into Inari to provide year-round activities. Extending eco-tourism and the sustainable expansion of the business hotel is seen as an opportunity and work has already begun. An opportunity could be to increase self-sufficiency in energy and food production. A new road will be ready at the end of 2018.
- Threats: There are more and more players entering the field. There are technological, economic, legislative and political level disputes over strategic raw materials. It is a possible risk that the provisioning and cultural services (e.g. tourism maximisation) are consumed unsustainably, leaving the sensitive Arctic ecosystem and landscape to suffer, as well as depleting local resources, which would end the tourism business in the longer term. The possible implementation of the Arctic railroad project (Liikennevirasto 2018) may threaten the pursuit of the indigenous Sámi people's livelihoods and the maintenance of their culture while also affecting local tourism. The transfer of land ownership to the outside of the region is a threat and so is the full natural economic exploitation of natural resources (e.g mining) and nature conservation areas in Sodankylä (Ympäristö 2018).

4.4. The indicator selection process

4.4.1. The conceptual framework of the indicators

An indicator is "a parameter, or a value derived from parameters, which points to, provides information about and describes the state of a phenomenon/environment/area, with a significance extending beyond that directly associated with a parameter value". Indicators describe the existing condition of systems or a situation and they also simplify communication by making information more understandable (OECD 2003). Indicators provide crucial information for decision makers by simplifying, clarifying and making aggregated information available to policy makers. Indicators also help measure and calibrate progress toward sustainable development goals (UN 2007).

Indicators may work for the follow-up of internal work, or as a way to identify problems and assess performance more widely within a *local territory* (Eckerberg and Mineur 2003). Local village level indicators provide more accurate, realistic local development measures of the region. Due to the local-level characteristics, the same indicators do not apply in different local or regional areas (Miller & Twining-Ward, 2005; Jokimäki & Kaisanlahti-Jokimäki, 2007). Therefore, each community needs to develop its own *individual set of indicators* within a common structure offering the possibility to compare communities without ignoring their specific needs and situations (Valentin and Spangenberg 2000). It is important to understand the local context in which the indicators are being developed (Rydin et al. 2003).

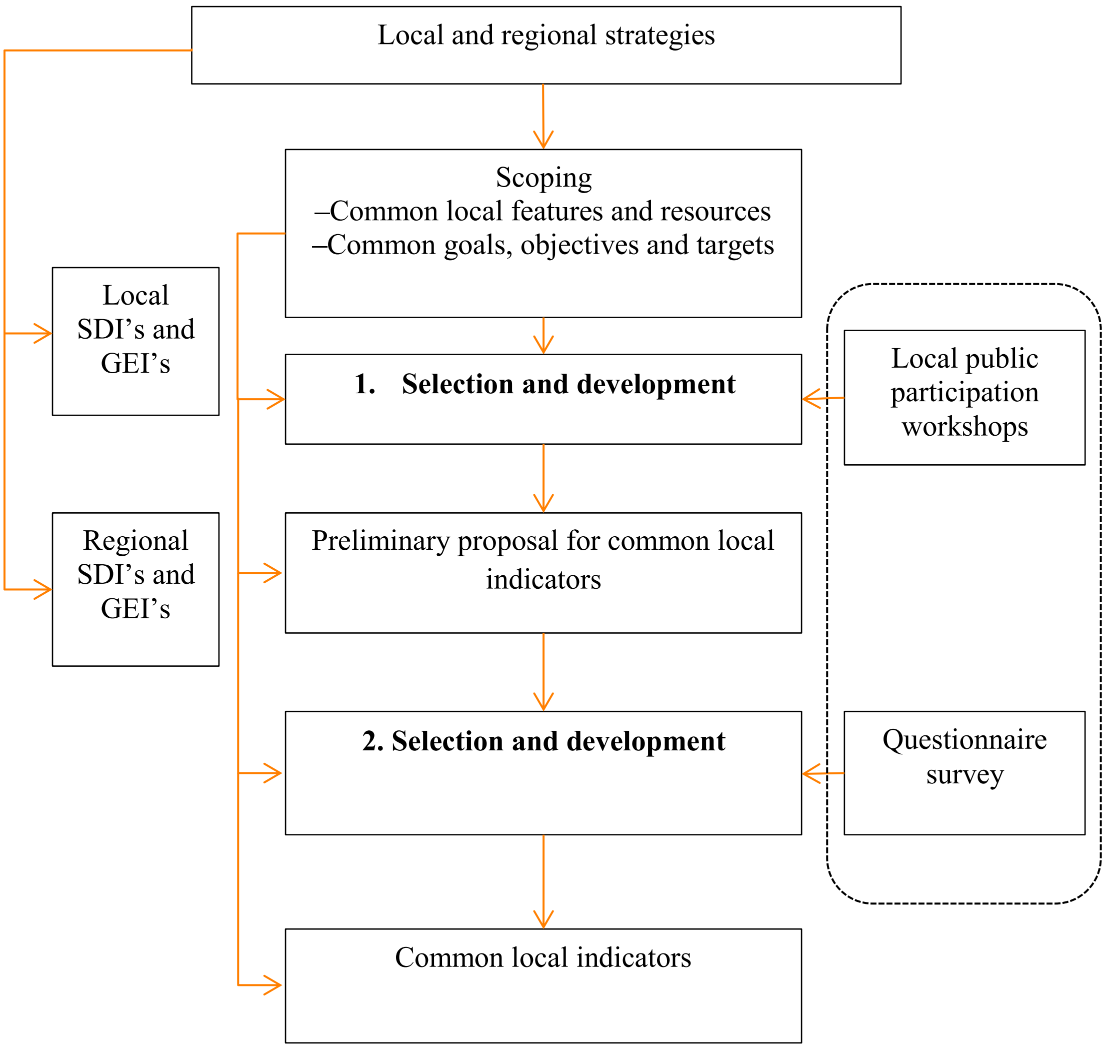

Figure 9. Conceptual framework for common local sustainability indicators (applied from Mascarenhas et al. 2010).

In this study, we apply the conceptual framework for common local sustainability indicators by Mascarenhas et al. (2010) to select and develop local level green economy indicators (Figure 9). The indicator selection process consists of many steps and includes two selection and development stages. The first step of the selection and development work is to find existing local and regional sustainability and green economy indicators and strategies. After that, scoping work by experts on local features and resources as well as defining goals in cooperation with local public workshops is needed. The data gathered during the previous steps is analyzed and utilised during the first stage of selection and development. After this the preliminary proposal for the indicators is presented and analysed according to the indicator criteria and questionnaire survey for the area residents. The indicators are selected and developed in the second stage for the final step of creating common local indicators.

4.4.2. Local and regional SDIs and GEIs

The regional scale is a good level of governance for planning, coordinating and assessing actions towards sustainable development (Mascarenhas et al., 2010). The already published national and international green economy indicator (GEI) publications (OECD 2014) are usually based on average information and excessive compaction of information and lack area level indicators (except Seppälä et al. 2016). Sustainable development indicators (SDIs) are one of the most commonly used tools to assess sustainable development from the international to local level supporting evaluation and reporting purposes (Mascarenhas et al. 2010). There are already several studies to be found which have reviewed sustainability (from ecological, economic and social point) *at a rural level* (e.g. Marsden 2003, Hedayati-Moghadam et al. 2014, Semenova et al. 2016), *municipality level* (Eckerberg & Mineur 2003, Mascarenhas et al. 2010) and *at the community-based level* (e.g. Valentin & Spangenberg 2000, Boyd & Charles 2006, Lu et al. 2017).

However, these different area level indicators do not take into account the special local-level characteristics. The same indicators do not apply to different local or regional areas (Miller & Twining-Ward, 2005; Jokimäki & Kaisanlahti-Jokimäki, 2007). Each community needs to develop its own *individual set of indicators* within a common structure offering the possibility to compare communities without ignoring their specific needs and situations (Valentin and Spangenberg 2000). Local village level indicators provide more accurate, realistic local development measures of the region. It is important to understand the local context in which the indicators are being developed (Rydin et al. 2003).

4.4.3. Local and regional strategies

According to the Finnish Bioeconomy strategy (2014) rural development is seen as one of the most important drivers of the bioeconomy because of the increasing demand for biomass produced mainly in rural areas and relating to rural areas development. According to the EU's territorial thinking (Lapin liitto 2016), the desirable regions of the internal market, in line with the smart specialisation strategy, are so strongly networked that the partnerships can balance each other across national boundaries. This goal links green indicators to regional networks. Lapland has been chosen as the European Commission model area of clusters development (European Commission 2018).

This project is linked to the government's top projects by promoting the bioeconomy, clean coal-free and renewable domestic energy, the circular economy, nutrient recycling, the bioeconomy experiments, short chain food supply and added value nationally and internationally. Pilot areas add to the nutrition and energy self-sufficiency of agriculture as well as the multi-active use of forests and wood supply. In addition, new products are being developed for the exploitation of forests and new jobs and businesses are being created in rural food production. The project's results will deepen the model for rural development and the advancement of the bioeconomy. In addition, the project seeks to find a practical example of a future model for regional services and the one-stop principle. The project also supports the Lapland Smart Specialisation objectives (Lapland Intelligence Specialisation) and the “Lapland Agreement” (Lapin liitto 2016).

4.4.4. Scoping: local features and natural resources

The aim of the data collection process was to gather data on renewable natural resources, production and side streams meeting the low-carbon and circular economy objectives in the local area of the study. Baseline data of the area was collected to define the present state of the local sustainability level, as well as to indicate the problems, potential and critical points from the point of view the green economy transition process. From the food production perspective, each of the active farms was separately analysed on the use of energy and the available raw material resources. The aim was to explore the potential of the farm in moving towards the green economy.

The material utilised here are statistics, company and resident surveys, in addition to the experiences, publications and conclusions of previous projects (e.g. Timonen 2017), as well as other projects of the Regional Council of Lapland, such as Lapland’s Artic Specialisation Programme (S3) (Lapin luotsi 2018). Pilot areas provide practical knowledge on the feasibility of the models and their realistic potential to achieve desired benefits. Process training was used to develop the capacity of farmers and other participants to create new earnings in the bio economics context.

The base data was collected by data specialists because expertise is required to specify the indicators, collect the data and monitor it (Rydin et al. 2003). Furthermore, independent experts are needed because there is a risk that the use of renewable resources could be unsustainable and impartiality is required in the data analysis. In other words, stakeholders with specific interests may dominate development processes, not necessarily contributing to the public good by utilising ecosystem services in an unsustainable way in the name of the bioeconomy.

In evaluating the ecological perspective, information on more holistic natural resources is needed, especially for the sustainable use of these resources in the region over the longer term, to ensure economic growth. This project aimed at the surplus potential of the self-sufficiency of symbiosis, network views and exports. The analysis of the economic perspective utilised this data to evaluate capital outflows, self-sufficiency potential, corporate profitability and the financial potential of exports. From a social perspective, we aim to use material for mapping the well-being, confidence, know-how, trust and other needs of residents in the case-village meetings (e.g. Timonen et al. 2016). Based on the results of company and resident surveys, the project explored the skills in the area, how many villagers and actors have time available, how the activities in the area are organised and what the responsibilities are. The project also aimed to determine possible premises for the power plant, what the status of the area’s planning was and what other operating requirements exist. Socio-economic factors were examined, and the initial local structure was mapped for the assessment of local potential for the green economy transition process. Data on socio-demographic indicators (e.g. the population, standard of living and service structure, education, and the service ratio) was gathered by utilising area level statistical data.

It was perceived that there was a large reservoir of unutilised natural resources that hold great potential for their local utilisation in the local area. In other words, the local habitants live among their own renewable energy production raw material resources. At the same time, the fossil energy demand was significant and is being bought and imported into the case areas from elsewhere; in other words, capital flows out of the area instead of remaining in the area through self-sufficient energy production. In addition, it was observed that most of the residents (due to migration) and services (e.g. health care, postal, groceries) are declining and have moved further from the local area. It could be seen that natural resources held the potential to also generate jobs in decentralised energy production and that population growth could be promoted by increasing jobs in the area and through sustainable utilisation of resources.

4.4.5. Scoping: goals, objectives and targets

The data gathered and the identified local strategies, features and natural resources in the previous phase was collected and analysed to define local level development needs as goals, objectives and targets and to create a future image that would also be in line with green economy concept (Chapter 3).

The preliminary goals were set by experts and were to be focused more specifically on energy systems, due to the significant fossil energy demand and significant natural resource potential for self-sufficient sustainable energy production. Side flows were especially seen as the main source for self-sufficient, renewable and sustainable energy production. Biomass based renewable energy is to be the first intermediate step as a means to creating a sustainable basic infrastructure for the mobilisation of wood resources in the area. This will also provide a basis to advance the vitality of the local area and create the foundation for future productivity and economic growth. However, ultimately the development activities of the local area must lead to fully emission-free energy production (e.g. wind and solar) and biomass should be reutilised for cascading use and higher added value products from forestry side streams in line with the cascading (see chapter 3) principle.

The goal was set also to create new operations and business based on intelligent resource use and economic growth. Enabling participation, shared opportunities and biogas ownership as a joint-stock company are consistent with the objectives of social equity. Furthermore, shared utilisation of ecosystem services, the growth of business opportunities and the region's viability promote social equity.

4.4.6. Local participation in workshops

As for the more defined goal, the focus of the research into setting the indicators was established in workshops for the Saija case. A resource analysis was used to help the locals realise and discover the potential of the village (natural and human resources) based on the data collected by the experts in the previous step. However, in the Nellim case we only gathered data through the SWOT analyses together with experts and tourism entrepreneurs. Nellim was utilised as for providing a company perspective instead of a local area perspective. For this reason, the workshops were smaller and discussions took place only with the local tourist entrepreneur.

However, indicator development is not just a technical issue and it cannot be left only to experts. The importance of local participation in sustainability-indicator development has been identified in several studies (e.g. Boyd and Charles, 2006; Bell and Morse, 2004; Freebairn and King, 2003; Yuan et al. 2003; Reed and Dougill, 2002; Valentine and Spangenberg, 2000). Stakeholder involvement in the conceptualisation and development of the indicators is crucial, in order to include their views, values, concerns and common goals (Valentin and Spangenberg, 2000; Beratan et al., 2004). The green economy cannot be formed without collaboration and vast natural resources will remain untapped without people and their ability to work together. Furthermore, no network will be able to function without active local participation. Communicating the sustainability of corporate actions to stakeholders is important. The involvement of different actors in the indicator development process is not just a matter of each actor wanting to serve their own interests or exercise power; it is also about each actor trying to impose their own view of what sustainable development should be (Rydin et al. 2003).

There were workshop meetings in 3 different local villages of north-east Lapland during the summer and autumn 2015 in which information on the potential, visions and objectives for the year 2020 were defined, in addition to a present state analysis. All together there were 42 villagers at the workshops: at Saija there were 17 participants (5 women and 12 men) in the workshop forming two groups. In Hämeenniemi altogether 12 participants attended the workshop (10 men and 2 women), and in Tanhua 13 participants joined the workshop (5 women, 8 men). Two groups were formed also in Hämeenniemi and Tanhua. In Saija there were more young people participating than in the other villages. A facilitator and secretary (both project group members) assisted the villagers to cover the villages' vision for 2020 and explore possible obstacles and drivers for achieving the vision.

At these workshop meetings, the Natural Step approach was applied and the vision (goal) for the year 2020 was defined in addition to a present state analysis. The Natural Step method is a reference framework for strategic sustainability and it is intended as a tool for designing complex systems (Upham, 2000; Byggeth et al., 2007). The idea behind the Natural Step model is to create a vision of a village/area for a specific future time, then map out the current state and ways to achieve the first priority of the vision for the village/region. The model has been used and developed for over 20 years, and has been applied to companies, municipalities and regions in different sectors. It utilises back-casting methodology, which is good when used in planning towards sustainability, e.g. when the problems at hand are complex and when present trends are part of the problems (Holmberg & Robert 2000). Natural Step method uses ABCD steps where A stands for raising awareness and creating a vision of what that organisation would look like in a sustainable future. B refers to baseline mapping, e.g. it examines issues such as where we are now, C stands for creative solutions, and D stands for decisions on priorities (Broman & Robèrt 2015). The villagers' meeting established a vision of the green economy for the villages by 2020, and clarified the view of the villagers concerning the current state of the area, as well as how they saw the challenges ahead and ways to achieve the vision. The vision was based on utilising the local resource base (natural resources and people).

The vision was focused on a decentralised biogas plant for self-sufficient bioenergy production, replacing the present energy demand being met by fossil fuels. This is because the decentralised organisation of the bioeconomy could promote benefits for rural areas (Pfau et al., 2014) and decentralised systems may foster social benefits through local employment and a fairer distribution of incomes, and, thus, more equity (Bruins et all. 2012). Enabling local reuse of by products and flexible, small-scale production will stimulate local economic development (Ossewijer et al., 2010; Bramsiepe et al., 2012; Bruins et al., 2012). A goal was also set to create new operations and business based on the intelligent use of resources and economic growth. Enabling participation, shared opportunities and biogas ownership as a joint-stock company are consistent with the objectives of social equity. Additionally, the shared utilisation of ecosystem services, the growth of business opportunities and the region's viability promote social equity.

4.4.7. Stage 1: Selection and development

In the first stage of selecting and developing local level green economy indicators, the previous steps of the data collection assessment work by experts and local public participation in workshops was combined. This part was mainly done in the previous project (Timonen at al. 2017) and was further complemented in this follow up project with a more defined green economy conceptual framework and targets (see Chapter 3). This included more inclusive aspects of social dimensions and the role of all the ecological processes. The indicators for the energy and food systems were complemented also with a tourism system (providing cultural ecosystem services) and preliminary development work on the new bioeconomy perspective (symbiosis indicators measuring synergies between energy and food systems, as well as the tourism system and the area's ecosystem boundaries) was completed.

As for the preliminary proposal for the indicators, we reflected the common indicator criteria in confirming the most practical, functional, viable and competent green economy indicators. The indicator selection criteria was a general definition setting terms for viable and competent indicators and is therefore applicable for all types of indicators. There are many studies dealing with different indicator criteria with different interpretations (Miller & Twining-Ward 2005; Rosenström & Palosaari 2000; Puolimatka 2002; Jokimäki & Kaisanlahti-Jokimäki 2007; Hametner & Steurer 2007; Hall & Ferris, 2011; Seppälä et al. 2016). In addition, these indicators are not necessarily all included in one set of criteria, rather there are many different sets of criteria according to studies (Lincoln and Cuba 1985; Rosenström & Palosaari 2000; Miller & Twining-Ward 2005; Hametner & Steurer 2007). In this study, for the selection process concerning the village based, green economy indicators the following five criteria were chosen: acceptability, reliability, viability, cost-efficiency of the data collection, measurability and accountability.

The chosen indicators meet the criteria on “acceptability” meaning that the indicators should be accepted as widely as possible as defined by Hametner & Steurer (2007). The base work for the selection process for the local green economy indicators was chosen through the base work and guidance found in already published studies (literature review analysis) and reports on international and national green economy indicators (OECD 2014; Seppälä et al. 2016) and cooperation with experts and local residents. The preliminary proposal for the local selected green economy indicators was presented to the project steering group (expert panel) and discussed further. Acceptability, trust, legitimacy and support for the development plans were also tested and evaluated in a questionnaire survey conducted for the local residents after the workshop meetings (see the next step for more information).

The chosen indicators met the criteria of “measurability” meaning it was possible to measure the value of the indicator and to repeat the measurement, e.g. it would give similar results in similar circumstances over time as defined by Rosenström & Palosaari (2000); Miller & Twining-Ward (2005); Jokimäki & Kaisanlahti-Jokimäki (2007). It is essential to identify measures which enable follow-up data to be gathered using novel methods. In order to choose the most suitable indicators for measuring the green economy data for now and in the future, there is a need to study the availability of data. It is also essential to identify indicators which enable follow-up data to be gathered using novel methods. The criteria of availability were assessed already during the collection work in Chapter 2.1., where only those indicators were taken into account that could be collected at the present and in the future at the village level and at the Lapland province level. It was observed that statistical data was often available at the communal level and local level information needed to be collected via interviews.

“Being accountable” means being transparent, taking responsibility for one’s actions, and subjecting oneself to scrutiny, control, and guidance (Dubnic & Frederickson 2011). In meeting the criteria of accountability, the data collection was done by experts and local residents. The statistical data was gathered via national statistics and can be assessed as being as transparent as possible. National statistics provide solid grounds for the data gathering and calculation. Accountability has been defined as a “perceived expectation that one’s decisions or actions will be evaluated by a salient audience and that rewards or sanctions are believed to be contingent on this expected evaluation” (Hall & Ferris, 2011, p. 134).

The indicator selection criteria of “functionality”, “relevance” and “validity” for the indicators was met by evaluating the availability of specific data and not average data, taking locality and its special features into account. The chosen indicators meet the criteria on “acceptability” by describing and verifying the right objectives and goals of the framework. The information reflects the green economy targets by utilising and exploring the existing literature and research related to the research context providing validity for the indicator selection.

In order to select and develop effective and versatile indicators there was a need to utilise a scientific reference framework (see chapter 3) within which to interpret the data and results collected by the indicators. Since there are no general concepts of the green economy, the framework had to be built by utilising different concepts inside green economy thinking, which included: the bioeconomy, resource efficiency, sustainability, and the ecosystem service framework.

The indicators chosen in this study meet the criteria of “reliability” which according to Puolimatka (2002) means the ability to offer trustworthy information concerning the field in which the study seeks answers. Reliability was met using experts to collect and analyse information (Chapter 2.1) and by arranging workshop meetings with the local residents (see Chapter 2.2) in order to prepare the base work for the indicators as for the best practical and reliable knowledge.

The "feasibility" of the indicators was met in this study by assessing that the data was to be collected well, in a cost-effective way and by defining who would collect the data, as specified by Miller & Twining-Ward (2005).

4.4.8. Questionnaire survey

Before the final second part of the selection process, the vision and information gained by utilising the preliminary indicators were detected through a survey assessing the trust, legitimacy and support for the project, as well as the village development plans and evaluated indicator values. These results indicated the collaboration skills and trust in other people and institutions, and in this case, trust in the development plans and calculations concerning the biogas plant, in a qualitative way. The acceptance of the information given by these indicators, e.g. concerning the area's potential and development needs was evaluated via a questionnaire for residents after the workshops had carried out the preliminary work. The survey was conducted by visiting all the households in Saija.

About 60 % of the respondents felt that the village had a lot of cooperation between different people, but about a quarter of the respondents thought there was no cooperation. Those who answered "do not know" felt that cooperation existed only between a small party of people. Less than half of the respondents were involved in planning village development. However, up to 95 % of the respondents reported being aware of village development plans (e.g. the biogas plant). Most respondents felt the plans were clear and understandable, but the rest could not say anything about the clarity and or the stability of the plans. The majority of the respondents (68 %) believed that the energy calculations presented by the project were credible, but a quarter could not say anything about the credibility (only 7 % considered them to be unconvincing). The reactions to the profitability calculations presented for the project were almost in the same proportion, i.e. 63 % considered them realistic and 28 % could not say anything (10 % considered them to be unrealistic). Of the respondents, 75 % believed that their own power generation unit would ultimately be built in the village and the rest of the respondents were either uncertain or doubtful.

Nearly 90 % of the respondents believed that the plant would be able to produce the planned amount of renewable energy for the village's needs. The same number believed that these plans would promote the interests of all villagers, i.e. all the inhabitants of the village would benefit from the planned facility. 75 % of the respondents felt that all those willing would be able to participate in the village planning work and that the decision on the power plant was unanimous and equal. Thus, the respondents indicated that there had been social equality regarding the planning. The same amount felt that the flow of information was open and sufficient.

Almost all the respondents believed that, through the development plans, co-operation between villagers/villages will increase and that the plans will increase local jobs. 80 % of the respondents believed that the plans would help to attract more residents to the village. However, only 25 % of the respondents said they were involved in creating a village vision. Reasons for not participating were including high age, lack of time, or interest which prevented participation. However, up to 55 % of the respondents said they wanted to be involved in the village's vision creation process. Only a quarter mentioned that they were uncertain, and the other quarter of the respondents stated that they did not want to be involved in the village vision creation work. However, 90 % of the respondents were confident that the development actions would implement the planned village's vision.

The general conclusion of the survey was that the bioeconomic project was of general interest to almost all the inhabitants of the village. The results and attitudes in the village were positive and the villagers were clearly interested in the project. The most frequently asked questions and comments about the project concerned the practical implementation and costs of the plan, e.g. "How will the logistics work in practice for the transport of cylinders? When will villagers receive concrete information such as figures and information on how much they should invest in the project? Is the calculation in the questionnaire realistic? etc."

The survey was conducted in every household of Saija. Altogether 41 households were interviewed and 19 households either rejected the interview or were not reached. Additionally, some forms were partly filled. The respondents' age group included mostly men over 40 years of age (25 % of the respondents were women). Nearly half of the respondents were retired, and the remaining were workers and entrepreneurs (only 8 % were unemployed). Almost all of the respondents had lived in Saija nearly all their lives. Half of the respondents were involved in the village association.

The interviewer was a student originally from the village of Saija. This was considered to be a positive aspect because it was assumed that people would talk more freely to the "villages own son". However, one third of the village's households did not answer the questionnaire.

4.4.9. Stage 2: Selection and development

In the second stage, the preliminary proposal for the green economy indicators along with indicator criteria analyses were combined with analysed results from the questionnaire. This further develops the work started previous project (Timonen at al. 2017) and the complemented work by this follow up project presented in last steps of indicator selection.

4.4.10. Common local indicators

In the final step "Common local indicators" the final results for selected indicators is presented. More specifically, the common local indicators for energy, food and tourism system were defined. Next to these, socio demographic indicators were added in order to reflect change in the green economy at the system to area level, as well as socio-demographic changes. The green economy concept framework was adopted in indicator development work more profoundly and also the more inclusive social capital dimension from the questionnaire results was analysed. In addition, a new bioeconomy perspective (symbiosis thinking) for measuring green economy systems was developed utilising the work on energy, food and tourism indicators and base data. This resulted in a preliminary proposal for symbiosis indicators. All of these selected and developed indicators are presented as results in Chapter 5.

4.5. Symbiosis modelling (Saija and Nellim)

The starting point for the creation of symbiosis was revealed by modelling and analysing the resources, economic activities, processes and networks of the region.

The development of symbiosis requires change forces that tend to break the standard "regimes" of the public body. In order to create symbiosis, it is also necessary to determine the kind of readiness required in the various administrative sectors to open up the situation and bring about change. In addition to private actors, public bodies were also taken into account in the modelling and how the growth of the green economy through business activity would affect public finances and green economy objectives.

The modelling of the symbiosis was based on:

1) The area description to provide the spatial framework for a symbiosis.
2) Statistical information from governmental offices and the statistical information on taxes and the villagers' own funds available to create an economic framework (Tilastokeskus 2017).
3) Energy balance calculations to provide information on energy self-sufficiency.
4) A resource inventory to provide a description of material flows.
5) Developing, information and discussions with villagers and entrepreneurs.

6) The material originating from the findings of the previous project to provide ideas on potential areas of development (Timonen et. al. 2017 pp. 95 - 108).
7) Data collected by utilising previous project information as well as new data collection methodologies for the complementary actions of the bioeconomy. Also using data to reveal complementary actions based on SWOT- analyses (fo the villages Saija and Nellim) and symbiosis indicators.
8) The data provided by the green economy indicators to show the potential benefit of utilising the side flows, potential of capital outflows, self-sufficiency and material and energy surplus as a potential for export. This data highlights the potential and impact of synergies between different actors in the region utilising indicators.
9) Using the materials exploring the potential for exploitation of side streams, such as the use of side streams of food production for other food products or energy in business (e.g. reindeer husbandry, spice components). Also, by investigating the potential of the energy output side flows (e.g. processing residues) as a nutrient in food production.
10) The data received from the development process symbiosis, itself, as well as from the results of the energy and food systems
11) The data from business models and by pooling different actors to provide a business orientation.
12) In finding the potential supply meeting the demand in the area, the data for developing symbiosis indicators is collected by utilising the initial local green economy indicators of energy, food and tourism system (Chapter 5.1.). The symbiosis indicators and symbiosis modelling revealed the potential interface between material flows and actors.

5. Results

In this chapter the final selected indicators are presented as results of the indicator selection process (Table 2, 3 & 4). In addition, this chapter also presents the symbiosis modelling including general level measurement, modelling, complementary mechanisms and new energy production forms.

5.1. Green economy indicators

In this section the local level green economy indicators chosen and developed on a Lapland regional scale are presented. The chosen indicators are results of the indicator selection process presented in Chapter 4. These indicators are meant to be utilised during the whole period of the green economy transition process (e.g. from the present time until the target state). The aim of these indicators is to measure and verify the green economy transition process in the area.

The green economy is a sustainability concept and will have ecological, economic and social consequences. Therefore, these indicators meet the total sustainability requirements and are categorised in three dimensions: ecological, economic and social. The ecological perspective indicators generate information on alternative production processes and resource potential and assess their sustainable use for the region over the longer term in order to secure economic growth. The economic perspective indicators look at the region's self-sufficiency and the economic value potential of sustainable ecosystem services. The potential of new, value-added products and exports (more refined products) is also evaluated. The social perspective for the direct social effects in the system is assessed with potential socio-economic and socio demographic indicators as well as taking into account their potential indirect effects on human well-being (e.g. employment effects). In addition, social capital indicators such as "trust" towards the development of green economy plans, and "know-how" as raising awareness for the development possibilities of the area are integrated.

The aim here was to further develop the energy and food system indicators initially developed in previous project. The main focus is on the energy sector since renewable energy plays a significant role in green economy thinking. Next to the energy system indicators, we present the food system indicators because they represent a relevant sector in the bioeconomy and have the potential to work in symbiosis with energy systems. Thirdly we are complementing these with indicators for responsible tourism, taking into account ecosystem boundaries of the area and sustainability, as services' utilisation potential for economic growth instead of utilising material services. Lastly, we present the socio-demographic indicators that present the total area level (not system specified) baseline for the human and demographic potential for green economy change. These are to be reflected in the changes in system-level indicators because there might be some correlations to be found between green growth at the system and area level.

5.1.1. Indicators for the energy system

These indicators aim to measure the energy self-sufficiency potential of the Saija case area by substituting imported fossil energy with self-produced renewable bio-based energy, then increasing renewable energy production with other potential bio-based energy sources and finally towards new emission free energy sources (solar, wind and hydrogen) to meet the green growth needs of the area. The indicators also seek to determine the export potential. The indicators are shown in Table 2 and the values are presented in a qualitative form for each indicator based on data collection from the Saija case village.

Table 2. Developed energy sector indicators

Local indicator	
ECOLOGICAL DIMENSION	
Sustainable utilisation of total raw material base	• *Description: The total raw material base must be utilized sustainable way.* Sustainable *utilization of raw material base (e.g. forest wood) focuses on meeting the needs of the present without compromising the ability of future generations to meet their needs. It is the ability to maintain the rates of renewable resources and non-renewable resource depletion.* • *Calculation: Increment of growing stock in relation to drain on growing stock* • *Interpretation: When annual increment of the growing of stock is the same or bigger than the drain (annual depletion) the utilization of raw material base is sustainable and maintaining ecosystem resilience and carrying capacity.* • *Value measured in this study: High potential of local natural forest resources were discovered at the local level during the project. The sustainable utilisation of this forest growing stock is guaranteed due to Finland's legislation and the raw materials utilised in this study are side flows (see more in Chapter 6.1).*
Utilisation of side stream volumes	• *Description: The utilization of side streams (co-products defined as waste in many cases) must increase in order to promote resource efficiency and the green economy.* • *Calculation: Unutilized side stream volumes in relation to total side stream production.* • *Interpretation: Increasing utilization share of side stream is reflecting growing resource efficiency as one of green economy's paradigms.* • *Value measured in this study: Unutilised forestry (woodchips, tree stumps, twigs etc.) and manure volumes in the area were calculated to meet the area's internal demand for energy. Other unutilised side streams will be assessed in the near future in terms of meeting potential growing demand and exports.*
Renewable energy production potential	• *Description: The share of renewable energy production in the area must grow and substitute fossil energy and finally meet the inner energy demand totally. It is seen that this indicator reflects the green economy target for a low carbon economy and maintaining ecosystem resilience and carrying capacity.* • *Calculation: Renewable energy production in relation to the demand for fossil energy.* • *Interpretation: The increasing share of renewable energy production reflects the growth of the green economy in the area.* • *Value measured in this study: It was assessed that the local energy demand can be met by utilising raw materials (biomass-based side streams) for energy production obtained from already existing production side streams. The total renewable energy potential could finally be complemented/substituted with solar and wind production.*
Energy surplus	• *Description: This reflects the excess amount of produced energy compared to the area's consumption. It reflects the potential for the area's development and growth as well as the potential for exports. This indicator serves as part of the measurement of the ecosystem carrying capacity.* • *Calculation: The area's internal demand for energy deducted from the total energy production potential* • *Interpretation: The bigger the energy surplus, the bigger the potential for export and business as well as greater self-sufficient in energy production meeting the area's potential growth in the near future.* • *Value measured in this study:There is potential for an excess amount of energy production once the local internal energy demand is covered (see more in Chapter 6.1).*
Ecological footprint	• *Description: An ecological footprint is the area required to sustainably support energy production and a given population. It is therefore the inverse of the carrying capacity (see theory 3) and provides a quantitative estimate of the human carrying capacity. The ecological footprint of a population is an area of land (and water) that would be required to sustainably provide all of a particular population's resources and assimilate all its wastes.* • *Calculation: An area of land (and water) that would be required to sustainably provide all of a particular population's resources and assimilate all its wastes.* • *Interpretation: If the ecological footprint is the same or smaller than the actually utilised area, it promotes the green economy and growth.* • *Value measured in this study:It was not yet possible to evaluate the area during this study.*
The life cycle assessment (LCA)	• *Description: Environmental impacts are assessed during the total life cycle of energy and digestate products in the area.* • *Calculation: ISO 14040 (2006) and ISO 14044 (2006) provide the standardised framework for environmental LCA studies. Also some methodological guidelines have been published, e.g. International Reference Life Cycle Data System (ILCD) handbook (JRC 2010). Environmental LCA is*

	carried out in four phases (ISO 14040). These phases can also be adapted to LCC and S-LCA. ● *Interpretation: Minimising the environmental impacts of energy products leads towards green growth in the area.* ● *Value measured in this study: It was not yet possible to evaluate the environmental impacts during this study. However, there are already LCA studies for energy products that can be utilised as when promoting green growth in the area.*
ECONOMIC DIMENSION	
Energy capital flight	● *Description: Capital flight represents the money flowing outside the area due to imported fossil energy consumption. It also represents the potential for the area's self-sufficiency because the imported consumption could be fulfilled with the area's own production. The consumption of imported fossil energy (capital flight) must be reduced to zero and renewable energy must grow to meet the total energy demand/consumption. This indicator meets the target for a low carbon economy and reflects the area's resource efficiency as one of the green economy's paradigms.* ● *Calculation: The consumption (€) of imported fossil energy that could be fulfilled by the area's self-sufficient local renewable energy production.* ● *Interpretation: A reduction of capital flight reflects value flowing back inside the area by substituting fossil energy consumption with self-sufficient renewable energy production. A decreasing value is also indicative of the local area's transition to renewable energy as consumption of imported fossil energy decreases. The more the imported fossil energy is substituted with self-sufficient renewable energy produced in the area, the more the green growth in the area.* ● *Value measured in this study: Capital flight is significant in the area. At this moment, the renewable energy production in the case area is small compared to the fossil energy consumption, even though it would be possible to produce sufficient energy to meet the demand locally in a self-sufficient way from the area's own renewables.*
Energy export	● *Description: The value of renewable energy production that exceeds the internal energy demand. This reflects the future added value for the area's development and growth as well as the potential for exports. The renewable energy export potential must be assessed after fossil energy consumption in the area is substituted totally by renewable energy production and once self-sufficiency objectives are met.* ● *Calculation: Value of energy surplus € (Energy production potential €– the area's inner demand for energy €)* ● *Interpretation: The bigger the value for the energy export potential, the bigger the potential for new business opportunities as well as for the green growth of the area.* ● *Value measured in this study: There is potential for an excess amount of energy to be produced after local energy demands are already met by local energy production (see more in Chapter 6.1).*
The life cycle costing (LCC)	● *Description: The life cycle costs and value creation assessed for bioenergy product as well as digestate. ISO 15686 (2008) defines LCC as "a technique which enables comparative cost assessments to be made over a specified period of time, taking into account all relevant economic factors, both in terms of initial costs and future operational costs". The LCC can be presented as a sum of the budget costs and transfers for all the activities included in the scenario. The more comprehensive E-LCC also includes environmental costs.* ● *Calculation: The basis of LCC theory was developed by Flanagan et al. (1989) and Kirk & Dell'Isola (1995) along with the following steps (summarised by Ristimäki et al. 2013) to undertake an LCC analysis.* ● *Interpretation: Minimising costs and increasing value creation during the life cycle of energy products leads towards green growth.* ● *Value measured in this study: It was not yet possible to evaluate this area. However, there are already cost benefit analyses and some LCC studies for different energy products that can be utilised as trendsetting results when promoting green growth in the area.*
SOCIAL DIMENSION	
The number of employed (energy sector)	● *Description: the number of jobs created due to green growth in the energy sector. This indicator reflects the biogas plant in the case village and is a social indicator that reflects direct effect from the energy sector (in the green economy sector).* ● *Calculation: The number of jobs in the area's energy sector. The number of jobs in the service sector was surveyed in villages from statistical data.* ● *Interpretation: An increase in the number reflects job creation in the area due to green growth in the energy sector reflecting how many jobs would be created in the green economy transition process. This also has an indirect effect on well-being.* ● *Value measured in this study: This project sought information on the number of jobs in the area*

	due to a potential biogas plant. It was estimated that in the case villages a local bioenergy facility would generate three person-work years on its own (see more in Chapter 6.1).
Local resident's trust in energy development	• *Description: Trust reflects the quality of the social dimension in the village. This indicates trust for the village's energy development plans, calculations concerning the biogas plant, as well as collaboration skills and trust in other people and institutions.* • *Calculation: Measured via a questionnaire for residents after workshops during preliminary work (see more in Chapter 4.2.2).* • *Interpretation: The more trust there is in the village the more the potential for green economy change and growth in the area* • *Value measured in this study: The majority of the respondents believed that the energy calculations presented by the project were credible, that their own power generation unit would ultimately be built in the village, that the plant would be able to produce the planned amount of renewable energy for the village's needs and that these plans would promote the interests of all villagers.*
The social life cycle assessment (S-LCA)	• *Description: A social LCA (S-LCA) focuses on aspects that can directly affect stakeholders positively or negatively during the life cycle of a product (UNEP/SETAC 2009) from cradle to grave, looking at the complete life-cycle of the product (in this case bioenergy and digestate).* • *Calculation: A basic framework and guidelines have been developed by UNEP/SETAC (2009 and 2013). Calculation of the social impact category indicators is done by utilising (PSILCA, Hot Spot Database) databases based on country specific general level qualitative information* • *Interpretation: The lower the risks associated with social impact categories during the life cycle of biogas products the more green growth in the area.* • *Value measured in this study: It was not yet possible to evaluate in the area. However, there are already some studies that have assessed S-LCA for biogas production that can be utilised as trendsetting results when promoting green growth in the area.*

5.1.2. Indicators for the food system

The aim of these indicators is to prioritise the progress and measurement of the self-sufficiency potential for food production and processing, in addition to the green growth needs for the area, as well as the export potential. The selected and developed food sector indicators are shown in Table 3. The values are presented in a qualitative form and are based on data collected for Saija case village.

Table 3. Developed food sector indicators.

Local indicator	
ECOLOGICAL DIMENSION	
Local food production potential	• *Description: It is basically realistic to further process milk, beef, pork, poultry, sheep and reindeer in the Lapland region (Kuha 2015.) In addition there is outdoor cropping, agroforestry, fishing and hunting and possibilities for glasshouse cultivation. This indicator serves as part of the measurement of the ecosystem carrying capacity.* • *Calculation: The model for evaluating the potential for the Lapland area to produce and process its own food is published by Kuha (2015).* • *Interpretation: The share of local food production in the area must grow in relation to imported food consumption to be more self-sufficient, sustainable and to implement green economy targets.* • *Value measured in this study: The potential food production was assessed for livestock, reindeer processing (reindeer chips), cattle (beef), mushroom cultivation (Matsututake mushrooms), and greenhouse cultivation (fruit and vegetables). The general level Saija village assessment reflected the assumptions in the study by Kuha (2015) where it was calculated that it was possible to produce almost 50 % of Lapland's overall food demand in Lapland. In addition, the potential for processing share in Lapland is about 30 % of the total price of the end products (see more in "food capital outflow) (Kuha 2015).*
Potential for cultivated fields (ha)	• *Description: This reflects the changes in the land use and land use classifications of the village every five years (ha/v). The measure reflects the shift of the village's production patterns (unused field, forest, energy raw materials, food production, and food security). It reflects the potential cultivated fields (ha) yet unutilised. This indicator reflects the ecosystem resilience as one of the green economy's paradigms. This indicator serves as part of the measurement of the ecosystem carrying capacity.* • *Calculation: Unutilised cultivated field (ha) in this year – Unutilised cultivated field (ha/after 5 years) > 0*

	• *Interpretation: When the difference between this year and the situation after 5 years is greater than 0 it means that the unutilised area has decreased over time and the area's own cultivation activities have increased towards green growth.* • *Value measured in this study: This project assessed an unused field area during this year. The assessment of the change will be done after 5 years.*
Change in plant biomass growth (t/yr.)	• *Description: This indicator and a change of the value reflect the growth of food production within the village and how efficiently the areas are used. This indicator serves as part of the measurement of the ecosystem carrying capacity.* • *Calculation: Plant biomass this year- Plant biomass last year (t/v > 0)* • *Interpretation: If the value is greater than 0 it reflects the growth of plant-based food production within the village and how efficiently the areas are used to meet the local demand for food. It illustrates the potential for exploiting the region's own provisioning field ecosystem service.* • *Value measured in this study: This project evaluated the potential area of unused field (ha) but not yet the potential biomass.*
Agroforestry potential volumes (harvest) in the area	• *Description: The potential harvest (e.g. berry yields, mushrooms yields, game animals) for humans (area residents and tourists) in terms of forest ecosystem provisioning services for food production. This indicator reflects the resource efficiency and ecosystem resilience as one of green economy's paradigms. This indicator serves as part of the measurement of the ecosystem carrying capacity.* • *Calculation: Berry yield models are included in a stand growth simulator. The joint production of timber and berries is optimised by maximising the soil expectation value (SEV). Miina et al. (2010) optimised the joint production of timber and bilberries. In addition, Miina et al. (2016) included bilberry and cowberry yield models in a stand growth simulator for the joint production of timber and berries which were optimised by maximising soil expectation value (SEV).* • *Interpretation: If utilising this model for sustainable agroforestry the area is moving towards green growth* • *Value measured in this study: This indicator was not calculated due to other prioritised development steps. However, there is a potential for berry harvesting and even mushroom cultivation (Matsututake mushrooms) in the area.*
Food production surplus	• *Description: The excess amount of food production after the internal demand has been met as optimally as possible (it is not possible to completely locally produce all of the food necessary to meet the total demand for food in the area). Reflects the export possibilities but also the possibilities in meeting the area's growing food demand in the near future. This indicator serves as part of the measurement of the ecosystem carrying capacity.* • *Calculation: Total food production in the area minus the area's demand for food products* • *Interpretation: The larger the surplus the bigger the opportunities there are for businesses and export potential.* • *Value measured in this study: This indicator was not yet calculated in this project, because the primary aim is first to assess the internal demand, capital flight and production possibilities (to achieve self-sufficiency) first.*
Basic change in primary nutrient/renewable nutrient (nutrient-footprint) of food production	• *Description: The $NUE_{product}$ value illustrates the efficiency of nutrient use for the main purpose of production, e.g. for the food product. The nutrient footprint is an indicator which combines the quantity of captured nutrients [kg of N and P] for use in the production chain and the share of nutrients utilised [%] either in the product itself or in the entire production chain, accounting also for side-products. The NUE_{total} value gives the benefit of the production chain, if it also produces other products or materials, and if the nutrient contents of those flows can be exploited. This indicator reflects the ecosystem resilience as one of the green economy's paradigms. This indicator serves as part of the measurement of the ecosystem carrying capacity.* • *Calculation: The nutrient footprint combines the presented nutrient flows as parameters demonstrating the nutrient use efficiency (NUE) [%] which can be achieved with the following equations:* $$\mathrm{NUE_{product}} = \frac{\text{Nutrient content of the product}}{\text{Total amount of nutrients captured by the production chain}} \times 100$$ $$\mathrm{NUE_{total}} = \frac{\text{Nutrient contents (product and side} - \text{products)}}{\text{Total amount of nutrients captured by the production chain}} \times 100$$ *Data is collected from soil samples or statistics annually. The nutrient footprint can be calculated separately for virgin and recycled nutrients.*

	• *Interpretation: An increase in the figure indicates increasing efficiency of nutrient use in food production. Indirectly it might also indicate an increase in renewable nutrient production because the digestate takes care of the soil and fertilises it.* • *Value measured in this study: In this context the calculation can be done indirectly by calculating volumes for virgin and recycled nutrients (e.g. digestate from a biogas plant) and their relative shares in food production. In Saija there is only 1 organic farm and therefore there is an estimate of 96 % for artificial fertilisers. The aim is to completely turn in the direction of recycled fertiliser so that the proportion of recycled fertilisers shifts to a 95 % share and mineral fertilisers to 5 % of the overall fertiliser use.*
Ecological footprint	• *Description: An ecological footprint is the area required to sustainably support food production and a given population. It is therefore the inverse of the carrying capacity (see theory 3) and provides a quantitative estimate of the human carrying capacity.* • *Calculation: An area of land (and water) that would be required to sustainably provide all of a particular population's resources and assimilate all its waste.* • *Interpretation: If the ecological footprint is the same or smaller than the actually utilised area OF land, it promotes THE green economy and growth.* • *Value measured in this study: It was not yet possible to evaluate this at an area level during this study.*
The life cycle assessment (LCA)	• *Description: Environmental impacts assessed during the life cycle of food products in the area.* • *Calculation: ISO 14040 (2006) and ISO 14044 (2006) provide a standardised framework for environmental LCA studies. Also some methodological guidelines have been published, e.g. the International Reference Life Cycle Data System (ILCD) handbook (JRC 2010). Environmental LCAs are carried out in four phases (ISO 14040). These phases can also be adapted to LCC and S-LCA.* • *Interpretation: Minimising environmental impacts of food products leads towards green growth in the area.* • *Value measured in this study: it was not yet possible to evaluate in the area. However, there are already LCA studies for different food products that can be utilised as trendsetting results when promoting green growth in the area.*
ECONOMIC DIMENSION	
The capital outflow of food (€ /a)	• *Description: Capital flight is the economic value of the area which is lost annually outside of the area due to imported food products or outsourced processing and production of food even though it could be possible to produce or process the food in the area (reindeer herding, livestock, fodder and berry crops, feed production, etc.). This indicator reflects resource efficiency as one of the green economy's paradigms.* • *Calculation: Based on the Kuha (2015) calculation model, the loss in the processing value of the products in Lapland is estimated by calculating the consumption of agricultural products (successful in northern conditions) in kilograms in Lapland, the total consumption value at consumer prices, the value of the raw material consumption and the value of processing. The value sum is comprised of the consumption value of the end products which could realistically be further processed in the Lapland region, basically milk, beef, pork, poultry, sheep and reindeer. Inside the assessment model other groups are also included, e.g. outdoor cropping that would be possible to practice in Lapland conditions.* • *Interpretation: A reduction of the capital flight reflects an increase in food self-sufficiency and income to the area and accelerates business. This also reflects growth and concentration of sustainable production in the area.* • *Value measured in this study: The value loss of processing was calculated to be approximately 30 % of the total price of the end product. The preliminary value for the food outflow (production and processing food outside the Saija area) in Saija was assumed to reflect the same shares as in the Kuha (2015) study of the total Lapland area. However, in addition the potential due special characteristics of Saija should be taken into account (e.g. glasshouse cultivation).*
Food exports€/yr.	• *Description: The value for the excess amount of food production after internal demand has been met.* • *Calculation: This is estimated by utilising the "Food production surplus" indicator. The market price for production volumes of the area not met by the area's own demand for food products.* • *Interpretation: The bigger the export value the greater the opportunities for growth and business.* • *Value measured in this study: The potential for food exports was not yet estimated in this project, but capital flight (self-sufficiency) was examined. However, the export potential for food products not meeting the area's internal demand was perceived during the study (e.g. reindeer chips, Matsututake mushrooms etc.).*
Life cycle costing (LCC)	• *Description: The life cycle costs and value creation assessed for food products. ISO 15686 (2008) defines LCC as "a technique which enables comparative cost assessments to be made*

	over a specified period of time, taking into account all relevant economic factors, both in terms of initial costs and future operational costs". ● *Calculation: The basis of LCC theory was properly developed by Flanagan et al. (1989) and Kirk & Dell'Isola (1995) steps summarised by Ristimäki et al. (2013).* ● *Interpretation: Minimising costs and increasing value creation during the life cycle of food products leads towards green growth.* ● *Value measured in this study: It was not yet possible to evaluate this in the region. However, there are some LCC studies for different food products that can be utilised as trendsetting results when promoting green growth in the area.*
SOCIAL DIMENSION	
Access and availability of edible and provisioning ecosystem services	● *Description: This reflects social equity in terms of accessibility (the given possibility for fair distribution of the yields) to ecosystem provisioning services e.g. berries, mushroom yields, fish, game animals.* ● *Calculation: Area for resident's to be utilised/Total local area* ● *Interpretation: The bigger the area for residents to utilise freely, the better the social equity of the area* ● *Value measured in this study: The social equity level is good for agroforestry products (mushrooms and berries) in Finland due to "Every man's right" guaranteeing access for every resident in the area to utilise ecosystem food provisioning services (berries, mushrooms), even though the area would be private property. However, for gaming one needs to be part of local game association and fishing requires a license which can be purchased by anyone.*
Improvement of food security	● *Description: Self-sufficiency of food production (primary production, processing) increases regional food security.* ● *Calculation: Local production/consumption rate >0 or Capital flight in this year – Capital flight next year >0* ● *Interpretation: If the value is greater than 0 and growing, the share of local production meeting the demand is growing. If the value is greater than 0 the capital flight of food is decreasing, the area's self-sufficiency and regional food security are increasing during the year.* ● *Value measured in this study: Decreasing capital outflow of food is reflecting improvement of food security when the analysis is done at certain intervals in order to interpret the change.*
Number of jobs through food production	● *Description: This indicator reflects the number of jobs created specifically by the production and processing of self-sufficient food in the region.* ● *Calculation: The number of jobs per year created by the production and processing of self-sufficient food in the region. Based on the conversion of the processing value, it is possible to estimate the displacement of work places outside Lapland (Kuha 2015).* ● *Interpretation: Growth suggests an increasing number of jobs in the region's food sector and rising living standards in the region* ● *Value measured in this study: In this project, the number of jobs was reviewed by industry, but the number of jobs brought by the growth of self-sufficient food production in the future cannot yet be verified*
The social life cycle assessment (S-LCA)	● *Description: The social LCA (S-LCA) focuses on aspects that can directly affect stakeholders positively or negatively during the life cycle of a product (UNEP/SETAC 2009) from the cradle to the grave, looking at the complete life-cycle of a product (in this case food products).* ● *Calculation: A basic framework and guidelines have been developed by UNEP/SETAC (2009 and 2013). Calculation of the social impact category indicators is done by utilising (PSILCA, Hot Spot Database) databases based on country specific general level qualitative information.* ● *Interpretation: The lower the risks for social impact categories during the life cycle of food products the more green growth in the area.* ● *Value measured in this study: It was not yet possible to evaluate in the area. However, there are already some studies that have assessed S-LCA based on general level country specific data for different food products that can be utilised as trendsetting results when promoting green growth in the area.*

5.1.3. Indicators for nature-based tourism

The tourism indicators take cultural ecosystem services into account. The direct and indirect effects of the cultural ecosystem services on well-being are also taken into assessment here. The selected and developed tourism system indicators are presented in Table 4 and the values are presented in a qualitative form for each indicator based on the Nellim case village.

Table 4. Developed tourism indicators.

ECOLOGICAL DIMENSION	
Cultural ecosystem services	● *Description: The total supply for tourism in the area is the number of a wide range of visitor facilities (Tourism Society 2018.). This must be reflected in the available recreational services and opportunities offered by the ecosystem (e.g. berry picking, mushroom picking, fishing, and hunting) in order to reflect the green economy potential through cultural ecosystem services. This indicator serves as part of the measurement of the ecosystem carrying capacity.* ● *Calculation: The number of available cultural ecosystem services in relation to the number of a wide range of visitor facilities (total tourism supply).* ● *Interpretation: If the share of ecosystem services in proportion to the range of total visitor facilities grows, it reflects green growth in the area. As the utilisation grows it should be done within the ecological limits of the ecosystem.* ● *Value measured in this study: It is not yet possible to get data on the utilised cultural services in the private sector. In the future this data collection could be done when gathering data on accommodation numbers.* *It is estimated that the majority of the village and Inari area residents go berry picking, fishing or hunting, e.g. utilise the recreational services of the area ecosystem. However statistical data about the use is not yet available. Memberships of local game associations provide some information on the topic.*
Area/Nature wear resistance	● *Description: The area wear resistance indicates the capacity to absorb or tolerate the effects of stress as a result of human activity. The ecosystem can try to either absorb the pressure caused or to tolerate it without significant changes in the structure or operation of the system. Vegetation tensile strength refers to the ability of vegetation to tolerate the utilisation and this can be described by a certain amount of use that the vegetation tolerates before harmful changes occur. Recovery ability means the ability of vegetation to be repaired more or less in the long run. This indicator serves as part of the measurement of the ecosystem carrying capacity.* ● *Calculation: One way to analyse and calculate the ecological carrying capacity is through vegetation tensile strength and its recovery ability (see Cole 1995).* ● *Interpretation: Better vegetation tensile strength and recovery ability takes the area towards green growth.* ● *Value measured in this study: This was not possible to estimate in this study. There is a need for further research and local data collection.*
Biodiversity	● *Description: This reflects the resiliency of the system hence biodiversity guarantees the resiliency of the ecosystem. This indicator serves as part of the measurement of the ecosystem carrying capacity.* ● *Calculation: The number of species (flora and fauna), number of endangered species, amount (ha) of natural state soil and rock (geological biodiversity), number of conservation areas (government owned land & implementation of Metso-programme in the area), number of nationally important landscape areas (see ympäristö.fi, Auvinen and Tuominen 2006, Jokimäki-Kaisanlahti-Jokimäki 2007).* ● *Interpretation: Maintained or increased biodiversity enables the ecosystem to recover and tolerate changes in the system.* ● *Value measured in this study: 99 % of the state driven conservation area programme has been implemented in Lapland (ympäristö.fi, 2018 a). Natura-areas exist close to Nellim village. In general the amount of endangered species has increased and many of them live in the old forests (ympäristö.fi 2018 b).*
Water quality	● *Description: Water quality reflects the water economy and system of the area. The water system is an essential part of the ecosystem and ecosystem services. This indicator serves as part of the measurement of the ecosystem carrying capacity.* ● *Calculation: The amount and quality of ground- and surface water (m3, quality indicators), eutrophication/ acidification, hydrogeological changes, e.g. water flows and amounts (see e.g. Jokimäki-Kaisanlahti-Jokimäki 2007).* ● *Interpretation: Good condition of the water system and situation maintains the biodiversity, its resilience and utilisation of ecosystem services.* ● *Value measured in this study: Nellim village is by Lake Inari and is widely utilised by tourists and local people. The quality of the water is excellent and the nutrient load caused by human activities is minor. However, rationing of water has had negative impacts on the flora and fauna in lake Inari. (ympäristö.fi 2018 c, d).*

Air quality	• *Description: Tourism has an effect on the air quality, e.g. travelling causes emissions, food production, housing etc.* • *Calculation: Air quality (different indicators for air pollutants, e.g. PM, NO_2, SO_2 (EEA 2017).* • *Interpretation: Good condition of the air maintains biodiversity, as well as resilience and utilisation of ecosystem services, especially related to tourism services.* • *Value measured in this study: In Lapland the air quality is good (WHO 2018).*
Energy self-sufficiency	• *Description: The self-sufficient rate in renewable energy production based on local resources. This indicator meets the target for the low carbon economy and reflects social equity as one of the green economy's paradigms. This indicator serves as part of the measurement of the ecosystem carrying capacity* • *Calculation: The energy self-sufficiency rate (%) in renewable energy production based on local resources (see energy system indicators).* • *Interpretation: Reveals the efficiency of local resource utilisation.* • *Value measured in this study: Self-sufficient thermal heat covers the entire heat consumption of the studied tourism company. Electricity is however purchased outside the area. The aim is that in the near future, area waste will be collected in a digestion plant where gas is collected and electricity is generated.*
Local food service utilisation in restaurants	• *Description: Local food consumption in restaurants. This indicator reveals the use of local resources in terms of food. The amount of local food refers to wild food (game animals, berries, fish, and reindeer) and other local food product use.* • *Calculation: The share of local food (%) in restaurants compared to total amount of food consumption.* • *Interpretation: As the number increases it reflects the shift towards more sustainable local resource use.* • *Value measured in this study: Circa 20-30 % of utilised food comes from the local producers. Reindeer, fish, game and berries are mainly local.*
Local facility material utilisation	• *Description: The locality level of building materials used indicates the utilisation of local resources.* • *Calculation: Locality level (%) of building materials (e.g. wood).* • *Interpretation: An increase in the locality level of building materials indicates an increase in green growth* • *Value measured in this study: In the Nellim case, the tourism company has agreements with a local building company. However, the cottages have been built from deadwood imported from Russia since deadwood is mainly situated in conservation areas in Finland and their utilisation is forbidden.*
Sustainable facility material utilisation	• *Description: Certified (e.g. eco labs) materials indicate the sustainability of resources, taking into account legislation, the environment and local well-being.* • *Calculation: Certified materials used (%) of the total use (e.g. wood).* • *Interpretation: An increase of certified materials indicates an increase in green growth.* • *Value measured in this study: Deadwood is imported from Russia and is not certified. Other wood material is certified.*
Waste utilisation	• *Description: In the approach to the circular economy the basic idea is to generate no waste; the waste should always be a resource of some other utilisation process. This indicator reflects resource efficiency as one of the green economy's paradigms.* • *Calculation: Utilisation amount (%) of the total waste amount.* • *Interpretation: An increased share reflects the shift towards more resource efficient and sustainable use of food.* • *Value measured in this study: This was not possible to estimate in this study. However, it was perceived that every effort has been made that no organic waste from restaurants has occurred, but still cannot totally be exploited. In the near future, waste will be utilised as energy in the digestion plant. In addition, in Finland no organic waste is allowed to enter landfills anymore, so waste is utilised at least for energy.*
ECONOMIC DIMENSION	
Capital out flow of tourism	• *Description: If tourism services are not under local ownership, it means that the value goes outside the area, i.e. capital flight occurs. Local owners understand the importance of sustainability and the maintenance of ecosystem services for future generations and residents. This indicator reflects resource efficiency as one of the green economy's paradigms.*

	• *Calculation: The value of tourism (utilisation of cultural ecosystem services) flowing outside the area due to non-local ownership.* • *Interpretation: Less capital outflow brings more value to the area from tourism services.* • *Value measured in this study: The actual value of tourism for the company and the area was not calculated but it was perceived that the case village is under local ownership and the supply for ecosystem cultural services are developed in a sustainable way taking into consideration the ecosystem boundaries.*
Value of tourism to the entrepreneur	• *Description: Turnover of the company.* • *Calculation: Value of tourism in €/yr. for the tourism company.* • *Interpretation: This indicator reveals the value for the company from the utilisation of cultural services in the tourism context. However, this increase in value should not happen at the expense of cultural services and has to take into account ecological indicators (ecosystem boundaries).* • *Value measured in this study: The turnover of the tourism entrepreneur was not calculated but it was perceived that in Nellim the ecological boundaries are taken into consideration both now and while aiming for growth of the businesses and expansion (more accommodation) by developing other small tourism villages widely in the Inari area.*
SOCIAL DIMENSION	
The number of tourists	• *Description: The number for tourists, visitor movements and expenditure (the Tourism Society 2018).* • *Calculation: The available statistics on visitor movements and expenditure.* • *Interpretation: This reflects the demand for tourism and it must grow in line with ecosystem boundaries in order to reflect the green economy and growth* • *Value measured in this study: The number of tourists coming to Lapland and Inari area is increasing. There are strategies for Lapland that emphasises the importance of sustainable tourism (Lapin matkailustrategia 2015-2018, Suomen arktinen strategia 2013). However, we were not able to assess the optimum number of tourists in relation to sustainable ecosystem and ecosystem boundaries.*
Access to ecosystem cultural services and distribution of these benefits among local residents	• *Description: Reflects the fair and equal access to cultural services for both tourists and residents. This indicator reflects social equity as one of the green economy's paradigmatic terms of accessibility and distribution of cultural services (recreational services, hunting, berry and mushroom picking, nature trails) among population groups and generations.* • *Calculation: Utilising the ecological indicator "Number of available services" for both tourists and local area residents.* • *Interpretation: The greater the area for residents to be utilised freely, the better the social equity of the area.* • *Value measured in this study: In Finland everyman's right guarantees access for every resident in the area to utilise cultural services even if the area is on private property.*
Number of jobs through tourism in the area	• *Description: Reveals the number of jobs created by the tourism business.* • *Calculation: Jobs created by the tourism in the region.* • *Interpretation: This indirectly reflects the well-being effects created by tourism. Growth in change suggests an increasing number of jobs in the region's tourism sector and rising living standards in the region* • *Value measured in this study: Employment has started to increase again in the Inari area. Tourism is the second most important business sector in the Inari area considering the number of jobs created (the Municipality of Inari 2018).*
Human well-being	• *Description: The indicator reflects the well-being effects of the cultural services experienced by tourists and residents.* • *Calculation: Interviews discussing the perceived well-being effects.* • *Interpretation: More positive effects indicate a change towards increased well-being of the residents.* • *Value measured in this study: Referring to the theoretical framework, it is assumed that recreational services will have a beneficial impact on the well-being of tourists and residents. There is also an indirect effect on expanded supply of health services with the growth of the green economy in the area, e.g. experiences from Levi.*

5.1.4. Socio-demographic indicators

The socio-demographic indicators presented below reflect the socio-demographic changes at the total area level. Therefore, these socio-demographic changes should not be interpreted solely in terms of green growth (unless direct socio-demographic/-economic effects from energy system are able to be assessed, e.g. by the number of jobs due to the bioenergy plant). The indicators should be considered and analyzed in relation to the changes in the system-level indicators (energy, food and the tourism sector) to find potential strong or weak correlations, for example, between the green economy transition process at the energy system level and local area economic growth. Changes inside socio-demographic indicators may correlate with changes in energy sector specific indicators, but socio-demographic indicators are affected by other factors too, so for that reason we present them separately from ecological, economic and social energy sector indicators. The chosen socio-demographic indicators are presented in Table 5 and are based on general level observations in the Saija area.

Table 5. Developed socio-demographic indicators.

Population	• *Description: This indicator reflects the population growth in the area. In this local area case (in the context of Finland and the peripheral regions in Lapland), the growth of the population is needed for green growth locally and globally. Migration is a current risk and potentially growing in Lapland. This indicator serves as part of the measurement of the ecosystem carrying capacity.* • *Calculation: Statistics.* • *Interpretation: As the figure increases, it indicates population growth in sparsely populated areas and thus change in a better and more sustainable direction in the sense of vitality of the area.* • *Value measured in this study: It was perceived that the population is a scarce resource in the Saija village area and this is due to the demographic development (young people are moving away and ageing.) However, in the Inari area the population has grown during the last years (the Municipality of Inari 2018).*
The number of employed in the total workforce	• *Description: This indicator reflects the number of employed residents in the area in relation to the number of qualified workers/total number of capable workers (meaning both employed and unemployed inhabitants). It reflects the degree of employment in the region, the standard of living, the level of participation and potential, and the number of persons at risk of exclusion and the degree/danger of exclusion in the area (lack of employment).* • *Calculation formula: The number of employed residents to the number of the total workforce of the area.* • *Interpretation: As the figure increases it indicates growth in the employment rate. Further, it should be reflected in sectors inside green economy (bioenergy sector, food sector, ecotourism) to reflect green growth in the area and how many jobs would come with the green economy transition process.* • *Value measured in this study: This project sought information on the total number of jobs in the area. In order to reflect the job creation in the future to green growth, the number of jobs are also evaluated separately for the energy sector (see 5.1.1.) and assessed in relation to total workforce. An increase in the total number of employed people in Saija and Inari (Nellim) is reflected in the energy, food and tourism sector. From the overall Lapland level perspective, tourism employs 7.5 % while the national average is 5.5%.*
Demographic dependency ratio	• *Description: This indicator provides insight into the number of people of non-working age compared to the number of those of working age.* • *Calculation method: A measure showing the number of dependents (aged 0-14 and over the age of 65) to the total population (aged 15-64).* • *Interpretation: A high ratio means those of working age face a greater burden in supporting the aging population.* • *Value measured in this study: It was revealed that the ratio was increasing in the Inari area (the Municipality of Inari 2018).*
Economic dependency ratio	• *Description: This indicator provides insight into the number of employed people compared to the number of those outside the workforce.* • *Calculation formula: A measure showing the number of pensioners, people receiving incapacity benefit and the unemployed in ratio to the number of employed people.* • *Interpretation: A high ratio means that employed people need to carry a greater burden to*

	finance the non-employed. A ratio below 1 indicates more balanced and sustainable development in the area. ● *Value measured in this study: The study revealed that the ratio was higher in Lapland and in the case villages compared to the national average (the Municipality of Inari 2018).*
Population per income categories in the region	● *Description: This represents economic equality and wealth in the region. The aim is to achieve an equal income distribution and a low number of people in the lower income group. This describes the distribution of earnings and capital income in the area and thus the economic equality.* ● *Calculation formula: Statistics.* ● *Interpretation: The ratio between the numbers of people in the middle or high income category compared to the number of people in the low income category reflects the economic wealth in the region. An increasing ratio indicates that more people moving into middle or highest income categories which means more wealth is available to a larger group of people. A more even distribution of wealth in the region reflects a rise in living standards.* ● *Value measured in this study: Most of the villagers belong to the middle income category.*
RGDP	● *Description: Regional gross domestic product. The market value of all final goods and services produced in a period of time in the area.* ● *Calculation: Statistics, interviews* ● *Interpretation: As the value for RGDP grows, it reflects the economic growth in the area taking into account ecosystem boundaries in order to reflect green growth in the area.* ● *Value in this study: It was not yet possible to evaluate area-level RGDP and targeted for specifically at a green economy sector during this study.*
Forest/land owners	● *Description: This describes the renewable resource related ownership in the region. It reflects the decision-making power concerning land use in the area.* ● *Calculation: Statistics.* ● *Interpretation: A larger number indicates wider ownership of the resources.* ● *Value measured in this study: It was noted that there were several forest owners in the villages and also common forest owners in the village of Saija and also in the Inari area. In the Inari area Metsähallitus a (state owned enterprise, responsible for the management of one third of Finland's surface area) owns a large amount of forest area. Water area ownership (control rights) is connected to land ownership. However, everyman's rights guarantee swimming, skiing, boating etc. in water areas to all people.*
Village and leisure association members	● *Description: This describes the number of people involved in the development and operation of the village. An increase in the number of active people involved indicates an interest in the common activities of the village. This describes participation in decision-making and the effectiveness and local activity.* ● *Calculation: Statistics, village Internet pages, interviews, social media.* ● *Interpretation: An increased number indicates increased involvement in the village development.* ● *Value measured in this study: It was found that most of the village inhabitants were members of the local village association.*
Participation of local people in development plans	● *Description: The reflects the social equity in terms of opportunities to participation in planning.* ● *Calculation: The number of opportunities for participation and the number of participants. In addition, the existence of a village development plan and the participant number provisionally reflect the participation of local residents.* ● *Interpretation: Increased opportunities and number of people (including indigenous people) participating indicate a change towards a more sustainable planning process.* ● *Value measured in this study: In Nellim there is a development plan for the village, in Saija the villagers have created vision for 2020 for the village.*
Industry sectors	● *Description: Industry sectors and the number of different sectors and companies inside them.* ● *Calculation: Statistics.* ● *Interpretation: A greater number indicates increased resilience of the area.* ● *Value measured in this study: At the moment the diversity in industry sectors is very narrow.*
Education	● *Description: This reflects the growth of education and know –how in the area.* ● *Calculation: Statistics.* ● *Interpretation: An increased number of educated people (number of degrees, diplomas, and certificates) indicates the increased know how level of the area, which is needed in adaptation and implementation of novel green economy systems. However, it is clear that the number of degrees only partially reveals existing know how and the potential of the villagers.* ● *Value measured in this study: In all villages 80 % of the population had either an upper secondary school education or tertiary degree.*
Service availability	● *Description: This indicator describes the new innovative forms of services (e.g. healthcare, postal services) that are needed especially in remote rural areas to guarantee the equality of*

	citizens. In addition, novel information technology also enables a more ecological service supply. ● *Calculation: Statistics, interviews.* ● *Interpretation: A greater number of services indicates change towards a more sustainable economy. However, in order to reflect green growth in the area, this should be more specifically on green economy services or reflected in other green economy services given the potential for more services to merge in the area.* ● *Value measured in this study: The study revealed that most of the services (e.g. healthcare, postal, grocery) have decreased or moved further from the village.*

5.2. Agro-ecological symbiosis modelling

5.2.1. Awareness and choices between the villages

Five villages signed up for the previous project and three villages continued in this project. Finally, two villages wanted to carry out more detailed studies of planned investments and workspaces. In Table 6 below the bioeconomy information sharing process from the beginning of these two projects is presented. The processes were multifaceted and long-lasting. A lot of material was presented and discussed, and questions were asked and answered. Once the information had been sufficiently shared and the interest had increased, two joint exploration visits to bioenergy facilities were organised. The exploration visits were made to CHP plants and the plant manufacturers' premises situated in Finland. In each village the process in this project was a bit different and the number of joint meetings varied a lot.

Table 6. Observations from the project meetings during 2016-2018 (ProAgria Lappi).

Process	Saija	Hämeenkylä	Tanhua	Kelujärvi	Puolakkavaara
	159 inhabitants, 5 active farms, forestry facilities	248 inhabitants, 5 active farms	85 inhabitants, no active farms	120 inhabitants, 3 active farms	116 inhabitants, no farms
Joint presentation, on the bioeconomy and project opportunities, and the results of earlier projects.	6 people present, lots of co-operation and events in the village.	10 people present, mainly farmers and entrepreneurs, there are no common spaces in the village.	6 people present, in the village hall, small events.	8 people involved, joint activities e.g. water company, hunting, fishing.	4 people present, joint development, development association.
Analysis: companies, vehicles, farms, business, communality, attitude, prospects for the future, competence	Statistical data collection, mapping of farms and businesses, working group activities, vision of business and village community: Creating and understanding of energy balance. The importance of change for all villagers.	Statistical collection of data, mapping of a farm and company-specific data, working group work, vision of business activity and village community. The importance of change for all villagers.	Statistical data collection, mapping of farm and company-specific, working group work, vision of business and village community. Importance of the energy balance of the village. The importance of change for all villagers.	No suitable appointment time was found.	No suitable appointment time was found.
Village's own information for residents and discussion tools	Invitations and meeting topics for the villagers starting in August 2015, setting up the "What's up" team and using Facebook for communication.		Discussions in small groups, village houses, village associations and hunting clubs.		

The importance of the green economy through workshops. Why bio economics, and bioenergy for our village?	Extensive discussion with villagers, data collection, relevance and opportunities for different actors.		Discussions and workshops, concretisation, and opportunities.	
Concretisation of the green economy and lessons to learn from workshops	How to implement, energy balance, calculations, data collection together with the compilation of different energy plant versions and idea flows on a business-specific basis. The Importance of every small Business.			
Wider project presentation, village SWOT work by working group, follow-up	Wide number of participants, genuine interest and participation, lots of questions.	Some interest and a lot of questions, the same people there. They want to make a small group.	A narrower number of participants, challenges, and new way of thinking would be needed.	Little interest in the matter, poor participation, no active groups gathered. At the same time, the municipality has several projects on the same main topic.
Collecting village information in co-operation with the village. The use of energy in the village.	A questionnaire that was distributed to the villagers together with the bioeconomy brochure.	Energy consumption data was collected from a small group of participants, farms and businesses.	A questionnaire that was distributed to the villagers together with the bioeconomy brochure.	
Capital flight from the village, own energy production, positive recycle program	Moderate number of participants, very interested.	Active with you, a good job, uncertainty for the money. A place ready made for the power plant.	A few active participants, interest in small-scale debris destruction.	The villages are continuing to carry out development in Sodankylä municipality projects.
Internal communication within the village	Background information and links delivered, questioning information quality for the villagers	Background information and links delivered, questioning information quality for the villagers	Background information and links delivered, questioning information quality for the villagers	
Results of the energy consumption survey for villagers	Plenty of answers, good results.	No survey of villagers, only farms and potential companies.	Moderate number of responses, fair results.	
A benchmarking trip to energy plants	Leaders from the village included.	Leaders from the village included.	No participants.	
Bioenergy plant investment, calculations, operating principle, feeds etc.	An interesting, wide-ranging participant set.	Business-economic aspects differed, emphasising entrepreneurship and benefits for the villagers	Actively involved, the investment is too expensive and does not get all the villagers involved.	
Energy calculations, different types of plants, operating principle and prices	New points for the villagers, interest remains and new questions can be found.	Active locally, deepening issues such as support and sales.	No personal calculation was made. Not enough interest, only the capital outflow was presented.	
The steps of the Agrohub modelling were presented	Increasing knowledge, new perspectives, deeper interest in own energy plant. Positive atmosphere and feelings.	Is it profitable? Questions and answers, discussion, positive atmosphere and feelings.	No more meetings.	

Why did some villages join the project and others refuse? According to *Choice Awareness* theory (Lund 2014), the perception of reality and the interests of existing organisations influence the societal perception of choices. The change from fossil energy to sustainable and renewable energy is a radical change. The change will affect to all stakeholders in village. This means that authorities, individuals, households, farms, companies and different organisations will face the change at the same time from their own point of view.

What was the motive for the change in village? According to Lund (2014) there are basically only two options for choice, a true or false choice. In this view, a true choice is a choice between two or more real options, while a false choice refers to a situation in which the choice is some sort of illusion. How could the villagers obtain more information about these choices? In the Sodankylä villages the municipality had already made that choice and villagers actually only had one option. According to Lund (2014), the theory says that when radical technological changes are at issue it are very difficult to have many real options to choose. Lund says, "The core element is to raise the awareness of the fact that society does have a choice," (Lund 2014). We tried to give the villagers new information to support the decision and to tell them about their chances of reducing the village's capital outflow. In the village of Saija, they established they established a "Whats App" group to deliver information. A democratic infrastructure in the village is crucial to implement change. In the village of Saija these democratic forces were the strongest compared to the other villages. According to Lund (2014) initiatives must come to the village from outside organisations or individuals. In villages, there must be some kind of pioneers of future social interest and a willingness to trust the potential of new technologies.

5.2.2. Business modelling integrating energy and food system (Saija)

The village of Saija, in the region of Salla, and Hämeenkylä in the region of Posio, are still developing an energy production plan. The significance of the agro-ecological symbiosis was understood once the villages' own potential was acknowledged. In those villages there is a willingness to shift from fossil energy and materials to bio-based energy and materials and to take care of the sustainability of the local ecosystem. The same process also includes the beginning of transformation of businesses in the area. Challenges in tackling climate change highlight significant business opportunities if research and funding can be steered while developing business at the same time. The current decentralised use of the village ecosystem that does not recognise all residents' needs creates a significant risk concerning how ownership of land areas will be focused in decision making process. This is linked to the question what is the power of ownership of the land area? The key to stability lies in who owns the ecosystem ends up exploiting the potential of new products, energy and new materials. Centralisation will result in uneven distribution of income and social problems, and thus increased costs for the state.

Fossil fuels and materials, as well as increased environmental burdens and unilateral varieties of material use increase the ecological burden on production. There is a risk of soil depletion and contamination and eutrophication of the waterways. In addition, the age structure of producers, poorer production conditions in Lapland, and the increase of size of farms have increased the economic risks in primary production. If continued, this process will inevitably lead to the transformation of the entire food system or possibly a radical decline in primary production.

The need for change is becoming more and more acute. Climate change is rapidly increasing challenges due to production conditions, risk of disease and persistent low profitability. The risk of the entire collapse of food production, in Lapland, is growing all the time. The sector does not attract new producers, and financiers see it as a significant risk to the industry, and current young people view the industry as uncertain.

The primary model and it's indicators for green economy was developed according to the symbiosis and network perspective, taking into account energy, food, tourism and ecosystem boundaries.

Measuring symbiosis highlights the symbiotic dependencies, reciprocal effects, synergies and exchanges between ecosystem services and their values in terms of energy and material flows. It also examines exchanges of cultural services and their values between different actors e.g. tourist companies, local residents etc.

In Figure 10 an idea of symbiosis is presented where many different production systems from the village to province level are partly separate and partly interlinked to each other. Renewable energy (in the middle of the figure) is the central basis for the system in the symbiosis of green economy thinking.

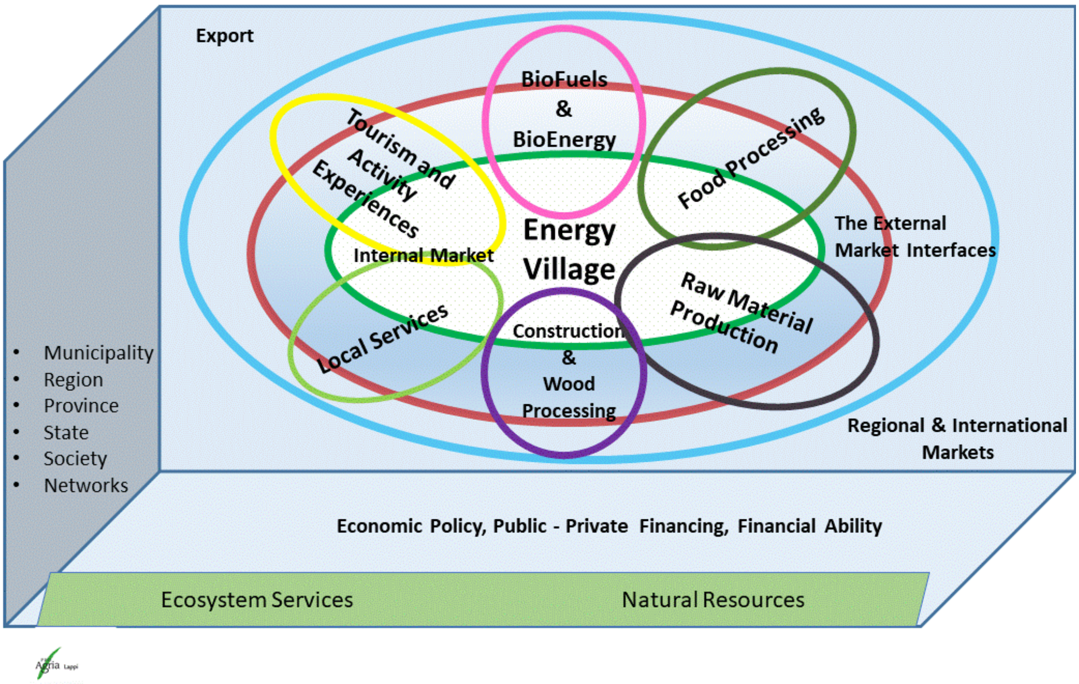

Figure 10. General symbiosis modelling (ProAgria Lappi).

The model above illustrates how energy affects the different rural areas significantly. Local hybrid energy production solutions and business combinations are easily enough for energy self-sufficiency, where the circular economy plays a significant role. The surplus can be sold outside the area. Observations are challenging the current view on cascading and defending the idea of smart specialisation and the relevance of locality and the necessity of regional co-operation. Local energy solutions broadly support the various industries and business sectors. At the same time, the prerequisites for building sustainability-based symbiosis are created. Development is dynamic and process-oriented and requires extensive regional cooperation. Development is vast and cross-sectoral and clusters are an excellent tool for organising the development and obtaining development indications.

In Figure 11, the aim is to model the potential connections (energy and material flows) between different actors in the symbiosis of energy and food systems (case Saija). In Table 7 we more specifically define these energy and food systems' material and energy flows, as well as their utilisation potential following the cascading principle (see the theory –chapter).

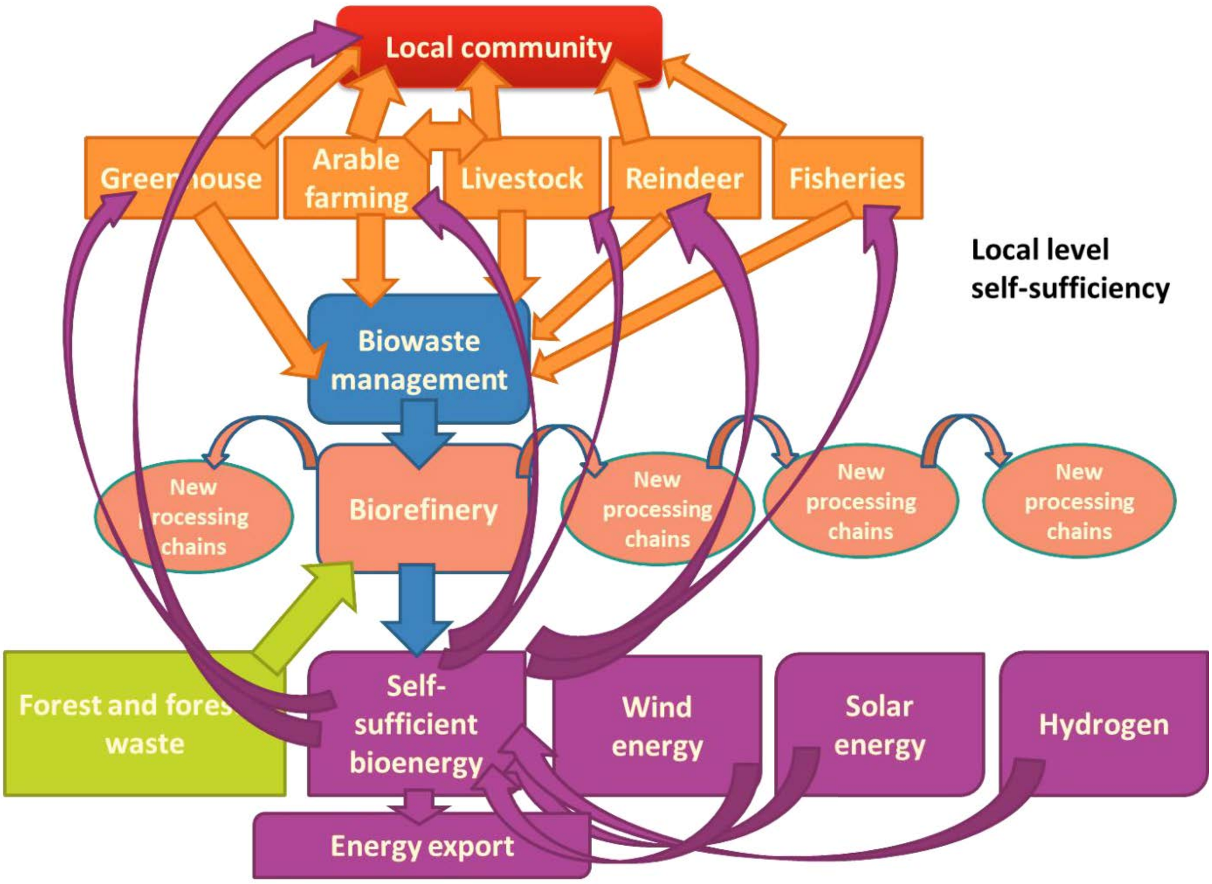

Figure 11. Area level symbiosis between energy and food systems (Luke).

The modelling starts from the potential renewable energy flows inside the system. In the symbiosis modelling, we start from energy as a base system and as a first stage in the green economy transition process because in sparsely populated rural areas, in Lapland, with decentralised energy production, a strict cascading principle has a risk of limiting the use of biomass-based energy. The bioenergy production raw material flow is firstly generated from biomass (e.g. from forestry side flows and manure), while complementary mechanisms (food system side flows as raw materials) from the food system work as a potential substitute. This works in cases where higher added value products are not yet able to be processed from these side flows. Finally, the aim is to move towards a range of diverse and also more sustainable forms of renewable energy (solar, wind energy, hydrogen production and energy storage potential) as complementary energy.

The produced energy is utilised in the energy flow in the food system (primary production, food processing) in order to produce food products for the community and consumers. This overall process creates main products as an exchange from one actor to the next as well as side products (e.g. digestate from energy production and food production side streams). Digestate is a potential fertiliser for cultivated fields. Food production side streams provide raw materials for energy production as long as they are not processed as more highly added value products (in line with the cascading principle). In other words, when assessing the symbiosis potential and the junction surfaces between different systems, it should be considered that with the **cascading use** principle (see chapter 3), the most favoured option is the industrial utilisation and recycling of the material to create more added value products and this is recommended over bioenergy use. According to cascading principle, all non-utilised main products/side streams/waste volumes need to be utilised primarily for higher added value products and lastly for energy, where prioritising renewal solar and wind energy is preferable.

Table 7. Symbiosis of material flows between energy and food sector.

Renewable energy production (raw materials)	**Main products**	**Primary production**	**Main products**	**Food industry**	**Main products**	**Local community**
Biogas production (manure, grass, food waste)	Bioenergy (electricity, heat, fuels)	Greenhouse cultivation	Fruits and Vegetables from the greenhouse	Vegetable processing	Fruit and vegetable products	Vegetable products
Wind energy production	Wind energy (electricity)	Arable farming	Grains and vegetables from the field	Mill (grain processing)	Grain products	Grain products
Solar energy production	Solar energy (electricity, heat)	Livestock	Meat Milk	Milk processing Slaughterhouse/meat processing	Milk products Meat products (beef, pork, chicken) Egg products	Milk, eggs
Hydrogen (energy storage)	Hydrogen (energy storage)	Reindeer husbandry	Meat	Slaughterhouse/meat processing	Meat products	Meat
		Fisheries	Fish	Fish processing	Fish products	Fish
		Forestry	Timber	Timber/other forestry product processing	Wood products	Wood products
		Agroforestry	Berries, mushrooms Game animals	Berry/mushroom processing Slaughterhouse/meat processing		
Side streams	**Unutilised main products**	**Side streams**	**Unutilised main products**	**Side streams**	**Unutilised main products**	**Side streams**
Digestate	Energy surplus	Manure	Bio-waste/food waste	Vegetable waste	Food waste	Food waste
		Grass		Slaughterhouse waste	Bio-waste	Bio-waste
		Field wastage		Fish processing waste		Mixed waste
		Dead animals		Forestry waste		
		Agro/Forestry side streams				
High added value products FERTILISERS	**Export and business growth potential**	**High added value products** **BIOENERGY PRODUCTION**	**High added value products** **Feed** **BIOENERGY PRODUCTION**	**High added value products** **Feed** **BIOENERGY PRODUCTION**	**High added value products** **Feed** **BIOENERGY PRODUCTION**	**High added value** **Feed** **BIOENERGY PRODUCTION**

In Table 8, we start to assess the connections (demand meeting the supply) and utilisation efficiency between the energy system and the food system. On the symbiosis level, we need to assess the internal flows between different systems and actors to understand the efficiency of the symbiosis. The aim is to determine whether the exchange works efficiently enough and in a sustainable way.

In order to work as symbiotic systems there need to be dependencies between two different systems and their actors. The supply, i.e. output, of a system must be met with the demand, i.e. inputs of another actor. The supply reflects the potential flows in the area, which can be measured by the already presented green economy indicators (for the energy and food sectors) and mapped flows (potentials). Potential joint interfaces can also be found in flows (opportunities).

Indicators measure the effectiveness of the utilisation of present or future opportunities. When the efficiency of the utilisation passes from the present utilisation (x %) towards 100 % utilisation, symbiosis is more efficient. The supply (potential) and demand are examined by looking at the utilisation rates. If these are less than or above 100 %, it tells you that there is either too little or too much demand, and that it needs to be tailored to complement the symbiosis.

Table 8. Symbiosis indicators for energy and food systems.

Energy system (biogas plant)	***Utilisation efficiency (%)***	***Food system***
Supply (energy sector)		***Demand (food sector)***
Renewable energy production (MWh) - *Biogas production potential (supply from food, forestry and agroforestry side streams)* - *Other biomass/waste resources* - *Renewable and zero emission energy forms (solar, wind)*	*The present utilisation (%) -> 100%* *Demand for energy is met completely by own energy production.*	*Energy demand in the area* - *self-sufficient production* - *export possibilities*
Energy surplus (MWh)	*The present utilisation (%) -> 100%* *If there is an energy surplus, it must be utilised and directed for dynamic processing between the growth of the area and export possibilities.*	*Increased demand for energy in the area including processing for exported products*
Digestate (tons per year) - *from biogas production*	*The present utilisation (%) -> 100%* *Production of total digestate as a by-product from biogas production is utilised and the demand of the area for fertilisers is met and no industrial fertiliser is needed.*	*Fertilisers in the field (tons per year)*
Digestate surplus	*The present utilisation (%) -> 100%* *If there is digestate surplus, it must be utilised and targeted for dynamic processing between the growth of the area and export possibilities substituting mineral fertilisers.*	*Increased fertiliser demand in the field or exported*
Demand (energy sector)		***Supply (food sector)***
Bioenergy production	*The present utilisation (%) -> 100%* *All waste needs to be utilised according to the waste hierarchy and cascading principle (see chapter 3).*	*Primary production side streams* - *manure* - *grass* - *Bio/Food waste from food production and processing* *Food processing side streams* - *slaughterhouse* - *waste from industries* - *Reindeer waste and processing waste from reindeer husbandry* - *Fats and biomass for barbecues and restaurants (Kirkonkylä and Salla tunturi)* - *Outputs for fishing fisheries* - *Garden and plant products or side streams* *Consumer bio and food waste*

5.2.3. Complementary mechanisms for an energy production and symbiosis model

Technological development and understanding the various factors contributing towards climate change will promote decentralised and sustainable energy production opportunities in rural areas. Combining forms of energy can provide better security of supply and independence. Energy can be produced from its own raw materials utilising the sun, wind and chemically pure water. “The era of fossil fuels is over, and the only question now is when the new era will be fully upon us. Economics make its arrival inevitable: Clean energy is less expensive,” (Hawken 2017). The village of Saija aims for emission-free and sustainable energy production. The village can produce self-sufficient energy from its own raw materials. The purchases of fossil energy and foodstuffs manufactured elsewhere are consuming 42 % of their income resources (Timonen et al, 2017). The village’s own energy production will enable new business start-ups. Climate change and greenhouse gas emission reduction requirements may change the origin of food raw materials. Cell factory agriculture (VTT 2018) may be one of the solutions to help mitigate climate change.

Traditional agriculture and livestock directly contribute about 11 % of global greenhouse gas emissions, and agriculturally-driven land use changes causes additional emissions (CGIAR 2018) By 2050, a growing global population with shifting consumption patterns will require agriculture to deliver 60 % more food, yet every 1°C of warming above historical levels is likely to cause a decrease of approximately 5 % in crop productivity (CGIAR 2018).

What does that mean for the village of Saija? The village must begin adapting to the future change. As cattle breeding decreases and at the same time more food is needed, it is time for new ideas. In the above described vision, Saija will start producing energy from agricultural side streams and forestry. The plant is designed to be fed from the side streams of nearby restaurants and public kitchens (fodder crops, side-streams of food production). The side stream from the slaughter of reindeer contains a lot of fat that is useful in the production of biogas and is a good addition to the feed of the plant. The slaughter of the reindeer takes place at the end of the year and side streams are only available at that time. The biogas plant can also utilise the community residues but in this case the rejection (digestate) cannot be used to fertilise the fields.

Salla municipal waste is currently exported to Oulu, where the local energy company process it and convert it into energy. We have initially discussed with the authorities of the Salla municipality about the Saija power plant’s ability to absorb some of the municipal bio-waste and thus reduce greenhouse gas emissions by reducing the transport mileage. When the biogas plant and the first distribution station can be operated, it will be necessary to determine the location of the second distribution station in the municipality centre. The biogas plant produces extra heat, which can be used in greenhouses, with the potential to be competitive on the market. Despite imports, the market share of domestic greenhouse production, in Finland, is quite good. The domestic share of total consumption is 58 % for tomatoes, 81 % for cucumbers, and almost 100 % for potatoes. Domestically, the market share of Finnish cucumbers and tomatoes is over 90 %. The high season runs from spring to the autumn. In 2008, some 15 kWh of energy was needed for the production of one greenhouse vegetable kilogram (Kauppapuutarhaliitto 2018).

Investment in passive energy production has been started in some households. This **geothermal** alternative is emerging as an increasingly popular way of generating heat for households. Geothermal heat is almost completely solar thermal energy and low geothermal heat energy is stored in a soil or water mass. The soil maintains the average annual temperature of the location at a couple of meters in depth, and in winter the soil is much warmer than the outside. With a geothermal heating system, heat energy can be used to heat buildings and domestic water and indoor air. Ground heating (Motiva 2018) is suitable for all types of buildings. It is more advantageous than district heating over its life cycle. The purpose for geothermal energy here is for heating, cooling and storage. Extra heat that will be produced by solar energy, heat pumps and CHP plant can be stored using geothermal storage and used later when needed. In the village, every household’s thermal energy is produced independently. There are now some households which have invested in geothermal energy in Saija village. Geothermal energy requires an electric current for operation, which is possible to produce from solar panels for part of the year also in Saija.

The energy collected by **solar panels** comes both from direct and radiant sun irradiation. The scattering of the radiation is reflected by the atmosphere and the clouds reflected by snow, shiny ceiling surfaces and water. In the village of Saija, irradiation occurs from March to September, when the monthly volume can be 40 kWh/m^2- 200 kWh/m^2 depending on the cloudiness (European Commission 2018). In Sodankylä the annual amount of radiation on a horizontal surface was about 790 kWh/m2 during a recent Finnish Meteorological Institute test year (Motiva 2018). Saija Village is situated a little bit further south than Sodankylä. By directing panels at an angle of 45 degrees to the south, the amount of radiation that can be utilised is increased by 20-30 percent annually compared to a horizontal mounting. A pilot case for solar panels for heating and the heat generated by solar panels found that solar energy could be used from March to April until September for water heating. Using local solar, wind and geothermal energy can reduce the need for fossil energy and transportation. How to store the energy is the most critical question.

Wind power is at present a sensitive subject for discussion, as many villagers oppose wind power. Based on our discussions, the resistance seems to be due more to the effect on the landscapes brought by large windmills. Small wind turbines are available on the market, the design of which has also paid attention to the appearance.

Even though livestock farming is declining, the biomass needed to produce bioenergy will continue to be produced as by-products of nature. Atmospheric warming increases plant productivity along with sunlight. Cellular agriculture needs raw materials for products and other ineffective side streams that can make bioenergy. If the whole village has its own enclosed power grid, the village can sell energy to the network or buy it when its own production is interrupted.

The **co-ownership of the energy** production plant is available to all the villagers. The cost of the hybride plant is about 1.3 million euros, with additional costs to convert the means of transport and machinery to biogas. Conversion of a passenger car to biogas will cost around 2,500 to 3,500 euros, while a tractor conversion will be around 8,000 euros. The aforementioned actions are the first step in moving the village to the use of bioenergy. These actions will ensure the rationality and reasonable payback of the operation of the biogas plant. A new socio-economic calculation model has been introduced to the villagers which takes into account the rationality of investments on the village scale. The calculation compares the total investment and the amount spent on fossil energy. It is assumed that most of the means of transport will be converted to biogas.

The production of village energy is based on the utilisation of the area’s own raw materials and side streams in the production of biogas, electricity and heat. The CHP plant consists of a digesting plant and an energy wood gasification plant. In addition, energy wood chipping or wood chipping is needed. The plant’s own generation of electricity is needed to achieve profitability and operational reliability (Timonen et al, 2017). When purchasing electricity through the national network, a transfer fee is included in the price (normally this is over 40 % of the total cost), which is higher than the actual fee due to electricity consumption (Hawken 2017).

The first development effort in Saija will be to establish a bioenergy plant. The villagers set Saija Energia Oy's goal to produce cheap energy for farms and households by means of a socially centralised and controlled distribution network. The farms will submit manure to the energy company, without charging for compensation. The company, which is owned by the farms, will produce manure gas that can be utilised for the use and heating of various vehicles. The residue will then be delivered to farms as a fertiliser containing soluble nitrogen and phosphorus. Currently some of the Saija’s fields are lacking in potassium and future opportunities for reducing the potassium deficiency through the digestion process will be explored. This process is not for making profit, rather the company carries out logistics and the farms receive fertiliser in return for delivering manure to the plant.

This system is best for organic farming because there cannot use synthetic fertilisers in organic production. With this system a farmer will be able to obtain organic fertilisers from the disposal of manure.

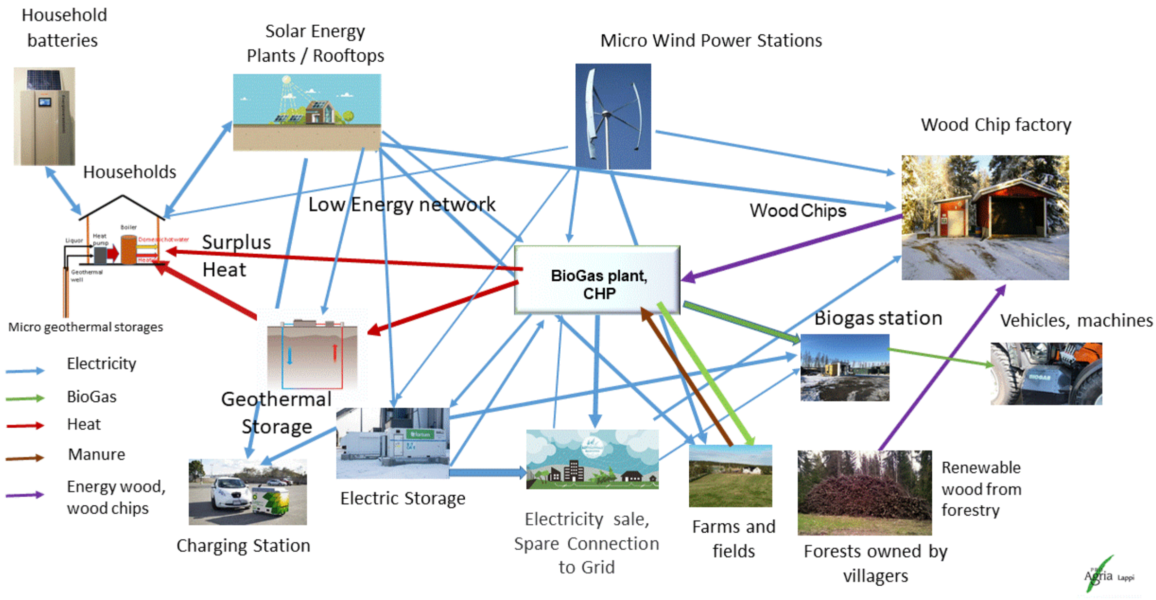

Figure 12. Vision for hybrid energy system symbiosis in Saija (ProAgria Lappi).

The process of the CHP plant requires other raw materials such as food, forestry and wood processing side streams. These side streams are not suitable for livestock feeding, but after the bioenergy plant process, residues can be used as fertilisers in landscaping and environmental management. In the calculations made in the previous project, we found that in addition to the manure and wood chips, one fodder bail is needed per day to ensure adequate gas production for the village's own needs (Timonen et al., 2017). In the village of Saija, there are now five farms. The village farms, businesses, forestry companies and households may recycle the side streams through the villagers own digester. In addition, the aim is to obtain suitable side streams from the municipality and from other companies as mentioned earlier. In this case study, the CHP plant's own electricity production is not big enough to selling energy to the national grid. In future, it will need other electricity production systems. However, producing biogas from biomass can be a first step in rural areas to shift from fossil fuels to bioenergy and provides a sustainable way to produce energy for village and local micro grid (Figure 12).

What kind of **waste or side streams** are available for the Saija energy plant? As mentioned earlier there is a reindeer processing company in the village and the aim is to direct reindeer slaughter side streams from local reindeer herding to the bioenergy plant. Also, as mentioned earlier in co-operation with restaurants and public kitchens in the Salla municipality, all suitable food and other bio waste will be collected and used in the bioenergy plant. The collection of recyclable materials will be organised in co-operation with a local contractor. Reciprocally, side stream donors have the opportunity to receive biogas for their own production. From the point of view of the production process, fat-based feeds significantly increase the amount of bio methane. **Wood Chip Production** uses side streams from forestry and construction as raw materials for the CHP plant. Energy for the processes comes from different sources such as solar energy, micro wind power and the CHP plant itself.

"While society grapples with electricity's pollution in some places and its absence in others, the mysterious waves and particles of the sun's light continuously strike the surface of the planet with energy more than ten thousand times the world's total use," (Hawken 2017). **Small-scale photovol-**

taic systems, typically sited on rooftops, can be used even in Saija for heating and electricity production during the summer time. In Finland and other northern regions, it is important to see solar energy as part of a wider range of production modes. The energy system currently consists of several mutually supportive energy sources as shown in Figure 12. In Saija there is one pioneer who has rooftop solar panels for heating and heat is available from April until November depending how clear the sky is and the visibility.

Micro wind is a typically windmill with capacity of 100 kilowatts or less, meeting the electricity needs of a family or small farm or business (Figure 13). In Finland, there are not very many micro windmills, because of good grid connections even in rural areas. The cost of electricity transmission fee is one reason to have another source for producing electricity that can be paired with utility-scale renewables, augmenting production. Micro wind turbines can achieve the same climate benefit: energy production without creating greenhouse gases. Micro wind power is not going to be the first investment in Saija, but they it be in line within couple of years because it avoids aesthetic issues. At present, the major demand for micro wind turbines is for off-grid use. When the wind does not blow we need to use other sources such as combined solar photovoltaic and CHP plant production. Improved battery storage technology will also boost the viability of small-scale wind power plants.

Figure 13. VisioAir3 Wind Turbine. V-Air Wind Technologies Inc. http://visionairwind.com/visionair-3/.

The local micro grid brings together various energy sources and enables energy storage and connection to the national grid (Hawken 2017). The village of Saija will need a standalone system together with the ability to plug into the larger grid when needed to sell or to buy electricity. Micro grids can provide reliable power and storage for a centralised model in emergency situations. The use of a local supply to serve local demand reduces the energy lost in transmission and distribution, also it has economic benefits for local grid owners. Micro grids need to have good data connections. In Finland, we already have data collections from electricity end-users such as house-holds and companies. These hubs provide information on the use of electricity and the need for the electricity supplier's needs. The activity of the data hub depicted in Figure 14 is based on various services and related events. In a symbiotic network, all the information is gathered together. The micro grid can meet predictable changes in load and unites variable sources of power, such as wind and solar. When flexible local micro grid solutions come online in hubs, different waste and side-streams can be transformed into electric energy and used in a smarter way, instead of becoming an environmental problem. Normally these waste and the side streams are carried to centralised energy production plants. "In the near-term, substituting fossil fuels by biomass can prevent rising carbon stocks in the atmosphere. Photosynthesis is an energy conversion and storage process, by which solar energy is captured and stored as carbohydrates in biomass," (Hawken 2017).

In the figure below is an example **data hub idea for a village.** As the energy demand of industry decreases, the knowledge is shifted through the hub for energy production and energy storage. Production is subtracted, sold or stored. In Skagen (Denmark) the CHP plant operates also in the automatic primary reserve market (Lund 2014). When there are better prices for energy on the market the energy is sold if there is heat in storage or if there is enough capacity available.

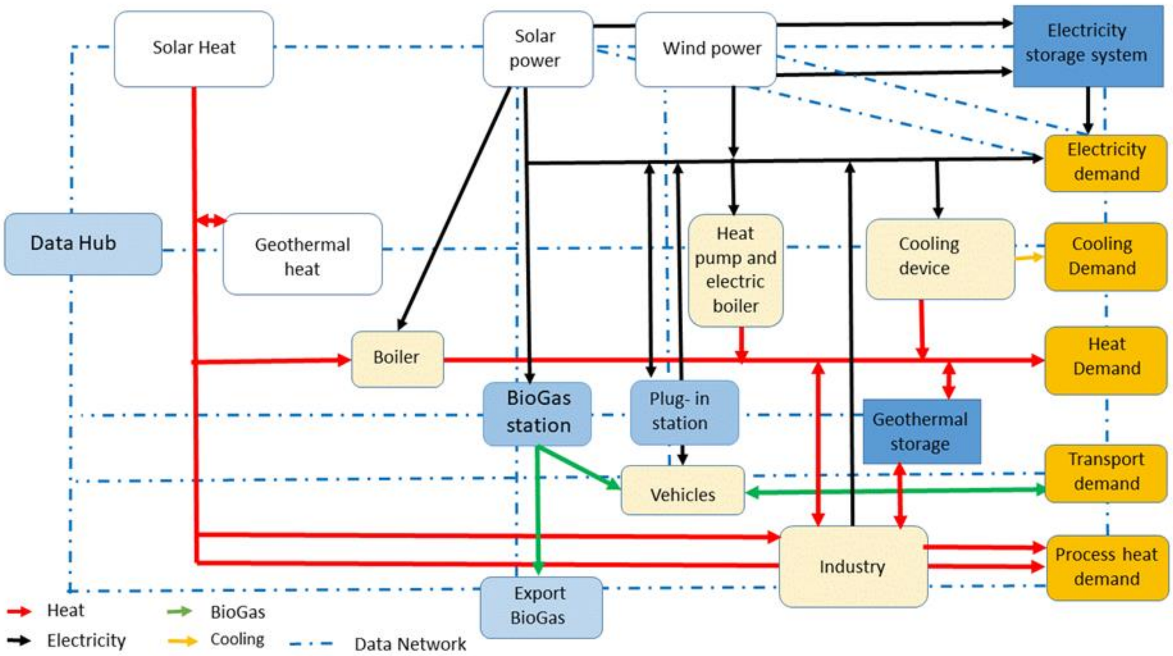

Figure 14. Data hub and symbiosis network modified by Myllylä from Energy System of Energy Plan model (Lund 2014)

The reliability and flexibility of the national network is important for the business community. This must also be taken into account in the transition from fossil energy to sustainable energy production. Combining multiple energy sources requires a flexible system that can work locally and with its own sources of energy production. Today 85 % of the world's electricity consumption is controlled through dynamic web networks (Hawken 2016).

In terms of reducing greenhouse emissions, how can energy be produced? Depending on the location, sources of production could include solar energy, hydropower or wind power. With everyday rhythms and variations in the wind, these vary from minute to minute, day to day, and season to season. The months from September to April in the village of Saija, for example, has notoriously low amounts of sun, so extra production must come from elsewhere. In addition to variability, solar and wind generation is diverse, ranging from centralised and utility-scale production to small and distributed systems, such as solar panels on rooftops. Integrating geothermal energy into the grid is a standard procedure. For an electricity supply to become predominantly or entirely renewable, the grid needs to become more adaptable than it is today.

Building a joint venture plant in a village takes time to build shared trust and trust in business leads to rationality and profitability. The first challenge in the investment phase is technology selection. Is there a technology that will certainly work? Another challenge is the financing of a socially-owned company owned by the village. The current support legislation does not known by such a player and the energy support legislation concerning farm’s is based on the concept that the energy generated by farms should only be used for their own use. This means, that in the current profitability scenario, few operators and only large producers can make use of the support option. In this case only a few achieve cost savings, but not both revenue and cost savings. The third challenge is to find a person or persons who would organise the whole activity in the early stages. Farmers are overwhelmed today and there is no time to run their own business.

New forms of counselling and financial solutions could provide opportunities to generate more common benefits by creating symbioses and making the most of the resources and opportunities available. Technology vendors specialise in technology are not social developers. The fourth challenge is the conversion of transport equipment and machinery to run on biogas. This process needs to be done by a local company in order to generate expertise in the utilisation of gas in transport, business and households.

Complementary mechanisms for food production and symbiosis model Saija's company stock consists mainly of primary producers and reindeer herders. Service companies employ themselves. At present, the initial earnings are based on the sale of raw materials. Saija’s reindeer breeder buys all the northern Salla reindeer and processes the meat further. Salla is the municipality, where the village of Saija is located.

In Figure 15, modeling of the overall regional development of Lapland is described. The goal is to combine expertise, experimenting with different industries and building the capability from a versatile, large-scale, private-sector partnership, the third sector and public actors. It is important to identify and understand the entity locally and regionally and see that everyone is also responsible for the success of others and the overall development of the region. There are no separate actors. Smart specialisation and clusters provide excellent tools to develop local and regional cooperation with synergies, symbiosis and entrepreneurs.

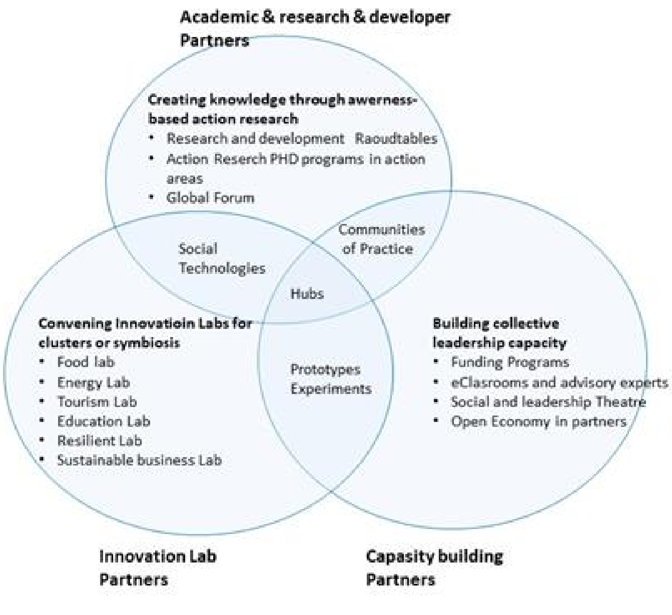

Figure 15. Source Charmer and Kaufer pp 247 (2017) modified by Keijo Siitonen.

Locally in Saija, as in other parts of Lapland, the profitability of agriculture is weak and the solvency is also weak. Large investments have been made to increase production volumes and increase the efficiency of primary production and improve profitability. In a chained system, the primary producer's position is weak and concentrated on industrial scale processin. Food system disruptions may change the whole system, due to changing consumer habits, changes in food production, and changing the way food is traded.

The village of Saija has developed business symbiosis with the development of the local **reindeer herding** business. Saija village has come a long way in refining meat products. At first, the herders sold the reindeer directly to processors. In the 1990s, there was a long period of development in reindeer husbandry between producers, processors and business. This also led to a significant deterioration in the profitability of Saija's reindeer herding. The solution was to process reindeer meat. The availability of the raw materials was based on reindeer meat produced by the reindeer herders of the village. In the beginning, the new processing company focused on quality cuts of meat and the production and sale of meat products for restaurants. The change in the business model achieved significant value enhancement and shortened the supply chain. The change supported the natural behaviour of reindeer, and strengthened the position of natural food production and sustainable management both as a competitive factor and as a value.

When the producer prices for reindeer herding collapsed in 2003, the entire industry was at a crossroads. The price offered by the meat chains did not allow for any profitable primary production and a change in the whole reindeer herding business system was forced. At the same time, entrepreneurship training for reindeer owners, reindeer herding training, product development, and the establishment and development of reindeer herding owners was initiated. The measures resulted in genuine competition in the production of raw materials and the creation of new types of products for the market in addition to new markets. These measures led to the recovery of reindeer husbandry. The success of this was made possible by the cooperation and extensive utilisation of private reindeer owners, the Association of the Reindeer Husbandry, public financiers, education and counselling. On the other hand, these developments also pose challenges for sustainability in reindeer husbandry.

Saija's **new products** were selected from non-additive smoked products and processed products, for example reindeer sausage. The next important product development goal came from the restaurant customer's request to develop a small fillet made of small reindeer with champagne. A reindeer product was born that changed the idea of refining to concentrating reindeer refining only on a particular carcass. The operation formed a small-scale symbiosis with other processors. This development path has brought significant gains for rearing reindeer meat and has led to a more thorough utilisation of the raw material and to the growth in the image value of naturally grown reindeer.

The business model is based on the idea of increasing the understanding of the symbiosis of present and future companies, as well as the opportunities of the bioeconomy. A positive growth cycle model (Timonen et al. 2017) combined with symbiosis is creating new growth spurs in the countryside. The key value is the balanced and sustainable exploitation of natural resources by creating a growing cohesion and mutual trust in the community. Generating renewable energy was a common factor and an opportunity for this process.

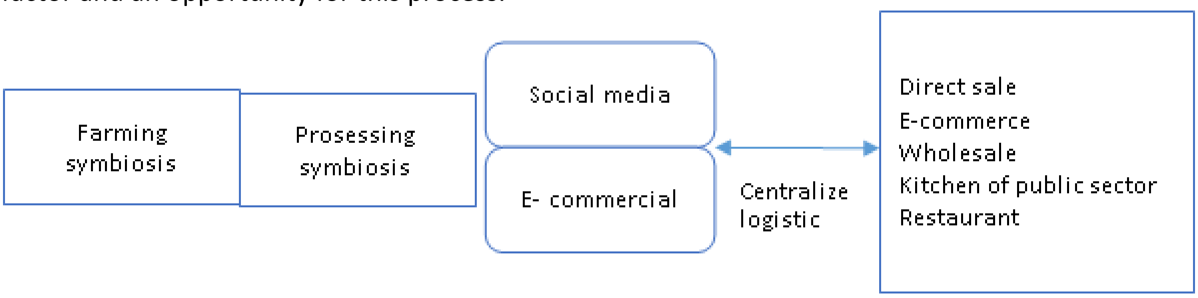

Figure 16. Example of symbiosis business model, Siitonen 2018.

In the **Symbiosis business model above**, the material and its production are used in a versatile manner and are very specific (Figure 16). In this case, the different business benefits are more evenly distributed and also individually improve the competitiveness and the common ecological sustainability of each operator. Farms benefit from biogas in transport and non-road vehicles. Sales of biogas are the main source of income from sales of common fractions of the symbioses. The proceeds from the sales will finance the current investment and its future upkeep and new investments. The growth of biogas will be accelerated by supporting the transformation of transport from fossil fuels to biogas. Social support will speed up the transition process and the de-fossilisation process, so the transition would not have to be a completely new investment. The aim is to get the entire logistics chain to operate as quickly as possible.

If the entity and companies buy gas at a calculated price, according to the profitability calculations the business will be profitable only for the village's own use. According to the calculations of Timonen et al, 2017 pp 73 presents that if the gas price were to be kept for four years at the current price level for gasoline or diesel, then the investment would be fully paid. The challenge is to understand why one must first invest in order to achieve the benefits. People’s purchasing habits guide their purchase decisions. The ease with which the consumption of fossil fuels is experienced is a major guiding factor for decision making. The same logic applies to buying food.

The second income stream in the business is the income from dealing with fractions or waste fractions. The next investment phase is designed to build a separate process that can take waste and side streams and hygienise them. The energy contained in them will be recovered in the process. The new hygiene device will enable the symbiosis to include public operators and companies as well as home owners. Co-operation opportunities with municipal waste and energy companies will be significant.

Local symbiosis specialises in the basics of the operating environment in the area. Operators are required to specialise in the area. The regional economic structures are significantly different, and also the structures of symbiosis are different.

Saija’s model is an alliance of actors (Appendix 1) deepening the **Agrohub** (Figure 17) in an ecological symbiosis. Operators form a joint venture, where the energy transition is solved and at the same time improving the conditions for more sustainable agriculture. The introduction of gas tractors, the availability of gas-powered vehicles, the belief in the benefits of bio-fertilisers and the renewal of water purification methods make it possible to change. At the same time, symbiosis is made possible by the profitable start of horticultural production and thereafter also by new fish rearing methods. The largest cost of greenhouse production is the energy cost. New low-energy greenhouses and the use of surplus heat will make greenhouse production profitable also in Lapland.

The operational models consist of two extremes and different applications between them. A sympathetic symbiosis, typically represented by industrial symbiosis, means that the goods, material, technology, or services are bonded in a symbiotic network. Key factors include business and financial drivers. A problem-oriented or potential-based symbiosis is formed by the common vision and intent of many actors. The goal is not to maximise profits, but to promote sustainable development, climate-friendliness, and the employment of people in the region and the expansion of business by creating competitive conditions.

The symbiosis is currently undergoing a process of fine tuning. Primary producers, households and food processors have found a common goal through bioenergy. At the same time, through energy exploration, plans are being made to get more actors in the village. The power plant surplus heat can be used at low temperatures throughout the network or to encourage a local garden entrepreneur to take advantage of the low cost energy gained.

The second step is to create a clear focus on refining meat and increasing its value. Different producers can be combined by phasing out the same production capacity within the limits set by the regulations. Through local reindeer herding, there is ready-made know-how, with markets and high-yield meat.

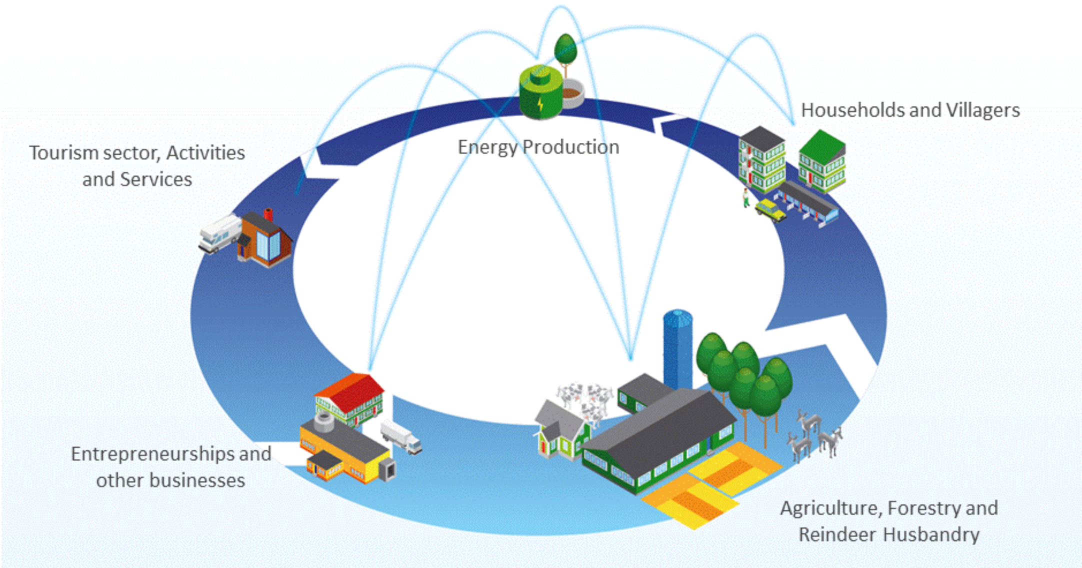

Figure 17. Agrohub (Timonen et al 2017, pic 15 ProAgria Lappi).

At the same time, we are investing in a **hybrid bioenergy production facility** that can be used to exploit primary production, processing, tourism and other bio-waste or side streams in the area. The hybrid plant also includes a CHP unit that utilises the by-stream flows from local forest owners to produce the electricity and heat required by the plant.

From a social point of view, a village-specific meat-processing symbiosis can be created that produces its own high value products for a narrow segment. At the same time, the profit base can be expanded by making use of the benefits of the joint venture, reducing fertiliser and energy costs and acting in a way that reduces carbon dioxide emissions in transport (Figure 16).

The target for the villages and stakeholders operating in the villages is to launch investments in energy plants. The investments will have an impact locally on employment by creating 3 new jobs. The value of the investment is approximately EUR 1.5 million in the first phase and EUR 2.5 million for the extension. Further refinement of food will lead to an increase of employment by 3 working years and the facilities will be able to invest in a new joint animal shed (Saija). In addition, bovine processing can also be initiated when the reindeer chips (Saija, Saijan Villiporo Oy) is in progress. The reindeer chips product is well suited to global digital distribution channels. Implementing such a process requires a new kind of chain thinking and building a spreadable model.

In this project the preliminary presentation for the Agro Centre and Agrohub (Timonen et al. 2017) was further developed through experiments and through concrete action plans. The first energy company in the Agro Centre has been established in the village of Saija. In Saija this means that food processing companies and the new energy plan form a symbiosis (Agrohub). The symbiosis business models for energy and food systems are based on the digital Agrohub model (Timonen et al. 2017, pp. 91).

In Lapland, the introduction of renewable decentralised local energy to meet the area's own energy consumption would create new 1,000 jobs and EUR 250 million in potential turnover. The project also supports the Lapland Smart Specialisation and the Lapland Agreement objectives (Lapin Liitto 2018) by other means.

5.2.4. Business modelling of tourism and area ecosystem (Nellim)

The Nellim tourism symbiosis is similar to an industrial symbiosis. The symbiosis is built from the needs of one of the area's main locomotives. The collaboration structure is as simple as possible. The company seeks to manage the tourism service alone to maximise the quality of service and the integration of activities. Daily situations change rapidly and therefore flexibility is needed.

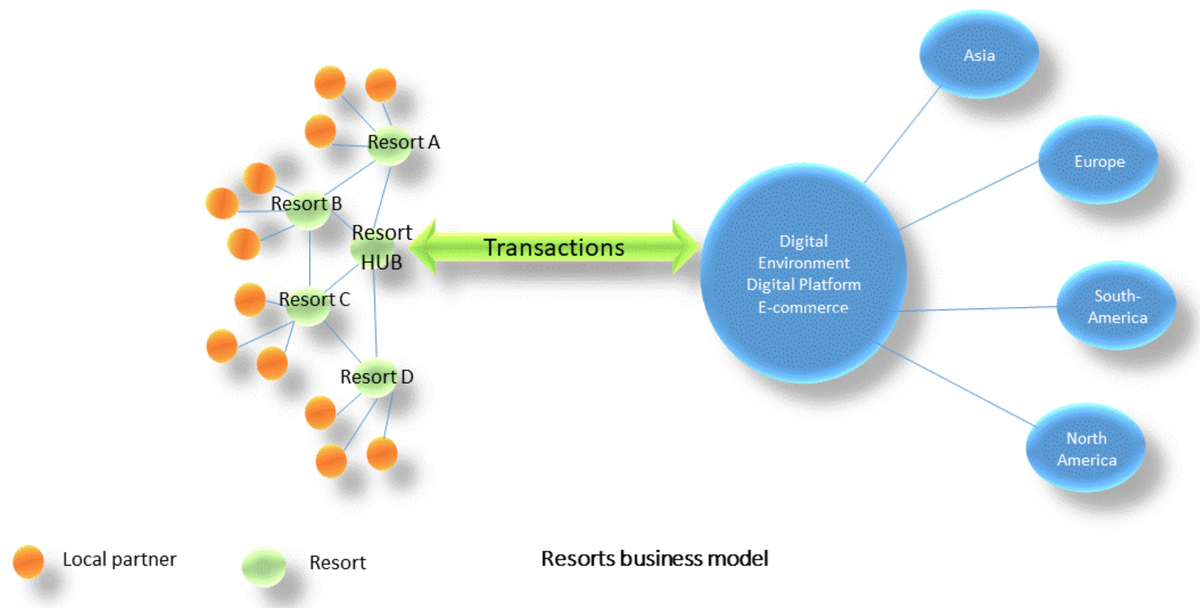

Figure 18. Nellim business model and symbiosis, Siitonen, 2018.

The tourism business model is good if it is simple enough and the creation of platforms has made it possible to simplify the business model. Figure 18 above is a simplified depiction of the image on page 73 detailing the different symbiosis, ecosystems and processes of a resort. Here the aim is to present the simplified, decentralised and centralised operation efficiency.

The **creation of platforms** has made it possible to simplify the business model. Tourism platforms on the international market offer the opportunity to build a fully digital offer and supply chain. Digital marketing channels provide built-in product packages, either directly or through global tour operators such as Booking.com/Nellim. Transactions occur directly between systems of the different companies. The resort offers authentic tourisim services as sustainable as possible. Each resort creates its own dynamic symbiosis. The targets are decentralised to minimise the impact on arctic-sensitive nature. The importance of ecosystem services is in the local actors' cultural heritage. Business success is not the main motivator of the local actors. Value production is shared into the region and increases regional capital and wealth growth. The impact is significant on the local private economy, the ability of companies to succeed and indirectly also on public finances.

Implementing the template takes time. The creation of the current model has required almost fifteen years of work, but the impact on the regional economy is significant. The most important driver for building the model has been a fixed link with the customers, tour operators and their goals and wishes. The company has had the ability to solve the aspirations of tourists and tour operators in an interesting and balanced way.

The most important part of the symbiosis is nature itself and the exploitation of nature. The company's strategy is built on the basis of the operating environment, taking the elements that can be specialised in the use of tourism. The Arctic nature and its phenomena (snow, coolness, winters, landscapes, watercourses, frost, air, trees and animals, and culture) have been taken as the starting point for commercialisation. Presenting these natural elements for easy access is one of the prerequisites for success. Authentic, pure nature, rather than commercial is emphasised through various activities, food, culture and history. The priorities of tourists coming from different continents vary concerning the importance of different phenomena. Some of them want to enjoy the experiences as easily as possible while some others prefer the extreme through challenging hikes. Creating and implementing services requires the staff, partners and management to understand the local natural conditions. Focusing only on wintertime nature tourism will create the minimum tourist burden.

The most important part of symbiosis modeling is the joint business and customer-based competence development of the various actors.

One of the backgrounds behind modelling the sustainable symbioses network was a model by Cambridge University. The goal in their model is to exploit natural capital as equally as possible and to maintain growth and renewal. Nellim is, in principle, a winter tourism destination, and it is a priority to ensure that all players in the network pursue a low carbon and sustainable way of doing business. The model has emerged as a partnership between consulting and tourism know-how, market-driven business, regional and local institutions.

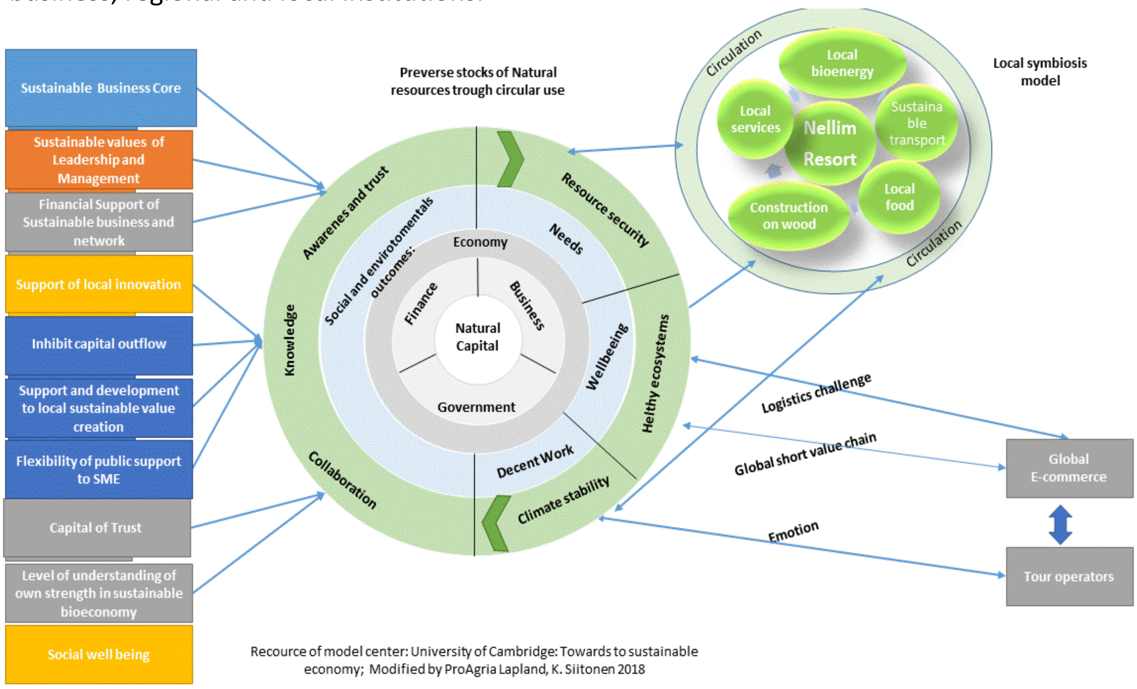

Figure 19. Nellim symbiosis.

The starting point is examine at the significance of the capital outflow that we found in the past research. Tourism does not create a capital outflow, but instead it **brings new capital**. We tried to find a model where a rural tourism company would operate in as remote a country as sustainably as possible. At the same time, we found a general model to work both in a company and in a joint venture. In Figure 19 above, the operating environment is described in accordance with the Cambridge University model and company management decisions as a separate tower. The most important parts of a company's sustainability and symbiotic construction are indicated in green in the figure and the multi-market elements are shown on the right.

In this case, the business is completely opposite to the situation that exists in the village of Saija. A single company that receives income from abroad and prosperity affects the prosperity of the community in the whole region. It enhances prosperity in local communities and builds a new knowledge base. Increasing the knowledge base is the key to generating future success for future generations and to believe in a better life in the region. This describes the complexity and the diversity of the symbiotic business model. The development is not just about capital and money, and therefore the model above is also an excellent picture of an operating environment for companies that are seeking the sustainable development of village communities and a sustainable business model. We also found that companies already in business find it very difficult to make their operations sustainable because it requires both a change in management culture and business culture. The issue arises of how the transition to sustainability can occur if unsustainable production is cheaper and more efficient.

Building a symbiosis around every target is natural because entrepreneurs in a small community know each other and trust has been built (or has not been built) in the face of different needs. The network will first gather the players whose activities are trusted. Construction, food, energy, and other local service providers are able to expand their operations as a result of basic demand, and co-operation creates better delivery and service capabilities. Joint growth supports the symbiotic cooperation and is recognised through accelerating collective growth. Sustainable development in the company has been the goal from the very beginning of the ecotourism vision of the development of the current project and the original location has been challenging.

The understanding of ecology has become clearer as the company expands and grows. The company supports its village community in Nellim by employing local workers and companies wherever possible. New jobs and business co-operation have been created and as well as the ability to maintain and develop a basic infrastructure, such as roads, public services, information networks, etc. The area will also gradually receive newcomers. In 2017, 250 new jobs were started in the municipality of Inari thanks to the company network.

Sustainability in the company has developed over time. In winter, it may be up to -45 degrees below zero, but the geothermal energy is still enough to keep the facilities warm. Water is purified on the spot. The most significant aspect is cooperation with the various actors locally. Construction, activities, part of catering services and the maintenance are usually done through local business co-operation or by using the local workforce. Purchasing food is mainly done wholesale, but the company's goal is to increase the number of local suppliers, especially for fish and reindeer meat, if the delivery capability allows.

It would be preferable to change to transport by biogas if local farmers or biomass owners could produce biogas. At the same time, there would be a place for human biomass treatment. Biogas can also be utilised as a source of spare heat, water heating, food preparation, fire burning and energy transfer. The business is one of the leading companies in the area, and has a significant impact on employment, even though this is only for a part of the year. Business is seasonal, and the summer season is quieter than the winter season.

Symbiosis is born through common goals and the **transition to a sustainable business model**, the change in the company per se is surprisingly high and called for the reconsideration of many individual actions. This is not just due to the circular economy, but also in the choice of workforce, wage levels, materials, food, information systems, traffic, energy, and values. Taking responsibility at the enterprise level is the key factor in implementing a sustainable business model and it should also be of general benefit as production costs are, in principle, more expensive.

Because the flows of biomass per company are low and do not alone form a profitable business for the potential bioenergy production, they need to be combined. Joining together leads to cooperation between different industries and different organs. Scaling up production technology is a great opportunity. Different sized biomass streams require different sized units locally to generate a profitable symbiosis. At the same time, one major player is required to combine either the production or the market. This also combines different clusters in the context of the individual village or business and in making responsible choices.

Concerning **in-company decisions** the set of values include: the internalisation of sustainability and accountability in business. Valuing sustainability is strong among key business people and owners. Local ownership often ensures understanding of sustainable operations in an operating environment.

Concerning **capital outflow or capital acquisitions:** in regional development, it is often not possible to think about the importance of capital or the importance of raising capital to the development of a company or a business area. Local entrepreneurs want to distribute income through investments or acquisitions to other entrepreneurs if they generally follow the general price trend or if the company's profitability allows. The meaning of the capital inflow is well understood.

Concerning **generating added value:** collaboration between businesses and locals was at the core of developing and sharing added value. A northern lights viewing house was one of the major innovations drawn from local culture and customer demand for high quality services and housing.

Tourism is a generic term to cover both demand and supply that has been adopted in various forms and used throughout the world. Tourism has been defined as "the activities of persons identified as visitors. A visitor is someone who is making a visit to a main destination outside his/her usual environment for less than a year for any main purpose [including] holidays, leisure and recreation, business, health, education or other purposes. This scope is much wider than the traditional perception of tourists, which included only those travelling for leisure" (UNWTO 2010).

As a concept, tourism is inevitably open to different interpretations, but it is now widely agreed that there is an urgent need to tighten or achieve greater precision in the way that key tourism terms are used nationally, regionally and locally. Planning and managing tourism when the various stakeholders involved have different conceptions of what tourism means can only ever be partially successful.

Tourism can be understood as a technical concept measured by the available statistics on visitor movements and expenditure (demand) and estimates of the number of a wide range of visitor facilities (supply). There are different interpretations of the concept of tourism. Successful planning and managing tourism require commonly shared understanding between different stakeholders on what tourism means (Tourism Society 2018).

In Table 9 symbiosis indicators are shown between the tourism (cultural ecosystem services) and area ecosystem. In this table, the symbiosis is divided between three systems: tourists, tourism companies and ecosystem area boundaries. In the table, the demand for tourism is based on the available statistics on visitor movements and the available statistics on expenditure, while the supply for tourism is based on estimates of the number of a wide range of visitor facilities (Tourism Society 2018).

The supply for tourism and the ecosystem boundaries are seen as the base system defining the supply of ecosystem services and ecosystem boundaries for the supply and demand of tourism. The carrying capacity of ecosystems must not be jeopardised, i.e. the pursuit of tourism must take place in a sustainable way (see Chapter 6.1.3), taking into account the demand of the ecosystems of the region and other sectors. Mutually, the supply of cultural ecosystem services, provides well-being and recreation for local people; hence, development in the demand for tourism based services should also benefit the local people needs (Table 9).

Table 9. Symbiosis indicators between tourism and area ecosystem

Tourist demand	***Company supply***	***Area ecosystem supply***
Demand for tourism (visitor movements and the available statistics on expenditure) ⇦	*Supply for tourism (visitor facilities)* ⇦	*Ecosystem services*
Demand for tourism (visitor movements and the available statistics on expenditure)	*Supply of tourism (cultural ecosystems)* - *E.g. recreational services: nature paths, skiing tracks use, berry picking, fishing etc.)*	*Cultural (recreational) ecosystem services e.g. nature paths, skiing tracks, berry picking, fishing etc.)*
Demand for tourism (visitor movements and the available statistics on expenditure)	*Supply of tourism (accommodation/beds)*	*Supply of other tourism companies and services in the area*
Demand for food and restaurant services	*Supply of tourism (food and restaurant services)*	*Local area food production:* *- Primary production* *- Food processing* - *Reindeer herding* - *Agroforestry* - *Game animals* - *Fishing* *Area supply of restaurant services*

Demand for other services Programme services, other services (e.g. health care, beauty treatment, staff in the tourist destination)	*Programme services, other services, staff*	*Supply of programme services, other services, staff*
Demand for souvenirs	*Souvenirs by a company* - *Manufacturing of souvenirs* - *Local resources used in the products %*	*Supply of souvenirs in the area* - *Manufacturing of souvenirs* - *-Local resources used in the products %*
Indirect energy consumption via facilities *-e.g. through ecotourism*	*Renewable energy production* *- Self-sufficient rate* *- Geothermal heat, bio fuel, solar, wind and other sources for renewable energy*	*Supply of renewable energy production* *(geothermal heat, other resources: forestry side streams, wind, solar)*
Indirect demand for facilities – buildings *-e.g. through ecotourism*	*Sustainable buildings*	*Sustainable building materials and know how*
Tourist supply	***Company demand***	***Ecosystem demand***
Visitor movements and growth rate	*Company demand for tourism (persons/year)* *Potential for tourist intake (persons/year)*	*Ecological carrying capacity (area (m2)/tourist numbers)*
Nature based tourism (person/year) - *Tourism company's expenditures* - *questionnaires and studies*	*Company demand for ecosystem services*	*Biodiversity* *Water quality* *Air quality* *Land use in the area*
Demand for local food and restaurant services	*Company supply of food and restaurant services*	*Sustainable local food production*

6. Discussion

This chapter discusses about the challenges in producing the green economy indicators, intepretation of the results and implementation of the benefits of the application of indicators. The information gathered and the relevant indicators were needed when modelling futures of new bioeconomy, which is also discussed.

6.1. Green economy indicators

The indicators were categorised in three sectors: the energy system (6.1.1.), the food system (6.1.2.) and the tourism system (6.1.3.). The indicators aimed to take into account the special characteristics of the Lapland region, such as its plentiful resources, Arctic conditions, delicate ecosystems and sparsely populated rural areas with some distinctive problems, for example migration, and a declining population even though the potential number of jobs are increasing. In addition to these system-based indicators, social socio-demographic indicators of the region (population, industry, employment structure, etc.) were also integrated in the assessment (6.1.4).

It was perceived in this study that there were many challenges concerning the measurement and development of green economy indicators. The green economy is a sustainability concept (Chapter 3) and the comprehensive measurement of the simultaneous maximisation of ecological, economic and social goals has proven to be extremely challenging in this study. This aspect was also mentioned by D'Amato et al. (2017). It was also perceived that in all three dimensions of sustainability impacts occur when improving the three paradigms of the green economy (resource efficiency, ensuring ecosystem resilience and social equity).

The green economy acknowledges the underpinning role of all ecological processes (D'Amato et al. (2017). Many of the developed indicators maintain and promote ecosystem resilience and link to the concept of ecological carrying capacity (see Chapter 3). In this study, we assessed the carrying capacity with many different indicators measuring the population, areas of land that support the population utilising the ecosystem's capacity and services and the maximum load (rate of resource harvesting and waste generation). Connections to the ecosystem carrying capacity are mentioned in the indicator descriptions (Chapter 5).

The *"Ecological footprint"* in the energy (6.1.1.), food (6.1.2.) and tourism sector (6.1.3.) *is* the inverse of the carrying capacity and it measures the area required to sustainably support a given population. The measure provides a quantitative estimate of the human carrying capacity. It measures the area of land (and water) that would be required to sustainably provide all of a particular population's resources and assimilate all its wastes.

The "life cycle assessment (LCA)" indicators in the energy (6.1.1.) and food sector (6.1.2.) require gathering extensive amounts of quantitative data, which is extremely challenging and time-consuming. Due to their complex and challenging characteristics they were not yet possible to assess and because the life-cycle perspective on forests is still under development. Climate emissions can, of course, be estimated by sectoral computation in the village context, but it is uncertain by whom and with what resources this can be done. However, there are already many studies that have assessed LCAs for biogas and food products and trendsetting results from these studies can be utilised when promoting green growth in the area. In addition, there is a need for developing a more comprehensive LCA work for both biogas and digestate production in the near future. Due these challenges, the reduction of environmental effects (e.g. reduction of GHG) was assumed to be achieved by utilising indicators in the management process: replacing and meeting the fossil energy demand with renewable self-sufficient energy production, by enhancing the side stream exploitation and resource efficiency of the area, and by securing forest ecosystems and the carbon cycle. In the context of forestry and biogas, production side streams are refined and made into products that are more easily exploitable and cause fewer greenhouse gas emissions. Biomass should act as a complete substitute for fossil energy, or the overall emissions in the area might grow. Biomass based energy still is not emission free and ultimately the development activities of the local area must lead to fully emission-free energy production (e.g. wind and solar energy). By securing the forest ecosystem by examining the logging and forest regeneration rates, the carbon cycle can be maintained and low-carbon activities can be promoted in the area.

Thus, these dimensions are also reflected by many of the developed indicators here. In meeting ecosystem resilience, this study took ecological processes into account acknowledging the ecosystem service framework (Millennium Ecosystem Assessment 2005), which was also presented in Chapter 3. However, the difficulties in understanding, identifying and measuring types of ecosystem services makes measurement and finding functional indicators challenging. Measuring the sustainable utilisation of all provisioning and cultural services in the ecosystem, as well as the dynamic process between them and regulating and maintaining them was proven to be extremely challenging, as was also mentioned in the Millennium Ecosystem Assessment (2005). It was assumed that the dynamic, sustainable process between different ecosystem services and ecosystem resilience could be maintained through sustainable utilisation of provisioning services. Provisioning services are the easiest to measure, and e.g. forest wood as a provisioning ecosystem service through forestry activities was the easiest to assess and measure during this phase of the project. Also, forests are among the most central resources in the examined case areas in Lapland, in Finland. In addition, according to Ollikainen (2014) & Roos & Stendahl (2015), forestry, agriculture and the forest industry can play a fundamental role in providing bio-based substitutes for non-renewables. Therefore, this study focused on provisioning services (energy and food) and cultural services (tourism and recreational services) when developing green economy indicators.

According to D'Amato et al. (2017), the concepts of the green economy, bioeconomy, and the circular economy remain limited in terms of questioning economic growth. Ecological sustainability on the other hand maintains and secures *economic growth or economic viability.* It was assumed in this project that positive economic effects would be caused by the sustainable use of ecosystems, which would also secure the functional capacities of systems, as well as provisioning services, productivity and sustainable economy or even economic growth. In other words, the sustainable use of ecosystem services would maintain ecosystem resilience as one part of the green economy. This in turn would secure, regulate and support ecosystem services which are responsible for the future productivity of the provisioning ecosystem services, sustainable economic growth, vitality and livelihood of the local area.

According to D'Amato et al. (2017), the green economy is more inclusive of some aspects of social dimensions at a local level. In this study, improvement in *human well-being* (such as finding meaning in life, feeling sufficiently challenged, and opportunities for self-actualisation) was too challenging to be measured quantitatively in all energy, food and tourism sectors. However, in this study the improvement in well-being was assumed to be guaranteed by improvements in other socio-economic indicators, which according to the Millennium Ecosystem Assessment (2005) would change due to changes in the ecosystem services (see more in Chapter 3.3.). For example, the sustainable and resource efficient utilisation of forests secures and increases the productivity of forestry and possibly employment, livelihoods and vitality and well-being of the local area. In addition, well-being effects can be experienced by local residents and achieved by utilising outdoor and recreational services (e.g. seeing, experiencing, and walking naturally), and utilising equal opportunities.

Social capital is challenging to measure, but it was found that cooperation and trust in other people and institutions was important for the vitality and development of village communities and for network thinking. The network would not be able to work and resources would be left unexploited without people and their ability to work together. The sufficiency of this human resource and the ability to cooperate can be decisive for promoting a local green economy. Furthermore, clear shared goals for networks and equal and open information sharing enable trust to be built in networks (Korkala 2010). Social capital gained through developments in the energy, food and tourism sectors, such as collaboration skills and trust between the residents and towards institutions is important for network thinking and to ensure the vitality and development of village communities. The green economy cannot be formed without collaboration between different networks and regions. People and their ability to work together are essential. Having sufficient human resource and collaboration skills is critical when promoting a local green economy. Furthermore, corporate actions are key in the shift towards the green economy, and communicating the sustainability of these actions to stakeholders is important. Social capital, which indicates collaboration skills and trust in other people and institutions and in this case trust in the development plans and calculations concerning a biogas plant, is important for the vitality and development of village societies as well as for network thinking. Enabling participation, shared opportunities and ownership are consistent with the objectives of social equity. All the residents of the village were offered ownership of the biogas plant and the benefits (energy and fuel) are available for all village residents.

In the future, more focus should be on how value in the production chain is shared and how equity in this context can be realised. Currently, the value of the production chain is often unequally divided especially in present global production chains. Novel forms of ownership will be needed, and specific indicators must be developed for this purpose. For example, *life cycle costing (LCC)* would be a potential option as a method for measuring the value formation through the production chain life cycle and the social life cycle assessment *S-LCA* could be used for other equality impacts (see more in 6.1.1 and 6.1.2). However, both of these require gathering extensive amounts of quantitative data, which is extremely challenging and time-consuming. Due to their complex and challenging characteristics, they were not yet possible to assess in this study, but they are in need of development in the near future (see the indicator descriptions in Chapter 5). The LCC needs to be more comprehensive taking into account internal and external (e.g. environmental costs) costs, and the S-LCA needs to be based on area/company specific assessment work because S-LCA databases are usually based on country level, quantitative generic data.

6.1.1. Energy system indicators

For the energy sector, the main aim for these indicators was to measure the energy self-sufficiency potential of the Saija case area by substituting imported fossil energy with self-produced, renewable, bio-based energy. In the previous project (Timonen et al. 2017), calculations were based on information gathered from the villages (interaction between the villagers and outside experts) to improve energy self-sufficiency. The result of this data and subsequent calculations was that it was found that all the energy that was used in those villages could be produced by the raw materials available in the village area (Timonen et al. pp. 57-63). The basis for energy production was taken to satisfy the energy needs of the whole village, also taking into account the area’s entrepreneurial activity and its development. There are sufficient available raw materials to be found from the village and the surrounding area. The studied villages had resource surpluses at all levels. As a rule, raw materials from waste streams and waste were sufficient to satisfy the village’s own energy needs.

In this study, we started to develop indicators of the forest ecosystem services because forest wood as a provisioning ecosystem service due to forestry activities was the easiest to assess and it was possible to measure during this phase of the project. Also, forests are among the most central resources in the examined case areas in Lapland. After this, growing renewable energy production with other potential bio-based energy sources and new emission-free energy sources (solar, wind and hydrogen) would meet the green growth needs of the area and export demands. In addition according to Ollikainen (2014) & Roos and Stendahl (2015) forestry and the agriculture and the forest industry could play a fundamental role in providing bio-based substitutes for non-renewables.

To avoid the unsustainable utilisation of energy resources, ecosystem services must not exceed and endanger their production in the long term (Kniivilä 2013). An indicator of the *sustainable utilisation of the total raw material base* would take into account that total biomass production (e.g. forestry) needs to be sustainable in order to maintain its raw material base (main and side streams) for different production lines in the future. This project aimed to include the potential of the collective exploitation of other potential provisioning services, e.g. berry picking (food system indicators), and recreational services (tourism system indicators), but these are not presented in this section because they are not part of energy system indicators. However, it is still too challenging to assess the most optimal collective exploitation of many different provisioning services (wood production, berries, recreation etc.) at the same time as a whole inside one ecosystem and its boundaries. Regulating and supporting services were not measured in this study but they are acknowledged indirectly as part of the whole when securing the sustainable use of the forest as a provider of provisioning and cultural ecosystem services. By securing the forest ecosystem and examining the logging and forest regeneration rates, the carbon cycle can be maintained and low-carbon activities can be promoted in the area.

The indicator for the utilisation of side stream volumes measured unutilised volumes of side streams in relation to utilised volumes of side streams. Side streams are mostly unutilised and defined as waste. Side streams should not be produced at the expense of unsustainable production of main streams (see the *sustainable utilisation of total raw material base)*. Side stream utilisation is always more sustainable as waste utilisation than leaving waste without any utilisation at all. However according to EU's Waste Framework directive waste streams should be prevented, reused, recycled and finally utilised in energy production (EU 2008). This promotes resource efficiency and the circular economy. In this study, the side stream potential for energy production was assessed in forestry (woodchips, tree stumps, twigs etc.) and agricultural side stream volumes (manure). Other unutilised side streams (e.g. in food production and processing) will be assessed in the near future for meeting the potential growing demand and for exports in the area, e.g. for high added value products and energy.

The local area's movement towards a more sustainable energy system is measured by an indicator of the renewable energy production potential. This takes into account that renewable energy must be a total substitute for fossil energy consumption in the area in order to transform the area towards green growth. The renewable energy production potential is assessed for different sources, e.g. biomass, solar, wind, thermal etc. In this study we primarily utilised the indicator for measuring side stream volumes (biomasses) as raw materials. Though the energy use of wood has often been seen as sustainable exploitation of a natural resource, it has also been deemed unsustainable from the viewpoint of material and resource efficiency. With efficient resource use, more can be produced with less and production can be increased. Therefore, in this study, the most essential and significant raw materials for energy production were perceived to be already existing and unutilised forestry and agriculture side streams (manure) because they are at this moment defined as waste and are as yet non-utilised and therefore do not compete with other exploitation options such as food production. Although the indicator does not precisely follow the cascading principle, it is acceptable with these sparsely populated case rural areas with decentralised energy production, where following a strict cascading principle could problematically limit the use of biomass energy (chapter 3.1.). For example, there were no systems at this moment to prioritise wood utilisation for high added value product processing, reuse, or recycling. This is only an intermediate step, a way to create a sustainable basic infrastructure for the mobilisation of wood resources in the area, as more sustainable forms of power (e.g. wind and solar energy) are adopted and these biomasses can be reutilised for higher added value products. In addition to potential self-sufficient renewable energy production, the *energy surplus* is an indicator reflecting the excess amount of energy after the local internal energy demand is already covered by energy production. This reflects the potential for exports, new business opportunities and green growth in the area.

Energy capital flight reflects the value (€) of the area's energy consumption flowing outside the area due to imported fossil energy which would be to reserve by producing renewable energy inside the local area. In other words, it also indicates the monetary value of renewable energy (and its raw materials) and also the economic dimension for provisioning ecosystem services. This is because unexploited side streams do not yet have a market and consequently there are no market prices or direct demand to assess the potential productivity and economic growth of the area. This was also based on an assumption that the demand and market price for fossil energy would be the same for renewable energy, meaning that the residents of the local area would buy energy only from the local area's own biogas-generating company and the funds would thus remain within the local area.

The energy exports (€) are a market value for the energy surplus that is sold outside the area for business. However, new business opportunities must be considered within the boundaries of the green economy definition and revenues must be prioritised for further developing local economy livelihoods and vitality.

The energy system's social impacts are challenging to measure, but we managed to develop some indicators and perceptions. Socio-demographic indicators reflecting the total area potential and change are presented in (6.4.) but they only partly reflect different effects from the energy, food and tourism systems. The only socio-demographic indicator reflecting the direct impacts of the energy system and biogas plant transition process in Saija was perceived at this moment to be *the number of employed (energy sector)* and this has the potential to be directly assessed for the energy system. It reflects the degree of employment in the bioenergy sector, the standard of living, the level of participation and potential, and the number of people at risk of exclusion and the degree of exclusion/danger in the area (lack of employment). The employment ratio reflects the opportunities to live in the peripheral areas because a job is basic element for living in the area. New job creation enables young people to settle in the area and provides job opportunities for unemployed people. In other words, this indicator reflects the regional equity in terms of people's opportunities to work and live in the area. Finland has a financial support system for unemployed people, however unemployed people are at risk of exclusion and unemployment affects the future visions for young people. It also reflects the workforce potential existing among the total workforce.

The *local resident's trust in energy development* is an indicator which was developed and measured through the questionnaire (see Appendix x) presented in chapter 4.2.2 for residents. The more the trust in the village, the more the potential for green economy change and growth in the area. In this study, it was seen that trust reflected the quality of social dimensions in the village. It indicated trust in the **energy village** development plans, calculations concerning the biogas plant, collaboration skills and trust in other people and institutions. The majority of the respondents believed that the energy calculations presented by the project were credible, that their own power generation unit would ultimately be built in the village, that the plant would be able to produce the planned amount of renewable energy for the village's needs and that these plans would promote the interests of all the villagers. Trust was raised, during village visits between village and area residents, decision-makers and development experts, i.e. positive iteration was based on trust building. The villagers were "awakened" to find opportunities to make better use of their natural resources based on networks, and to increase cooperation opportunities for existing companies and to identify new business opportunities. Village visits are essential to map the region's initial intent and potential and to create a self-induced enthusiasm for village development. Hope for a better future is empowering and motivating to work towards wellbeing and vitality. Very often, in the baseline scenario, conflicts between residents and entrepreneurs have been identified, and the start of these problems has long history. A common vision of the future and setting common goals can reduce conflicts. The self-perception of the villagers, that is, the perception of their own abilities and opportunities, increased with local **energy plans** and related business models. During the project, it was found that the perception of shared empowerment in village development increased. During this project the local residents began to notice the capital outflow of the area and how these potential resources of their own area could cut this capital outflow. At present, the capital of private individuals, corporations and corporations flows outside the region because of the energy and food they buy. There is a risk of residents moving elsewhere if the amount of money available in the area decreases. As a result, the villagers' knowledge and labour could be lost, and the physical framework and the business could disappear. It is possible to create new jobs in the area through an efficient circular economy and the new transdisciplinary entrepreneurship that would bring, while also taking care of the environment. Through the calculations of the selected indicators, it was perceived that the capital outflow would increase to 41-50 % of the available funds for the purchase of fossil energy.

6.1.2. Food system indicators

After the capital flight for energy has been reduced and investment costs for an energy production plant have been covered in three years (Fig. 8), the village's own food production and further processing will be developed. The main aim of using the food system indicators therefore is to measure the progress of the self-sufficiency of food production, processing and consumption in the area. In addition, exports are taken into account.

When considering the indicator for *local food production potential* it must be realised that the share of local food production in the area must grow in relation to reduced imported food consumption to be more sustainable and to implement green economy targets. We assessed the general level food production potential of the village of Saija by reflecting the Kuha (2015) assessment model, also keeping in mind the Saija area specific food production potential perceived through expert analyses (glasshouse cultivation potential in the near future through renewable energy potential) and perceived in workshops (e.g. reindeer chips, Matsutake mushrooms). According to the Kuha (2015) assessment model, it should be possible to produce almost half (50 %) of Lapland's total food in the Lapland region. In addition, concerning processing, it would also be realistic to further process milk, beef, pork, poultry, sheep and reindeer in the Lapland region. The volume for processing foodstuffs in the Lapland area is evaluated to be approximately 30 % of the total price of the end product (Kuha 2015.) In addition, there is also potential for agroforestry, fishing and game animals. The Saija village assessment was reflected in the assumptions in the study by Kuha (2015).

The food production potential can also be measured from another point of view. More specifically food production potential and changes can be assessed by utilising indicators such as: *the change in plant biomass growth (t/a)*, and the *potential for cultivated field (ha)*. Grass production for feed is important in animal production and in Lapland the majority of the fields are used for grass production. In addition, grass production is connected to climate change as the ability of grain legumes to bind nitrogen reduces carbon dioxide emissions from fossil fuels and produces lower nitrous oxide emissions compared to industrial nitrogen fertilised crop and grazing systems. Grain legumes also accelerate the storage of carbon in the soil.

Agroforestry is considered to be a more resilient opportunity to utilise local ecosystems the change rate reflects the shift towards more sustain production patterns. *The potential agroforestry harvest* evaluates berry yields, mushroom yields and hunting catches for humans as forest ecosystem provisioning services for food production. However, as the green economy must take other ecological processes into account, the potential harvests should also take into account all ecosystem services and its boundaries at the same time. In other words, optimal harvest amounts need to be found for all provisioning services inside the ecosystem in order to maintain the balance. We did not have enough resources to evaluate the optimal potential for forest ecosystem harvests, but there are already some models for evaluating potential berry harvests inside the ecosystem. For example, berry yield models are included in a stand growth simulator and the joint production of timber and berries is optimised by maximising the soil expectation value (SEV). Miina et al. (2010) optimised the joint production of timber and bilberries. In addition, Miina et al. (2016) included bilberry and cowberry yield models in a stand growth simulator for the joint production of timber and berries optimised by maximising soil expectation value (SEV).

The *food production surplus* indicator reveals the excess amount of food production in the area when the own demand is covered/when the capital flight of food is reduced as optimally as possible. It summarises all the excess food production volumes.

However, most of the food is still produced and processed outside the Lapland area (for example, there is no milk processing anymore in Lapland). From an economic point of view, the money capital of private individuals, corporations and corporations flows outside the region because of the food they buy. By increasing the production and processing potential of the local area it is possible to prevent the capital outflow of food. The *capital outflow/processing value loss* indicator means the economic value that could stay in the Lapland area by processing foodstuffs in the area, but the value is currently flowing elsewhere because the food processing takes place outside the area. 50 % of the food demand could be met through production in Lapland and the value loss of processing is calculated to be approximately 30 % of the total price of the end product. The sum is comprised of the consumption value of the end products which are realistic to further process in the Lapland region, basically milk, beef, pork, poultry, sheep and reindeer.

The *food Export (€)* indicator reveals the value for surplus exports, in other words the value the excess amount of food production once the own demand is covered. The export potential also rises when the local supply does not fully meet the food demand for different products (e.g. reindeer chips, etc.). The Surplus and export (when interpreted this way) utilisation level reflects the resource efficient use of the resources (food production), e.g. what is not needed in the area can be imported outside leaving the monetary value inside the production area. In addition, part of the raw material price is determined by the global market. Specialisation can provide price flexibility that improves the core profitability. A short supply chain also adds flexibility to the raw material price. In this study it was not possible to calculate the added value of Arctic food products, however this has been studied elsewhere, for example by Kurppa et al. 2015.

Based on the conversion of processing value, it is possible to estimate *the displacement of work places* outside Lapland (Kuha 2015). The socio-economic indicator for the number of jobs due to food production makes it possible to directly assess the food system, and it was therefore utilised. It brings growth to the area's livelihood and may also reflect the variety in industry sectors and increased job opportunities created by expanded food processing opportunities. Also, from the social impact point of view, the indicator examining *improvement of food security* can be used see if the local economy is improved by self-sufficiency by preventing capital flight and enhancing economic sustainability. Social equity on the other hand is reflected through the indicator on the *access and availability of edible and provisioning ecosystem services* in terms of accessibility to local resources (yields of berries and mushrooms, hunting prey and fish catches kg/year) as well as the distribution and division of the benefits and how the resources are divided inside the local community. In this study, it was left without more specific evaluation because in Finland the *social equity* in the food sector was assumed to be guaranteed partly through legislation for berries and mushrooms, as well as the related guaranteed everyman's rights in Finland, where equitable justice for the inhabitants of the area is also created. Shared utilisation of ecosystem services, the growth of business opportunities and region's viability meet the targets of social equity. However, for gaming one needs to be part of a local game association and fishing requires a license which can be purchased by anyone.

6.1.3. Tourism system indicators

In this follow up project the previous energy and food system indicators were complemented with green economy indicators for the tourism system providing the cultural ecosystem service's perspective. Achieving sustainable tourism was regarded as a continuous process and it requires constant monitoring of impacts and introducing the necessary preventive and/or corrective measures whenever necessary. These indicators they serve as preliminary proposal indicators for the base framework for future implementation.

There were challenges when developing different types of demand or supply tourism indicators (traditional tourism, nature based tourism, sustainable tourism, responsible tourism, ecotourism etc.) For instance, the concept of "ecotourism" is not unambiguous. There is no general definition of ecotourism or its related principles (Sirakaya et al 1999, Edwards et al 2000: 1, Fennell 2001, Donohoe & Needham 2006, Cobbinah 2015). Despite the diversity of concepts, it can be argued that the underlying idea is nature-based, learning oriented tourism which is managed in a way that maximises the probability of sustainable environmental and socio-cultural impacts. Additionally, the value of such tourism is shared with the local communities (Nevanpää 2017). In this work the case tourism company identified itself as a nature-based tourism company aiming for sustainability in their actions. Hence the developed indicators aim towards sustainable nature-based tourism in the green economy context.

The total number of visitor facilities in the area reflects the supply of the tourism. As part of these facilities the local area can offer *cultural ecosystem services* for tourists. The ecological perspective highlights the ecosystem services and ecological boundaries as bases for tourism utilisation. This indicator measures the available recreational services (e.g. berry and mushroom picking, fishing, and hunting) and the opportunities offered by the ecosystem for tourists and residents. It is essential that as the number of tourists and utilisation grows it should be done within the ecological boundaries of the ecosystem, respecting the biodiversity and resilience of the systems. Collecting data from the utilised services is still under development, but could be collected along with the accommodation data. However, for some tourists being in nature without any particular recreational service or action is the service they want. On the whole, especially the statistics concerning nature-based tourism are insufficient (Sievänen et al 2017). This indicator also measures the number of different services and amount of use. It is estimated that the majority of the villages residents and Inari area residents go berry picking, fishing or hunting, i.e. they utilise the recreational services of the area's ecosystem. However statistical data on the use is insufficient (Sievänen et al 2017). As the utilisation grows it should be done within the ecological limits of the ecosystem.

The *ecosystem well-being* indicator measures the wellbeing of the ecosystem in terms of biodiversity and the change in it. This includes diversity within and among species and diversity within and among ecosystems. Maintained or increased biodiversity also strengthens ecosystem resilience, which is extremely important. Biodiversity is the source of many positive ecosystem aspects, such as food and genetic resources, and changes in biodiversity can influence the supply of ecosystem services. Also this should reflect the cultural services and their link to other ecosystem services. The interlinkage between different ecosystem services is still challenging to measure but it should be recognised.

It is still challenging to explore the ecosystem as a whole and it also requires the recognition of the whole system of ecosystem services. Tourist destinations have an impact on the surrounding environment, its flora and fauna and the relationship between them and hence affect the whole ecosystem. *The area wear resistance* indicates the capacity to absorb or tolerate the stress effect as a result of human activity; the ecosystem can try to either absorb the pressure caused or to tolerate it without significant changes in the structure or operation of the system. The better the vegetation tensile strength and recovery ability the better the situation is. However, if the natural environment is not able to absorb or tolerate the environmental pressure, it will cause adverse changes in the ecosystem. In this case its ability, i.e. capacity, against pressure has been exceeded. Several studies show that the relationship between the effect of recreational use and the amount of use of the area is not linear (Cole 2004). This means that the largest changes in the natural environment already occur with low usage and during the first couple of years, after which recreational use causes only a few additional effects on the environment. The area's wear resistance reflects the boundaries of the ecological system affected by the tourism, thus limits where the green economy can grow.

Biodiversity and the changes in it reflect resilience. The more diverse the system is the better the resilience, e.g. coping with the change is. However, it is challenging to measure biodiversity as such, there is not one way to measure it (Auvinen and Toivonen 2006). The endangered species, number of conservation areas and the diversity in species can be interpreted as impact indicators (showing how the population of an endangered species has changed), situation indicators (number of species) and action indicators (establishment of conservation areas). *Air and water quality* indicators show an essential part of the ecosystem of the area. The quality is important for the ecosystem services production and utilisation, hence their condition is also linked to biodiversity. Even though the air and water quality were not calculated in this project, it is acknowledged that the air quality is excellent (e.g. WHO 2018) in Lapland and the water quality in Lake Inari is excellent in most parts of the lake. Furthermore, the nutrition load from human activities is minor (Ympäristö.fi 2018d). However, the rationing of the water in lake Inari has negatively affected the coastal area flora and fauna (Ympäristö.fi 2018c).

The *local energy utilisation* indicator measures the amount of renewable energy usage and the non-renewable (fossil) energy use. It reflects the shift towards more ecologically sustainable energy use, the higher the amount of renewable energy use and the lower the non-renewable use is the better the change towards the green economy is. The initial goal is to replace all fossil energy use with renewable energy sources as renewable energy must be a substitute to fossil energy production and consumption in order to transform the area towards green growth. This indicator reflects the change needed in the transition towards the green economy. The *energy self-sufficiency* rate in renewable energy production based on local resources reveals the resource efficiency of local resources. The utilisation of local resources for own energy production reduces the capital flight from the area and increases the resource efficient use of local resources. Hence this indicator also reflects the economic equity in terms of preventing capital flight from the area.

The *local food services' utilisation (e.g. in restaurants)* indicator reveals the use of local resources in terms of food. The amount of the local food refers to wild food (game animals, berries, fish, and reindeer) and other local food production product use and indicates the shift towards the more sustainable use of local resources. Hence it increases the opportunities to use local subcontractors as providers of food and thus boosts the local food production/processing. In the green economy context, this indicator reflects the resource efficient use of local resources and also equity in the terms of how benefits coming from tourism are reflected in the local community (local subcontractors). The *waste disposal* indicator reveals the amount of waste utilisation (% of the total generated waste). It reflects the resource efficiency in the waste context and the realisation of the circular economy approach where the basic idea is to generate no waste; the waste should always be a resource of some other utilisation process and utilising waste should always follow cascading principle and waste hierarchy. The interpretation of waste will change as the circular economy approach is implemented in industry sectors. Waste becomes a raw material for other processes (e.g. see energy system indicators and indicator for side stream utilisation potential) and may become valuable instead of something that creates costs.

The *local, sustainable facility utilisation* indicator reflects the level of local material used in building and this reflects the utilisation of local resources (e.g. local wood use). An increase in the locality level of materials indicates an increase in green growth (especially in the northern context where resources (wood) are available). Certified material use reflects the verified sustainability of the materials (e.g. certified wood use). For example, FSC and PEFC certifications are a way to impartially demonstrate that wood and wood products come from sustainably managed forests and/or companies that respect legislation on the forest, environment and personnel welfare. Natural dead wood is nearly finished in Lapland due to heavy utilisation during past twenty years. The remaining deadwood in Finland is mainly situated in conservation areas; hence its utilisation is practically impossible. Therefore, importing dead wood from abroad is the only way to use it as construction material. However, problems may occur with the sustainability of foreign dead wood material.

From the economic point of view, tourism indicators illustrate the economic value gained from the tourism due utilising these cultural ecosystem services. The indicator for the capital *outflow of* *tourism* reveals the value of tourism (utilisation of cultural ecosystem services) flowing outside the area due to foreign ownership. If tourism services are not in local ownership, it means that the value goes outside the area, i.e. capital flight occurs. It was considered that local ownership would have a better understanding of the importance of sustainability and the maintenance of ecosystem services for future generations and residents. It is extremely important that there are common goals and mutual benefits of tourism to the owners and local actors and residents. Developing social sustainability and a mutual win-win situation between different actors and interest groups needs to be developed further.

The *value of tourism for the company* indicator reveals the value for the company (annual turnover) from the utilisation of cultural services in the tourism context. However, this increase in value should not happen at the expense of cultural services and has to take into account the ecological indicators (ecosystem boundaries). The value indicates the economic importance of tourism services, which is estimated to grow in the future. In order to reflect green economy growth, companies need to respect ecosystem boundaries and resilience in their value creation. The value of the tourism entrepreneur for the surrounding human ecosystem (residents and other businesses in the area) is substantial but was too challenging to measure in this study. The value indicates the economic importance of tourism services, which is estimated to grow in the future. This reveals the monetary value coming from the utilisation of cultural services in the tourism entrepreneur context and is reflected to the whole area. For example, this might be evaluated concerning the taxation effect of the company, as well as value of tourists for other companies in the area and residents. In Lapland the corporate tax is 20 % of the company revenue but a local purchase % is not yet possible to estimate and needs further research.

The *number of tourists* reflects the demand for tourism and must meet the ecosystem boundaries in the area. The share of foreign and domestic tourists was not included here because the interpretation is very challenging and not as straight forward as, for example when concerning social equity, environmental impacts through travelling or income effects outside the area.

The indicator for *the number of jobs through tourism in the area* has a potential to be directly assessed for the tourism system. This indirectly reflects the well-being effects created by tourism. Growth in the change suggests an increasing number of jobs in the region's tourism sector and rising living standards in the region. In Lapland the impact of tourism was nearly 6,000 person years in 2016 (Lapin suhdannekatsaus 2017). Furthermore, the importance of tourism for the regional economy is growing. Tourism has important potential to increase jobs in Lapland. As a matter of fact, there is a shortage of manpower and qualified staff in the Inari area, which is reflected in the Nellim area as well. The improved economic impact has the potential to increase well-being in more equal ways as job opportunities increase.

The *access to ecosystem cultural services and distribution of these benefits* indicator reflects social equity because it reflects the accessibility and distribution of cultural services (recreational services, hunting, berry and mushroom picking, nature trails and other activities) among tourists and residents (local and indigenous people). However, without calculations, it was acknowledged in this study that in Finland everyman's right guarantees access for every resident in the area to utilise cultural services even though the area would be privately owned (e.g. as recreational services - berry/mushroom picking in private forests is allowed, but however, for game hunting one needs to be part of local game association and fishing requires a license (in some cases) which can be purchased by anyone).

Social equity in the green economy context also means the well-being of local communities. Well-being cannot be considered in isolation from the natural environment. Secure rights to environmental resources (e.g. land, water, trees) are an important dimension of well-being. Indicator for the *well-being effects on human beings* is percepted and welfare being distributed in the local area. However, it was not possible to carry out actual calculations due to the lack of local data, the immaterial nature of the services (experimental and mental benefits due to recreational services) and also multiple different nature based tourism concepts and interpretations. The indicator reveals the well-being effects of the cultural services perceived by the customers, tourists and local people. The perceptions of increased well-being (e.g. health, physical, emotional, and aesthetic impacts) are subjective and difficult to measure without interviews. Well-being as a concept is multidimensional and holistic and is interlinked with mental and physical well-being and they support each other. Tourism increases the availability of recreational services also for local people (e.g. skiing tracks, nature paths, landscape maintenance). In addition, the cultural heritage, sense of place (often associated with recognised features of the environment, including aspects of the ecosystem) and information connected to places is often important in the local context to local people. The indirect effect on well-being relates to increased area vitality and the welfare of the local people.

6.1.4. Socio-demographic indicators

Examining the industrial structure of a region gives information about its regional resilience, which has impacts on the vitality of the area and well-being of its residents. Some of these indicators also directly reflect equity, wellbeing, opportunities to participate and influence one's own life, but social dimensions are also reflected in energy, food and tourism system indicators as well. Furthermore, social equity as one of the paradigms of the green economy is to be analysed also through socio-economic indicators. In this project, it was perceived that social equity as one of the green economy paradigms is challenging to measure and therefore this project sought information on the aspects linked to social equity and social profiles e.g. population characteristics, industry sector aspects and the ownership situation related to resources. Also, changes in the values of socio-economic indicators are not necessarily direct consequences and reflections of the green economic transition process. In other words, they might partly be reflections from other projects as well. This means statistical socio-economic indicators must be analysed together with other green economy indicators in order to analyse possible correlations and linkages.

The growth of *the population* indicator a needed direction to maintain the green economy than a reduction of the indicator value reflecting the continuation of migration. This is because in the context of Finland's peripheral regions, the growth of the population is not a problem but rather a resource that is scarce due to migration problems (defined in 4.1).

Indicator for *education* describes the potential increase in the level the local residents' know-how. Increased know-how is needed in adaptation and implementation of novel green economy systems, hence an increased know-how level represents the potential to achieve novel required skills and knowledge. However, the availability of education varies in different parts of the country even though education, even at the higher level, is free and in this sense available to everybody.

Some sociodemographic indicators are seen to reflect social equity directly in the area. *The population per income category in the region* indicator reflects social equity more directly in terms of the economic equality in the area. It also reflects the ownership of the natural resources (income from the timber trade). *The number of forest owners* in the region reflects social equity more specifically/directly in the area; the ownership of the natural resources refers to accessibility to resources (forests as a renewable energy source) and decision making. Also the gender of the owners reflects the gender equality in terms of ownership.

In addition, *the participation of local people in development plans* measures opportunities for participation (e.g. land use planning events, callings, discussion events) that concern local development. The number of events and local people who attended reflects the social equity in terms of participation. The participation of local communities and people (including indigenous people) (Koivurova and Heinämäki 2006) is recognised and it is seen, for example, as one of the most important aspects when heading towards sustainable community development (Kelly and Van Vlaenderen 1995, Price and Mylius 1991, Kolavalli and Kerr 2002). Involving all the stakeholders in the planning prevents conflicts and adverse effects on local culture and ensures a fair distribution of benefits (Backman et al 2001: 451).

For example, local self-sufficiency will *increase independency and provide better opportunities to participate in decision making* related to the use of renewable natural resources. In particular, nature tourism in the lands of indigenous peoples requires the involvement of local communities. According to the World Tourism Organisation (2004) "Sustainable tourism development requires the informed participation of all relevant stakeholders, as well as strong political leadership to ensure wide participation and consensus building."

The change in the value of the *demographic dependency ratio* represents the sustainable demographic development needed also in terms of equity. This gives insight into the number of people of non-working age compared to the number of those of working age. A high ratio means those of working age face a greater burden in supporting the aging population. The ageing of the population and declining number of working age people is a trend of peripheral regions in Finland. Hence a more balanced ratio is needed moving towards green economy. The *economic dependency ratio* shows the number of pensioners, people receiving incapacity benefit and those who are unemployed in ratio to the number of employed people. The ageing of the population and high unemployment is the current situation in many peripheral regions in Finland (Hörnström & Roto 2013). To achieve a more sustainable direction as a basis for the green economy a better balancing ratio between the working and not working population should be achieved. However, the dependency ratio does not directly reflect the demographic structure of the region. In some areas, the population's dependency ratio is burdened by the large number of children, while on the other hand, a large number of retirees. In addition to the age structure of the region, the economic dependency ratio is affected by the employment situation in the region. *The number of employed to the number of total workforce reflects* the degree of employment in the region, the standard of living, the level of participation and potential, and the number of people at risk of exclusion and the degree of exclusion/danger in the area (lack of employment). The employment ratio reflects the opportunities to live in the peripheral areas because jobs are a basic element for living in the area. Finland has a financial support system for unemployed people, however unemployment carries a risk of exclusion for the unemployed and affects the future visions of young people. It also reflects the workforce potential for the overall workforce. Social equity in the green economy context also means fairness in the distribution of gains and losses, and the entitlement of everyone to an acceptable quality and standard of living. Employed people in general have better opportunities to provide an acceptable quality and standard of living.

Further changes to *industry sectors* (especially linked to renewable energy utilisation) represent a move towards more sustainable development. This is reflected in the case village as the renewable energy production plant has the potential enable the growth of new business activities utilising renewable energy and thus to expand the diversity of industry sectors and create new jobs. More diversity in the industry sectors (connected to renewable energy utilisation, sustainable tourism) has the potential to increase resilience in the area and enhance development in a sustainable direction. The indicator of *service availability reflects the available services such as healthcare, postal services, or shopping* which can be seen as indicators of equity in terms of citizenship. In the coming years Finland faces challenges with its ageing population and service availability (OECD 2008). New innovative ways to provide services (e.g. healthcare, postal and shopping services) are needed especially in remote rural areas with ageing populations and increasing needs in healthcare or childcare services, to guarantee the equality and equity of citizens. In addition, new information technology also enables more ecological service supply and also enables access to more diverse education opportunities.

The traditional economic growth indicator gross domestic product (GDP) was considered too general-level, while the gross regional domestic product" (GRDP) area level indicator was not possible to calculate since there was no relevant local level information available. In addition, the GRDP should also reflect the specific green economy level development in the area, in other words the direct or indirect effects through sectors, goods, companies, etc. inside the green economy businesses. Also according to D'Amato et al. (2017), the green economy alongside the circular economy and bio economy concept, remain limited in questioning economic growth. However, in this study, economic growth was assumed to be achieved (without measuring) by minimising capital flight and increasing the energy and food self-sufficiency of the area, as well as by increasing sustainable tourism in the region.

6.2. Measuring symbiosis with indicators

The green economy will not arise without cooperation between different sectors, regions and networks. From a scalability point of view, sector-based indicators should eventually be incorporated and used to add data hierarchically to the local, regional, provincial, national and finally to international level indicators. The importance of rural areas for the green economy is emphasised through utilising these sector-based indicators because most renewable resources and biomasses are located in rural settings. The prevailing urban-rural confrontation cannot contribute to the green economy and therefore a centralised-decentralised network perspective can provide a more fertile way for this debate to go forward.

Local sector level indicators need to be sensitive to the non-linear and dynamic process and modification of the green economy, and preferably should be able to predict its development (the nonlinearity of green growth). In decentralised systems, regional-level networks should be able to either balance or utilise nonlinear changes at the local level. The same requirement is extended to the national level according to the goals of sustainable development. However, according to the EU's territorial thinking, in line with the smart specialisation strategy, desirable regions of the internal market should be so strongly networked that partnerships can balance each other across national boundaries. This goal links the challenges of producing green indicators to regional networks.

The green economy concept includes elements from circular economy (D'Amato et al. (2017). Symbiosis combines elements of the circular economy by connecting different sectors (energy, food, tourism and area ecosystem) and promoting resource efficiency and dynamic networking. Measuring symbiosis should finally be able to take into account that symbiosis is also a dynamic process: the construction of symbiosis and the creation of new complementary mechanisms will increase the business and the vitality of the region, which in turn creates opportunities for symbiosis growth (i.e. growth in supply). As the demand and business activity develops, the economic value of the exchange may decrease, but the welfare value will increase. Increasing ecological performance reduces the value of the exchange in the short term, but stabilises the fluctuation and increases the value of the exchange and prosperity in the long run. The value of trust between the demand and entrepreneurship sectors increases and at the same time the cost of risk management is reduced. When, for example, should export-driven flows be directed towards the increased internal activity of the region and replace the demand for exports? For example, the energy demand is only the current demand estimated for energy production potential for an area where forestry plays a major role. However, this situation exists all the time and will also exist in the future, when the values for the indicators need to be re-evaluated.

However, measuring the symbiosis process and synergies between energy and food systems, as well as the tourism system and area ecosystem boundaries is challenging work. Therefore, in this project only a preliminary proposal for these measuring indicators was done. Concrete cooperation with these networks was limited and should be strengthened in the future, for example, in relation to research cooperation.

6.2.1. Measuring symbiosis between food and energy systems

These indicators measure and reveal the potential for total renewable energy production in the area as the demand for energy production raw materials. This is met by the supply offered by the food system side flows in case forest system side flows are not sufficient to meet this demand, and in the situation in which food system side flows are not yet able to be produced for higher added value products in line with cascading principle. Vice versa the demand created by the food system for renewable energy is taken into account. This way the linkage between energy and food system symbiosis is revealed. All the demand should be fulfilled in a sustainable way, e.g. by respecting the ecological boundaries of the area. The ecological limits define the utilisation potential of the area.

Potential material and energy flows are easier to assess, but as the demand and business activity develops, the economic value of the exchange may decrease, however the welfare value will increase. Increasing ecological performance reduces the value of the exchange in the short term, but stabilises the fluctuation and increases the value of the exchange and prosperity in the long run. The value of trust between the demand and entrepreneurship sectors increases and at the same time the cost of risk management is reduced.

The accessibility to the unutilised side streams (waste streams) is linked to the question of ownership. Who or which companies own the material flows available in the area and how open the opportunities for utilisation are. For example, do all the actors (side stream producers) have equal opportunities to sell and buy side streams?

The monetary value of the side streams and how the value is developed and shared in the utilisation process is also a question of equality. Hence the cascading principle should also take into consideration the producer of high-end value components so that the monetary value would also concern the raw material producer.

Additionally, the future growth potential for food production due the excess of thermal energy in greenhouse production will increase the symbiotic flows enabling organic waste to be utilised in biogas production.

6.2.2. Measuring symbiosis between tourism and the area’s ecosystem

These indicators measure and reveal the demand from the tourist side (domestic and mainly foreign) and the supply (potential) offered by an individual local tourism company and the supply of the whole area. As defined in Chapter 5.2.1, tourism is essentially a technical concept measured by the available statistics on visitor movements and expenditure (demand) and estimates of the number of visitor facilities (supply). Market based tourism driven demand reveals the growing tourism demand for individual tourism companies as well as area tourism companies and destinations. The tourism growth rate in Lapland is high and was 13 % in the 2015-2016 period. The total demand in 2017 amounted to one billion euros, of which 400 million euros were from abroad (Lapin liitto 2018). *All the demand should be fulfilled in a sustainable way, e.g. by respecting the ecological boundaries of the area.* The ecological limits define the utilisation potential of the area.

The demand indicators for nature based tourism (persons/year) and ecotourism (persons/year) reveal the demand for the total area and should be reflected in the supply both from the perspective of individual companies and from the area perspective. Ecotourism (see chapter 6.1.3) refers to high end value services, which also have educational purposes. The number of tourists coming to the area should acknowledge the ecological boundaries of the area (sustainable use) and the capacity of the individual company (accommodation/beds). This needs to be compared to the area supply, e.g. the ecological limitations of the area. The ecosystem boundaries of the area (the area size (m2) compared to tourist numbers, the area wear resistance, and land use in the area) reflect the ecological perspective in terms of land use and area. This reveals the land use in the area, as well as the interests of the multiple actors of the area and the needs of the growing tourism. It illustrates the existing land use practices and the needs of the growing tourism demand. The overall demand for cultural ecosystem services, e.g. recreational use (number and time) by tourists, needs to be fulfilled by the supply of individual companies and the area supply within the limits of sustainable numbers of tourists as well as the area residents recreational use demand should be forgotten.

Tourist driven demand of food should be taken into account in local food production and processing potential by individual companies or at the area level. This reveals the possibilities of the area to fulfil the demand coming from the tourists and individual companies. Local food utilisation is an indicator for more sustainable food provision. The tourist demand also concerns other services such as programme providing services and the supply consists of individual company and area supply. This concerns souvenirs and their manufacturing from the local materials. Indirect demand created by the tourists relates to facility needs (energy consumption, buildings and service personnel demand). The supply to meet this demand should be fulfilled by using local renewable energy, sustainable buildings and local human resources (staff). Hence the indicators measure the use of local renewable energy production, sustainable buildings (materials, energy efficiency) and local human resource utilisation.

The transactions between the systems (tourist-company-area) are done with money. Tourists pay for the recreational and other services. This creates monetary opportunities for companies and to increase wealth in the area. In the previous chapter (6.2.1) material flows between the systems were explored and the transaction was between the material flows. The most important aspect is that growing tourism should take into consideration the ecosystem boundaries in the area, e.g. the potential for sustainable ways to supply and fulfil the growing demand created by the tourists. It is the only way to create sustainable business in the area.

6.3. Modelling future green bio economy

During the project, we went through various possibilities for generating energy in one of the villages we studied (the village of Saija). We examined what the impact of energy production from the village's own raw materials would be on the village. Linked to the project, the Saija villagers founded an energy company, which aims to generate energy for the villagers and sell traffic fuel to outsiders. The village of Saija will investigate the construction of an energy plant by a village-owned joint-stock company. The above image captures the most important aspects that were examined during the process. The villagers want to stop the constant capital flight (Timonen et al, 2017) and keep the village alive. This is not going to be easy because in Finland the production and distribution of fuel and electricity is in the hands of large operators. The current laws have been designed to support this system.

Future plans were discussed in several sessions and Figure 20 shows the result of these meetings. Development continues and the Saija Energy has decided to apply for support to invest in the energy sector. The aim of the villagers has been to reduce the burden on the capital, and this action will help to start a new business in the village. The closing down of the village shop was a big disappointment for many people in the village, but now they are dreaming of a new store or kiosk.

According to Hawken (2017), in countries where heat and electricity are produced together in relatively large combined heat and power (CHP) plants, there is a growing need for energy security nationally. Big companies, cities and municipalities own the CHP-plants and generate heat which is distributed throughout urban areas (as a biproduct of electricity generation); the production of district heating covers 47 % of the building volume of the entire country's residential buildings (Energiateollisuus 2017). In Denmark, 63 % of heating in private houses is provided by district heating (Danish Energy Agency 2018). This means that cities and most towns have central heating systems, but the rural areas do not. Most villagers have own heating systems which use wood chips, pellets, fossil fuels, or electricity from the national grid.

In Finland, the electricity grid and waste disposal are part of the free market economy, protected by legislation for large operators. Rural area villagers have to pay to deliver their energy by-products and waste streams to large operators. In decentralised energy production, electricity transmission by energy units should be introduced, whereby the energy produced by a small producer would have the same value as the energy of the big producers. It is currently difficult to get the electricity generated in the village from the village without the cooperation of a network company. Negotiations are currently underway and it will be interesting to see if a solution can be found. Denmark has been a pioneer in decentralised energy production and the exploitation of micro-networks. Their model would also be good for Finland in sparsely populated areas, so we could keep the country as a whole and secure access to labour for rural entrepreneurs as well.

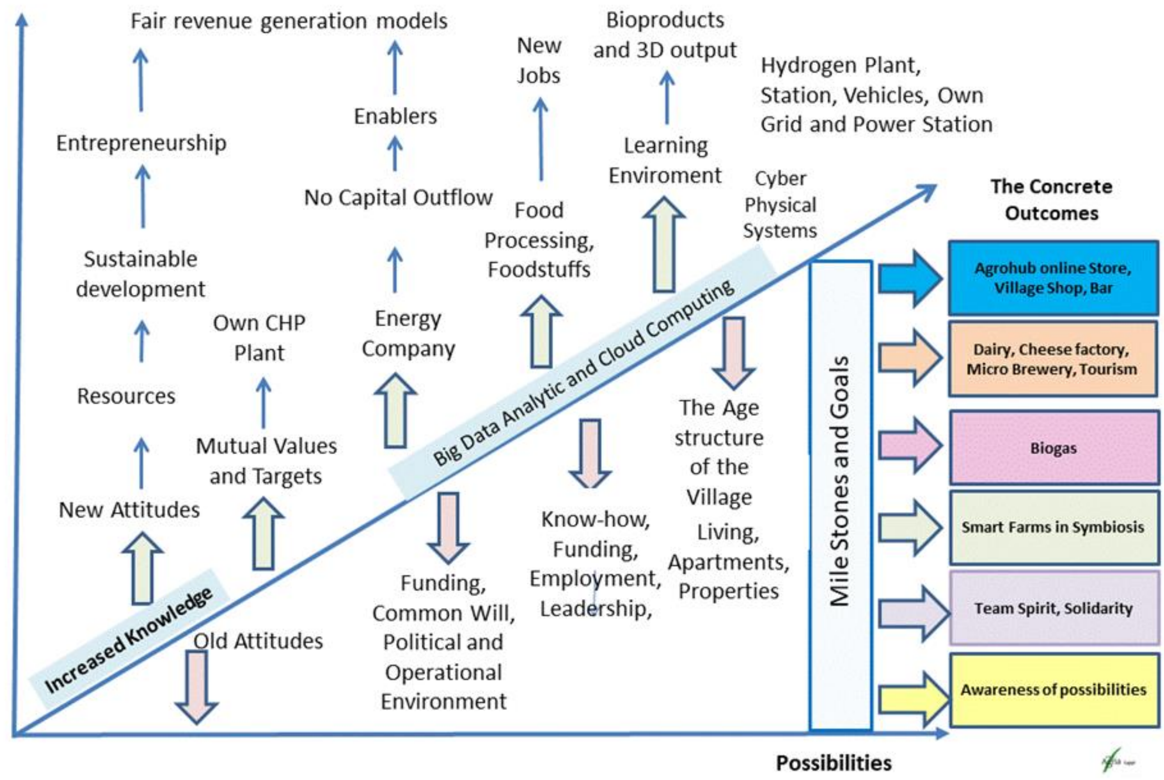

Figure 20. Vision and roadmap for Saija Village 2050.

Future business models will be combined with artificial intelligence and symbiosis of the Internet. The traditional business model companies are in trouble because of global digital platforms. The development of technology and the link between the new and old technology is a major cause of change. A traditional business that operates on a business to consumer or company to company basis faces many challenges. The key weakness include long distances and delivery chains. The drivers for change in business models will be sustainability and digitalisation.

The future offers increasingly diverse opportunities for consumers to form their own markets. Sharing economics is one example. Consumers enter the market alongside entrepreneurs. The opportunities offered by various applications have provided consumers with the opportunity to trade with each other. Wide attention has been paid to Airbnb tourism and the uber taxi business among others. Additionally, on the financial markets Fintech companies are coming up alongside banks, while the financial markets are also diversifying. The platforms that come to various industries will become more common and diversify business models. The relationship between consumers and businesses will change. Consumers and businesses work together on the same market.

The sharing economy (Figure 21) creates a new kind of working culture, simultaneously being an entrepreneur and a worker. The sharing economy also creates great opportunities for sustainability. Some of the goods may be superfluous to one another and others may need them. Furthermore, the actors can best find each other through various applications. Facebook has created such an opportunity. However, the sharing economy provides opportunities, e.g. for the emergence of new types of village shops. Sharing economies have been utilised by fast-trackers who have been able to create clear earnings by creating platforms. Clean exchange or recycling is becoming more and more common.

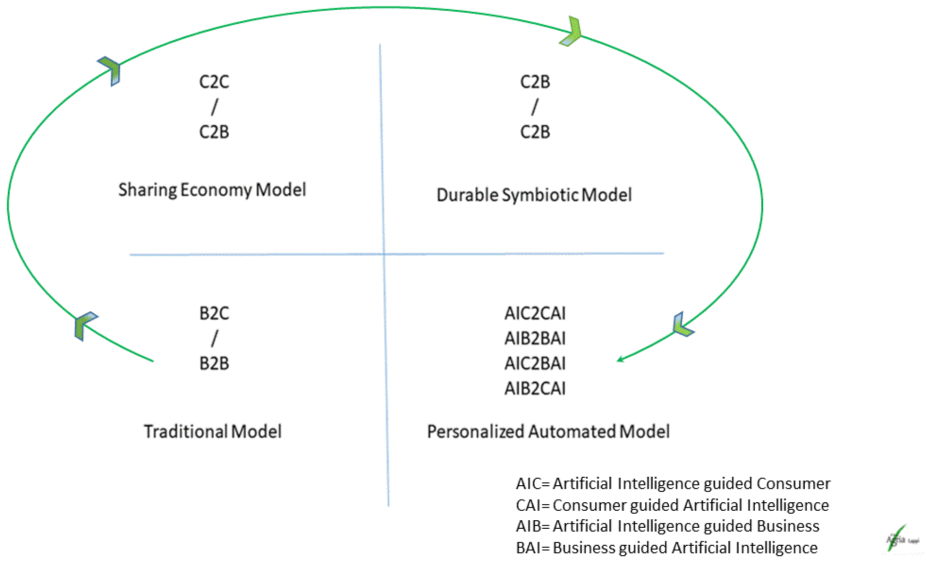

Figure 21. Trajectory for future business models, Siitonen (2018).

In order to function, the bioeconomy requires a decentralised centralised model. Distributing production and creating hybrid models locally can create sustainable energy solutions and sustainability in business. The potential of the circular economy provides excellent opportunities to replace current energy use. Agriculture holds great potential here. The criterion for sustainability create a new economy because business needs to be re-thought.

Along with the development of digitalisation and automation, there are symbioses that complement each other. These are not static but dynamic organs that adapt to existing demand. Networking creates significant flexibility and the opportunity to take advantage of both the consumer and business resources. The sustainable symbiotic business model is particularly significant for small and medium sized businesses, because centrifugal consolidation strengthens the business of other businesses where consumers can be part of the chain.

Energy solutions can be implemented jointly and this stabilises their impact on business. Technological cooperation creates new innovations and sustainable solutions. Skills and manpower can be used for the common good. Symbioses are able to jointly create new service solutions that are tailor-made for their own needs. A sustainable symbiosis model is the solution model for a sustainable bioeconomy business where the roles of consumers and businesses can vary at different stages of the process. Significant stability and success are supported by the digital solutions of the platform economy and the potential of automation and robotics. Symbioses should be formed by agile innovators. Smart sustainable symbiosis is a potential winner of disruption to the current food and energy model. Challenges to this business model lie in the attitude towards self-employment and the deep rootedness of mutual competition.

Artificial intelligence, new platforms and the industrial Internet as well as data repositories will be found in the everyday lives of consumers and businesses in the near future. Likewise, there will be a whole new chain of food and energy production and different business systems. Integration of machines and equipment as well as various platforms will become involved in day-to-day operations. We are part of a virtual and automated system. Similarly, the way in which the different actors in the market act on the market is changing. Everything comes into production and consumption in its own way. Consumers and companies interact with each other via interaction between machines, software and digital environments. Today, like an Airbnb model, a home-based restaurant idea is already being implemented among consumers. The scenario for the near future may be a refrigerator that, at the owner's request, checks the food requirements for dinner and stores them in a virtual shop or restaurant so that a cold robot supplies the refrigerator at an agreed time to the customer. The refrigerator informs the owner of the order. Food is personified according to the needs of each user and health applications provide suggestions about the composition of different meals. Consumers make transactions with artificial intelligence and recycle or exchange services or goods. Consumers and businesses are globally in different forms with each other in exchange. Things are changing radically.

The development of digital, automation and artificial intelligence creates new possibilities to change business models in the whole production and marketing chain. Digitalisation change behaviour of customers and business companies.

Sustainability of the digital transactions and production chain is a challenge to everyone in business but it will be forced to do. Sustainability must be taken into account in digital business models also. To make business sustainable is a difficult challenge, because it will bring additional cost, endangers the current business model and earning and, also, endangers the current position on the market. Unsustainable production should always be more expensive than sustainable production. Now, to produce unsustainably is many times cheaper than produce sustainably. Even though, it is often risky in terms of food or energy security.

Climate change requires taking responsibility by everyone. However, the most important role is loaded to the supply chains of materials, energy and food, and their producers. The climate change has to change a mind-set of business owner very quickly. Maybe the only way to do this is regulation or setting of different fees or taxes.

At the same time with the large scale of digitalization, the labour market change and also bring new models of entrepreneurship. All these changes are threats and opportunities. To support smart way transformation locally and globally needs more investment to research, development and education and especially for small businesses.

7. Conclusions

During this follow up project, the green economy modelling with different green economy indicator selection process that started in previous project (Timonen at al. 2017) was completed. The indicators were presented as local level indicators based on regional scale features for Lapland. The aim these indicators is to measure and verify the green economy transition process in the area and therefore these indicators are eventually meant to be utilised during the whole period of the green economy transition process (e.g. from the present time to the target state).

The development work on the indicators was complemented with a more clearly defined green economy framework, with three green economy paradigms (resource efficiency, ecosystem resilience and social equity) as well as by using a more comprehensive sustainability perspective taking into consideration social capital, ecological and economic dimensions. Additionally, the indicators for the food and energy system were complemented with tourism system indicators, including measurements of cultural ecosystem services and provisioning ecosystem services. In addition to these system level indicators, socio-demographic indicators at the overall area level were defined and are reflected as green economy system level indicators in order to understand the green economy effects on the area's growth transition process. Furthermore, preliminary development work on a new bioeconomy perspective was started by developing symbiosis indicators between energy and food systems, as well as including tourism system indicators matching the synergies between the area level ecosystem and its boundaries.

For the energy sector, the main aim for these indicators was to measure the energy self-sufficiency potential of the area by substituting imported fossil energy with self-produced renewable bio-based energy. Indicators showed all the energy that was used in the case villages could be produced by the raw materials available in the village area. We started to develop indicators for the forest ecosystem services because forest wood as a provisioning ecosystem service, harvested through forestry is traditionally the easiest to assess and to measure. Furthermore, these are among the most central resources in the examined case areas in Lapland.

After the capital flight due to the purchase of fossil based energy has been reduced and the investment costs for the new energy production plant have been covered, the area's potential for self-sufficient food production and further processing will be developed. The potential for this transition process is to be measured with the developed food system indicators, taking into account local food production as well as ecosystem services as sustainable food provisioning services.

For the tourism indicators, a measurement framework was developed that measured the demand and supply for tourism within ecosystem boundaries and taking the ecosystem service perspective into account. This provides a novel set of indicators and many of ecological and social indicators were calculated. However, many of the actual indicator calculations were not done and were not possible to complete due to the lack of local data, the immaterial nature of the services (e.g. experiments and mental benefits due to recreational services), subjective perception and also multiple nature based tourism concepts and interpretations. Sustainable tourism should also maintain a high level of tourist satisfaction and ensure a meaningful experience for the tourists, raising their awareness about sustainability issues and promoting sustainable tourism practices. Fulfilling the growing demand for tourism requires the respect of ecological boundaries of the areas especially in Lapland's delicate ecosystems.

Co-ownership in rural areas is often based on shared nature and community resources, exploitation of side streams and waste streams of businesses, farms and households, and the creation of a sufficiently large unit for the market. In Finland, we have examples of such as the Joint Forest coalition, which are intended for the sustainable pursuit of forestry in favour of shareholder facilities. Joint Forest coalitions consist of private individuals and farms and do not have a public-law nature or bear any similar such obligations (Yhteismetsät 2018). The operations in these joint companies or networks are based on mutual trust or critical mass, and are further organised into the Agrohub through corporate structures. The purpose of cultural co-ownership is to preserve the community language, identity, traditions, music, heritage and customs. In addition, digital joint ownership creates the foundation for success as a community and strengthens the businesses in the community. This digital joint ownership is lagging behind in Lapland and its potential has not yet been widely exploited. Farmers in micro-communities are not just primary producers of food raw materials, but play an important role in the development of other business activities. Farm capital outflows are a key part of the energy production process and without them, the profitability and competitiveness of other food products would not be possible.

For example, joint energy production will reduce the costs of farm inputs in the integration of energy processes (energy and fertilisers). This will reduce emissions through the circulation of waste streams, eutrophication, and the overall water consumption. In addition, farms allow the production of competitive energy for other companies. The challenge for farms is the industry’s desire to control the use of primary materials. Current chain studies and the unilateral use of materials do not support a broad readiness to change.

Farming is facing a strong and multi-level technological transition. Potential could be found in particular through automation, robotics, digitalisation, sensors, virtual reality imaging, renewable energy production, and the development of new community-based ways of working. The ability of large and small players to reach the same markets will converge. Legally, we strongly recommend securing opportunities for small businesses alongside sustainability. Raw material producers should be allowed to sell their raw material to whomever they want without the restrictions of the chain agreement or without fear that his raw material would not be bought. Without raw material competition, the vitality of primary producers is maintained and defended only by the producer price.

Farms should be divided into at least three different development sectors. Firstly, primary producers focusing on pure production and industrial raw materials, secondly primary producers focusing on further processing or short chain production, and thirdly, new producers of new raw materials and proteins. Examples of these could include industrially manufactured primary raw materials produced without farm animals. Insect cultivation would also be another way to continue farming, and these biomass producers could work in symbiosis.

Sustainability and ethics are competitiveness-enhancing values because they would help to export foods to the international markets as widely as possible. Strategically, weak profitability should be tackled by production through integrated symbiosis and the international market, as has been the case in the Netherlands. Securing small-scale production through legislation is indispensable. Small players cannot compete with large global players. These aspects should be taken into account in the subsidy legislation. Energy production, as well as meat or milk production, and the processing of food require support for small producers, and micro-environments need higher support levels and easier access to the markets. For example, electricity production has been made impossible for small producers due to barriers to business entry. This has been reflected in the equal treatment of small and large operators; even though it is not only about electricity production but through intelligent electricity grid to build new services and enable automation and robotics to land in rural businesses. Similarly, energy production in farms should be supported by higher investment rates because it is far more economical and efficient for society to support agricultural risks. Preservation of ownership through local decentralisation is important, especially for raw materials. The competitiveness of co-operative activity does not lie in the volume of production but concerns the wise use of proprietary production factors, which generate superior price competitiveness as technology advances, e.g. 3 D printing.

Current incentives will not reduce carbon emissions sufficiently. If the taxation on business was to shift from the collection of VAT to the collection of taxes on carbon emissions for the whole business, the unnecessary transport of goods would be reduced and corporate profits would no longer be based on the unsustainable use of raw materials from the nature.

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Appendix 1

SWOT -analyses for Saija

Saija: politics and legislation

Vahvuudet S=Strength	Heikkoudet W=Weaknesses	Mahdollisuudet O=Opportunities	Uhat T= Threats
The present policy guidance is aiming towards renewable energy utilisation and regional development	Short-term focus in policy making: the next election period may not have/continue same development programs and financial support especially concerning policy guidance on natural products, energy policy, fertiliser disposal	EU politics is far enough away	EU policy, which smooths out the different regions, while emphasising the special features of the regions
The aim of policy making is to make good decisions and promote the equality of people	The needs of the forest industry are prioritised, how do we combine different interest of several actors?	Finnish civil service culture (openness, easy approach, desire to make good decisions (basic processes encourage inclusion)	Basic processes for participatory planning process exist but practices do not allow and utilise large-scale participation (lack of time, money)
	Civil society - how to enable participation close to local people?	It is possible to change politics	

Saija: economy

S=Strengths	W=Weaknesses	O=Opportunities	T= Threats
Seed financing for planning, investment allowance is possible (30-40%).	Due to location, there is a low collateral value for investments.	Big cowshed investments enable raw material production and further processing	If there is no funding, it will not be possible to proceed with the plans
	How does the chain's own brand affect small entrepreneurs?	Increasing support opportunities will help increased investments	Raw material availability? (what will happen to the product if the raw material coming from reindeer is replaced by beef?)
	Tekes does not support farming.	New business opportunities enable jobs and living conditions.	Prohibiting of wood chip use?
			The decline in population will affect the potential of the municipality to support the village.

Saija: social

S=Strength	W=Weaknesses	O=Opportunities	T= Threats
There are families with children in the village	Conflicts? Disappointing confidence?	New forms of action have the potential to increase co-operation in the corporate interface, in particular.	Conflicts? Developing plans are perceived as those that only drive a small number of interests, so it does not motivate joint cooperation.
The tradition of co-operation, trust networks (with a few key persons good networking))	Fatigue and lack of time (the same people are involved as active actors). The number of inhabitants is declining.	Potential players are available - activation. Potential returnees.	Demographic decline. Unfavourable demographic and economic dependency ratio.
An active developer set,	Do you have the necessary	Expanding knowledge by	No interest or ability to

lots of activities and events. There are residents in the village, including families with children.	new skills? Does this be dependable on few individuals only?	opening new openings. Innovative food processor drives with the other operators.	improve skills (training provision). An individual entrepreneur cannot create a major drift.
For example, know-how is related to food processing. The food processor has good networks, e.g. restaurants and cooks.	Currently, one active, innovative entrepreneur.	Extending business activities The image of rural industries.	Finance, courage, lacking expertise. The image of rural industries.
Existing entrepreneurship	Currently, one active, innovative entrepreneur.	Extending business activities The image of rural industries.	Finance, courage, lacking expertise. The image of rural industries.

Saija: technology

S=Strength	W=Weaknesses	O=Opportunities	T= Threats
Basic technology exists and warehousing technology's strong development work going,	Competence concerning new technologies (e.g. digestion plant or hydrogen expertise)	Using different technologies to utilise different resources (it is possible), technological development is an opportunity	Competition between technologies (different technologies utilise different resource resources while using the same technology to make full use of all resources).
Resources exist (financial and expertise	Understanding of resources, funding base	Resources available for more efficient use e.g. separation of bio materials from processing residue/raw material, processing, merchandising, processing of fertiliser and its enrichment.	
People are ready to move towards renewable energy generation	The difficulty of combining the various forms of technology (they do not “talk” to each other)		
There is active farming in the village	Lack of standards and control systems		
Technologies undergoing trustworthiness experiments abroad		Construction of control systems	

Saija: environmental

S=Strengths	W=Weaknesses	O=Opportunities	T= Threats
UPPER LEVEL			
Vast resources in Lapland Plenty of production services: Forest, berries, game, firewood and industrial wood	Lapland is a very sparsely populated and modern welfare requires different commodities, products and services so that life is sufficient for modern people	Own energy and food production Eco tourism Focus on fractions whose exploitation would lead to low-carbon energy production and lead to multi-faceted use of resources Raw material sources for renewable energy are being processed: forestry and forestry by-products streams into wind-flowing	Unsustainable production and finite resources More and more players may become involved, and strategic raw materials may be contestedat a technological, economic, legislative and political level. Renewable sources of energy must not compete with reuse. Fossil energy may not be not replaced by renewable energy and emissions are increasing.

		water household by-product streams	Energy production is maximised through natural products. Attention is only focused on maximising the strategic raw material reform. Bioenergy production may not replace fossil energy so emissions may grow
Material ecosystem services, i.e. production services.	Delicate arctic environment		
Saija forest resources in the area are large. Saija Land Register Village has a forest area of approximately 16,000 hectares. A growth of about 35,000 solid cubic meters a year. The current decentralised private forestry has acted as a guarantee of balance between public and private.	The sensitive arctic Saija region. Unproductive forests material flows. Making the potential challenging permits and financing. At present, energy is the largest cost item. Part of the biogas production is limited (know-how).	Sustainable farming in the village. Sell-sufficiency of biogas is a major contributor to many things. Raw material for forest-friendly side streams (Energy wood and side locks account for approximately 25% of the total growth of the stock, or about 8700 solid cubic meters per year)	Unsustainable production. Termination of resources in progress. Processed to be easier to recover and to produce lesser greenhouse gases. Fossil purchasing energy is not replaced by renewable self-sustained biogas and the area's emissions are increasing.
Scrub land Potential sources of biomass and the use of suitable plants increase the potential of biomaterials and energy production.		The use of barge offers a wide range of opportunities Self-sustaining bioenergy is a great opportunity for many things to do	Do not compete with food production
	No water power available	Small-scale power is available in many of the Lapland's Villages	Renewable sources of energy must not compete with utilisation primary raw materials but are refined in agriculture, forestry, wind and flow water and household side product flows
In Lapland, solar power plants are very good sources of energy		The potential of passive energy sources such as solar power plants combined with biogas. Energy stored in winter for example through hydrogen production.	
It is in the middle of the resources needed for energy production (renewable). On the other hand, the cheap price of electricity limits the investment	Bought of fossil energy from elsewhere. There is no sufficient critical mass for the production of energy from a single area of raw materials	Small-scale power has potential on a village scale in Lapland In Lapland, it is possible to produce decentralised energy from own local raw materials Energy must be produced by combining different types of production.	Unsustainable use of raw materials for energy and the end of resources
Combination of energy and food production	Community legality. Critical mass? Energy balance, surplus, prices still need to be updated. Waste	Networks can produce valuable biomaterials, components, foods and natural products, but only if their own energy production is part of the refining process.	
7 cattle farms in Saija	Unused side streams (manure).	Manure as a bioenergy raw material	The concept of waste and side streams and the strict

	The concept of waste and side streams and strict interpretation At present, the difference between waste and by-stream is unclear and causes delays in investment projects or can even be completely rejected. Achieving potential due to challenging permits and financing. The cheap price of electricity limits the investment	Food products from livestock farming In the future, as technology evolves, more and more waste may be interpreted as bystreams which can be utilised better for nutrition	interpretation of the future Waste may not be utilised potentially
Grass cultivation is possible in Lapland	The conditions in Lapland challenge the grain growing. Conditions are challenging for non-grass cultivation for feed. There is no potential arable land in the area, except for old parcels that are not currently in productive use	Old unused field plots for productive use? Addition of greenhouse cultivation and self-contained food production. Utilisation of self-sustaining bioenergy in greenhouse cultivation	Utilising fossil energy in greenhouse cultivation. The production of energy crops must not compete with the use of arable land for food production. Renewable sources of energy must not compete with reuse.
Wild berry yields.	Utilisation of berry yield as part of the multi-use forest (tree, energy tree, forestry side streams, recreational services, ecotourism).	Increasing the utilisation of berries as part of the multi-purpose forest. Good for blueberries are left with logging pots and decaying wood, providing habitats suitable for pollinators and ensuring the success of berry harvest.	Impact on the ecosystem and other species? It is a threat that utilisation of berry picking services will not be taken into account in utilising forestry side streams.
Natural Matsututake mushrooms grow on Saija's ridge .	Factors affecting the occurrence of fungus and their promotion are not yet known (Luke has currently on a research topic)	Enhancing the cultivation of the Matsututake; especially appreciated in Asia.	Impact on the ecosystem and other species? The utilisation of mushrooming services should continue to be taken into account in the utilisation of forestry side streams.
Reindeer husbandry Organic pasture rotation.	Wild predators are a challenge.	Reindeer chips, the product is valuable the product family is extended to other meat	The preconditions for reindeer farming may be threatened by the impact of competing land use for pasture land as well as by the strengthening of predator populations.
The total annual catch of professional fishermen is over 600,000 kg Employment: in the inland waters of Lapland there are 74 fishermen registered in the professional fishermen register.	There is no predicted catch potential for sea fishing since sea fishing is not economically viable	Sustainable fishing does not permanently undermine the reproduction of fish and does not cause other long-lasting disadvantages	Unsustainable fishing
An active hunting club			
Intangible ecosystem services			
Cultural services (e.g. museum, village history/culture) Refreshing and experimental services		Ecotourism	The unsustainable expansion of tourism

Salla Fell The village of Saija has consistently developed the village and its comfort			
Landscape value, landscape area Saija's landscape area was established by the decision of the Environmental Centre of Lapland The creation of landscape areas is free of charge The village has actively participated in the management and use plan No land-use or forestry restrictions have been recorded in the landscape area.	Delicate arctic environment Consideration should be given to the importance of landscape value and recreation as part of a forest or field ecosystem.	Sustainable expansion of recreational services Potential of ecotourism	The suffering of a sensitive ecosystem
Maintenance and regulatory services: Maintain production/return on material production services 1. carbon footprint of forests 2. Forests water recycler 3. Air pollutant 4. Disposal of emissions Important water basins exists in Saija	The impact of the utilisation of ecosystem production services on maintenance and regulation services Consider how the utilisation of ecosystems affects maintenance and regulation services Consider how to use multi-shape or nutrient and water circulation (Saija's important groundwater basins) if these areas are to be utilised.	Sustainable use and safeguarding the return on production facilities in the future Responding to climate targets and emission reductions	Unsustainable use of forests Assessment of the utilisation of ecosystems on maintenance and regulation services How will biodiversity or nutrient and water circulations (important water basins in Saija) occur if these areas are to be exploited?

Appendix 2

PESTLE/SWOT –analyses for the village of Nellim

Nellim: politics and legislation

S=Strengths	W=Weaknesses	O=Opportunities	T= Threats
Policy guidance on granting co-financing, a decision to grant aid Municipal business policy The goal of politics is to make good decisions and promote people's equality	The logic of improving workplace benefits, which is to reduce working hours Labour law, opportunities for local agreement (we have to go through work security/legislation so that we can make progress even if we are flexible in terms of legislation on the other hand) Racking-is not allowed now	EU policy far enough away. Finnish civil service culture (openness, easy approach, desire to make good decisions (basic processes encourage inclusion) Dead wood fields	EU policy, which smooths out the different regions, while emphasising the special features of the regions The Arctic Sea cost?
The goal of politics is to make good decisions and promote people's equality	Policy guidance on natural products, energy policy, fertiliser use - definition of waste, civil society-how participation is brought closer to local people	It is possible to change politics?	Basic processes for inclusive planning exist but there is no way to practice and take advantage of broad-based participation (time, money).

Nellim: economy

S=Strengths	W=Weaknesses	O=Opportunities	T= Threats
Seed funding existed: coarse financing 60 % and the rest as the state loan of 40 % (as a result of wars shrubs moved here from Petsamo) basic investments came to Nellim from this, otherwise the rural financing, ERDF funding, risk-taking capacity	Lack of capital and financial resources (no venture capitalists in rural areas)	Subcontractors enter into new businesses, short chains for food	Can small producers be protected if the price of fossil fuels falls? (required for policy guidance) Unilateral production of farms and contracts, no possibility of selling to outsiders
The economy built the customer base above, sold in advance and then built only		Improving authenticity and increasing value added	
Support services of the right size (small restaurants, group travel - not single night stays) Competition for tour operators, not selling on an exclusive, demand-driven basis, the value of place/experience			

Nellim: social

S=Strengths	W=Weaknesses	O=Opportunities	T= Threats
Link to place (legitimacy)		Business expansion from local approval	Envious behaviour
Co-operation with the region's stakeholders (buying services, purchasing local products, employees).	Local supply (human resources) does not fulfil the demand during the high season.	Specific tailor-made training enables qualified staff (e.g. school guides) There is also the potential to increase the use of local products if only the supply is increased.	Obtaining skilled personnel

The neighbourhood (reindeer husbandry) shares the same values with respect to business acceptability.		Business expansion by local approval.	Continuity of values in the next generation? Understanding/willingness of local residents to understand the needs and wishes of the customers of the tourist centre
Good networks (domestic and international), years of cooperation with tour operators Collaboration with several tour operators Co-operation with other entrepreneurs	There is no co-operation with the other large entrepreneur in the region	Possibility to lengthen the high season from spring and autumn The potential of corporate co-operation with other entrepreneurs in the region	Problems and ambiguities in the activities of other tourism business operators may also be reflected in other activities
Company experience, environmental awareness understanding of nature values, brute values, customer segments courage and faith in your own eye (selfishness) is made against the mainstream (before only ski resorts are allowed) communicating with customers right-to-side sparring from the right (ask for berry-picking berries from host and mother) Paying local people Networks (with a few key people in good network) Listening to your customers and understanding their experience- this is the most important aspect that is moon-tele and know your own customers Reindeer herders share the same values as entrepreneurs Legitimacy for village development (local developers) Wood construction supports local expertise and materials (except for cottages made of weathered snag wood)	Building authenticity?	The question of authenticity or the authenticity of the physical environment is questionable (reindeer herding one big pasture and reindeer grazing in this environment, the amount is regulated – Hänninen owns 60 % of local reindeer) New legislation facilitates wood procurement	New locations in Inari, Levi, Nangu, add more customers Reindeer Hänninen's genome-knee-shift-shares the same values with the father?

Nellim: technology

S=Strengths	W=Weaknesses	O=Opportunities	T= Threats
Basic technology exists, strong development work of storing technology in the menu, resources existent (financially-available) + expertise in the home country) ready to move towards renewable energy generation, active farming in villages, technologies have reliable-to-hop experiments in foreign countries	Competence in relation to new technologies (e.g. digestion plant or hydrogenation), understanding of resources, funding base, the difficulty of combining different forms of technology (they do not talk to each other), the lack of standards Lack of control systems	Using different technologies by using different resources (it is impossible), technological development is an opportunity, access to resources for more efficient use, separation of biomaterials from waste management/raw material, processing, trade refurbishment, processing of fertiliser and its refining	Competition between technologies (different technologies are utilised with different resources, with the same technology being used to make full use of all resources); The end of agriculture unprofitable loss of know-how
		Construction of control systems	

Nellim: environmental

S=Strengths	W=Weaknesses	O=Opportunities	T= Threats
Scale of Lapland			
Resource in Lapland There are a ,lot of production services: forest, marl, game, firewood and industrial wood Unique environment Cultural services: experiences	Delicate arctic environment Lapland is a very sparsely populated area	Self-sufficient production of energy and living materials Eco tourism Utilising intangible services New road The Arctic Sea, ecological tourism?	Attention is only focused on maximising tourism More and more players will become involved, and a strategic raw materials will be fought over at a technological, economic, legislative and political level Unsustainable use of cultural services, maximisation of tourism, local resources may run out The utilisation of bioenergy in the area does not replace fossil energy, with the threat that emissions will increase Growth in general and growth of the mining industry, growing demand for critical metals http://www.gtk.fi/geologia/luonnonvarat/metallit/ The Arctic Sea, nature and reindeer herding
Material ecosystem thematic services i.e. production services			
Production services abundant: forest, berries, game, resources in the area The most critical reasons why village activities are advanced include: good trust and good reputation for the owner/founder Feedback surveys -> 5 star feedback mostly, meaning customer satisfaction is good Nellim open all year. Groups also in summer.	How can multipurpose use of the forest be guaranteed? It is challenging to utilise the natural resources of the Nellim region in full respect of the demand, for example in a restaurant or similar. This cannot be covered by the production fleets of the region In the Ala carte list you can offer the region's food but most of the rest comes from Kesko Reindeer products are local The hills are picked up by themselves	Accommodation facilities close to "clumps" In fact, Nellim will no longer be expanded ... A detached house is coming near We get Nellim's blind folders kept here when they are held all year round. Animal services are bought from others because animals do not want to buy their own Reindeer and fish come close	
Reindeer meat Precise control of how many reindeer can be in this area, 60		Sustainable production and regulation of the reindeer economy through regulation,	Future generational change may lead to conflict (from a business point of view), e.g. starting a dog-kennel busi-

% of reindeer herding is in the hands of one of the reindeer herders Particularity in the area		To replace the reindeer husbandry and the dog-reindeer operations with other functions, such as therapeutic activities and symbiosis?	ness?
Beef	Reindeer meat production growth in relation to cattle? Growth of beef value? Big beef cattle. in relation to the increased price The effect around the euro will fall, but it is not known whether consumption will continue to rise while still rising and falling from another product category? "Rebound effect?" Social added value?		
Fire wood	Fire wood from close surrounding		
Industrial wood, construction Authenticity Environmentally-friendly construction, snag wood, customer demand It is heard and appears to be part of the environment The idea is that the experience is built around the accommodation and the accommodation is built to support the experience Other hotels are based on the same principle, the same material ideas, decorations are little changed by era, but the principle is the same	Snag wood is not locally produced. No possibility for Finnish raw material: Snag wood is protected in Inari. Due to the legislation, it is not possible to produce snag wood. Raw material from Russia, supporting the local workforce there. The operator? Sustainable? Zero transparency? The logboard all the dents, if you build a double layer, you should not make the wood.	The following items for the construction of wood and timber elements (Levi, Nangu) Demonstrational construction for a visual environment is in line with customers' demand It is heard and appears to be part of the environment The idea is that the experience is built around the accommodation and accommodation is structured to support the experience New regulations for wood-building in travel, fire regulations will be renewed in 2018	The utilisation of domestic production in the future will not be possible? The raw material purchased from Russia is not sustainable.
Location Protected area in Inari In Eräkylä customers have certain routes, designated fire places, snowshoes protect, with Metsähallitus agreed that they can make a leash with the inheritance There is no contradiction with Metsähallitus With the Reindeer husband in good agreement, dogs: with them, the program is devel-			Changes in the policy of Metsähallitus

oped together and get it from tourism There are no reindeer rides because it requires training			
Immaterial ecosystem services			
Cultural services: Recreational and entertainment services Attractions: Orthodox Church Husky farm Safari-house Lapland is a very sparsely populated area	Nellim is off the beaten track In the summer, there is little activity customers are staying one night late People cannot easily leave Nellim (Finns in summer but foreigners almost only in winter)	463/5000 Owners could intensify their expansion to Inari in order to provide year-round activities Extending ecotourism Sustainable expansion of the boutique hotel: night spots could extend to small clusters of nearby surroundings Restaurant on the beach of Inarijärvi Other villages are small and fragmented around Lappi (Inari hotel 2016, Levi hotel 2023) Customers want to experience the "EAS experience" and thus set the boundaries for enlargement	The unsustainable expansion of tourism unsustainable use of natural cultural services The suffering of ecosystems
Landscape value, landscape area Wilderness tourism Northern lights Unique environment Abundant resource resources Understanding the values of nature Understanding the nature of the brand Nellim is the most popular nature travel destination in Lapland (the second?) And hotel (source: TripAdvisor). Is the dumbbell then the first one? 40,000 tourists per year (other than just Nellim calculated here cannot say a lot) High season, Inari Finnish summer,	Delicate arctic environment Consideration should be given to the significance of today's semaphore and recreation as part of a forest or field ecosystem	Sustainable expansion of recreational services The potential of ecotourism and the expansion of activity/ecosystem services	Affliction of the sensitive arctic ecosystem and landscape Unsustainable exploitation of the natural value of the landscape
Maintenance and regulatory services: Maintains production/return on material 1. carbon footprint of forests 2. forests water recycler	Impact of the utilisation of ecosystem production services on maintenance and control services Consider how the utilisation of ecosystems affects maintenance and regula-	Sustainable use and safeguarding the return on production services in the future Responding to climate targets and emission reductions	Unsustainable use of forests Evaluating the effects of utilising ecosystems on maintenance and regulatory services How is biodiversity or nutri-

3. air purifier 4. disposal of emissions	tion of services Consider how biodiversity or the nutrition and water cycle can be used if these areas are to be utilised.	 The village of Nellim is used only in winter, so ecosystems are not as burdensome as in summer use	ent and water rotation if these areas are to be exploited?

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