Sharing the doughnut

Exploring sustainable and just futures

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Title: Sharing the doughnut[1] – Exploring sustainable and just futures

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[1] The doughnut refers to Kate Raworth's doughnut economics and the notion of a safe and just operating space for humanity.

Till min vän Mats Hollander som verkade för en bättre värld i det lilla som i det stora och som gick tyvärr bort alldeles för tidigt i början på året.

Abstract

Despite decades of international discussions or summits on the need to radically reduce e.g. increasing concentrations of greenhouse gases (GHGs) or biodiversity loss, these are still rising. While these negative environmental trends continue, it is important to discuss alternative futures in an attempt to redirect society on a more sustainable and just path.

The overall aim of the thesis is to develop images of the future and explore what sustainable and just futures might look like.
The current environmental impact of Swedish consumption, both in Sweden and abroad, is shown using eight indicators of environmental pressures and resource use – illustrating where in the world the pressures or resource use occur and for which product groups. This gives us a starting point as to where we are today regarding some of the environmental challenges facing Sweden.

Alternative futures that can challenge existing unsustainable trends are explored using four images of the future – so-called backcasting or long-term transformative scenarios. All of these need to fulfil two environmental and two social sustainability goals and do not rely on continued GDP growth.
These images represent different strategies to reach the four selected goals.

Such strategies may however have different consequences not just for these four specific goals but also for other sustainability issues and may have different implications for various groups in society. Therefore, they need to be evaluated accordingly. Existing methods to evaluate future scenarios regarding sustainability aspects are discussed in this thesis as well as the need to develop new methods to encompass all issues.

A combination of methods and data is used to evaluate what it would actually mean if the scenarios were to fulfil a climate target for Swedish consumption in line with the 1.5°C. trajectory suggested as the target to strive for in the Paris Climate Agreement and in the latest IPCC report (IPCC, 2018) as regards reduction of goods consumption and altered consumption patterns in Sweden.

This thesis stresses the need to clarify the assumptions made when formulating goals such as whether a perspective on intergenerational (between different generations) and intragenerational justice (within the current generation) is considered. It also underlines the need to identify and discuss potential goal conflicts that necessarily occur when considering several sustainability goals, whether they can be avoided or require potential trade-offs. It highlights the importance of making the underlying values embedded in assessment methods more visible. The intention in revealing goal conflicts, contradictions or hidden values is not to reach consensus but to ensure that the decisions are informed and made in a transparent manner.

Indeed, these considerations imply moving from a first and rather vague level of meaning of the concept of sustainability where everyone can agree on a definition but no concrete and practical guidance can be gained to a second level where conflicts arise and values differ.

Keywords:
Sustainability goals, goal conflicts, trade-offs, environmental justice, futures studies, backcasting, future scenarios, climate and energy targets, sustainability assessments.

Sammanfattning

När de negativa miljötrenderna av t.ex. ökad koncentration av växthusgaser eller förlust av biologisk mångfald fortsätter trots flertalet internationella samtal och toppmöten om behovet av att radikalt minska dem, är det viktigt att diskutera alternativa framtider för att styra om samhället i en mer hållbar och rättvis riktning.

Det övergripande målet med den här avhandlingen är att utveckla framtidsscenarier och undersöka hur hållbara och rättvisa framtider i Sverige skulle kunna se ut.

Resultat för den nuvarande miljöpåverkan från svensk konsumtion i Sverige och utomlands presenteras genom åtta indikatorer för utsläpp av växthusgaser och andra utsläpp till luft samt för resursanvändning som visar var i världen utsläppen eller resursanvändningen sker och för vilka produktgrupper. Detta ger en utgångspunkt för var Sverige står idag vad gäller dessa miljöutmaningar.

Då radikala minskningar av Sveriges miljöpåverkan behövs, undersöks sedan alternativa framtider som kan utmana nuvarande ohållbara trender genom utvecklingen av fyra framtidsbilder för Sverige, år 2050. Dessa så-kallade backcasting eller långsiktiga transformativa scenarier måste alla uppfylla fyra hållbarhetsmål: två miljömål och två sociala mål. Dessutom förutsätter inte scenarierna en fortsatt BNP-tillväxt. De belyser olika strategier för att nå de fyra valda hållbarhetsmålen.

Sådana strategier kan emellertid ha olika konsekvenser både för de fyra valda målen men också för andra hållbarhetsaspekter och för olika grupper i samhället. Därför måste de utvärderas gentemot flera hållbarhetsmål. Befintliga metoder för att utvärdera framtida scenarier diskuteras i denna avhandling samt behovet av att utveckla nya metoder för att omfatta alla relevanta hållbarhetsaspekter.
En kombination av metoder och data tillämpas för att utvärdera vad det skulle innebära, när det gäller minskad varukonsumtion och förändrade konsumtionsmönster i Sverige, om scenarierna skulle uppfylla ett klimatmål för svensk konsumtion i linje med den i det globala Parisavtalet föreslagna ambition att begränsa den globala uppvärmningen till maximum 1,5°C som också understryks i senaste IPPC rapport (IPCC 2018).

Denna avhandling betonar behovet av att klargöra de antaganden som görs när man formulerar mål, t.ex. om ett perspektiv på intergenerationell rättvisa (dvs. rättvisa mellan olika generationer) och intragenerationell rättvisa (inom den nuvarande generationen) har beaktats. Den belyser också behovet av att identifiera och diskutera potentiella målkonflikter som nödvändigtvis uppstår när man överväger flera hållbarhetsmål samtidigt, oavsett om de kan undvikas eller innebär potentiella kompromisser. Dessa kompromisser måste lyftas fram. Den här avhandlingen understryker även vikten av att synliggöra de antaganden och underliggande värderingar som är inbäddade i bedömningsmetoder. Syftet med att lyfta fram målkonflikter, värderingar eller implicita antaganden är inte att komma överens utan snarare att se till att beslut fattas på ett transparent och medvetet sätt.

Detta innebär att gå från en första nivå och en ganska vag definition av begreppet hållbarhet som alla är överens om men som inte ger någon konkret och praktisk vägledning till en annan nivå där konflikter uppstår och värderingar skiljer sig åt.

Nyckelord:
Hållbarhetsmål, målkonflikter, miljörättvisa, framtidsstudier, backcasting, framtidsscenarier, klimat och energimål, hållbarhetsutvärderingar.

Résumé

Plusieurs décennies de discussions et une succession de sommets internationaux n'ont toujours pas permis de réduire de façon significative les concentrations croissantes de gaz à effet de serre (GES) ou l'érosion de la biodiversité. Alors que ces tendances environnementales alarmantes se poursuivent, il est important de mettre la pluralité d'avenirs possibles au centre des débats, afin de tenter de réorienter la société sur une voie plus juste et plus durable.

L'objectif général de cette thèse est de développer des images de l'avenir et d'explorer ce à quoi pourraient ressembler des futurs durables et justes.

L'impact actuel de la consommation suédoise sur l'environnement, tant en Suède qu'à l'étranger, est ici mesuré par le biais de huit indicateurs des pressions exercées sur l'environnement (par exemple les émissions de gaz à effet de serre) et de l'utilisation de ressources naturelles - illustrant à quel endroit du monde elles produisent leurs effets et pour quels types de biens et services. Le résultat fournit une description de certains des défis environnementaux auxquels la Suède est aujourd'hui confrontée.

La thèse examine des visions alternatives d'avenir plus soutenable sur la base de quatre scénarios normatifs en «backcasting», c'est à dire de transformation à long terme. Chacune des quatre représentations du futur doit remplir quatre objectifs de durabilité, dont deux environnementaux et deux sociaux, et cela sans compter sur une croissance continue du PIB.

Ces représentations ou « images du futur » constituent différentes stratégies pour atteindre les quatre objectifs sélectionnés.

De telles stratégies peuvent toutefois avoir des conséquences positives ou négatives, non seulement pour ces quatre objectifs spécifiques, mais également pour d'autres aspects environnementaux ou sociaux de la durabilité. Ils peuvent aussi avoir des implications diverses pour différents groupes sociaux. L'évaluation des scénarios doit donc tenir compte de ces impacts. Les outils existants d'évaluation de la durabilité dans les scénarios prospectifs sont discutés dans cette thèse, de même que la nécessité de développer de nouvelles méthodes pour mieux appréhender les différents aspects de la durabilité.

Un éventail d'outils et de données est déployé pour évaluer les effets pour la Suède de la limitation du réchauffement planétaire à 1,5 degrés pour chacun des quatre scénarios, en termes de réduction de la consommation de biens et de modification des habitudes de consommation. Le seuil d'un réchauffement de 1,5 degrés au-dessus des niveaux préindustriels est en effet l'objectif le plus ambitieux fixé dans l'Accord de Paris sur le climat et confirmé dans le dernier rapport du GIEC (IPCC, 2018).

Cette thèse souligne la nécessité de clarifier les hypothèses retenues lors de la formulation des objectifs, par exemple en mentionnant si on privilégie une perspective de justice intergénérationnelle (entre différentes générations) et intragénérationnelle (au sein de la génération actuelle). Ce travail met également en évidence la nécessité d'identifier et de discuter des conflits qui se produisent nécessairement lorsque plusieurs objectifs de durabilité doivent être conciliés, afin de les éviter ou d'envisager les compromis possibles. Le propos insiste également sur l'importance d'une plus grande transparence quant aux valeurs sous-jacentes aux méthodes d'évaluation. En révélant ces conflits d'objectifs, ces contradictions ou ces valeurs cachées, l'objectif n'est pas d'atteindre un consensus, mais plutôt de veiller à ce que les décisions soient prises en connaissance de cause et de manière transparente.

En effet, ces considérations impliquent de passer d'un premier niveau de définition assez vague du concept de durabilité, sur les termes duquel tout le monde peut s'accorder sans qu'aucune orientation concrète et pratique ne puisse être obtenue, à un deuxième niveau plus précis, où les valeurs diffèrent et les conflits surgissent.

Acknowledgements

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Finally! This thesis is completed. It has been a rather fascinating journey with periods of compulsive writing interrupted by a sort of writer's block every once in a while and it has given me useful insights into my own work process.

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List of papers:

Paper I: Fauré, E., Finnveden, G., Palm, V., Persson, L., Schmidt, S., Wood, R., Dawkins, E. (Submitted to Journal of Cleaner Production). Environmental pressure from Swedish consumption – the largest contributing producer countries, products and services

Paper II: Svenfelt, Å., Höjer M., Fauré E. (Submitted to Sustainability). Social justice perspectives in energy and climate targets.

Paper III: Svenfelt, Å., Edvardsson Björnberg, K., Fauré, E., Milestad, R., Van der Voorn, T. (To be submitted). Towards a multi-target backcasting approach for robust climate change mitigation strategies: A Swedish case study on an environmental assessment of climate mitigation scenarios.

Paper IV: Fauré, E., Svenfelt, Å., Finnveden, G., Hornborg. A. Four sustainability goals in a low-growth/degrowth context. Sustainability 2016, 8(11), 1080; doi:10.3390/su8111080

Paper V: Svenfelt, Å., Alfredsson, E., Bradley, K., Fauré, E., Finnveden, G., Fuehrer, P., Gunnarsson-Östling, U., Malmaeus, M., Malmqvist-Stigell T., Aretun, Å., Buhr, K., Hagbert, P., Isaksson, K., Öhlund, E., Skånberg, K., Stigson, P. (Submitted to Futures) Scenarios for sustainable futures beyond GDP growth 2050

Paper VI: Fauré, E., Arushanyan, Y., Ekener, E., Miliutenko, S., Finnveden, G. (2017). Methods for assessing scenarios from a sustainability perspective Eur J Futures Res (2017) 5: 17. https://doi.org/10.1007/s40309-017-0121-9

Paper VII: Fauré, E., Finnveden, G., Gunnarsson-Östling, U. (Submitted to Journal of Cleaner Production) Low-carbon futures for a Swedish society beyond GDP growth

Comments on co-authored papers:

Paper I: I am the main author of this paper and was responsible for the results section, the summary table in the discussion, and I contributed to the introduction and the discussion.

Paper II: I am a co-author of this paper. I was mainly responsible for the review of energy and climate targets. I also contributed to the analysis of justice perspectives.

Paper III: I am a co-author of this paper. I was responsible for conducting a literature review and collecting information on potential goal conflicts or synergies for different environmental and social areas. I also made a preliminary analysis of the goal conflicts, which was later discussed and developed together with two of my co-authors.

Paper IV: I am the main author of this paper together with Åsa Svenfelt. Göran Finnveden and Alf Hornborg were co-authors. I wrote the abstract, the main parts of the background, the method, the climate goal, the goal on distribution of power and influence in society and contributed to the discussion and to the goals on land use and welfare/resource security. I was responsible for the process of gathering information about the doughnut areas and about the selection process of the goals. I also conducted interviews with experts on security and health issues.

Paper V: I am a co-author of this paper. I was part of the development process of the scenarios by participating in the different workshops organised and in the writing of the reports describing the scenarios and contributed to some specific parts in the article relating to the goals of the scenarios and assessment.

Paper VI: I am the main author of this paper. Yevgenyia Arushanyan and I were equally responsible for the literature review. I wrote the introduction together with Göran Finnveden, the discussion part based on discussions with and written inputs from Göran Finnveden. I wrote the descriptions of tools together with Yevgenyia Arushanyan and Elisabeth Ekener.
Paper VII: I am the main author of this paper. I was responsible for data collection, calculations and for writing most of the paper with ideas, discussions and supervision from Göran Finnveden and Ulrika Gunnarsson-Östling.

Paper IV, V and VII are part of the **Beyond GDP Growth Project**, a transdisciplinary project comprising 17 researchers from different disciplines such as environmental systems analysis, future studies, sociology, urban studies, political science, organisation theory, social anthropology, economics and human ecology. The project also includes societal partners such as five Swedish municipalities, the region of Västra Götaland, the regional unit of the Swedish Ministry of Enterprise and Innovation and the Transition Sweden movement. Three case study municipalities are also tied to the project. More information from the project can be found at: www.bortombnptillvaxt.se

Paper II is part of a pre-study for **Energy futures studies for a sustainable society – a pre-study**, whose aim was to lay the foundations for a futures study of a Swedish sustainable energy system.

Paper I is part of the Policy Relevant Indicators for Consumption and Environment (**PRINCE**) Project, whose aim was to analyse the potential environmental pressures and resource use linked to Swedish consumption, both in Sweden and abroad and to quantify those with the help of indicators. The project comprises seven organisations and a reference group with representatives from different governmental agencies and organisations. The project has produced several other publications with different areas of focus such as chemicals, food production and consumption, environmental pressures development over time. More information can be found at:
http://www.prince-project.se

Paper VI is part of the project **Sustainability Assessment Methods and Impacts**, whose aim was to contribute to the methodological development and use of tools for sustainability assessment of ICT solutions and plans and future scenarios.
Paper III is part of the project **Strategies for mitigating climate change – scenarios for land use in rural areas**, whose aim was to increase knowledge on plausible characteristics of, and possible measures towards, sustainable land use in rural areas through developing normative scenarios with a backcasting methodology.

Paper IV and earlier versions of Papers II and III were part of my licentiate thesis (Fauré, 2016). Parts of this cover essay are also based on my licentiate thesis.

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1 Introduction

Emissions of greenhouse gases (GHG) and other environmental issues such as a loss of biodiversity, land-system change and eutrophication of freshwater and marine coastal ecosystems are major challenges to humanity (Rockström et al., 2009; Steffen et al., 2015). For these planetary boundaries, we have already exceeded critical levels, which may threaten Earth System stability (Ibid.) and undermine the very basis for human well-being (Hansen et al., 2013; McMichael et al., 2005; Steffen et al., 2015).

And we are not heading in the right direction. With the Paris Climate Agreement, which is one concerted effort at international level to tackle one of these pressing issues, most countries have committed to curbing climate change and keeping the average global temperature increase to "well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels" (UNFCCC, 2015, p. 3). However, the gap between the emissions reductions needed to be in line with these levels and the current non-binding national reduction pledges made by individual countries is, in UNEP's words, "alarmingly high" (UNEP, 2017) and efforts by nations need to be both much more ambitious and far more rapidly put into place (Ibid.).

On a national level, the Swedish parliament has agreed on a set of 16 environmental goals covering different areas which in most cases are to be fulfilled by 2020 (Government Bill 1997/98:145; Government Bill 2004/05:150). However, Sweden is not reaching its environmental quality objectives with the current policies (Swedish EPA, 2018).

Therefore, urgent and collective action is needed. Failing to do so could risk locking the Earth System into a "Hothouse Earth" pathway if a certain threshold is crossed and unleash uncontrollable self-reinforcing feedbacks even if heavy emissions reductions were then to be undertaken (Steffen et al., 2018). And such a pathway would imply catastrophic consequences for ecosystems and humanity.
Besides, the environmental pressures and resource use are currently unevenly spread between and within countries and some groups of people are disproportionately affected by environmental problems. Oxfam (2015) describes, in a briefing released prior to the 2015 United Nations Climate Change Conference in Paris, how climate change is "a crisis that is driven by the greenhouse gas emissions of the 'haves' that hits the 'have-nots' the hardest". The organisation has assessed the lifestyles and consumption patterns of rich and poor citizens in a wide range of both emerging and OECD countries, and estimates that the richest 10 per cent in the world account for approximately 50 per cent of the global emissions as a result of individual consumption, whereas the poorest 50 per cent in the world are responsible for only 10 per cent of the global emissions, and a majority of these citizens live in countries that are affected the most by climate change (Ibid.). Countries with a high income per capita use also

approximately five times more ecosystem goods and services per capita and year than low-income countries, and to satisfy this consumption they rely heavily on the biocapacity of other nations or the global commons (WWF, 2014). There is therefore a need to add a justice lens to sustainability goals, which is further discussed below.

In 2010, Sweden adopted a generational goal considering both inter- and intragenerational justice, (i.e. justice between different generations and justice within the same generation respectively). The goal states that "the overall goal of Swedish environmental policy is to hand over to the next generation a society in which the major environmental problems in Sweden have been solved, without increasing environmental and health problems abroad" (Swedish government, 2010). Earlier studies (e.g. Davis & Caldeira 2010; Swedish EPA 2017) have shown that a large proportion of environmental pressure from Swedish consumption as regards climate gases occurs abroad but there is less knowledge as to whether this is also the case for other emissions to air or resource use. There is a need to monitor various indicators on a regular basis, in which countries these pressures or resource uses occur and for which product groups. In that way, the issue of intragenerational justice can be considered and followed upon. In Paper III in this thesis we suggest indicators that could be a basis for such a monitoring and analyse them for a specific year.

When it comes to social issues, although some improvements have been made globally within some areas such as gender equality in education, many disparities remain both geographically and between e.g. socio-economic or gender groups (United Nations, 2015a).
Raworth (2012) has stressed the need for simultaneously considering environmental and social issues when introducing the "doughnut economy", a framework designed to ensure basic needs for all within the planet's carrying capacity and create a safe and just space for humanity. However, there is not only a need to consider social and environmental goals simultaneously, but also to identify the potential goal conflicts or synergies that may arise whether it is between different environmental goals, between different social goals or between both. The possibility of having continued growth, which has been an official policy objective in most countries (Government Offices Of Sweden, 2014; Jackson, 2009; Malmaeus and Alfredsson, 2017; State Council of The People's Republic of China, 2018; U.S. Government, 2018), has been for instance increasingly questioned, especially in high-income countries on a planet with finite resources (Daly, 1996; Jackson, 2009; Victor, 2008). Increased economic growth has historically been a driver of increased GHG emissions (Raftery et al., 2017) and a continued reliance on economic growth seems to be in conflict with the goals set by the Paris Agreement of achieving the necessary decrease in carbon emissions required to keep temperature increase below 2°C (De Koning et al., 2015; Jackson, 2009). And although increased GDP growth is still seen as a priority for policy in most societies, long-term projections suggest that a lower economic growth is to be anticipated (Alfredsson and Malmaeus, 2017). There is therefore a need to explore alternative sustainable futures that do not rely on increased economic growth, something that is investigated in this thesis (especially Papers IV and VII).

Future scenarios are often used to inform policy, to address sustainability challenges and provide alternatives to business-as-usual developments. Backcasting is a target-fulfilling scenario approach that has been suggested as particularly useful for situations where large change is needed and where current trends are leading towards an unfavourable state (Börjeson et al., 2006; Höjer and Mattsson, 2000; Vergragt and Quist, 2011). This approach would therefore be suitable to guide sustainability policies characterised by both complexity and a high degree of uncertainty. Yet, backcasting studies often focus on a single goal and Robinson (1990) has highlighted the need to assess backcasting scenarios against other sustainability goals in order to identify potential goal conflicts. This step has however often been the most neglected in the backcasting process (Ibid. 1990), but is something that is explored in this thesis (especially in Papers III, VI and VII).

2 Aim of the thesis

The overall aim of the thesis is to develop images of the future and explore what sustainable and just futures might look like.

In order to achieve the overall aim of the thesis, seven studies were conducted, the specific aims being:

- to analyse which product groups from Swedish consumption cause the largest environmental pressures in terms of emissions and resources used and in which countries or regions these pressures occur. (Paper I)
- to explore what kind of justice principles are discussed and are, or could be, applied to energy and climate targets at different institutional levels. (Paper II)
- to perform a goal conflict analysis for climate mitigation scenarios, by identifying potential goal conflicts and synergies with other environmental policy goals (Paper III)
- to select, operationalise and discuss a set of sustainability goals for Sweden for the use in backcasting scenarios. (Paper IV)
- to present the development process and qualitative content of scenarios that explore sustainability strategies for Swedish society when economic growth is not seen as an end in itself. (Paper V)
- to explore methods for assessing the sustainability impacts of future scenarios (Paper VI)
- to assess whether four specific scenarios fulfil the consumption climate goal and further develop and refine the different scenarios (Paper VII)

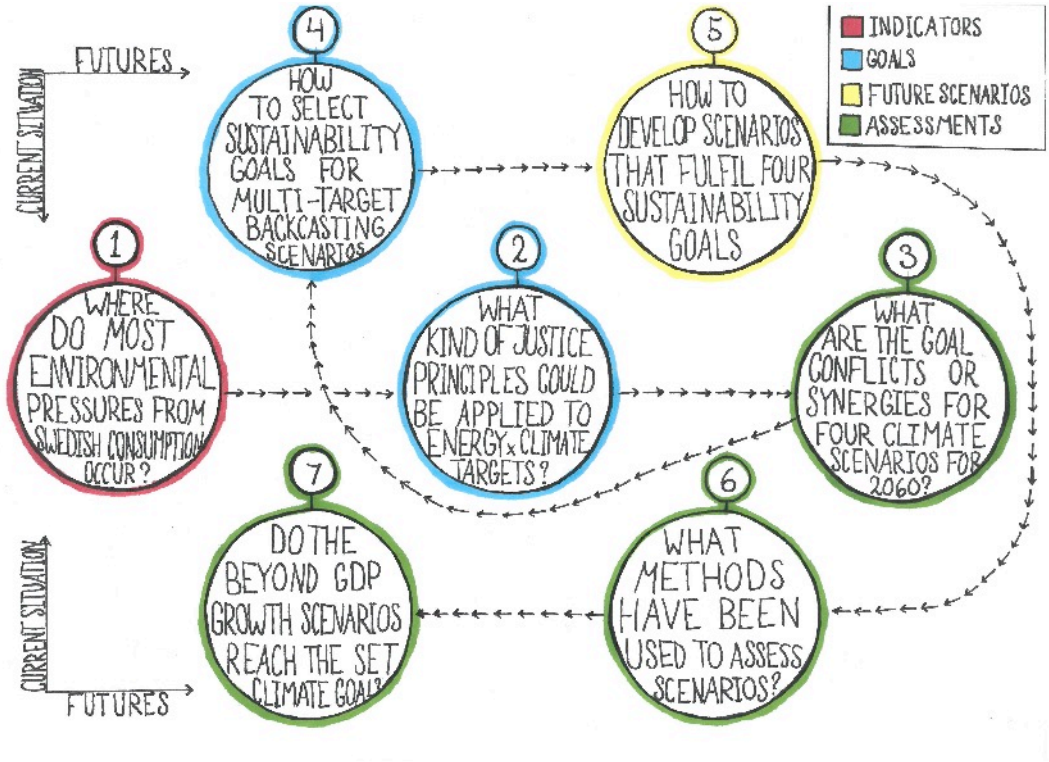

Figure 1: Papers included in this thesis

Image by Liv Elfström Fauré

Figure 1 describes steps of a typical backcasting process covered in this thesis and the different papers in order of appearance. All papers do not follow the same specific backcasting process but rather looks in detail at specific steps in different backcasting processes. In Paper I, the current status of environmental pressures and resource use from Swedish consumption is explored using several indicators. Then, in Paper II, the goal-setting process is discussed more generally in relation to justice perspectives that can be applied to different climate and energy targets at different institutional levels (from global to municipal). In Paper III, a goal conflict analysis is conducted for four "land-use" scenarios, which pinpoints the need for a multi-target backcasting process as the social aspects are more difficult to evaluate than the environmental aspects that were more in focus in the scenario descriptions. Following this, in Paper IV, the selection of four sustainability targets for multi-target backcasting scenarios is conducted and the distance to goals is discussed. In Paper V, the process of developing four multi-target backcasting scenarios and their content is presented. In paper VI, a review of existing sustainability assessment methods of scenarios is done in order to get an overview of the current state of the art at the intersection of the fields of future studies and assessments. This was done prior to conducting, in Paper VII, an assessment of the climate aspect for the scenarios developed in Paper V.

3 Background

Several central concepts are used in this thesis and are introduced below.

3.1 Sustainability

There are different meanings of sustainability. Jacobs (1999) argues that sustainability is a contested concept in the sense that it is a complex and normative concept with two levels of meaning. The first level of meaning, expressed in the form of a short definition is endorsed by many, as it is rather vague and could be exemplified with the Brundtland Commission's definition of "development which meets the needs of the present without compromising the ability of future generations to meet their own needs" (United Nations World Commission on Environment and Development., 1987).This definition has been widely quoted, probably due to its conciseness, which qualifies most of what Jacobs (1999) labels first level of meanings. At the same time, the specification of what and whose needs are to be prioritised and the reference to intragenerational equity included in the remaining text of the declaration has often been overlooked (Kates et al., 2005). The second level of meaning is more a subject of debate as it attempts to specify how sustainability should be attained in practice and distinguishes between *strong* and *weak* sustainability. According to Gomez-Baggethun et al. (2015) the sustainability policy discourse has, since the first Earth Summit in Stockholm 1972, evolved from acknowledging and addressing the conflict between environmental, equity and growth issues to a vision where not only are all three issues reconcilable but where we can achieve "growth for sustainability". The emphasis of the full text from the Brundtland Commission's declaration on "development" and economic growth has indeed been subject to criticism (e.g. Robinson, 2004; Xue et al., 2016). "By denying the conflict between economic growth, social equity and ecological limits, current conceptualisations of sustainability obscure planetary boundaries and the positional not generalisable character of developed-nation lifestyles" (Gómez-Baggethun and Naredo, 2015). Such conceptualisations are therefore considered as representing weak sustainability.
The recently adopted 17 Sustainable Development Goals (SDGs) decided by the world's governments and proposed by the United Nations (United Nations General Assembly, 2015) are the latest global attempt at defining sustainability. Although the SDGs have the merit of including both environmental and social goals and underline the need to fulfil them all, they stipulate the goal of achieving "a sustainable, sustained and inclusive growth" (goal 8), thereby ignoring the conflict raised by Gometz-Baggethun and reflecting, in my view, a weak sustainability approach.

In this thesis, sustainability is defined as strong sustainability as delimited by Jacobs (Jacobs, 1999) in the sense that it acknowledges the need to discuss and apply equity issues (paper II on justice perspectives in climate targets and consumption-based indicators and goals in Papers I, IV). It recognises environmental limits such as the

planetary boundaries for areas such as climate change, loss of biodiversity, land-system change defined by Rockström et al. (2009) and further developed by Steffen et al. (2015) that cannot be traded off e.g. with economic priorities (Papers IV, V). It adopts a broad set of concerns (both environmental and social issues in Papers IV, V, VI, VII) as we take our point of departure from Kate Raworth's doughnut economics framework (2012). This framework combines the abovementioned planetary boundaries (Rockström et al., 2009; Steffen et al., 2015) with a social foundation, with eleven "social boundaries" covering the most pressing social issues identified by governments at the Rio+20 conference, such as food, jobs and social equity, thereby building "a safe and just operating space" (Raworth, 2012). In this framework, the economy is more seen as a means to achieve other societal goals than an end in itself.

One movement that has long acknowledged the conflict between economic growth and sustainability is the political, economic and social Degrowth movement.
With its roots dating back to the 1970s and the works of e.g. André Gorz (Kallis et al., 2015), the term Degrowth has gained recognition and now represents a growing movement of both activists and researchers. The Degrowth movement is challenging the assumption that economic growth can be compatible with a prosperous life within Earth limits and advocates "an equitable downscaling of production and consumption that increases human well-being and enhances ecological conditions at the local and global level, in the short and long term" (Schneider et al., 2010, p. 511). This would entail a reduction of societies' throughput of energy and raw materials (Kallis et al., 2015). However, for Degrowth proponents, it is not a question of doing less of the same but rather of redirecting societies towards a radical transformation with e.g. new types of activities, new gender roles, a different division between work and leisure time (Ibid. 2015) and such transformations are explored in Paper V. According to Kallis et al. (Ibid. 2015, p. 9) referring to Ariès (2005) "Degrowth was thrown explicitly as a 'missile word' to re-politicise environmentalism and end the depoliticising consensus on sustainable development".

3.2 Sustainability goals and indicators[1]

Papers II, III and IV analyse sustainability goals from different perspectives. A goal "specifies an end-state to be achieved" (Edvardsson and Hansson, 2005, p. 348). Successful goals are "achievement-inducing", either because they are, through preciseness and evaluability, a good support in achieving a desired end-state, or because they motivate the agent to work towards the desired end-state through "approachability and motivity". (Edvardsson and Hansson, 2005)

Goals serve as a direction or an end-state to be achieved for different actors to gather around, but there are several difficulties in setting goals. Views may diverge regarding for instance how strictly e.g. a climate goal should be dependent on the values embedded

[1] Partly based on Fauré et al. (2016)

in different philosophical views and associated scopes of moral considerability e.g. whether they are biocentric or anthropocentric (Robinson, 2004). Views also vary a great deal on *how* to reach the goals. First, goals are often set one by one, but acknowledging them together can reveal goal synergies as well as conflicts and trade-offs. This can be done by discussing potential implications of achieving one goal on a selection of other goals (Paper VII) or on a wide array of environmental goals (Paper III). Secondly, goals set on a certain scale are often difficult to translate into another scale. Nykvist et al. (2013) have attempted to downscale the nine planetary boundaries (Rockström et al., 2009) and suggested four tentative national planetary boundaries for Sweden, although the authors call for a cautious use of these due to uncertainty on data and assumptions made. Finally, goals always include and exclude different aspects, such as e.g. the issue of equity that is often excluded in environmental goals, and in particular in the case of climate and energy goals (Paper II), and which groups in society may benefit or may be affected by a certain goal or measure to reach that goal.

The use of indicators to measure and monitor sustainability has increased exponentially for nearly 30 years (Holman, 2009). Ness et al. (2007, p. 499) define indicators as "simple measures, most often quantitative that represent a state of economic, social and/or environmental development in a defined region – often the national level". Depending on whether they aggregate nature/society parameters, indicators can be either integrated and are then called indexes (such as the Human Development Index or HDI combining parameters of education, longevity and per capita income) or non-integrated (such as tonnes of CO_2 eq. per capita to monitor climate pressure or the different environmental pressure indicators used in Paper I) (Ness et al., 2007). According to Jacobs (1999), indicators play three roles in that field:

- If goals and targets are adopted in order to work towards sustainability, proper indicators need first to be designed (e.g. tonnes CO_2 eq. to measure climate pressure)
- The use of an alternative indicator to complement or replace the often-used economic GDP indicator in politics and media place a new emphasis on what should be the new goals of economic and political life if sustainability is to be a priority
- Indicators also have a communicative function in that they can be a tool to inform the wider public about a certain environmental or social issue and whether progress is made or not over time and may enable better public participation.

Integrated indicators are according to Gasparatos et al. (2008) in line with a weak sustainability perspective as they allow for trade-offs between different sustainability aspects. The issue of weighting between indicators, which Hardin (1968) qualifies as value judgements may also not be done in a transparent manner and may not be subject to discussions or arguments over values as it otherwise would have (Gasparatos et al., 2008). In this thesis, non-aggregated indicators are used to monitor environmental pressures resulting from Swedish consumption (Paper I) and to assess the "distance" to sustainability goals (Paper IV).

3.3 Justice perspectives [2]

There are different perspectives on justice, and in this thesis (Paper II), the framework of Dobson (1998) further developed by Page (2007), is used, as it offers a well-structured way to discuss justice.
Dobson (1998) combines environmental sustainability and the question of justice and addresses three questions that have to be considered when looking at intergenerational justice and intragenerational justice:
- Who are the providers and receivers, respectively, of justice, the "community of justice"?
- What is distributed, i.e. the environmental goods and bads or benefits and disadvantages that are distributed?
- How is it distributed, i.e. the principles of distribution, e.g. needs, equality, utility?
Page (2007) further developed what is to be distributed as "the currency of justice", with a focus on intergenerational justice, adding the notion of capabilities introduced by Sen (1990). This approach (Ibid.) views life as "a set of beings and doings", also referred to as "functionings". "Functionings" are e.g. the opportunity to live long and to be well nourished (Sen, 2005). Quality of life is therefore seen as the capability to function where capabilities are "the opportunity to be able to have combinations of functionings" (Ibid.). According to Sen, the same capability or opportunity might require different amounts of primary goods depending, for instance, on the physical or mental variations between individuals.

Intragenerational justice is considered in this thesis through the development of several indicators to follow up pressures and resource use globally due to Swedish consumption (Paper I), as previously mentioned and in the consumption perspective chosen when formulating the climate and land-use goals that the backcasting scenarios, developed in Paper V, have to fulfil (Paper IV).
The aim of Raworth's framework (used as a starting point in Paper IV) is, as mentioned earlier, to redirect society towards a "safe and just operating space". While the notion of the satisfaction of basic needs is widely used internationally, upper limits to consumption have not yet received the same attention (Alfredsson et al., 2018). Yet, even if Raworth only stresses the needs of those who are poorest in her social foundation, the upper limits set by the planetary boundaries would implicitly lead to a well-needed redistribution of access to resources. A prerequisite for a transition towards ecologically sustainable welfare societies, i.e. societies in which all human needs (now and in the future) can be satisfied within ecological limits, is indeed the redistribution at multiple levels, from global to local, of e.g. material resource use and GHG emissions (Koch and Mont, 2016).

[2] Partly based on Fauré et al. 2016

3.4 Futures studies[3]

When addressing socio-ecological systems and sustainability goals, it is necessary to consider the long-term character of the issues at stake and their uncertainty.
Sustainability issues require long-term planning and a way to anticipate change and uncertainty. Futures studies can offer an approach that can be both flexible and visionary.
Bell and Olick (1989) refer to Eleonora Masini's description of the role of futures research, which is rather "to reveal the alternative possibilities, and analyse the risks concomitant of these possibilities and their consequences than predict the future".
Futures studies are, according to Amara (1981), the study of possible, probable or desirable futures. Börjeson et al. (2006) discern three main categories of future scenarios:

- Predictive scenarios addressing the question "what will happen", e.g. forecasts
- Explorative scenarios addressing the question "what can happen", e.g. strategic scenarios
- Normative scenarios addressing the question "how can a specific target be reached?" e.g. backcasting.

Backcasting is a normative type of scenario, which Börjeson et al. (2006) qualify as transformative, which means scenarios that will require profound changes in society in order to reach a set goal. Robinson (1990) describes backcasting as an analysis of how to attain desirable futures. Whether futures should be labelled desirable has been however challenged as the following question then becomes: desirable for whom? (Gunnarsson-Östling et al., 2012; Masini, 2006). There are different traditions in the futures studies' field of research. Höjer et al. (2011a) provide an overview of the most important backcasting approaches and distinguish for instance between path-oriented backcasting and target-oriented backcasting scenarios. The first approach is defined in Vergragt and Quist (2011) as "generating a desirable future, and then looking backwards from that future to the present in order to strategise and to plan how it could be achieved". In this approach the emphasis is put on the pathways to the images of the futures (Höjer et al., 2011a) The second approach is described in e.g. Börjeson et al. (2006), who use instead the term target-fulfilling images of the future. In such target-oriented scenarios more importance is given to the visioning part or scenario development than on the pathways towards the images of the future (Vergragt and Quist, 2011, p. 751) but more emphasis is also put on the targets and the description of how targets can be achieved (Höjer et al., 2011a). In this thesis, the focus is more on the images of the future themselves and on analysing how well the sustainability targets are reached in the scenarios, even though it is also important to analyse what policies are needed to reach the targets, which is to some extent done within the Beyond GDP Project.
Another approach identified in Höjer et al. (2011a) is participatory backcasting, which (Carlsson-Kanyama et al., 2008) define as a process including other stakeholders than researchers from different disciplines in contrast to the "think-tank" approach mainly

[3] Based on Fauré (2016)

involving a research group. The choice of a participatory approach can be made out of different purposes and may sometimes be difficult to combine with e.g. the purpose of a target-fulfilling approach, for instance if stakeholders' views may not be radical enough to reach the targets (Höjer et al., 2011a). In other cases, several approaches can be combined. In Davies et al. (2015), for instance, pathway-oriented backcasting scenarios are developed in a participatory setting and focus on everyday practices such as heating, washing and eating. The authors label the approach as POP (Practice-Oriented Participatory) backcasting.
The process of developing backcasting scenarios in the Beyond GDP Project, presented in this thesis could be labelled as being participatory given that the Ministry of Enterprise, different municipalities, organisations or national agencies actively participated in the development of scenarios in a transdisciplinary manner (Papers IV and V).

For Dreborg (2004, p. 32), the aim of backcasting is "to find ways to shape the future in accordance with visionary goals." Another important aim, in the Swedish tradition of backcasting studies, is "to provide different actors in society with a better foundation for discussing goals and taking decisions to act or to seek further knowledge" (Dreborg, 1996, p. 824).
Although backcasting is sometimes referred to as a method (Robinson, 1990) with several steps, Dreborg (1996) argues that it should rather be seen as an approach or a school of thought in order to make the implicit philosophical views apparent. Comparing backcasting to the well-established scientific tradition of forecasting, Dreborg (1996) emphasises the deterministic view of the latter whereas backcasting would more reflect partial indeterminacy.
Typically, backcasting studies produce images of the future, which all fulfil a certain goal and have a time frame of 20 to 100 year (Robinson, 1990). Such scenarios facilitate the exploration of alternative futures that may be more desirable than the most likely future usually depicted in forecasting studies (Ibid. 1990). Backcasting facilitates a breaking of trends as opposed to forecasting, which is often based on the extrapolation of current trends (Dreborg, 1996).
The importance of imagining alternative futures has also been highlighted by other scholars such as the geographer Erik Swyngedouw (2011), who claims that, otherwise business-as-usual policies seem apolitical. In this thesis, this is explored (in Paper V) through four backcasting scenarios that do not rely on GDP growth but fulfil a selection of sustainability goals. Other parts of backcasting processes are explored by looking into the process of selecting goals (Paper IV) and methods for assessing scenarios (Papers III, VI, VII).
Backcasting scenario methodology can also be helpful in the exercise of separating goals from means. The aim of scenarios is to suggest alternative futures to the current development. However, if a backcasting scenario is to fulfil a goal that is rather a means than a goal, it could create a lock-in, i.e. constitute a barrier to considering other

possible developments than the most likely one, and the confusion between goals and means would be more obvious. [4]

3.5 Sustainability assessments

As, generally, backcasting scenarios are designed to meet one specific goal, there is a risk that the impact that scenarios have on other sustainability issues is ignored and – ultimately – the scenarios may not fulfil their purpose of helping to discuss, and plan towards, a more sustainable future. Thus, scenario assessment is a critical stage of the backcasting exercise, even if it is often, as previously mentioned, neglected.
In this thesis, sustainability assessment tools or frameworks are examined from different perspectives, e.g. indicators, sustainability matrix to highlight potential trade-offs, methods used in practice to assess scenarios and quantification of climate impact (Papers I, III, VI, and VII).
The field of sustainability assessment encompasses a plethora of frameworks and methods emerging from different disciplines such as economics (monetary tools e.g. cost-benefit analysis) or biophysical (e.g. ecological footprint) or indicator-based tools (Gasparatos and Scolobig, 2012).
Pope et al. (2004) distinguish between assessments that are baseline-led, whose aim is to reduce negative environmental impacts compared to a chosen baseline and objectives led, whose aim is to assess the degree to which a project or proposal helps achieve a sustainable vision. In this thesis, both baseline-led (Paper VI) and objectives-led (Papers III, VI, VII) assessment tools are reviewed.

Important criteria for sustainability assessments are that they ought to encompass all issues of sustainability (environmental, social and economic), consider both intergenerational and intragenerational equity, and bring to the fore, and reflect on, the values behind different methods that stem from different perspectives on sustainability (i.e. strong versus weak) and whether a reductionist or non-reductionist approach is chosen (Gasparatos et al., 2008; Gasparatos and Scolobig, 2012). Munda (2006, p. 91) defines a reductionist approach as "the use of just one measurable indicator (e.g. GDP per capita – author's comment), one dimension (e.g. economic), one scale of analysis (e.g. the municipality – authors comment), one objective (e.g. the maximisation of economic efficiency) and one time horizon", as well as allowing for aggregation between different dimensions of sustainability, through the use of an index. Complex systems, such as those addressed in sustainability science mean that there can exist simultaneous and contrasting but legitimate accounts of the same system depending on the perspective and the scientific language chosen. A non-reductionist approach would acknowledge the incommensurability of different values (i.e. that there are non-reducible value conflicts and that there is therefore a lack of a single comparability term or common measure, for instance monetary, to rank options).
Here the question of trade-offs is important and some assessment tools may be rooted in different views on sustainability. According to Gasparatos et al. (2008), Cost Benefit

[4] Based on Fauré (2016)

Analysis (CBA) for instance, is a tool based on a weak sustainability perspective as it allows for trade-offs between different costs and benefits stemming from the different dimensions of sustainability (environmental, social and economic).
The different perspectives on sustainability assessments included in the different papers of this thesis mostly focus on environmental and social issues as the economy is viewed as a means to provide sustainable welfare for all rather than an end goal.
In several papers in this thesis (Papers III, V, VI, VII), we discuss how to combine sustainability assessments with future scenarios. Dreborg (1996, p. 819) suggests that one distinction between backcasting and forecasting is that the former should be apprehended in the context of discovery rather than in the context of justification. In the context of discovery, what matters is the generation of ideas, to stimulate creativity whereas in the context of justification, the main focus lies in the demonstration of the validity of the results. The majority of assessment methods reviewed here are, similar to forecasting, best understood in the context of justification, where the focus is on the validity of results and where causality is central (Dreborg, 1996). However, backcasting studies rely both on causality and teleology (purposefulness), the latter taking into account the role intentions play in human behaviours. According to Dreborg (Ibid.), intentions are dependent on the potential options actors perceive to have and images of the future, by providing alternative visions, may impact actors' intentions. Assessment methods relying only on causality may therefore prove limited when used to assess long-term transformative scenarios.

4 Methods

In order to tackle different sustainability challenges, different types of knowledge are needed. The research presented in this thesis attempts to answer a wide array of research questions and has involved different academic disciplines. The research approach has therefore been multidisciplinary, with elements of transdisciplinarity, as other stakeholders, societal partners, have also been involved in the research process in Papers IV and V.

This chapter describes the scientific methods used in Papers I-VII that are applied to gather, analyse and quantify data. The research methods used in the thesis are mostly qualitative but quantitative methods are also used. There are many differences between quantitative and qualitative research, however, the divide has been debated and is not clear-cut.
Qualitative research can be defined, as opposed to quantitative, as being "construed as a research strategy that usually emphasizes words rather than quantification in the collection and analysis of data" (Bryman, 2016, p. 32). The methods we qualify as qualitative here are literature review, interviews, goal conflict analysis and the participatory workshops used in Papers II, III, IV, V, VI and VII, whereas quantitative methods such as the use of a hybrid model and a spreadsheet model respectively are also applied in Papers I and VII.

4.1 Assembling and co-creating data:

4.1.1 Literature review

A literature review is, according to Bryman (2016), "a critical examination of existing research relating to the phenomena of interest and of relevant theoretical ideas."

There are two types of literature reviews (Walliman, 2006) either an article compiling the current literature on a certain topic, which is what we do in Paper II and Paper VI, or a review that forms part of a research paper or dissertation (Papers I, IV and VII).
In the latter case, the purpose of the literature review differed: in Paper IV and VII, the aim was to depart from the existing knowledge in a particular field and use it as a building block in our research. In Paper I, we searched the scientific literature for studies that could be compared to our results.

Advantages of a literature review, apart from providing an overview of what has been done, are that it also helps identify key contributions within a field and possible controversies about the topic (Bryman, 2016).

Paper II is based on a review of official documents about climate change mitigation and energy goals at different levels (international, European, national, and municipal), examples of peer-reviewed articles and reports from environmental NGOs dealing with such goals, as well as peer-reviewed articles specifically about justice principles in climate goals.

In Paper VI, a more comprehensive literature overview was conducted, where the purpose was to learn from the research already carried out in the field of sustainability assessments of future scenarios.
Another research field of interest related to sustainability assessments was the planning field and the use of Strategic Environmental Assessment (SEA). SEA is a procedural method (Finnveden et al., 2003; Nilsson et al., 2005) that is specifically developed for the assessment of plans which could be thought of as scenarios. SEAs can include several types of analytical tools. Due to practical knowledge and experience from that field, a selection of SEAs of Swedish municipal plans from the Stockholm region as well as several guidelines for SEAs were reviewed.
This overview of assessment tools served as a good basis for Paper VII, in which a combination of assessment tools was used to quantify scenario narratives regarding GHG emissions.

In Paper IV, a literature review was first conducted in order to identify policy goals and suggestions for goals for a vast array of sustainability aspects. The aim of this review was to gain an overview of what goals are currently set or proposed for several sustainability areas, e.g. the issue of health, and to assess whether they could be used in our context or further developed. The literature review comprised policy documents at

the Swedish, European, and international level, scientific literature, scenario projects, and reports from non-governmental organisations and was used as a base to discuss goals in a participatory setting.

In Paper VII, we looked for relevant literature on future developments for the consumption sectors that were not covered by the research group and where rather detailed information was needed and where the statistics based on the hybrid model using MRIO (further described under 4.2.2) in the Prince Project presented in Paper III were too rough to use.

In Paper I, we looked for similar studies, i.e. studies that had used Multi-Regional Input-Output analysis (MRIO) to monitor environmental pressures from consumption for Sweden and at EU level, for GHG emissions or other indicators in order to have better knowledge of what has been done and to compare our results with previous ones.

4.1.2 Interviews[5]

Kvale (1997) defines interviews as an interaction between two persons where a common area of interest is discussed and where knowledge is the outcome of this dialogue. The aim of the interviews in Paper IV was to acquire richer knowledge of issues where our project and reference groups and I myself lacked sufficient knowledge, while having at the same time limited time to gather such information. The use of such interviews proved beneficial in order to get an overview of a field and of the main literature or policy documents (e.g. related to health). Kvale (Ibid. 1997) distinguishes between different categories of interviews, open, semi-structured and structured. The interviews used in Paper IV were semi-structured interviews, which means that some questions are pre-defined to cover specific topics, but it also allows for questions to arise throughout the conversation (Ibid. 1997). According to Alvesson and Sköldberg (2003), proponents of interviews often highlight the advantages of the method when it comes to gathering information, knowledge, ideas or impressions. Interviews were used both with selected members of the project groups and with external experts in order to gain insight into specific goal areas included in the Doughnut (Raworth, 2012) or other issues deemed relevant for the Swedish context, e.g. some issues covered by the Swedish environmental goals such as “a good built environment” (Government Bill 1997/98:145).

4.1.3 Participatory workshops[6]

In this thesis, participatory workshops were used to select sustainability areas and goals based on the literature review mentioned above (Paper IV), in the development process of the Beyond GDP Growth backcasting scenarios (Paper V) and to discuss and agree on a level of consumption for each category, such as clothes, electronics or leisure services

[5] Based on Fauré (2016)
[6] Partly based on Fauré (2016)

that were not described in enough detail in the narratives, expressed as a percentage of the current Swedish level for each scenario (Paper VII).

Mayer (1997, pp. 250–251) distinguishes seven types of participation in the field of policy analysis. The degree of participation varies depending on the aim of the participatory process, which can range from information only to co-production. According to Mayer (1997), participation can be a strategy to:

- Inform or educate stakeholders in order to increase their awareness
- Consult groups or individuals to obtain input for problem solving
- Anticipate future developments, if the aim is to develop long-term goals and future policies
- Mediate, in case the aim is to deal with strong conflicts of interests among the stakeholders
- Co-ordinate, if the aim is to create interdisciplinary knowledge and relate issues from different sectors or policies
- Co-produce, if the aim is to develop common actions and shared responsibilities
- Learn, if the aim is to change core knowledge and attitudes

Mayer (1997) adds that a mix of these different strategies is often used.

In Paper IV, the selection of sustainability goals was made in two participatory settings, within the research group representing different disciplines and within the reference groups with societal partners. In both cases, the participatory process served as a means to anticipate the future, coordinate between different sectors or disciplines, consult groups or individuals and co-produce knowledge.

In Paper V, different workshops were organised with the project group, the societal partners as well as with other stakeholders at different stages during the development process of the scenarios.

In Paper VII, the workshop was organised with a selected group of researchers within the Beyond GDP Growth Project who had all been writing parts of the scenario narratives of relevance for consumption practices and therefore had a thorough understanding of the scenarios. The participants were specialised in futures studies, time use, everyday practices and sufficiency practices. The purpose was therefore to obtain information on how consumption levels differed in the scenarios but it was also a way for the research group to gain a common understanding of what our scenarios actually meant in practice as to how much consumption was reduced in each scenario. In Paper VII, the workshop was a way of gathering input but also of coproducing the scenarios by honing them further.

4.2 Analysing data:

4.2.1 Goal conflict analysis[7]

Goal conflicts and synergies can be identified by assessing whether a certain measure aimed at reaching a specific target may at the same time facilitate or hamper the achievement of other targets.
In Paper III, a goal conflict analysis was conducted using existing "land-use" scenarios and conflicts and synergies were identified based on knowledge from scientific papers, reports and policy documents. For each goal, aspects of the goal were compared to the content of the scenarios, first individually by one of the authors, and later as discussed and adjusted by three of the authors together in a workshop format. This analysis is summarised using a compatibility matrix (in accordance with UK Department of Transport, 2009) (Table 4), included in Chapter 5 in order to document (in)compatibility between different environmental goals.

The goals chosen for the analysis were the Swedish environmental objectives. The analysis of conflicts and synergies between the climate goal that all scenarios had to fulfil and the remaining goals was first carried out in a systematic way by the author of this thesis, through:
1. Selecting the aspects in the description, specification and interim goals of the Swedish goals that were relevant to scenarios, i.e. where scenarios were descriptive enough to analyse whether there was a conflict or a synergy.
2. Analysing against the content of each scenario whether there could be a synergy or conflict between the selected goals.

4.2.2 Hybrid model and multi-regional input-output analysis

In Paper I, about environmental pressures and resource use as a result of Swedish consumption, data was analysed based on a new method, a hybrid model combining two economic tools: Swedish environmentally extended input-output (IO) tables and a type of multi-regional input-output (MRIO) model called EXIOBASE (Stadler et al., 2018), for data on what is imported into Sweden. IO tables show which transactions occur between industries in the Swedish economy and how final demand is divided between private consumption, public consumption and investments. An input-output analysis (IOA) can be used for identifying environmental impacts by adding emission coefficients to the monetary IOA (e.g. Lave et al., 1995). Results can be presented for sectors and for broad product groups. As Sweden has a lot of trade with other countries and thereby increases environmental pressure in other countries, a multi-regional input-output analysis (MRIO) allows for including trade between different regions as well as geographic differentiation of economic and environmental aspects to track the resource use or emissions from a product or service occurring in each step of the supply chain, wherever in the world they occur. MRIO therefore gives better precision as to where goods and services give rise to environmental pressure or resource use and for

[7] Based on Fauré et al. (2016)

which product groups than current Swedish statistics based on single regional input-output tables. Indeed, in current statistics, different national average emission intensity coefficients are used depending on the import country but usually assume that these countries have the same production structure as the country under study (Steinbach et al., 2018), Sweden in our case. Current statistics therefore present shortcomings when it comes to taking into account the varying emission intensities between sectors in import countries neither do they give an accurate picture of the international supply chains. Different MRIO models exist such as EXIOBASE, WIOD or Eora (Dawkins et al., submitted). In Paper III and for the Prince Project in general, the EXIOBASE model was chosen both due to the level of detail of product groups and due to its larger choice of environmental indicators (Steinbach et al., 2018). The results are for different indicators and for the whole economy divided into 50 product groups.
To analyse the data, a summarising table for all indicators was developed in order to reveal patterns in the data regarding the largest product groups and countries.

4.2.3 Spreadsheet model

In Paper VII, Low carbon futures beyond GDP growth, we use a spreadsheet model to quantify GHG emissions arising from different consumption areas such as food, transport, private consumption of other goods and services, public consumption and public and private investments for the year 2050 in the different scenarios. A similar approach has previously been used to analyse backcasting scenarios in a comprehensive manner by quantifying narratives with the help of calculations and data from external sources looking at different consumption or production areas in a life cycle perspective (e.g. Åkerman et al., 2007; Höjer et al., 2011a).
The data used comes to a great extent from current statistics from Swedish consumption, developed in the Prince project introduced at the beginning of this thesis and partly presented in Paper I. These statistics are obtained using a MRIO analysis (see previous section) to track the climate pressure from Swedish consumption along the whole supply chain. This was used to estimate private consumption of other goods and services as well as public consumption and public and private investments. However, although the statistics are useful in obtaining a complete picture of Swedish consumption, the figures are too aggregated for some specific areas such as food or transportation, e.g. when it comes to different types of meat where no distinction is made between meat from ruminants and other meat, although this has great implications for the climate impact. Effects at high altitude from air travel, something which is typically excluded in current statistics, but represents a significant proportion of the total climate impact of air travel were considered separately.
For these more specific areas, data was based on several scientific papers (see Paper VII for more details) focusing on these aspects for Sweden.
Using a spreadsheet model and combining data from literature, statistics and workshop allows to depart from current levels of GHG emissions but also to include changes in consumption or production patterns or categories needed for assessing transformative scenarios.

5 Results from Papers I to VII

Goal setting and monitoring of current situation

5.1 Paper I – Environmental pressure from Swedish consumption – the largest contributing producer countries, products and services

The aim of this paper is to examine which product groups cause the largest environmental pressures in terms of emissions and resources used as a result of Swedish consumption and in which countries or regions these pressures occur.

The indicators for environmental pressures were the following:
-emissions of GHG, Sulphur dioxides (SO_2), Nitrous Oxides (NOX)
- particulate matters (PM 10 and PM 2.5)
- use of land, blue water (i.e. "the volume of surface and groundwater consumed as a result of the production of a good or service" (Hoekstra et al., 2011) and materials (including sand and gravel, metals, fossil fuels, forest products and food in weight)
The data presented is for 2014.
Results show that for all indicators, except for land use (see figure 2), most pressure occurred abroad.

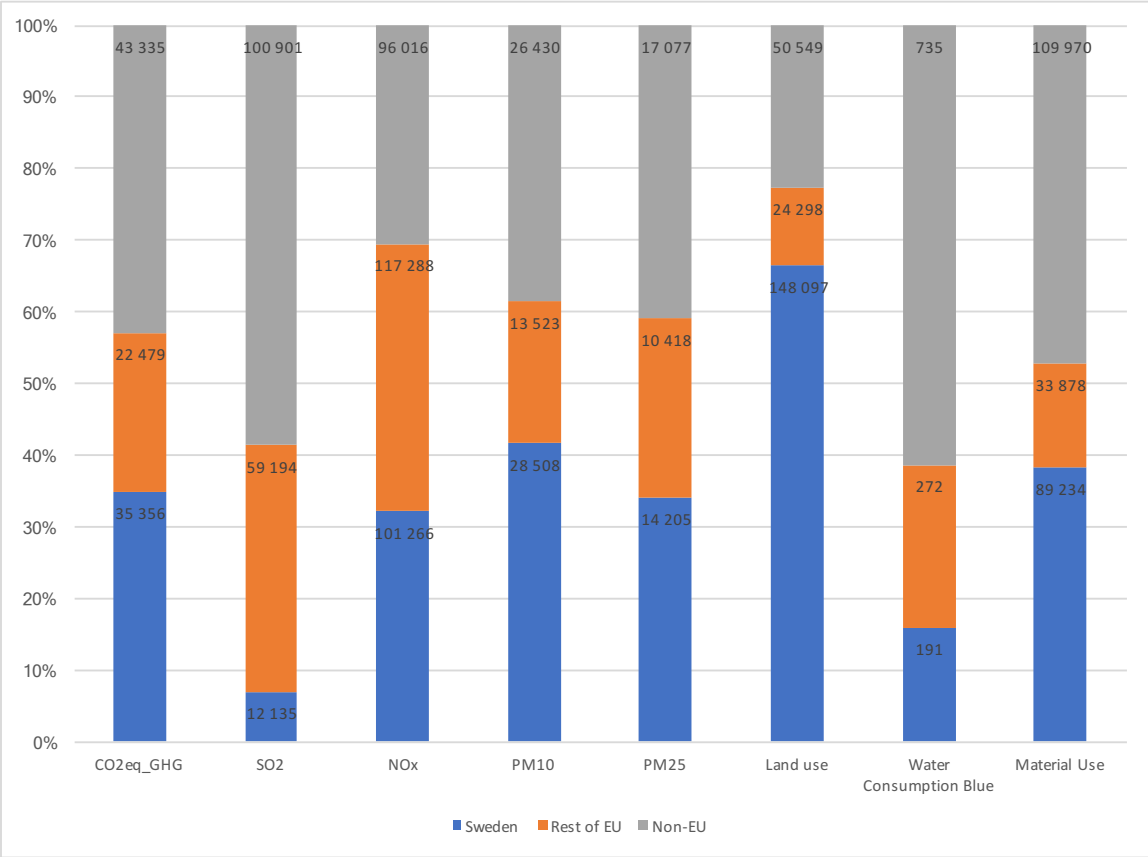

Figure 2: Pressure from Swedish consumption occurring abroad in relation to pressure in Sweden (Paper I)

However, if comparing the environmental pressures of what is produced by Swedish actors in Sweden and what is consumed by Swedish consumers (both private and public) the material use, along with land use for production is higher than that from consumption, indicating that Sweden is a net exporter of both land use and materials. This indicates that, although Sweden imports a large proportion of materials for its consumption, it exports an even larger proportion destined for other countries' consumption.

Table 1 summarises for each indicator which product groups account for the largest pressures and which is the top country (or two top countries in case two countries are very close in terms of pressure or resource use) for the specific product group and indicator. The top three product groups per indicator are shown in red, countries ranked 4th to 10th in yellow and below in green.

Table 1: Overview of largest products and services per environmental pressure and country where largest pressure occurs for that product/service (Paper I)

	Indicators							
Product groups	**GHG**	**SO2**	**NOX**	**PM10**	**PM2.5**	**Land use**	**Blue water**	**Materials**
Construction	Sweden	China	Sweden	Sweden	Sweden	Sweden	China	Sweden
Household direct emissions	Sweden		Sweden	Sweden	Sweden	Sweden	Sweden	
Food products	Sweden	Denmark	Sweden	Sweden	Sweden	Sweden	Rest of Asia-P	Sweden
Coke and refined petroleum	Russia							Russia
Electricity	Sweden					Sweden		Russia
Wholesale and retail	Sweden	China/Germany	Sweden	Sweden	Sweden	Sweden	Rest of Asia-P/China	Sweden
Architecture and engineering	China	China	China/Sweden	China	China	Sweden	China	China/Sweden
Dwellings	Sweden	China	Sweden	Sweden	Sweden	Sweden		Sweden
Motor vehicles	Germany	China	Germany	China	China			China
Machinery and equipment	China	China	China	China	China			
Furniture		Rest of Asia-P/China		China /Rest of Asia-P				
Warehousing and postal services		Germany/Sweden	Sweden					
Electronic products		China			China			
Land transport			Sweden					
Fabricated metals				China	China			
Chemicals and pharmaceuticals							Belgium/Rest of Asia-P	
Healthcare							Rest of Asia-P	
Forestry products						Sweden		Sweden
Agricultural products						Sweden	Spain	Sweden
Wood						Sweden		
Accommodation							Rest of Asia-P	
Textiles							China	

Colour scheme explained:

	Top 3 product groups with highest impact for chosen environmental pressure and largest country
	Top 4-10 product groups with highest impact for chosen environmental pressure and largest country
	Top 11 and lower product groups for chosen environmental pressure and largest country

Main product groups:

Across all indicators, most pressure comes from the product groups construction, food products and, for all indicators except for sulphur dioxides emissions and material use, from direct emissions from households. Household emissions are the emissions from Swedish households e.g. from direct use of fuels in cars or homes and therefore the impacts always occur in Sweden.

Other prominent product groups although to a lesser degree are wholesale and retail, architecture and engineering, dwellings, motor vehicles as well as machinery and equipment.

Some specific product groups are significant for resource use (blue water, land and material) such as agricultural and forestry products for the last two.

Main countries where pressures occur:
Although a larger proportion of environmental pressure occurs abroad for all indicators apart from land use as previously mentioned, the table above shows that Sweden is the single top country for not only land use but also for GHG emissions, nitrous oxides, particulate matters, use of blue water and materials.
A few other countries particularly stand out when it comes to specific indicators. China for instance is the top country for emissions of sulphur dioxides for several product groups but also for particulate matters and several manufacturing sectors (e.g. motor vehicles, machinery and equipment). Russia accounts for a large proportion of material use and GHG emissions from coke and refined petroleum. Three other countries are quite significant: Germany (motor vehicles for GHG and NOX emissions, wholesale and retail as well as warehousing and postal services for SO_2 emissions), Rest of Asia-Pacific (blue water use for food products, wholesale and retail, chemicals and pharmaceuticals, healthcare and accommodation as well as furniture for the indicators SO_2 and PM10) as well as Denmark (food products for SO_2 emissions). Spain is the top country for blue water use from Swedish consumption for agricultural products.

5.2 Paper II – Social justice perspectives on energy and climate targets[8]

Paper II reviews a selection of climate and energy targets at different scales (ranging from a Swedish municipal to an international level) and analyses whether they include justice perspectives, or whether such perspectives could be applied. Official targets related to climate and energy have been criticised by both researchers and non-governmental organisations (NGOs) for not being ambitious enough in relation to aspects of justice e.g. in terms of emissions reductions or emissions quotas. We therefore reviewed a selection of both official targets, i.e. adopted at different institutional levels and alternative ones, i.e. suggestions put forward in research publications and by non-governmental actors.
There are different ways of setting targets in order to address climate mitigation. In the examples of official and alternative targets reviewed, we found eight different approaches. The goals are categorised below in Table 2 according to what they measure and the institutional level at which they are set (i.e. global or EU).

[8] Based on Fauré (2016) – Results from paper II

Table 2. Reviewed official and alternative climate and energy targets. (Paper II)

	Research	NGOs	Global	EU	National	Regional	Local
Prevention of negative interference with the climate system			""stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" (UNFCCC, 1992, Article 2)		"concentrations of greenhouse gases in the atmosphere must be stabilised at a level that will prevent dangerous anthropogenic interference with the climate system" (Government Bill 2008/09:162)		
Average global temperature increase	Curb all further warming (Hansen et al., 2013)	1.5°C (SSNC, 2011) Less than 2°C: (Teske et al., 2012).	Well below 2°C, above pre-industrial levels, striving for 1.5°C: (United Nations, 2015b)	<2°C (COM, 2007)	Well below 2°C, above pre-industrial levels, striving for 1.5°C (Swedish Climate Policy Council, 2018)		
Concentration of GHG in the atmosphere	450 ppm CO_2 eq. (to meet 2°C target) (IPCC, 2014) 350 ppm CO_2 (Rockström et al., 2009; Steffen et al., 2015)	350 ppm CO_2: (SSNC, 2011)		450 ppm .CO_2 eq. (COM, 2007)	400 ppm CO_2 Eq. (Government Bill 2008/09:162)		
Radiative forcing	+1.0 W m-2 relative to pre-industrial (Steffen et al., 2015) 2.6 W/m2 in 2100: (van						

	Vuuren et al., 2011)						
Total emissions of GHG	41–47 Gt CO_2 eq./ year in 2020 (Rogelj et al., 2012) Not exceeding 290-350 GtC from 2000 (Steinacher et al., 2013) Not exceeding 4440 - 3670 $GtCO_2$ since 1870 (IPCC, 2013) 1.15 tonnes CO_2 eq. per capita (Åkerman et al., 2007) Max 0.82 tonne CO_2 eq. per capita per year by 2050 (Fauré et al., 2016)	1 tonne CO_2 per capita per year (Friends of the Earth Sweden, 2007)					3 tonnes CO_2 eq./capita and year by 2015 (City of Stockholm, 2012)
Percentage reductions of GHG	40% to 70% lower global GHG emissions in 2050 than in 2010: (IPCC, 2014) 70% reduction of global CO_2 emissions in 2050 compared	By 2020: 40% reduction of GHG in industrialised countries in 2020 compared to 1990 and 15-30% compared to projected growth in		40% by 2030 and 80% by 2050 compared to 1990 (COM(2014) 15, 2014)	Emissions for non-CO_2-trading activities in Sweden should be 40% lower in 2020 than 1990, 63% lower by 2030 and 75% lower by 2040. No net emissions of GHG by 2045:	Fossil independent in 2030 (Region Västra Götaland, 2009)	Fossil-free by 2050 (City of Stockholm, 2012) <40% by 2020 and zero emissions by 2030 (City of Malmö, 2009)

	to 2000 (EEA, 2005; Stern, 2006) Reduction of Sweden's total emissions by 85% in 2050 (Åkerman et al., 2007)	developing countries: (Teske et al., 2012) Near zero emissions in Sweden 2030 (WWF Sweden, 2017)			(Swedish Government 2017)		
Reduction in energy use/energy efficiency	Max 14 MWh/capita and year: (Höjer et al., 2011b)	50% in end use in 2030 (SSNC, 2011)	Doubled energy efficiency improvement by 2030 (United Nations General Assembly, 2015)	27% increased energy efficiency by 2030 (European Council, 2014)	20% improvement in energy efficiency by 2020: (Government Bill 2008/09:162)		10% decrease by 2015, in own buildings: (City of Stockholm, 2013) 20% decrease per person by 2020 and by another 20% by 2030 (City of Malmö, 2009)
Share of renewable energy	100% renewables, (Milestad et al., 2014) Close to 100% renewables, (Gustavsson et al., 2011)	80% renewables in Sweden 2030: (WWF Sweden, 2011)	Substantially increased by 2030 (United Nations General Assembly, 2015)	27% by 2030: (COM(2014) 15, 2014)	50% by 2020: (Government Bill 2008/09:162)	>80% of heating energy and 75% of transports by 2016; 100% of heating energy and 100% of transports by 2020: (Region Skåne, 2009)	100% in 2020: (City of Malmö, 2009)

In general, the justice aspect is not explicitly formulated in existing climate goals and often remains vague, if mentioned at all. In the Paris Climate Agreement for instance, an explicit justice perspective is clearly adopted with the reiteration of Article 3.1 of the United Nations Framework Convention on Climate Change (UNFCCC, 1992), stating that in the implementation of the agreement, "equity and common but differentiated responsibilities and capabilities, in the light of different national circumstances, should be reflected" (United Nations, 2015b). Yet, it is not reflected in any existing targets. A global temperature target is set but the agreement does not require any legally binding emissions reduction commitments based on the principle of fair and equitable burden sharing. Neither historic and future emissions nor vulnerability and economic capacity to reduce emissions are discussed and taken into account. In the scientific literature and NGO reports, it was easier to find more concrete suggestions regarding justice perspectives.

For our analysis of how a justice perspective could be applied to official and alternative goals, we use the framework introduced by Dobson (1998) and further developed by Page (2007) (who, what, and how?) introduced in Chapter 3.
We find in our review that regarding the community of justice, i.e. the receivers of justice, climate and energy targets are often expressed as a per capita measure at a national level. Such a target is easy to calculate, but also includes some severe drawbacks which I elaborate on in the discussion further on.
We also find that several suggested alternative climate and energy targets are based on an equal distribution principle. Equality as a principle of distribution would, in the example of ecological space, give every human being the right to use an equal amount of environmental resources as long as the capacity of the resources is sustained for the sake of future generations (Chambers, N., Simmons, C., Wackernagel, 2000; Page, 2007). In our review, we found examples of either an equal distribution of rights to emit (e.g. Mattoo and Subramanian, 2010; Tavoni et al., 2012), to access energy (Höjer et al., 2011a), or the distribution of responsibilities (e.g. to reduce emissions). Some targets do not, however, focus on the equal distribution of resources, but on the opportunities these resources give. For example, Costa et al. (2011) link the need for emissions with the Human Development Index (HDI)[9] of a country, where countries with a low HDI get a larger proportion of emissions, something we interpret as an example of a capabilities approach to justice (Nussbaum, 2000; Sen, 2003), even if it encompasses a limited number of issues compared to Nussbaum's more extensive list of 10 capabilities (Nussbaum, 2000).

[9] The Human Development Index includes aspects such as life expectancy, education level and GDP.

5.3 Paper III – Towards a multi-target backcasting approach for robust climate change mitigation strategies: A Swedish case study on an environmental assessment of climate mitigation scenarios [10]

In Paper III, the aim was to analyse what the consequences could be for the scenarios when all the focus was put on one single goal and whether such scenarios could provide a good basis for informed decisions. The question asked was: How would the way of fulfilling one goal in a specific scenario impact on other goals? Does it imply that other sustainability goals will be fulfilled or be easier to fulfil or would it, on the contrary, make it more difficult to achieve other goals, thereby making the scenarios unsustainable?

The goals that were analysed were the Swedish environmental goals (Government Bill 1997/98:145; Government Bill 2004/05:150).
The backcasting scenarios (Milestad et al., 2014), used as a case, differed in two aspects, which the targeted actors could not influence. The first one is an external scenario element, whether there is an international climate treaty or not. The other aspect is a normative target-fulfilling scenario element, whether decision power is centralised or not. The main characteristics of the scenarios are shown in Table 3.

Table 3. Main characteristics of the four "land-use" backcasting scenarios (Milestad et al., 2014).

	No international climate treaty (Case A)	An international climate treaty (Case B)
Centralised power (Case 1)	*- Energy from biomass* *- Differentiated land use* *- Large-scale food production* *- Intensive forestry* *- Road transport of goods* *- Population in urban centres* *- A world in turmoil* *- Global energy crisis* *- Severe climate changes*	*- Investment in production of electricity* *- Differentiated land use* *- Large-scale food production* *- Environmentally friendly forestry* *- Rail transport of goods* *- Population in urban centres* *- A stable world* *- No global energy crisis* *- Less severe climate changes*
Localised power (Case 2)	*- Energy from biomass* *- Multifunctional land use* *- Small-scale food production* *- Intensive forestry* *- Local self-sufficiency* *- Population close to food and energy production* *- A world in turmoil* *- Global energy crisis* *- Severe climate changes*	*- Investment in production of electricity* *- Multifunctional land use* *- Small-scale food production* *- Environmentally friendly forestry* *- Local self-sufficiency* *- Population close to food and energy production* *- A stable world* *- No global energy crisis* *- Less severe climate changes*

[10] Based on Fauré (2016) – Results from paper III

In this paper, we found that there were more potential conflicts between the backcasting goal (zero CO_2 emissions in Sweden 2060) and other environmental goals in scenarios with no global climate agreement, i.e. labelled “local” in Table 4 below.

Table 4. Synergies and conflicts between environmental goals and mitigation of climate change in the "land-use" scenarios (Paper III)

Objective	Critical aspect of the goal	Central+ Biomass	Central + electricity	Local + biomass	Local + electricity
2. Clean Air	Emissions from traffic				
	Small scale wood burning				
	Ground level Ozone				
	Emissions of NOx				
3. Acidification	Emissions of sulphur dioxide				
	Emissions of NOx				
4. Non-toxic environment	Pesticide use				
	Supervision and control				
6. Radiation	Closure of nuclear plants				
7. Eutrophication	NOx emissions from biofuels				
	Distances in food systems				
	Ploughing of agricultural land				
	Catch crops and buffer zones				
	Small scale sewage systems				
	Meat production and import				
8. Lakes & streams	GMOs				
	Natural & cultural assets				
	Ecosystem services				
	Small scale hydro-power				
9. Groundwater	Pesticide residues				
	Water protection areas				
	Decreased ground-water levels				
	Use of salt on roads				
10. Marine Env., Coastal Areas & Archipelagos	Oil spills				
	Recreational values (e.g. noise)				
	Human disturbance				
11. Wetlands	Protect and re-establish wetlands				
	Forestry methods				
12. Forests	Forestry methods effect				
	Protected areas				
	Climate change				
13. Agricultural landscape	Agricultural landscape diversity				
	Energy forests/open landscape				
	Sustenance of Swedish landraces				
14. Mountain landscape	Exploitation (mining)				
	Noise				
15. Built environment	Traffic noise				
	Public transportation				
	Green areas close to residential				
16. Diversity plant and animal life	Safeguard habitats & ecosystems				

Synergies are marked as green, conflicts as red and question marks as white.

The higher occurrence of conflicts in scenarios without a global agreement was mainly due to the fact that some environmental problems are global such as oil spills or air pollution and are, therefore, dependent on what actions other countries are taking against climate change. An underlying assumption was that the use of fossil fuels globally would continue to develop as "business-as-usual" in a future with no climate agreement. This has implications for Sweden, even though Sweden has its own trajectory towards a zero CO_2 emissions future. These issues are, therefore, difficult to deal with and resolve at a national level other than by advocating a global agreement.
Another result is that, if there is a global failure to reach a global climate agreement, several conflicts may arise in scenarios A1 and A2 due to more land-intensive activities and, therefore, tougher competition over land. Indeed, in these scenarios, biomass was chosen before electricity from wind and solar power as an energy source, being more readily available in times of recession but putting more strain on land use.

5.4 Paper IV – Four Sustainability Goals in a Swedish Low Growth/Degrowth Context[11]

The aim of this paper is to select, operationalise, and discuss a set of sustainability goals for Sweden. These goals are used in backcasting scenarios for building and planning in a context of degrowth or low growth, therefore the focus for the scenarios is to explore what societies fulfilling selected sustainability goals might look like irrespective of the resulting level of economic growth.

Both the research and reference groups, comprising researchers from different disciplines and societal partners, then selected four sustainability goals: two environmental, climate and land use, and two social goals, fair distribution of power and participation in society and welfare and resource security. Four selection criteria were used: whether goals were central to sustainability, relevant for planning and policy in Sweden, possible to operationalise (i.e. quantify or assess qualitatively) and endorsed by the project and reference group of societal actors. These are formulated in Table 1 below.

[11] Based on Fauré (2016)- Results from Paper I

Table 5. List of the selected goals for the Beyond GDP Growth backcasting scenarios (Paper IV)

Environmental goals	Social goals
Climate change	Distribution of power, influence and participation in society
Sweden is fossil-free by 2050, i.e. no fossil fuels are used as fuels or in industrial processes.	All residents in Sweden, regardless of, e.g. gender, gender expression, sexual orientation, ethnicity and religious affiliation, age, disability, class or income level, should be entitled to participate in and influence political choices and decision-making that affect their lives.
A maximum amount of 0.82 tonne CO_2 equivalents (GHG) consumptive emissions per capita per year in Sweden	
Land use	Welfare/resource security
The per capita land area used for final consumption does not exceed global biocapacity	Residents in Sweden should have sufficient access to resources and services that can create opportunities for housing, education, social care and social security, as well as favourable conditions for good health.
	The distribution of the same resources and services should be made according to fairness principles.

The climate goal consists of two sub-goals, one regarding the type of energy supply and use of energy in production in Sweden, and one for emissions from Swedish consumption. Several studies have underlined the fact that, in recent decades the effects of national emissions reductions have been cancelled out by an increase in consumptive emissions in Sweden (Isenhour and Feng, 2014; Swedish EPA, 2012a). While domestic emissions have decreased by 30 per cent over the past 20 years, emissions abroad as a result of Swedish consumption have increased by 50 per cent over the same period (Swedish EPA, 2015), even though emissions from Swedish consumption[12] occurring both in Sweden and abroad decreased between 2008 and 2014 despite a peak in 2011 (Palm et al., submitted).

The aim of a fossil-free Sweden by 2050 is to reduce territorial CO_2 emissions and avoid a situation where Swedish industries with a large export share continue to use fossil fuels. The goal to limit emissions from Swedish consumption is derived from a pathway to keep global warming under 1.5 degrees Celsius by 2100 with at least a 50

[12] Non-CO_2 emissions from Swedes' air travel are excluded

per cent likelihood (UNEP, 2015), divided by the estimated global population in 2050 (United Nations, Department of Economic and Social Affairs, 2015 medium variant), which results in a quota of 0.82 tonne CO_2 equivalent per capita.

The second environmental goal is about land use. The need for both renewable energy and food production to address the global population increase may place severe strains on land resources. We chose a consumption-based measure for land use so as to incorporate a justice perspective. This means that Sweden should not use more than its equal share of land, as land used abroad for Swedish consumption will be accounted for, and land areas in Sweden will have to be accessed by other countries on an equal share basis.

The first social goal is about the distribution of power, influence, and participation in society, and is adapted from one of Nussbaum's ten capabilities (Nussbaum, 2000) regarding "the control over one's political environment", but broadened to encompass all relevant decision contexts.

The second social goal is about welfare and resource security. It encompasses both what is to be distributed, e.g. access to resources in order for everyone to have similar opportunities and shares, i.e. a fair distribution, which can mean different things in different scenarios.

These four goals are challenging. In 2014, the emissions from Swedish consumption amounted to about 10.5 tonnes CO_2 equivalent per capita [13] (Palm et al., submitted). Thus, Swedish inhabitants would need to reduce emissions from consumption by 92 per cent in order to reach the 0.82 tonne CO_2 equivalent per capita goal.

In 2014, 53 per cent of the energy used in Sweden came from renewable energy sources (Swedish Energy Agency, 2016 table 13.1).

When it comes to land use, the goal implies that the amount of land used per capita for Swedish residents, measured in global hectares and taking into account the projected global population increase, should be decreased by 65% in relation to 2015.

The social goals are currently reasonably well-achieved in some aspects, but differences remain e.g. depending on the socio-economic group considered. For instance, regarding the distribution of power, influence and participation in society, women usually have less power and influence than men in the private business sector. In state-owned or partly state-owned companies, women are better represented than in listed companies (Statistics Sweden, 2012).

Regarding welfare and resource security, the goal is to a large extent within reach although there are significant differences between different social groups. For instance, there are differences in health between different socio-economic groups (Burström et al., 2011). Socially vulnerable groups have poorer health and are using healthcare services to a greater extent (Ibid.).

5.5 Paper V – Scenarios for sustainable futures beyond GDP growth 2050

[13] The original figure used in Paper IV was 11 tonnes CO2eq. per capita. Here I use the latest figure based on data from the Prince model (see Paper I) as it is more recent and based on a better estimate of emissions resulting from imports.

The aim of this paper is to present the qualitative content of scenarios that explore sustainability strategies for Swedish society when economic growth is not seen as an end in itself, and the goal is instead other values that society might wish to achieve, i.e. the four goals that are formulated in Paper IV. In the paper, we also present the process of the development of the scenarios and feedback from stakeholders. Stakeholders, the research group and reference group with societal partners, were represented throughout the process, albeit to different extents and also took part in the development of the scenarios. Case study municipalities and other stakeholders such as experts on a specific strategy illustrated in the scenarios or e.g. in health issues were also involved in the development of the scenarios on different occasions. The scenario narratives were developed with the idea of presenting alternative futures that do not assume continued economic growth but are based on fulfilling the four sustainability goals described in Paper IV pertaining to climate, land use, distribution of power and resources by 2050. The resulting four images of the future have emerged from twenty scenario sketches based on literature studies. These were discussed in a transdisciplinary process and either merged or discarded. The resulting scenario sketches were fleshed out into narratives in a first report, scrutinised and discussed by project partners, researchers and case studies municipalities and revised in a second report (Gunnarsson-Östling et al., 2017; Svenfelt et al., 2015). The four scenarios imply changed production systems and consumption practices. In the scenario "collaborative economy", people share, rent, borrow or exchange things with each other, both physical goods or time and skills. People are "prosumers" (i.e. both producers and consumers) mainly organised in cooperatives or networks.

In "circular economy in the welfare state" service consumption has increased. Waste does not exist, instead products are repaired and reused as much as possible and only as a final resort recycled. Material and energy flows are circular.

In the scenario "automation for quality of life" a high level of technology and automation is assumed in production. At the same time "sufficiency" has become one of the main values in society and has led to a decrease in material consumption.

In "local self-sufficiency" production and consumption have been relocalised, with a drastic reduction in exports and imports. People dedicate more time to welfare and subsistence activities such as growing food and less to waged work.

The main ideas behind the scenarios are further described in Table 6.

Table 6: Summary of the leading ideas in the Beyond GDP Growth backcasting scenarios introduced in Paper V

Scenarios	**Collaborative economy**	**Circular economy in the welfare state**	**Automation for quality of life**	**Local self-sufficiency**
Modes of production, exchange and consumption	Sharing, trading and borrowing practices (analogue and digital) People are prosumers, i.e. both producers and consumers	Materials are reused. Waste no longer exists. More service than goods consumption, such as welfare services, culture and nature experiences in Sweden Material status no longer important Labour-intensive production	Increased automation and ICT use The specialisation of production means that much trade takes place with other countries, both in the form of imports of consumer goods and commodities to industry, as well as exports of goods and services produced in Sweden. Sufficiency characterises people's lives	Local production and consumption Imports have dramatically decreased Production is labour-intensive Focus on essential production e.g. food production Complementary currency to steer towards consumption of local goods and services Voluntary simplicity and sufficiency Convivial technology
Use of time	Larger share of unpaid work, use of time bank to adapt working time to life situation	Similar working time as today but can be dependent on seasons (especially in leisure industry) Mostly waged work	Drastically reduced working hours More free time thanks to automation in industry People engaged in social activities with family and friends	Long working hours and larger proportion of unpaid work for self-sufficiency

Scenarios	**Collaborative economy**	**Circular economy in the welfare state**	**Automation for quality of life**	**Local self-sufficiency**
Spatial	People live more scattered across the country in dense clusters of medium-sized cities, due to digitalisation	Heavily urbanised	People more scattered across the country but there are still urban cores	Many people live in rural areas and small towns. Cities are less densely populated
Governance	More power to networks of citizens	Strong state creates incentives for efficient resource use	Political decisions are mostly made on the national level (technology development companies have a strong influence) at the same time possibilities for more direct democracy have increased	Locally governed communities

5.6 Paper VI – Methods for assessing future scenarios from a sustainability perspective

The aim of this paper is to explore methods for assessing the sustainability impacts of future scenarios and answer the question "What can we learn for the further development of sustainability assessments of scenarios?"

Future scenarios are often used as a way to handle uncertainty and complexity in long-term decision-making through exploring alternative futures to business-as-usual development. Future scenarios are therefore particularly well-suited to support decision-making and guide action towards sustainability. But which sustainability aspects are mostly discussed in scenarios and which methods have been used to assess the environmental and social impacts of the aspects depicted in scenarios?
We distinguish, following the typology introduced by Börjeson et al. (2006), three types of scenario: predictive, explorative and goal-fulfilling scenarios. We reviewed 38 papers on assessment of scenarios and SEAs of eight municipal plans for the Stockholm region.

Few of the reviewed articles clearly described the choice of assessment method, when they did it was usually in methodological papers or papers combining a methodology discussion and applying it in one case.
Except for the purely methodological papers, the case studies reviewed here did not reflect on the purpose of the assessment and the method chosen. To the extent it was done it was more a discussion on the benefits of the method used than a clear choice from the beginning. The choice of method was therefore more ad hoc. The same applies to the sustainability aspects selected in the assessment. The reasons behind the choice of aspects were not explained either.

In the table below, the different tools used in the case studies are categorised according to their purpose, whether it is to guide the assessment process, to analyse data, to aggregate data to prioritise a certain alternative or both and are further described in Paper VI:

Table 7: Sustainability assessment tools categories (paper VI)

Procedural tools	• SAFS – Sustainability Assessment Framework for Scenarios • Sustainability Impact Assessment (SIA) • Framework for Participatory Impact Assessment (FoPIA)
Analytical tools	• Qualitative mapping of sustainability impact and goal conflict analysis • Network analysis • Life Cycle Assessment (LCA) • Social Life Cycle Assessment (S-LCA) • Life Cycle Sustainability Assessment (LCSA) • Input-Output Analysis (IOA)
Tools for aggregating impacts and prioritising between alternatives	• Multi-Criteria Decision Analysis (MCDA or MCA) • Cost-Benefit Analysis (CBA)
Combined scenario building and assessment methods	• Systems modelling and simulation • Computable General Equilibrium (CGE) models • Integrated models used for IPCC scenarios modelling and assessment
Tools for SEAs (often more geographically dependent)	• Geographical Information Systems (GIS) • Overlay maps • Vulnerability analyses

When done in a participatory assessment, the choice of aspects usually reflects the different stakeholders' values but in most cases, no description of the process was included.
Climate and GHG emissions were the most common environmental aspects assessed in the reviewed case studies.

Social aspects were included in about half of the assessments and in two out of eight SEAs and varied substantially from including one single aspect such as employment to up to ten aspects such as social cohesion or quality of life.

Distributive issues were only addressed in seven out of 38 papers and one SEA and when social justice or impacts on vulnerable groups were mentioned, even fewer actually identified which vulnerable groups had been identified.

One finding is that there is no single method that can be used in all cases, both because different tools may be needed to cover all sustainable aspects and because different types of scenarios and time horizons may require different methods. Often a combination of methods is needed depending on the purpose of the assessment such as in Kowalski et al. (2009), where an LCA was first performed to assess environmental aspects followed by a multi-criteria analysis and a qualitative assessment of social aspects.

In this thesis, procedural tools are suggested as a first step for all types of scenarios, as they could help identify the purpose of the assessment, the sustainability aspects to select and the need of stakeholders' involvement.
Both social and environmental aspects need to be considered in order to avoid suboptimisation, i.e. focusing solely on one goal which risks impacting negatively on other goals. Different strategies for achieving a goal of reduced emissions for instance, could have undesirable impacts on e.g. the land-use goal if a massive cultivation of biomass is chosen. Similarly, the manner in which a strategy is implemented could have implications for participation and influence in society, e.g. if decisions are made at a national or international level with no room for local or regional adaptation.

To some extent the purpose of the assessment is a result of the types of scenarios used, for instance what type of question the assessment should aim to answer, which could be "do we reach our goal(s)?" which is typical for goal-fulfilling backcasting scenarios or "what are the potential conflicts and synergies with various sustainability goals?", which could be applicable to all types of scenario assessments. Other aspects to consider are the time frame and the degree of change implied in the scenarios compared to the current situation. Conducting a quantitative assessment of long-term scenarios might be needed in the case of e.g. backcasting scenarios having to meet quantitative targets. This task may prove challenging as uncertainties increase the longer the time frame and using figures may give the impression of being accurate. It is therefore important to make it clear that the assessment is not an exact calculation of whether or not scenarios fulfil the goal but rather an estimation of the order of magnitude of the changes needed in order to approach the goal and which areas would need to be in focus in the different scenarios. One advantage of conducting a quantitative assessment may be to identify whether one or several scenarios need to be revised in order to reach the goal and the process can then be done in an iterative manner.

5.7 Paper VII – Low-carbon futures for a Swedish society beyond GDP growth – Potential opportunities and challenges

The aim of the paper is to further hone and quantify different scenario narratives, developed within the Beyond GDP Growth Project and described in Paper V and in more detail in Gunnarsson-Östling et al. (2017), with a focus on GHG emissions in order for the backcasting scenarios to fulfil the climate goal from a consumption perspective of 0.82 tonne CO_2 eq. per capita described in Paper IV. The other climate sub-goal, that Sweden is fossil-free by 2050, is here an assumption.
Potential opportunities and challenges to reach the climate goal are discussed as well as consumption areas of particular interest.
Some potential implications on land use and biodiversity are also highlighted.

Based on the scenario narratives we quantify GHG emissions arising from different consumption areas such as food, transport, private consumption of other goods and services, public consumption and public and private investments for the year 2050 in the different scenarios.

Assumptions were made as to the level of imports and average global emission intensity in the different scenarios for 2050.
The results are presented in the following figure. Details about data and the many assumptions behind the figure below are described in Paper VII.

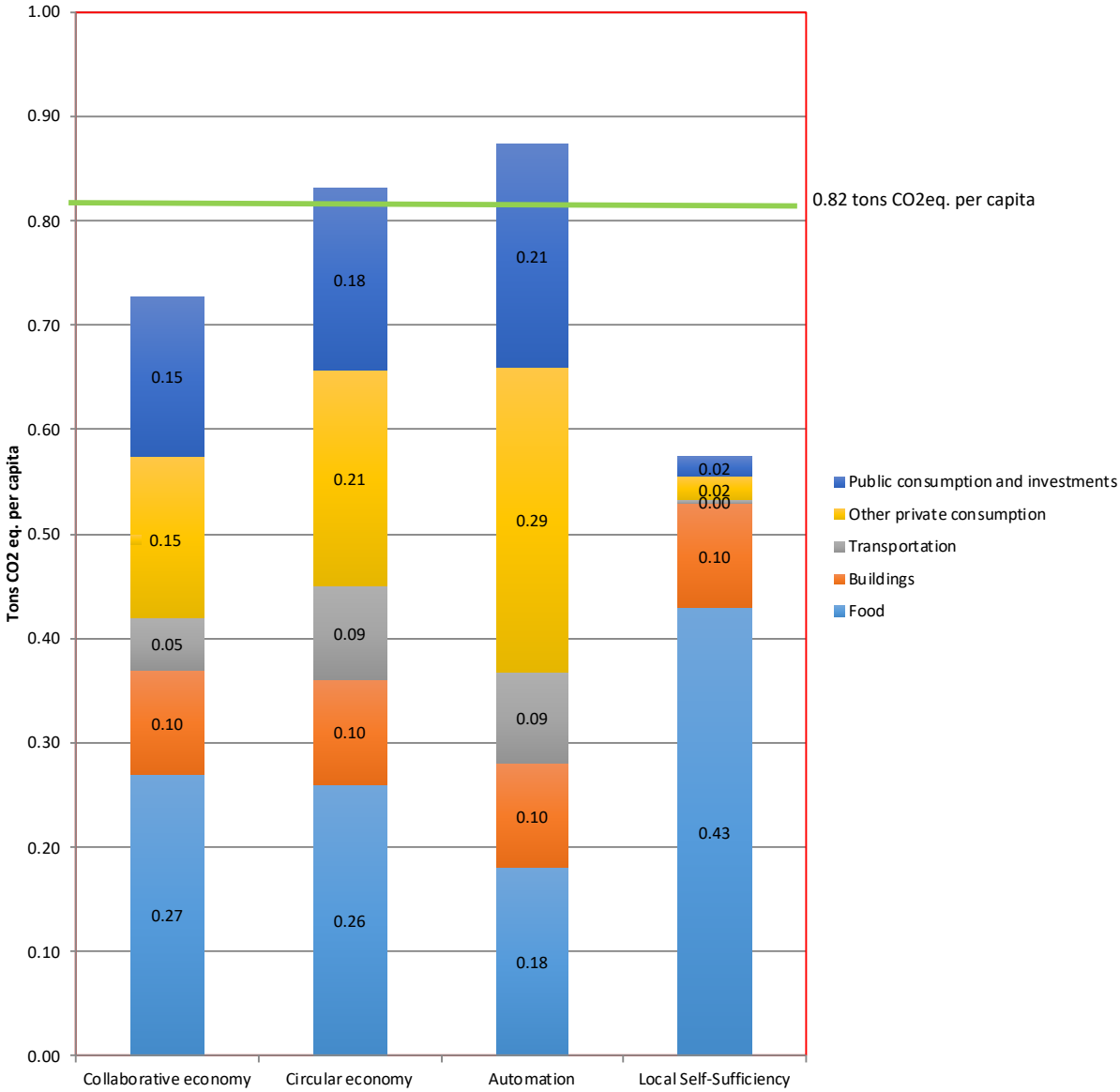

Figure 3: Total emissions per capita in the different Beyond GDP Growth scenarios (Paper VII)

Assuming different import shares compared to current import level (50%, 50%, 75%, and 10% respectively) and global average emission intensity globally of current level (45%, 25%, 25%, 85% respectively). Vegan diets with different technological levels are assumed for the three first scenarios whereas the diet in local self-sufficiency included meat from ruminants and non-ruminants. International travel is excluded.

Our results show that all scenarios can potentially fit into the emissions budget of 0.82 tonne CO_2 eq. per capita but this will require radical changes in each scenario.

In the circular economy and automation scenarios, the emission budget is equal and slightly overridden respectively. Yet, compared to the current situation of 10.5 tonnes CO_2 eq. per capita per year and the large uncertainties of such estimates, the excess can be considered marginal.
For all scenarios, international air travel has been excluded - although for one of our scenarios, circular economy, continued international air travel would be rather coherent with the characteristics of that specific scenario since similar worktime and income levels as today are assumed and due to the high income elasticity of air travel highlighted in e.g. Xue et al. (2016) and especially for international routes (Gallet and Doucouliagos, 2014). This does not however seem possible in that scenario as all emissions in the set quota are already used up by other consumption categories.
In three scenarios, apart from local self-sufficiency, the selected diet is vegan. This is due to the fact that diets containing meat products give rise to higher GHG emissions, especially those including meat from ruminants as well as dairy products, due to the non-CO_2 emissions of methane and nitrous oxides.
Our scenarios also imply a reduction in goods consumption, to different extents however, with the lowest consumption level in local self-sufficiency and changed consumption patterns, e.g. a drastic decrease in car ownership in all scenarios.
The automation scenario has the highest level of imports compared to the other scenarios (75% of current level), followed by circular and collaborative economy (50%) and will be highly dependent on the decarbonisation rate of trade partners abroad.
Two scenarios have some room left for GHG emissions, for local self-sufficiency this could either mean that higher levels of consumption may fit in the quota or that the remaining budget could be seen as a further contribution from Sweden in order to compensate for past emissions or to give more space to poorer countries. For collaborative economy, the latter could also be valid, but other options could be some limited consumption of non-ruminant meat or an occasional international air trip.

6 Discussion of findings

Swedish consumption is currently giving rise to large environmental pressures and resource use in many other countries and if we take the examples of GHG emissions and land use for which we have suggested what sustainable levels could be, a drastic decrease is necessary. Addressing these problems requires a great deal more than incremental change and the use of, for example, different images of the future can be helpful in visualising and discussing what is needed to set society as a whole and, in our case Sweden, on a more sustainable course. The scenarios presented in this thesis show that a radical decrease in consumption levels and change in types of consumption is necessary, which is in line with earlier findings (Anderson et al., 2008; De Koning et al., 2015; Höjer et al., 2011a; Mont et al., 2014; Xue et al., 2016)

I will here discuss why it is relevant to gain a better understanding of the current pressures that occur as a result of Swedish *consumption* and then why we need to discuss alternative futures. Several recurrent themes emerge from the different papers:

- the need to discuss justice perspectives in goal-formulation, scenarios and assessments
- the need to explore and discuss alternatives to current development
-the need to address several sustainability aspects through the use of several indicators and to analyse goal conflicts in order to avoid suboptimisation
- the benefits of combining different research approaches but also the tensions that can arise from such a process.

6.1 Justice issues

Jacobs (1999) claimed that ”(t)he dominant non-egalitarian conception of sustainable development [characteristic for the global North] generally includes only a passing and non-committal mention of global resources distribution and frequently fails to refer to intra-country equity at all”.

This still seems to be the case in the review of official climate targets in Paper II, where we found agreement that GHG emissions should not exceed harmful levels. Yet, as soon as the questions of who has to reduce its emissions and by how much arise, views diverged more widely. This can also be related to the two levels of meaning of the word sustainability, where it is easier to agree on the first level, on a maximum temperature or concentration of GHG, i.e. targets with non-divisible aspects, but as soon as there are more concrete proposals as regards how to achieve the goal, there is much less agreement. Even if writings about equity and a reference to “common but differentiated responsibilities and capabilities” was reiterated in the Paris Agreement (UNFCCC, 2015), our review in Paper II shows that justice perspectives are still lacking in official climate targets and that a discussion about equity is needed. Indeed, if justice perspectives are not considered when setting goals, or in the scenarios or in assessments against other goals, and not discussed at all, then there is a risk that the outcomes will not be just. Non-divisible targets based on temperature or concentration measurements should therefore be complemented with other targets, such as a maximum budget of GHG emissions that can be divided, where it is possible to apply justice principles.

6.1.1 Intergenerational justice

In Paper IV, when setting the climate target, we use the lowest temperature increase suggested in the emissions trajectories in the scientific literature, and thus implicitly cover intergenerational justice, as 1.5°C is a safer level than the otherwise widely used 2°C target. According to UNEP (2015), all 1.5°C consistent scenarios entail greater emission reductions at an earlier stage than 2°C consistent scenarios, which would lessen the burden on future generations.
However, the global emission budgets forecast for the years 2050 or 2100 and in line with 1.5°C consistent scenarios are expressed in **net** emissions. Net emissions imply that actual GHG emissions can be compensated for by negative emissions, i.e. the removal of carbon dioxide (CO_2) from the atmosphere through different strategies. In scenarios consistent with 1.5°C (Ibid. 2015) that were available at the time we developed the climate goal for the Beyond GDP Growth scenarios in Paper IV, negative emissions are assumed at the end of the period (Rogelj et al., 2015). Larkin

et al. (2018) warn that in practically all 2°C scenarios, such as those from the IPCC, net emissions are assumed and call for the use of net emission technologies (NETS). Similarly, Grubler et al. (2018) also note that scenarios for limiting global temperature increase below 1.5 degrees Celsius focus mainly on energy supply side and assume ever-rising energy demand, thereby relying on NETS in order to keep climate emissions down.
UNEP (2017) distinguishes between different strategies for carbon dioxide removal:
- natural (from agriculture and forestry, e.g. afforestation, reforestation or soil carbon management)
- combined (Bioenergy with Carbon Capture and Storage or BECCS)
- technological (such as direct air capture)
NETS, such as the massive and rapid deployment of bioenergy with carbon capture and storage (BECCS) are thus regularly assumed, although their feasibility and potential to be upscaled are uncertain (Grubler et al., 2018) and could delay the necessary and more reliable near-term efforts to curb emissions such as supporting low-carbon behaviours (Anderson and Peters, 2016) . Anderson & Peters (Ibid., p.183) qualify NETS as "an unjust and high-stakes gamble" that should not form the basis for climate mitigation policy although they can be researched further. If these technologies cannot be upscaled, as evidence is currently lacking, then we will be locked into higher temperatures and the consequences for future generations will be far more dangerous, thereby ignoring intergenerational justice issues.
The burden on future generations would decrease if net emissions are not automatically assumed or at least to a lesser extent.
Grubler et al. (2018) propose an alternative scenario to scenarios implying a continued increase in energy demand, "Low Energy Demand" or LED, that assumes a 40% decrease of global energy demand by 2050 compared to the current level, mainly thanks to social and institutional changes that reverse the historical trajectory of ever-increasing energy demand. This is an important contribution as global scenarios such as the IPCC scenarios are widely used both to inform policy and as a basis for other research, such as ours when setting the climate target for our national scenarios in Paper IV. Underlying assumptions when it comes to negative emissions and reliance on NETS need to be made visible in goal setting or scenarios. Besides, according to the latest report from the IPCC (2018), 1.5°C consistent pathways, assuming lower energy demand, lower material consumption as well as low GHG-intensive food consumption entailed fewer trade-offs and had more synergies with sustainability goals such as the SDGs.
Alternative global scenarios challenging the taken-for-granted assumption of escalating energy demand are therefore greatly needed.

Using scenarios not assuming negative emissions, such as the above-mentioned LED scenario, would have implied steeper emissions reductions at an earlier stage and a stricter quota per capita for Sweden by 2050. This may have further lessened the burden on future generations. However, in Paper VII we have assessed the scenarios against a quota of gross GHG emissions and we then discuss the potential of negative emissions separately.
In Paper VII, we have chosen to focus only on natural negative emissions technologies as these are, according to UNEP (2017) the least contentious, although many uncertainties remain as to the potential CO_2 volumes that can be removed, the duration of carbon sequestration or the impact on ecosystems (UNEP, 2017).

Despite of the critique elaborated in Paper II about not explicitly considering intergenerational justice in climate and energy targets, which could be extended to other sustainability goals, we chose not to include such a consideration in the land-use goal in paper IV. We calculate the global land availability per capita, thereby taking into account intragenerational justice but we do not stipulate how much land should be exploited or kept as nature reserves, which may be of benefit to future generations.

6.1.2 Intragenerational justice

As previously mentioned, Sweden adopted a generational goal in 2010 in order to consider inter-and intragenerational justice in its national environmental policy. Several authors (Barrett et al., 2013; e.g. Peters and Hertwich, 2008) suggest monitoring consumption-based emissions at a national level, as a complement to territorial emissions to spur a more sustainable domestic consumption, as long as there is a lack of a global emissions cap and corresponding ambitions in national emissions reductions. Yet, at a national level, the recently adopted climate framework in Sweden (Swedish Climate Policy Council, 2018) does still not address justice and particularly intragenerational justice, as the perspective used is from a territorial perspective, i.e. accounting for emissions occurring within Sweden's borders. This, in spite of the fact, as Paper I shows, that for most environmental pressures a larger proportion occurs abroad - notably in China or Russia for several indicators.

The Swedish EPA (2012b) has acknowledged that the way to measure and work towards the generational goal is far from easy. The results presented in Paper I are part of the PRINCE Project, whose goal is to follow up several pressures occurring as a result of Swedish consumption both in Sweden and abroad. When it comes to policies aiming at actually reducing the environmental pressures and resource use from Swedish consumption, some alternatives would be to either reduce imports associated with high environmental pressure or resource use or support more sustainable production methods in supply chains (Persson et al., 2015).

Isenhour & Feng (2014) have explored the different efforts made by Swedish policy-makers to integrate issues of generational justice into climate policy and argue that both technology transfer down the supply chain such as Swedish efforts to assist the diffusion of energy-efficient technologies to China and consumer information campaigns or environmental labels have had mixed results, however. The former, although having the advantage of being easier to achieve than "unilateral border adjustments taxes" (Isenhour and Feng, 2014, p. 326) or import restrictions for carbon intensive goods, does not address the absolute consumption growth but the relative energy efficiency of goods produced in China. This poses the risk that, instead of achieving its intended goal, namely decreasing the impact of Swedish consumption, such technological transfer could contribute to efficiency gains per production unit. This, in turn, may lead to increased consumption, whether originating from Sweden, other countries or from the growing domestic demand in China, which Isenhour and Feng (Ibid. 2014, p. 326) label a "globalized rebound effect". In economics a rebound effect "most commonly refers to behavioural or other systemic responses to the introduction of new technologies that increase the efficiency of resource use" (Börjesson Rivera et al., 2014, p. 107). The second

strategy, which leads to increasing public awareness, although “crucial for building policy legitimacy” (Isenhour and Feng, 2014, p. 326) has not resulted in decreased environmental impact as positive attitudes towards environmental issues do not automatically translate into more sustainable behaviours (Mont et al., 2013). Information measures such as voluntary environmental labels rely too much on individual choice and put large demands on consumers’ own judgement, whereas environmental problems require collective actions, for which consumers can also have a greater acceptance (Swedish EPA, 2012c). Besides, such a strategy does not address the structural obstacles, whether economic, social or political that often stand in the way of even the most environmentally aware consumers (Isenhour and Feng, 2014). Instead, the authors (Ibid. 2014) underline that the focus should be on demand-side policies, although politically sensitive, such as heavy restrictions on the purchase of single-use or carbon intensive goods and services, the promotion of repair and reuse, collaborative consumption and sharing practices that may challenge the current market logic. The latter are emerging social innovations that have been identified in e.g. Mont et al. (2014) as particularly promising sustainable living practices. In Paper V, the backcasting scenarios from the Beyond GDP Growth Project, all implying reduced levels of total goods consumption, explore some of these strategies, e.g. through sharing practices in the collaborative economy scenario spurred by higher tax on production or through reuse in, mainly, the production processes but also consumption practices in the circular economy scenario (Gunnarsson-Östling et al., 2017). More research is needed to address the need for such policies and their potential to reduce the absolute levels of emissions, energy and resources from Swedish consumption.

Globally, the issue of burden sharing and climate emissions reductions between countries can be discussed according to different principles with different implications for groups of countries, which we discuss in Paper II.
Caney (2012) distinguishes two approaches when allocating climate responsibilities, whether climate responsibilities are treated in isolation from other justice considerations (e.g. global justice and issues of development, poverty or health) or together with such considerations. Another distinction is whether an allocation takes historical emissions into account, which Caney labels as "history sensitive". In Paper I, on the formulation of goals for the backcasting scenarios, our aim was to consider both inter-and intragenerational justice and for both environmental goals (climate and land use) a consumption perspective was adopted. The climate goal in Paper IV is based on the amount of global GHG emissions in 2050 according to a trajectory in line with the 1.5°C goal (50% likelihood) and divided by the estimated global population that same year. The land-use goal in the same paper is based on the total amount of available global biocapacity divided equally among the same estimated global population in 2050. However, it could be argued that historic emissions or the level of development of countries could be taken into account, which would reduce even further the allowed quota for a wealthy nation such as Sweden. This is also something we discuss in Paper VII, where both the local self-sufficiency and collaborative economy scenarios could allow for an even lower emission quota than 0.82 tonne CO_2 eq. per capita and where Sweden could take on greater responsibility.
According to Höhne et al. (2014), the outcome of effort-sharing approaches, i.e. focusing on how to allocate future GHG emissions reduction targets, may differ depending on how the distribution principle is implemented, whether e.g. looking at

equal per capita cumulative emissions or at globally cost-effective distribution. The latter would favour so-called developed countries as a group and thereby be less ambitious in respect of social justice than the former. Another issue to consider is the different starting points nations may have in terms of available resources. Achieving low emissions is relatively easier for a country with rich natural resources, like Sweden, as we argue in Paper IV, which has a lot of hydropower and land resources if a territorial perspective is used. But even taking a consumption perspective, if the total amount of globally available resources is not divided equally, the outcome may be unjust. We have, for instance, formulated a goal in Paper IV based on an equal share of the total biocapacity for embedded land use. Paper I shows that even if most pressure is occurring in Sweden, Swedes are currently using through their consumption a large share of embedded land. When compared to the total available biocapacity equally divided between all humans, as suggested in Paper IV for setting the land-use goal, Swedes are using far more than their fair share.

A focus on GHG emissions has the advantage of giving information on emissions that are not related to energy use - such as methane emissions from cattle or emissions at high altitude from air travel, which are, as discussed in Paper VII, far from negligible. Besides, the data available for GHG emissions embedded in consumption is more extensive than that on embedded energy and further research may still be needed in that field to provide a good basis for assessments.

Yet, having only a focus on GHG reductions rather than on the actual energy use per capita may also fail to address the issue of the limited amount of fossil-free energy potentially available globally and of a fair distribution of this available energy, regardless of a country's energy potential, as e.g. Swedes could maintain a relatively high-energy use as long as it is fossil-free. Therefore, an equal per capita distribution of GHG emissions may not automatically lead to just outcomes and several indicators need to be considered such as energy or resource use.

In Paper VII, the assumption that Sweden is fossil-free by 2050 makes it relatively easy for scenarios to fulfil the GHG emissions quota, especially local self-sufficiency, as both production and consumption are relocalised but the activities described in the scenarios may require rather large amounts of fossil-free energy and there may need to be a degree of prioritisation as regards the different activities. The very low level of goods consumption in the local self-sufficiency scenario compared to today may however compensate for e.g. the relatively high energy use for heating and hot water in buildings.

Both the automation and circular economy scenario, as well as collaborative economy to a lesser extent, assume a rather large increase of ICT equipment and services compared to today. The digital transition could help mitigate climate impact from emission intensive activities (e.g. when it comes to replacing emission intensive transportation) and is often presented as unproblematic from an environmental point of view by several international organisations, e.g. UNCTAD or UNESCO (Shift Project, 2018). Data (from actual measurements) about the global energy consumption from the ICT sector has been lacking (Ibid.). There is disagreement whether the ICT sector's energy consumption is increasing or not depending on the assumptions made (Malmodin and Lundén, 2018). The Shift project, in a report stemming from a collective reflection by academics, experts and industry professionals on the potential synergies between an energy transition and a digital transition, estimates that the global energy footprint of digitalisation, including the production and use phase of ICT equipment (data centres, networks and devices)

increases - and will increase - by 9% per year between 2015 and 2020 (Shift Project, 2018, p. 15). The same applies to its proportion of final energy demand - from 1,9% in 2013 to 3,3% by 2020 (Ibid, p.16). In both the automation and circular economy scenarios, the number of electronic devices in homes and in industry increases. The production phase of ICT devices accounts for 60 to 90% of the total energy consumption over the life cycle of devices when solely the direct energy consumption of the device is considered during the use phase (i.e. not the indirect consumption from data centres etc. which would also itself account for a large proportion of total energy consumption) (Shift Project, 2018). This could put pressure on global energy resources and compete with other sectors' energy needs.

6.1.3 Intranational justice

Justice among different groups within the same country is another consideration lacking in the reviewed climate and energy targets in Paper II. This could be due to the fact that ecological debt, often used as an "indicator of the cumulative sum of historical environmental injustices" (Warlenius et al., 2015, p. 23) has been a central concern when discussing the sharing of environmental burdens between states or groups of states and often between the global North and South but has been largely disregarded at a more local level (Ibid.). Martinez-Alier (2012) emphasises the fact that there are huge differences within the North and the South. "Some people annually use 300 GJ (gigajoules) of energy, most of which comes from oil and gas, while other people manage with less than 20 GJ, including their food energy and some wood or dried dung for cooking" (Martínez-Alier, 2012). The North/South divide, reveals global inequalities between countries but disregards other important patterns such as differences dependent on e.g. gender or social class.

Another potential reason why such perspectives were lacking in the reviewed targets in Paper II is that the more local the targets get, the more concrete they become as to who needs to reduce emissions. One way to level out these differences between groups at a national level would be to introduce individual emissions rights instead of looking at average emissions per capita or to further downscale targets at a more local level.

In Paper IV, we use per capita goals for climate and land use. However, such goals are just an average of the emissions per person per year in a specific country. It does not take into account how this may differ in terms of e.g. gender (Räty and Carlsson-Kanyama, 2009) or income (Pachauri and Spreng, 2002; Reinders et al., 2003). In Paper VII, the assessment is also done using an average quota of 0.82 tonne CO_2 eq. per capita. As it is a theoretical case of future emissions where we look at the average Swedish consumption and how it needs to decrease, it would have been irrelevant to set an individual emission right for citizens in Sweden. Instead, the fact that we have also set a goal on access to resources and services, i.e. both financial and non-financial resources creating opportunities for e.g. housing or education, has sparked qualitative discussions. These discussions within the project and reference groups as well as in case study municipalities, focused on how the strategies to achieve lower emissions impact on different groups and on who might not have access to resources and the type of injustices which may occur.

There is a lack of discussion on intranational justice perspectives in the official climate and energy targets reviewed in this thesis and such discussions need to be

taken up even though they may meet resistance and opposition from the more privileged.
Indicators in Paper I are also set as average per capita and we highlight the need for further disaggregation of data at an intranational level to better reflect differences related to e.g. gender or income, which could be a way of making such issues more visible.

Gasparatos et al. (2012) argue that sustainability assessments should include issues of intergenerational and intragenerational equity. However, in Paper VI, we found that distributional issues were rarely considered in the reviewed assessment tools. Walker et al. (2005) have argued that this lack of consideration in methods for evaluating and assessing policies in the UK may be one reason why environmental impacts are so unequally distributed. In Papers III and VI, we argue that there is need to further develop methods to include such considerations. Although some attempts have been made to include distributional impacts in existing tools the results are mixed. Munda (2009) gives an example with the widely-used cost-benefit method to rank different policy options, which is one of the tools reviewed in Paper VI. If groups of people are negatively affected by a decision, this is considered a negative social cost, an externality in standard economic terms or rather "cost-shifting" in the words of Martinez-Alier and O'Connor (1996). It is based on the compensation principle (Kaldor-Hicks) i.e. a sum of money to compensate the affected people. However, that cost is lower if applied to future generations or poor people. Munda (2009) exemplifies with the World Bank advocating in an internal report, ultimately made public, for the storage of toxic waste in Africa due to lower compensation costs. It is therefore important to make the values embedded in tools or the vested interests of involved stakeholders visible.

6.2 The need to discuss alternatives to current development

As we cannot predict the future, considering several alternative futures can increase the capacity to plan for other possible developments (van Der Heijden, 1996).
In Paper V, four backcasting scenarios are used to explore alternatives to business-as-usual which we argue help deal with uncertainty and can be a support for more informed decisions on how to minimise climate pressure and land use.
As we have previously discussed, economic growth has been a driver of GHG emissions and environmental impact (Raftery et al., 2017) and besides, continued economic growth cannot be taken for granted. Despite this, macro-economic models generally do assume continued economic growth (Ahlroth and Höjer, 2007). One counter-example however is a study by De Koning et al. (2016) investigating three different scenarios to keep global temperature increase below 2°C, which concludes that technological solutions combined with behavioural changes won't suffice and that a 50% reduction in economic growth would be necessary to approach the goal, although such a reduction is not on political agendas and the authors label that scenario a thought experiment.
According to Alfredsson and Malmaeus (2017), prospects for continued economic growth for the coming 50 to 100 years rather lean towards lower growth rates and it may be risky to continue with policy-making based on economic growth. Victor (2008) also argues that it may be wiser to prepare for stalled growth then to suffer

its effects. Malmaeus and Alfredsson (2017) highlight that negative effects from declining growth would occur mostly in the short term and partly because current policies rely on continued economic growth.
Indeed, there are very few examples of long periods of low growth (Malmaeus and Alfredsson, 2017) but in general most economists see a risk with unmanaged and sudden faltering growth in terms of e.g. rising unemployment and debts. However, some economists underline the fact that with the right adaptations to a new normal (Malmaeus and Alfredsson, 2017) negative consequences could be avoided in the longer term (Malmaeus, 2011; Martínez-Alier et al., 2010; Victor, 2008). When it comes to inequality, if global growth halts, the size of the pie or of the doughnut in our case, will be smaller and "there is less room for an unequal distribution of income and resources in a full world" (Malmaeus and Alfredsson, 2017, p. 59). And according to Woodward (2015), due to the ecological constraints affecting the growth rate of the global economy, the only remaining option to reduce global inequality is to increase the share of global growth that goes to those who are poorest, i.e. "changing the global income distribution to the benefits of the poorest" (Woodward, 2015, p. 58). Woodward (Ibid.) highlights the need to shift the focus on economic growth to the distribution of the benefits of such growth.
Exploring futures without economic growth or not relying on growth may help counteract such short-term negative consequences of faltering growth such as unemployment or indebtedness (Malmaeus and Alfredsson, 2017) by discussing what policies may be needed to tackle these different challenges. The stakeholder feedback from the case study municipalities and the reference group in the Beyond GDP Growth Project also showed that this was a much-needed discussion. Indeed, in Paper V, stakeholders within the project including a variety of societal partners, emphasised the need to discuss alternative futures with a longer time frame that are not restricted by short-term economic growth expectations but that rather embrace different visions of what society wants to achieve to tackle the pressing issues of environmental destruction and social inequalities. As the fear of negative short-term effects of halted growth may hinder the design of new policies, it is important to create positive images, which according to Boulding (1988) can help create positive action. Even though stakeholders had different views on whether a specific scenario was attractive and some suggested a combination of the different scenarios, the scenarios included no dystopia but examples of futures that fulfil goals and imply radical changes. The developed scenarios can therefore help design policies for planning for a more sustainable future that can work reasonably well under a range of possible situations.

The need for alternatives also had implications for how the four goals which the backcasting scenarios had to fulfil were formulated. In Paper IV, in order to avoid lock-ins, social goals were broadly formulated. Instead of using the categories of work and income suggested by Raworth (2012), which were considered too narrow, a target of resource security was instead opted for, as work and especially income are means for achieving resource security and the aim was to open up for other ways of securing resources such as those described in Paper V with sharing and borrowing practices or time banks in the collaborative economy scenario or with own production in local self-sufficiency. Besides, the social goals should be particularly relevant to the context of degrowth/low growth, which framed the four scenarios. Per capita GDP growth has commonly been equated to rising incomes leading to

richer lives and increased prosperity, reduced to its material dimension (Jackson, 2009). This is the main reason why it has been at the heart of policy-making across the globe for many decades (Ibid. 2009). Yet, Jackson (2009, p. 5) argues, "growth has delivered its benefits, at best, unequally". One of the selected social goals addresses, therefore, the access to resources, instead of merely income or employment, and the capabilities they give. It is also complemented by a specification of the distribution of resources and services.

6.3 The need to consider several indicators and geographical scales - Balance between simplicity and reductionism

In sustainability policy, the focus has long been on climate issues, both due to the urgency of the challenge and probably to the concerted regular international efforts to constantly re-evaluate the current status of the climate and the consequences of different mitigation trajectories e.g. with the work of the International Panel on Climate Change (IPCC). At a Swedish level, the Swedish EPA has been monitoring GHG emissions occurring as a result of Swedish consumption for several years. Steen-Olsen et al. (2012) have however emphasised the need to include several indicators simultaneously as policies developed with a focus on a single goal could potentially impair the fulfilment of other goals.

In Paper I, we present data for eight indicators; five for emissions to air and three for different resource use, to track the pressures from Swedish consumption which can contribute to a better follow up of the Swedish generational goal. It is noteworthy, however that some issues are currently not taken into account in the GHG emissions data in Paper I although they could have a significant impact on results: emissions from deforestation and emissions at high altitude from air travel. The current statistics for GHG emissions from Swedish consumption of 10.5 tonnes CO_2 eq. per capita may therefore be underestimated.

Although our results in Paper I indicate that, regarding the main product groups for which most impact occurs from Swedish consumption, there are some similarities between the indicator for GHG emissions and other indicators, we also find that there are some differences in both product groups and main countries as well. Only focusing on one indicator, which could seem attractive for the sake of simplicity and communication and hoping for synergies with other goals may miss other potentially important pressures. Besides, policies targeted at reducing GHG emissions for a certain product, e.g. through the phase-out of fossil fuels, may not necessarily entail a reduced pressure (e.g. water use) for that same product group although the product group may rank high for both indicators.

The issue of the geographical scale often used in environmental indicators is also worth discussing.

The indicators in Paper I are monitoring the pressures and resource use in other countries at a national level. However, according to Dearing et al. (2014, p. 228), “natural resource management takes place predominantly at regional scales as part of national and regional development planning”. Water or material intensive goods produced in regions with water scarcity or poor mining conditions may be important to identify and may require a further disaggregation of data to better link the environmental pressures to regional or local conditions.

6.4 The importance of evaluating scenarios and making goal conflicts apparent

As social and environmental issues are interrelated in social-ecological systems, approaches and tools to support decision-making towards more sustainable futures have to encompass a large variety of aspects, both environmental and social, and conflicts between such goals may arise. According to Munda (2009, p. 319), approaches that can provide systematic information about goal conflicts may "help to arrive at political compromises by making a complex situation more transparent to policy-makers and lay people". Returning to the discussion in the background section about the two levels of meanings of the word sustainability, identifying goal conflicts can help to move from the first to the second level of meaning. Such an analysis focuses on how to get to where we are aiming and what the consequences and underlying values are in different ways of setting targets, of disregarding some targets or groups of stakeholders without justification or in the way we value different aspects of sustainability. Goal conflict analyses can be useful to make the different interests from various stakeholders in a well-functioning democracy visible (Bartholdsson, 2011). Indeed, it may for instance slow down decisions put forward by lobby groups who promote projects and ignore potential negative environmental or social consequences. On the other hand, goal conflict analyses may also be lengthy and convey the idea that there is no solution to the problem at stake (Ibid.).

In Paper IV, we argue that considering these issues separately, for instance with the help of indicators and for the sake of reducing complexity and increasing user-friendliness, may give the impression that the issues are compartmentalised and disconnected. Although this might be needed in order to carry out a more in-depth assessment, there is need to balance between dealing with complexity by considering the different parts of a system and having a more holistic approach to sustainability issues. There is therefore a need to go back and forth between in-depth studies and all-encompassing ones that consider as many issues as possible and to analyse their relationship/interdependency.

Gasparatos & Scolobig (2012) have emphasised the need to consider both environmental and social aspects in assessments. In Paper VI, however, half of the papers reviewed regarding assessments of future scenarios did not include social aspects and most papers did not reflect on why aspects had been selected or left out, something we argue should be dealt with e.g. with the use of a procedural tool such as SAFS guiding the process and calling for a more transparent selection of aspects. This procedural tool also suggests the reiteration of the assessment of social aspects by considering the results from the environmental assessment in the first round as contextual factors in the second round.

In Paper III, we conduct a goal conflict analysis for scenarios that have to fulfil one climate target and highlight the positive or negative consequences for other sustainability goals, which means that scenarios can help identify trade-offs. We argue that the exercise of highlighting and analysing conflicts and necessary trade-offs is relevant for supporting decision-makers and anticipating challenges which they may face when drafting policies. Conflicts may not just arise in the long term, but also right now with regard to current policies. In Paper III, one strategy identified to meet the climate goal is through a decreased use of pesticides and improved nutrients recycling based on a small-scale agriculture and extensive farming model.

However, since the 1950s, the agricultural sector in Sweden has been characterised by size rationalisation with fewer and larger businesses (Andersson et al., 2017). This focus on large-scale intensive agriculture may conflict with that strategy. Goal conflict analysis may, therefore, also be valuable for current or short-term policies.
However, one methodological challenge in Paper III was that we could not assess all the aspects that we originally planned to address. Indeed, the goals that were originally analysed were, besides the Swedish environmental goals (Government Bill 1997/98:145; Government Bill 2000/01:130; Government Bill 2004/05:150), the gender equity goals (Government Bill 2005/06:155, 2005), and the public health goal and 11 associated objective domains (Government Bill 2004/05:33; Government Bill 2007/08:110)[14].
The aim was to have official public policy goals from different fields that covered social issues. Gender equity goals were specifically chosen, as the issue of gender has rarely been addressed or at least not sufficiently in futures studies (Gunnarsson-Östling et al., 2012), something we suspected was also valid for other social issues. The national health goal and its target areas were chosen as they covered a large array of social issues from areas usually and typically associated with health (such as physical activities or eating habits) to broader prerequisites for good health such as participation and influence in society or access to resources. Yet, not all aspects of the goals could be analysed as - due to the focus on land use - the scenarios did not provide sufficient information on social issues to enable identification of potential goal conflicts or synergies. The table listing potential conflicts and synergies between the climate goal and social goals (see Fauré, 2016) was ultimately removed from Paper III.
This was an important learning outcome and one of the reasons for suggesting the use of multi-target backcasting, which we then performed in Papers IV and V, a method that although challenging had several benefits. Setting four goals for the backcasting scenarios to fulfil helped broaden the narrative descriptions in the scenarios to also encompass social aspects regarding access to resources and participation. These could then be critically discussed by the project stakeholders in a participatory way and the social goals could be qualitatively assessed regarding for instance, whether different scenarios would entail certain groups being excluded. In the collaborative economy scenario for instance, with a focus on networks, stakeholders were concerned with the fact that some people could be excluded due to a lack of skills, whether social or practical (Paper V). In some cases, some revisions were made in the second description of the narratives (Gunnarsson-Östling et al., 2017), e.g. regarding the family constellations that were described rather in-depth in the first version (Svenfelt et al., 2015) but were deemed to be outside the main scope of the scenarios. Therefore, such a process contributed both to the further development and the assessment of the scenarios. Similarly, in Paper VII, the assessment of the scenarios served both as honing the scenarios, where information was lacking in the narratives (e.g. when it came to food and diets or international air travel) but also to estimate what would be needed in terms of radical change for the scenarios to stay within the set quota of GHG emissions.
On the other hand, the multi-target backcasting exercise proved difficult methodologically and in particular the question of how to manage several targets

[14] Paper IV includes the goal conflict analysis with the environmental goals, whereas in Fauré (2016) the analysis against the social goals can also be found.

simultaneously. This issue was already raised in Paper III, i.e. before we developed scenarios that had to fulfil four targets. We considered whether managing the targets could be done through iterations or if one target sets the prerequisite and restricts the room for manoeuvre for the other goals. Both can be said to be true in our application of a multi-target backcasting within the Beyond GDP Growth Project in Paper V. Although the climate target may have been the easiest one to relate to when building the scenario narratives compared to the more complex land-use goal and may have influenced them to a higher degree, the social goals have been enabling discussions on potential risks and opportunities for different groups in society depending on the scenario at a rather early stage in the process (Paper V). This was also thanks to the participatory character of the process with a diversity of disciplines represented in the research group involved in the project, the case study municipalities and the reference group of societal partners. Nevertheless, the scenarios were not assessed against other potential goals apart from the four goals described in Paper IV.

In Paper I, we found that most environmental pressure and resource use (apart from land use) is occurring in other countries and according to Peters et al. (2011), about 26% of global CO_2 emissions are embodied in trade. And as Munda (2008, p. 25) puts it: "trade may be in fact the appropriation of the carrying capacity of other territories". Therefore, efforts to work toward greater sustainability need to permeate other policy fields. In an assessment of the Swedish generational goal, the Swedish Environmental Protection Agency (Swedish EPA, 2012c) estimates that the scope for measures at a national level in order to facilitate the goal's achievement is substantial. However, world trade prices or agreements set limits on some areas, for instance regarding under which conditions products are manufactured in other countries.

Goal conflicts may sometimes be unavoidable and require trade-offs. However, other goal conflicts may be only illusory, and a change of strategy to achieve the goal could alter the result. In Paper III, the choice of energy type was decisive. Opting for electricity from wind turbines, hydropower or sun means putting less strain on land resources, which may be scarce in the future, as competing needs from food and energy production may increase with a growing population. However, choosing that option may still have impacts on other goals. Placing wind turbines in the mountains may, for instance, conflict with the Swedish environmental quality objective "a magnificent mountain landscape," due to the noise of wind turbines. Ultimately, prioritising sustainability goals may be needed.

In paper VII, two scenarios assume a large increase of ICT devices and services. The Shift Project (2018) pinpoints one implication regarding the wide array of metals, rare or critical and whose accessibility today is limited (at current cost, with current technologies or due to geopolitical reasons) used in electronic equipment. Many of these metals are difficult to recycle and new ICT devices will therefore require more extraction (Ibid.). As the use of some metals in electronics (e.g. indium) competes with the demand for the same metals from other technologies such as renewable energy or low-carbon technologies (Ibid.), it may create a goal conflict between the goal of decarbonising the energy mix and increasing digitalisation in the hope of reducing carbon emissions.

When it comes to potential synergies with other environmental goals, such as land use and biodiversity preservation, the switch to diets with no or much less meat may

require less agricultural land (Bryngelsson et al., 2016; Röös et al., 2016) and this in turn has positive implications on biodiversity preservation (Millennium Ecosystem Assessment, 2005).Yet, many red-listed species are found in semi-natural pastures (Swedish EPA, 2016). The local self-sufficiency scenario, in which grazing is allowed as long as it contributes to biodiversity conservation (Röös et al., 2016), is thereby the only scenario that can have a positive impact on the preservation of such species.

Gasparatos et al. (2008) argue that most sustainability assessments have thus far built upon reductionist tools and methodologies such as the use of a single indicator, goal, or a single sustainability dimension. Although such tools may be more user-friendly (Costanza, 2000) due to the appeal of simpler tools when communicating with decision-makers, these may not be appropriate for the study of complex systems such as ecosystems and societies and inadequate for forming sustainability policy (Munda, 2006). Gasparatos et al. (2008) advocate the use of participatory sustainability assessment frameworks such as methodologies using multi-criteria evaluation, another method for prioritising between options presented in Paper VI.
It is important to reflect upon the values embedded in assessment tools and what is included or excluded. Munda (2009) has highlighted that issues of power relation and hidden interests should be made visible in decision-making. Any policy option always implies winners and losers, it is thus important to check if it looks good just because losers are not taken into account (Munda 2017,p.5). One option might seem preferable because one dimension (e.g. the environmental) or a specific social group has been ignored in the evaluation of options and such omissions have to be made visible (Munda, 2009).
According to Gasparatos et al. (2008) there is a need for stakeholders and analysts to become aware of the underlying assumptions of assessment tools, if the final outcomes are to be transparent.

6.5 Tension between two disciplines: future studies and assessments

As previously mentioned, Robinson (1990) has highlighted that the assessment part, which is the last of six steps of his suggested iterative process for generating backcasting scenarios has been the most neglected and in Paper VI we conclude that it still is.

In Paper VI, we discuss that assessment of future scenarios is at the frontier of two disciplines, sustainability assessments and future studies and that some tension may exist between the two.

First, we found that the choice of method is dependent on the type of scenarios and those assuming longer time frames and a higher degree of change, such as transformative normative scenarios, may require a different approach than short-term forecasts, for instance whether a quantitative or qualitative approach might be preferable. It is more difficult to make a precise quantitative analysis the longer the time frame is and the larger the uncertainty is. Besides, assessments practitioners, especially those working quantitatively, may expect future scenarios to provide precise and detailed information about parameters to use in the assessment. Futurists on the other hand rather expect scenarios to remain not too precise in order to avoid lock-ins, especially in the case of long-term transformative scenarios such as the backcasting scenarios assessed in Papers III and VII, and rather see the assessment as a basis for discussion. Whereas the context of justification is central to forecasting studies, the context of discovery may essentially be the basis of backcasting studies even though the context of justification also plays a role and methods from different scientific disciplines are needed to address both. Backcasting scenarios' aim to open for different alternatives may contrast to the more narrowing process of assessments.

Although we underline the fact that our review of assessment of scenarios in paper VI is not comprehensive, as the purpose was to make an inventory of methods used, one reason why some assessments of scenarios might have been omitted could be that the term assessment is sometimes not used by futures practitioners to the benefit of other terms such as e.g. analysis.

Dreborg (1996) argues that current trends or behaviours are sometimes wrongly interpreted as laws of nature. And indeed, many assessment methods are based on current trends and current categories, whereas transformative backcasting scenarios imply a trend break and a redefinition of certain categories or indicators that have been taken for granted.

One example of a redefinition of categories can be seen in Papers V and VII as regards the dividing line between work and leisure and formal and informal work. Environmental statistics, such as those used in Papers I and VII, usually look at what is being purchased and monetarised. Yet, in the scenarios local self-sufficiency or collaborative economy, goods could be produced for direct consumption without any monetary transaction and services provided by making use of time banks.

Robinson (1990, p. 838) states that "it may also be the case, given the level of uncertainty inherent in future analysis, that qualitative impacts (the "feel" of the scenarios, illustrated by rich textual descriptions) may be as, or even more, meaningful than estimates of quantitative impacts.

However, in Papers V and VII, the backcasting scenarios had to fulfil quantitative goals, something we argue in Paper VI may require quantitative or semi-quantitative assessments and, due to the long-term time frame and the radical changes implied, the use of a combination of methods such as the tailored assessment conducted in Paper VII. The aim of such assessments is not to give a precise answer on whether the scenarios exactly fulfil the quantitative goals and it is important to communicate that clearly in order to not give a false sense of accurateness or certainty. The aim is rather to identify areas that are crucial in order to reach the goals and to give an order of the magnitude of the changes needed. In Paper VII, for instance, when a quantification of the transport sector was done and presented, the reactions to the change varied. In the narrative description of circular economy (Gunnarsson-Östling et al., 2017), it was described as "car ownership has dramatically decreased and the increase in passenger travel has mostly switched to electricity-driven public transport". When this description was quantified (see Paper VII), it implied that rail traffic would increase tenfold, which seemed like a much more dramatic change than when expressed in words. A quantification of aspects from scenario narratives may therefore better reveal what is meant by an increase or a dramatic reduction and may in fact also be a way for stakeholders involved in a project, especially when many and diverse, to agree on a level of the changes needed.
Originally the plan was to complete the climate assessment of the scenarios directly after the first draft of the scenarios was produced. That would have contributed in correcting some inconsistencies in the narratives, such as, for instance, the fact that there are ruminants in the scenario collaborative economy although there is no room for that in the climate budget. This process could have been conducted within the project and reference groups. One advantage instead of completing the assessment once the scenarios were revised was that some inconsistencies within scenarios could be corrected following discussions on the text, thereby providing a more coherent basis for assessments.

7 Conclusions

The overall aim of the thesis is to explore how sustainable and just futures could be developed and what they might look like.

Eight indicators to track Sweden's environmental impact abroad are presented
Currently, most impact from Swedish consumption in terms of environmental pressures and resource use occurs abroad, except for land use. China, Russia and the rest of Asia-Pacific are the top countries or regions where most pressure or resource use occurs and construction, households' direct emissions and food products top the list of product groups. For indicators such as GHG emissions or land use, current levels are far above what is considered sustainable.

As business-as-usual does not seem to be leading us in the right direction, there is a need for more radical changes. Considering alternative futures may be a way to widen the scope of possibilities that can be scrutinised and discussed. In this thesis four target-fulfilling scenarios based on what we really aim to achieve in terms of environmental and social sustainability rather than focusing on continuous

economic growth are developed, illustrating different potential strategies: collaborative economy, circular economy in the welfare state, local self-sufficiency and automation for quality of life.

These scenarios have to fulfil four goals by 2050: two environmental goals that imply large reductions in GHG emissions and land use in respect of consumption in Sweden and two social goals related to resource distribution and participation in society, the main challenge for the latter two is to ensure that they are met with environmental constraints too.

Scenarios are often used to explore more sustainable futures - but how sustainable are these futures? Future scenarios need to be evaluated in order to assess their implications, positive or negative, for environmental and social goals.
Yet, this thesis (Paper VI) shows, through an inventory of assessments methods that have been used in practice to evaluate future scenarios, that half of the 38 reviewed assessments of scenarios only considered environmental aspects and sometimes only GHG emissions and the reason for choosing a certain assessment method or for selecting (and rejecting) sustainability aspects was rarely explained. This thesis also highlights that no single assessment method can be used to cover all aspects, instead several methods need to be combined.

In Papers III and VII, a selection of methods is implemented to assess backcasting scenarios. In the first case, a goal conflict and synergy analysis is conducted for another set of backcasting scenarios for Sweden, all fulfilling a climate goal of zero net emissions by the year 2060. The goals analysed are the Swedish environmental goals. In the second paper (Paper VII), an evaluation of what it would mean, in terms of consumption levels and categories, to keep Swedish consumption (both private and public) in the four above-mentioned scenarios within a set GHG emission quota in line with a maximum global temperature increase of 1.5 degrees Celsius. Radical changes need to happen in all reviewed scenarios but to different extents when it comes to e.g. car ownership, floor areas in houses or reduction in goods and service consumption. Besides this, for two scenarios, the diet needs to be vegan. The quota does not allow for international air travel or at least to a much lower extent than today.

As mentioned earlier, environmental pressures and resource use are unevenly spread between and within countries. This thesis presents a review of existing climate and energy targets at the global, national, and municipal levels, where intergenerational, intragenerational (i.e. between generations and within one generation) and intranational (within a country) justice perspectives are lacking. The reviewed climate and energy targets suggested in the scientific literature and by Swedish NGOs address intragenerational justice but still lack the other two perspectives to a large extent.
Both inter- and intragenerational justice perspectives should be made more concrete and explicit when setting goals, if the outcomes are to be just or at least transparent as to how they will affect future generations or already affect the current one. Sweden not only needs to monitor its environmental impact in other countries, but its national sustainability goals such as the recently adopted Climate Policy Framework and its overarching goal of zero net emissions by 2045 (Swedish Climate Policy

Council, 2018) should also reflect this ambition, e.g. by adopting a consumption perspective.
Distributive issues and the potential impacts on different groups of people were also rarely addressed in the abovementioned review of assessment methods.

Based on the findings of this thesis, I would like to highlight some implications from the results presented above.

Several indicators should be used when monitoring the environmental pressures and resource use from a consumption perspective, in order to avoid problem shifting. Similarly, when planning for more sustainable futures, social and environmental issues should be considered simultaneously. This should preferably be done at an early stage, e.g. with the use of multi-target backcasting scenarios.

Exploring alternative futures can help articulate different strategies to reach sustainability goals and can be a basis for discussing diverging views on how to reach such goals and the consequences of these different strategies for environmental or social goals can be discussed. This thesis also highlights the need to look at alternative futures that focus on demand-side changes too and not just on changes in the production systems.

Not all relevant sustainability issues can be handled at once when developing scenarios and it is important to conduct sustainability assessments.
This thesis stresses the need of reflecting on the purpose of the assessment and of combining different assessment tools in order to cover both environmental and social aspects and include often overlooked issues such as distributional issues. New types of assessment tools to cover e.g. gender equity issues.
Identifying and addressing goal conflicts can lead to more informed strategies both with regard to conflict with future policies and also current policies that might be an obstacle to more sustainable futures. Some conflicts may be avoided due to a change of strategy whereas others may not, and in such cases, when making a decision, what is prioritised or not, whether it is a certain group in society or a certain issue (climate vs. water) would at least become more transparent to both policy-makers and lay people.
Since assessments are rooted in different scientific disciplines it is important to reflect on the embedded values of assessment tools. Revealing and questioning assumptions in e.g. models or results is vital if assessments are to serve their purpose as a basis for decision-making. For instance, underlying assumptions in assessment tools with implications for justice should be made visible.

In short, this thesis emphasises the need to consider alternative futures to business-as-usual as a way to challenge taken-for-granted assumptions about e.g. continued economic growth and critically examine how sustainability goals are set, what they include, exclude or imply and what they are assessed against and how.
This implies moving from the first level of meaning of sustainability where everyone can agree on a definition but no concrete and practical guidance can be gained to the second level where conflicts arise and values differ. If these conflicts are made visible, decisions can be informed and made in a more transparent manner.

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