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Two Contrasting Scenarios for a Zero-Emission Future in a High-Consumption Society

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Abstract: The Paris agreement on climate took effect on 4 November 2016. The agreement plans on holding the increase in the global average temperature 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. This paper compares an ecological modernisation (EM) development path with a degrowth development path, using urban and land-use planning impact on housing and transportation as cases. The two positions (EM and degrowth) agree on the need for a fundamental reduction in climate gases but disagree on which strategies should be pursued. EM transitions do not challenge the values associated with the capitalistic market economy and believe that policies, such as the right-price signals, should nudge producers and consumers in an environmentally benign direction. Conversely, degrowth rejects the EM belief in green growth, and holds that it will not be possible to decouple the economy from environmental loads to the necessary extent if the economy keeps growing. We conclude that we need a fundamental transformational change in society, i.e., a steering away from the growth ideology, and pursue policies that introduce maximum housing standards and limit mobility to succeed with the goals of the Paris agreement.

Keywords: ecological modernisation; ecological modernisation; degrowth; zero-emission society; scenario

1. Introduction

This paper presents the response to a call from the National Energy Agency of Norway for research project on scenarios of a Norwegian low emissions society. As stated in the call, the objectives with the project are to improve the understanding of how the Norwegian post-2050 society might look like, identify framework conditions that enable or restrict the materialization of that society, and gain insight into how strategic national political choice made today is linked to different societal states of the future.

It is interesting to note that the call is not confined to the mainstream thinking about a sustainable society based on the growth ideology. Instead, the intrinsic conflict between the economic and population expansion and the finiteness of the Earth's resources is well recognized and considered as the core of the problem that needs to be addressed in the project. It is the very first time that any national government in Norway has officially related to the international discourse on degrowth. The open-mindedness of the call brings new horizons into the discussions on a Norwegian future sustainable society.

The UN conference on climate change in Paris in 2015 has agreed on the goal of "holding the increase in the global average temperature to well below 2 °C above preindustrial levels and pursuing efforts to limit the temperature increase to 1.5 °C" [1]. To achieve this goal means substantial

cut in greenhouse gas (GHG) emissions—in principle to achieve what IPCC describes as "net zero emissions"—and the need to move out of the fossil fuel economy. According to proposed EU regulations on binding annual greenhouse gas emission reductions, Norway has to reduce its greenhouse gas emissions by 40% by 2030, compared to the 2005 level. The Norwegian Parliament voted in June 2016 that Norway is to become a carbon neutral society by 2030. Related to this, governmental white papers and the National Transport Plan state that there should be zero-growth in person transport by car in Norway's major urban regions.

The ambition and urgency in achieving the global and Norwegian climate goals and reduction in GHG emissions suggest that immediate actions have to be taken. However, there are still controversies regarding which actions are most effective which strategies and pathways we should follow. There are different norms on what is a future sustainable society, and that will shape socio-economic structures and relations of societal actors in different ways. The implications for how to pursue the sustainable society and the potential barriers in the process are therefore varied. A strategic choice today is significantly important for realizing a carbon neutral and sustainable society in future.

Even though the awareness of environmental deterioration and climate change has increased, policy efforts to curb GHG emissions have been limited and the policies themselves have been far from effective [2]. This paper contributes to the academic discourse on the implications of sustainable development to wealthy countries, such as Norway. The publication of the report *Our Common Future* in 1987 by the World Commission on Environment and Development [3] marked a renewed interest in environmental issues—the so-called second wave of environmentalism [4]. The debate is still on-going, with profound discussion about the content of sustainable development [5,6]. Despite diverse interpretations of the concept of sustainable development in the policy and scientific discourse, the most frequently cited definition is from *Our Common Future*. This definition states that sustainable development should meet "the needs of the present without compromising the ability of future generations to meet their own needs" [3] (p. 43). In this paper, we develop and compare the ecological modernisation (EM) and the degrowth scenarios, which are contrasting positions in the sustainability discourse. Both positions discuss policy and social science perspectives in addition to economic and environmental interactions.

Our analysis takes place in two steps: first, we describe the two scenarios and then compare how they will achieve sustainable development in wealthy countries; and, second, we address the practical implications of these two scenarios for land use, housing, and transportation at the urban level. We focus on the urban level because several studies show the urban environment to be crucial for meeting the goals of fundamental reductions in climate gases [7]. In addition, relatively few studies have made a thorough comparison between degrowth and EM [8,9] or discussed the practical implications at the urban level using the scenario methodology. Thus, this paper contributes to the discourse by discussing how to achieve sustainable mobility [10–12] and sustainable housing [9,13] in urban environments.

Our approach for addressing the objectives of the project has drawn on the scenario method. Through making scenarios, the differences between strategic choices and the advantages and weaknesses of each strategic choice will be made explicit. This will provide analytical foundations for making political choice. We develop and compare two scenarios: "Ecological modernisation" and "Degrowth". Ecological modernisation and degrowth are contrasting sustainability discourses discussing policy and social science perspectives in addition to economic and environmental interactions. We apply a back-casting approach in discussing challenges and potentials of achieving the two scenarios. Based on the expertise of the research team, we narrow the scope of the paper down to the urban development domain including housing, transportation and land use. The research questions are formulated as follows:

(1) How may a low-emission Norwegian 2050 society look in an "ecological modernisation" versus a "degrowth" version?
(2) How may the development path towards the two scenarios look like, and how may they in particular differ with respect to economic, social and cultural structures? Moreover, how may socio-economic structures and technology play out as barriers and enablers?
(3) What are the problems and benefits of choosing the described development path leading towards a "degrowth" versus that of an "ecological modernisation" 2050 low-emission scenario?

To answer these research questions, the next section begins with an elaboration of the scenario and back-casting approach used in this paper. In Section 3, the norms, principles and rationales of the ecological modernisation and degrowth scenario of a sustainable society are introduced and compared. This is followed by a discussion of how urban development in Norway would look like by applying the two overarching scenarios. After sketching the future urban development scenarios, we discuss the socio-economic structural conditions hindering and enabling the achievement of the degrowth versus the ecological modernisation Norwegian society. In the final section, we conclude the paper with some reflections on how the discussion in the field of urban development is relevant to other sectors.

2. Methods

2.1. Scenario Building

According to Schwartz [14] (pp. 3–4), scenarios are "stories about the way the world might turn out tomorrow", and "a tool for ordering one's perceptions about alternative future environments in which one's decisions might be played out". In this study, we present two scenarios representing different images of the future that might exist for building up a Norwegian low and in the end zero emission society. Our focus of the article is to discuss the barriers that can make it difficult to realise the two scenarios, and to a less extent we describe the processes and developmental pathways for the two scenarios. The two scenarios are "ecological modernisation" (EM) and "degrowth". Although they share the same goal, they differ in how the society is organised, which mechanisms of changes come into play, and thus in pathways towards this goal. The two scenarios are developed based on existing global environmental and sustainable development discourses and reflections regarding the current development trend in Norway. Generally speaking, the EM scenario represents the dominant sustainable development discourse and mainstream political solution to environmental problems both globally and in Norway, whereas the "degrowth" scenario is often viewed as more innovative, radical and transformative—and at the same time also viewed as more political controversial. These two broader scenarios for societal development are exemplified by two narrow scenarios specific to urban development, housing and transportation sectors in Norway. The year 2050 as the time horizon for the future image is near enough to be imaginable and far enough to allow major changes in technologies, lifestyles and cultural norms. The time horizon is also long enough to be captured by current climate change scenarios. This choice of time horizon also takes into account the reflections presented by Meinshausen et al. [15], in which they argue that most of the GHG reductions have to be done well before 2050 in order to reach the 1.5 to 2 °C goal.

In developing the two scenarios, we start by identifying the rationales and principles of an EM society and a degrowth society, drawing on academic theories and debates on both EM and degrowth. The primary objective of the scenarios is to build up a Norwegian low-emission society, and the achievement of this goal should also be evaluated against the criterion of social justice. The EM scenario can be seen as a normative *preserving* scenario which aims to fulfil a low-emission society within prevailing discourses and societal structures, but still allowing for adjustments—some of which can be challenging to implement. The degrowth scenario represents the normative *transforming* scenario which needs more than marginal adjustment of existing structures in order to reach the target [16]. Then, these theoretically informed rationales are contextualized into the Norwegian society in the field of urban development including the housing and transportation sectors. The images of the

future are depicted by focusing on the elements shown in Table 1. We mainly resort to a qualitative approach to articulate the scenarios with a focus on the consistency of the storyline, i.e., how the different elements look like in each scenario, why they happen in a certain way and how they are interrelated. The two target-fulfilling images in the urban development domain are constructed based on accumulated knowledge and expertise of the authors from a range of previous specific studies. Lastly, we assess the likelihood of fulfilling each future scenario by analysing the potentials and limitations of the current physical, technological and socio-economic conditions. Our analysis is not confined to the urban development field but is embedded within the discussion on the broader societal structures as hindering and enabling forces. It will provide knowledge on how general trends counteract or facilitate the target fulfilment.

Table 1. Contents of the scenarios.

Scenario	Normative Perspective	Objective	Constitutional Elements	
			Broader Scenario (Societal Level)	Narrow Scenario (Urban Development)
Ecological modernisation (EM)	Preserving society	Norwegian low-emission society	• Ontologically, human-nature relationship • Perceptions on growth • Solutions to environmental problems and social justice • Socio-economic organizations	• Urban spatial structure: pattern, size, efficiency • Housing development: size, volume, housing type, building energy efficiency, location • Transportation: traffic volume, modal split, vehicle efficiency, fuels
Degrowth	Transforming society			

2.2. *Back-Casting Analysis*

The normative scenarios suggest the adoption of a back-casting approach in the study. Back-casting is particularly appropriate in exploring how Norway moves towards a low and zero emission society, a topic that is complex and needs major change and where the dominant trends are part of the problem [17]. Back-casting has not only the normative and goal-oriented side, but also the analytical, descriptive and critical side, that is: how can we attain the desirable states as articulated in the EM and degrowth scenarios [18]. To address this analytical side, a much deeper analysis of the fundamental mechanisms of society that may influence the realization of the scenarios is needed. In doing so, back-casting provides a holistic and systematic perspective on the transformation process. Höjer and Mattsson [18] suggest that the analysis on how to attain the desired states includes working back from the desirable future to check the feasibility of the scenarios in current physical and social conditions, identifying necessary measures and actions for the realization of the scenarios, and during this process employing models or other tools to help quantify the consequences of different measures. In this study, as indicated in the last step of scenario building, we will primarily focus on detecting the feasibility of that future under present socio-economic and technological conditions, and therefore revealing structural obstacles and institutional gaps that may prevent the attainment of the desired future images. It is the so-called pathway-oriented back-casting which emphasizes on exploring the gaps between the sustainable image of the future and today [19]. In addition, there is an increasing call for including the analysis of social structures and conditions in back-casting studies for sustainable development [19,20]. However, we will not propose concrete policy measures and implementation plans that can lead to the trend-breaking changes.

The discussions on the structural mechanisms as enabling or hindering forces in each scenario cover the following dimensions: economic structures; social and cultural structures such as consumerism, lifestyle, value, and political system; and technology.

3. The Two Scenarios

3.1. Main Characteristics of the Scenarios

When developing the two scenarios, we have done so along four axes: ontology (how the scenarios relate to the human-nature relationship); perceptions of economic growth and how this relates to the concept of sustainable development; the main approach when presenting solutions to environmental problems; and the stated preference regarding socio-economic organisation. Table 2 sums up how the two scenarios differ along these axes.

Table 2. A comparison between ecological modernisation and degrowth.

Main Axis	Ecological Modernisation	Degrowth
Ontology	• Economy-centrism, anthropocentrism	• A laminated totality
Perceptions on growth	• Growth is not antithetical to sustainability	• Long-term growth is neither environmentally possible nor socially desirable
Solutions to environmental problems	• Can be found within the context of industrial capitalism without challenging the growth rationality • Absolute decoupling is plausible • Technological innovation and science are key solutions	• Cannot be achieved without jettisoning the growth rationality • Absolute decoupling is a delusion • Eco-efficiency technologies and substitution are not sufficient • Downscaling of production and consumption is key to solve environmental problems
Socio-economic organisations	• Transformations within the capitalist mode of production and consumption	• Marginal changes within capitalist system are not enough • Deep structural changes in the socio-economic configurations and associated norms and values are needed

3.2. Ecological Modernisation

In the 1960s and 1970s, the industrial and capitalistic character of modern societies was blamed to be the dominant factor in bringing about environmental problems, leading to the critiques on growth [21–23]. Admitting that ecological crisis is associated with the existing institutions of modernity, ecological modernisation (EM), however, challenges this growth- and capitalism-critical position, and instead tries to reconcile economic, environmental and social development goals within the capitalist organization of production and consumption. The emergence of the EM position can be said to be rooted in the 1980s in an era of neoliberalist globalization, the "new economy", and the belief in developing economic, social and environmental "win-win" policies [24]. EM is a reaction to environmental problems, but according to Hajer [25], could also be viewed at a reaction to the solutions presented by radical environmental movements of the 1970s—which heavily criticised the goal of continues economic growth. Thus economic modernisation represents a new conceptualization of the relationship between economic growth and environmental protection in which the latter is not a burden upon the economy and the care for the environment can be internalized by the existing political, economic and social institutions.

EM is seen as a process of industrial society, and as such, the basic principles of industrial society, including the economic rationality in the market economy, are not challenged [26]. Instead, the process of EM is highly dependent on market logic and competition for innovation. The adherents of EM believe that "there is no principle or theoretical argument making a 'modern' organization of production and consumption and its technology antithetical to sustainability" [27]. Growth is not considered as antithetical to sustainability, because negative environmental impacts can be decoupled from a growing economy through environmental technological innovations addressing eco-efficiency [28].

Modern science and technology are central institutions for the environmentally induced rationalization of production and consumption [29]. The conceptualization of technological change

has widened in EM discourse from "end-of-pipe" technologies, through preventative technologies, to "structural change of socio-technological systems" [26]. The latter combines technological hardware with reformed institutional settings such as new management systems, ownership relations, incentives, etc. While environmentally friendly technologies are the main solutions to environmental problems, proponents of EM argue that their perspective cannot be labelled as merely a "technological fix" approach. They emphasize the social construction of technology. According to EM advocates, the failures so far in obtaining a sufficient decoupling of energy and GHG emissions from economic growth are exactly due to the lack of proper social policies, e.g., relatively low energy and carbon prices. To decouple energy use and GHG emissions from economic growth, we should introduce more effective regulatory standards, financial support, and pricing of carbon emissions [30].

Although EM does not disassociate itself from a capitalist organization of production and consumption, it does require reforming the existing institutions in order to address environmental problems in a more structural manner [24]. In favour of technological innovation and diffusion, such changes include "ecologizing the economy" through institutionalizing ecologically rational actions into the central social institutions of modernity (such as the economic sphere, the political sphere, the cultural sphere, etc.); as well as government taking the role of "enabler" of market forces, providing incentives, standards, and regulations, and "economizing of ecology" by placing economic values on the environment.

More recently, EM has been experiencing a "consumerist turn", complementing the original emphasis on technological innovation and production by a supplementary focus on changing household consumption and lifestyle—also applying the concept of sustainable consumption [24]. However, there are much more divided opinions among EM proponents regarding the definition of sustainable consumption and the efficacy of consumption-oriented strategies than there are on the technological innovation in the production sphere [31]. When it comes to strategies interfering with consumers, EM seeks to draw attention to improving consumption efficiency through applying sociotechnical innovations in everyday household practice and changing consumption pattern by substituting unsustainable products with less environmentally harmful products. Strategies aiming at reducing the volume of consumption seem to fall out of the scope of how sustainable consumption is defined by proponents of EM [32].

From the above description, it can be seen that EM primarily takes an econocentric capitalism [33] and anthropocentric approach [34] to environmental problems. Solutions consist in the internalizing of environmental issues into the technological sphere by virtue of economic agents. This reflects an ontological belief of econocentrism and anthropocentrism where attributes of biological reality are seen from the viewpoint of the level of market and human society, and explanations and solutions are reduced to the elements at that level. Properties of nature are ignored. This ignorance leads to the belief that no absolute limits exist but "limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs" [3].

The discourse of EM has a strong association with the dominant ideology of neoliberalism and its concrete embedding of environmental economics, where market is promoted as the most efficient and effective way to deal with environmental problems. What is shared is also an optimistic attitude towards economic growth and the potential of changing into an "environmental friendly" mode of economic growth. This optimism permeates the international discourse on "sustainable development" advocated by the Brundtland report. It is considered there that economic growth not only in poor countries but also in industrial countries is important to alleviate poverty of the world's poor, and thus being a necessary precondition for sustainable development. Although EM cares mainly about the environment and has nothing to say about social sustainability [35], its strong connection to the political neoliberal agenda and its acceptance of the growth rationality suggests that we should consider the implications on the issue of social sustainability by taking into account these broader social contexts. In an EM society, continuous economic growth makes it possible to enhance the consumption levels and living standards of the least well-to-do through the so-called "trickle-down

effect". However, the capitalist system in its neoliberal form tends to exacerbate inequality within as well as among countries [36]. In order to counteract this tendency, strong re-distributional policies must be in place, but the strong neoliberal institutional arrangements will constrain the applicability of such policies. The potential unemployment issue due to increased labour productivity has to be solved by generating more economic growth in the EM scenario. The society is thus operating along this line: higher productivity, higher income and higher levels of consumption.

3.3. Degrowth

The first international Degrowth conference in Paris in 2009 marked a renewed interest for degrowth—a concept which has its historic roots back to the 1970s inspired by scholars like Georgescu-Roegen [37] and Andre Gorz [38]. The reinvigoration of degrowth is a response to the current multiple crises characterized by ecological deterioration, social injustice and economic recession, as well as the unsuccessful attempts of solving these crises based on the growth ideology. Degrowth is a normative project that "challenges the hegemony of growth and calls for a democratically led redistributive downscaling of production and consumption in industrialized countries as a means to achieve environmental sustainability, social justice and well-being" [39] (p. 209). Although the core idea of degrowth lies in the shrinkage of production and consumption levels, it embraces more than that, and challenges the ideology of growth and envisions a deep socio-ecological transformation [40]. The transformative nature of degrowth implies a break with business-as-usual pathways and suggests a radical change of lifestyle, attitudes, social norms, institutions and value systems distinct from a growth society.

Ontologically, degrowth transforms the cosmological order in the respect of the relationships between human beings and the natural worlds. As opposed to the ontological belief of modernity and hegemonic neoliberal economics where anthropocentrism takes hold, degrowth, partly inspired by ecological economics, holds a nature-centred worldview, embedding human beings in the natural world as a subset of and conditioned by the Earth's ecosystem—thus linking back to the standpoint of eco-philosophers like Arne Næss. This has led to the acknowledgement of the existence of the biophysical limits of planets to human activities, thus the denial of unlimited economic growth.

For degrowth advocates, endless economic growth is neither environmentally plausible nor socially desirable. Human prosperity without economic growth is possible and obtaining the goals of human development, well-being and ecological sustainability is not conditioned on economic growth [41,42]. Instead, the ideology and practice of economic growth is addressed as one of the root causes of social, political and environmental degradation [40,43].

Compared to the EM paradigm, these beliefs of degrowth imply different approaches to and attempts for the pursuit of ecological sustainability, quality of life, and social justice within and among countries. Regarding ecological sustainability, the EM idea of "decoupling" economic growth from adverse environmental impacts through eco-efficiency strategies is questioned. It is argued that absolute decoupling is implausible and even a delusion [9,44,45]. In addition, eco-efficiency improvements in a society dominated by the growth ideology are likely to be converted into higher levels of production and consumption, offsetting the expected environmental benefits or even making the efficiency strategy counterproductive [46,47]. The key to reduce the environmental impacts as much as needed in order to stay within the biophysical limits of the planet is reduction in the scale of the total economic output [48]. A sufficiency strategy seeking to lower the affluence level in the Global North is proposed as a necessary way to cope with environmental unsustainability.

Reducing consumption does not necessarily entail a decrease in well-being or quality of life, but opens up freedom for the pursuit of non-consumptive and non-materialistic sources of life satisfaction. People can live meaningfully and happily by maintaining a minimally sufficient material living standard and pursuing non-materialistic sources of meaning and satisfaction, such as self-esteem, feeling of belonging, and own interests and values [49].

Degrowth as a normative concept should be distinguished from "negative economic growth". Merely shrinking production and consumption levels without transforming the institutional settings of a growth society is highly likely to deteriorate living conditions, as demonstrated in current global economic recession. To reach a socially acceptable process of degrowth necessitates deep structural changes in the socio-economic configurations and associated norms and values. First of all, the growth imperative intrinsic to the market-dominated economic system should be transformed. This fundamentally distinguishes the degrowth paradigm from EM. In addition, the wealth distribution model in the growth paradigm premised on the "rising tide lifts all boats" assumption does not make sense when there is no "rising tide". Since the degrowth aims for a more socially just society, it becomes important to redistribute the wealth from the rich to the poor in order to avoid the tendency to enlarge the gap when overall social wealth cannot grow [48]. Degrowth therefore holds an ethical stance of distributive justice achieved by "less competition, large scale redistribution, sharing and reduction of excessive incomes and wealth" [39] (p. 199). To address the problem of inequality, economist Thomas Piketty [36] proposes redistribution through a progressive global tax on wealth. Transformations in other societal spheres include, among others, changing the positive perceptions on population growth but instead deliberately shrinking global population size, redirecting technology development towards prolonging the durability of products [47,50]. In a degrowth society, unemployment will be solved by reducing working hours and work sharing. The society is thus operating along the line: lower productivity, more leisure time and lower income, and lower level of consumption.

4. Applying the Scenarios on Urban Development Futures

EM and degrowth frame the ecological problems differently, and the framing of the problem has implications for what is seen as necessary changes. When applied to the urban development domain, the two ideas for a sustainable society lead to different understandings of urban sustainable development and policies that occur in regard to this pursuit.

4.1. Scenario 1: The EM Paradigm of Urban Development

According to Næss et al. [51], an EM urban development paradigm means finding ways to accommodate growth in the building stock and ensuring accessibility to facilities while reducing negative environmental impacts resulting from the construction and use of buildings and infrastructure. Assumptions behind this EM urban development are that: urban growth is decisive for future prosperity and should be taken as the primary goal of urban development, ever-increasing mobility is essential for prosperity, urban development aims to satisfy different preferences by enlarging freedom of choice, and urban growth can be reconciled with environmental sustainability.

4.1.1. Urban Spatial Structure

On the premise of a growth society, Norwegian large and medium sized cities are facing the challenges of a growing population size and thus increasing demands for housing and transportation. Increased average affluence level facilitated by economic growth also tends to heighten housing consumption per capita and the need for personal mobility. In addition, most cities are eager to enlarge the availability of job and leisure opportunities through providing transportation infrastructures at a larger regional level. To accommodate these demands, cities cannot avoid physical growth in buildings and infrastructures. To avoid posing heaving strains on climate change, natural environment protection and farmland conservation due to urban sprawl, the EM paradigm of urban development aims at high land use efficiency. The compact city model stands out as the major strategy to this end.

The compact city strategy emphasizes high-density development, reuse of built-up areas and mixed land use. Through densification and rebuilding on brownfields, land use efficiency is enhanced, preventing undeveloped land from being converted into urbanized areas. High-density urban development and mixed land use will shorten distances between destinations and make facilities available through proximity, thus reducing energy consumption for transportation. Pursued in Norway

over the last couple of decades, the Oslo region has become a very illustrating case of applying the compact city model.

Oslo, the capital of Norway, had in the beginning of 2016 about 976,000 inhabitants within the continuous urban area, of which 653,000 in the municipality of Oslo and the remaining 324,000 in nine surrounding municipalities in the county of Akershus (see Figure 1). Population density within the continuous urban area of Greater Oslo increased by as much as 37% over the period 1985–2016 (from 26.7 persons/hectare in 1985 to 36.7 in 2016), with particularly high density increase in its central parts [52,53]. Within the inner city of Oslo, the density increase was substantial, where the urban population density increased by as much as 66% from 1989 to 2016 [54,55]. High-density urban development has not been applied to the same extent in other Norwegian cities as in Oslo, suggesting room for further strengthening this strategy in the future to accommodate physical growth in buildings and infrastructure.

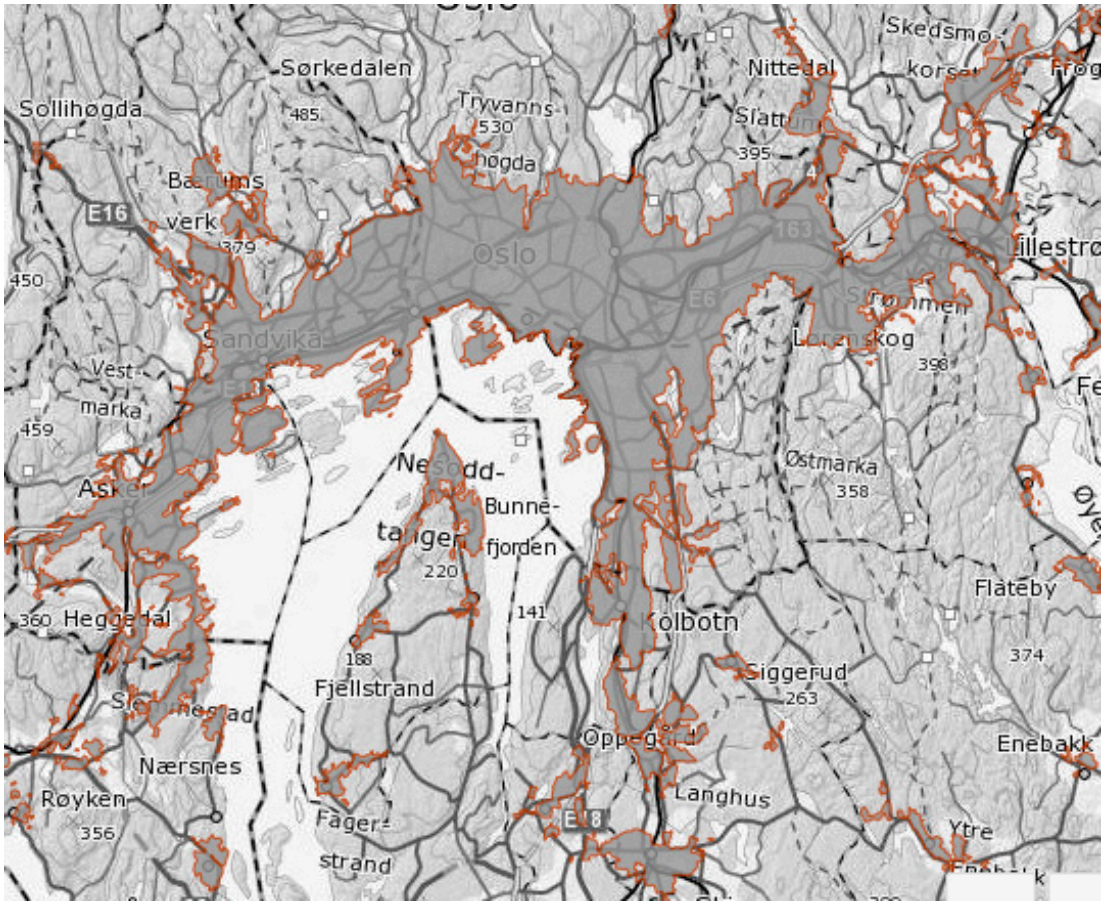

Figure 1. Demarcation of the continuous urban area of Greater Oslo ["Oslo tettsted"], i.e., the continuous grey-coloured area to the west, north and east of the fjord. Municipal borders are shown with dotted lines.

Several factors have contributed to Oslo's strong densification [52]. Key land use policy instruments include a strong greenbelt policy (the Marka border) protecting the very popular outdoor recreation forests surrounding the city (Figure 2), a relatively restrictive national policy on farmland conversion, and Central government policy guidelines for Coordinated Land Use and Transport Planning adopted in 1993 and updated in 2014. There has been a strong planning discourse promoting the compact city as a sustainable urban form. Case-specific natural, historical, cultural and political conditions have also been important. Rocky terrain surrounding the city makes urban expansion costly, and farmland as a scarce resource in Norway has given rise to national restrictions

on farmland conversion (cf. above). The city had a relatively low urban density at the outset, which made densification easier than it would have been if the density was already high. Preceding deindustrialization had left several vacant sites suitable for urban transformation. The cultural context has also been important. A strong tradition of skiing and walking in surrounding forests has secured popular support of urban containment. Increased popularity of "cafe culture" and urban living has contributed to a shift in housing preferences away from suburban single-family houses. Finally, there is a high acceptance of public land use control and state-level policy instruments in Norway compared to many other countries, and national land use planning policies have largely been implemented at a local scale.

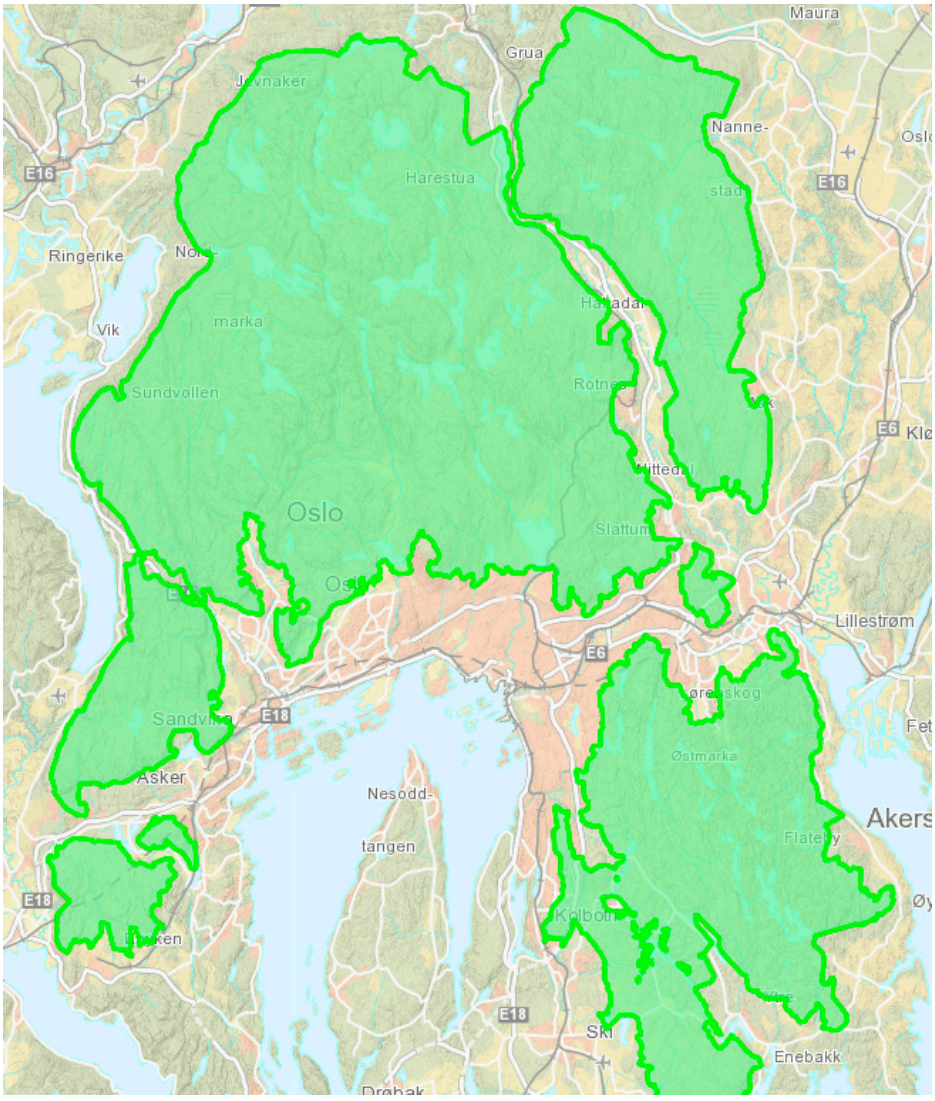

Figure 2. The protection border against the forested outdoor recreation areas surrounding Oslo ("Marka"). Affected municipalities were instructed in 1986 to incorporate this border in their land use plans. In 2008, the border and strengthened protection regulations were included in a separate act about the Marka areas.

4.1.2. Housing

In the EM scenario, current forecasts for population growth in Norway will be applied. Growth in floor area per capita is presupposed to continue, although the years since 1990 have witnessed a slower increase. This will lead to a continual growth in the total building stock. Housing provision will be

further marketed to better fulfil housing demands and preferences of different market segments. Apart from primary dwellings, Norway has more than 423,000 holiday homes (cabins and apartments in mountain and coastal areas) with an annual growth of 5000, and almost half of Norwegians have access to a holiday home. The Norwegian holiday homes have undergone important changes including increase in size and per capita floor area, increase in technical standards, and shift from few long stays to many short stays [56]. These development trends towards spacious and luxury holiday homes will continue in future.

Energy-efficient building technologies and the compact city model are the major strategies contributing to decoupling the housing sector growth from negative environmental impacts. These strategies aim at lowering energy and material consumption and land-use associated impacts per unit of floor area. Compact cities require dense and concentrated types of dwellings. This implies that one should promote the proportion of multi-family buildings and row houses rather than detached single-family homes. Compact types of housing imply more efficient use of building materials, energy for building operation and land resources per unit of floor area. This tendency to develop more resource efficient dwelling types has been very pronounced in the Oslo region. The share of detached single-family houses among newly constructed dwellings has experienced a decline, from on average 36% in the period 1983–1989, to 26% in the 1990s and 15% during the period 2000–2015 [57,58]. The declining share led to the decrease in the average floor area per dwelling built in these periods. The average size of completed dwellings was 158 m^2 in the period 1983–1989, and this number went down to 129 m^2 from 1990–1999 and further declined to 119 m^2 in the period 2000–2015 [57,58]. For the country as a whole, the tendency to build compact types of dwellings is not as strong as in the Oslo region. Future eco-modernisation strategies should therefore strengthen this aspect.

Another strategy addressing decoupling housing sector growth from increasing energy consumption and GHG emissions focuses on energy-efficient building technologies. The principal technologies are mainly applied to develop sustainable building materials, improve the thermal performance of buildings, increase the efficiency of energy systems, and utilize renewables. Especially in energy use for space heating and cooling, an energy efficiency of factor 4 or even 10 appears possible in new buildings [59]. These technologies can also be employed to retrofit existing buildings. In Norway, due to heightened building regulations for new houses, an increase in the proportion of dwellings with heat pumps and eco-renovation of building envelope of old residences, energy consumption per square meter of residential floor area has decreased by around 10% during the period 1993–2012 [6,60].

However, these EM patterns of residential development have not been found for Norwegian holiday houses. Increasingly larger holiday homes have been built in the years following 2000, compared to the previous two decades. Average size of newly constructed holiday houses increased from 65 m^2 over the period 1983–1999 to 87 m^2 in 2000–2015. In addition, a remarkable increase in energy use per square meter has occurred [6]. Given the higher growth rate for energy use in holiday homes, measures to enhance building energy efficiency in this sector should be much more addressed.

4.1.3. Transportation and Mobility

Norway is a highly mobile society, and there is a trend that Norwegians are becoming more and more mobile. Vehicle kilometres have increased by 17% and the number of private cars by 20% during the period 2005–2015 [61]. In 2012, Norway reached the top in Europe in per capita daily driving distance, with an average of 33.5 km [62]. In the EM scenario, the strategy for the transport sector considers that further increasing individual mobility fulfils the need for enhancing freedom of choice, and thus represents societal progress. The EM paradigm of transport policy will partly continue with the conventional approach, taking an effective transport system as the primary goal and seeking to improve traffic flow and reduce travel time in order to strengthen economic competitiveness [63]. However, an EM approach would, alongside with improving vehicle technology, also aim at changing the proportions of travel accounted for by different means of transport, in particular by increasing the

share of public transport. Mobility should be increased, but not in the form of increased car travel—at least not in the bigger cities and city regions. The official Norwegian goals that all increase in person transport in the major urban regions should take place as public transport and non-motorized travel are examples of this. Land use policies providing improved access to facilities through proximity rather than through increased mobility are also part of an eco-modernization approach. Compact urban development, as illustrated in the example of Greater Oslo in the previous section, is conducive to this end. Dense cities tend to be less car-dependent, provide for shorter trips and have lower per capita consumption of energy for transportation than do sprawling, low-density cities [64–66]. In particular, locating a high proportion of new buildings close to the city centre normally contributes to reduce car travel (for an overview of research undertaken in a Nordic context, see [67]; see also [68,69] for recent studies in Greater Oslo).

The preferred measures of an eco-modernist transport policy then comprise electrifying the transport sector, introducing alternative fuels, increasing vehicle energy efficiency, and changing the modal split in favour of environmentally friendly transport means. The government does not adopt normative measures to limit or reduce mobility. The focus is on technological improvements that reduce the energy consumption of the vehicles and emissions per person kilometre rather than reducing the transport demand in the long run.

In the EM scenario, expanding individual mobility will continue also in domestic and international travel, not the least for the purpose of leisure. How such travel can be carried out without violating environmental and climate mitigation concerns still appears unresolved within the eco-modernization paradigm. The technological possibilities for replacing today's polluting and climate-destructive air travel with environmentally friendly alternatives are much smaller than what is the case for travel within cities and urban regions, where a radical shift from car travel to public transport and biking can theoretically compensate for mobility growth within a medium-long horizon. The prospects for sustainable growth in international mobility thus appear much more remote than the possibility of reducing the environmental load per person kilometre travelled within cities and urban regions.

This conflict between on the one hand mobility growth and globalization and on the other hand the emission reductions necessary to reach the climate policy objectives is an example of a contradiction within the eco-modernization paradigm where its proponents must resort to their faith in future technological innovations that may or may not be possible at all. Another contradiction lies in the difficulties in establishing institutional frameworks securing the implementation of environmentally friendly technologies in a capitalist market economy. Private enterprises and many politicians have been strong opponents of the constraints on their economic freedom that would be necessary in order to achieve a high degree of eco-efficiency (e.g., bans or high taxations on particular materials and products). The institutional arrangements prescribed by eco-modernization theory to make capitalism green may therefore be contradictory to important inherent traits of capitalism (free enterprise, competition and consumer sovereignty) of capitalism itself.

Since air travel compared to other forms of transport has the highest income elasticity [70], a faster growth in air travel than other forms of travel can be expected in future along with income increases and further deregulation and liberation of the airline industry. The climate impact from aviation is dominated by climatic gases other than CO_2. A recent study found that when all transportation activities by Norwegians, both domestic and abroad, were estimated for their absolute global change potential per unit of emission in a 50-year period, Norwegian air travel abroad account for 51% of the total emissions compared to 39% from car transport [71]. Strong technological innovations to enhance aircraft energy efficiency combined with a substantial increase in the use of bio-fuels will be expected in order to reduce GHG emissions from air travel.

The policies in the transport sector in Norway since the 1990s have incorporated some elements of the EM paradigm, but have at the same time pursued "pre-ecomodernisation" business-as-usual policies within important parts of the sector. A review of Norwegian person transport policy made by Osland [70] shows that strategies have not intended to reduce the growth in passenger travel volume,

but tried to use economic instruments and technological improvements to decouple this growth from GHG emissions. Investment in public transportation has increased through city transport reward schemes, with the intention of increasing market share for public transportation. However, at the same time road planning and investment has favoured expanding road capacity to meet demands. The latter can hardly be said to be in accordance with the ecological modernization paradigm. For road transport, measures for reducing carbon emissions have mainly resorted to lowering emissions per passenger kilometre through more energy-efficient vehicles, shifting from gasoline to diesel, and promoting electric cars.

In cities and urban regions, an eco-modernization transport strategy includes both a change in the modal split toward environmentally friendlier modes of transport and measures to provide accessibility through proximity rather than through increased mobility. Such a strategy is not considered to be in conflict with the pursuit of economic growth; it is rather the opposite [72,73]. Replacing urban sprawl with densification is key to this end. Such densification has taken place to a considerable extent in Norwegian cities over the last couple of decades. Eight of the ten largest Norwegian cities have increased their density since 2000, and for some of them (Oslo, Trondheim, Drammen, Stavanger and Tromsø) the density increase has been quite substantial (see above). Apart from this, there are very few measures regulating demand in car use, and the introduction of congestion charges does not receive widespread political support. [70]. Most planners and policy-makers consider enlargement of the functional urban regions by means of new high-speed rail connections to be not in conflict with the environmental and climate objectives, although such region enlargement will most likely also entail considerable growth in car traffic [74]. The desirability of continual growth in accessibility to facilities, availability of opportunities and options for choice is not questioned in either eco-modernization theory or Norwegian planning practice.

4.2. Scenario 2: The Degrowth Paradigm of Urban Development

A general principle for urban development in the degrowth scenario draws on both the "eco-efficiency" and "sufficiency" dimensions in relation to mobility, land use, residential floor space and infrastructure, with an emphasis on the latter. The level of consumption per capita is reduced, total volume of urban built environment shrunk, and individual mobility declined. This will reduce energy consumption and GHG emissions, protect rural and undeveloped land and the integrity of habitats of other species. This shrinkage takes place in a socially sustainable manner with a strong commitment to social equity. Environmental hazards and benefits are equally distributed, and access to affordable housing, public facilities and transportation for the low-income groups are ensured [75]. In particular, the issue of social inequality can be worsened if no proper policies are in place in a degrowth society.

4.2.1. Urban Spatial Structure

Associated with the degrowth advocacy of economic localism, anti-globalization, self-sufficiency, direct democracy, and bioregionalism, there is an anti-urban bias in the degrowth debates which tends to deem decentralized, small-scale and self-contained human settlements as a normative spatial scenario of a degrowth society [76–78]. An elaborated argument has developed elsewhere, suggesting that decentralized and small-scale human settlement ignores the wider spatial fabric and the existing urban structures, which not only results in some social and environmental consequences contradicting the desirable degrowth goals but also represents unrealistic solutions [79]. Although degrowth requires curbing conspicuous consumption of positional goods and more equal distribution of wealth, different individual preferences and a certain freedom of making individual choices should be allowed to some extent, such as for jobs, education, and services. The spatial organization of self-contained and small-scale human settlements does not facilitate such freedom, since individual activities will be mainly located to their small neighbourhood or village.

We instead argue for the compact city development as the spatial organization of a degrowth society. It allows and facilitates a certain level of freedom of choices while reducing consumption

levels and environmental impacts. As aforementioned, urban sprawl in Norway has stagnated over the last decades, particularly pronounced in Oslo. Oslo's densification strategy has saved natural ecosystems, farmland and energy. However, growing in building stock and infrastructure has partially compromised the environmental gains from densification [51]. This suggests the limitations of compact city as an eco-efficient urban development strategy in the growth society, but it by no means an irrelevant strategy in the degrowth scenario. In the degrowth context, dense development is in combination with setting caps on urban land consumption per capita. For comparison, the urban area per capita within the continuous urbanized area of Oslo is 277 m^2 in 2015 [53], while in Hangzhou, a typical Chinese metropolis, it is 152 m^2 [80]. This means, technically, a stricter densification policy can be implemented in Norway. If per capita built-up area were set to be 200 m^2, to accommodate a projected population growth of 350,000 up to 2035 in the Oslo region would save 66 km^2 undeveloped land from being converted to built-up areas. This would in practice mean stricter land regulations for the "regional cities" surrounding Oslo. A boundary could be drawn against the zones of ecological preservation and farmland protection in addition to the existing protection zone for the "Marka" areas mentioned above, forbidding the encroachment on extended zones of protected land.

Apart from capping urban land consumption and densification, the location of residences and workplaces affects traffic demand and thus energy consumption, cf. the discussion of these issues in the section about the eco-modernization paradigm. This emphasis on compact urban development and proximity to city centre should be reinforced further in the degrowth scenario. Because there will be no growth in the size of the building stock, at least per capita, it will be possible to locate a higher proportion of the total new building stock centrally without building at excessively high densities. If the total building stock is not to increase, the construction of new and more environmentally friendly buildings through densification should be combined with the abolishment of some of the environmentally least favourable built environments, such as car-dependent office parks, shopping malls and single-family home areas. This could open up possibilities for nature regeneration projects and a larger coherence of the natural areas and landscapes surrounding the city. Moreover, locating offices and residential development close to public transport nodes also contribute to reducing the total amount of car traffic. Transforming centrally located single-family house areas into multi-storey perimeter blocks, each surrounding a large green space [81], would be relevant in this context.

4.2.2. Housing

Using the same method as presented in Hille et al. [82] (pp. 29–33), we find that the per capita residential floor area in Norway is 56.8 m^2 in 2016 [58,83,84]. Norway has one of the highest residential floor area per capita of any country in the world. Arguably, per capita housing consumption in Norway may already have passed the level in which housing consumption should not be increased further if global-scale environmental sustainability and a just international distribution of consumption are to be obtained. The moderate lifestyle advocated by the degrowth paradigm should be applied to dwellings that Norwegians consume. Although decoupling strategies for improving residential building energy efficiency should still be implemented as much as possible, it is urgent to set maximum standards for housing consumption per capita [85]. This implies that increase in total volume of the housing stock in future will be mainly due to population growth rather than further increase in floor area per capita.

Thus, how big should the newly constructed dwellings be? The new construction should consider the maximum standard and meanwhile allow certain differences in preferences for housing standards, as some people may value more of living in a high-standard dwelling than spending money on other kinds of consumption. However, with a "ceiling" on housing consumption, every increase in floor area per capita among some population groups must be balanced by reduced floor area per capita among some other groups. Too big differences between the highest and lowest standards would generate large housing inequality. The poor are usually the losers in such a situation because a limit on the size of the housing stock will induce housing scarcity and push up housing prices. The normative justification of housing as a kind of basic need and a welfare right suggests the necessity to

set minimum housing standard in such a way that no one is denied access to housing consumption at this minimum standard [84]. In a degrowth context, this cannot be realized without redistributing from those who have excessive access to dwellings to those who are lacking a dwelling or live in a substandard residence. Therefore, to fulfil both the criteria of maximum and minimum standards and to reduce the residential inequality, new construction should avoid spacious dwellings. If the maximum size of new dwellings had been set to, e.g., 140 m^2, this would have led to 26% reduction in floor area of the dwellings built from 2005 to 2009 in the Oslo region.

Since wants and desires evolve within certain time and space and should be judged as proper based on certain ethical and normative premises, smaller dwellings should be accepted as a new social norm in this degrowth image of the future. This applies to not only new housing construction, but also existing spacious dwellings which can be subdivided into more units and shared by more than one household. Detached single-family houses due to their usually spacious size and heavier environmental burdens compared to other types of dwellings should be banned in the new development. Newly constructed dwellings will mainly take the form of apartment buildings and row houses, and apply the highest building energy efficiency standards and environmentally friendly materials. The energy performance of existing dwellings will be largely improved through widespread energy efficiency retrofitting practices.

The Norwegian multi-dwelling home lifestyle characterized by high access to holiday homes is material, energy and space intensive, leading to escalating consumption levels, and is dependent on high individual mobility [86]. It can be argued that the seemingly necessary needs and desires for such holiday homes will be considered as luxury and overconsumption when judged from the need for fair distribution both locally and globally within limited ecological carrying capacity. This suggests that the development of holiday homes should be controlled. Furthermore, increased leisure time in the degrowth scenario together with a limit on the size of primarily dwellings one can consume is likely to generate rebound effect within the housing sector and thus enhance the demand for such holiday homes. In order to cater for this, the maximum standards should include any second homes.

4.2.3. Transportation and Mobility

In contrast to the EM paradigm where continually increasing mobility is considered essential for competitiveness, growth and prosperity, in the degrowth scenario, a reversal of present trend is assumed with stabilized or even declined traffic volume and particularly for passenger cars and air travel. In Norway, the availability of mobility resources and accessibility of facilities is arguably high enough to enable people to choose jobs and services on a large geographic scale. There seems to be sufficient freedom of choice. However, land use policies, such as in the Oslo region, still aim for regional enlargement by connecting exurban centres with inner city through high-speed transportation infrastructure in order to provide a larger job and service catchment area. Arguably, the resulted increase in commuting distances and other journeys may offset any environmental benefits from transportation-saving strategies, such as high-density urban development. Similar to the requirement for downsizing consumption of housing, reducing environmental impacts to be consistent with the carrying capacity of the planet makes it necessary to change our travel behaviours towards certain degree of collective self-limitation. People confine much of their major activities in the local area, although "local" here should not be understood as a small village envisioned in the ecovillage movement [79]. People are still provided mobility possibilities and options to make individual occupational, educational and leisure choices according to their preferences to a certain degree, but not so freely as in a society for the purpose of economic growth.

In the degrowth scenario, although leisure time increases, people take more home-oriented living and spend less time for leisure activities in far distance. That is possible because people have shorter working hours and thus less money to afford expensive holiday trips. The dominant Norwegian holiday activities of cabin use based on frequent and short-distance car trips are largely substituted by

home-based leisure activities. The number and distance of domestic and international air travel, not the least for creational purposes should also be reduced.

Not only the total traffic volume is reduced through, as mentioned above, proximity of activity destinations, containment of regional enlargement and downscaling of leisure activities, the share of public transport in forms of bus, metro and railways and active transport of walking and cycling is increased in the total traffic volume. Currently, car has a predominant position in Norwegians' daily and holiday trips, with 55% of daily trips and 72% of holiday and leisure trips done by cars in 2013/14, and car driving has experienced an increase compared to 2009 [87]. To control car-use calls for the halt of expanding motorways and road capacity, initiatives which are likely to lead to induced traffic [88]. In the degrowth context, not only being stopped from expanding, these environmentally harmful transportation infrastructures are shrunk and replaced by environmentally friendly elements such as biking infrastructure, walkable neighbourhoods, and better public transport services. Research studies suggest that relocating road-space from car traffic to buses, pedestrians or cyclists has most often not led to any lasting increase in traffic congestion as predicted [89]. Instead, people have adapted to the changes, and significant reductions in overall traffic volume can take place. In addition, car ownership and use should be subject to strict control through aggressive policies, e.g., a lottery system for new car license plates, congestion charging, limited driving days for cars. Even so-called zero-emission vehicles are not the solution since they do not sufficiently curb GHG emissions in the car's lifecycle (i.e., the emissions associated with production of the car and its propulsion energy as well as the associated infrastructure), and they do not address that it is the number of cars and kilometres driven that are the real challenges [90,91].

The shift towards public transport and non-automotive transportation combines with enhancing environmental performances of automobiles. Electric cars, smaller vehicle types, fuel-efficient vehicles make up the majority of the car fleet. However, distinct from the EM scenario, promotion of the environmentally friendly vehicles is not to facilitate growth in vehicle stock and driving distances. Instead, further modernisation of vehicle fleets takes place on the premise that the total traffic volume and car ownership are constrained. In this way, the eco-efficiency strategies will contribute to further decline environmental harmful consequences from the transportation sector. Table 3 summaries and points out the main differences between the two scenarios.

Table 3. Summary of overarching goals and strategies taken by ecological modernisation and degrowth for housing and mobility at the urban level.

	Scenario 1: Ecological Modernisation	Scenario 2: Degrowth
Housing	Overarching goal: Combination of continued growth in buildings with major reductions in environmental loads. Strategies: Decoupling through energy efficient buildings, energy efficient building technologies and the compact city model.	Overarching goal: Total level of urban built environment is reduced. Strategies: Dense development combined with setting cap on urban land consumption per capita. Maximum size of new dwellings also including second homes.
Mobility	Overarching goal: Continued growth in transport and major reductions in emissions from transport. Strategies: Electrifying the transport sector, introducing alternative fuels, increase vehicle energy efficiency and a modal split towards environmental friendly transport modes and forms.	Overarching goal: Declined transport volumes. Strategies: A major shift to more environmental forms of travels such as bus, rail as well as walking and cycling. Major reductions in expansion of environmental harmful infrastructures. Total traffic volume should be reduced and car ownership should be constrained.

5. Discussion: Socio-Economic Structural Conditions Hindering or Enabling the Two Scenarios

5.1. Potentials and Barriers to Realizing the EM Scenario

The ascendency of EM in global and Norwegian environmental politics reflects its pragmatism in current political and socio-economic systems. Compared to the degrowth scenario, the EM scenario appears more politically realistic, since it does not necessarily imply a challenge to the foundations

and logics of the capitalist market economy [32]. In fact, EM utilizes the compulsion inherent in capitalism which urges to modernize and increase competition through technological renovation [29]. The pursued economic-environmental win-win solution generally enhances the acceptance of EM strategies by market actors, despite potential resistance of "modernisation losers" such as powerful polluters [29]. Regarding intervening in consumers' choices, as argued by Osland [70], since EM tends to employ economic measures to mobilize citizens, it accentuates the choice as a real moral dilemma based on normative considerations of what is right or wrong. Instead, citizens become value-calculating consumers who react to price signals. Furthermore, consumption-oriented strategies direct consumers to change the composition of consumption, but do not reduce the opportunities for choice which actually will be enlarged on the premise of a growing economy. These EM strategies make the interventions in the consumption field less intrusive, and thus more acceptable by consumers.

As discussed in Section 4, urban densification is a key element in spatial urban development following an eco-modernization strategy. Despite the fact that Oslo has implemented such a strategy to a great extent, several authors hold that metropolitan-level decentralization of workplaces and residences is a strong and more or less general tendency in Europe [92–94]. According to the European Environmental Agency, urban sprawl is a common phenomenon throughout Europe, although it has been less pronounced in Western Europe in recent decades than in the 1960s and 1970s [95]. In the post-communist East European countries, urban sprawl is still proceeding at a high pace [96,97].

However, actual urban developmental trends in Europe are far more nuanced than what has been claimed by the most "decentralization-deterministic" debaters. In Sweden and Norway, a long period of spatial urban expansion since the 1950s has been succeeded by a trend of re-urbanization (concentration of new development within the existing urban space) during the latest couple of decades [68,98,99]. Besides the strong densification that has taken place in Greater Oslo, similar densification processes, albeit at a slower rate and not as consistently as in Oslo, have taken place in Trondheim, Stavanger, Bergen and most of the other larger Norwegian cities. In eight of the ten largest Norwegian cities, densities are more than ten percent higher today than they were in 2000. There is thus considerable scope for limiting and even reversing sprawl. New highway construction in urban regions does, however, counteract the policies aiming at more compact urban development.

There have been enduring debates between EM adherents and neo-Marxists on whether the EMs' pragmatic realism as above is sufficient to resolve the global ecological crisis. The radical ideas for an ecologically sound society point out the fundamental limitation of the EM paradigm, which is its reformist trajectory on change within the capitalist socio-economic structures. The line of the criticism emphasizes that eco-destruction is inherent within capitalism due to its relentless capital accumulation which exploits nature wantonly regardless of the long-term effects on the ecosystem's sustainability [100]. If ecological breakdown is to be avoided, an ecologically viable alternative should replace the capitalist mode of production, its institutions and worldview [101].

Besides this radical criticism, several other barriers for realizing the EM societal paradigm are debated. First, reducing the environmental impacts to a sustainable level would require extremely large resource efficiency improvements in the coming decades. With an annual economic growth of 3%, eco-intensity must be reduced by 65% of present if we are to absolutely decouple environmental impacts from economic growth over the next 34 years up to 2050. However, a reversal of current unsustainable trends requires more than just remaining at a constant impact level but instead substantially reducing the level of impact. For CO2 emissions and other GHGs, the reduction has to be a "net 100%" by 2100 if we are going to achieve the goal of keeping global warming below 2 °C [102].

Second, "time" is a crucial factor if society is going to achieve the 2-degree goal. We cannot think in the traditional "linear" way when implementing new GHG mitigation measures, spreading them equally along a timeline from today until 2100—the year when IPCC has stated that society needs to have achieved "net zero" emissions. On the contrary, the most substantial GHG emission cuts need to be done in the very near future. The available time-slot for implementing measures will be drastically reduced and the ambition level of the measures will have to be dramatically increased if

implementing new measures are postponed [15]. IPCC has furthermore calculated the consequences of moving from a 2.0- to a 1.5-degree goal, which implies an even further shortening of the available timeslot. More specifically, they calculated the number of years that current global GHG emissions could continue before using the available carbon budget for different levels of warming. Given a 50% chance of reaching the goal in question, moving from 2.0 to 1.5 degrees would be, according to these calculations, a reduction from 28.2 to 9.8 years. Thus, major changes in society have to take place within a rather short time to achieve the 1.5–2.0 degree goal. This requires much more than just a 65% reduction in eco-intensity, and this reduction has to be applied on average to all societal sectors. In comparison, as shown before, energy consumption per square meter of residential floor area in Norway has decreased by only around 10% from 1993 to 2012. What is even more problematic is the air travel which has shown a rapid increase in Norway, but where the technology for energy efficiency and GHG mitigation does not offer any "low-hanging fruit" solutions [8].

Thirdly, environmental benefits in per unit produced through eco-efficiency strategies are often neutralized by growth in the volume of production and consumption, forming the so-called rebound effects [46,103]. Studies in both Denmark and Norway of residential energy consumption found that when direct electric heating is replaced by more energy-efficient air-to-air heat pumps, households increase comfort standards and heat more space than before, undermining the energy-saving potentials of advanced technology [6,104]. The rebound effect is both a natural consequence of the growth-dedicated society and a driver of further economic growth [47]. The growing purchasing power derived from economic growth has to be channelled to somewhere, leading to higher levels of consumption. For producers, obtaining higher profitability is the intention of the win-win solution. Rebound effect is therefore received with welcome in the growth society. Only when being examined from an environmental perspective is rebound effect regarded as problematic, as it increases the level of production and consumption which offsets intended environmental gains from efficiency strategies. This demonstrates an internal contradiction of EM.

Fourthly, EM has a focus on efficient use of resources. The key and basic assumption is the idea of environmental re-adaptation of economic growth and industrial development by means of increasing the marginal environmental efficiency of industrial production measured, e.g., in the form of energy per unit of production or per unit price. The final and total output receives less attention; that is, whether applying a strategy of EM or eco-efficiency has actually reduced the total environmental pressure on society, or just literally moved the pressure to other regions or related economic activities, often referred to as geographical transfer effect and rebound effect [8,32,105]. For instance, the possibilities for densification in Oslo were largely from relocating manufacturing industries to other places and replacing freight by ship with truck transport. Although the environmental impacts appear to be reduced within the boundaries of Oslo, taking into account the increase in the more environmentally harmful truck traffic and the encroachment on nature due to relocation, the aggregate environmental pressure might have increased. In this sense, the densification that has saved nature and reduced transportation emissions in Oslo has been an environmentally favourable side-effect of the environmentally very harmful prior relocation of industries to developing countries and other places with cheap labour and lax environmental regulations.

5.2. Potentials and Barriers to Realizing the Degrowth Scenario

It can be imagined that capping urban land consumption, introducing maximum housing standard, banning construction of single-family houses, limiting mobility and constraining car ownership will go against the need for economic growth in the current neo-liberalized capitalist society. Resisting mechanisms stem from the economic, social and cultural realms.

While cities in a sense could be described as the primary cause of global ecological degradation, they are also conceived as the major drivers of economic growth. Cities have long been considered as growth machines, driving urban development and politics in the quest for wealth accumulation [106]. It has been extensively argued that cities play a significant part in perpetuating and expanding capitalist

accumulation [107–109]. Land use and built environment have been wrought to adapt to the needs of capital, resulting in the production and transformation of the built environment, such as time-space compression, land appropriation, building boom, creative destruction of land, etc. On the other hand, the built environment, like transport networks and houses, provides necessary physical conditions to facilitate the capitalist production, consumption and exchange processes. Urbanization also increases the level of consumption and investment in infrastructure. Local government, being powerful in allocating resources, aims to create the physical and social conditions that can serve the economic interests and attract high human capital workers. Promoting economic growth and enhancing the city's competitive edge have become the most ambitious enterprise for local government. Even efforts for conserving the natural environment tend to be co-opted to serve the purpose of economic growth, indicating a subordinate position of environmental sustainability to the growth ideology [110].

The predominance of the growth ideology in urban development politics is propelled by the inherent growth compulsion characterizing the capitalist market economy [108,111,112]. Fierce and coercive competition in the market sets the "growth or die" dynamic in motion for individual capitalists and forms the profit-driven economy at the aggregated level. Consequently, in the urban development domain, the growth imperative leads to, e.g., the development of infrastructure to create continuous and smooth flow of traffic, lax land use regulation for urban expansion to attract investment, and building luxury housing to attract the wealthy. All of these are in tension with striving for a degrowth urban development scenario.

The doctrine of neoliberalism says that market mechanism is the best vehicle to provide goods and services to satisfy people's diverse demands. Neoliberalism takes individualism and freedom of choice as its essential values. Economic and social policies should not interfere with people's preferences but aim to satisfy them to the greatest extent. In the consumer society, this focus on free choice is further emphasized as the factor that should orient what is offered in the economic and social domains. Today, the market does not only satisfy demands, but also creates new demands by massive consumerist propaganda through commercials, TV programs and through the ways in which we generally speak and write [113]. With prevalence of the neoliberal agenda, any policy that aims at constraining the type and level of consumption will be considered as improper and thus be met with resistance. Furthermore, the hegemony of market is capable of co-opting any original non-consumables, like anti-mainstream culture, into marketable commercials, serving the purpose of economic efficiency [114]. As mentioned before, in the current society structured for economic growth, eco-efficiency strategies like energy efficient buildings and vehicles, electric cars, etc. tend to generate rebound effects, which heighten the consumption level. Even the sufficiency strategy curbing housing consumption, travelling distance and car ownership can also lead to similar rebound effects [115], as rendered surplus disposable income has to be channelled to other consumptive goods and services. Both types of rebound effects will offset expected environmental gains from these strategies. The conversion of efficiency gains into higher levels of production and consumption is an intentional pursuit of market economy to seek higher profitability. Arguably, the more we increase eco-efficiency, the higher the aggregate consumption level, and hence the more difficult to reduce environmental impacts [47]. In addition, as long as the purchasing power increases as a result of economic growth, the sufficiency rebound effect cannot be avoided. In the growth society, both efficiency and sufficiency strategies tend to be "co-opted" into the growth mechanisms, leading to higher levels of consumption. It is thus impossible to reduce environmental impacts as much as needed by resorting to either eco-efficiency or sufficiency strategy when the economy is rising.

To sum up, degrowth as a radical environmental solution requires an intervention in the established patterns of production and consumption, and therefore is more likely to meet resistance from strong economic and political actors. The degrowth scenario is contradictory to the growth imperative of capitalist economy and its associated institutions, values and norms. To achieve a degrowth urban development, only introducing the suggested strategies in the urban and planning

domains are not sufficient; transformations in the deep societal structures have to be carried out as well.

6. Conclusions

This article provides insight into how degrowth and EM could meet the goal of sustainable development in wealthy countries. We found that a transition to sustainable degrowth would be required in order to achieve a fundamental reduction in GHGs. We discussed an EM versus a degrowth scenario of a low-emission Norwegian 2050 society. The EM development path does not question the growth ideology associated with capitalism, although EM theory presupposes that capitalism must undergo a process of transition to be sustainable in the long term. A key in the transition process is to reduce energy use and GHG emissions by decoupling economic growth from resource consumption and environmental deterioration. On the other hand, the degrowth position argues that economic growth is the fundamental mechanism leading to climate change and environmental deterioration, which implies that technological solutions alone are not sufficient to reach environmental sustainability without shrinking our economy.

We used a scenario methodology and back-casting analysis to look at the structural obstacles and institutional gaps for attaining the desirable state in each scenario. A key barrier for the EM scenario is the unrealistically high resource efficiency that a society needs in a society if it is to maintain continued growth and still succeed in decoupling the economy from human-made GHGs and environmental deterioration. In the degrowth scenario, the key barrier is to move away from the hegemonic status of economic growth. Because degrowth as an ideological position implies that changes must be made in a democratic manner, broad public support is needed to make real political changes with re-oriented values. Accomplishing policies in line with EM will likely meet less resistance from society compared to degrowth, since EM does not involve a fundamental re-orientation of cultural norms and current economic policies. However, it seems very unlikely that EM policy will be sufficient to reduce GHG-emissions in accordance with the Paris agreement. On the other hand, the degrowth scenario is a development path with the potential to achieve major GHG reductions, since policies in line with degrowth address the fundamental mechanism behind environmental deterioration and point to the need of finding alternatives to the growth ideology. This paper shows how such policies might look like through policy measures such as setting maximum limits to housing sizes and limiting mobility.

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