Institute of Transport Economics
Norwegian Centre for Transport Research

Planning for change in the transport sector

Knowledge status and needs in planning a low-emission society under uncertainty

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Summary

The transition to a low-emission society and other major societal challenges have triggered a need for new planning methods, both within transport and society at large. Rather than planning incrementally, based on historical trends and adopted policy, one should plan for a desired future and transformative change. This requires foresight methods that cover how the future should look, and possible pathways there. New planning methods should enable larger changes, ensure that a low-emission society is achieved by 2050, account for nature and land-use objectives, and ensure efficient use of scarce resources – all under increasing uncertainty. Two such planning methods are backcasting and extended scenario methodology. These can be combined with 'accessibility' or 'sufficiency' perspectives and the Avoid-Shift-Improve framework (ASI). This report synthesizes current knowledge and knowledge and methodological needs, and intuitively presents 'new' planning perspectives: what must be in place, how should we plan, how not to plan, and how can and should 'new' methods and perspectives be used in practice?

Kort sammendrag

Omstillingen til lavutslippssamfunnet og andre store samfunnsutfordringer har utløst behov for nye planleggingsmåter, både innenfor transport og samfunnet generelt. Istedenfor å planlegge inkrementelt, basert på historiske trender og vedtatt politikk, er det behov for å planlegge for en ønsket framtid, med mer transformativ omstilling. Det må tas i bruk fremsynsmetodikk som dekker hvordan fremtiden skal se ut og hvordan veien dit kan se ut. Dette må muliggjøre større endringer, slik at vi når lavutslippssamfunnet i 2050, tar hensyn til natur- og arealmål, bruker knappe ressurser effektivt, og ivaretar en rekke andre føringer på vei til lavutslippssamfunnet – alt under økende usikkerhet. To slike planleggingstilnærminger er backcasting og utvidet scenariometodikk. Disse kan kombineres med «tilgjengelighets»- eller «tilstrekkelighet»-perspektiver og UFF-rammeverket. Fordi de fleste land fortsatt står i startgropen, samler og konkretiserer denne rapporten kunnskapsstatus og -behov og gjør «nye» planleggings-perspektiver lettere tilgjengelige: Hva må være på plass, hvordan bør vi planlegge, hvordan ikke, og hvordan kan og bør «nye» metoder og planleggingsperspektiver brukes?

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Preface

Societies around the world are facing major changes and increasing uncertainty, both in transitioning to a low-emission world, but also as a result of other large societal trends. In this context, it is increasingly pointed out that current analysis and decision-making processes have weaknesses, and that there is a need for further development of methods, analytical tools, and decision support for transport and societal planning.

Amongst others the OECD/ITF, the UN's Intergovernmental Panel on Climate Change (IPCC), and Norway's Climate Change Committee (NCCC) have drawn up recommendations that require radical changes in the way we do things, not least with regard to transport planning. While a few countries have cautiously started implementing 'new' perspectives, the development of such planning methods is still at an early stage in most countries. At the same time, concepts such as 'backcasting' and 'scenario methodology' are starting to attract increasing attention and foothold – both amongst policy-makers, planners, and researchers. Nevertheless, there remains a significant gap between high-level discussions and the actual implementation and operationalization of these approaches.

The Institute of Transport Economics (TØI) aims to be a knowledge leader on these issues, and to develop knowledge that benefits planning and decision-making on the path to a low-emission society. In February 2025, TØI therefore published a report (TØI-report 2079/2025) with the goal of reviewing and synthesizing the current state of knowledge, knowledge gaps, and the need for methodological developments going forward, while also making 'new' planning perspective more accessible: *What must be in place? How should we plan? What should we avoid? And how can and should we use 'new' methods and planning perspectives?*

Given national and international feedback and interest in the original report (which was in Norwegian, save an extensive English summary), the current report aims to cater to readers more internationally. With slight adaptations, it constitutes an English translation of TØI's February report. As such, some references may particularly apply to the Norwegian context. Overall, however, we consider the report's contents to be highly relevant to policy-makers and researchers in many countries.

The original report was written by Daniel Ruben Pinchasik, with valuable contributions from Paal Brevik Wangsness, Askill Harkjerr Halse, and Bjørne Grimsrud. Halse and Grimsrud, along with Kjell Werner Johansen, were also responsible for quality assurance of the report. As original author, Daniel Ruben Pinchasik has also been responsible for the current English translation/adaptation.

Oslo, March 2025
Institute of Transport Economics

Bjørne Grimsrud	Kjell W. Johansen
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The transition to a low-emission society and other major societal challenges have triggered a need for new planning methods, both within transport and society at large. Rather than planning incrementally, based on historical trends and adopted policy, one should plan for a desired future and transformative change. This requires foresight methods that cover how the future should look, and possible pathways there. New planning methods should enable larger changes, ensure that a low-emission society is achieved by 2050, account for nature and land-use objectives, and ensure efficient use of scarce resources – all under increasing uncertainty. Two such planning methods are backcasting and extended scenario methodology. These can be combined with 'accessibility' or 'sufficiency' perspectives and the Avoid-Shift-Improve framework (ASI). This report synthesizes current knowledge and knowledge and methodological needs, and intuitively presents 'new' planning perspectives: what must be in place, how should we plan, how not to plan, and how can and should 'new' methods and perspectives be used in practice?

Society is facing major changes and increasing uncertainty, both with regard to the transition to a low-emission society and as a result of other major societal challenges. In recent years, it has become increasingly clear that today's analysis and decision processes suffer from weaknesses and that 'business-as-usual' will not result in a low-emission society in 2050 which simultaneously meets key nature preservation and land-use objectives and uses scarce resources efficiently (e.g. energy, biomass, capital, minerals, metals, other natural resources, and high-skilled labour). In this light, there is a need for further development of methods, analytical tools and decision-making support for long-term planning. Such planning should enable more structural and transformative transitions and organizational changes.

This report aims to synthesize current knowledge, knowledge needs, and needs for further methodological development and to make 'new' planning perspectives more accessible: *what must be in place, how should we plan, how not, and how can and should 'new' methods and planning perspectives be used in practice?*

Given the need for societal transitions and improved long-term planning, the OECD/ITF, UN's Intergovernmental Panel on Climate Change (IPCC), and Norway's Climate Change Committee (NCCC), among others, have published a wide range of principles, recommendations, guidelines and nuances. Although the current report focuses on *transport* planning, many of these apply to societal planning more generally. A central premise is that planning should be based on goals that represent the future society desires, instead of where historical trends and adopted policy will lead us. This is referred to as 'decide-and-provide' or 'design the future' approaches that are driven by visions, rather than today's 'predict and provide', which is more reactive and based on trend extrapolation and projection (e.g. of transport demand).

Planning for a 'desired future' requires strategic long-term visions and supporting methods. Such methods should yield more holistic planning across transport modes and other societal sectors, integrate long-term goals into all planning, and be put in place within the next few years. *This requires foresight methods covering two central questions: 'how should the future look?', and 'what can pathways to such a future look like?* For example, whilst reaching a low-emission society by 2050 could be an obvious goal, many such futures can be imagined, with anything from low to high consumption of resources. Because pathways to desirable futures can also take different forms with wholly different emissions profiles, the NCCC further recommends the use of 5-year carbon budgets, of which the first two budgets should be more binding.

Both within transport and other sectors, it may be necessary to reduce or curb growth in activity levels. There is a need for approaches that prioritize measures that 'avoid' emissions and reduce activities that generate emissions, over measures that 'shift' or 'improve' (the ASI framework). Within transport, reduced demand is also central to results of socio-economic analyses and investment choices. Reduced transport demand further has implications for the level of resources required (e.g. energy) and for resources available to other sectors. Better knowledge is needed on the drivers of transport demand, both to allow for better targeting this demand and to gain better insights into links between transport and spatial planning, so that the latter can be used more strategically. This may entail a need for developing knowledge and perspectives related to concepts such as 'accessibility' and 'sufficiency', which some countries have started to use in planning. Better insights into demand and activity levels are also necessary to be able to define which (small) emissions may remain in 2050, and to be able to include changes in trends and transport demand in general. Similarly, there is a need for insights into 'inevitable' transport that, in future, will be necessary for society's energy transition, climate adaptation, carbon capture and storage, etc. These future demands must be captured in planning systems, but cannot be derived from historical data or trends, and are difficult to predict.

In general, there is a need for socio-economic assessments that better take into account other qualities of transport than time use. Assessments should also assess, address and aim to avoid path-dependency, and better include climate and nature considerations. Here, improved methodology for valuing and quantifying land-use, and for comparisons between modes of transport, is required. Emissions should not only be highlighted better in analysis and decision-making processes, but actively be included as constraints. The same applies to total energy and resource demand, which should also be reported *across sectors.* It should become clear what different sectors of the economy are expected to contribute with, and tools should be developed for evaluating progress along the way.

For transport, planning should take place *across* transport modes, so that developments of the transport system are in line with a low-emission society. The transition to a low-emission society and challenges along the way imply a need to re-assess which infrastructure should be prioritized from a societal perspective. This includes both the different infrastructure needs society may have, and the implications that infrastructure projects have on society's ability to meet increasingly strict climate targets and needs with regard to climate adaptation, technology transition and resource scarcity. All choices should be compatible with a low-emission society.

With the above as starting point, there is a need for tools to define concrete future visions and alternative pathways to achieve these. In this context, there are different but related foresight methods that can contribute to a greater understanding of factors that affect developments, and how to achieve change. In recent years, particularly 'backcasting' and extended scenario methodology have been highlighted as promising approaches going forward.

Backcasting involves defining one or more desired futures and working backwards in time to identify possible pathways to these futures (see Figure S.1). A characteristic that distinguishes backcasting from many other foresight methods is its explicitly normative nature: backcasting emphasizes futures that are desirable, rather than futures that are most likely. Backcasting can be used as valuable decision-support tool, e.g. to illustrate political possibilities for achieving goals, to illustrate alternative pathways, and to provide insights into critical choices, timing of choices, and their sequence. Backcasting methodology can be particularly suitable when there is a need for transformative change, time horizons are long enough to allow radical changes, goals lie relatively far ahead in the future, business-as-usual and incremental measures are insufficient to achieve desired changes, problems are complex or persistent, externalities play a significant role, and when planning is carried out under high uncertainty. Backcasting is also compatible with different types of tools and methods, both qualitative and quantitative. Because backcasting is normative, it can be argued that using backcasting can be a strategy to reduce uncertainty.

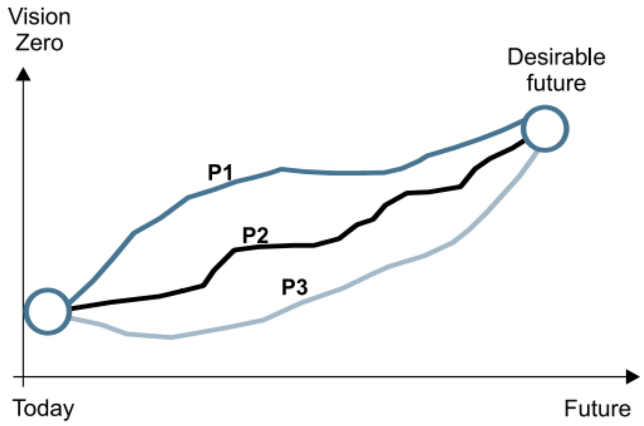

Figure S.1. Illustration of a backcasting approach. Source: Whitelegg et al. (2010).

Scenario methodology, in turn, can be useful for exploring different futures under uncertainty. A range of methods and techniques exist, each with its own strengths and nuances. In practice, the number of scenarios and level of detail will often have to be limited based on assessments of internal consistency, plausibility, overlap, representativity, etc. Narratives are a much-used approach, often combined with numbers, and with scenario families that employ extremes or large contrasts (e.g. the so-called Shared Socio-Economic Pathways used in climate research). Backcasting and scenario methodology, can, but don't necessarily have to be tightly linked. The current report provides detailed descriptions and 'recipes' for using these methods in practice.

In recent years, some few countries have slowly started to integrate concepts related to the ASI framework, 'accessibility', 'sufficiency', backcasting and scenario methodology, into their transport and societal planning. Similarly, a few countries have started to somewhat put climate and environmental objectives in the driver's seat for transport planning. This can particularly be noted for Wales and Austria. Even though interest for 'new' perspectives and methods is increasing, most countries are still at an early stage, with discussions remaining and at a relatively general level. By synthesizing and presenting new perspectives, methods, 'recipes' and considerations, we hope that this report makes future planning methods more accessible and intuitive.

Transportøkonomisk institutt
Stiftelsen Norsk senter for samferdselsforskning

NORSK **Sammendrag**

Omstilling til et lavutslippssamfunn
Kunnskapsstatus og kunnskapsbehov i transport- og samfunnsplanlegging

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Omstillingen til lavutslippssamfunnet og andre store samfunnsutfordringer har utløst behov for nye planleggingsmåter, både innenfor transport og samfunnet generelt. Istedenfor å planlegge inkrementelt, basert på historiske trender og vedtatt politikk, er det behov for å planlegge for en ønsket framtid, med mer transformativ omstilling. Det må tas i bruk fremsynsmetodikk som dekker hvordan fremtiden skal se ut og hvordan veien dit kan se ut. Dette må muliggjøre større endringer, slik at vi når lavutslippssamfunnet i 2050, tar hensyn til natur- og arealmål, bruker knappe ressurser effektivt, og ivaretar en rekke andre føringer på vei til lavutslippssamfunnet – alt under økende usikkerhet. To slike planleggingstilnærminger er backcasting og utvidet scenariometodikk. Disse kan kombineres med «tilgjengelighets»- eller «tilstrekkelighet»-perspektiver og UFF-rammeverket. Fordi de fleste land fortsatt står i startgropen, samler og konkretiserer denne rapporten kunnskapsstatus og -behov og gjør «nye» planleggingsperspektiver lettere tilgjengelige: Hva må være på plass, hvordan bør vi planlegge, hvordan ikke, og hvordan kan og bør «nye» metoder og planleggingsperspektiver brukes?

Samfunnet står ovenfor store endringer og økende usikkerhet, både med hensyn til omstillingen til lavutslippssamfunnet og som følge av andre store samfunnsutfordringer. De siste årene pekes det i økende grad på at dagens analyse- og beslutningsprosesser har svakheter og at inkrementelle endringer og «business-as-usual» ikke fører til et lavutslippssamfunn i 2050 som også ivaretar sentrale mål for natur og areal og gir effektiv utnyttelse av knappe ressurser som kraft, biomasse, kapital, mineraler, metaller, andre naturressurser og kompetanse. Det er derfor behov for videreutvikling av metoder, analyseverktøy og beslutningsstøtte for langtidsplanlegging. Slik planlegging må muliggjøre strukturelle, alternative og mer transformative, radikale og organisatoriske endringer.

Denne rapporten har som formål å samle og konkretisere både kunnskapsstatus, kunnskapsbehov og behov for metodeutvikling framover og gjøre «nye» planleggings-perspektiver lettere tilgjengelige: *Hva må være på plass, hvordan bør samfunnet planlegge, hvordan ikke, og hvordan kan og bør vi bruke «nye» metoder og planleggingsperspektiver?*

Med bakgrunn i behovet for omstilling og bedre langtidsplanlegging har blant annet OECD/ITF, FNs Klimapanel (IPCC) og Klimautvalget kommet med en lang rekke føringer, nyanser, prinsipper og anbefalinger. Selv om foreliggende rapport har hovedfokus på, og eksempler fra transportplanlegging, gjelder mange av disse for samfunnsplanlegging mer generelt. Et sentralt premiss er at det er behov for å planlegge basert på mål om hvor man vil, ikke dit historiske trender og vedtatt politikk fører oss. Dette omtales som «decide-and-provide» eller «design the future»-tilnærminger som er drevet av visjoner, fremfor dagens «predict-and-provide»-tilnærming som er mer reaktiv og basert på trendframskrivninger, for eksempel av transport-etterspørsel.

Å planlegge for «dit man vil» utløser behov for langsiktige strategiske visjoner og tilhørende metoder. Disse må gi mer helhetlig planlegging på tvers av transportformer og sektorer og integrere langtidsmålene i all planlegging. Dette må komme på plass i løpet av de neste få årene. Det må tas i bruk fremsynsmetodikk som dekker to sentrale spørsmål: «*Hvordan skal fremtiden se ut?*» og «*Hvordan ser veien til fremtiden ut?*». For eksempel kan et åpenbart fremtidsmål for 2050 være et lavutslippssamfunn. Dette må imidlertid konkretiseres, ettersom det kan tenkes mange mulige lavutslippssamfunn, med alt fra lavt til høyt forbruk av ressurser. Fordi veien til fremtiden kan utvikles på mange måter og tidspunktet for utslipp har betydning for omfanget på klimaendringene, anbefaler Klimautvalget i tillegg å ta utgangspunkt i 5-årige karbonbudsjetter, hvorav de første to skal være mer bindende.

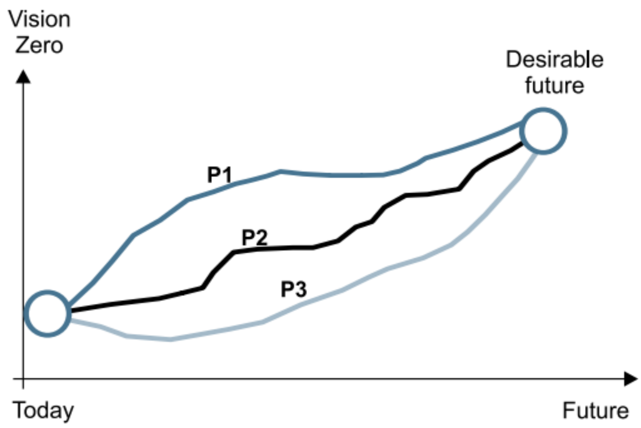
Både innenfor transport og andre sektorer kan det være nødvendig å redusere aktivitetsnivået. Det er behov for tilnærminger som prioriterer tiltak som unngår utslipp og reduserer utslipps-genererende aktivitet, framfor «flytte»- og «forbedre»-tiltak (UFF-rammeverket). Innen transport er redusert etterspørsel også sentralt for utfall i samfunnsøkonomiske analyser og investeringsvalg, og for behovet for knappe ressurser og muligheter i andre sektorer. Kunnskaps-grunnlaget om drivere av transportetterspørsel må forbedres, både for at denne etterspørselen kan påvirkes og for å få bedre innsikt i koblingen mellom transport- og arealplanlegging, slik at arealpolitikk kan brukes mer strategisk. Dette medfører behov for kunnskaps- og perspektivutvikling knyttet til konsepter som «tilgjengelighet» og «tilstrekkelighet», som noen land har begynt å se på. Bedre innsikt i etterspørsel og aktivitetsnivåer er også nødvendig for å kunne definere hvilke (små) utslipp som kan være igjen i 2050 og for å inkludere endringer i trender og transportbehov generelt. Tilsvarende er det behov for innsikt i hva som er «uungåelig» transport som er nødvendig for bl.a. energiomstillingen, klimatilpasning og karbonfangst- og lagring. Denne fremtidige etterspørselen må fanges opp i planleggings-systemer, men kan ikke avledes gjennom historiske data og er vanskelig å forutse.

Generelt er det behov for samfunnsøkonomiske vurderinger som i større grad tar hensyn til andre kvaliteter ved transport enn tidsbruk, som vurderer, vektlegger og unngår stiavhengighet og som bedre inkluderer hensyn til klima og natur. Her trenges det også bedre metoder for verdsetting og kvantifisering av bl.a. arealbeslag og for sammenlikninger mellom transport-former. I analyser og beslutningsprosesser må utslipp ikke bare belyses i større grad enn i dag, men også få en *førende* rolle. Tilsvarende gjelder det totale energi- og ressurs-behovet, som også bør synliggjøres og rapporteres *på tvers av* sektorer. Det må tydeliggjøres hva ulike sektorer skal bidra med og det trenges verktøy for å formidle fremgang underveis.

For transportsektoren må planlegging skje på tvers av transportformer, slik at transport-systemet som helhet blir i tråd med et lavutslippssamfunn. Omstillingen og utfordringer på vei til lavutslippssamfunnet impliserer et behov for å revurdere hvilken infrastruktur som bør prioriteres når alt tas i betraktning, herunder både de forskjellige infrastrukturbehovene og de samlede effekter som infrastrukturprosjekter har for mulighetene til å oppfylle stadig strengere klimamål og hensyn til klimatilpasning, utslippsreduksjoner, teknologiomstilling og ressurs- og energiknapphet. Valg som tas, må være kompatible med lavutslippssamfunnet.

Med dette utgangspunktet er det behov for verktøy for å definere *konkrete fremtidsvisjoner* og alternative *veier* dit. I denne sammenhengen er det forskjellige, men relaterte metodiske retninger for fremsynstenkning som kan bidra til større forståelse av hva som påvirker utviklingen og hva som kreves for å endre den. Spesielt «backcasting»-metodikken og en videreutviklet scenariometodikk blir de siste årene trukket fram.

Backcasting går ut på at det defineres én eller flere ønskede fremtider, for deretter å jobbe seg tilbake i tid for å identifisere mulige veier («pathways») til disse fremtidene (se figur S.1). Det unike med backcasting er at metoden eksplisitt er normativ og legger vekt på hvilken fremtid som er ønskelig, istedenfor hvilke utfall som er sannsynlig. Backcasting kan brukes som verdifullt beslutningsstøtteverktøy, f.eks. til å vise det politiske mulighetsområdet for å nå mål, til å illustrere alternative utviklingsbaner og til å gi innsikt i kritiske valg og tidspunkt og rekkefølgen for tiltak. Backcasting sine styrker når det er behov for transformative endringer, tidshorisonten er lang nok til å tillate radikale alternativer, målene ligger langt fram i tid, business-as-usual og inkrementelle tiltak ikke gir ønsket endring, problemer er komplekse eller vedvarende, eksternaliteter spiller en viktig rolle og det planlegges under stor usikkerhet. Backcasting er dessuten kompatibelt med forskjellige typer verktøy og metoder, både kvalitative og kvantitative. Fordi backcasting er normativt med hensyn til hvordan fremtiden skal se ut og hva det skal planlegges for, kan det argumenteres at bruk av backcasting kan være en strategi for å redusere usikkerhet.



Figur S.1. Illustrasjon av backcastingtilnærming. Kilde: Whitelegg m.fl. (2010, s.18).

Scenarioer kan i sin tur være et nyttig verktøy til å utforske forskjellige fremtidsbilder under usikkerhet. Det finnes en rekke relaterte metoder og teknikker, med hver sine styrker. I praksis vil antall scenarioer og detaljnivået vanligvis måtte avgrenses basert på vurderinger av intern konsistens, plausibilitet, overlapp, representativitet, mm. Narrativer eller historiefortellinger er en mye brukt tilnærming, gjerne kombinert med tall, og med scenariofamilier som tar utgangspunkt i ekstremer og kontrasteringer (f.eks. såkalte Shared Socio-Economic Pathways fra klimaforskning). Backcasting og scenariometodikk *kan*, men *må ikke* være tett sammenkoblet, og rapporten gir detaljerte beskrivelser og «oppskrifter» for å bruke metodene i praksis.

I praksis har noen få land forsiktig begynt å implementere konsepter knyttet til UFF-rammeverket, «tilgjengelighet», «tilstrekkelighet», backcasting og scenariometodikk innenfor transport- og samfunnsplanlegging. Tilsvarende er det et fåtall land hvor sentrale klima- og miljømål kan sies å utgjøre konkrete føringer i transportplanlegging. I denne sammenhengen synes spesielt Wales og Østerrike å skille seg ut. Selv om interessen for «nye» perspektiver, metoder og verktøy øker, står imidlertid de fleste land fortsatt i startgropen, med diskusjoner på et relativt overordnet nivå. Ved å samle og konkretisere, samt beskrive trinnvise «oppskrifter» og betraktninger, håper vi med denne rapporten å gjøre fremtidens planleggingsmetoder lettere tilgjengelig.

1 Introduction

In recent years, policy-makers and scientists have increasingly been calling for further development of methods, analyses and tools that support the transition to low-emission societies. Not least, this applies to transport planning and decision-making support for transport and infrastructure investments. There is increasing recognition that current analysis and decision-making processes suffer from weaknesses. For example, socio-economic analyses used in decision-making are usually based on forecasts of transport demand. These forecasts, in turn, are based on historical data, continuity in current trends, and a continuation of current policies or *incremental* changes in these policies (Hegsvold et al., 2022; Norway's NTP[1] 2025-2036; Eriksson et al., 2024).

Although transport modelling in itself is a broad field, with a wide range of techniques[2] and many applications, there are also major weaknesses. For example, questions have been raised about the suitability of current models in face of required transitions away from historical trends (the climate and energy transition). Amongst others, this implies that there is a need to study radical, transformative, organizational and systemic changes, realistic long-term planning, planning under increasing uncertainty, and for more holistic planning across sectors. Planning processes will have to take into account constraints set by climate and environmental objectives, but also by the scarcity of critical resources, such as energy, biomass, capital, land, minerals, metals, other natural resources, and relevantly skilled labour. Current transport and planning models may also be less suitable to capture the dynamics of future technological innovations and changing behavioural patterns. In addition, it has been pointed out that that 'baseline forecasts' used in analyses underlying Norway's National Transport Plan (NTP) are inconsistent with overarching societal objectives, e.g. regarding emissions reductions, land use, nature conservation, and zero growth targets in Norway's larger cities. In other words, such overarching objectives do not constitute boundaries or defining frameworks for transport planning, in practice (see e.g. Buus Kristensen et al., 2024)[3]. Transport planning in many other countries suffers from similar challenges. Not least, recent years have shown increasingly broad agreement on the need to reduce both transport demand and transport volumes, in light of implications for climate, environment, biodiversity, land policy, costs, efficiency, resource scarcity and negative externalities (Lyons and Davidson, 2016; Endres, 2018; Holz-Rau and Scheiner, 2019; Filippi, 2020; Klimaträttsutredningen, 2022; IPCC, 2023; Eriksson et al., 2024; Ertelt, 2024; Holguín-Veras et al., 2024; Lyons et al., 2024; Paddeu et al., 2024).

Several of the above points have been highlighted in the OECD's/ITF's Transport Outlook (2023a), IPCC's Sixth Assessment Report (2023) and in detail in the final report of Norway's Climate Change Committee (2023) – **hereafter also: NCCC**. References to these have found their way into Norway's NTP for 2025-2036. Here, Norway's government also announced new research centres ('Transport 2050'[4]), with the aim of strengthening authorities' basis for decision-making, including in policy-making on the transition of the transport sector to a low-emission society.

A central premise for future transport and societal planning is the need to plan based on where we want to be, not where historical trends take us. This is also referred to as a 'decide-and-provide' approach driven by visions, or 'design the future' or 'vision-led' approaches – rather than the current

[1] NTP = National Transport Plan

[2] Including 4-step models, techno-economic models/IAMs, SD models, ABMs, geographical models, behavioural models, planning models, etc.

[3] Norway's NTP 2025-2036 also explicitly acknowledges that an important challenge of transport projections that are currently used, is that they are in conflict with a number of key transport policy objectives (Buus Kristensen et al., 2024).

[4] See Box 2

‘predict-and-provide’ paradigm, which is reactive to projected transport demand (see Box 1 and OECD/ITF, 2023a). A main argument is that for societies in transition, current projection-based approaches are ill-suited as they reinforce undesirable developments and are based on demand patterns showing steady increases over time. In addition, such projections assume that transport volumes and modal choice are influenced by known, historical conditions and relationships. These may, however, change over time, both as a result of trends in society, and due to measures aimed at making societal developments compatible with a low-emission society.

In this context, different but related methodological directions for visionary, future or foresight thinking are pointed out, including ‘backcasting’ and further-developed scenario methodology. Both can contribute to a greater understanding of what influences societal and transport developments, and what is needed to change these developments. Similarly, there is a need for tools related to improved assessments, including the quantification of land use and unpriced external effects, and assessments of overall, cross-sectoral resource demand. In general, further development of methods and tools for analysis should also contribute to better assessments of the relationship between different types of policies and measures, objectives for the transport sector, and long-term implications and effects.

This report attempts to synthesize and make more concrete both the current knowledge status, and future knowledge needs, and to make ‘new’ planning perspectives more easily accessible. To this end, we present considerations on important guiding principles and nuances related to a transition to a low-emission society in 2050 and beyond (Chapter 2). This is followed by a review and summary of recommendations and principles for long-term planning from the NCCC, both overall (cross-sectoral) and for transport planning specifically (Chapter 3). In addition, this chapter discusses the weaknesses of ‘predict-and-provide’, the need for reducing transport demand, and challenges with the latter. Chapter 4 on backcasting and scenario thinking then provides a review of the background, principles and application for these methods, including strengths, links with other methodologies, and possible extensions. Furthermore, the chapter discusses perspectives on uncertainty and planning under such uncertainty. In addition to discussing backcasting and scenario methodology conceptually, we provide concrete examples of ‘recipes’, steps that can be followed, and considerations to take into account when taking these methods into use. Based on the premise *that* demand for transport must be reduced, Chapter 5 presents a number of perspectives on *how* this can be approached, both with regard to types of measures that can be used and ways of thinking about transport and planning (spatial planning, Triple-Access-Planning and the sufficiency perspective). Chapter 6 then provides examples from countries that have started to implement backcasting, scenario methodology and/or focus on demand reductions in practice. Chapter 7 provides a brief introduction to schools of thought in which major societal transformations are approached from a socio-economic perspective, and not just the techno-economic perspective often dominating in practice. Finally, Chapter 8 makes concrete and synthesizes the knowledge and development needs that must be covered in future planning by means of a detailed ‘checklist’, followed by short summaries on the practical use of ‘new’ methodologies and planning perspectives.

Although some references in this report may particularly apply to the Norwegian context, overall, we consider contents to be highly relevant to policy-makers and researchers in many countries.

2 Transitioning to a low-emission society: Important guiding principles and nuances

In its 2023 report, Norway's Climate Change Committee highlighted important nuances when emissions reductions are approached based on targets for 2030, compared to more long-term planning towards a low-emission society in 2050. Both in policy and public debate, the 2030 targets have dominated, and focus has mainly been on which sectors can contribute to emissions reductions in the relatively short term. In practice, this means that much focus has been directed at some sectors (including transport), and at types of measures and solutions that are both available, or can be obtained within few years, while also allowing for significant emission reductions in the short term. At the same time, there is less focus on sectors where major emissions reductions are not expected to be achievable by 2030, such as agriculture.

The dominant focus on the 2030 targets poses several challenges. Among other things, it can lead to choices that are suboptimal in the longer term, e.g. by choosing measures that are reversible, create path dependency (cfr. also Klimaträttsutredningen, 2022) or require resources that would have had a better alternative use. Not least, there is a risk that important underlying drivers are not addressed because they are difficult to change significantly in the short term (for example, transport demand). Similarly, there is a risk of postponing (time-consuming development of) measures that are needed to make significant emissions reductions from other sectors possible in the years after 2030.

The NCCC's premise is that in a 2050 perspective, the question is not which emissions should be cut, but which small emissions can be allowed to persist. Norway's Climate Change Act requires emissions reductions of 90-95% compared to 1990. In practice, this means that emissions must be reduced to 2.5-5 million tonnes CO_2 equivalents (CO_2-e). In other words: by 2050, virtually all greenhouse gas emissions must be eliminated for good. In the long term, *all* sectors will therefore have to have near-zero or even negative emissions.

As long as activity levels remain unchanged, however, it is found that a reduction to 2.5-5 million tonnes CO_2-e in 2050 will be very challenging to attain even under unrealistically optimistic assumptions such as unlimited access to expertise, labour, energy, land, biomass, minerals and metals, and even when assuming the use of all known, but not necessarily mature, technology[5]. The NCCC therefore concludes that a change in the level of activities that produce emissions, is necessary (although carbon capture could provide an opportunity to reduce the concentration of CO_2 in the atmosphere, and thereby compensate for *some* of the remaining emissions - but this is both land- and energy-intensive). At the same time, it is pointed out that economic growth will continue to be an important driver of energy consumption and greenhouse gas emissions, and that many climate scenarios indeed explicitly assume that economic growth will continue. The NCCC's review also illustrates that there are several sources of emissions that are difficult to reduce or eliminate without lower activity levels, behavioural change, or new ways of doing things. For example, this applies to emissions from meat production and from the petroleum sector. In the NCCC's analysis, around three-quarters of the

[5] The NCCC refers to observations by the International Energy Agency (IEA), that all the technology needed to achieve 2030 targets is available, while towards 2050, nearly half of the required emissions cuts will have to be achieved using technology currently at the demonstration or prototype level.

emissions budget for 2050 is filled by emissions from agriculture, in addition to emissions from petroleum extraction and from what are *currently* small, 'other sources'[6].

Not least, an important challenge is that even though 2050 emissions in theory can only be a very small fraction of current/historical emissions, both climate change and climate adaptation will inevitably lead to a demand for resources and transport *that goes beyond* current needs. This is discussed by McKinnon (2024) in a review of what he calls 'the many roles of logistics in the climate crisis'. McKinnon argues that efforts for reducing emissions and managing the consequences of climate change are increasingly dependent on logistics, and identifies eight specific roles that logistics has in this context[7]. Several of these roles are associated with climate change mitigation and adaptation activities that are very material- and transport-intensive, which McKinnon argues increases the challenge of reducing emissions from the transport sector. For example, climate adaptation requires large volumes of construction and bulk goods that need to be transported and stored. At the same time, large-scale development of renewable energy requires a lot of materials, transport and logistics, while carbon capture and storage also requires a lot of freight transport and other resource use. The NCCC also addresses these topics and highlights that the transition to a low-emission society will be closely linked to the energy transition, while there will also be needs related to the transport system, decarbonisation of industrial processes, and new industries, among other things. Carbon capture and storage also requires significant amounts of energy and land, and in many contexts there will be a need for new technologies, minerals and raw materials. A further challenge is that many of the critical materials for renewable energy and electronics are scarce. In practice, these issues therefore increase societal challenges beyond what can be observed from current levels and trends. Similar points are also discussed in detail in a Danish report on the need for new perspectives on transport and infrastructure planning and decision-making (CONCITO, 2023).

McKinnon (2024) argues that while it is critical to reduce emissions from transport, the diversity and scale of the contributions that logistics activities will have to make in the future, are underestimated. Specifically, McKinnon also points to a need for better insights into the effect that logistics' many roles have on transport volumes, as current transport models exclude future transport demand from processes such as renewable energy infrastructure development, physical climate adaptation and carbon capture, all of which are transport-intensive. Similarly, there are a number of other elements and relationships that are poorly captured in current transport models but are important in the transition to a low-emission society, and that will affect logistics and freight transport volumes.

Partly adding to, and partly overlapping with McKinnon's arguments, it should be noted that simultaneously to the transition to a low-emission society, there are also many other objectives that must be met, and that affect the structure of the industrial sector, trade, transport demand, energy demand, etc. Amongst others, Norway has identified several focus areas for transitions within the industrial sector and for exports, related to the phasing out of the petroleum sector, the further development of carbon capture and storage and renewable energy production, the production of batteries and components for vessels and vehicles with zero-emission technology, and the production and distribution of new types of fuel. Other societal trends, for example related to emergency preparedness and (total) defense, but also changes in trade, will also affect the need for transport - and which measures may be suitable and necessary, how, and when. The same applies to the transition from a linear to a circular economy[8], which is considered a prerequisite for the low-emission transition.

[6] Mostly non-combustion emissions, but which are difficult to eliminate.

[7] Cause, decarboniser, victim, adaptor, facilitator, rescuer, remover, geo-engineer.

[8] For a thorough review of challenges, opportunities and perspectives, see Circle Economy (2020) – for Norway.

3 Long-term planning: Recommendations and principles from Norway's Climate Change Committee

The report by Norway's Climate Change Committee (2023) contains many recommendations and principles. Some of these are applicable across sectors or intended as general principles, whilst others are sector-specific. This chapter discusses a selection of the NCCC's recommendations, both with regard to overall or general principles, and recommendations specific to transport planning. Although the main focus of this chapter is on recommendations from Norway, these recommendations bear extensive overlap with recommendations in several other countries, including 'Klimatrāttsutredningen' in Sweden (2022) and developments in Wales and Austria, among other countries (cfr. Chapter 6).

3.1 Cross-sectoral/overarching principles

The NCCC generally identifies a need for systemic and systematic changes in how climate and nature are protected, and states that such protection requires strengthened frameworks and systems and processes that allow us to think more long-term, better, and more holistically.

The Committee states that the required societal transitions must start without delay, and that all planning should be centred around a very limited emissions budget for 2050, scarcity of resources, and in ways that avoid undesirable path dependency. This entails, among other things, that all central decision-making tools and societal objectives must be compatible with a low-emission society and that choices and prioritization must fit requirements both towards 2050 and beyond, and not hinder further emissions reductions and absorption of greenhouse gases after 2050. This also entails that temporary solutions should not stimulate the development of value chains or industries that will be incompatible with a low-emission society.

It is highlighted that many decisions that are made today, affect both the scale and structure of economic activities, and thereby also emissions, absorption, and nature and biodiversity losses for many decades. Some types of choices are also hard to reverse. This includes decisions related to transport structures, urban and rural development, and industrial structures, all of which set important premises for the demand for transport, materials, resources, and energy. This, in turn, affects greenhouse gas emissions.

Further, long-term planning should emphasize the *prevention* of emissions. At the same time, the NCCC points out that many decisions are characterized by uncertainty about the future, and that it can be of great importance whether one expects developments in line with climate objectives or not. Societal planning should be based on achieving a low-emission society, not on projections that build on historical or current developments – for example with regard to expected future energy consumption, transport growth, or the extraction of natural resources.

The Committee further posits that it is critical to define what different sectors should contribute with, and what resources will be required, not least because choices within one sector can be critical for the availability of resources needed for transitions also in *other* sectors. There is therefore a need for holistic assessment of overall access to, and demand for different resources. As the transition to a low-emission society will require significant energy and natural resources, and climate change must be addressed in parallel with other threats to nature and the environment, measures and instruments should have the lowest possible overall impact on natural systems.

Overall, the NCCC states that a strengthened climate management system must be established without delay, consisting of three main pillars (translated from NCCC, 2023, p.220):

- ***'Planning:*** *Planning should be centred around the achievement of set objectives. All planning must be based on Norway reaching a low-emission society with near-zero emissions by 2050, on resources being scarce, and on avoiding undesired path dependency. Climate policy must be integrated across and at all levels of government and society at large.*
- ***Implementing:*** *Good organization, coordination, knowledge and expertise are important for rapid and effective policy implementation.*
- ***Evaluating:*** *Efforts and progress must be evaluated along the way. Policy should be adjusted when progress is insufficient or conditions change. Open and accountable reporting is essential; it also helps the public to track developments and to hold politicians accountable at elections.'*

The NCCC further recommends setting five-year emission budgets until 2050, and to make the first two budgets particularly binding. Norway is also recommended to draw inspiration from the way in which other countries use their Climate Acts as steering tools, and to further develop Norway's own Climate Act.

The Committee also describe a number of overarching principles that are important for all planning. This includes the so-called ASI framework (Avoid-Shift-Improve, or 'UFF' in Norwegian). The ASI framework is based on the principle that activities or actions that cause emissions should be reduced or avoided as much as possible. If such reductions or avoidance are not possible, the activities should be shifted, i.e. the way in which the activities are carried out should be changed. Only if neither Avoid or Shift measures are possible or sufficient, should 'Improvement' measures be implemented. This often involves technological improvements or more efficient use of resources.

Another important point of departure in the NCCC's recommendations is that there is a significant climate benefit to implementing emissions cuts as early as possible. Early emissions reductions limit climate change more than late reductions because they reduce the likelihood of exceeding carbon budgets and thereby of triggering irreversible and severe changes. The Committee also argues that an early transition will allow Norway to contribute more to technology development and experience with low-emission solutions, even though costs in some sectors may be high in the short term.

Other important premises include that it is important not only to reduce emissions, but also total energy demand, and that biomass should be prioritized for purposes other than energy. In particular, it is highlighted that all important resources for the transition to a low-emission society are scarce and that many emission-reducing measures require access to resources such as energy, biomass, capital, land, minerals, metals, other natural resources, labour and expertise. Choices in one sector that entail significant use of one or more scarce resources therefore limit the opportunities available to other sectors. In this context, the NCCC posits that it is important that assessments used for decision-making consider both the climate impact of decisions, and how the decision itself is affected by climate change. Similarly, it will be important to identify effects on resource demand and impacts on nature that are not directly emission-related.

Overall, the Committee also posits that *given* the ambition to become a low-emission society, the number of possible pathways to such a future is limited. However, it is also noted that some paths are more central to said transition than others, whilst the paths and the order in which measures are taken also have a bearing on public support for climate policy.

3.2 Transport planning

3.2.1 Organization and principles

Also for transport planning and Norway's NTP, the NCCC posits that the goal should be to become a low-emission society. This entails that the scope for emissions from transport towards 2050 is very limited. Also processes leading up to new NTP cycles are highlighted as important. In practice, defining principles and guidelines towards new NTP's are set by Norway's Ministry of Transport and Communications, on behalf of the Government, whilst the technical basis of assessments and decisions is largely prepared by the transport authorities ('transportvirksomhetene')[9].

Traditionally, Norway's NTP is based on projections of current and historical mobility patterns, which will not necessarily result in the desired developments. Specifically, the NCCC therefore recommends to improve the NTP process by not using projections of current transport patterns and historical developments as basis for forecasts of future transport demand, but rather to define that mobility in 2050 will be emission-free and not require more land use than today. In other words, projections should be based on where one wants to be in 2050, consider the necessary steps to get there, and adapt policy to achieve these and other objectives accordingly. Furthermore, the technical basis for the NTP should be prepared more holistically across transport modes and expertise, rather than by individual transport authorities that are each responsible only for parts of the transport system. This is important in order to achieve a transport system that, as a whole, is compatible with a low-emission society.

Also for transport planning, the NCCC's recommendations are based on the ASI framework: if it's not possible to avoid transport, measures that shift transport to less emission-intensive modes should be prioritized over measures that improve existing transport. It is pointed out that policy should centre around avoiding the need for, and thus the extent of transport, and on reducing the overall consumption of resources. This applies particularly because the size of transport volumes has implications for other measures that are needed, and the extent to which other emission-reducing measures that also require scarce resources, are possible. Additionally, continued transport growth will make it more demanding to meet Norway's obligations adopted under the Convention on Biological Diversity (CBD)[10]. With regard to resource scarcity, the Committee states that it is very important that, in addition to emissions, also overall energy use for transport is reduced. This, in turn, implies that when 'improvement' measures are chosen, focus should primarily be on direct electrification, not energy-intensive fuels such as hydrogen or biofuels. These should instead be reserved for transport that cannot be easily electrified, such as long-distance transport with ships.

Box 1: 'Predict-and-provide' and the use of 'baseline projections' pose challenges:

The predict-and-provide approach has been a cornerstone of transport planning since the 1960s (Jones, 2016; Ertelt, 2024). In practice, this means that in many countries, transport planning in general, and transport infrastructure planning in particular, is based on a baseline projection of future transport demand (the 'central forecast'), combined with cost-benefit analyses of measures or infrastructure projects (Eriksson et al., 2024). In recent years, this approach has increasingly been criticized and described as unsuitable for achieving transi-

[9] These are the Norwegian Public Roads Administration, 'Nye Veier', the Norwegian Railway Directorate, 'Bane Nor', the Norwegian Coastal Administration and 'Avinor'.

[10] In December 2022, the world's countries agreed on a global framework to conserve nature (the Nature Agreement/Kunming-Montreal Framework for Biodiversity)

tions to low-emission societies (Næss et al., 2014; Lyons and Davidson, 2016; OECD/ITF, 2023a; NTP 2025-2036; Alessandrini et al., 2023; CONCITO, 2023; Engholm et al., 2024; Eriksson et al., 2024, Ertelt, 2024).

First and foremost, demand projections under 'predict-and-provide' are based on historical data, trends and relationships, and usually on a continuation of current policies or *incremental* changes to them (Lyons and Davidson, 2016; Hegsvold et al., 2022; CONCITO, 2023; NTP 2025-2036). For societies in transition, this approach does not work because it is based on developments where demand has been steadily increasing over time, and thereby reinforces developments that are undesirable. 'Predict-and-provide' also makes transport planning reactive to projected demand, rather than to overarching societal objectives, e.g. on emissions reductions, land use, or zero growth targets (OECDs/ITFs, 2023a). The fact that climate objectives are not integrated into or guide transport planning is a challenge in several countries (Klimaträttsutredningen, 2022; CONCITO, 2023) and is problematic given broad agreement among both researchers and policy-makers that 'business-as-usual' is neither sustainable nor compatible with the path to a low-emission society (see e.g. Chovankova et al., 2023; NCCC, 2023). Among other things, there is broad agreement that the demand for transport must also be reduced (e.g. Klimaträttsutredningen, 2022; IPCC, 2023; NCCC, 2023). Today's projection-based decision-making, however, is based on continued and significant increases in transport volumes for many years to come (Ertelt, 2024). In this context, it is also noted that transport projections over time have often proven to be unreliable: indeed, both projections and sensitivity analyses tend to overestimate rather than underestimate developments in demand. Deviations from observed developments are thus not purely random, but have a systematic bias (Jones, 2016; Engholm et al., 2024).

Another challenge with projection-based transport planning is that trends, relationships and needs may change in the future, without such changes being captured in assessments and decision-making (Buus Kristensen et al., 2024). Both passenger and freight transport may for example be impacted by various societal developments and megatrends. Not least, the transition to a low-emission society will in itself trigger new needs and changes[11] in passenger and freight flows and their location (cfr. the discussion in Chapter 2).

Predict-and-provide is also known to yield 'more of the same', through marginal or incremental changes. To achieve a low-emission society, however, there is a need for structural, alternative, transformative changes, based on where one wants to be in 2050, and what is necessary on the way there (CONCITO, 2023; NCCC, 2023; Eriksson et al., 2024; Ertelt, 2024). In addition, predict-and-provide is not automatically compatible with the ASI framework, nor does it provide answers about what needs to be done (Ertelt, 2024). Amongst other things, it is posited that capacity expansions that are implemented in response to expected growth have a self-reinforcing effect on traffic growth, resulting in 'induced' traffic (Næss et al., 2014; Klimaträttsutredningen, 2022; Alessandrini et al., 2023). It is also pointed out that this effect is given too little consideration in practice, because projections are often used for analyses of *where and when* to build new infrastructure, and only more sporadically for analyses of *whether* infrastructure should be built (Næss et al., 2014). When induced traffic receives too little focus, this can lead to overestimation of traffic volumes in planning alternatives that do not include capacity-increasing investments, because growth trends are extrapolated based on trends observed *given* capacity increases. As such, the deterrent effect of congestion is ignored or underestimated (Næss et al., 2014). Expectations of traffic increases and high focus on road user utility also entail that planning alternatives that include new investments are more easily calculated to be beneficial (Klimaträttsutredningen, 2022). Even though the main transport models used in Norway to a large extent attempt to take into account congestion and induced demand, they still have some weaknesses. Amongst others, current models do not explicitly take into account changes in the time-of-day for trips, or land use (see also Flügel et al., 2024).

Also with regard to the institutional organization of decision-making and transport planning, research finds that current structures help maintain 'more of the same', rather than supporting change, new developments, and the use of new methods. The article 'A climate report gone missing – power mechanisms in Swedish national transport planning' (Eriksson et al., 2024) discusses this in detail in the context of Sweden, where transport

[11] Buus Kristensen et al. (2024) provide a detailed overview of various development trends and examples of what can be analyzed with the main modeling tools in the NTP process, as well as information needs and/or facilitation for analysis, and what current models (and projection methodology) cannot be used for. For further perspectives on the impact of a number of key societal and technological trends on future transport demand and the societal benefits of national road infrastructure projects, see the report Veien til framtiden (2024) and TØI report 1939/2023 on alternative development paths for NTP 2025-2036.

planning has many similarities with Norway. Klimaträttsutredningen (2022) also points out that the way in which responsibility, mandates and processes within transport planning are distributed institutionally, triggers a main focus on Improve and Shift measures, and not Avoid measures: In practice, Swedish national transport planning is therefore described as a reverse ASI process.

The Danish think tank CONCITO (2023) posits that the above weaknesses can lead to some infrastructure investments that are important for the green transition being initiated too late, while simultaneously, resources are being used on the development of new or previously adopted infrastructure that only increases environmental challenges and may be obsolete in a low-emission society. This can delay the green transition or make it more expensive than necessary, increase the risk of malinvestment in 'business-as-usual', and use CO_2 budget space and scarce resources on projects that are incompatible with the desired future.

As discussed in more detail in Box 3, there is much, or 'deep' uncertainty about a number of important societal developments and how these will affect transport and transport needs. Within the 'predict-and-provide' framework, the approach to uncertainty has usually centred around sensitivity testing of the baseline projection or a few alternative projections (Engholm et al., 2024). A conceptual challenge with this approach is that it implicitly assumes the existence of a future or projection that is 'most likely' and tests variations around this, but still based on extrapolation of historical trends. Sensitivity analyses will therefore only to a limited extent be representative of alternative futures that can be imagined or arise. Variations around one central alternative can further lead to this alternative being perceived as the 'truth', and to decision-makers not using the scope of possibilities they themselves have to shape the future and the scope of transport (Lyons, 2018; Blainey and Preston, 2019).

3.2.2 The need to reduce transport demand

The NCCC points out both that it will be very challenging to reduce emissions in 2050 in line with a low-emission society, and that there is very little room for emissions from transport, because the small remaining emission budget will mainly be filled by other, near-unavoidable emissions. For some areas, it will therefore be necessary to reduce activity levels, change behaviour, or find new ways of doing things. This includes the transport sector. OECD's/ITF's Transport Outlook 2023 describes how economic growth drives demand for transport, and that in most countries, GDP and the demand for freight and passenger transport are closely linked. A similar relationship exists between population increases and transport demand. Because of this, transport demand is expected to increase in the future, even in scenarios such as the ITF's 'high-ambition' scenario.

To achieve a low-emission society, however, current growth rates for transport demand cannot continue, and policies are needed to reduce demand for both passenger and freight transport. This challenge is exacerbated by transport demand segments that are relatively small today but will inevitably have to increase manifold in the years ahead (cfr. the discussion in Chapter 2).

The NCCC discussed that policy aiming at changing transport demand, and that is steering for society's mobility needs, requires a different analytical perspective than policy aimed at transport itself. Transport policy should change from being about the specific movements of goods or people from one place to another, to also include how the desire or need to transport goods and people is affected by the transport system, i.e. understanding how facilitating transport, and transport efficiency induce demand for transport and for different forms of transport. Policy should take into account how mobility is affected by the spatial organization of cities and towns, the location of institutions with many visitors (such as schools and hospitals), the construction of quays and ports, the establishment of shopping centres outside urban areas, the geographical distribution and extent of production and consumption, as well as cultural and social expectations and ideals. Simply put, one can say that measures to avoid transport lie at the societal level and are best mediated through the planning of the transport system and larger social structures. This includes land use policy, where choices can entail a high degree of both path dependency and irreversibility. OECD/ITF (2023a) also point out that logistics, and especially urban logistics and planning, must be part of strategic planning.

To reduce transport demand and emissions, (international) trade should also be taken into account, as production, trade, consumption and distribution systems (for example just-in-time) are closely linked to emissions with today's technology and production processes. The NCCC finds that trade policy is not sufficiently highlighted in Norway's climate policy, neither nationally, nor globally. Chapter 5 presents a number of perspectives on *how* reductions in demand can be approached, both with regard to types of measures and ways of thinking about transport and planning.

3.2.3 Related considerations for transport planning

Related to many of the guidelines described by the NCCC, McLeod and Browne (2023) conducted a broad thematic review of policy development and needs for freight transport – concluding with four guiding principles are described. These are summarized in Table 3.1 and can be interpreted in the context of the NCCC's guiding principles for societal planning in general, and transport planning specifically.

Table 3.1: Guiding principles for planning. Reproduced from McLeod and Browne (2023, table 2).

Guiding principle	Negative framing of principle	Intended outcome on freight patterns	Time scale/influence level	Related theoretical concepts
1. Plan for long-run succession of industries	Do not privilege old non-renewable industries over new sustainable development	Prioritise industries which transport higher value-density products and/or minimise transport impacts	Macroscopic (long-run strategic economic policy impacting on regional economic structure)	Freight decoupling: industry succession and creative destruction; economic diversification
2. Protect options for future decisions	Do not 'lock out' future opportunities to improve sustainability	Maximise the set of future options for public policy and firms' supply chain design	Macro/mesoscopic (enabling divergent future regional infrastructure choices and uses)	Institutional fragmentation, path dependence, bounded rationality
3. Develop competitiveness on attributes other than cost and speed alone	Do not target generalised user cost reductions	Incentivise firms to compete on attributes other than marginal transport cost; incentivise transport reduction	Mesoscopic (setting regional policy influencing firm location and supply chain design choices)	Induced demand and supply chain dynamism, fiscal competition
4. Explicitly value negative externalities	Do not discount or downplay impacts caused by freight	Incentivise the sustainability of supply chains and individual transactions which generate trips	Microscopic (incentives on transactional/operational decisions)	Deliberative planning methods; pricing

3.2.4 Norway's 'Transport 2050' research centres

Box 2: Transport 2050: Objectives and themes from call by the Research Council of Norway (2024)

Through the NTP for 2025-2036, the Norwegian government announced an intention of establishing one or more research centres under the name 'Transport 2050', with a goal of strengthening the decision-making basis for authorities' planning and prioritization, in light of major societal changes towards 2050. This was followed up through a call by the Research Council of Norway (autumn 2024), which pointed to specific needs for knowledge about how the transport system as a whole should be developed and how the transport sector will be affected by various types of shocks and changes in framework conditions. This need was thematically distributed across three research centres, with high expectations regarding interdisciplinarity and the policy-relevance of research results.

Centre 1: Development of methods, models and basis for analysis

"A transition to a low-emission society in 2050 requires the development of methods, models and a basis for analysis. Among other things, various forms of assessment of future transport demand and needs should be developed, such as backcasting and scenario methodology, so that the authorities can plan for a transport system that is consistent with the 2050 climate target. The fulfilment of Norway's nature obligations, and how the transport system should be developed in the face of other societal challenges, may also be relevant to

develop a methodology for. (…) In this context, there is also a need for knowledge about the importance of technological development, changes in the distribution of means of transport and changes in transport activity up to 2050[12]*. The centre should also take into account developments related to issues such as digitalisation, automation, technological development, electrification, artificial intelligence and increased computing power."*

Centre 2: Climate adaptation and management of vulnerability
"The centre will show how society should adapt to a harsher climate and more extreme weather in 2050. This requires analysing what measures governments and public transport operators should take to reduce the negative effects of these changes. Research will also be conducted on vulnerabilities that arise in society when the transport sector becomes digital and electric, for example what consequences electrification of the transport sector may have for total defence. The centre will also analyse measures that the authorities and transport companies can implement to reduce vulnerabilities."

Centre 3: Development of the transport system within tighter frameworks for nature, the environment and land use
"Increasing natural and environmental challenges and tighter frameworks for land use place stricter demands on how the transport sector can be developed in order to achieve an efficient, environmentally friendly and safe transport system throughout the country in 2050. There is a need for more knowledge about how the transport sector can be developed within this framework, either by avoiding, shifting or improving (the ASI principle). It is important to have knowledge about how the transport system affects nature, the environment and land use, and the effect of introduced measures, including regulations and national land-use guidelines. Furthermore, there is a need to develop methods and systematics that enable transport companies and authorities to better assess and manage their impact on nature, the environment and land use. This involves developing measures that can ensure the necessary development of the transport system, without creating unacceptable negative consequences for nature, the environment and land use."

[12] Earlier versions of the call texts indicated that the centre would analyse *reductions* in transport activity (adjusted to 'changed' in transport activity in the final call). Similarly, it was originally planned that the centre would assess the consequences of *reduced* passenger and freight transport for society, as well as the role that public authorities can play in contributing to such a development, and experiences with demand reduction. This was also changed in the final call text.

4 Backcasting and scenario thinking: Background, principles, and application

Large and increasing uncertainty about the future (Box 3) triggers a need for tools to assess different alternative futures (Engholm et al., 2024). Together with increasing criticism of 'predict-and-provide' (Box 1), particularly backcasting and scenario methodology have been highlighted as approaches with potential in this context and are recommended by the NCCC (2023) and Klimaträttsutredningen (2022), among others.

Backcasting and scenario methodology *can* be, but *aren't necessarily* closely linked, and are sometimes discussed together or interchangeably. For example, scenario methodology can be useful to define (different) desirable futures, ways in which they can be achieved, or for illustrating the need to adjust measures along the way, as a result of different societal developments. As such, scenario methodology can contribute to a greater understanding of what influences developments and what is required to change them. This, in turn, can be useful in assessments of specific investment measures and resource use. However, scenario methodology can also be used completely separately in the projection of different scenarios, where parameters such as population growth or implementation of measures vary between scenarios. In practice, one will often end up somewhere in between, with scenario methodology being used as one of the tools in a backcasting approach, or with analyses that implicitly use elements from both backcasting and scenario thinking.

4.1 Backcasting's place in the literature

Backcasting belongs to the research field of 'future studies' and is considered an important type of 'future studies' and scenario studies (Kishita et al., 2024). More specifically, future studies can be categorized based on three (four) basic ways of thinking about the future (Miola, 2008; De-Toledo et al., 2023):

- Probable futures (what *is most likely* to happen?): This category includes studies based on projections, often characterized by predictive approaches, and usually involving trend monitoring and analysis of historical data.
- Possible futures (what *could* happen?): This category includes scenario studies, which can be categorized as descriptions of possible future situations and associated developments. As shown in Figure 4.1, some studies make a further distinction between possible futures and a subset of these that are considered not only *possible* but also *plausible*.
- Preferred futures (what do we *prefer* the future to look like?): This category covers normative perspectives of what is desirable and includes methods such as backcasting and normative forecasting.

The aim of future studies is not to predict the future, but to provide a better basis for decision-making under uncertainty, especially for decisions with long-term dimensions (see also Box 3). In other words, a distinction can be made between 'projective' and 'prospective' scenarios (Miola, 2008).

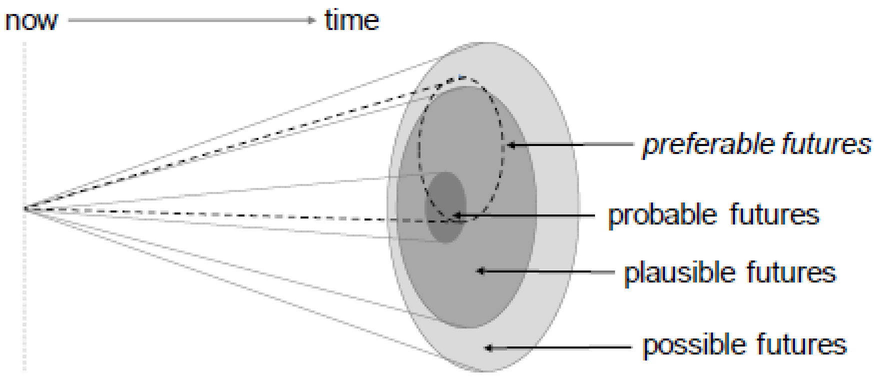


Figure 4.1: Illustration of the 'Futures Cone'. Source: Lyons (2018).

Unlike other futures methods focusing on probable or possible futures, backcasting is unique in that it is explicitly normative. This means that one sets normative goals and envisions (un)desirable, but radically different futures by thinking radically differently and by exploring how the necessary changes can be achieved step by step (Voorn et al., 2023). Backcasting is normative because it always starts with a goal (Kishita et al., 2024), and deviates from conventional projection methodology by putting emphasis on exploring which outcomes are desirable, rather than which outcomes are probable (Fuady et al., 2024).

Box 3: Perspectives on uncertainty

Society is said to be facing a period with increasing, and greater uncertainty than before (see e.g. Jittrapirom et al., 2023; Buus Kristensen et al., 2024). This applies not only to transport and the transition to a low-emission society, but also to other recent, ongoing and potential future societal developments – from the pandemic to geopolitical changes, from digitalisation, automation and electrification to advances in AI, and from new forms of interaction and mobility to the effects of and adaptation to climate change. All of these developments can lead to major changes in how society is organized and in the demand for and efficiency of transport solutions. At the same time, it is difficult to quantify or map the extent and relationships between these uncertainties (IPCC, 2023; Buus Kristensen et al., 2024).

Uncertainty is often defined on a scale from determinism to total ignorance (Engholm et al., 2024), i.e. from a completely certain/sufficiently certain future (Level 1), alternative futures each with their own probability (Level 2), a few plausible futures (Level 3) to 'deep uncertainty' (Level 4). For deep uncertainty, a distinction is further made between cases in which many plausible futures can be imagined (Level 4a) and completely unknown futures (4b) (Jittrapirom et al., 2023). Deep uncertainty is characterized by the fact that it is difficult to assign probabilities between different alternatives due to the complexity of the problem, too little information, or due to 'inherent' unpredictability (Engholm et al., 2024).

For transport (and a number of other societal developments), the medium- to long-term future is often associated with deep uncertainty (see e.g. Lyons, 2018) because it is highly uncertain how major societal developments will affect transport needs, patterns and opportunities (Blainey and Preston, 2019; Jittrapirom et al., 2023). The fact that transport and societal planning must take place under deep uncertainty has implications for how such planning can and should be approached. This affects what visions one can have for the future, what alternatives one realistically has or can envisage, and whether different visions of the future and associated 'pathways' towards it, can be achieved (Jittrapirom et al., 2023). Deep uncertainty triggers a need to imagine development paths that are not based on developments that are observable, but that may nevertheless arise. This includes developments paths that may seem unlikely, but may nevertheless occur (Mäntysalo et al., 2023). A challenge with 'predict-and-provide' is that uncertainty perspectives are usually limited to a set of variations *around a baseline projection* (Lyons, 2018; Jittrapirom et al., 2023)[13]. In practice, decision-making therefore only takes into account lower levels of uncertainty, while higher levels are implicitly or explicitly ignored (Lyons et al., 2024). Backcasting and scenario methodology, on the other hand, explicitly include uncertainty in the visioning process. This supports discussions about such uncertainty and the future, and the extent to which uncertainty can be managed. It also helps to make decision-making processes better-informed. Additionally, it can also be argued that precisely because backcasting is normative, it can be a strategy for reducing uncertainty by creating a clear picture of the future one wants to plan for.

With deep uncertainty and multiple possible futures, an important question becomes how policy measures perform under different future developments, with regard to risks and benefits/advantages. For example, some measures may work well in future A, but work less well or fail in futures B, C or D. Other measures may provide acceptable, but not entirely optimal benefits across multiple possible futures and thus provide lower risk overall (Lyons, 2018).

When backcasting and scenario analysis are discussed in the literature, this is sometimes done in conjunction, for example through claims that backcasting is a type of scenario analysis approach that has been useful for the analysis of possible alternative transport futures and the strategies and pathways needed to arrive at these futures (Camilleri et al., 2024). Similarly, backcasting and similar approaches that focus on normative and desirable outcomes are not necessarily always referred to as 'backcasting', but sometimes described by different terms. For example, there are both similarities and differences between backcasting and related approaches such as transition management (see also Chapter 7), ('normative') roadmapping, ('normative') scenarios and ('normative') visioning (Kishita et al., 2024). This also highlights a nuance, in that backcasting is in principle always normative, while scenario thinking can be both normative and non-normative.

Regarding visioning, Voorn et al. (2023) observe that normative approaches used in the context of climate adaptation often involve visioning rather than backcasting, with visioning being the process of creating a vision that represents a desirable future (Jittrapirom et al., 2023). This in turn is also *a step*, and usually key step, in backcasting, but not the entire process.

Within transport planning, backcasting can be used as a valuable decision support tool for at least two related types of transport policy decisions (Buus Kristensen et al., 2024):

- To illustrate *the available policy space* for achieving an objective; i.e. to present different combinations of measures capable of achieving the objectives, and the extent of measures required for this.
- *Alternative development paths* (compared to the baseline projection) for the base alternative and investment alternatives in transport model calculations, and as a basis for cost-benefit analyses of infrastructure investments. This can, for example, be part of the assessments and prioritization of projects that are considered towards the NTP - and for which one wishes to assess changes in profitability when demand projections are adjusted to be compatible with overarching societal objectives.

Because backcasting is compatible with different types of tools and methods, it has the potential to address climate uncertainty in long-term decision-making on climate adaptation (Voorn et al., 2024).

[13] For example, it was considered a small breakthrough when the UK Department for Transport cautiously began using scenario testing in 2015/2018, instead of just sensitivity testing around a baseline projection (Lyons, 2018).

4.2 Strengths of backcasting

The literature discusses different types of issues and characteristics for which backcasting can be a useful approach. This includes situations where there is a need for transformative changes/paradigm shifts at the system level (Hegsvold et al., 2022; Kishita et al., 2024). Recent examples include issues related to 'post-growth' and 'degrowth' and issues related to the UN's Sustainable Development Goals. The same applies when there is a need for major or large-scale changes (Voorn et al., 2023). For backcasting to be useful, the time horizon and scope of the issues must usually allow for the development of radically different alternatives (Voorn et al., 2023). Objectives are typically set far in the future, and the underlying assumption is that 'business-as-usual' will not lead to the desired future. For issues surrounding climate adaptation, all of these elements are usually present (Voorn et al., 2023).

The literature further points to strengths and useful contributions that backcasting can have when planning under great uncertainty (Voorn et al., 2023). Here, it is highlighted that in planning based on forecasts and projections, uncertainty is usually approached by studying how sensitive results are to changes in external variables. Backcasting and future studies aim to find out what will actually happen, so that society can adapt to more or less inevitable trends (Miola, 2008). Backcasting also has its strengths when problems are complex (Miola, 2008; Voorn et al., 2023; Kishita et al., 2024), when the current situation forms part of the problem, as is often the case for sustainability issues (Miola, 2008), or when dominant trends are part of the problem (Voorn et al., 2023). Furthermore, backcasting can be useful when problems are persistent (Voorn et al., 2023), when externalities play an important role (Voorn et al., 2023) and when problems are characterized by conflicts of interest between different types of stakeholders (Kishita et al., 2024). Backcasting can also help to better highlight how much time is available to solve a problem and to define a point in time when a decision must have been made (OECD/ITF, 2023b). In addition, backcasting can contribute by providing insights into the need for prioritization of different measures (Hegsvold et al., 2022).

4.3 Backcasting: Overall approach

Backcasting assumes that the future is uncertain and aims to define a broader conceptual framework that allows discussing the future in a meaningful way. The methodology involves formulating desired future scenarios, and then working backwards to identify which pathways are critical. This can provide insights into which measures may be necessary to achieve the desired future situation, or the timing, sequence or connection between different measures, which again is useful for decision-makers today (Hegsvold et al., 2022, Fuady et al., 2024). The world health organization defines backcasting as '*Moving step-wise back in time from a future scenario to the present in order to identify the decisions and actions that must be taken at critical points if the scenario is to be achieved*'. Other organizations use related and similar terms, e.g. by stating that backcasting entails 'envisioning of alternative futures', followed by exploration of which 'adaptation' pathways enable us to achieve such desired futures, or to '*strategize'* and plan for how such futures can be achieved (Voorn et al., 2023). This is illustrated in Figure 4.2. As can be seen, a vision (or visions) of a desired future is a central element, whilst there is often more than one path to this future.

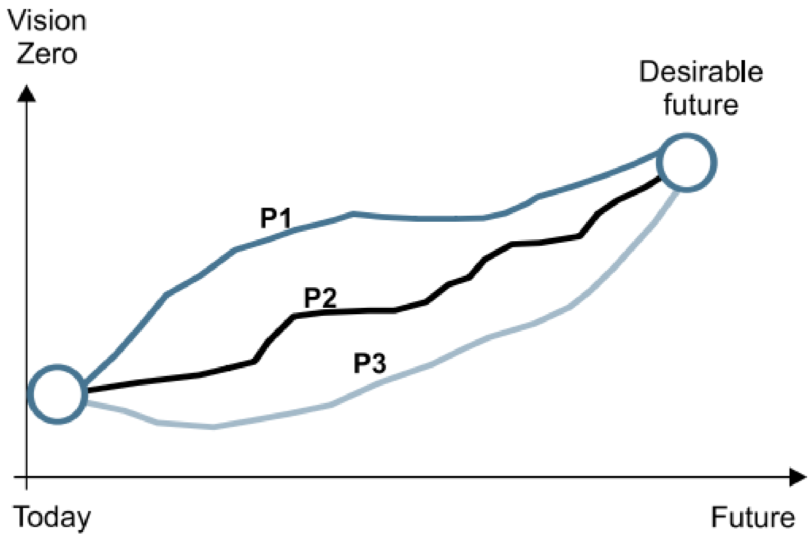


Figure 4.2: Illustration of a backcasting approach. Source: Whitelegg et al. (2010).

4.4 Extensions of backcasting methodology

Backcasting is often used in combination with other futures methods, such as scenario methodology and road-mapping, but also together with various analytical tools, design methods, simulations and ‘participatory methods’ (Kishita et al., 2024).

In order to use backcasting effectively in climate adaptation issues, there is a need for extensions (‘add-ons’) that allow for more advanced systems analyses, the development of more robust ‘pathways’, and ways to deal with uncertainty (Voorn et al., 2023). In practice, such extensions entail that quantitative and qualitative scenarios will often have to be studied more in combination. The literature also points to extensions linked to comprehensive modelling and simulation tools, methods for advanced systems analysis, inclusion of robust elements for ‘pathway switching’ and dealing with uncertainty, as well as ‘hybrid pathways’ for climate adaptation (Voorn et al., 2023).

Using backcasting in combination with other methods is useful not only in the analysis phase. Indeed, results or insights from backcasting exercises can in themselves provide input for further analyses. One such example can include a combination of backcasting with a KAIA-decomposition approach (see description for transport in Pinchasik, 2022), or the ASI-approach: here, backcasting can provide insights into characteristics of the desired future and possible pathways, followed by an assessment of the potential relative contributions of technological developments (Improve), use of less emission-intensive transport modes (Shift), and demand reductions (Avoid). Similarly, insights from backcasting processes can be linked to real options theory. Amongst other thing, this can contribute to more robust transition strategies (Jones, 2016) or provide additional insights into appropriate sequencing and timing of measures, and the balance between making final/irreversible choices, vs. postponing these choices to maintain flexibility.

4.5 ‘Recipes’ for and steps in backcasting approaches

Several studies discuss ‘recipes’ for the use of backcasting or different categories of approaches for using backcasting in practice. Backcasting approaches can, for example, be based on ‘participatory backcasting’, which can include workshops, focus groups, interviews, Delphi methodology and ‘expert consultation’ (Kishita et al., 2024).

Traditional backcasting often entails a goal or a vision to be achieved, and alternative solutions to achieve this (Hegsvold et al., 2022). An alternative to this approach is ‘pluralistic backcasting’ in strategic transport planning: here, multiple goals or visions are used as part of the strategic planning process (Jones, 2016). Amongst others, this has been tested for several cases in Finland (Hegsvold et al., 2022).

Robinson (1990) proposed a method that can be used in backcasting projects more generally. This method consists of six steps (determine objectives, specify goals, constraints and (intermediate) targets, describe the present system, specify exogenous variables, conduct scenario analyses, conduct impact analysis). Robinson’s method has been used in many contexts and has also been adapted by others (Kishita et al., 2024).

Fuady et al. (2024), in turn, discuss that backcasting is generally based on three primary phases, to achieve a given objective:

- The first phase is the ‘visioning’ process, which involves envisioning or defining clear future goals. This phase guides decision-makers towards a desired future state that is in line with their sustainability objectives.
- The second phase involves identifying policy packages. In this phase, decision-makers collaborate to identify a set of measures and instruments that will stimulate the desired changes described in the visioning phase.
- Finally, the third phase involves the identification of ‘policy pathways’, i.e. exploring different routes or directions that could lead to the desired future being achieved. This phase builds upon on systems thinking and modelling techniques, in order to assess the potential impacts and trade-offs associated with different policy choices.

Other studies divide backcasting into two phases. The first phase consists of imagining alternative futures that differ from the unsustainable futures that would result under business-as-usual. The second phase is the ‘visioning’ phase and consists of exploring innovative policy pathways that have the potential to enable and achieve the desired futures (Camilleri et al., 2024). From these discussions, it can be seen that the term ‘visioning’ is used for related but different aspects; visioning what the future looks like, and visioning what innovative policy pathways might look like.

Kishita et al. (2024) present a framework to help decision-makers and researchers develop backcasting approaches for given problems, based on four key questions: ‘When, Which type, How and What?’. As illustrated in Figure 4.3, this framework is divided into two phases: the design phase (when, which type, how?) and the Execution phase (what?).

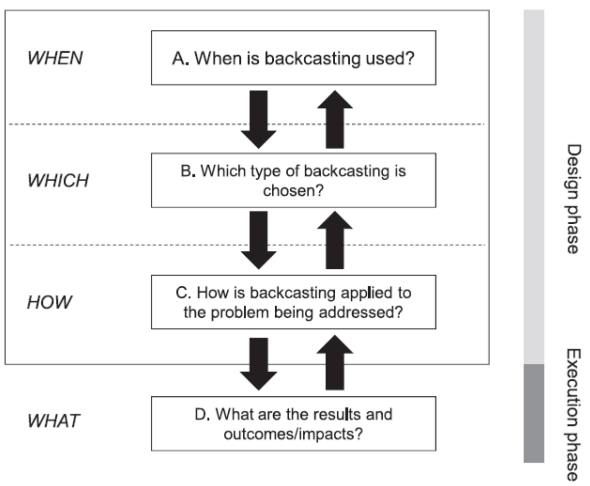


Fig. 6. Design framework for planning and operationalizing backcasting.

Figure 4.3: Illustration of the backcasting framework presented by Kishita et al. (2024).

For this framework, Kishita et al. (2024) created a checklist with elements and possible choices, shown in detail in Table 4.1. The first question: 'When is backcasting used?', covers several elements. First, one defines the problem to be solved (A-1) and the goals to be achieved sometime in the future (A-2). Next, one defines choices regarding the time horizon (A-3), scale (A-4), domain (A-5) and any key partners and target groups to be involved (A-6).

For the second question: 'What type of backcasting is chosen?', the authors suggest considering three elements: whether the approach should be goal-oriented or pathway-oriented (B-1), the degree of participation (for example, which part of the process is 'participatory') (B-2), and whether the approach should be qualitative or quantitative (B-3). These choices are not independent of the choices made with regard to the first question. For example, a goal-oriented approach is chosen when the purpose is to highlight the changes that are necessary to achieve a specific goal or to create a shared vision, while a pathway-oriented approach is chosen when the purpose is to examine whether a predefined vision (for example, a carbon-free future) is realistic, or to explore possible paths to achieving this vision. In practice, the choices for (B-1) and (B-3) are often not black and white, but rather combinations, for example a combination of goal-oriented and pathway-oriented choices, or a combination of qualitative and quantitative choices.

For the third question: 'How is backcasting used?', more detailed choices are made to operationalize the backcasting approach, based on the choices for the first two questions ('When' and 'what type'). Here, the process (C-1) is selected, i.e. which steps and activities are carried out, and in what order. These may be based on existing backcasting methods and must be consistent with the goals set in (A-2). Under (C-2), tools, methods and techniques are selected.

For the last question: 'What are the results and outcomes/impacts?', elements consist of content-related results with regard to design, analysis and method (D-1), results with regard to process and learning, such as increased understanding of relationships, new perspectives and approaches (D-2) and 'outcomes', such as various changes, activities that are initiated, etc. (D-3).

Examples of how this framework can be used in practice are given in Table 6.1 in Chapter 6, based on five real-life projects.

In order for backcasting processes to identify the most suitable sequences of measures (strategies), it is crucial that analyses are carried out in such a way that all relevant adaptations that people and businesses make when framework conditions change, are included. If not, there is a risk that adjustments will appear more costly than would actually be the case, for example in the form of greatly reduced mobility or value creation. This is illustrated in Figure 4.4 (reproduced from Buus Kristensen et al., 2024).

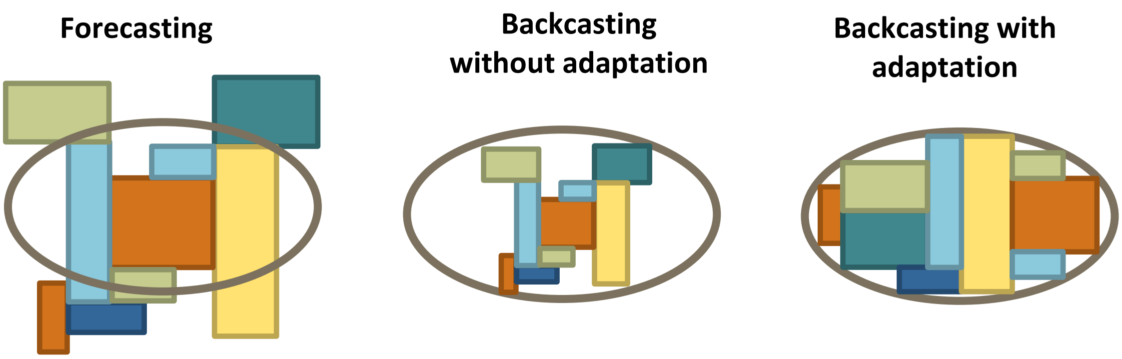


Figure 4.4: Illustration of the importance of including relevant behavioural adaptations in backcasting analyses that involve changes in framework conditions. The ellipses illustrate the framework conditions based on politically adopted goals, whilst the area in white illustrates untapped potential.

Table 4.1: Illustration of the checklist in the framework of Kishita et al. (2024).

A. WHEN is backcasting used?		
A-1	Goals to be fulfilled in the project's vision or image of the future	Important long-term goals (e.g., carbon neutrality by 2050) highlighted to be achieved in the future and consequences of achieving them.
A-2	Objectives of the project	Defining project objectives (e.g., to create a shared vision, highlight goal conflicts, challenge forecast-driven planning) and the target application (e.g., policy making, business model development or strategy development, awareness making/commitment creation, methodological development, and research design). A distinction can be made between content-related objectives, process-related objectives, and knowledge-related objectives, the latter including methodology development.
A-3	Time horizon	Period covered within the project, such as short-term (e.g., 10–20 years), mid-term (e.g., 20–30 years), or long-term (e.g., 30 years or longer).
A-4	Scale	Scale and system boundaries being considered in the project. Examples include industrial sector, specific company, local, regional, national and global scale.
A-5	Domain/Topic	Domain and topic considered in the project. Examples include climate change, energy, transport, and urban systems.
A-6	Core partners & target groups	Core partners and target groups for the project. Key is whether there is a commission partner, or whether additional partners are needed to conduct all activities and have all (interdisciplinary) knowledge and expertise within the project, while different target groups are possible, e.g., researchers, policy-makers, and corporate strategists.
B. WHICH type of backcasting is chosen?		
B-1	Goal-oriented or Path-oriented	Emphasis on either goal-oriented or path-oriented depending on the objectives (A-2). Goal-oriented backcasting refers to what futures may look like while achieving predefined goals and targets (A-1). This may include necessary changes that need to be made from the present. On the other hand, path-oriented backcasting refers to how desirable/undesirable future endpoints may be reached from the present, and what technologies, policies, and other measures/actions are mobilized.
B-2	Degree of participation	To what extent the backcasting process is participatory including the parts involved. For instance, problem analysis and definition, goal setting, creation of scenarios, analysis, what target groups (e.g. citizens, policy makers, external experts, industry representatives) and what level of influence is given to the participants. Level of influence can be related to Arnstein's (1969) ladder of participation or the derived 3 level structure proposed in Quist (2007) and Quist et al. (2011).
B-3	Qualitative or quantitative	Whether qualitative or quantitative data is used, or both (Van Notten et al., 2003).
C. HOW is backcasting applied to the problem being addressed?		
C-1	Process	A sequence of steps to be followed to execute backcasting. The process may be developed based on existing backcasting methodologies (see Table 1 for examples) and can include both research and stakeholder engagement activities.
C-2	Methods and tools	Methods, tools, and techniques that are used to support the process. These are related to (i) design, (ii) analysis, (iii) modeling, (iv) participation, engagement, and co-creation, and (iv) project coordination, communication, and dissemination. For participatory projects, methods and tools for participation (e.g. using workshop, interview, and questionnaire) and co-creation are possible.
D. WHAT are the results and outcomes/impacts?		
D-1	Content (design, analysis, and methods) results	Different kinds of content results, such as: • Design results including visions, scenarios, pathways, proposals, and interventions • Analytical results informing design results as well as assessing designs • Knowledge regarding policies counteracting sustainability • Models and simulation results • Methodology development and refinement, aiming at new, tested, refined, and validated tools and methods within a backcasting approach
D-2	Process and learning results	Different kinds of process results and learning, related to: • Increasing awareness on issues, problems, possible solutions, required changes and actions, as well as on the views and preferences by other stakeholders • Changes in mindset, preferences, and values due to higher order learning • Commitment to solving issues and problems, as well as the solutions, changes and actions needed • Endorsement to joint/shared views and priorities reflected in joint/shared support for visions, pathways and actions
D-3	Outcomes	Outcomes and impacts obtained, such as: • Changes in behavior, relationships, actions, or activities of stakeholders as a result of sharing and uptake of research • Changes in organizational practices and decision making • Follow-up and implementation activities • Spin-off activities, which are inspired by the backcasting project yet not intended • Other use of results and knowledge, contributing to structural change • Awareness among public, practitioners and politicians about alternatives to forecasted futures

4.6 Scenario methodology

As discussed, backcasting and scenario methodology can be closely linked, but the latter can also be used in isolation, both normatively and non-normatively. For example, OECD/ITF (2023a) shows how scenarios can be used to quantify the economic impact of a package of powerful policy measures for achieving 2050 climate targets.

Regarding needs identified by the NCCC and in Chapter 8, Asgarpour et al. (2023) point out that even though scenario-based approaches are not uncommon in analyses of road infrastructure investments, there are thus far few examples which also include comprehensive analyses of energy use and emissions in different scenarios. However, scenario methodology does have a potential to contribute to improved decision-making and planning by taking into account uncertainty about the future and enabling a proactive approach to planning, rather than a reactive and projection-based approach (Lyons, 2018).

In principle, scenarios can be a useful tool when exploring different futures under different forms of uncertainty, as is the case for transport planning (Lyons et al., 2024). However, scenario methodology does not constitute one fixed method, but rather a collection of approaches and methods (Hickford et al., 2015; Engholm et al., 2024). For example, Bishop et al. (2007) identifies eight main techniques and 23 variations among them, with each technique having its own advantages and disadvantages (Hickford et al., 2015; Grišakov, 2023). Overall, analyses based on scenario methodology usually consist of 4-6 steps (Louen et al., 2023). Weimer-Jehle (2018), for example, suggest the following four steps:

1. Identification of influencing factors
2. Selection of key impact variables
3. Development of so-called projections (possible developments) for all 'key impact variables'
4. Derivation of consistent scenarios, e.g. based on cross-impact matrices for all projections.

In turn, Grišakov (2023, pp.22-23) builds upon the analysis by Bishop et al. (2007) and divides scenario-based processes into 6 steps:

1. **Framing**: The process of creating a project plan by scoping the project
2. **Scanning**: Collecting information about the history and context of the issue and selecting approaches for scanning the future of the issue
3. **Forecasting**: Describing the drivers and uncertainties that eventually will lead to a baseline future and alternative futures
4. **Visioning**: Choosing a preferred future and envisioning the outcomes and performance measures
5. **Planning**: Making a strategic plan for reaching the selected future, including resources and options
6. **Acting**: Implementing a plan, communicating the results, and developing action agendas

Which methods and techniques should be chosen for specific issues depends on the objective and perspective of the analysis in question. Common for most scenario-based approaches, however, is that they are time- and resource-intensive (Gall et al., 2023). Given uncertainty about the future and the fact that one is often faced with a wide range of possible combinations of potentially relevant social developments, practitioners will usually have to limit both the number of scenarios that can be analysed, and their level of detail (Lyons, 2018). Such delimitation may for example be based on exclusion of combinations that are not internally consistent or plausible or are illogical. Similarly, some combinations may yield similar futures, entailing that not all individual scenarios need to be studied as long as one covers a good representation of the overall space of uncertainty for possible futures (Lyons, 2018; Buus Kristensen et al., 2024). Both to limit the number of scenarios to assess, and with regard to communication and creating a shared understanding, practitioners often use narratives or storytelling alongside quantitative measures (Hickford et al., 2015; Lyons, 2018). Such narratives should be well-explained, and preferably give one set of clearly distinct future scenarios, alongside a base scenario (Kristensen et al., 2024). As an advantage of using narratives combined with numbers, it is pointed out that it helps to identify important exogenous variables and how their parameter values should be adjusted for model analyses. Furthermore, such approaches can complement transport modelling, for example when important exogenous variables cannot be incorporated, but one still wants a rich picture of possible futures. This in turn strengthens the ability to assess what is over- or underestimated in transport models, given different futures (Buus Kristensen et al., 2024).

Examples of narrative-based scenario analysis includes 'scenario families' based on extremes and contrasts, such as a future driven by high economic development vs. an environment-driven future, or globalization vs. regionalization (Hickford et al., 2015)[14]. A mobility example from New Zealand (Jones, 2016) starts with 4 scenarios[15] that each represent a combination of developments with regard to relative energy costs (low-high) and accessibility preferences (physical-digital). Standardized scenarios from international climate research constitute another example. These scenarios have helped streamline and improve the quality of analyses with 'Integrated Assessment Models' for different types of climate policy and other future developments (Kristensen et al., 2024). These so-called Shared Socio-Economic Pathways (SSPs) are illustrated in Figure 4.5, each with its own internally consistent narrative on how the world will develop. Buus Kristensen et al. (2024) summarize that the 5 SSPs differ from each other through distinct development paths for population growth, economic growth, technological development, lifestyle preferences, developments in social conditions, inequality, etc. In addition, many of the underlying assumptions are broken down by country, as documented in the Shared Socioeconomic Pathways Scenario Database.

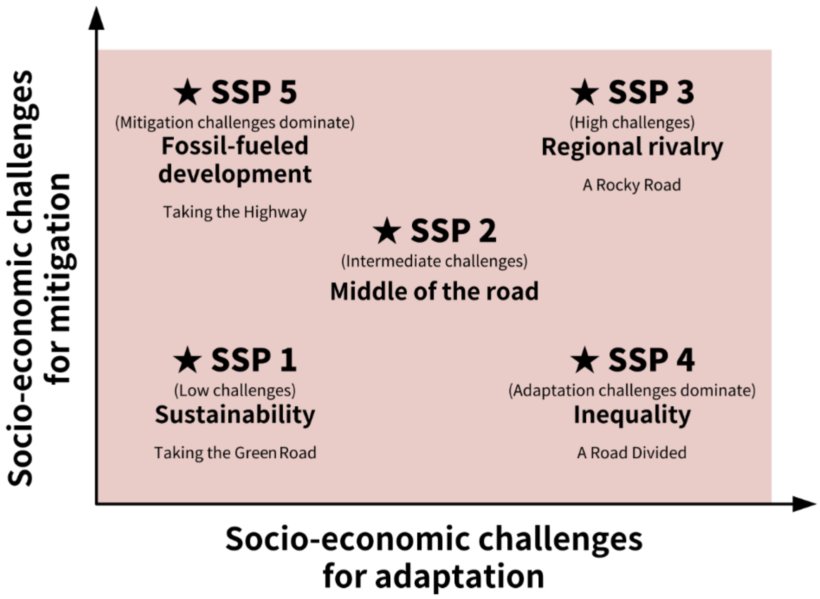


Figure 4.5: Illustration of Shared Socio-Economic Pathways from climate research. Source: O'Neill et al. (2017).

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14 This is for example illustrated through 6 scenarios, referred to as Economic-Technological Optimism; Reformed Markets; Regional Competition; Regional Sustainable Development; Global Sustainable Development and Business-as-Usual. Similarly, 7 narratives on transport and infrastructure development are used: Decline-and-Decay; Predict-and-Provide; Cost-and-Constrain; Adapting-the-Fleet; Promo-Pricing; Connected-Grid; Smarter-Choices

15 Cooperative and close; Global locals; Travellers paradise; Digital decadence

Furthermore, inspiration can be drawn from the scenario thinking used in Asgarpour et al. (2023). Here, the starting point was formed by four future scenarios (the core scenarios) from another study. These were then adapted to provide quantitative inputs for drivers for the demand for passenger and freight transport (especially socio-economic variables, global trade, and fuel prices). Together, the scenarios represented four futures: a 'green revolution', a 'missed boat', a 'safety revolution' and an 'infraconomy', all summarized in Table 4.2. Similar scenario approaches can also be used during the 'visioning' stage in backcasting analyses. However, it should be noted that limiting analyses to a limited number of drivers or extremities, may risk overlooking other plausible combinations of societal developments. If this entails that completely different futures may arise, but are overlooked, this can weaken the robustness of decision-making.

Table 4.2: Illustration of narratives used in Asgarpour et al. (2023).

Green Revolution	Represents an environmentally friendly future with a drastic reduction in the use of fossil energy and emission. Policy measures are directed toward reaching the climate goals set in the Paris Agreement. Much will be invested in energy transition; thus, environmentally friendly technologies will be extensively adopted with a high societal acceptance for a less polluting lifestyle. This includes a high level of remote working facilitated by technological developments required for secure and satisfactory distant working. Moreover, polluting energy resources are taxed to encourage a transition toward cleaner resources.
Infraconomy	Envisions a future in which economic interests act as the driving force. That results in strong product-based economic developments and the dependency on fossil energy. Liberal market mechanisms favour no energy resource in providing them with tax advantages. Globalization continues at a high pace with an increase in global trade. Much will be invested back in constructing and expanding infrastructures—with more focus on road—rather than investing in research and development. Face-to-face business meetings are valued more. Limited efforts will be put into tackling the climate crisis. However, some developments such as the limited modal shift to waterways—proportional to the growth of the port companies—reduce emissions.
Missed Boat	Envisions a future based on failed compromises to impose policy measures directed toward climate change. This future will leave us with different environmental, societal, political, and governance-related challenges, which causes failure in the attempts to reach a more sustainable society. Environmentally friendly technologies will be adopted to a limited extent. Fossil energy will remain the main source of energy, and global trade will be affected by protectionism and political conflicts.
Safety Revolution	Wellbeing is the central driver. People tend to work less, more meetings will take place virtually, the use of less polluting means of transport will increase, population growth in rural areas will be higher than in dense urban areas, and there will be reduced achievement of environmental goals because of slow economic growth. A more conscious lifestyle will result in more consumption of local goods. This trend, in addition to low economic growth, leads to a reduction in world trade. Furthermore, low research and development budgets resulting from low economic growth decrease investments in new technologies and energy transition. Despite the social acceptance of remote working, widespread, reliable, and secure remote working infrastructure will not be available.

5 Reducing the demand for transport: Perspectives and measures

As discussed, both the ASI framework and the scarcity of various resources indicate a need to reduce the demand for transport. This is especially important because current trends of increasing demand exacerbate challenges related to climate emissions, nature conservation, and resource needs, including the demand for clean energy.

In practice, policy strategies to reduce emissions from transport are dominated by 'Shift' or 'Improve' measures, while 'Avoid' measures receive significantly less attention (see e.g. Pinchasik, 2022a). This is partly because transport demand is strongly linked to economic growth and is therefore unpopular to limit (ibid). In addition, transport demand has various complex drivers and is influenced by many different actors, both of which are less 'plannable' for policy-makers (Holz-Rau and Scheiner, 2019). Although some work has been done on the integration of transport and land use modelling (for example through LUTI models[16]), knowledge about causal relationships remains limited (ibid). Not least, it is argued that in many countries, responsibilities and mandates for transport and spatial planning are distributed such, that planning strategies mainly focus on infrastructure development and on 'Shift' and 'Improve' measures (see discussion in Klimaträttsutredningen, 2022).

Recent years have seen increasing focus on the need for and necessity of also reducing the demand for transport (Filippi, 2020; Paddeu et al., 2024). Indeed, several countries have started to set targets for reducing or curbing the growth of transport volumes (cfr. Chapter 6; Hegsvold et al., 2022; Climate Foresight, 2024)[17]. In this context, it is pointed out that the demand for transport or mobility is a 'derived demand'. Even though transport activities may have some inherent value, they essentially constitute *a means* of *accessing* activities, people, jobs, services, markets, goods, facilities and other societal needs that are *located in different places* (Lyons and Davidson, 2016; Filippi, 2020; Lyons et al., 2024; Paddeu et al., 2024).

One approach that has started attracting particular attention and support from both the ITF and various national transport authorities, is Triple-Access-Planning (TAP). This approach centres around different forms of accessibility and is a new way of thinking about community planning. Another related concept and alternative to 'predict-and-provide' is so-called 'sufficiency-oriented planning', which is based on the premise that there is some level of transport that must be considered sufficient or enough. Box 4 summarises these approaches and how they relate to 'predict-and-provide' vs. 'decide-and-provide', and to the ASI framework.

In addition to more conceptual approaches, the literature also points to opportunities for concrete measures. For freight transport, especially in urban areas, for example, measures are pointed out related to infrastructure choices, parking, loading and unloading facilities, vehicle-related measures, traffic management, price incentives, logistics management, and measures aimed at the demand for freight transport and land use. In practice, authorities have mainly adopted *supply*-oriented measures. In recent years, there has been increasing focus on demand-oriented measures ('freight demand management'). Such measures are aimed at changing the behaviour of transport *recipients*,

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[16] Land Use and Transportation Interaction

[17] For Norway, often-cited examples include zero-growth targets in several cities, and city assessments ('byutredningene'). These are examples of setting a target and implementing measures accordingly. Here, one has also assessed different combinations of measures and projects. See, for example (in Norwegian): https://www.vegvesen.no/fag/fokusomrader/nasjonal-transportplan/byvekstavtaler/byutredninger/

for example with regard to the number of deliveries (service level), time (avoiding rush hour), destination (for example to consolidation centres), or means of transport. It is argued that taken together, such measures have a potential to trigger meaningful changes in both the volume of freight transport (urban logistics) and the time distribution of transport. Although the terms are used interchangeably, it should be noted that 'Freight Demand Management' is not equivalent to 'Freight Traffic Management'. The latter affects the choice of carriers, but not the underlying transport demand (Holguín-Veras et al., 2024).

Box 4: Triple Access Planning (TAP) and Sufficiency-oriented Planning:

Transport planning under 'predict-and-provide' has focused on transport, traffic, and a need to move. The TAP framework, on the other hand, is not centred around the need for transport, but around the underlying need for access to 'opportunities' (Paddeu et al., 2024).

The framework assumes that it is not just physical transport that can provide (better) accessibility, but that many needs can be satisfied in other ways, without physical mobility (Lyons and Davidson, 2016; Paddeu et al., 2024). The premise is that society's economic and social activities are enabled and defined by both 'spatial proximity' (land use), 'physical mobility' (transport) and 'digital connectivity' (online opportunities) (Lyons and Davidson, 2016; Endres, 2018; Lyons et al., 2024). This is illustrated in Figure 5.1. As such, improvements in 'spatial proximity' and increasing digital opportunities can reduce the need for physical mobility (Lyons and Davidson, 2016). These factors, and thus the residual need for physical mobility, can be influenced, for example by selecting locations precisely *because* they can be reached by sustainable modes of transport (Alessandrini et al., 2023). Where 'predict-and-provide' can be said to take a demand-driven and reactive approach to building transport infrastructure and capacity, TAP is considered to be a supply-driven approach to transport demand, and is driven by visions ('decide'), rather than projections ('predict') (Lyons et al., 2024; Paddeu et al., 2024).

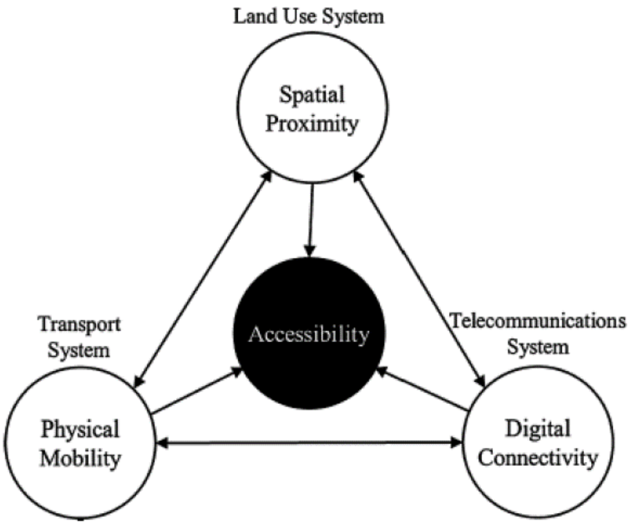

Figure 5.1: Illustration of Triple-Access-Planning. Source: Endres (2018).

Although the TAP framework is gaining increasing attention and opens for more holistic and integrated transport and spatial planning, its implementation lags behind in practice (Holz-Rau and Scheiner, 2019; Filippi, 2020; Klimaträttsutredningen, 2022; Alessandrini et al., 2023). In part, this is because accessibility is not as measurable as mobility (Paddeu et al., 2024)[18]. Ultimately, the objective is to increase the number of users that can access given opportunities within a given (acceptable) time/effort, as well as to increase the number of opportunities available within a given (acceptable) time/effort, from users of an area (Alessandrini et al., 2023).

[18] Although accessibility is not as measurable as mobility, different accessibility measures do exist, of which some are related to, among other things, actual travel demand and user utility (see discussion in Eliasson, 2020).

This again varies with the type and quality of opportunities, population density, user groups, and means of transport (ibid).

Another trend in transport research is based on ‘sufficiency-oriented planning’ as an alternative to ‘predict-and-provide’. Here, the premise is that instead of facilitating projected increases in transport demand, one first looks at the need for and legitimacy of this demand. Key questions are how much transport is sustainable and which transports are actually necessary. In practice, this involves both objective, but also subjective, normative, and idealistic assessments related to concepts such as ‘enoughness’ or sufficiency, and perspectives on what constitutes optimal consumption (Ertelt, 2024).

It is argued that sufficiency-oriented planning both overlaps and is compatible with the ASI framework. The objective is to change or reduce the need for transport (Avoid), and only thereafter to use ‘Shift’ and ‘Improve’ measures. Among other things, sufficiency-oriented planning also includes specific focus on sensible and efficient use and distribution of resources (Ertelt, 2024).

6 Selected examples from practice: Backcasting, transport demand reductions, and climate constraints in transport planning

Although their use is still limited, concepts related to backcasting, scenario methodology, the ASI framework, Triple-Access-Planning, and planning under uncertainty are increasingly being used in practice. Hegsvold et al. (2022) study seven selected countries, and the extent to which 'Avoid' measures can be said to be part of their transport strategy. The authors find that some countries have both overarching and sectoral emissions targets, whilst others only have overarching targets. Several countries have actively started to include climate constraints in their transport planning, both at the strategy level and for individual projects. Several countries also have 'Avoid' strategies as explicit and active parts of their transport strategy (Hegsvold et al., 2022).

Backcasting and related approaches have been used in various contexts, notably in other sectors than transport. Overall, the literature provides some examples, for example related to 'The Natural Step', a Swedish NGO that was founded in 1989 and contributed to a sustainable development framework with the same name – and which can be considered a detailed backcasting framework (Miola, 2008; Kishita et al., 2024). Another example is 'La Prospective', a research approach that originated in France and has been used to develop scenarios for 'future states' (Miola, 2008). In Germany, the 'Leitbilder tradition' has been used to inspire visions of what the future might look like (Miola, 2008).

Also an OECD project on sustainable transport (EST) in the early 2000s, used backcasting methods to explore what the European transport system could look like if current transport emissions had been reduced by 80-90% (Miola, 2008). The project used backcasting to define a desired future for transport, both in terms of emissions and other characteristics. In this context, the project demonstrated that it was not impossible to reduce transport activity sufficiently by 2030, compared to activity and emissions under business-as-usual (Whitelegg et al., 2010).

More recently, the UK looked at the possibilities of reducing emissions from transport by 60% by 2030, using scenario and backcasting approaches within the VIBAT project (Visioning and Backcasting for UK Transport Policy). Another example is Austria, where backcasting has been used to assess what developments are needed to achieve a climate neutral transport sector by 2040 (what combination of Avoid, Shift, Improve measures). This exercise identified a need to change assumptions that would allow further increases in passenger and freight transport in the years ahead – and instead to focus on reducing the volume of transport (Hegsvold et al., 2022).

As mentioned in the discussion of the framework by Kishita et al. (2024), ('When', 'Which', 'How', 'What'), Table 6.1 shows some examples of how this framework can be used in practice, based on five projects in Japan, the Netherlands and Sweden.

Table 6.1: Examples of how the framework by Kishita et al. (2024) can be used.

	Example I (Japan) (Ashina et al., 2012)	Example II (Japan) (Uwasu et al., 2020)	Example III (The Netherlands) (Quist and Leising, 2016; Vita et al., 2019)	Example IV (The Netherlands) (Quist et al., 2001; Quist and Vergragt, 2006)	Example V (Sweden) (Höjer et al., 2023)
Title	Low carbon society in Japan	Sustainable energy vision in a Japanese municipality	Sustainable lifestyles & green economy	Sustainable food consumption	Sustainable transport system futures 2035
A. WHEN					
A-1	80% CO2 reduction of the country by 2050	75% CO2 reduction of the city by 2050	100% sustainable lifestyles & green economy	100% sustainable food consumption	63% reduction in greenhouse gas emissions (GHG) for 2018–2035 from Swedes' transport
A-2	To explore technologically feasible pathways to achieve a low-carbon society in Japan	To develop sustainable energy visions for a Japanese municipality in 2050	To explore scenarios for sustainable lifestyles and green economy in Netherlands	To explore scenarios for sustainable food consumption in the Netherlands	To explore scenarios for travel and freight transport in 2035 using a consumption-based lifecycle perspectives with respect to GHG emissions
A-3	2005–2050	2017–2050	2015–2040	2000–2040	2018–2035
A-4	National scale	City scale	National scale	National scale	Consumption-based, nation
A-5	Climate change	Energy and urban system	Lifestyles, consumption	Household consumption	GHG, transport, consumption perspective
A-6	Researchers	Researchers, policy makers, and citizens	Researchers, government, and NGOs	Researchers, government, business, and NGSs	Researchers
B. WHICH					
B-1	Path-oriented	Goal-oriented	Goal-oriented	Goal-oriented	Goal-oriented
B-2	Non-participatory	Participatory	Participatory	Participatory	Non-participatory
B-3	Quantitative	Combined (qualitative + quantitative)	Combined (qualitative + quantitative)	Combined (qualitative + quantitative)	Combined (qualitative + quantitative)

(…continues on the next page)

C. HOW					
C-1	1. Setting future visions 2. Assuming technologies considered in the study 3. Making detailed assumptions based on the future visions 4. Quantitative analysis to achieve the future visions 5. Developing technology roadmaps	1. Problem framing 2. Analyzing current situations 3. Visioning 4. Describing scenario descriptions 5. Drawing pathways to a vision 6. Scenario assessment	1. Problem orientation 2. Visioning & workshop 3. Scenario elaboration 4. Backcasting & pathway workshop 5. Pathway development 6. Elaborating lifestyle options & environmental assessment	1. Problem orientation 2. Stakeholder analysis & involvement 3. Stakeholder visioning workshop 4. Scenario construction 5. Scenario assessment 6. Backcasting & implementation workshop 7. Follow-up & implementation	1. Setting an emission reduction goal 2. Developing a goal-fulfilling image of the future 3. Comparing with an image of the future, based on trend development 4. Illustrating images of the future with considerable amounts of calculations
C-2	Simulation	Logic tree (step 3), spreadsheet calculation (step 4), and roadmapping (step 5). For stakeholder participation, workshops involving citizens to develop visions and pathways (steps 3–5) and an online questionnaire for citizens (step 6) were also used.	Stakeholder analysis (step 1), interviews (step 1), workshops (step 2 & 4), scenario elaboration (step 3), pathway development (step 5), environmentally extended multi-regional input-output analysis	Stakeholder analysis Workshops, scenario construction, economic evaluation, and environmental assessment. Consumer focus groups	Calculations (Step 4)
D. WHAT					
D-1	Graphs describing the trajectories of different scenarios to 2050 in terms of CO_2 emissions and cost.	Images of the future visions in the form of narrative storylines and illustrations.	Visions, pathways, and lifestyle scenarios environmentally assessed	Three visions, evaluated for economic aspects, environmental gains & consumer attractiveness	Images of the future Policy advice based on the images of the future, identifying critical policy areas for goal fulfillment.
D-2	N/A	Aiming for learning effects for workshop participants (citizens)	Learning among researchers, workshop participants, and policymakers	Learning among researchers, and involved stakeholders	Aiming for changes in mindset among transport planners and decision makers, towards understanding of what it takes to achieve a sustainable transport system.
D-3	The authors developed reports for policy makers based on the described scenarios.	The authors shared the resulting visions with households living in the city and received feedback from them to gain insights into energy policy making.	No clear impact in the Netherlands	Limited implementation impact, only proposals, clear scientific impact (replication).	Too early to evaluate, but there will be a workshop series with practitioners during 2024 based on among other material, this study.

Similarly, some countries have started to look at transport demand from perspectives related to TAP- and sufficiency-oriented planning or have started to let climate targets guide and shape transport planning. Frontrunner countries in this regard include Wales and Austria (cfr. Hegsvold et al., 2022; CONCITO, 2023). In addition to transport-specific targets, targets for the timing of emissions reductions and climate neutrality, and use of the ASI framework, Austria has also started to look at how much transport is 'sufficient' (CONCITO, 2023). In Wales, too, climate targets provide important guidance for transport planning. This is an interesting example of a relatively radical implementation of both TAP-and sufficiency-related elements. For example, Wales' transport strategy and its revised National Transport Delivery Plan from 2023 are based on three main principles, which in turn are based on recommendations from the UK Climate Committee (cfr. CONCITO, 2023, p.25):

- Bring services to people so the need to travel is reduced
- Allow people and goods to move easily from door to door using accessible, sustainable and efficient transport services and infrastructure
- Encourage people to switch to more sustainable transport

Wales also temporarily paused road development projects and established a 'Roads Review Panel' to review whether planned road projects were in line with or compatible with, among other things, overall strategic transport objectives and CO_2 targets. Criteria for this review are based on specific purposes that are considered legitimate (x4), and on requirements/conditions that must be fulfilled (x4).

This is illustrated in the following figures (both reproduced from WRRP: p.5/p.9). Planned projects must meet at least one of the purposes, and all of the requirements in Figure 6.1. Furthermore, each individual project is assessed against a number of questions (Figure 6.2). In Sweden, the Klimaträttsutredning (2022) pointed out that similar principles should be used, both for previously adopted infrastructure investments and for new decisions. The same Swedish report also recommended that transport planning should be based on accessibility perspectives.

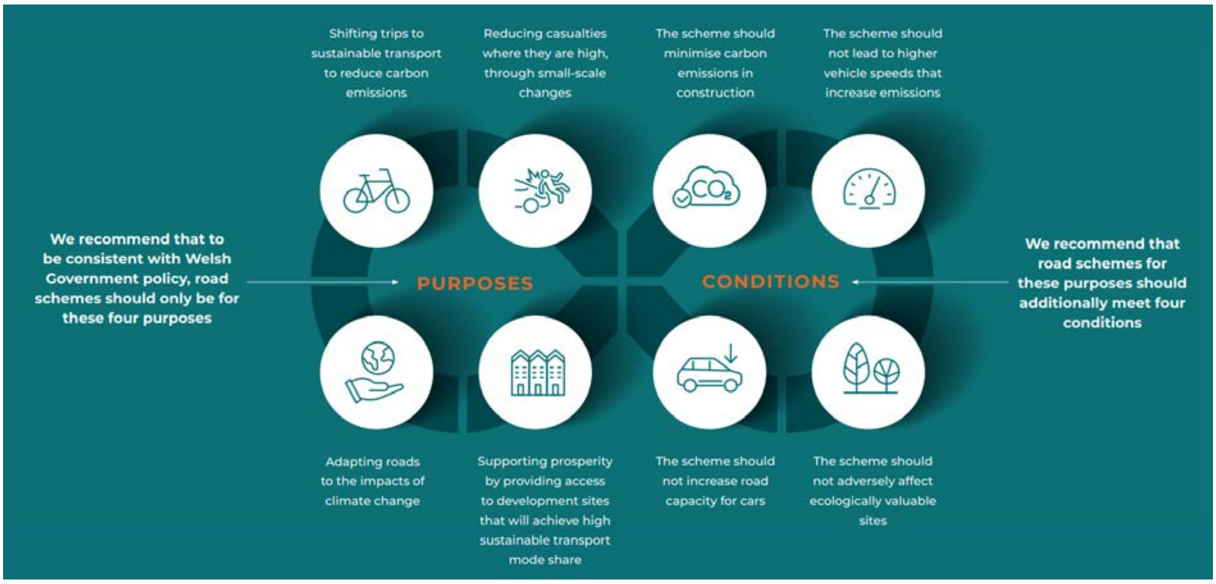

Figure 6.1: Wales: Assessment framework based on purposes and conditions. Source: WRRP (2023).

Figure 6.2: Part of assessment framework from Wales Roads Review Panel. Source: WRRP (2023).

In assessments of individual projects, emphasis is placed on:

1. Whether the project is well-founded
2. Whether the project is in line with transport strategy objectives (including climate and nature objectives)
3. Whether all relevant alternatives have been considered
4. The CO_2 implications of the project
5. Whether the project is good for people and local communities
6. Whether the project is good for the environment
7. Whether the project is good for the local economy
8. Whether the project is good for culture and the Welsh language
9. How robust the project is to different possible futures

7 Techno- or socio-economic transition

As discussed, there is broad agreement on a need for radical and structural changes, and therefore also for transformative and systemic change in both the transport sector and its planning (De-Toledo et al., 2023; IPCC, 2023; van der Voorn, 2023). Current policy approaches tend to be techno-economic. In practice, however, there are also many other factors, e.g. socio-economic factors, that may be important. In this context, it may therefore be appropriate to consider perspectives from the field of 'transitions theory'. Within this field, it is argued that major societal changes require a restructuring of the socio-technical system, and that the way transformative change takes place, requires triggering changes across multiple dimensions, at the system level, and between organizations and actors (IPCC, 2023).

Based on insights from different disciplines, four related frameworks have emerged: the Multi-level perspective (MLP), strategic niche management (SNM), transition management (TM) and technological innovation systems (TIS) (van Wee et al., 2022). Particularly the MLP framework is often highlighted in relation to system changes in both transport planning and other societal transitions, and in relation to how transitions from one socio-technical system to another, can occur (van Wee et al., 2022; Paddeu et al., 2024). In the MLP framework, transition processes are considered non-linear processes that arise through the interaction between developments at three levels (illustrated in Figure 7.1):

- Landscape (macro level)
- Regime (meso-level)
- Niche (micro-level)

The landscape level represents the broader context, such as economic or political developments, climate change, demographics, etc., and can be considered an exogenous environment that influences the other levels but is beyond their control. Within the landscape level, trends or shocks can arise that can challenge the existing system or regime. The regime in turn represents the current situation, how things are done, often as a result of developments over a long period of time. As such, the current system is usually subject to several lock-in effects (Paddeu et al., 2024). The niche level, in turn, is the level where radical changes start, grow and develop. The reasoning in the MLP framework is that transformative changes occur as a result of processes within and between the three levels: Potential changes and innovations arise and grow at the niche level, but this in itself is not sufficient to change the current system. However, when the regime level is also challenged through changes in landscape factors, opportunities may arise for niche changes to gain a foothold in the current system (partial solutions) and to grow further, or to replace the current system in its entirety (Pinchasik, 2022b). An example of an MLP application in a transport context is given in Figenbaum (2017), who discusses socio-economic perspectives on how Norway became a leader in the adoption battery-electric passenger cars.

Insights into how change and transformation take place (from the MLP) can be useful inputs in backcasting processes. Mäntysalo et al. (2023) posit that within backcasting, a distinction can be made between approaches focusing on strategies ('pathways') towards a vision, and approaches focusing on measures and actors. MLP-based insights can therefore constitute inputs to backcasting with regard to how changes can be triggered or driven, which factors are transformative, etc. ('how?'). Similarly, insights can be linked to which actors are important, and how these actors can and should contribute ('who?').

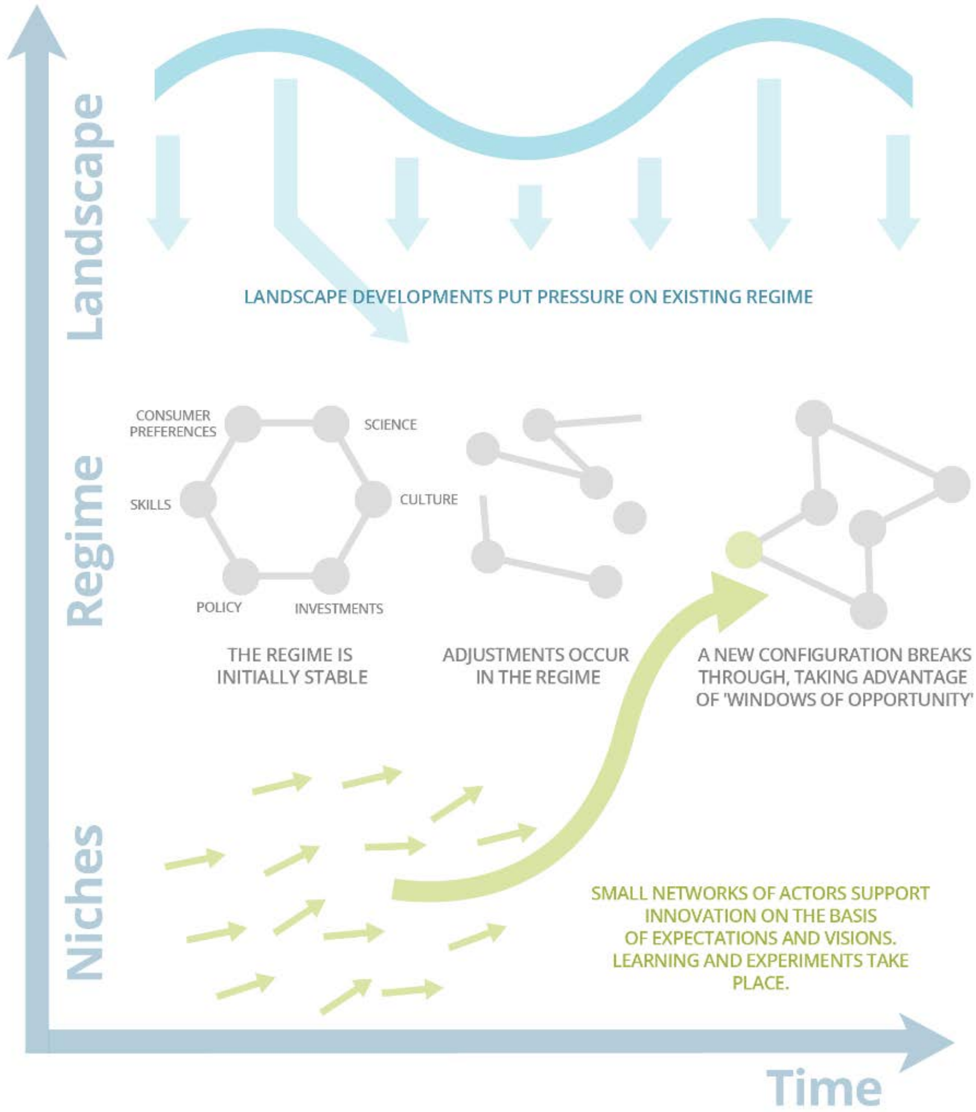

Figure 7.1: Illustration of the MLP framework. Source: European Environment Agency (EEA).

8 Conclusion: Implications, needs and opportunities

This report has reviewed guiding principles for transitioning to a low-emission society, illustrated important principles and recommendations for planning, and discussed the background and opportunities for using 'new' planning methods and perspectives – providing many insights. In this final chapter, these insights are compiled into a concrete and detailed 'checklist', with a focus on implications and needs: *What must be in place? How should we plan? What should we avoid? And how can and should we use 'new' methods and planning perspectives?* Finally, the chapter provides brief concluding summaries on key opportunities and considerations when implementing backcasting and scenario methodologies in practice, and on perspectives on transport demand and transformative chance – all of which were discussed in detail earlier in the report.

8.1 Knowledge and development needs in planning for a low-emission society

Overarching principles for planning

- Business-as-usual is insufficient for attaining a low-emission society by 2050 that simultaneously meets objectives regarding nature conservation, land use, and efficient use of scarce resources.
- There is a need for new/improved approaches to transport and societal planning.
- Such planning should enable structural, alternative, and more transformative, radical, and organizational changes, rather than the marginal or incremental changes that are common today (Köhler and Brauer, 2023; Voorn et al., 2023; Camilleri et al., 2024). The link between transport demand and emissions must be broken (OECD's/ITF's Transport Outlook 2023), and planning should shape and design the future, rather than reacting to trends using short-term measures.
- There is a need for long-term strategic visions and corresponding methods that enable more holistic planning across transport modes and sectors. These must come about within the next few years and take into account risks related to the reversibility of emissions cuts, and the creation of undesirable path dependencies.
- This entails a need for shifts away from business-as-usual, and towards foresight methods that allow for radically new perspectives on how transport systems should function and can be integrated into a low-emission society ('reimagine transport systems').
- There is a need for methods and processes that ensure integration of long-term objectives into all planning efforts. Amongst others, this should ensure that measures are initiated and developed early, also for sectors that receive less attention in a 2030-emissions perspective. This integration should also ensure that developments and investments that are incompatible with a low-emission society, are avoided (see also Klimaträttsutredningen (2022) and Chapter 6). An analogy from economics/finance is that such investments should be considered 'stranded assets'.

Methodological needs, future visions and planning under uncertainty

- Development of new planning and assessment methods should take into account that planning takes place under increasing uncertainty (see also Box 3).
- Overall, foresight methods should be (further) developed and be capable of answering two key questions: '*how <u>should</u> the future look?*', and '*what can <u>pathways to</u> such a future look like?*'.
- The first of these questions entails a need for tools to define *future visions*, while also making them *concrete*. To exemplify, objectives of attaining a low-emission society by 2050 lack concreteness, as one can imagine many such societies, ranging from low resource consumption to high

resource consumption (even though some variants obviously are more compatible with other future objectives than others). What the future vision looks like also affects which transition pathways are possible, available, necessary, and sufficient.
- Similarly, there is a need for tools and clear decisions on which emissions can be allowed to persist – as this has implications both between and within sectors and for activity levels throughout different parts of the economy.
- The second question: '*what can pathways to such a future look like?*', triggers additional needs for analytical tools. These should also support other needs and objectives, amongst others by including links between transport and other sectors.
- Pathways to the future can be developed in many different ways, e.g. with regard to the sequence, timing and combination of measures, and important milestones. As pointed out by the NCCC, benefits of early emissions cuts in the form of risk reduction should be taken into account. The same goes for intermediate objectives and emissions profiles towards 2050. The NCCC recommends 5-year carbon budgets, of which the first two should be more binding.
- Tools that contribute to the above must be implemented and developed further. Examples include foresight methodology, backcasting, scenario methodology, and a number of combined and related approaches.
- Because backcasting is normative with regard to how the future *should* look like, and *what society should plan for*, its implementation may be part of a strategy to reduce uncertainty.

Reducing or curbing growth in transport demand

- Demand increases under business-as-usual are likely incompatible with a low-emission society that also attains other important societal objectives. Historically, policy-making has largely focused on 'improve' measures. As such, tools and approaches should be developed that ensure that transport planning prioritizes measures that *avoid* emissions and *reduce* emission-generating activities, rather than 'shift' and 'improve' measures.
- Reduced transport demand is also central to decision-making more generally, as (projected) demand significantly affects the results of socio-economic analyses, and thereby which projects end up being recommended and implemented: with higher transport demand, new projects are more easily calculated to be beneficial, while dampened or reduced demand makes projects (particularly those contributing to increased transport) less profitable/more unprofitable in assessments.
- The demand for transport and demand reductions should therefore play a central role. This requires expanding our knowledge base on the drivers of transport demand, and better inclusion of these drivers in assessments, e.g. with regard to what people prefer to spend their travel time on, preferences for different transport modes, and how different modes can facilitate people's preferred use of travel time. Similarly, a better understanding is needed of how the facilitation of transport (e.g. roads) and efficiency both contribute to creating demand for transport, and demand for different modes. Transport is not necessarily a goal in itself, but often a means. An analogy from a different field is that people do not want electricity, they want their lights to work.
- Insights into transport demand are necessary to gain a better understanding of the drivers of transport demand, so that these drivers can be targeted.

Changes, drivers and perspectives on transport demand

- Amongst others, the above implies a need for better insights into, and better linkages between transport and spatial planning. Land use policy should become part of strategic planning. The location of housing, workplaces and visitor-intensive locations strongly affects society's transport patterns and the demand for transport – particularly in areas in the immediate vicinity of these destinations, but with ripple effects also in other areas. Examples include shopping centres and hospitals located outside city centres. Land use policy should emphasize the compactness of cities and towns.

- Better linkages between transport and land use planning may also entail a need for the development of knowledge and perspectives regarding concepts as accessibility-oriented and sufficiency-oriented planning, which some countries have started to look into (cfr. chapters 5&6).
    - Accessibility concerns 'the ease with which the activities of the destination can be reached within an acceptable travel time, cost and effort', and thereby depends on interactions between transport, land use, and available time and characteristics of/for the person travelling (or the goods). Opening hours/time windows are often important, whilst digital accessibility is also becoming an increasingly relevant option. Key themes within accessibility-oriented planning include the relationship between accessibility and qualities of the transport system (how easy is it to get somewhere?), and spatial planning (where are relevant destinations located?).
    - Sufficiency principles are amongst others considered and used in Austria and concern the need for behavioural changes in order to reduce transport volumes.
- The need for improved knowledge on transport demand is also linked to the need to define visions on which (small) emissions can be allowed to persist in a low-emission society in 2050, and the need to include changes in trends and transport demand more generally – as this will affect which types of transport will take place in the future.
- This entails that there is a need for insights into changes in industrial structure and transport demand, in connection with digitalization, the transition from a linear to circular economy, new types of transport and dynamics (e.g. shared mobility) and changes in behavioural patterns.
- Similarly, there is a need for insights into 'inevitable' transport that does not currently exist or only constitutes small volumes but will emerge or increase to enable the energy transition and climate adaptation. Likewise, transport will be generated as a result of initiatives such as Norway's export strategy[19], the Green industry strategy[20], and other key focus areas, such as carbon capture and storage, expansion of renewable energy production, battery and component production for zero-emission vessels and vehicles, and the production and distribution of new types of fuels. Transport will also change as a result of developments in (international) trade patterns, e.g. due to shifts in production structures and the division of labour between countries, or developments towards increased backsourcing and local production. Similarly, warehouse structures may change, e.g. through new decentralization trends.
- It is important that planning systems capture such trends in representative ways. Both demand implications and such trends, however, are hard or impossible to derive from historical data, and are difficult to predict. While there may be a reasonable consensus on qualitative descriptions of benefits and disadvantages that may be expected from certain transport trends, the major challenge is to quantify effects on transport demand and societal/transport utility for society as a whole. An analogy from another field is that these elements, at least to some extent, represent 'black swans'.

Guiding principles and visibility of key elements in decision-making processes

- Overall, there is a need for socio-economic assessments that:
    - Better take into account other qualities and characteristics of transport than time use.
        - Examples can include the development and inclusion of measures related to quality of life, social impact, and environmental/ecological costs of transport (Miola, 2008)
    - Place less emphasis on facilitating high speeds in the road system, as more moderate speeds will limit overall energy use and have positive ripple effects on land use.
    - Assess and emphasize risks of path dependency in all decision-making.

[19] 'Hele Norge Eksporterer'

[20] 'Grønt industriløft'

  - Further develop methods to better include climate and nature considerations. This also requires further development of perspectives and methods for valuation and quantification of land use (among other things), and better comparisons between segments, which is currently challenging (e.g. comparisons of land use between road, sea and rail, or between passenger and freight transport).
- Emissions should not only be highlighted better in analysis and decision-making processes, but actively be included as central constraints. This is exemplified by the observation that baseline projections used in Norway's NTP process, are not compatible with achieving climate objectives.
- The same applies not only for emissions, but also for constraints set by scarce resources (e.g. renewable energy, expertise, labour, biomass, minerals and metals) and by the availability of known, but not necessarily mature technologies. Similarly, (constraints on) activity levels should be taken into account in planning.
- Processes and measures are required that ensure that considerations regarding energy and biomass availability are taken into account, and that, where possible, the main focus of 'improve' measures is on direct electrification.
- There is a need for the development of methods that highlight and illustrate resource use and needs across sectors. In this regard, expectations on the individual contributions of each sector should also be clarified (cfr. also Klimaträttsutredning (2022) in Sweden).
- Similarly, there is a need for tools to evaluate progress along the way, and that allow steering and adjustments when progress is insufficient.
- For the transport sector, the scientific basis that underlies decision-making should be developed across transport modes and expertises, so that the transport system as a whole is developed in line with a low-emission society.
- The NCCC's recommendation that Norway should take inspiration from how other countries use their climate legislation (and to further develop the Norwegian Climate Act) triggers knowledge needs on other countries' practices, and assessments of what may be appropriate to use in Norway as well.
- Overall, the transition and challenges on the way to a low-emission society imply a need to reassess which infrastructure should be prioritized when all relevant factors are taken into account. This includes both the different infrastructure needs and the overall effects that infrastructure projects have on society's possibilities of meeting increasingly stringent climate objectives (compatibility), but also considerations regarding climate adaptation, emissions reductions, technological transitions and resource and energy scarcity[21].

8.2 Backcasting and scenario methodology: Opportunities and considerations

The transition to a low-emission society requires transformative changes both in society and in the way we plan. For transport planning in particular, there is growing consensus that the 'predict-and-provide' approach has weaknesses, and that planning processes should instead be based on 'decide-and-provide'. Combined with increasing uncertainty about the future, this yields a need for 'new' methods and for being able to assess a range of alternative futures. In recent years, backcasting, scenario thinking and related foresight methods have gained increasing attention as promising methodological approaches.

Both backcasting, scenario thinking, and 'foresight methods' are umbrella terms that are often used interchangeably, or collectively as names for families of related approaches. Backcasting and

[21] Freely translated from the Danish think tank CONCITO (2023, p.3)

scenario methodology *can be*, but *aren't necessarily* closely linked. What sets backcasting apart, is that it is explicitly normative. This means that it sets normative goals, envisions (un)desired but radically different futures, and explores how necessary changes can be achieved step by step. In other words, backcasting emphasizes which outcomes are desirable and how these can be shaped, rather than focusing on what is most likely to happen. Because of this, it can be argued that using backcasting can be a strategy to reduce uncertainty.

Typically, backcasting involves defining one or more desired futures and then working backwards in time to identify possible pathways to achieve these futures. Within transport planning, backcasting can serve as a valuable decision-support tool, for example to illustrate the policy space that is available for achieving objectives, to illustrate alternative development paths, and to provide insights into critical choices, timing, and sequencing of measures. Backcasting approaches can be particularly suitable when there is a need for transformative change, time horizons are long enough to allow radical changes, goals lie relatively far ahead in the future, business-as-usual and incremental measures are insufficient to achieve desired changes, problems are complex or persistent, externalities play a significant role, and when planning is carried out under high uncertainty. Other strengths include that backcasting is compatible with different types of tools and methods, both qualitative and quantitative. This has been illustrated through detailed descriptions and 'recipes' for use of backcasting in practice (Chapter 4). When employing backcasting, it is crucial that the process accounts for all relevant adaptations that people and business make when framework conditions change. If not, one risks that transitions (e.g. to a low-emission society) appear more costly or intrusive than is actually the case.

8.3 Perspectives on transport demand, and use of 'new' ways of thinking in practice

Even though there is broad agreement that transport demand should be dampened or reduced, most policy measures and strategies have thus far focused on 'Shift' and 'Improve'. Approaches gaining traction in recent years include 'Transport Accessibility Planning' (TAP) and 'sufficiency-oriented planning'. TAP is based on the idea that a society's economic and social activities are enabled and shaped both by 'spatial proximity' (land use), 'physical mobility' (transport) and 'digital connectivity' (online possibilities). By influencing these elements, it is possible to reduce the need for transport. Sufficiency-oriented planning, in turn, is based on the premise that there is some level of transport that must be considered sufficient or enough.

While a few countries have cautiously started implementing 'new' perspectives, most countries' planning is still at early stages. Particularly Wales and Austria are highlighted as countries that have started to approach transport planning and demand through perspectives such as the ASI framework and TAP- and sufficiency-oriented planning. Similarly, they have started to integrate climate objectives as concrete guiding principles for transport planning. As a result, Austria is actively working towards reducing transport volumes and has set specific timelines for achieving sectoral targets in transport. Wales, in turn, temporarily halted road construction projects and established a commission to review whether planned infrastructure projects were compatible with overarching transport-political objectives and CO_2-objectives. This review process resulted in the definition of a handful of purposes that are considered 'acceptable' when investing in infrastructure, and a number of requirements/conditions that must be fulfilled for projects to be carried out.

Since current approaches to transport and societal planning tend to be techno-economic, whilst transformative change also requires changes in socio-economic elements, it may be useful to include perspectives from the field of transitions theory, when planning for change. This field argues that major societal transitions require triggering changes across multiple dimensions, at the system level, and among organizations and actors. For transport, particularly the MLP framework is often highlighted. This framework views transition processes as non-linear and driven by interactions between developments at three levels (Landscape or exogeneous factors; Regime or the current status quo; and Niche, or developments that could potentially shape the future). Understanding how change and transitions occur (through the MLP) can therefore provide valuable input into backcasting processes.

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