GLOBAL UTMANING

NORDIC TRANSPORT WAYS

NORDIC ACTION GROUP
ON CLIMATE AND ENERGY

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Transforming to Sustainable Transport in the Nordic Countries – and in Europe

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NORDIC TRANSPORT WAYS

PREFACE

In 2012 Global Utmaning launched the report ”Nordic Energy Ways in Europe” and thereby established the business platform NAG - Nordic Action Group on Climate and Energy. A range of business leaders and academic experts took part in the work, which resulted in policy recommendations for the energy sector in the Nordic countries.

Since then, NAG has expanded into two programs; NAG Power and NAG Transport. By bringing together business from the whole value chain, from the production of fuels to logistic companies, NAG Transport examines the entire transport system. Through the committed participation also from academia and the civil society, the work has been able to keep a holistic view. As a consequence, the approach of NAG Transport starts from an increasingly realistic angle to analyse sustainability in the transport sector; ecology, social/human ends and economy.

This report is the result of a large number of workshops and seminars, as well as of numerous separate discussions with individual experts in the partner companies and organizations.

We are pleased to share this work with a larger audience, and we hope it will contribute to increased understanding and to widen some horizons.

Stockholm, November 12th, 2015

Johan Hassel,
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The context

The European transport sector was in 2012 responsible for 26% of the total European, energy related, CO2 emissions. The Nordic countries reveal much higher transport related CO2 emissions, as a share of total emissions, than most other European countries, namely 34.5%. 89% of these are related to road transport. For Europe as a whole, and for the Nordic countries in particular, this indicates a significant potential for transformation in a world in need of climate change mitigation.

The five Nordic countries have all set out ambitious long-term decarbonising targets *i.e. becoming carbon-neutral by 2050 at the latest*. The actual global development with regards to CO2 reductions is, however, far from satisfactory. In a recent report IPCC concludes that without aggressive and sustained mitigation policies, global transport emissions may increase at a faster rate than from other energy end-use sectors and reach 12 Gt CO2 e/yr by 2050. This is almost twice the global level of today.

Against this background, the *Nordic Action Group on Climate and Energy* (NAG) is undertaking a project to bridge vision-action gaps, i.e. to put forward policy recommendations and concrete action initiatives to the policy-makers both in the Nordic countries and at the European level to push for coherent implementation and actions in favour of a transformation of the transport sector – with a strong business case and a joint Nordic voice!

Our intention is to contribute with new ideas and show what can be done. We do not suggest status quo or how to preserve our old business models. Instead of "business-as usual", we suggest the creation of more innovative, inclusive and broad paths for development and transformation of the transport systems. This will make it possible for all actors involved to adapt, upgrade and transform their activities to sustainability, parallel to maintaining, and even improving, competitiveness and profitability.

The policy framework

Climate mitigation is not only about the magnitude of the global emission reductions achieved, but also about the speed of that reduction process. Approximately half of the reduction has to be done before 2030. Bearing in mind that it is the accumulated GHG emissions that create climate change the transformation strategies should have an upfront profile. Based on that, we argue for Nordic governments to consider and create the political conditions for a stepwise "50%-50%-50%" GHG-emissions reduction strategy in the Nordic transport sector:

• 1st 50% reduction between 2015 – 2030 => decarbonisation rate of 4%/year
• 2nd 50% reduction between 2030 – 2050 => decarbonisation rate of 3.5%/year
• 3rd 50% reduction between 2050 – 2080 => decarbonisation rate of 2.3%/year

The Nordic countries ought to *declare annual minimum targets as described above* instead of distant ones and *calibrate climate policies if the targets are not achieved*.

We suggest a policy of "lead by example" with the intention to result in a "snowball effect", that is providing incentives for other countries and actors to join the process. We do not suggest that Nordic countries should deviate from mainstream EU transport policy, but that Nordic countries should take the lead and show the direction.

When pursuing an ambitious Nordic transport way, a key question is what it has to offer the business sector in the Nordic countries. In other words, a business case for the Nordic way is needed: it is the precondition for leading by example and for generating a "snowball effect". Except being a precondition, it also has additional advantages:

First, with access to both "clean" electricity and biomass for biofuel, the Nordic business in both the energy and the transport sectors are in a favourable position to create first mover advantages in the carbon-neutral transformation; taking Nordic-specific conditions and strengths into account this is a case for "smart specialization".

Secondly, the Nordic "home market" is large enough to create competitiveness and act as a stepping stone towards a larger expansion in Europe and globally.

Although the target for this process is radical, the *transformation process* is not. Industries, not the least related to transport, have transformed and restructured before at a speed of 4%/year. This can be done again and Nordic companies can be in the forefront; given that governments and decision-makers also dare to change the rules of the game and create fair and strong incentives.
Following the IEA, the means for transformation of transports can be grouped into three broad categories:

• *Avoid/reduce transport work*
• *Shift and go green*: shift from motorised travel to more energy efficient modes and/or from fossil to clean and "green" fuels
• *Improve/efficiency*: when motorised travel/transport is necessary, "improvement" can be achieved through more efficient fuels and vehicles

Our report is in line with that recommendation.

Transport systems of the future: the technologies

We know enough to immediately speed up the transformation of transport systems. The main powertrains of today are, in general, well suited to adapt to the needs for sustainability. The rolling fleets of tomorrow's land based transport will be powered by *electrical engines* and, to a much lesser extent, by the two main forms of *combustion engines* (we have to build upon the Otto and Diesel engines for decades ahead).

Transport systems of the future: energy sources

All energy sources of tomorrow must ultimately be based on the annual inflow of the sun to the planet. The energy inflow is approx. 10000 times the level of what mankind captures; in other words, the sun needs approximately one hour to deliver what we transform during a year. We are thus not running out of energy for transport; *the challenge is to develop policy paths that make future transport solutions possible, sustainable and profitable.*

There are only two sustainable ways to capture the solar energy and make it useful for transport; the *electric way* and the *biofuel way*. Both need supportive institutional frameworks to allow them to "take off" and to guarantee their sustainable production and developmment. The two ways are necessary and complementary. Both can, already today and increasingly in the future, contribute to the transformation of the Nordic energy and transport systems and to Nordic competitiveness.

It is extremely important that the Nordic governments promote European policies for both an electric way and a biofuel way in the transformation of the transport system. There are no other ways.

Transport, travel and mobility – a rapid shift towards public transport and extended delivery systems

The annual reduction of CO2 emissions in the transport sector by 4% in the coming two decades creates large challenges in transport planning. Neither densely nor sparsely populated areas can be excluded from this over all target although transformation paths may differ. In general the new sustainable solutions must have the capacity to become as attractive for transport and commuting as those of yesterday.

For heavy transport the implication is large infrastructural investments, new solutions and policies to increase efficiency in the transport system.

The most rapid and cheap results for personal transport can probably be obtained by forceful expansion of bus systems, bicycles and ebikes in combination with significant transformation of personal car transport. Within a framework of sharp reduction of car travel, the remaining car transport must be transformed from fossil fuels to electricity and/or biofuels. The mirror image of this transformation will probably also be an increase in commercial transport services for goods (eg. e-commerce) and people (eg. taxi). It may also be combined with new forms of contracts for small vehicles (eg. Autolib and Car2Go).

A reduction of personal car transport by half before 2030 is what a climate mitigation policy requires. That is consistent with an annual reduction of car traffic with approximately 4%. This necessitates a growth of public transport with 7%/year unless parts of this travel can be reduced or transferred to bicycles or ebikes.

To speed up this transformation process, and get a momentum we argue that Nordic governments should co-ordinate and actively promote *a Nordic demonstrator, a five cities program with a massive and rapid introduction of sustainable transport solutions in the five most densely populated regions in Scandinavia* (Helsinki/Espoo, Stockholm, Copenhagen/Malmö, Oslo and Gothenburg).

Nordic policies: general principles

We argue for harmonized interventions from Nordic governments, neutrality between sustainable technical solutions (unless they are "pre competitive"). Governments should strongly avoid direct subsidies on well working sustainable technologies and instead favour taxes and fees on non sustainable systems. Governments should harmonize rules (and taxation) between the Nordic countries so that sustainable solutions are always favoured before non sustainable ones. This will require policy activities also on EU level.

Significantly cutting transport sector emission will require proactive and sustained policy interventions and concerted action in a number of areas. It is important that policies as a whole balance "carrots" and sticks" to create incentives and acceptance for transformation to sustainability, e.g. so they contribute to welfare for households as well as become commercially attractive for transport related industries.

Nordic policies: core issues

- *The two energy ways - electricity and biofuels* - should dominate Nordic transport policy – also on a EU level.
- *Tax swaps and bonus malus systems* increases the leverage effect (efficiency) of transformation policies. They also face a higher probability to become accepted.
- *The base for taxation of fuels* should be energy use and CO2 emissions. This is far from the present case neither in the Nordic countries nor in the rest of Europe.
- *Public procurements* of transport infrastructure as well as vehicles and transport solutions/functions are – in particular when coordinated among Nordic governments – an important tool for transformation.
- Quota systems for biofuels should be raised from "fuel" level to "Nordic" level.

Nordic policies: illustrating the details

We suggest several improvements in vehicle dimensions and weight on Nordic level to increase energy efficiency and facilitate shifts between systems. This includes *heavy trucks, buses, light trucks, and e-bikes. We also suggest Nordic rules for platooning.*

Financing the Nordic Transport Way

The need for finance of the suggested measures is huge. To facilitate the parallel mobilization of private money and taxpayers money *we suggest the establishment of a Green Nordic Bank.* To finance the Nordic five cities program we also suggest new forms of PPP where public transport companies can purchase transport functions from fleet owners/managers financed by private capital and/or pension funds.

Conclusion

Returning to our main message: Although the long term *target* for this process is radical, *the transformation process is not*. The annual 4% decarbonisation target for the transport system is a clear yardstick towards which Nordic policy makers can continuously calibrate the activity levels of their tools too hesitantly used today.

1. INTRODUCTION

The rapid industrialization, which had its European take off two centuries ago, was based on a growing trade of raw materials and goods. The development of industrial specialization between countries and companies contributed to this trade creation. Furthermore the large global travel and migration was an important factor (Pomeranz, 2012). This process was, physically as well as literally, fuelled by the development of the steam engine, followed by the development of combustion technology in the 20th century. For almost two centuries we have learned to identify growth, welfare and modernity with the steady growth of travel and the physical movement of the industrial products we use. However, during recent decades, the knowledge has grown that this fossil fuel based model for transport and communication, is not sustainable; approximately 94% of the total energy demand from the transport sector on a global level is fuelled by oil, and 63% of the global oil consumption takes place in the same sector. Additionally, 6.6% of final demand of natural gas is allocated to transport (IEA, 2014b). The growth rate of energy consumption in the transport sector, and emissions of green house gases (GHG), has also been the highest among all the end use sectors on a global level (IPCC, 2014a, chapter 8). This creates an enormous challenge; on the one hand transport is a natural and necessary part of an efficient organization of the economy as well as a means for individual welfare and freedom, on the other it is a large contributor to climate change.

Although the Nordic countries have high declared political ambitions on climate mitigation in the transport sector, as shown in section 2, the Nordic countries do not fundamentally deviate from this global development. In fact, the five Nordic countries, Denmark, Finland, Iceland, Norway and Sweden, probably have the most ambitious long-term decarbonising targets in the world. This high ambition implies that the transport sector in these countries is facing the huge challenge of reducing its CO2 emissions, from 80 million tonnes (Mt) in 2010 to 10 MtCO2 in 2050 in order to meet their long-term decarbonising targets (NETP, 2013). Consequently, the transport decarbonisation actions are actually falling far short of declared targets in all Nordic countries at both speed and scale. This casts doubts on the feasibility of the political aspiration and creates unpredictable market conditions for business and investments.

"This report reveals that we know enough for a transformation process to start"

Against this background the *Nordic Action Group on Climate and Energy* (NAG) is undertaking this project to bridge vision-action gaps, i.e. to put forward policy recommendations and suggest concrete action initiatives to the policy-makers both in the Nordic countries and at the European level to push for coherent implementation and actions – with a strong business case and a joint Nordic voice!

The Nordic companies and actors behind this project are all directly or indirectly connected to the transport system in a wide context: as manufacturers of vehicles, of fuels or of subsystems as well as users and service providers in various segments and parts of the transport system. Our business models rely to a significant extent, directly and indirectly, on well-functioning and competitive transport systems and logistic solutions. Recognising that the transport models that we have inherited from the past are not sufficiently efficient and sustainable for the future, we are eager to contribute to a transformation of today´s activities and models that are more integrated, intelligent and climate-friendly.

This report reveals that we know enough for a transformation process to start. That is not the same as neglecting or denying the need for strong efforts in basic as well as applied research in transport related areas of knowledge. But the hope for future breakthroughs should not allow us to remain passive today. However, it is important to enter upon paths, which can absorb and include the learning of tomorrow.

To make such a transformation possible, it is an obvious task for the political system to facilitate acceptance and deployment for new solutions for communication, travel and transport as well as to create incentives that will enable fair and long-term market conditions. Our intention with this project is to contribute with new ideas and show what can be done – from a business perspective. What we suggest here is not to preserve status quo or old business models. Instead of "business-as usual", we suggest the creation of more innovative, inclusive and broad paths for development and transformation of the transport systems. This will make it possible for all actors involved to adapt, upgrade and transform their activities towards sustainability, while maintaining, and even improving, competitiveness and profitability. It will also initiate large scale investments in sustainable transport solutions.

This is a practical Nordic business initiative contrasting the slow climate change adaption and mitigation actions within the Nordic countries as well as on a global level. Agreements like a "new" Kyoto protocol and related UNFCC negotiation processes suffer from large uncertainty and frustrating inertia. The climate- and energy framework at EU level, particularly regarding the role of the transport sector, is far from sufficient. As a consequence, isolated, national initiatives run a high risk of becoming meaningless, due to limited market potentials as well as regulatory uncertainty and constraints. Coordinated initiatives among a small set of like-minded and progressive countries can provide a window of opportunity to pave the way for a rapid transformation path which, if successful, may inspire other countries and actors to follow. In addition, such first-mover transformation actions may be rewarded by first-mover advantages in the market; if they are built on robust and sustainable business cases.

The Nordic countries can be such a group; small as individual countries, but "likeminded" enough to reach agreements as well as large and advanced enough to have impact and inspire followers. If managed productively and constructively, this process can also show the potential for win-win solutions in the transformation of transport to sustainability. In other words, sustainability and competitiveness should go hand-in-hand – supported by fair and predictable market and policy framework conditions.

The overall objectives of this project are to:

• Create a joint "Nordic Business Voice" for bridging the vision-action gaps in the transport decarbonisation actions;

• Put forward a pragmatic, but yet ambitious "Nordic Business Plan" for the structural transformation towards a decarbonisation of the transport system, which is both environmentally sustainable and makes business sense;

• Bring the "Nordic Business Voice" and the Nordic Business Plan" to influence the Nordic, the European, and the global energy- and climate decision- making process, i.e. *to take the lead by good example, intending to generate "snowball effects". If climate mitigation policies should ever become effective, more have to follow*.

The structure of the report will follow the key questions to be addressed - underlying the Nordic transport way:

2. Why a Nordic Transport Way? – The magnitude of challenges and the role of the Nordic business community

3. What is a Nordic Transport Way? – A Stepwise "50%-50%-50% reduction" decarburization pathway

4. How to create a Nordic Transport Way? – A "policy toolbox" for supporting a business-driven structural transformation

2. WHY A NORDIC TRANSPORT WAY?

- HIGH AMBITIONS, GREAT CHALLANGES AND SNOWBALL EFFECTS

2.1 The magnitude of the challenge – in a global, European and Nordic context

The global context - climate change and its implications for transport

Global transport relies overwhelmingly on oil and is also responsible for 23% of energy related CO2 emissions. 75% of these emissions have their origin in road transport (IEA, 2014a). "GHG emissions from transport have in fact more than doubled since 1970 and have increased at a faster rate than any other end-use sector to reach 7.0 Gt CO2e in 2010 /…./ Around 80% of this increase has come from road vehicles /…/ The final energy consumption for transport reached 27.4% of total end-use energy in 2010[1], of which around 40% was used in urban transport" (IPCC, 2014, chpt 8, p. 7).

IPCC argues that without aggressive and sustained mitigation policies, global transport emissions may increase at a faster rate than from other energy end-use sectors and reach 12 Gt CO2 e/yr by 2050; almost twice the level of today. The report also concludes that it is possible to decouple transport related emissions from GDP growth – provided that "stringent policy options are implemented in all regions" (IPCC, 2014, chpt 8, p. 4). The policy challenges to reduce transport related CO2 emissions are underscored by the recent forecasts on global transport growth published by the OECD (OECD, 2015).

The European context

At the European level, transport related GHG emissions increased with a magnitude of 1.5% anually from 1990 to 2007. After the crises 2008, transport volumes, freights and passenger transport, have declined faster than GDP. This is also true for GHG emissions. Transport related GHG emissions had the same share of total GHG emissions in 2012 as they had 2008, mirroring the general decline in European economic activity. (Eurostat, 2015a). The European transport sector was in 2012 responsible for 26.4% of the total European energy related CO2 emissions (IEA, 2014a). Whether the decline in European transport indicates a decoupling of transport from growth is too early to conclude. There are, however, indications on a peak car(-travel) phenomenon on European and OECD level since around year 2000 (Economist, 2012; Goodwin, 2012; OECD, 2015).

1. To facilitate comparisons the radiation impact of GHG:s are often transformed to CO2 equivalents, CO2e(q). Although "other" GHG:s play a significant role in total for climate change they play a minor role in the transport sector. The difference between CO2e emissions and CO2 emissions in global transport is around 4%: 7.0 Gt resp. 6.7 Gt for 2010.

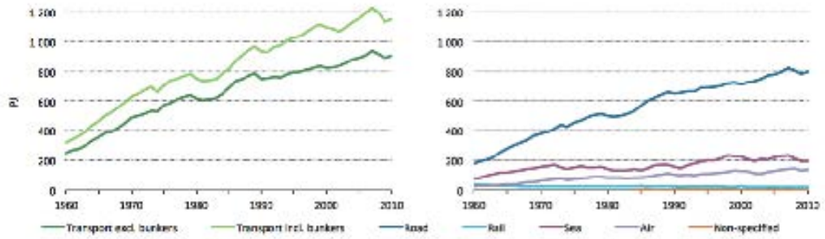
The Nordic context

The Nordic countries have much higher transport related CO2 emissions as a share of total emissions from fuel combustion than most other European countries: 34.5%, of which 89% are related to road transport (IEA, 2014a). The fundamental reason for that may be explained by the energy mix in the Nordic area where hydro power, nuclear power and biomass as well as wind power have strong positions for non-transport purposes. It also indicates strong efforts of energy efficiency measures in other sectors. The heavy ratio of CO2 emissions of transport indicates a significant potential for change.

The long term growth of energy use in the Nordic transport sector is revealed in figure 2.1, which also shows the growing role of international bunkers. In figure 2.2 total energy use is divided between transport sectors. Figure 2.3, finally shows the development of CO2 emissions in these sectors.

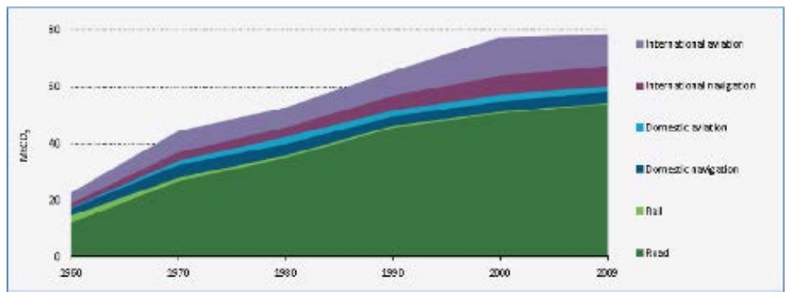
Figure 2.1:

Figure 2.2:



Source: NETP, 2013, chapter 5

Figure 2.3: CO2 emissions by transport mode in Nordic countries



Source:NETP, 2013

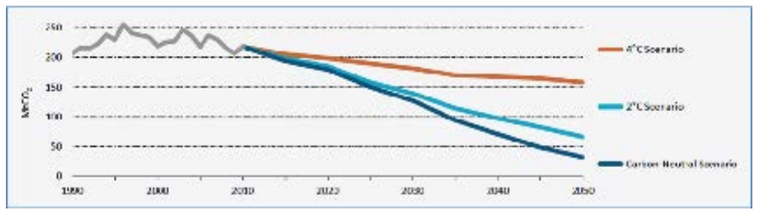
2.2 The challenges

The five Nordic countries have all set out the most ambitious long-term decarbonising targets in the world, i.e. becoming *carbon-neutral by 2050 at the latest*. This carbon-neutral scenario (CNS) is even more ambitious than the global 2°C *Scenario* (2DS) that has been put forward by the International Energy Agency (IEA)[2] and agreed at COP15 in Copenhagen. The CNS implies a deeper cut of domestic energy-related CO2 emissions by 85% (compared to 70% in the 2DS). To achieve the long-term decarbonisation targets in the Nordic region, emissions from the transport sector must be reduced sharply, from 80 million tonnes (Mt) CO2 in 2010 to 10 MtCO2 in 2050 (NETP, 2013, chpt. 2).

Climate mitigation is, however, not only about the *magnitude* of the global emission reductions achieved, but also about the *speed* of that reduction process. A significant part of the reduction (approximately half of the present level) has to be done before 2030 (IPCC, 2014; IEA, 2013).[3]

The present declared Nordic plans are illustrated in figure 2.4 below and compared to the IEA 4°C and 2°C scenarios.

Figure 2.4: Nordic energy-related CO2 emissions reduction plans (base year=1990)



Source: NETP, 2013, page 8.

Given the Nordic plans for CO2 reductions and the historical increase in transport demand and, the transport sector is facing daunting decarbonising challenges. Some of them are "very Nordic" in character (although Denmark is an outlier in this):

2. The 2DS is defined by IEA in "Energy Technology Perspectives 2012" and is broadly consistent with the "450 Scenario" from IEA's World Energy Outlook (2012). The 2DS describes an energy system consistent with an emissions trajectory that recent research indicates would give an 80% chance of limiting average global temperature increase to 2°C. The progress towards that scenario is analysed in IEA (2014b).

3. As shown in a recent policy study by Boyd, Stern and Ward (2015) the committments by the largest CO2 emitting countries do not presently live ut to this requirement.

• Sparse population and small urban areas – increasing transport distances
•Large natural resource based industries – creating large and heavy transport needs;
• Geographical conditions, such as large distances, mountains and islands – contributing to complexity of logistics;
• Tough winters contributing to complex maintenance and construction of infrastructure;
• Small and open economies heavily reliant on both exports and imports.

2.3 A business case for "lead by example"?

What is suggested here is a policy of "lead by example" with the intention to result in a "snowball effect" providing incentives for other countries and actors to join the process. We do not suggest that Nordic countries should deviate from mainstream EU transport policy, but that Nordic countries should lead by example. The strategy is based on the overwhelming consensus among scientists and international policy organizations that all countries, urgently, must follow paths similar to what we suggest.

When pursuing an ambitious and progressive Nordic transport way, a key question is what it has to offer the business sector in the Nordic countries; in other words, which is the precondition for enabling a Nordic business case?

First, a Nordic home market - with a population of 25 million and an advanced economy comparable to 40% of Germany´s - can be large enough to create competitiveness and act as a stepping stone towards a larger expansion in the global market.

Secondly, with access to both "clean" electricity and biomass for biofuel, the Nordic business in both the energy and the transport sectors are already in a favourable position to create first mover advantages in the carbon-neutral transformation; this is a case for "smart specialization", taking Nordic-specific conditions and strengths into account.

Thirdly, by creating a joint Nordic demonstrator in the Nordic metropolitan areas (as suggested in chapter 4 below) governments contribute to a momentum in policy, a Nordic Way, which may transform reactive and reluctant actions to proactive and self-reinforcing positive development processes.

3. WHAT IS A NORDIC TRANSPORT WAY?

- BUSINESS-DRIVEN AND INTEGRATED STRUCTURAL TRANSFORMATION

To find and pursue a Nordic transport way is about thinking outside the box, e.g. turning some of our views on transport upside down and open up new opportunities. However, paradigms do not shift until there are visions and stories showing alternatives that work.

In other words, the Nordic transport way must, beyond the high decarbonisation targets, contain concrete visions and action plans on paths for change, which combine realism and creativity. When identifying such paths there will always be divergent views and interests in the short run, which hopefully will converge in the long run. When the "rules of the game" are changed, actors may adapt and change positions.

A decarbonisation strategy may be formulated in different ways. In this report we focus on the *time dimension* and the *systems dimension* – taking ambition and levels as well as unique Nordic strengths into account.

3.1 How fast can we transform? – A Stepwise "50%-50%-50% reduction" de-carbonisation pathway

Bearing in mind that it is the accumulated GHG emissions that create climate change, it has been argued that transformation strategies should have an upfront profile. Based on that, we argue for Nordic governments to create the political conditions for a stepwise "50%-50%-50%" GHG-emissions reduction strategy in the Nordic transport sector:

• 1st 50% reduction between 2015 – 2030 => decarbonisation rate of 4%/year
• 2nd 50% reduction between 2030 – 2050 => decarbonisation rate of 3.5%/year
• 3rd 50% reduction between 2050 – 2080 => decarbonisation rate of 2.3%/year

"Industries, not the least related to transport, have historically transformed and restructured at similar speed"

The Nordic countries ought to *declare annual minimum* targets as described above instead of distant ones and to *annually recalibrate climate policies if the targets are not achieved*. This is a somewhat slower rate than what has been *declared* by Nordic governments themselves, but much faster and more demanding than what can be observed in actual policy implementation.

Although the *target* for this process is radical, the *transformation process* is not. Provided that the political and institutional conditions create the right long-term regulatory framework and "right and fair" incentives (discussed more in Chapter 4). Industries, not the least related to transport, have historically transformed and restructured at similar speed. This can be done again and Nordic companies can be in the forefront – given that governments and decision-makers also dare to change the rules of the game.

3.2 How to do it – Towards a new vision of an integrated transport system approach

There seems to be a global consensus that the transformation ahead must be based on a multifront strategy. Just pouring new fuel in old containers will not be enough; neither in magnitude nor in speed. This is also how IEA argues (eg. NETP, 2013 and IEA, 2014b). The means for transformation of transports can be grouped into three broad categories:

• **Avoid/reduce transport work:** address transport energy use and emissions by decreasing and reducing transport and travel demand;
• **Shift and go green:** enable and encourage movements from motorized travel to more energy efficient modes and/or shift to clean and "green" fuels;
• **Improve/efficiency:** when motorised travel is necessary, improvement can be achieved through the introduction of efficient fuels and vehicles as well as through other enabling technologies and measures.

The tough implication of the IEA approach is that all categories have to be involved in the transformation. This is illustrated in the transformation box 3.1 below.

Box 3.1 Search for an integrated pathway of the Nordic Transport Way?
The transformation pillars: illustrated with activities to handle each strategy

Avoid:	**Shift/Substitute:**	**Improvement / efficency:**
• New urbanism • Smart city logsitics • Behavior- and life style reduce non-necessary global sourcing of goods	• From private travel to public transport • From combus-tion-driven to e-cars • From fossil fuel to bio-fuel • From air and road to maritime, railway, truck, bus... • New light trans-port mode (e-bike, ligh-e truck)	• More efficient fuels and vehicles... • Application of ICT in transport systems • Harmonised regulations

Source: IEA (2013)

The IEA estimates that between now and 2050, the "avoid, shift and improve" approach can contribute to meet the 2DS objective. Although innovations in vehicle and improvement in fuel technology have a significant potential to reduce transport sector energy emissions to 2050, this is not enough to reach the 2-degree scenario (2DS) objectives by 2050. Reducing overall motorised travel (avoid) and shifting private motorised travel to more efficient modes (shift) will also be necessary (IEA 2012a).

Academic as well as business literature is full of illustrations on transport activities which can be avoided, some of which have developed as a consequence of low transport costs on the one hand and significant global disequilibria in costs structures on the other. The global shipment of Nordic salmons and shrimps for processing in Asia before they are returned and sold on European markets is an extreme example of this (Vold et.al. 2003).

"These engines can, sometimes with minor modifications, already run on the biofuels we can produce in the Nordic countries"

3.3 Transport systems of the future: the technologies

An important argument in this report is that we know enough to immediately commence and speed up the transformation.

With regards to the vehicles of tomorrow we argue that the main powertrains of today, in general, are well suited to adapt to the needs for sustainability. The rolling fleets of land-based transport will increasingly be powered by electrical engines and/or (to a much lesser extent) by the two dominant forms of combustion engines; the Otto engine and the Diesel engine.

The *electrical motors* will receive their electricity either via transmission from grids, while parked or when moving, in the air or on the ground or via on board facilities like batteries, fuel cells or from combustion generators. Large scale on board storage of electricity has always been, and will continue to be, a bottleneck. The necessary technologies for electric vehicles exist today – even the fuel cell technology has recently seen significant reductions in cost. All these technologies can be improved and most of them can be industrialized or installed in large scale within a short period provided policy actions that make them attractive and/or profitable.

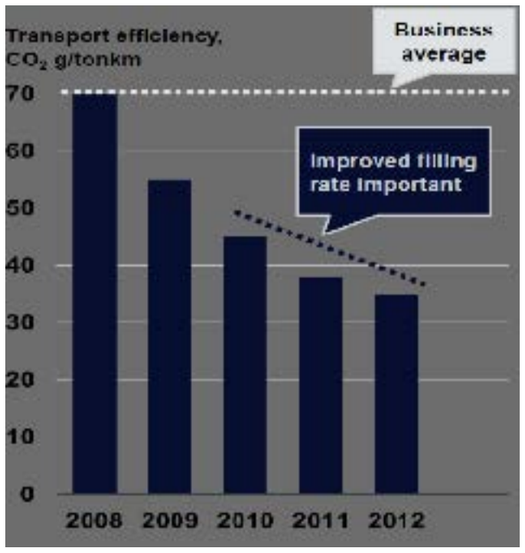
Both systems of *combustion engines* represent mature technologies, which probably have limited potential for further improvements of efficiency on "engines systems level".[4] However, these engines can, sometimes with minor modifications, already run on the biofuels we can produce in the Nordic countries. That includes bio-gasoline, biodiesel, bioethanol and biomethanol, and biogas. These engines can also be fed with mixes of biofuels as well as blends between different biofuels and fossil fuels. In addition, electrical engines and combustion engines can be combined in various forms of on road charging and plug in-hybrid solutions in individual "vehicle systems".

4. The potential for incremental improvements is summarized by Csere (2010) and Babcock (2014).

Box 3.2 Transport systems of he future: illustration from Scania

Scania's vision for transport sector is to halve CO2 per tonne-km by 2020. Scania Transport Laboratory has been conducting research activities and applying a holistic approach on the road since 2008 by transporting its own materials under realistic operating conditions between Scania's production units in Södertälje, Sweden and Zwolle in the Netherlands.

The results are very promising; CO2 emissions per tonne-kilometre have been halved in 5 years as a result of an integrated and holistic approach with a combination of driver training, better logistics, well maintenance of vehicles and use of biofuels.



Following Scania's request, The Swedish Transport Agency has granted permission to operate rigs of 31.5 meters in total length between Södertälje and Helsingborg in Sweden. Tests show that these rigs are as safe as shorter rigs. By driving with two full-length trailers, Scania reduces fuel consumption by up to 30 percent with an equivalent reduction in CO2 emissions. Unfortunately, the regulations in most other EU states only permit a maximum length of 18.75 meters for the truck-trailer combination.

"There are few chances for sustainable solutions to compete on price with fossil fuels unless the external costs of the later are added to their market prices"

Our message here is that the technologies for the necessary transformation of transport systems to sustainability already exist or can be industrialised within a very short period. The main reason for this transformation not to take off is *"socio-technical systems inertia"* as well as *"relative prices"*. If Nordic governments take climate change seriously they must act as midwifes to open the paths of opportunity for the sustainable technologies to industrialize on a large scale; some in competition to each other, others as complements.

Admittedly, the unregulated market prices of sustainable solutions are, with some exceptions, higher than those of fossil fuel based ones. In some cases sustainable solutions are not allowed to have a lower price than the corresponding fossil fuel at the same time as receiving state aid, according to the present interpretation of the European treaty by the European Commission.[5] This situation has become even clearer after the large price reductions on fossil fuels, which took place during 2014. There are many reasons to believe that these low prices will dominate for some years ahead. As we can see, and which is discussed in depth below, there are few chances for sustainable solutions to compete on price with fossil fuels unless the external costs of the later are added to their market prices.[6] This can be done in many ways. As discussed in Chapter 4, political actions and policy support are necessary, although not enough, to push forward a transformation towards sustainable transport systems.

3.4 Transport systems of the future: energy sources

Shifting away from fossil fuels reduces the energy sources for future transport systems. Not least the gasoline, until now based on fossil oil, has a high energy/weight ratio which is difficult to replicate and which argues for new systems solutions, not only putting new fuels in old tanks.

All energy sources of tomorrow must ultimately be based on the inflow of the sun to the planet. That energy inflow is approx. 10000 times the level of what mankind captures, in other words; the sun needs approximately one hour to deliver what we transform during a year (Sandén, 2008). We are thus not running out of energy for transport even if we would stop depleting the historically stored fossil fuels today; *the challenge is to develop policy paths that make future transport solutions possible, sustainable and profitable.*

5. https://www.energimyndigheten.se/PageFiles/47453/2014-7515 Övervakningsrapport avseende skattebefrielse för flytande biodrivmedel under året 2014.pdf.

6. Estimating the external costs of fossil fuels is far from easy in a situation when significant aspects of human life is threatened. Neither is it necessary. Enough is to raise costs for fossil fuels to a level that makes it economically feasible with a transformation path towards sustainable fuels.

There are only two sustainable ways to capture the solar energy and make it useful for the transport system; the *electric way* and the *biofuel way*. Both need supportive institutional frameworks to allow them to "take off" but also to guarantee their sustainable production and development. In addition to the still small scale, direct generation via photovoltaics and still smaller scale fuel cells, electricity can be generated via indirect sun based processes. These are in turn based on the kinetic energy provided by wind and water as well as by combustion processes based on biomass grown with help of he sun.

The Nordic countries are well positioned globally to produce these forms of energy sustainably and to further develop already working technologies and systems based on them. Both can, already today and increasingly in the future, contribute to the transformation of the Nordic energy and transport systems and to Nordic competitiveness.

The electric way

Although electric engines have high energy efficiency, electric transport systems cannot disregard the GHG emissions generated in the power plants. Globally this is a challenge since 68% of electricity generation is still based on fossil fuels (IEA, 2014c). In this sense, the Nordic countries have a unique strength with its already high ratio of renewable and clean electricity production. The Nordic countries have approximately 83% carbon neutral electricity generation and 63% renewables. In addition the Nordic countries have a high potential to increase this ratio. Not the least is there (with possible exception for Denmark) a large potential for wind power investments (Laestadius, 2015).

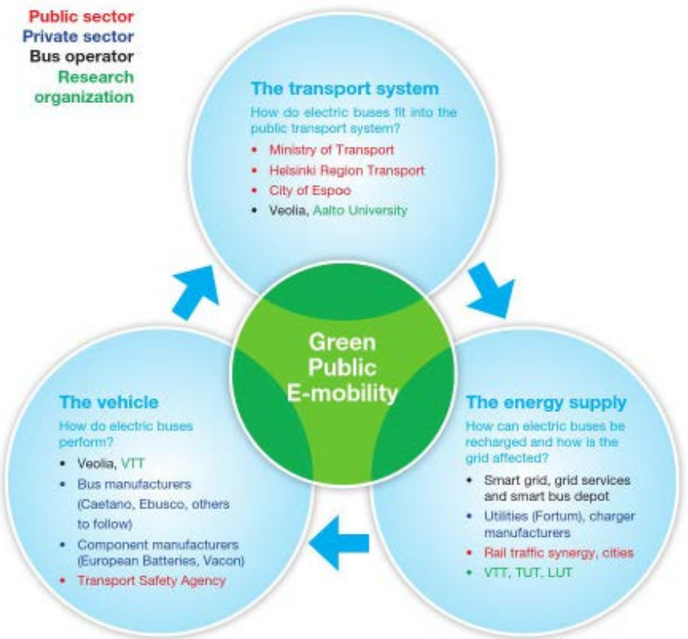
On the average, electricity is an efficient source of energy to create motion. The energy efficiency of Otto and Diesel engines is much lower than what is the case for an electric engine.[7] However, many of today´s transport systems, solutions and vehicles are not fitted to large-scale use of electricity. In short; the electric way is also dependent on a large scale transformation from private to public transportation.

"The electric way and the biofuel way both need supportive institutional frameworks to allow them to 'take off', but also to guarantee their sustainable production and development"

7. As a consequence it is sometimes beneficial for efficiency as well as sustainability to produce electricity with the help of biofuels.

Box 3.3 eBus systems in Helsinki

Together with a large number of stakeholders, the Helsinki region has launched an electrification of public transport project. Electrifying the bus system is not only about vehicle technologies, but also about how electric busses integrate into the transport system and how to charge the electric buses.



Electric energy may also be transformed into carbon neutral fuels, e.g. hydrogen. This process, which may be looked upon as a reverse of the fuel cell process, may also facilitate the production of other fuels like methane or methanol. In short, there is a potential family of "electro-fuel" technologies, which in the future may provide a bridge between the electric way and combustion technology. This way of producing "non-harvested biofuels" is not a "low-hanging fruit" which will dominate the transformation immediately ahead.[8]

8. See http://arpa-e.energy.gov which is a US gvt. Agency for research on electrofuels.

The biofuel way

However, the Nordic countries also have a large potential to take the lead in the transformation along the second path, the biofuel way. The share of biomass and waste in the Nordic energy system is, with a significant variety between countries, 8%. Most of this is used for electricity generation and heat. On the one hand we argue that there is a large potential to increase the use of biomass for energy purposes, but on the other we argue that there are significant advantages to transform biomass to fuels rather than using them in the heat-power system.

Not least do the Nordic countries contain large areas suitable for production of cellulosic biomass, which is more useful for energy and construction materials than for food. In addition, there is a net regrowth of forests in Nordic countries. For instance, the total standing volume in Sweden has increased by more than 80 % since the 1920's, while the forest area in Sweden has grown by a total of 8 % since 1900. (Skogsstatistisk årsbok, 2014).

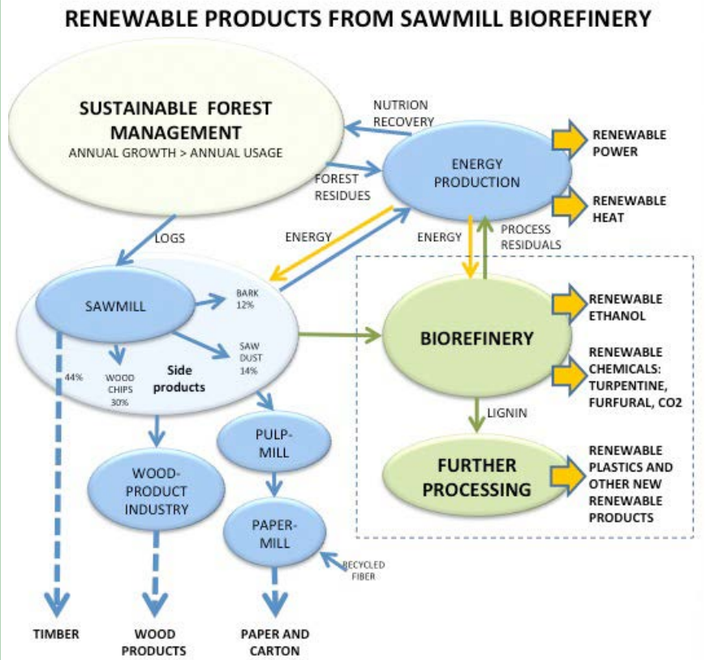
Large parts of the Nordic areas are also well suited for production of biomass from agriculture and forestry which may be used in a flexible way for various purposes; such as construction materials, food & feed, biochemical and energy products. We argue that transport will always need fuels with high energy density in situations when electricity is not feasible and here biofuels are sometimes the only alternative.

Biomass is an attractive resource for many activities when sustainably produced and harvested. Consequently there may, in the long run and on global level, develop a strong competition between using it for eating (and feeding of livestock), drinking, production of transportation fuels, construction, packaging, new materials, and various other purposes (cf. Novotny & Laestadius, 2014). This will necessitate a more efficient use of the biomass (cf. Canadell & Schulze, 2014; Running, 2012; Smith, 2014). Studies of biomass potential indicate that there must be no shortage of food for decades to come (Slade, Bauen and Gross, 2014).

"Not least do the Nordic countries contain large areas suitable for production of cellulosic biomass, which is more useful for energy and construction materials than for food"

Box 3.4 Biorefineries – an emergent industry

Global biobased industries in general, and the pulp and paper industry in particular, are rapidly transforming due to diminishing demand for printed papers and increased demand for other biobased products. In a Nordic context, particularly in Finland, Norway and Sweden, pulp (and paper) mills transform to biorefineries. These systems yield multiple outputs, such as conventional pulp and paper products, electricity, heat, bio-chemicals and biofuels. The integrated approach is a key to efficient utilization of biomass resources. In the extension these and other traditional biorefineries may produce raw material to the same products as those produced today with fossil fuels. The picture below illustrates how this process may work.



Sources text: Novotny & Laestadius, 2014; Nylund & Beloni, 2014
Source picture: ST1 and NEOT, 2015

Saving the biosphere in the decarbonisation process is a general challenge – not something particular for biofuels.[9] This, we argue, is compatible with creating good conditions for biofuels. In fact this is an important part of the transformation policy.

In addition it may be argued that biomass is not a homogenous material. Among all species used by mankind some are more useful for direct food, others for feeding the livestock and yet others for construction. On top of that, most biomass is not 100% useful for its main purpose; sugar cane has typically a bagasse content of 20% and the straw content of cereal plants is typically 50% of the total weight (Kretschmer, et al., 2012). Although some areas can be used for many different types of biomass production, other areas are suitable for only a few products. Production of sustainable biofuels is also an efficient way to transform wastes and residues (Harrison, P., ed., 2013)

Similar to the case of electricity, biofuels are not by definition sustainable. Even if we exclude CO2 emissions related to their production (a problem relevant also for all other "sustainable" forms of energy) it may be argued that also the combustion of biofuels ends up emitting CO2 (se eg. Chrintz, 2013). Once emitted, the bio based CO2 molecule has a similar impact as the fossil based. The carbon neutrality occurs first and only when new biomass is growing and substituting for the one that was harvested. Although there are varieties between different sources of biomass, *this is a non-issue in the well regulated Nordic countries where forests are expanding and agricultural land is available, and have been so for century.*[10]

Box 3.6 Bio-diesel is already available

Preem can already today produce bio-diesel based on tall-oil. Crude tall oil, based on residues from the forest industry is refined to raw tall diesel and finally to HVO-diesel which is almost identical in its molecule structure with classic diesel oil. The present 50% blend of HVO in "Evolutionary Diesel" is thus fully compatible with today´s modern fleet of diesel powered vehicles. Transformation to still larger shares of HVO is no fundamental technological challenge and will require only minor – if any – modifications of modern vehicle engines.

Increasing the production of HVO/biodiesel – and introducing bio-gasoline in a similar way – will, however, require significant investments which necessitates clear long term decisions (at least to 2030) on quota rules and taxation models and levels.

Source: Preem 2015

9. This increase of efficiency in the use and availability of biomass has to take place in all sectors. Four important cases with high leverage impact may illustrate that: 1) livestock production and consumption; 2) the global use of firewood (presently responsible for up to half of forest biomass production); 3) intensified tree plantations as well as fighting deforestation; 4) elimination of food waste (which presently is about 30% of global food production, FAO (2011))

10. For a comparison between different sources of biomass for bus transport, see Nylund & Koponen, 2012

Box 3.5 The Händelö energy combine in Norrköping including the Lantmännen Agroetanol biorefinery

By means of industrial symbiosis, sustainable biofuels for transport is produced showing a world class GHG performance. Industrial symbiosis is a cooperation to find synergies in order to produce a joint result that is better than the sum of the individual parts. In the case of bioethanol from grains, a GHG reduction of more than 90% is achieved compared to gasoline and diesel.

The EON combined heat and power plant produces electric power and steam from biomass and waste. This steam is in turn used by Lantmännen Agroetanol biorefinery to produce bioethanol, proteins and carbon dioxide from grains. Bioethanol is used for transport fuels, proteins to animal nutrition and liquid carbon dioxide for food and technical applications.

Excess heat from condensates is utilized in the district heating system in the city of Norrköping; heating a large range of buildings. Excess organic material may be further treated by Svensk biogas by anaerobic digestion to produce biogas for transport fuels and bio fertilizer. The biogas fuels city buses and the biofertilizer is returned to the grain fields together with carbon dioxide, which is produced from using transport fuels and absorbed by the growing grain using photosynthesis and thus completing the cycle.

Source text and picture: Lantmännen 2015

Two complementary Nordic ways

There are essentially only two forms of sustainable energy solutions for the global transport system and they are complementary to each other. In addition to the obvious energy solutions, electricity for railways and biofuels for air traffic, it may be assumed that electricity in general is more competitive on short and regular distances and biofuels favourable on longer and non-regular transports.

Both forms of sustainable energy can, already today, contribute to the transformation of the Nordic energy and transport systems. This transformation can also contribute to Nordic competitiveness. We argue that it is important that the Nordic countries influence European policies towards a sustainable production and use of electricity as well as biofuels, the only and necessary alternatives for the transport system.

Favouring the use of electricity and biomass in the transport sector is greatly helped by reducing their use in other sectors, notably in the housing and building sector. The housing and building sector is where energy efficiency is most easily and cost-effectively brought about (Murray, 2015). In the Nordic countries oil has to a great extent been replaced by electricity and biomass in heating and operating buildings. Energy efficiency in this sector should thus be part and parcel of the Nordic Transport Way.

3.5 Towards new solutions for transport, travel and mobility

Although it may be argued that urban transformation towards sustainability is a very long term process due to the long lived physical investments in roads, houses and fixed facilities, it is also the case that the large populations and the size of the economies (in densely populated areas) create large opportunities to speed up the transformation process. The necessity to reach significant results in climate mitigation within a few decades motivates a multitude of decarbonisation strategies for urban areas: short term as well as long term. In this report we focus on short-term activities related to transport and mobility.

Given the slow renewal rate of the car fleet, still dominated by combustion engine technology and existing infrastructure, limits the deployment of new alternative energy carriers, the most realistic and cost efficient solution in the first 50% GHG reduction step (2015-2030) is a, quicker than today, expansion of sustainable or low GHG emitting biofuels into the existing energy mix.

The most rapid and cheap results for personal transport can, in addition to various "avoid transport" strategies, probably be obtained with forceful expansion of bus systems, bicycles and ebikes in combination with significant reduction of personal car transport. Within such a framework the remaining car transport must be transformed from fossil fuels to electricity and/or biofuels. The GHG reduction paths may differ between densely and sparsely populated areas, while reductions in personal car travel may dominate in the former transformation to biofuelled hybrids may dominate in the later.

The mirror image of this transformation will probably also be an increase in commercial transport services for goods (eg. e-commerce, innovative last mile solutions) and people (eg. taxi). It may also be combined with new forms of contract for small vehicles (eg. Autolib and Car2Go).

Experiences from EU-sponsored *sustainable urban mobility programs* (SUMP) reveal that this transformation process can be facilitated if municipal governments co-operate with companies and large employers in active *mobility planning*. Such a process may include joint efforts of Triple Helix character, e.g. by the municipalities, employers and individuals.

These SUMP activities may also be aided by innovative information and communication technologies, which are able to manage and optimize traffic flows within urban areas as well as between different transport systems. The reduction of personal car transport opens, in addition to low hanging fruits like bicycles and buses, for new creative solutions of coordinated or self organizing commuting solutions in urban areas. This will necessitate network connected vehicles (Kramers, 2014).

The mirror image of growing e-commerce as well as of reduced travel with personal cars is an upsurge of distribution services, which may be performed with a large variety of sustainable vehicles and systems which may demand expansion as well as new forms of short term parking facilities in urban areas.

Most of what is discussed here are municipal responsibilities in the Nordic countries. However, national authorities have many roles to play. First, relative prices have to be changed via the taxation system to favour this transformation. This is unavoidable. Secondly harmonized Nordic rules regarding energy efficiency and emissions performance etc. should be implemented.

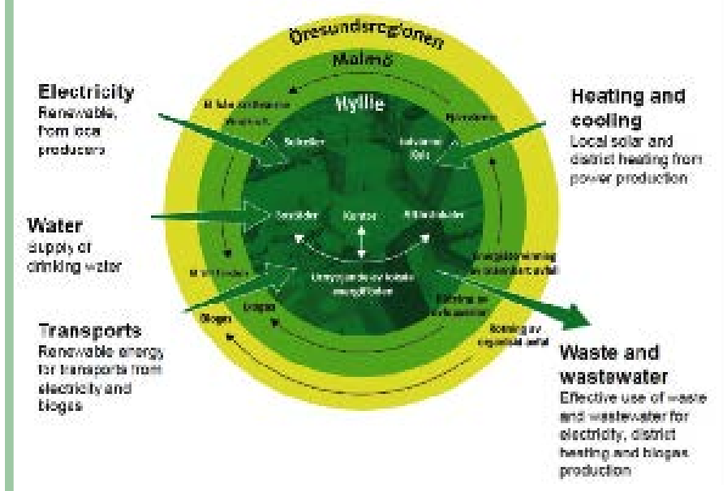
Significant results can be achieved at municipal and county level with integrated urban planning having sustainability in focus. This is illustrated in box 3.6 presenting an ongoing project in Malmö, Sweden. Similar projects now take off in many places of the world (C40, 2015).

Box 3.7 Hyllie – a Sustainable City project in Malmö

The vision of the project is to create the most sustainable city district in the Öresund region and a global role model for sustainable urban development.

The new district will be an integrated part of Malmö and contain 9000 offices and 9000 homes by 2030. The project is a co-operation between the City of Malmö, VA SYD and E.ON with a Climate Contract in 2011.

The approach may be labelled holistic: a sustainability dimension is integrated in all infrastructure planning.



Source: EON, 2015

3.6 A rapid shift towards public transport

Around 80% of personal transport in the Nordic countries is performed with private cars; only 20% is performed with public transport. The situation is similar in the rest of Europe (Eurostat, 2015b). There is, as discussed in section 3.2 above, no chance to decarbonize all these personal transports within reasonable time and with reasonable costs, without a large increase of public transport. It may thus be argued that public transport has to increase rapidly all over the Nordic area (cf. VTT, 2014).

A fifty per cent reduction of personal car transportation, before 2030 is what a climate mitigation policy requires. This is consistent with an annual reduction of car traffic with approximately 4% per year. Given that the need for personal transport is constant, it necessitates a growth of public transport from 20% to 60%, i.e. a growth with 7%/year unless parts of this travel can be avoided or transferred to bicycles or e-bikes.

This transformation is in itself decarbonizing as busses and trains normally cause less GHG emissions per pkm than cars do. In addition bus manufacturers can already today produce buses that run on various combinations of sustainable fuels. To stimulate this necessary transformation is a challenge for policymakers since it includes introducing new taxes and pricing as well as various other regulatory activities. This problem should not be neglected. While the public transport has indeed increased since 2000, the costs have been rising faster than traffic and passenger kilometres – and the cost is subsidized by local tax money. Thus, future transformation must combine increased comfort with changing relative prices in favour of public transport.

The shift towards more public transport will differ between urban and rural areas and will also necessitate different policy measures. Combinations of electric/hybrid cars and biofuelled buses to and from hubs may be a part of the solution in rural areas. Never the less, personal car travel will continue to be more common in rural areas compared to urban.

From the past experience and lessons learned, the public transport planning should be brought together with other key institutional, regulatory and planning-related issues. While there are clear diversities in public-transport models in the Nordic countries there are also some common challenges ahead (Hrelja et al. 2013).

One is to transform the technical focus on transport planning towards *development of sustainable and attractive cities and regions with long-term environment and climate policy objective*; i.e. "if some time ago, all the talk over public transport was about capacity, now it seems much more focused on the contribution of public transport investment to the transformation and modernisation of city areas…"

In addition there is a need to de-bunk the planning myths that undermine the long-term competitiveness and attractiveness of public transport; e.g. a car-based transport as a norm for how transport systems ought to be designed and regulated. In short this means that the transport related planning must become more pro-active to facilitate the transformation away from non sustainable logistic solutions. As argued in section 4.3 below, this will also necessitate public procurement of the new solutions.

To speed up this transformation process, and get a momentum we argue (see chapter 4 below) that Nordic governments should co-ordinate and actively promote *a Nordic demonstrator in the form of a five cities program for a massive expansion of BRT- systems and other sustainable transport solutions in the five most densly populated regions in the Nordic countries* (eg. Helsinki/Espoo, Stockholm, Copenhagen/Malmö, Oslo and Gothenburg).

3.7 Transport systems and technologies of the future: the infrastructure for efficiency improvement and a multimodal shift

Infrastructure investments tend to be long term and have impact on how activities are organized for decades and even centuries. These investments have historically almost always been dominated by, or strongly connected to, governments (Kaijser, 1994). Thus, the transformation may in many cases be path dependent on history; the inherited infrastructure may often serve as a point of departure for new development. And just as big a problem is to divert from the past practices when necessary and start afresh with planning clearly based on sustainability.

The tricky challenge for governments is on the one hand to govern the transformation of today´s transport infrastructure towards sustainability, which may be a giant task, while on the other not reduce the competitiveness of solutions which may be sustainable. In the sparsely populated Nordic regions, parallel investments in road, railway, and maritime transport is normally not efficient and will sometimes require tough priorities between systems.

This report will not offer detailed evaluations between how different transport solutions may be combined on Nordic level. There is, however, need for a few inputs for policy makers:

Biofuels provide a much-needed "low hanging fruit" while the multimodal shift to alternatives is being developed. Reduction of transport emissions is essential and requires a holistic approach to vehicles, fuels and supply infrastructure. Widening energy sources to alternative fuels, increasing efficiency measures and increasing the share of renewable energy should all be part of the policy mix. It is imperative to fully utilize the readily available short and medium term GHG reduction opportunities, such as biofuels into existing supply infrastructure. Sustainable biofuels can reach up to 95% of CO2 savings and may be produced from a wide range of feedstock that are considered waste and residues.

"Infrastructure investments have historically almost always been dominated by, or strongly connected to, governments"

Railway transport is an obvious solution for large scale transformation of personal travel as well as for long distance and frequent material transport. Not the least is this the case between large hubs and/or in areas where railways are already available. Although fast trains offer a logical substitute for the necessary reduction of air transport in the future, it is far from obvious what kind of high speed trains are most suitable for the Nordic countries. While speeds in the latitude of 200-250 km/h can be reached with modest upgrading of existing infrastructure, speeds above 250 km/h normally demand expensive and totally new infrastructure, which in addition may cause a lot of GHG emissions (Westin & Kågesson, 2012 & Åkerman, 2011). There is a need for higher capacity also for freight trains in the Nordic railway system. Partly this can be achieved with technological upgrading and improved traffic control. Basically, however, it necessitates new track and large scale investments.

Although *air transport* is rapidly growing on global scale and becoming an integrated part of modern life styles, it is obvious that IEA´s transformation classification as shown in box 3.1 is relevant also for that mode of transport. Some air travel/transport must be avoided; not the least is there a large potential for substituting teleconference-based meetings for travel. Significant parts of air transport may also be transferred to railways primarily but also to long distance buses. These transformations will create huge challenges for Nordic governments. What is left of air transport must be more energy efficient but also be based on biofuels. In short: we identify a need for an annual reduction target of 4% for air transport related CO2 emissions in the Nordic countries (although we realise that Norway may give priority to other forms of decarbonisation).

Electric roads based on upgraded sections of the existing road system may serve as an alternative in areas facing high and growing need for public passenger and material transport and where new railways are not feasible. This may be important for many regions in the Nordic countries. Electric road investments can be done much faster and cheaper than in railway systems and may be much more flexible. In close collaboration with firms like Volvo and Scania, the Swedish project Elvägar is in fact ready for demonstration projects in 2015 although commercialization still lies some years ahead.[11]

At present the situation in electric road development may be characterized as a fluid phase when a dominant design has not yet been established (regarding what continuous charging technology that should be

11. http://www.trafikverket.se/AktuellIt/Nyhetsarkiv/Nyhetsarkiv2/Nationellt/2014-05/Ett-steg-narmare-elvagar-i-Sverige/

selected). This is an opportunity for the Nordic countries, governments as well as companies, to take the lead in a formative phase of a technology which may develop as a complement to railways also in other countries. The present situation, we argue, is very similar to what once was the case for Nordic Mobile Telephony (Berggren & Laestadius, 2003).

Maritime transport is in many cases significantly more energy efficient than transport by rail and road. A standard ship for short distance transport uses half the energy per tonkm compared to trains and approximately 20% of road transport. Due to less flexibility and higher loading / reloading costs and as well as low energy cost for transportation over land, coastal maritime transport has hitherto not been very competitive. Facing the need to reduce GHG emission it may be argued that bio-fuelled ships should take a larger share of future transports on coastal waterways. Moreover, new infrastructure around ports and a comprehensive plan to streamline multimodal transport is needed from governments.

The transformation to sustainability in the transport sector will necessitate more of *multimodal* transport systems; that is the combination of different transport systems in an optimal way. Multimodality has historically had difficulties to take off due to low energy and CO2 prices, lack of institutional framework and significant handling costs, which could change if new policies came into place. The recent development of "green corridors" illustrates one potential development path.

Box 3.8 Green corridors

> Green Corridors in the North Sea region, an EU funded project focusing on the flow of goods between different locations, was first launched in 2012. The multimodal corridors, routs that transport goods by various methods of transportation, aims at achieving well in the three aspects; economy, quality and environment. The project ended in December 2014 and had, among other things, established a green corridor between Olso in Norway to Randstad in the Netherlands. The project has, by ambition and necessity, worked with multiple factors such as infrastructure, logistic solutions, transport techniques and laws and regulations, demonstrating very well what one can achieve when a holistic method is applied.
>
> Source: http://www.grecor.eu/

4. HOW TO CREATE A NORDIC TRANSPORT WAY

- TOWARDS A TRANSFORMATION-FRIENDLY TOOLBOX

4.1 Regulatory framework for the transport system of tomorrow: conditions

In section 3.1 above the speed and magnitude of the necessary transformation was discussed. Although what is outlined in our report is somewhat less than what Nordic governments officially have declared, our ambition is higher than what can be observed in actual policy implementation. We talk about three halving steps:

- 1st 50% reduction between 2015 – 2030 => decarbonisation rate of 4% / year
- 2nd 50% reduction between 2030 – 2050 => decarbonisation rate of 3.5% / year
- 3rd 50% reduction between 2050 – 2080 => decarbonisation rate of 2.3% / year

Instead of adopting distant goals, the implementation of which can be postponed until later, we argue that *Nordic countries should adopt year-by-year targets which may be followed up for fine tuning of the policy tools we discuss below*. This also makes it possible to speed up the process (e.g. stay on the 4% track after 2030) if necessary.

The Nordic governments should agree on policies, what innovation researchers label *path creation*, that create the right incentives for this process to take off and sustain. In short; it is not required that all the tools are put in use or in full effect immediately, but they must be explicit, reliable and convincing so companies and other actors – not the least ordinary people in their daily decision making - dare to invest and transform their activities. This will increase private sector investments in sustainable solutions.

Our aim is to convince Nordic governments that there are many ways of Nordic co-operation that can contribute to sustainability as well as competitiveness. We are well aware, however, that although Nordic governments can decide on a lot themselves, several of our proposals necessitate joint Nordic policy initiatives to change European rules and policies.

4.2 A transformation-friendly policy "box" for the transport system of tomorrow: key principles

The fact that we argue for more precise and harmonized interventions from Nordic governments makes it necessary to outline the general principles for those interventions:

• Basically we argue for policy neutrality between different solutions and technologies on the market, which fulfil the requirements of sustainability.
• This allows promotion of sustainable solutions and technologies which are still in pre-competitive stages and/or which may face steep future learning curves (Azar & Sandén, 2011).
• Direct subsidies on well working sustainable solutions and technologies (the goods) must be phased out and, if necessary for the transformation, be substituted by taxes and fees on non-sustainable systems (the bads).
• Relief from CO2 taxation for non-fossil fuels (as is now the case within EU) should not be considered a subsidy.
• Governments should establish long term policy and taxation paths so actors have time to adapt.
• Sustainability classification criteria on transport systems/vehicles must be harmonized and incentives to transform to non CO2 emitting solutions must be created.
• The Nordic governments should jointly harmonize rules, regulations, taxation and financial models regarding climate change policy.
• The harmonized classification must be based on a life cycle analysis (well-to wheel) including both fuels and vehicles/systems.

Slowing, stabilizing and ultimately cutting transport sector emission will require proactive and sustained policy interventions and concerted actions in a number of areas.
It is important that policies as a whole balance "carrots" and sticks" to create incentives for transformation to sustainability, e.g. so they contribute to welfare for households as well as become commercially attractive for transport related industries. Without taking any position on the over all tax rates for the Nordic countries, this report argues that the increases over time in GHG related taxes and fees must be compensated in other parts of the economy in order to get acceptance for the transformation. We are aware that different policies may be applied for urban and rural areas.

All Nordic countries have large tool boxes for environmental and climate policies. But the transformation of transport we propose here will have impact on many taxes outside the environmental field, not the least to compensate actors who otherwise will face higher overall costs.

This report does not introduce many new policies. What we suggest is primarily to use existing tools more forcefully and fine tuned – e.g. CO2 taxation - to keep the speed of transformation on a 4% level annually. In section 4.3 we present some of the tools for further analysis and detailed suggestions.

4.3 A transformation-friendly policy "toolbox" for the transport system of tomorrow: illustrations

Taxes as levers: tax swaps and bonus malus systems

There are two fundamental arguments for tax swaps and bonus malus systems (the same family of policies). The first relates to acceptance: it is easier to get *acceptance* for taxes and fees for a certain activity if governments can show that they redistribute the money to, or reduce taxes in, closely related areas rather than collecting them in the Ministry of Finance. The second relates to *efficiency*: increasing costs for a certain activity parallel to reducing it for a substitute will normally create a leverage effect (cf. T&E, 2014; Naturvårdsverket, 2015).

Suggestively all fees and taxes intended to speed up the transformation of the transport system to sustainability should have this double character. The redistribution of incentives can however be constructed in many ways. A classical bonus malus system, used in France is for example, to increase the tax for cars with high CO2 emissions and reduce it for cars with low emissions is one way. Fees on private car transport (eg. congestion fees) is another and can be distributed to other more energy efficient transport systems, e.g. urban bus transport.

Box 4.1 An illustration: a harmonised Nordic registration tax on vehicles

A Nordic bonus malus model for registration tax on vehicles could be based on a life cycle environmental performance, both in terms of energy efficiency and capability of using fuels or other energy carriers with low carbon intensity. The first element can be a scaled tax based on life cycle CO2 emissions. The second element could be related to the capability of a vehicle to use high blends of low carbon fuels. This model will speed up the transformation away from the present low-blending around 5-7%vol which is dominant in the EU region.

This model will offer incentives for both car dealerships and car buyers to make the right selection at the pump during the following 15-20 years.

What is argued here on *systems* is relevant also for *fuels*; independent from the absolute level of various energy taxes, increase in the relative prices of fossil fuels can be compensated with decrease in the taxation of electricity and biofuels.

Taxation of fuels: a base related to the transformation aim

European fuel taxation normally has its base in "litres". This taxation model does not take into account the fact that biofuels normally (with a few exceptions, e.g. biogas, FAME and HVO) have a lower energy density (or calorific value) than fossil fuels. Unless such a system is supplemented by other measures, it leads to higher energy taxation for biofuels in comparison to fossil fuels. The current model provides incentives to fossil fuels rather than to low carbon fuels and due to this systemic flaw, fossil fuels stay competitive over biofuels.

We argue that *taxes intended to speed up transformation of the energy and transport sectors should have energy use (MJ) and CO2 emissions as their base*. We have no final opinion on the exact level of the energy tax, which must reflect overall targets on energy efficiency.

Such a model should treat fuels in a technologically neutral way. Tax rates should be harmonized on a Nordic level and have flexible tariffs so they may be changed underway. We also argue that the establishment of Nordic, harmonized energy and CO2 taxes has to be supplemented by other incentive measures in order to achieve the annual 4% target of CO2 reductions. *Energy and CO2 taxes alone are not enough to spur the transformation necessary.*

Given that harmonized energy and CO2 taxes are not enough as sole measures, we would also like to provide a concrete example of what this model possibly could look like. T*hese figures should be seen as the very minimum level required in a harmonized Nordic system (please see examples of tax bases below)*. The table beneath is an example of what the taxation could look like for a sample of fuels. It is important to notice how each fuel have different energy content/liter as well as carbon intensity. These figures are based on the Finnish excise duty law methodology.[12]

Energy taxation base: 0,016 €/MJ
CO2 taxation base: 58€/t CO2

Fuel	Energy tax €/liter	CO_2 tax €/liter	Total €/liter
Gasoline	0,51	0,16	0,67
Diesel	0,57	0,18	0,76
Ethanol	0,33	0,01	0,34
HVO	0,52	0,03	0,55

This set-up would encourage the industry to promote new advanced biofuels or improve the CO2 footprint of existing ones and speed up the adaption of combustion technologies to biofuels. It would also encourage consumers to select low carbon alternatives, first at the car dealer and then at the pump.

A manageable quota system

Quota obligation systems are introduced all over Europe to stimulate the introduction of biofuels. In short they are based on promoting low blend of biofuels of different character into fossil fuels to achieve upfront results in the reduction of CO2 emissions. These positive results are however balanced by the problems created for policy makers and transport actors of all kind. First, as illustrated in the section above, a fair and consistent taxation system promoting the transformation away from fossil fuels has been difficult to achieve. Secondly, it is far from obvious that the focus on low blend biofuels – a low hanging fruit - contributes to an optimal transformation to systems which are *totally* independent of fossil fuels, i.e. are fuelled by electricity and/or biofuels only.[13] To form a strong, regionally integrated Nordic biofuel policy in analogy with the certificate system presently used in the integrated Swedish – Norwegian electricity market may be a measure to balance upfront and long term transformation.

12.https://www.finlex.fi/sv/laki/ajantasa/1994/19941472?search%5Btype%5D=pika&search%5Bpika%5D=1994%2F1472

13. While there is an increasing political demand for quota systems, it is also important to note that it is the Swedish system using tax reductions that so far has achieved the most successful results in terms of reducing fossil fuels in the transport sector.

However, there are also challenges involved in creating a functioning quota system. By smart design of the system the challenges may be handled and here we outline a few key prerequisites:

• The system needs to be supported by and synchronised with a balanced *bonus malus system and fuel taxation model*. If any of the three instruments in the toolbox are missing, a quota system is likely to fall short or to be suboptimized.

• The level of quotas must be ambitious enough to create markets for high blends of biofuels and to avoid the pitfall of ”low blend only” markets. During the transition special attention is needed in existing high blend markets (eg. Sweden).

• The ability to create and preserve high-blend markets is essential. Further efforts to achieve that through the principle of annually increasing quotas, a liquid and efficient market for certificates or tax reduction systems for high-blends has to be investigated.

• A technologically neutral structure with well-to-wheel approach leads companies to seek for cost efficient solutions.

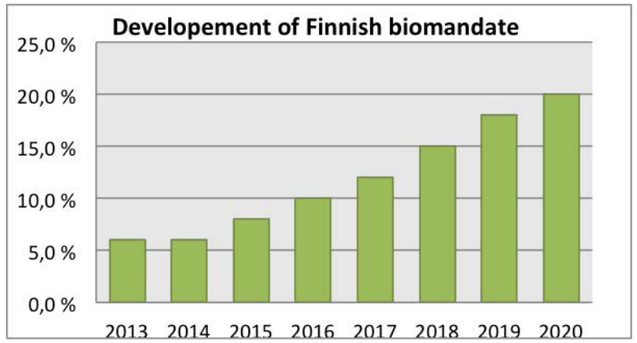
The Finnish quota system is an example of an already existing practice. Although this group recognizes that there are points where the Finnish system could be improved, it is a good example to look at for inspiration. A further elaboration on the Finnish system is presented in the box below.

Box 4.3 Case Finnish biofuel mandate

In 2011 the Finnish government introduced a biofuel quota system that steadily increases the demand of biofuels on the market. The system is based on the total energy from liquid fuels consumed in the transport sector. A given percentage of the supplied fuels has to be renewable.

Biomandate = total energy used in transport sector from liquid fuels × mandate percentage of the year

Fuel suppliers, who provide the products to the market, are the obligated parties and therefore they have an incentive to convert fossil fuel supply to renewable supply. The introduction of mandate was complimented by a fuel taxation reform. The fuel taxation in Finland takes energy content of the fuel as well as CO2 content into account. The model is similar to the one described in the chapter XX



The mandate is based on the total pool of energy, hence it does not separate different products under different quotas. Through increased mandate the blend wall will be met and this means that introduction of higher blends are necessary. Non-compliance of the mandate is combined with a fine of 4 snt/MJ, which is high enough for obligated parties to have a need to develop new ways of fulfilling it. This has opened the Finnish market for the introduction of new high-blend biofuels like E85 and ED95.

The mandate system is also complimented by a ticket trading system. In case fuel suppliers have distributed more biofuels to the market than the mandate requires. It can sell the extra MJ’s to some other operator in the market. Although there are only a handful of obligated parties under Finnish mandate system, the ticket market has been liquid.
Source: ST1 and NEOT, 2015

Public procurement

Not only has Nordic governments always had a strong position in creating the conditions, e.g. regarding infrastructure and regulations, for the transport system; they are also in all Nordic countries a significant purchaser of transport services. In a world where large-scale transformation towards sustainability is needed, it is natural that public procurement is a key contributor to this transformation.

To become efficient as a tool for transformation, public procurement should be directed to the "high end" of sustainable solutions and to systems that need help to take off and become competitive on their own merits. Public procurements should also contribute to eliminate "catch 22" situations, like those between charging stations and electric cars.

The list below illustrates how public procurement can be used:

Public municipal or regional transport: all vehicles used in these systems should be constructed for either the electric way or the biofuel way or both.

Public sector cars: all vehicles used in these systems should be constructed for either the electric way or the biofuel way or both. These vehicles must not necessarily be purchased by the public sector, but can preferably be leased from pooling agents allowing for private use during the weekends. Such models may contribute to advantages with regards to finance.

Charging systems should be purchased for all public spaces. This may improve the development of metering and payment models.

Fueling infrastructure for biofuels should be supported. As a minimum to meet the Alternative Fuel Infrastructure Directive 2014/94/EU and as long as needed to grow a sustainable market in various Nordic regions.

Entrepreneurs and contractors paid by taxpayers money and working for the public sector may be required to fulfill certain sustainability standards in their transport solutions which may be tightened over time.

Functional public purchasing: the intention behind public procurement in the transport sector is to facilitate the transformation to sustainability. Therefore, "sustainability functions" should be in focus in public purchasing contracts, that is; sustainable services and performance can be purchased rather than artefacts. Purchasing the functions and services rather than the physical systems that deliver them, makes it possible to obtain resource efficiency.

Public procurement as described above will sometimes fail. So is also the case in the private sector. In a transformation of this kind there are always elements of experiment and risk. We do not in advance know all those solutions that may be the most sustainable and will have to be revised/improved along the transformation ahead.

Box 4.4 Using requirements in public procurement: example from Västtrafik, Sweden

Västtrafik, who coordinates and procures the public transport in Västra Götaland, has since the early 90s worked actively on using requirements in public procurement as a tool for enhanced environmental performance. Among other things Västtrafik have required the companies delivering the services to use a certain share of renewable energy in their energy mix, to fulfill standards regarding emissions of NOx and particles, and lastly, to use a certified environmental management system. These requirements in combination with a monthly reporting system have shown great results. Västtrafik is committed to providing 95 percent of all passenger kilometers using renewable energy by year 2025. 2015 90 percent of all passenger kilometers were provided with renewable energy. Västtrafik is also committed to reduce energy consumption by 25 percent, reduce emissions of particulates and nitrogen by 60 percent and to reduce noise from public transport by 2025.

Source: Västtrafik and Svensk Kollektivtrafik

4.4 A transformation-friendly policy "toolbox" for the transport system of tomorrow: The small policy steps

The interventions needed for the giant transformation ahead must pervade public sector authorities on all levels. Although it is natural to focus on the large scale policies, we are eager to point out that in a society with deep roots in burning fossil fuels, many small decisions have to be taken to facilitate the transformation towards sustainability. The pervasiveness of our addiction to carbon necessitates that we look through all minor details which may be changed to facilitate a transformation to sustainability. The list below illustrates many "small" decisions that can be taken within the transport sector. It can be extended a lot.

Vehicle dimensions and weight regulation for more efficient transport: heavy trucks

The vehicle dimension and weight regulations in Europe are based on the EU Council Directive 96/53/EC. Individual states are responsible for implementing the directive. In Sweden, Finland, Denmark and the Netherlands vehicles are allowed to have a maximum length of 25.25 meters, compared to 18.76 meters in many other EU countries.

The maximum weight for trucks in Europe is 40 tonnes. On most roads in Sweden and Finland trucks are allowed to have a gross maximum weight of 60 tonnes.[14]

The Swedish Transport Agency has put forth a proposal to allow for heavier and longer road trains on regular roads. The maximum length should be 32 meters and on some roads up to 74 tonnes gross maximum weight should be allowed. This of course must be combined with technical specifications regarding the vehicles' brakes, manoeuvrability and stability as well as limitations regarding road conditions. However, in a transformation towards sustainable transport, which includes significant reductions of passenger cars and thus congestion on our roads, Nordic and European coordinated policies to increase truck dimensions will lead to increased energy efficiency in transport and reduce emissions, while keeping the same level of safety on the roads.

Vehicle dimensions and weight regulation for more efficient transport: buses

One of the tools for achieving sustainability in the transport sector is to substitute personal transport by public. As shown above, this transformation has to be fast and significant. One step in order to facilitate that transformation is to make buses more comfortable and efficient, especially in BRT systems. We suggest that the Nordic governments coordinatedly increase the width of buses from the present maximum of 2.6 m to approximately 2.8 m. Increased lengths up to 32 m should also be allowed under similar conditions to what we suggest for trucks.[15]

14. Although in Finland the maximum weight is even higher; 76 tonnes are allowed and there are experiments with 90 tonne trucks.

Nordic standard for platooning

Platooning is an area where ICT can improve environmental impact by reducing fuel. Best result is obtained for heavy trucks when driving very closely, supported by automatic speed control. Theoretical models give a fuel saving of 10-15% with a 0.5-1 second distance between the trucks. Practical test has proven a 2% reduction with a 3 seconds distance. To reach full effects of platooning and to drive with a 0.2-0.5 seconds, different truck brands must be able to connect to each other's automatic speed control system and automatic braking systems. Nordic countries should take the initiative to create a harmonized European standard for platooning.

Vehicle dimensions and weight regulation for more efficient transport: light trucks

3.5 tonne freight light trucks that are converted to run on biogas or electricity is another area where regulations could improve environmental performance. As the biogas tanks and batteries are quite heavy, the amount of cargo that each light truck can carry diminishes as a result. By introducing a compensation for the added weight by raising the total maximum weight for biogas/electricity light trucks, the transport efficiency for this type of freight transport could be increased. For example, the VW Transporter has a maximum gross vehicle weight of 3200 kg and the biogas version has about 200 kg less cargo capacity. Gross vehicle weight for these light trucks, which will have a more significant role in a Nordic region, where private car based transport is reduced, should be increased to approximately 4 tons.

Vehicle dimensions and weight regulation for more efficient transport: electric bikes

The E-bike regulations in the Nordic countries are the same as in the European Union directive 2002/24/EC: "Cycles with pedal assistance which are equipped with an auxiliary electric motor having a maximum continuous rated power of 0.25 kW, of which the output is progressively reduced and finally cut off as the vehicle reaches a speed of 25 km/h (16 mph) or if the cyclist stops pedaling." Electric mopeds might have up to 4000 W engine power, but are limited to a top speed of 45 km/h. By allowing higher maximum speeds electric bikes and mopeds might become a more attractive alternative to cars and complements to public transport. In densely populated areas this may also motivate or even necessitate dedicated roads or lines.

15. The city or Bergen is currently experimenting with long buses.

4.5 A Nordic demonstrator: a five cities program

We are aware that initiatives towards sustainability in general and sustainable transports in particular, are taking place in many Nordic countries, not the least in the large urban areas. Due to the importance of getting a rapid take off in climate mitigation activities, we argue that the Nordic governments together take the initiative to coordinate and speed up the transformation towards sustainable transport in the five Nordic metropolitan areas: Helsinki/Espoo, Copenhagen/Malmö, Stockholm, Gothenburg and Oslo. These efforts should be locally adapted rather than streamlined in detail or forced into a common shape. With the help of financial resources, harmonizing efforts and facilitating rules from Nordic governments, *a Nordic five cities program can serve as a demonstrator and role model for transition to sustainability.*

The core in this plan must be a large transformation of personal transport. This process must have its point of departure in the existing plans in the various areas and be scaled up during the years ahead. Although there will and must be variety among the cities the plan may include:

- A fast expansion of bus transport and/or bikes/ebikes. No transformation policy consistent with the 2DS goal can be achieved with an expansion of public transport less than 5% annually (unless a "Copehagen style of biking" is promoted). The mirror image of this is a sharp reduction of urban personal car transport.
- A focus on BRT systems.
- A transformation of all buses (100%) to electricity and/or biofuels before 2020.
- Government regulations and (local/regional) taxes/fees on non-sustainable transport activities (including congestion fees) to promote this transformation.
- Government contribution to harmonization of solutions regarding systems and technologies (when convenient) and coordinated purchasing of transport solutions and/or vehicles.
- Government contributions and support to finance investments in infrastructure and vehicles.

4.6 How to finance a Nordic Transport Way?

The economic challenges brought about by climate change are significant. The "greening" of public transport and transport infrastructure in the Nordic countries may well exceed EUR 10 billion annually (Global Utmaning, 2014).

The Nordic public sector is not in a position to take on excessive borrowing and it is extremely cautious in committing to new infrastructure investments. Furthermore, many Nordic banks have reduced their international networks and reduced long-term loans, while requiring higher margins from corporate clients. Few Nordic companies have access to the bond markets. The total annual financing gap for the necessary green investments during the years ahead is in the magnitude of EUR 30 billion (Global Utmaning, 2014). This financing gap has significant negative implications for the transport sector because of its relative size and the diversity of needs from large and small companies and public bodies.

Investments in *public transport* and in *energy efficient solutions for transport* will be financed mainly by entities controlled by regional and central government for rail and bus transportation, in and between urban areas. The increased use of electric power for cars, biogas for buses and other vehicles *require long term and large financial suppor*t. Public financial support in various forms is required for SME private sector and large company involvement in supplying and developing innovative solutions. Although the public sector can finance parts of its needs from local government funding agencies and the debt markets, there are still huge needs from large companies and SME's involved in supplying and developing innovative solutions. This latter challenge is especially evident for the development of the following in both the national and export markets:

a) Biofuels and their distribution networks
b) Electric power transmission networks for small and large vehicles,
c) Electric battery power and charging systems,
d) Smart logistics for freight on regional, national and Nordic roads and railway networks
e) Smart rail networks for regional, national and Nordic networks
f) Smart public shared transport,
g) Traditional vehicle and lightweight vehicle development.

In order to ensure bridging the financing gap, we argue for a Green Nordic Bank (GNB) in line with the proposal launched by Global Utmaning and others. This proposal is in line with two effective existing organizations; (KfW) in Germany[16] and Export Development Canada[17] (EDC) in Canada. It also follows the launch of the Green Investment

16. www.kfw.de

17. www.edc.ca

Bank[18] (GIB) by the UK government and another in the United States, a new State initiative[19], the Clean Energy Finance and Investment Authority (CEFIA).

GNB will allow each Nordic country to reduce the absolute level of investments by coordinating investment policies across the region and systematically optimizing resources. It will also identify a path for securing cost-efficient, long term funding for such domestic investment projects and for similar export projects over the coming decades. Not only will there be sufficient and robust sources of finance, but professional financial expertise will be consolidated into a single Nordic entity.

Box 4.5 Financing the "Nordic Demonstrator"

The joint *Nordic Five Cities Program* will face a bottleneck in finance unless creative solutions for finance can be found. Even if buses need far less of infrastructure investments than railways there is a large need for investments in rolling stock. This problem can preferably be solved with a two-layer company structure. On the one hand the fleet of vehicles can be owned by large companies with *fleet management experience* (like car rental companies) or by fleet managing firms able to raise "green investors" capital (like pensions funds). On the other hand the operation of the various public transport systems can be performed by firms specialized in that similar to what is now the practice. This public *purchasing of green transport functions* from operators which lease their fleets from private – or semi private – fleet managers/owners will reduce the financial burden from municipalities and counties in a situation where large investments are needed.

In order for the GNB to be a significant financier, it must increase the current equity capital of the existing entities by a factor of at least 5 from the Nordic governments. Such an important entity triple-A rated would have no problem in securing and debt from institutional investors in a cost efficient manner. A GNB should be commissioned to ensure the most appropriate solutions for each Nordic country and for the region as a whole and for domestic as well as export projects.

18. http://www.greeninvestmentbank.com

19. http://www.ctcleanenergy.com/Home/tabid/36/Default.aspx#

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Material and presentations

Consultation meeting 1
International comparison of road freight CO2 emissions and energy efficiency, Dr. Niklas Arvidsson, University of Gothenburg and Viktoria Swedish ICT

Cutting Road Transport Emissions from a European and a Swedish Perspective, Per Kågeson, Nature Associates

Consultation meeting 2
Nordic Action Group on Transport – the pathways, Staffan Laestadius, prof.em KTH, Chair of NAG Transport

The load factor paradox, Dr. Niklas Arvidsson, University of Gothenburg and Viktoria Swedish ICT

The advanced biofuels in the current and future Nordic transport system – Necessary markets- and policy conditions for scaling up and speeding up, Anja Silvennoinen, President of Energy Business Group, Pöyry Oy

Consultation meeting 3
Nordic Action Group on Transport – an innovative, coherent, and long term policy toolbox for a structural transformation of the transport system: ideas for further discussion, Staffan Laestadius, prof.em KTH, Chair of NAG Transport

Fossil free road transport in the Nordic countries, Urban Wästljung, Manager Sustainable Transport, Scania

Why creative & low-emitting cities need electrified heavy vehicles and policies required for their implementation, Christian Berggren, Professor industrial organisation, Linköping university

How to create a sustainable transport system, Lars Nilsson, Director of Environment and Health, Swedish Transport Administration

Consultation meeting 4
Challenges in the transformation of mobilities – examples from a social science perspective, Lise Drewes Nielsen, Prof emerita, Roskilde university

Bioenergy and climate, Richard Murray, Senior advisor Global Utmaning

CCC - Framtidens beslutsstöd och incitamentsverktyg för den attraktiva staden, Karl-Johan Koivisto (Kristian Lundberg, Björn Lagerquist), SAAB

Consultation meeting 6
Bussplan Stockholm - vad är syftet?, Allan Larsson, Senior Advisor Global Utmaning

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