Creating prospective value chains for renewable road transport energy sources up to 2050 in Nordic Countries

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Abstract

If the Nordic energy and transport sectors are to meet the 2050 energy and climate policy targets, major systemic changes are necessary. Along with new technologies, changes are required also in other societal functions such as business models and consumer habits. The transition requires cooperation between public and private actors. This paper discusses the paradigm change towards 2050 Nordic road transport system based on renewable energy. More precisely, it proposes an approach for creation and analysis of prospective value chains up to the year 2050. The value networks arise from three alternative, but partly overlapping technology platforms, namely electricity, biofuels and hydrogen. The approach outlined in the paper combines elements from the fields of system level changes (transitions), value chain analysis and forward looking policy design. It presents a novel, policy relevant application with a set of practical tools to support development of implementation strategies and policy programmes in the fields of energy and transport.

Keywords: Value networks; transport system; energy system; foresight; multi-level perspective; transition

Résumé

Les grands changements systémiques sont nécessaires si les secteurs de l'énergie et des transports nordiques sont de répondre aux objectifs énergétiques et climatique 2050. Avec les nouvelles technologies, des changements sont nécessaires dans d'autres fonctions sociales telles que les modèles d'affaires et les habitudes de consommation. La transition exige une coopération entre acteurs publics et privés. Ce document examine le changement de paradigme à l'horizon 2050 du système de transport routier nordique, basée sur les énergies renouvelables. Plus précisément, il propose une approche pour la création et l'analyse des chaînes de valeur jusqu'à l'année 2050. Les réseaux de valeur proviennent de trois alternatives plates-formes technologiques, à savoir l'électricité, les biocarburants et l'hydrogène. L'approche décrite dans le document combine des éléments dans les domaines des changements de système de niveau (transitions), l'analyse de la chaîne de valeur et la conception de politiques prospectives. Il présente une nouvelle application avec un ensemble d'outils pratiques pour soutenir le développement de stratégies de mise en œuvre et des programmes d'action dans les domaines de l'énergie et des transports.

Mots-clé: Réseaux de valeur; système de transport; système énergétique; anticipation; perspective multi-niveaux; transition

1. Introduction

Sustainable energy technologies are driven especially by the climate change challenge, which necessitates paradigm shift also in global energy production and consumption structures. Currently, about 20 % of the Nordic

CO_2 emissions are due to transport sector. If the Nordic energy and transport systems are to meet the 2050 energy and climate policy goals, a major transition is necessary. Along with new technologies, changes are required also in other societal sectors such as business models and consumer habits. The transition requires cooperation between public and private actors. Policy decisions should create potential to enterprises which can provide renewable energy solutions in a way that they attract also consumers and transporters of goods.

In order to be able to make informed policy decisions foresight actions are needed to get an idea about the future trends and needs, and possible ways of shaping the future. Technological systems, such as transport system, are socially constructed and shaped (Huges 1987). This gives various transport system actors an opportunity to create the future together (participatory foresight). Further, more knowledge and understanding is needed on the roles of various actors in the change process. In our understanding actors are outlined in value chains and networks.

In this paper the paradigm change towards a new sustainable and innovative energy system of 2050 is discussed in the context of road transport sector in the Nordic countries. The focus is on developing tools to understand, create and analyse prospective value chains up to the year 2050. With 'value chain' we mean a network of activities needed in order to deliver a specific valuable product and service for the market, incl. activities related to energy sources or feedstock production; energy production; distribution and transportation; retail; consumption; regulation and governance; and research and development. In our case the value chains arise from three alternative, but partly overlapping technology platforms, namely electricity, biofuels and hydrogen. In addition, the prerequisites for the feasibility of the resulting value chains are considered. The motivation for the paper is to produce knowledge for future decision making and policy support in order to create enabling ground for sustainable energy solutions for the future transport sector. The proposed prospective value chain creation process seeks to identify the critical elements in the networks to be taken into consideration in strategic planning and decision making.

Traditionally value chains are considered in rather short term business opportunity analyses. In our case, we need to outline the value chains, or networks, in the far future. Hence, our research questions are more specifically:

- What are the essential elements of the process for creating and understanding the key dimensions in prospective value chains for renewable energy and transport systems?
- What role can such a process have in assisting sustainable decisions and policy-making in the fields of energy and transport?

The paper is based on TOP-NEST project, which is a Nordic Energy Research funded effort to explore three renewable energy technology platforms: 1) electricity systems, 2) liquid and gaseous biofuels, and 3) hydrogen systems, and the potential of the systems to give rise to new value networks, creating entrepreneurial opportunities in the road transport sector. The focus of the paper is thus in value networks that are needed and/or expected to develop in these free platforms, and in possible synergies between these platforms. This paper describes preliminary results of the TOP-NEST prospective value chain process. The development work will continue.

2. Theoretical background

The theoretical background of the paper stems from integrating insights from three disciplines, long-term foresight, socio-technical transitions, and value chain analysis in order to assist sustainable decisions and policy-making in the field of energy and transport.

2.1. The functions of foresight in policy making

The impact of foresight on policy-making can be discussed through its three major functions: 1) informing, 2) facilitation and 3) guiding. The issue has been discussed recently widely among foresight experts and practitioners (e.g. Georghiou & Keenan 2006, Da Costa et. al. 2008, Weber et.al. 2009, Könnölä et al. 2011).

Policymakers are dealing with increasingly complex issues that are highly interconnected and multidimensional. Extensive amount of information is available, but the challenge is, how to make sense of it in the given timescale of policy-making. The informing function of foresight refers to generation of insights regarding the dynamics of change, future challenges and policy options, along with new ideas, and transmitting them to policymakers as an input to policy conceptualisation and design (Da Costa et. al. 2008).

The second function, facilitation of policy implementation, gets it motivation from the changing nature of policy-making. There has been a shift in the conceptual understanding of policy process (Weber et. al 2009; Da Costa et. al 2008). The shift has been from linear models of policy-making, consisting of successive phases such as formulation, implementation and evaluation phases, into cyclic models, where evaluations are supposed to feed back into the policy formation and implementation phases. In this function foresight can be seen as an instrument which builds common awareness, networks and visions among stakeholders, and provides a forum for various actors for interaction, cooperation and learning in relation to specific change or transition. Foresight process promotes the development of “future-oriented attitudes” among participants, which may ease policy implementation (Da Costa et al. 2008).

The third function, which is called policy guiding, refers to the capacities of foresight to support strategic planning or policy formulation. Weber et al. (2012) describes this function as strategic counselling of the policy process. This function operates only if foresight process is carried out jointly with the policymakers in charge of the specific policy field. Foresight exercises may even bring to light the inadequacy of the current policy system to address the major challenges that society is facing (Da Costa et al. 2008). Adaptive Foresight is an example of practical tool to support policy making in this function (Eriksson & Weber 2008).

The proposed process for analysing prospective value chains presented in this paper contributes all of these three functions and is hence supports well strategic planning and policy design in the field of renewable energy for transport.

2.2. Multi-level perspective to transition

Change towards sustainable energy and transport systems in the climate change context is possible only through systemic innovations for example in the fields of renewable energy production, energy efficiency, energy saving, behavioural changes in energy consumption, etc. These innovations require changes in all system functions. It means that the whole societal system has to be opened up in order to find out the barriers and drivers for the innovative systemic change; decision makers in all levels, households, companies, schools, universities, ministries, parliament and other levels, should be involved.

Transition Management refers to an attempt to redirect the existing dynamics of technological change and the entire techno-economic and societal system. Transition management intends to clarify the content and challenges of systemic change and societal embedding of new innovations. In transition management approach the technological system, such as energy or transport system, is understood as being composed of physical technologies -in the form of components, combined systems and infrastructure, and social technologies (institutions) – in the form of culture, social patterns, constrains and mechanisms of behaviour such as social norms, routines, legislation, standards and economic incentive mechanisms. The Netherlands is among fore-runners in developing, applying and implementing transition management approach (see e.g. Geels 2005, Geels and Kemp 2007, Geels and Schot 2007).

A dominating essence of a complex technological system is path dependence, which highlights that directions for future development are foreclosed or inhibited by directions in the past development. Most innovations are built on past discoveries and needs to be adapted to pre-existing conditions for successful diffusion. The path-dependent and irreversible nature of techno-institutional co-evolution makes transitions difficult to achieve; the prevailing system acts as a barrier to the creation of a new system.

Systemic change, i.e. transition in path-dependent system is a complex multidimensional societal change process, dealing with the co-evolution of technological, industrial, policy and social changes. A Multi-Level Perspective (MLP) framework has been developed (Geels 2005), in order to describe this complex process. The framework has also been developed and applied in UK (Foxon et. al. 2010). Geels has applied the MLP framework also to the transport system in his recent work as he has studied transitions towards low-carbon futures of automobile systems (Geels 2012). Three levels of change are abstracted in the MLP framework: landscape, regime and niche. *Landscape*, forms an exogenous macro level environment that influences developments in niches and regimes. General developments in global operating environment, including e.g. economic, cultural or environmental factors compose the landscape level. *Regime* refers to the existing structures and actions of the system. In the context of this paper, these structures and actions are related to e.g. nuclear power or mode specific transport systems. The specific form of the regime is mainly shaped and maintained through the mutual adaptation and co-evolution of its actors and elements. The development is very path dependent. *Niches*, in turn, form the level where radical novelties emerge. Niches are local innovative solutions, experiments. Niches provide opportunities for learning and incubation of alternative solutions that may gradually become strong enough to challenge the existing regime or adopt and transform the regime towards new directions.

The system transition, which in our case aims towards renewable energy solutions in the Nordic transport sector in 2050, is possible if the change processes in all these different levels are synergetic. In other words, the socio-technical change is a result of the interaction and synergy of all the different levels. One single change cannot change the whole system, but a system innovation is needed. Old regime is transferred into new 2050 regime due to a system change affected by the landscape and niche level changes. This transformation is possible only if policy, regulation, markets, values, resources, strategies and technology are changed so that they boost the system into the same direction. Institutional factors, behaviour and energy infrastructure are also the key factors, which define the crucial elements for political decisions.

2.3. Value chain analysis

Global value chain (GVC) analysis has emerged since the early 1990s as a novel methodological tool for understanding the dynamics of economic globalization, international trade as well as particular industries such as automobile manufacturing (Sturgeon et al. 2008). GVC is based on the analysis of discrete ‘value chains’ where input supply, production, trade and consumption or disposal are explicitly and (at least to some extent) coherently linked. In addition to the descriptive aspects of territoriality and input-output structure, much GVC discussion has revolved around two analytical issues: how GVCs are governed (in the context of a larger institutional framework), and how upgrading takes place along GVCs. Application of GVC into the context of technological innovation and renewable energy as in the TOP-NEST project is novel field of research.

In traditional manufacturing network operations of suppliers, lead producers (such as OEMs – original equipment manufacturers) and customers are seen as independent sequential tasks, which form a value chain. Since the 1990s, however, this pattern has been changing and the theoretical discussion has also emphasised the transfer from value chains to value networks (Normann & Ramirez 1994; Peppard & Rylander 2006). Value network perspective is considered to be more suited, especially, to those organisations where both the product and supply and demand chain is digitized, such as banking, insurance or telecommunication. Figure 1 illustrates the need for new kind of collaborative approach within manufacturing networks. Still, in practice, co-operation of manufacturing networks is mostly limited to bilateral collaboration, e.g. vertical relationships between a customer and a supplier and the change towards network level decision making and operations is in the wind. As definitions, we may present the following (Valkokari et. al 2011): (1) Value chain consists of entire sequence of activities or parties that provide or receive value in the form of products or services, (2) Value network consists of organisations (companies) co-operating with each other to benefit all network members. Recent literature points out also that external actors can have an important say in how a GVC is governed, e.g. governments, large NGOs, ‘experts’, certification bodies and service providers (Ponte, 2007; Riisgaard, 2009). External actors are often important in emerging industries like those for renewables.

In the context of this paper, we need to make a distinction between value chain analysis, in the meaning of analysing and developing of existing value chains, and the analysis of prospective value chains. As our approach is forward-looking and we want to anticipate value chains that may exist in long-term future, we need slightly different viewpoints. Value network approach provides us with an interesting ground. Peppard and Rylander (2006) present a procedure of Network Value Analysis (NWA), which takes the network-oriented model as a starting point. The aim of NVA is to generate a comprehensive description of where value lies in a network and how value is created. The analysis is based on step-wise procedure starting from network objectives definition and identification of network participants to the analysis of value dimensions and influences, and shaping of the final value network. Another approach to future-oriented analysis of business models and business ecosystems is presented in Ahokangas et al. (2012). This approach aims at developing new business models for companies. The analysis starts from identification of the key actors and analysis of their needs and benefits in the business ecosystem. Second stage of the analysis is to generate scenarios for the identified ecosystem, so that new business models can be created. Our approach (see section 3.2) outlines prospective value chains in the context of transport energy systems. It incorporates elements from the above mentioned approaches. Central aspects in our approach are value network thinking and future anticipation based on scenario approach.

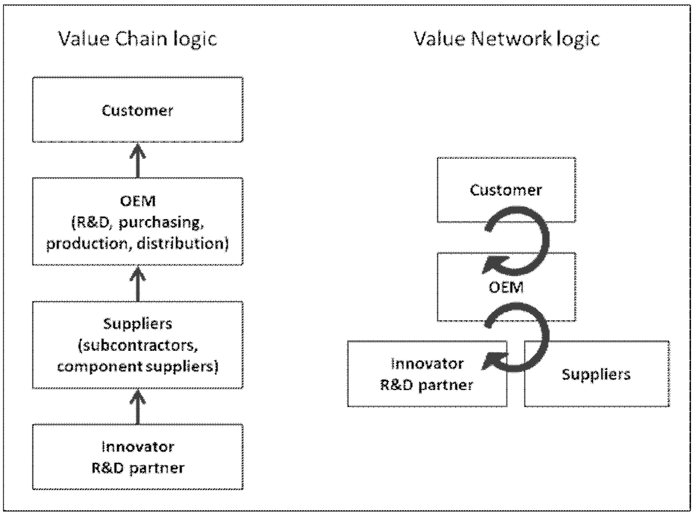

Fig.1. Changing paradigm from value chain to value networks.

3. Method

3.1. Energy and transport in MLP framework

Transport and energy systems, which we propose to analyse against multi-level perspective (MLP) form the context for our method. Figure 2 presents the three basic components of the transport system: users, vehicles and transport infrastructure. In addition, in the middle of these components, all of which interact with one another, are illustrated a fourth and a fifth components: transport services and transport system organisation, governance and regulation. Each of these components is then further elaborated into some key elements that characterise them. For example, transport vehicles and other means of transport rely on alternative technologies and materials, and besides the manufacturing processes, these require also maintenance. Different vehicle solutions make use of different fuels and other energy carriers, and they result in environmental impacts. Furthermore, the use of vehicles involves behavioural and business models, and different types of solutions are available concerning issues such as vehicle ownership (adapted from Auvinen and Tuominen, 2012). The illustration presents also the main elements of the energy system (primary energy sources, production and storage), which are linked to the transport system mainly through energy and transport infrastructures and are crucial for transport operations.

The transport and related energy system components and elements in Figure 2 can be analysed against the multi-level perspective (Geels 2004). The three levels adjusted to the transport domain are landscape, transport system and technologies and solutions. The components and elements are positioned on the most appropriate levels to indicate their main application areas, but it should be acknowledged that there are no clear boundaries in here. This structuring is supported by the recent work by Geels (in press), where similar early steps in exploring multi-level perspective in the study of transitions in the transport sector are taken. Geels suggests very similar definitions when drafting the automobility system in the context of multi-level perspective when studying transitions towards low-carbon futures. Multi-level perspective in structuring the socio-technical system for land-based road transport has also been used by van Bree et al. (2010). In their work, hydrogen and battery-electric vehicle scenarios were mapped when taking the relationship between car manufacturers and consumers into focus.

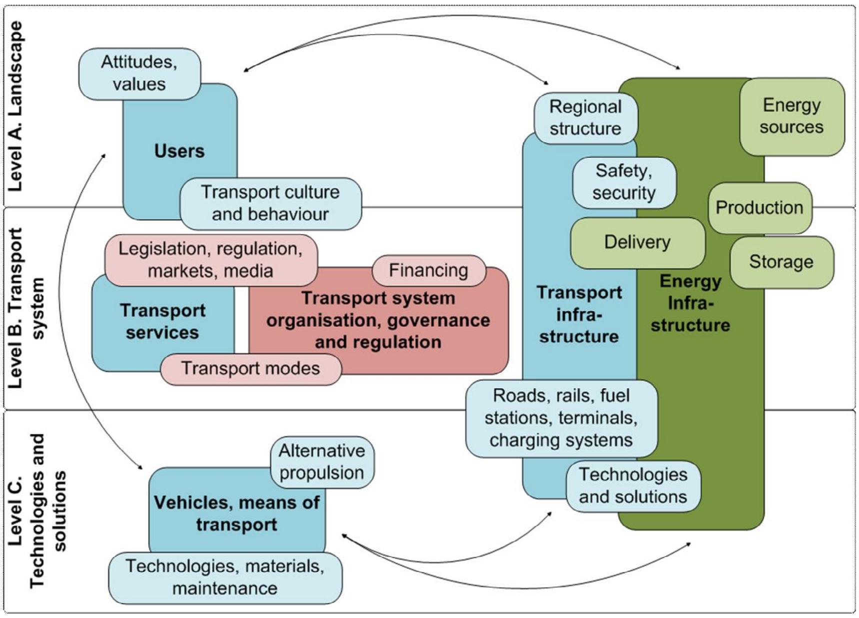

Figure 2. The basic components of transport and related energy systems against multi-level perspective.

3.2. An approach for outlining prospective value chains for sustainable energy systems in road transport

The proposed approach enables participative foresight and supports sustainable policy making. The process consists or three stages (see Figure 3): Step 1: Building future context for the prospective value chains; Step 2: Identification of value network actors; Step 3: Outlining of the prospective value networks

The process starts with identification of the context were the prospective value networks will operate (Step 1). For this purpose, various foresight methods, such as Futures Wheel (Glenn 1994), and scenario methodology (e.g. UNIDO 2005) can be used. The purpose of the futures wheels is to open future thinking and help the recognition of key factors or drivers, which affect the future development of energy and transport systems. Based on the futures wheel exercise, it is possible to create alternative futures using scenario methodology. The alternative futures create alternative possibilities for different technology platforms to develop. Next, to be able to anticipate the technological development in different futures, the strengths, weaknesses and development possibilities of the different technology platforms need to be analysed. The SWOT analysis of the technology platforms and evaluation of the scenarios from the perspective of various technologies present the tools for this. The goal of the first step of the procedure is to recognize the ideal future for each technology platform. In other words, this enables the identification of the factors, which support the development of single technology platform the most. By doing so, it is possible to use backasting approach to formulate policy measures on what kind of actions are needed to achieve the desired future.

The second step identifies the value network actors and analyses their individual interests, and connections between different actors. The analysis covers value chain activities from energy sources and feedstock production to energy production, distribution and transport, retail and consumption. Also regulation, governance and R&D actors are included in the analysis. First, all possible actors are listed and then their opportunities and advantages, as well as supportive needs are analysed. Opportunities refer to the possibilities to make profit in the value network (How the actor benefits from the value network?), and advantage refers to created value by the actor (What is the added value the actor produces to its customer or in the network?). The analysis of the supportive activities is needed to recognize the connection between different actors.

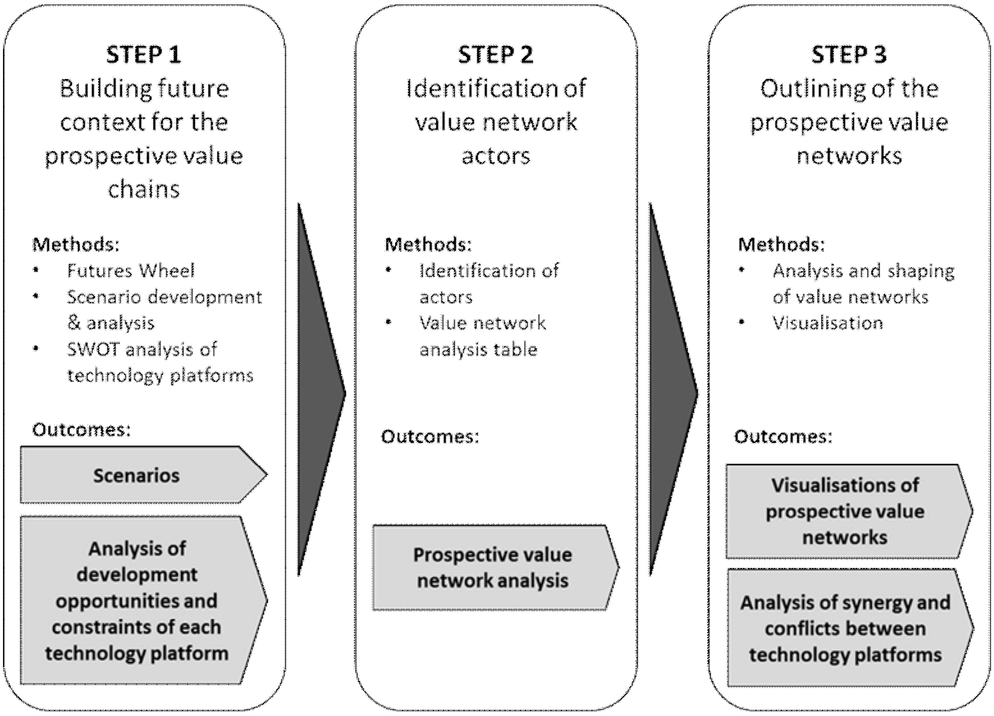

Figure 3. A process for prospective value chain analysis.

The third stage includes outlining of the prospective value chains. Here, it is important to consider the following issues. Different technology platforms will co-exist in the future, but as was mentioned above, different futures create different opportunities and development possibilities for different technology platforms. Therefore, one needs to describe the level of technological development of the given technology platform in the outline of the value network. In other words, the outline of the value network works only in selected scenario, and the level of technological development of a single technology platform varies across Further, it is important to consider the different customer or transport segments of the value network, both in passenger and goods transport and also across in urban and long distance transport.

The following section of this paper presents an illustrative example of the use of the method in the context of Nordic road transport system 2050 based on renewable energy. The example is based on the workshops and literature surveys carried out during the TOP-NEST project. The project is still in progress, and the procedure is not completely finalised.

3.3. Building future context for the prospective value chains

Building future contexts started with a group brainstorming session using Futures Wheel as an aid. Interdisciplinary group of researchers from Finland, Sweden, Denmark and Norway form the fields of technology, modelling and social sciences participated the work shop. Based on the futures wheel exercise, the following three future directions were recognized: (1) “Green energy and transport”: Environmentally sound transport system, which is resulting from strong environmental regulation and policy making, (2) “Co-existence of technologies”: Various technologies co-exist in the transport system due to each one’s limitations and advantages. A key driver in this line is technological development, (3) “Changing values as a base for new transport system”: Changing values are the main driver for change and new transport solutions are developed to meet new needs. From the exercise, two main dimensions as a basis for scenario building could be identified. The first one is the *policy coherence* factor: the level of which the whole society works towards transition. The second is the *societal structure* (centralised-decentralised). Using the dimensions presented in Figure 4, we formulated four different scenarios for 2050.

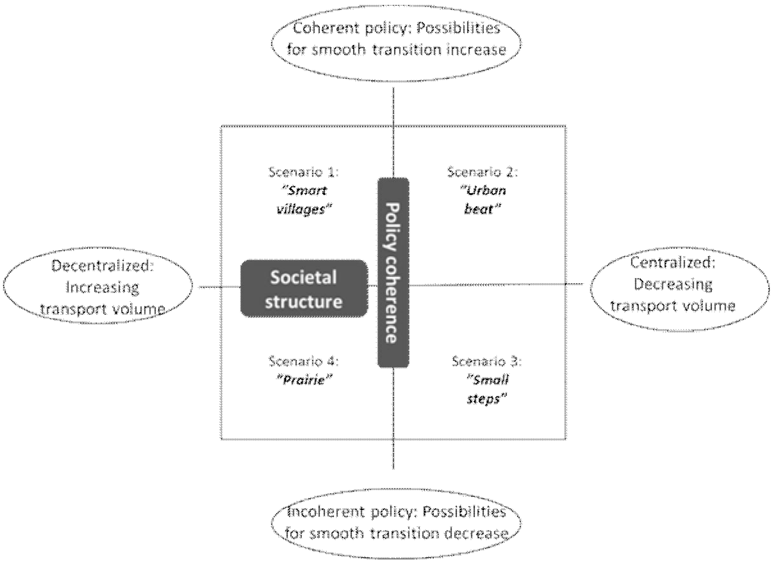

Figure 4. The key dimensions for scenario building and the four transport scenarios formulated for 2050.

"Smart villages" presents decentralized community structure and energy system as well as coherent policies towards sustainability. *"Urban beat"* describes centralized community structure and energy system together with coherent policies. *"Small steps"* scenario presents centralized community structure and energy system, in which policies are incoherent. Finally, *"Prairie"* describes decentralized community structure and energy system as well as incoherent policies. Detailed descriptions of the scenarios are presented in Appendix 1.

Next, alternative scenarios were analysed against the three technology platforms. The analysis covered two issues. Firstly, strengths, weaknesses, threats and opportunities of the technology platforms were identified by SWOT analysis. Secondly, benefits and challenges of each scenario could provide for the three technology platforms was identified. Table 1 sum up the results of the scenario analysis.

Table 1. The results of the scenario analysis.

Scenario	**Dominant technologies ***	**Challenges for other technology platforms**
Smart villages	Biofuel Hydrogen	Goods transport is based on road transport, which is challenging for electricity. High need for energy storages and adjustment power to guarantee the availability of electricity in the decentralized society.
Urban beat	Electricity	Small volumes for biofuels, because electrification of society is emphasized.
		Advancing bio economy creates competing uses for biomass (decreasing transportation volume may compensate this).
		Possible shortage of R&D investments.
		No demand for long distance electric passenger traffic (challenge for hydrogen).
Small steps	Biofuels	Contradicting interests hinder the development of public transport and its electrification.
		No coherent regulation or coordinated development activities.
		Companies are not willing to develop technology.
		Organisation of heavy road transport is very challenging for electricity and hydrogen.
Prairie	Biofuels	Global economic crisis delays development, no money for implementation of new technologies.
		Disintegration of the infrastructure (challenge for electricity).

*benefitting from the circumstances

The analysis reveals which scenarios are the most beneficial for each technology platform. For example, the characteristics of biofuels and hydrogen technology are in line with the decentralized structure and demand for local solutions of the “Smart villages” scenario. On the other hand, the same demands create a challenge for electricity, as they result in high need for energy storages and adjustment power. Biofuels are also strong in the “Small steps” and “Prairie” scenarios, because they are compatible with the existing energy and transport structures, and therefore they can evolve even if there is shortage of R&D investments or shared objectives in the technology development.

3.4. An example of analysed value network actors – a biodiesel case

The use of the prospective value network analysis process was tested with a 2nd generation biodiesel case. In this case a company has started to develop its biofuel business by building a hydro-treatment based biorefinery next to the pulp mill of the company. Crude tall oil is used as a primary raw material. The hydro-treatment biodiesel biorefinery investment is made without any public subsidy. It is the first market oriented hydrogen treatment biorefinery in the world. The chosen case-study corresponds to the “Small steps” scenario, as it describes a situation, where a forest industry company is refocusing its business. Drivers for this redirection are the dramatic decrease of the demand of traditional forest products and global monetary crisis. At the same time, there is a global need for increasing the use of renewable energy in road transport. In these circumstances, the production of biofuels is a tempting path for a forest company to follow. One could say that this case-study is strongly path dependent example. The biorefinery company has long forest industry history in Finland. Pulp production started in 1880. An important strategic goal is to start to produce 2nd generation bio fuels from wood material. Since the company is a traditional forest industry company, the production of 2nd generation biofuel continues nicely its history. Tall oil is produced from black liquor soap, a side flow of sulphur-chemical pulp mill process. In theory, other bio-oils and fats, Fischer-Tropsch wax, black liquor, lignin, turpentine and pyrolysis oil from forest biomass could also be used in the process. The same fuel distribution system can be used as used in fossil fuel distribution.

Firstly, the actors which constitute the value chain network were identified. The network focal is naturally the tall oil producer (see Figure 5).

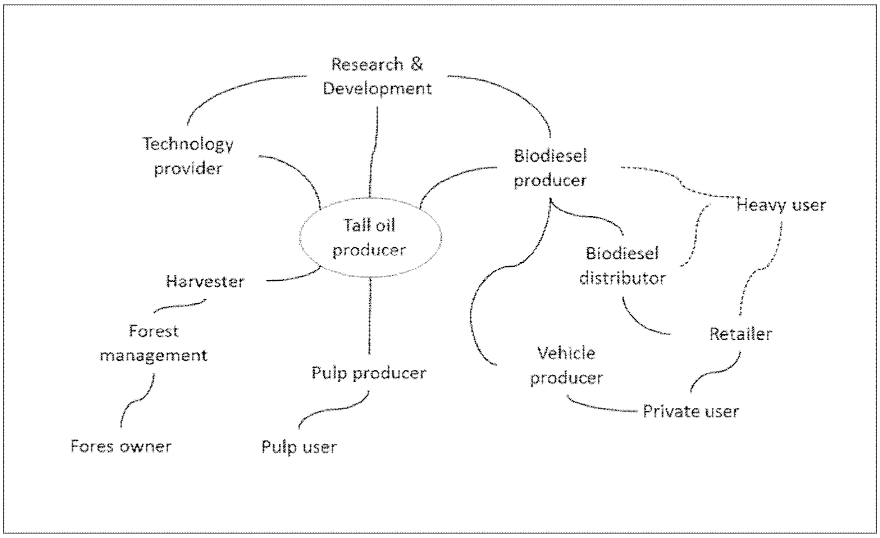

Figure 5. The value network of a biodiesel example based on tall oil.

The network shows the relationships between different actors. After the network structure is constructed, value creation potential of the connections can be analysed. The analysis may reveal new potential relationships or ways to organise the value chain structures in the future. For instance, the biorefinery company or the tall oil producer may be converted to technology supplier in the future, as it owns the intellectual property rights to the process. Another example of the possible findings based on the value network chart is that there may be changes in the delivery part of the value network. For example, some heavy users of biofuels might get the fuel straight from biodiesel producer instead of various intermediary actors. The network analysis reveals also that tall oil based biodiesel production requires pulp production to be profitable. In addition, to be able to use this biodiesel option, we need liquid fuel distribution system and vehicle industry in favour of biodiesel as an energy source for road transport. The above results provide first examples of the final finding of the value chain analysis of the TOP-NEST project.

4. Discussion and conclusions

In this paper we have proposed an approach to create and analyse prospective value chains in the context of Nordic road transport 2050. The starting point for our analysis was that future value chains and future actors within have to be recognised in order to find out prerequisites of the future actions related to renewable energy sources for transport. Identification of key actors is important since they are responsible on the decisions towards low carbon futures.

The proposed approach may act as a checklist for the key issues to be covered in outlining prospective value chains in the road transport context. For instance all the value chain activities should be discussed to find out the relevant points, from the perspective of actors and value creators in the network. The process integrates methods from different theoretical starting points, namely foresight, multi-level perspective and value chain theories. It also integrates energy and transport systems, and expands the context far to the future. The process is not yet complete but the work will continue in the TOP-NEST project up to the end of year 2013.

The most challenging parts in outlining future actors are: firstly, to be able to imagine potential new actors as well as changing roles of the old ones and secondly, to create potential new relationships between the actors. This task is especially difficult in a strongly path dependent situation, as the biodiesel case is. We assume that for instance in testing this procedure in hydrogen technology system the challenge may be slightly easier, because for instance in Finland the whole context is new and hydro technology actors are currently very few.

Getting relevant stakeholders to either take part of the workshops or give interviews is demanding. Stakeholders may be too busy to join workshops, which are quite usual methods used in today's research and business world. At least in this road transport context, the issue to be discussed is so large including energy, transport and transition policies, that the discussion would take time if done properly. There may also be confidentiality problems concerning new emerging technologies; stakeholders do not want to be part of public discussions. In the context of renewable energy, it is also challenging to look at different technological platforms, biofuels, hydrogen and electricity, simultaneously, in order to find synergies between them. It is not realistic to depend on only one option, but to look for also alternative technological solutions.

Despite the challenges, we believe that prospective value chain analysis helps various system actors to figure out landscape level constraints, like values and global trends, as well as the needs which guide the society to change the existing regime in order to achieve the goals, such as renewable energy use. Value chain analysis may act as a tool to increase the knowledge of different actors in making decisions towards low carbon futures.

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Appendix 1

Detailed descriptions of the four scenarios.

SMART VILLAGES **-** *Decentralized community structure and energy system & coherent policies*
Road transport is a dominant mode for both passenger and goods transport. Smart, low carbon public and goods transport solutions for small communities are deployed and attracting more users. Community based thinking and acting is strong, but it does not prevent generation of private passenger transport. Slight increase in passenger transport demand has taken place, but the demand for transportation of goods has decreased. Technological development is on a moderate level. Industries and services are mainly locally based. Public, private and research organisations have built up strong local or regional clusters for co-operation and decision making. Powerful local, regional and national regulations and incentives steer vehicle and fuel production, distribution and use.

URBAN BEAT **-** *Centralized community structure and energy system & coherent policies*
Due to the centralised community and energy system structures, rail transport and non-motorised transport (cycling, walking) dominate in cities. For long distance travel and transportation of goods, high-speed rails are the main transport mode. Urban regions have seamless, just-in-time, public transport and urban logistics services. Transport system end-users consider green, renewable energy production and transport as a fundamental value of the society. Substantial decrease in transport demand has taken place. Technological development is fast and large service sector companies have reconstructed the industrial structure. Public, private and research organisations at national and Nordic levels have built up strong urban clusters for co-operation and decision making. In addition, powerful, complementing global and EU regulations and incentives steer vehicle and fuel production, distribution and use.

SMALL STEPS **-** *Centralized community structure and energy system & incoherent policies*
Various modes of transport, such as road, rail and NMT are used in cities without clear priorities. Road transport dominates long distance travel and transportation of goods. Both private and public transports are supported, but no clear decision on preference has been taken. End-user views and needs towards energy and transport are dispersed. Passenger transport demand has decreased slightly, but in transportation of goods, there is no evident change. Centralised energy intensive industries form the industrial back bone. Technological development is moderate due to lacking coordination of R&D activities and cooperation between public and private research organisations. Various (even conflicting) regulations, incentives on fuels and vehicles, their production and distribution have been prepared and realised.

PRAIRIE - *Decentralized community structure and energy system & incoherent policies*
Due to the decentralised community and energy system structures, road transport is the dominant mode for both passenger and goods transport. However, the development and maintenance of road network is poor. In the absence of common vision and co-operation networks, public transport is slowly fading away. The overall economic situation is bad, travelling and transportation of goods is expensive and hence transport demand decreases. The state of energy intensive industries is poor, because no renewal has taken place. Also, technological development is slow. Public, private and research organisations have very little cooperation. Each organisation tries to survive individually. Only few poorly supervised regulations and incentives on vehicle and fuel production, distribution and use have been carried into effect.