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A strategic approach to sustainable transport system development - part 1: attempting a generic community planning process model

Karl-Henrik Robèrt, Sven Borén*, Henrik Ny, Göran Broman

Department of Strategic Sustainable Development, Blekinge Institute of Technology, 37179 Karlskrona, Sweden

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ABSTRACT

Electric vehicles seem to offer a great potential for sustainable transport development. The Swedish pioneer project GreenCharge Southeast is designed as a cooperative action research approach that aims to explore a roadmap for a fossil-free transport system by 2030 with a focus on electric vehicles. It is the following *combination* of objectives that puts demand on a new process model adapted for cross-sector and cross-disciplinary cooperation: (i) a fossil-free transport system in Sweden by 2030 and, to avoid sub-optimizations in the transport sector, (ii) assuring that solutions that support (i) also serve other aspects of sustainability in the transport sector and, to avoid that sustainable solutions in the transport sector block sustainable solutions in other sectors, (iii) assuring cohesive creativity across sectors and groups of experts and stakeholders. The new process model was applied in an action-research mode for the exploration of electric vehicles within a fully sustainable transport system to test the functionality of the model in support of its development. To deliver on the above combination of objectives, a framework was needed with principles for sustainability that are universal for any sector as boundary conditions for redesign, and with guidelines for how any organization or sector can create economically feasible step-by-step transition plans. The Framework for Strategic Sustainable Development (FSSD) is designed to serve such purposes and therefore is embedded into the new process model. The exploration of this new model also helped to identify four interdependent planning perspectives ('Resource base', 'Spatial', 'Technical' and 'Governance') that should be represented by the respective experts and stakeholders using the model. In general, the new process model proved helpful by giving diverse stakeholders with various competences and representing various planning perspectives a common, robust, and easy-to-understand goal and a way of working that was adequate for each of their contexts. Furthermore, the evolving process model likely is relevant and useful not only for transport planning and electric vehicles, but for any other societal sector as well and thus for sustainable community planning in general.

1. Introduction

This section describes transport sector challenges, responses, and approaches to pave way for the aim and scope of the study.

1.1. Greenhouse gases and resource challenges in the Swedish transport sector

The transport sector can be described as the 'blood system' of global economies, ensuring flows of resources and products, connecting organizations and people, and facilitating everyday life and economic development. However, the current transport sector also contributes to unwanted effects that threaten the very fundament that society depends upon. Examples are that the transport sector represents very large flows of limited natural resources that will eventually become prohibitively expensive, some of them probably already in a short term perspective (Carlson, 2011; IEA, 2012; Sverdrup et al., In this issue). Those material flows also contribute largely to global pollution. Moreover, as part of the pollution aspect, the fossil fuels that the transport sector primarily runs on generate

Abbreviations: ABCD, A procedure for strategic planning towards sustainability; CO_2, Carbon dioxide; EU, European Union; EV, Electric vehicle; FFF, Investigation for how to reach a fossil-fuel-independent vehicle fleet by 2030; FSSD, Framework for Strategic Sustainable Development; GHG, Greenhouse gas; SP, Sustainability principle.

* Corresponding author. Tel.: +46455385723.
E-mail address: sven.boren@bth.se (S. Borén).

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greenhouse gas (GHG) emissions. The transport sector also occupies large areas, for instance, through urban sprawl, and is a challenge for spatial planning. It is essential to apply a full systems perspective and to set appropriate system boundaries when trying to find solutions to these problems. An example of this is the Swedish case. On the one hand, Swedish GHG emissions have decreased significantly in recent decades (Swedish Environmental Protection Agency, 2012). In reality, though, when a life-cycle perspective including imports of products and services is applied, it is clear that Sweden continues to increase net emissions of GHGs (Statistics Sweden, 2014).

1.2. Early Swedish responses

A further look at Sweden, which is the focus area of this study, reveals that combustion of fuels within the transport sector causes about one third of the Swedish GHG emissions (Swedish Environmental Protection Agency, 2012). To deal with this problem, the Swedish Government has decided on two transport-related, long-term goals: a GHG neutral society by 2050 and a fossil-fuel-independent vehicle fleet by 2030 (Ministry of the Environment, 2011). The latter has been interpreted to imply that 80% of the energy carriers used by the vehicle fleet should be renewable-based by 2030 (Johansson et al., 2013). To reach these two national goals, many Swedish municipalities have joined the global Covenant of Mayors that aim to decrease carbon dioxide (CO_2) emissions by 20% and energy use by 20% by 2020. Furthermore, the plan is to increase the renewable energy share to 20% in Europe (The European Commission, 2009). Moreover, Swedish public transport authorities aim to double public transportation by 2020 (the Swedish Doubling Project, 2011). Goals of this kind may be essential stepping-stones towards sustainability with concrete numbers that can be monitored and serve as a "pull" of inspiration. However, when goals are set sector-wise like this, with no connection to similar goals in other sectors and with no plan for the forthcoming steps after the targets have been reached, there are big risks that change may happen *in ways* that will later on prove to be sub-optimized (Alvemo et al., 2010; Borén, 2011). For instance, it is quite feasible for the European Union (EU) to reach the agreed targets with large investments in making today's transport systems more efficient, only to discover how such vision-less reactions may create "path-dependencies" (Hukkinen, 2003a, 2003b) towards unattractive futures that still are dependent on inherently unsustainable practices, including the use of fossil fuels. The negative side effects of such planning is also called "the tyranny of small steps" (Haraldsson et al., 2008). This is not to say that efficiency is bad per se, but it must be seen in a wider context and assessed against, and combined with, other measures in a strategic way with respect to the end goal of a sustainable transport system within a sustainable society.

As further described in the second paper of this tandem publication (Borén et al., 2016, In this issue), electric vehicles can potentially play an important role for development of Sweden's road transport towards sustainability (Johansson et al., 2013), and an increasing share of local and national politicians believe the timing is right to start implementing EVs in the Swedish society to reach transport-related goals.

1.3. The importance of a strategic approach

Swedish society seeks to move the transport sector towards sustainability, but an overarching operational plan for how this shall be achieved, over and above reaching fossil fuel independence, is still missing. Planning for any societal system to develop towards sustainability includes many complicated tasks. Duić et al. (2015) have identified that "There is a need for improvements and new developments in the conceptual, legal and methodological frameworks to facilitate the penetration of sustainability thinking into various system scales. This includes developing scientific foundations for correct setting of boundaries of sustainability systems, to enable effective implementation of advanced models for system analysis and decision support." Furthermore, Roth and Kåberger (2002) claim that it would be preferable to use long-term sustainability criteria and a backcasting process when planning for sustainable development in the transport sector. Also, Baumgartner (2011) stresses that sustainability research has to be based on solid scientific principles. Lately, several methods and tools have been adopted in transport projects to support *sustainable* transport development, for instance, Cost Benefit Analysis, Life Cycle Assessment, Multi-Criterion Decision Analysis, and also Multi Actor Multi Criteria Analysis. As mentioned by Macharis and Bernardini (2015), none of them seems to be complete due to lack of stakeholder involvement, and, as mentioned by Bueno et al. (2015), none of them addresses sustainability sufficiently.

To effectively deal with such considerations, there is a need for a framework with principles for sustainability that are universal for any sector as boundary conditions for redesign (i.e., covering all aspects of sustainability regardless of scale) and with guidelines for how any organization or sector can create economically feasible step-by-step transition plans to comply with the boundary conditions. Such a framework should also be capable of informing all kinds of concepts, methods, and tools to make them cohesively functional to support this kind of systematic approach to sustainability. The authors are only aware of one such framework: the Framework for Strategic Sustainable Development (FSSD), (Broman and Robèrt, 2015, In this issue), which is designed for such purposes and has been successfully tested and used in municipalities, businesses, and sectors, including projects with the ambition to design plans for sustainable development of transport (Alvemo et al., 2010; Borén, 2011). The FSSD's sustainability principles (SPs) are elaborated in a continuous scientific consensus process and designed to form a generic and still operational definition of sustainability to be useful for systematic planning and guidance of redesign of any system towards sustainability. The scientific consensus process aimed at developing such a definition started in Sweden in the early 1990s and has gone through several iterations of refinement since then. Given all these theoretical and practical strengths, the FSSD therefore is chosen as a shared mental model to structure the research performed in this study.

1.4. Scope of the study

This study, presented in tandem as two papers, aims to identify an approach to sustainable transport planning at large, and with this as a base, analyze the potential role of electric vehicles (EVs) in a sustainable society. This first paper attempts a generic approach to strategic development of any societal sector, applied and developed here for the case of the transport system, in support of societal development towards sustainability. As described above, there is a need for a study that clarifies how road transport in Sweden can be developed towards a sustainable future. The second paper (Borén et al., In this issue) therefore applies the generic approach to transport planning in southeast Sweden, particularly in regard to the role of EVs as a contribution to the national goal of a fossil-fuel-independent vehicle fleet by 2030.

2. Strategic approach

The FSSD includes an inter-relational model with five levels (system, success, strategic guidelines, actions, and tools). The SPs

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forming the definition of sustainability are at the success level. The following version was used in this study e.g. (Ny et al., 2006):

In a sustainable society, nature is not subject to systematically increasing …

I … concentrations of substances extracted from the Earth's crust,
II … concentrations of substances produced by society,
III … degradation by physical means, and in that society …
IV … people are not subject to conditions that systematically undermine their capacity to meet their needs.

The social part of the definition (principle IV) is currently being further elaborated (Missimer, 2015).

In the regional multi-stakeholder seminars of this study, the so-called ABCD procedure of the FSSD was applied to the Swedish society as a whole (Fig. 1):

A. In this step, participants discussed and learned about the FSSD and built a shared understanding of the big picture of the planning topic and how, in general, societal un-sustainable activities degrade the socio-ecological system, metaphorically illustrated as a funnel with a steadily closing wall (Fig. 1). A further discussion of the funnel dynamics and the related business case of sustainability has been conducted by several authors (Holmberg and Robèrt, 2000; Willard, 2012; Robèrt and Broman, In this issue). Furthermore, a tentative vision of a sustainable Swedish society was defined within the frame of the SPs.
B. The current reality was assessed in relation to the sustainable vision created in A to identify major Swedish challenges and strengths in relation to the vision within the SPs.
C. Informed by the results from A and B, participants brainstormed possible steps towards the vision, i.e., investments and measures that can serve as stepping-stones or final steps towards compliance with the sustainability-framed vision.
D. Participants then prioritized among the brainstormed proposals from C, resulting in a step-wise strategic plan. Priorities were set by a three-question logic: will the respective proposed measure (i) provide a solid and flexible platform for forthcoming steps towards the sustainability vision in A, while striking a good balance between (ii) pace towards the vision and (iii) return on investment?

In Fig. 1, the national 'GHG neutral society by 2050' and the GreenCharge Fossil-free vehicle fleet by 2030 goals are shown as intermediates on the way towards sustainability. In line with our introductory remarks, it is important that these intermediate goals be designed to serve as flexible platforms to comply with the SPs I-IV, that is arrive at the full scope of sustainability.

In goal setting in complex systems, it is a mistake to look only at one boundary condition of success at a time, for instance, dealing with poverty first, and only thereafter with ecological problems'. Systematic planning towards complex goals in complex systems requires use of all boundary conditions for success *together*, giving a creative tension-field for innovations and step-wise approaches. This strategy is similar to the strategic game chess. Each move should serve as a flexible platform for forthcoming moves, bringing the game closer and closer to *all* the principles of checkmate being fulfilled. One of those is that the other player's king is under threat. If that boundary condition of winning is prioritized on behalf of the other principles of checkmate, it is a strategically flawed mind-set. Just like in chess, nobody can look into the future at any higher level of detail, for example by foreseeing early on exactly how checkmate will be pictured on the board. However, a successful future can be invented if there is access to robust boundary conditions for the desirable objective. Reality will inevitably change conditions along many different dimensions, such as new demands on the market, costs, availability of resources, technical innovations, and business models. Planning towards robust boundary conditions for any essential aspects of objectives, for instance, 'sustainability', allows creative and adaptive pragmatism, where changes of plans and tactics will prove necessary as the game unfolds, but only for as long as the endgame defined by the robust boundary conditions is not compromised. Unlike 'backcasting from scenarios', backcasting from boundary conditions for sustainability offers such a systematic, strategic, and still pragmatic process (Ny et al., 2006).

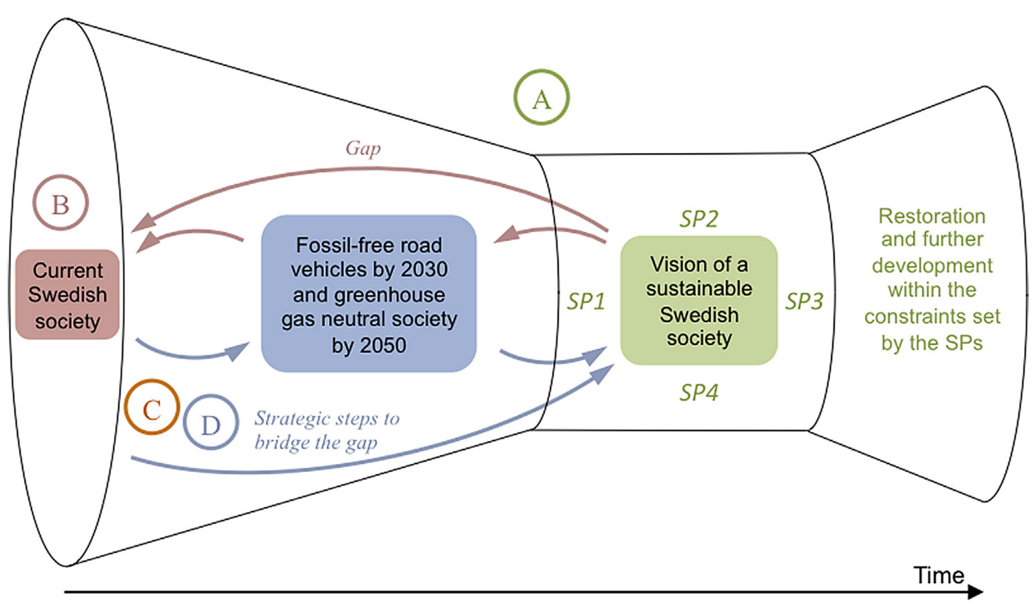

Fig. 1. An illustration of the ABCD procedure, with a vision of a sustainable Swedish society with a focus on transport. Developments are positioned metaphorically in a 'funnel', representing declining potentials of the social and ecological systems to sustain civilization. The wall of the funnel leans inwards until society complies with the sustainability principles (SPs) and thus no longer systematically degrades social and ecological systems. When the vision is arrived at, Sweden does not contribute to unsustainability on any scale, anywhere in the world.

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3. A new approach to sustainable transport planning

Our multi-stakeholder study was initiated in 2007 after the Swedish governmental agency, Vinnova, requested proposals for a pre-study for future transport solutions (Blinge and Eriksson, 2007). The request from Vinnova was to produce a sketch of a sustainable transport system vision. Accordingly, the Royal Institute of Technology in Stockholm and The Natural Step, a Swedish NGO, proposed a pre-study aimed at identifying guidelines and a method for cooperative planning and designs of sustainable traffic systems (Cars et al., 2008). A panel of researchers from different arenas - transport, energy, spatial planning, and ecology - gathered together for a few seminars to draw conclusions from the SPs of the FSSD in producing the asked-for sustainable traffic sketch as well as from 20 years of experiences gathered in community- and municipality-planning using the FSSD (James and Lahti, 2004; SEKOM, 2010; VANOC, 2010; Gal and Ouden den, 2014). The collected experiences from that previous work pointed to the importance of iterative learning loops engaging many stakeholder groups during planning, follow-up, and new decision-making. Furthermore, the efficacy of those learning loops is intimately linked to (i) the level of engagement at top-management levels, (ii) how well the FSSD framework had been understood as a shared mental model across the stakeholder groups, (iii) as well as to the existence of infrastructures and traditions for regular cross-sector and interdisciplinary ABCD meetings to make use of the shared understanding.

The above-mentioned ABCD process was used in those seminars, the first of which focused on natural sciences and systems thinking. This was followed by seminars where transport system stakeholders from business and politics were recruited into the process to reflect on the joint conclusions drawn from the panel of scientists. Again, the ABCD format was applied to scrutinize the economic and political feasibility of the scientists' proposals, and those reflections were relayed back to the scientists. Some of their previous conclusions were modified from the governance perspective, resulting in a new learning loop (Fig. 2). Based on this, five interlinked *transport subsystems* emerged and the authors of that study concluded them to be: ‘Resource base’, ‘Energy carriers’, ‘Motoring’, ‘Infrastructure’, and ‘Social system’ (Cars et al., 2008). Moreover, it was exemplified how a step-wise approach towards compliance with the SPs in each of those sub-systems should occur in parallel, so that solutions in one subsystem will not block necessary solutions in another.

In 2014, reflecting on the history of the original Vinnova project, the authors predesigned a similar process in the GreenCharge project. The seminars in the GreenCharge project discovered some incongruences and unintended overlaps of the subsystems from the Vinnova study. Furthermore, the authors observed that the identified subsystems were inappropriately and narrowly focused on transport as such. Terminology that is more generic would make the method more appropriate for transport planning from a full strategic sustainability perspective, decreasing the risk of solutions in the transport sector blocking sustainable development in other sectors, while possibly being applicable to any societal sector. Finally, the authors realized that the ideal terminology should strive to make the respective scientist groups, stakeholders, and responsible actors easy to identify. With this philosophy, the authors derived the interdependent *planning perspectives* (see Section 3.1.), assuring their respective views on how the above mentioned transport subsystems should be developed towards sustainability. The authors thereby take a whole system cross-disciplinary and cross-sector community perspective, as outlined below.

3.1. Exploration of essential planning perspectives

An important aspect of the ABCD planning process is to imagine the full implications of compliance with the SPs for all sectors before intermediate goals for the respective individual sectors can be established. This surfaced as a major concern early on during the GreenCharge seminars. It was perceived essential to realize that all areas and/or sectors, with their respective planning perspectives, must aim at becoming sustainable *together* within the constraints set by the SPs. A world to backcast from, one not violating the SPs, where natural resources are no longer overused, squandered, and turned to pollution (Wackernagel et al., 2006; Iyengar et al., 2014), was pictured. What are the challenging planning perspectives in this context? From the iterative seminars, four intuitive planning perspectives emerged. In particular, the second of those is highly

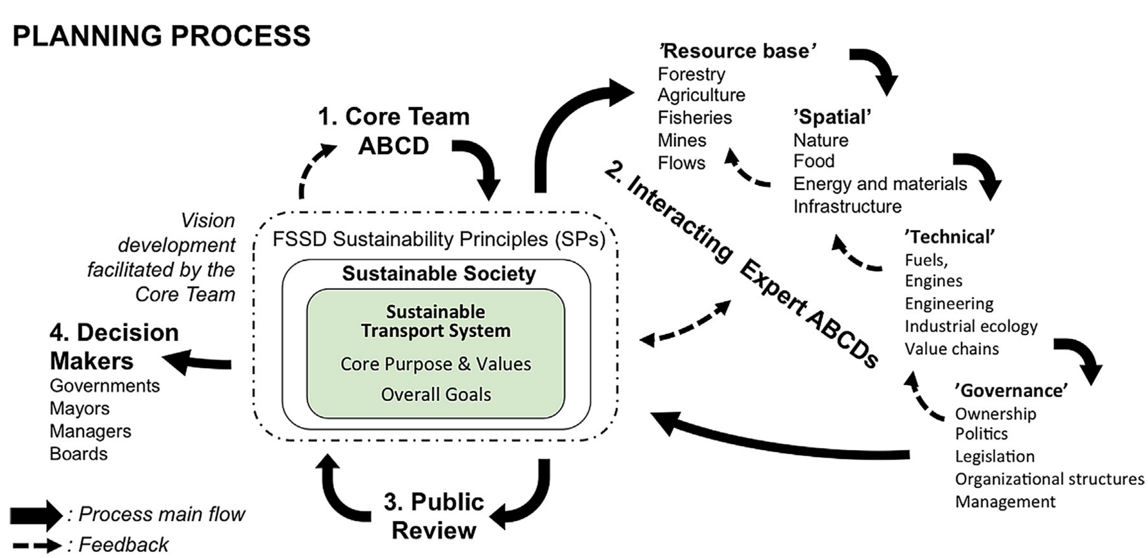

Fig. 2. An illustration of an iterative process for sustainable transport planning. Based on an overall societal vision, framed by basic sustainability principles, experts from relevant sectors draw conclusions, applying the ABCD planning procedure of the FSSD. The resulting ideas regarding challenges, opportunities, and plans of prioritized actions in each sector are compared with those from the other sectors. This leads to modeled and coordinated solutions from numerous meetings within and across sectors; big and small, formal and informal, planned as well as spontaneous meetings. Thus, the figure denotes the logic of sector-interdependencies to inform effective cooperation across disciplines and sectors, but it does not suggest to always organize big formal meetings.

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critical as society turns away from un-sustainable energy sources, and it is heavily influenced by choices made from the other three perspectives.

1. **The resource-base perspective.** Civilization relies on the sourcing of energy- and material-resources from the fundamental resource bases of agriculture, fisheries, forestry, mineral ores, and flows (e.g., waves and winds). Each of those must be planned to eventually comply with the SPs.
2. **The spatial perspective.** The purpose of this perspective is to make sure the fundamental resources are sustainable *together within spatial constraints.* Areal challenges will be more prominent in the future when the emptying of finite fossil fuel and uranium reserves for the sourcing of concentrated energy has ended. Sustainable energy is more area-requiring. Areas are needed for, for example, production of biofuels and capturing of energy from the sun, wind, waves, and hydro. It is also likely that sustainable food production requires larger total area than our current intense farming, the latter being enabled by cheap fossil fuels for machinery and for production of nitrogen fertilizers and by fertilization with phosphates, also from declining finite reserves. Such intense farming also often *erodes* essential areal functions, for example, soil fertility and biodiversity. Loss of fertile land, in turn, often leads to the encroaching on forests and other wilderness to create new agricultural land, which results in even more biodiversity loss and threatens the resilience and stability of the whole biosphere. The key question under the spatial perspective is, 'in a sustainable world, how should humanity utilize the available area cleverly to secure the necessary areal functions?' From the seminars, the below categories of areal functions emerged and stimulated creativity as they were modeled against one another, including discussions on how the same area could provide several categories of functions. First the categories are presented and then some essential modeling considerations are given.
   a. **Nature.** This category includes the areal functions that secure a long-term healthy biosphere, i.e., sufficient assimilation and purification capacity, climate regulation capacity and diversity, for a clean, stable, productive, and resilient biosphere. This category is labeled 'nature' because, also in the future, these functions will likely have to be provided to a significant degree by essentially uncultivated areas (wilderness).
   b. **Food.** This category includes the areal function of food production for humanity. The authors have introduced this as a separate category because, also in the future, food for humanity will likely have to be provided to a significant degree by specialized areas for agriculture and aquaculture and only to a smaller degree from wilderness.
   c. **Energy and materials.** This category includes the areal functions of primary energy and materials provision for societal purposes (besides food). Also in the future, these functions will likely have to be provided to some degree by specialized areas, although the authors see significant potentials for overlap with (b) and to a smaller degree with (a).
   d. **Infrastructure.** This category includes the areal functions of space for buildings, industries, roads, power grids, telecommunication equipment, and other infrastructure. These functions will likely have to be provided to some degree by specialized areas also in the future, although the authors see some potential for overlap with the other categories, primarily with (c).

First of all, it was concluded that a clean, stable, productive, and resilient biosphere is a prerequisite for any (higher) form of life on Earth. Thus, from the perspective of societal design, the following constraint applies:

(i) The area providing (a) functions cannot be below a certain critical limit.

It is imperative to understand that the integrity of the biosphere is the primary condition for everything else. Obvious as this may seem, it has so far been neglected to a great extent in societal design. This is not surprising. In the early days of civilization, global aspects needed not be taken into account. Today, however, basic biosphere functions should be a primary concern in societal design. Humanity has become a significant agent in the biosphere, in fact more significant than nature itself regarding many material flows (Azar et al., 1996), and the Earth system has already been pushed close to the above-mentioned critical limit (Rockström et al., 2009; Steffen et al., 2015). Thus, humanity is now threatening the whole biosphere with its life-sustaining functions, which obviously must come to a stop for any scenario of a future sustainable civilization to be possible. The basic cause of this degradation is society's violation of the ecological SPs of the FSSD, and the framework as a whole makes this biosphere perspective operational for any actor and redesign effort, regardless of scale (Broman and Robèrt, 2015, In this issue). Modern science has also helped us understand more in depth the impacts from violating these SPs and which impacts are most acute and thereby should be prioritized in planning and redesign (Robèrt et al., 2013; Steffen et al., 2015). Examples of activities that can directly ensure a safety margin are the protection of national and marine parks and other areas for wilderness and the application of the precautionary principle for all activities that risk degrading the capacity for (a) functions.

Furthermore, it was concluded that in a future sustainable society there is enough food (including potable water) for all people. Thus, also the following constraint applies:

(ii) The area providing (b) functions cannot be below a certain critical limit.

The area needed for food production is primarily dependent on the population size and diets. Examples of activities that can ensure a safety margin are restrictive policies for infrastructure on fertile land, a rapid shift to agricultural methods that do not cause degradation of the long-term food production capacity, and prioritization of food products with a high energy- and nutrient-content per area use and other resource input. The bottleneck for sustainable human nutrition and food production, that is, proteins and the recycling of phosphates, could be a starting point to estimate the necessary area (Ragnarsdottir et al., 2011; Sverdrup and Ragnarsdottir, 2011).

People also have other needs and desires. Again, humanity's ability to sustainably meet needs and desires depends greatly on how cleverly the available area is used. To support a population of 9–12 billion (United Nations, 2013) having a good standard of living, an optimal mix of area types for *all* categories need to be strived for, within the above-mentioned constraints. Infrastructure, for example, although it might at a first glance seem to always impede the other categories, can actually be an important enabler of sustainable area utilization. It does not only directly support fulfillment of certain human needs and desires, but can also support a higher total spatial efficiency if used cleverly. For example, an energy transmission infrastructure (d) that connects several energy systems might improve the overall energy efficiency and thus reduce the need for area for capturing primary energy (c), which would leave more area for categories (a) and/or (b). This might be true even if that infrastructure would occupy a piece of fertile land

and/or wilderness. On the total, there could still be more area for agriculture and/or wilderness than without that infrastructure, for the same human utility. IT-infrastructure is another obvious example, which can greatly facilitate a higher total system efficiency and with that a reduced need for areas both for (b) and (c) functions (as well as for other types of (d) functions). However, given the likely closeness to the critical limits, it is imperative that such analyzes are actually made and that it is ensured that the new infrastructure does not instead push the system even closer to the limits.

In the strive for an optimal mix of area types, also quality aspects need to be weighted in. For example, different regions have different suitability for different agricultural or forestry products. A certain degree of specialization, and a transport infrastructure allowing for exchange of products, can aid a higher total system efficiency and a lower need for agricultural or forestry land, for the same human utility. Moreover, all types of wilderness are not equally important for securing the (a) functions. In this context it might also be worthwhile to point out that human interference with the wilderness is not necessarily always bad. It can even improve some (a) functions, for example, biodiversity. Traditionally cultivated meadows and pastures in northern Europe are home to an extraordinary high biodiversity and are sometimes compared to tropical rainforests in this regard (Cousins and Lindborg, 2009).

Modeling the categories of areal functions in the seminars, an additional possibility for improved total system efficiency came up. It is obvious that if the same area could be used for several functions, the potential 'population-affluence-product' (i.e., the population number multiplied by the affluence per capita) could be higher than if that area could only be used for one function or one category of functions. For example, there could be some sustainable harvesting of resources from wilderness through limited hunting, fishing, and other harvesting for food, medicine, materials, and scientific purposes. Other examples of getting more functions from the same area are agro-forestry, rooftop agriculture, wetland production of edible algae and other aquaculture, photovoltaics on roofs and transport infrastructures, and windmills on cropland. However, without areas that are specialized for food production for humanity, only a relatively small population could be supported on Earth. The same is true if no areas were specialized for provision of primary energy, materials, and infrastructure for civilization. Also, although some types of cultivated areas may have a high biodiversity as exemplified above, many areas specialized for the (b), (c), and (d) functions are not performing that well for the (a) functions. This implies that there is probably a need to leave some areas essentially uncultivated to secure enough of the (a) functionality to avoid a collapse of the entire biosphere.

The technologies considered with the above mind-set indicate how large areas are needed, which brings us to the next planning perspective.

3. **The technical perspective.** The spatial planning perspective provides creative constraints for proactive engineering and innovation. Given the various resources and the functional priorities that need to be taken into account, what are the sustainable resource potentials of those systems? How could new types of technical systems be developed that tap into those potentials while respecting the above outlined spatial constraints? When backcasting from a sustainable world, it is obvious, among other things, that biofuels, even if they could be very helpful as an intermediate solution for the coming decades, represent a very small resource potential. Why harvest biomass for fuel purposes, when photosynthesis, the first step in energy conversion from sunlight, only captures 1–3% of the incoming solar energy as chemical energy? Thereafter follow further energy losses as biomass is harvested, fermented, refined, and transported. In comparison, photovoltaics on roofs and other unfertile areas, which do not need to compete for areal space with food production, convert more than 15% of the solar energy directly to electricity. This highlights the use of electricity as a promising 'fuel-system' for transport, inherently bypassing the need for area-consuming, big-scale production, refinement, and distribution of biofuels. This will be discussed further in Paper 2 of this tandem publication.
4. **The governance perspective.** Structures must be in place for governance and decision-making power to ensure that the other three planning perspectives are coordinated, communicated, monitored, and sufficiently sourced. Knowledge about leadership and decision processes is a field of expertise in itself. In this context, the governance planning perspective naturally is about ways to design adequate and effective processes to act on, and source, proposals that are derived from the other planning perspectives.

In this paper, the authors refer to those planning perspectives as 'transport planning perspectives', but our findings and discussion point to a more general applicability of those planning perspectives for any societal sector including energy, agriculture, forestry, water, and waste management. The SPs of the FSSD frame the future use of resources (resource-base perspective); which set the boundaries for what can be spatially planned (spatial perspective); which then determines what technical systems, products, and services can be designed and planned for (technical perspective); and which need to be prepared for assessment and valuation in governance and management systems by politicians and managers (governance perspective).

3.2. A new strategic iterative planning process including planning perspectives

Based on the experience from hundreds of multi-stakeholder seminars over two decades of implementing the FSSD in municipalities across the world, the initial Vinnova study, and the current GreenCharge project, the authors suggest a new strategic and iterative planning process (Fig. 2).

The first part of the new process is to (1) sketch a sustainable vision, which often happens by a self-selected Core Team. This team may, or may not, include decision makers upfront that can decide on the economic and other resources needed to commence and perform the planning process. If this is not the case upfront, they very well may become part of the process later on, if only the proactive forerunners, perhaps middle managers of the 'change agent' type, produce good and attractive enough preparatory work (Nattrass and Altomare, 2002). Furthermore, if these people do not themselves have FSSD-competence or time to drive and facilitate the process, such people should be recruited to the Core Team for this purpose. Thereafter, (2) people representing relevant specific disciplines and sectors are invited to have their say along the described planning perspectives, both individually and later on together in seminars. Strong decision-making power of leaders taking active part in the envisioning during (1) could increase the likelihood of effective multi-disciplinary cooperation in (2). During the modeling between experts, notes are compared under challenges (B), opportunities (C), and prioritizations (D) from the different planning perspectives to find opportunities for cross-sector and interdisciplinary cooperation and synergies. Thereby various proposals are scrutinized and prioritized from all perspectives. The experts can now provide a joint proposal of well-thought-out early steps (flexible and economic with regard to all planning perspectives) of a systematic approach towards a sustainable transport system within a sustainable society. The process also lends itself well to (3) consult the general public by inviting citizens to share their points of view, for example, through organized citizen dialogues, while continuously displaying planning progress. Finally, (4) decisions about the proposed plan, and necessary economic and other resources for its execution, are made by the involved decision makers in the region. There is an overall flow from (1) to (4) in the process. However, from years of experience, it is empirically clear that the essential elements of the model are plenty of small informal meetings, feedback, cross-routes, and sub-processes occurring during this main flow, all by people *who understand the logical flow from (1) to (4)* as illustrated in Fig. 2. Envisioning, creative learning, planning, budgeting, following-up, and improving occur in iterative learning loops between all engaged parties. The learning of systematic cross-sector development of this kind occurs during the process.

4. Discussion

Presented in tandem as two papers, this study aimed to identify an approach to sustainable transport planning at large, and then analyze the potential role of EVs in a sustainable society.

4.1. Key results

This study has resulted in a new strategic approach to sustainable transport planning based on the Framework for Strategic Sustainable Development (FSSD) and its operational ABCD process of backcasting from a vision framed by a principled definition of sustainability. The new approach is captured in a comprehensive planning process for multi-stakeholder co-learning and co-creation of sustainable transport systems. A key feature of the process is a set of four essential transport-planning perspectives: resource-base, spatial, technical, and governance. In the spatial perspective, the authors have shown how a sustainable future without fossil fuels relies on clever and strategic steps regarding spatial planning. The resource potential of functionally different areas in the biosphere, with subsequent differences regarding their respective capacities to meet various human needs, must be taken into account when new technologies and governance models are designed. The authors present an overall and guiding reasoning for the societal use and stewardship of different areal types and the functions they can provide.

4.2. Comparison with other studies

Other studies have been presented recently regarding planning for sustainable development with a focus on transport and reduction of CO_2 emissions. The investigation for how to reach a fossil-fuel-independent vehicle fleet by 2030 (FFF) (Johansson et al., 2013) focused on development towards a Swedish fossil-free vehicle fleet in the upcoming decades and included many ideas, actions, and incentives. However, will they be enough to deal with sustainability challenges in time? Based on our literature reviews and research to date, the authors claim that no road map has presented a credible pathway towards a future sustainable situation. More specifically, the authors have not found any proposal where: (i) the full scope of sustainability is aimed for, (ii) concrete multi-stakeholder processes are outlined for how to model and plan sectors to become sustainable *together*, and (iii) infrastructures and norms for cross-sector meetings are outlined for heavily occupied executives to find it sufficiently relevant and feasible to continue being actively engaged.

This study adds to the literature on methods for sustainable transport planning by incorporating a whole-systems community perspective that is enabled by identification of a helpful terminology and processes for cross-disciplinary and cross-sector learning and planning. Many components of systems planning, speaking to the relevance of backcasting from a principled definition of social and ecological sustainability, have been extensively explored in previous literature on the FSSD. In this study, we have synthesized those components into an elaborate process model and tested it for community building around the GreenCharge project. It has been designed in an action-research mode, delivering on the need to not only use the FSSD thinking-sector wise, but to develop and operate step-wise plans within and across sectors such that they can become *mutually* supportive and/or at least not blocking each other. The study has also clarified how the development towards a civilization complying with the SPs relies heavily on an understanding of how our areal uses and stewardships must be optimized for a sustainable vision.

4.3. Conclusions and further work

This study emphasized the complexity and interconnectedness of the various planning perspectives connected to transport. The new process model proved helpful by giving diverse stakeholders, with various competences and representing various sectors, a common, robust, and easy-to-understand goal and a way of working that was adequate for each of their contexts. The results and conclusions presented in this first paper of the tandem publication are exemplified further in the second paper, focusing specifically on a sustainable vision for EVs in southeast Sweden.

The authors think that it is a breakthrough to have demonstrated how the strategic approach to sustainable transport planning supported by the new process model has effectively attracted and served an iterative learning and planning process counting large numbers of heavily occupied experts and decision makers in high positions in Swedish society. To make this possible, the authors have made direct use of two essential elements of sustainable development and think it is fair to say that a combined existence of both is usually missing in the public discourse, as well as in leadership at most levels in society:

(i) First, a robust conceptual framework is needed, which aids clarification and structuring of the big picture of sustainability where all stakeholders can find their respective challenges and opportunities within the same, universal boundary conditions of sustainability. Such a framework should also contain logical hands-on guidelines for assessing challenges and opportunities and for prioritization of actions into economically feasible transition plans, all in relation to sustainable futures modeled within such boundary conditions (the ABCD process). Without such a framework, applied as a shared mental model for concrete multi-stakeholder cooperation, such large groups of competent experts tend to end up working inefficiently.

(ii) Second, infrastructures and norms for adequate co-creation across sectors and disciplines are needed. If knowledgeable people and informative publications on the above are in place, but no infrastructure or cooperative norms are, such strong frameworks are irrelevant for any other purpose than publishing scientific papers.

Both the above essential elements need to be in place. There is also a connection here. The authors believe that attempts to use various kinds of process instruments that solely help tackling the infrastructures and norms side, for example, tools to 'get the right experts and decision makers into the room', 'listening more effectively to one another' and 'communicating and administering progress', generally fail to keep people cooperative and operative for the long term. In the lack of robust definitions of long-term goals, the learning curves tend to become depressingly flat and outcomes too superficial to motivate heavily occupied people to remain engaged over the long term.

The authors would like to present a hypothesis for generalization beyond transport planning. The developed and presented approach has been centered on transport, but because this has been done using a whole-systems community perspective, the authors see no reason why this approach could not be used with some other societal sector or aspect as the focus. Consequently, the combined theoretical and empirical approach, in fact, presents a generic strategic approach to sustainable community planning. Although based on a logical theoretical conclusion, as well as on some experience with parts of the planning process in other contexts, this cannot be claimed with full confidence until the hypothesis has been fully tested and validated. This is precisely what will be done in a recently started PhD project at Blekinge Institute of Technology. In that PhD project, a group of Swedish municipalities and regions and the county of Åland in Finland (the latter is an example of substate governance through territorial autonomy, a 'country-model') are going to serve as a testing ground for the planning process. The authors expect to refine the process model further through that project, study obstacles for implementation and how to overcome such, and equip the model with relevant indicators for support and monitoring of systematic cross-sector progress in communities.

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