

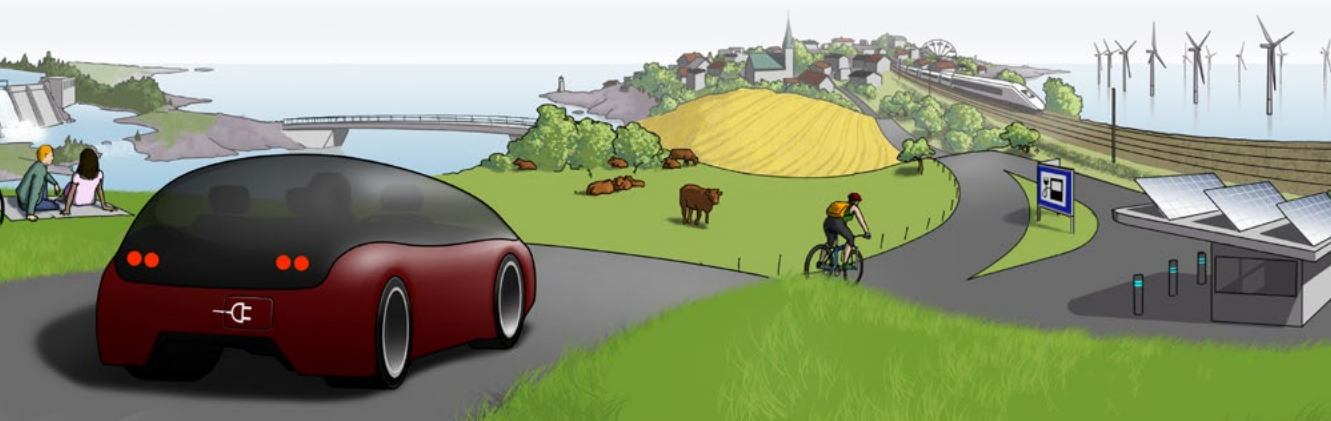
ON TRACK FOR 2030

ROADMAP FOR A FAST TRANSITION
TO **SUSTAINABLE** PERSONAL TRANSPORT

ENGLISH SHORT VERSION
with foreword by Peter Newman



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Foreword by Peter Newman

How fast can our personal transport system go electric and zero carbon?

This is an important question as the warming of the planet is now happening and we need to create new transport and power systems that are solving this whilst solving other problems such as the geopolitics of oil.

Power systems have been changing quicker than transport but both are now well underway. Most of the EU are firmly decoupling economic growth from fossil fuel consumption so we can see the future emerging in a way that does not damage our economies. Indeed it is clear now that the new technologies for renewables, batteries and electric vehicles (both cars and transit) are going to be the basis for the new economy and the countries and cities who start using them first will benefit most in terms of new jobs and associated economic activity.

But, can we make the transition to electric vehicles quickly enough to make the 1.5 degree goal from Paris? This report shows some of the complex modelling and suggests it is possible for South East Sweden but it will be a stretch. The report is worthy of detailed consideration as government commitments and demonstration projects need to be turning up their intensity to achieve the goals.

Another related project I have been working on is a fabulous invention from China - the Trackless Tram - which lends itself to application in cities where fast electric transit is needed to unlock development of urban centres¹. Such integrated solutions can be achieved with minimal government funding and hence can accelerate delivery across the city. These are the types of solution also being pursued in this new study.

I recommend it to you.

Perth, Australia, September 2018

Peter Newman

Professor at Curtin University, Australia and IPCC Lead Author.

About this report. This is the English short version of the report 'Vägval 2030. Färdplan för snabbomställning till HÅLLBARA persontransporter'. The report is written by researchers from Blekinge Institute of Technology (BTH) based on a close cooperation with partners from the first phase of the GreenCharge project (2011-2015). See the report backside for a list of the project partners in Spring 2015. This report and a complete version (in Swedish) are available at www.bth.se/sustaintrans.

Cover Illustration by Stefan Borell

1. For more on the Trackless Tram: <https://vimeo.com/278969345> (accessed 2018-09-24).

Summary

The transport sector's dependence on fossil fuels is one of the biggest challenges in a shift towards a climate-neutral and sustainable society.

This roadmap report aims to investigate how electric vehicle systems can contribute to a faster transition to sustainable passenger transport in Southeast Sweden, as well as to present a methodology for guidance of similar work for faster transitions in other regions and sectors.

This work has been guided by a scientifically designed and proven Framework for Strategic Sustainable Development (FSSD). Specifically, answers are given to four research questions structured in relation to the four subsystems 'Politics and instruments', 'Users and markets', 'Vehicles and infrastructure' and 'Energy and materials':

1. What could a sustainable vision for passenger transport in Southeast Sweden look like?
2. What could be a milestone goal for 2030?
3. What is the current reality in relation to the 2030 goal and the vision?
4. How could the gap between the present, 2030 and the vision be bridged?

The report's results show that **today's focus on fossil independence and measures against climate change must be broadened to cover the whole sustainability challenge** so that other sustainability issues are addressed and so that solutions to some of the sustainability issues do not create new ones.

The report also clarifies that **it is necessary, practically possible and economically advantageous for Southeast Sweden to make a faster sustainability transition of passenger transport** than what has been proposed in previous studies and investigations. It is also likely that the same applies to the entire transport system and for the whole of Sweden and the world.

Even geopolitical benefits are likely. **A global transition to transport and energy systems based on energy from widely available flow resources like sun and wind instead of the limited fossil fuels would likely reduce the conflicts risks in the world.** Restricted cobalt, lithium and platinum resources that battery and fuel cell cars depend on, and other metals needed for solar cells and wind turbines can, however, give rise to similar conflict risks. This roadmap report's recommendations on reduced transport needs and car dependency and its focus on resource efficiency counteract these conflict risks by striking against underlying resource-driving mechanisms. Should this roadmap be translated into practical policies, the forthcoming transition would therefore likely be made considerably more 'future-proof'.

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Background, Purpose and Research Questions

What if there could be a practical way to make good choices when large societal systems are to transition to fossil freedom and sustainability? And, what if there was a methodology that could facilitate strategic and coordinated cooperation between the many actors and stakeholders needed to implement such a change? This roadmap report tells about how such a methodology was adapted for transportation and tested for the first time on a regional scale in Southeast Sweden.

The transport sector's strong dependence on fossil fuels is often highlighted as one of the biggest challenges in a transition towards a climate-neutral and sustainable society. In line with this, the Swedish government has set a target for fossil-independent transport by the year 2030. Several research and demonstration efforts have been made for this purpose. One of these was the GreenCharge electric vehicle initiative that used collaboration and knowledge-building to develop decision support for municipalities, other public actors and private companies. During the first phase (2011-2015), led by Blekinge Institute of Technology, 25 municipalities, four regions and counties, four county administrative boards and many companies in Southeast Sweden were involved in GreenCharge.

An early hypothesis in this work was that 'road passenger vehicles', as well as 'carbon dioxide emissions', imply too tight perspectives - also to make an adequate sustainability assessment of passenger transport vehicles that were in focus in GreenCharge. Instead, the chosen starting point was to aim for a society that is in its entirety sustainable. That is to say, all the areas and sectors that are important for the prosperity of civilization must be considered and developed together for overall sustainability. Apart from the transport sector this includes industry, energy, agriculture, physical planning, and social systems. What conclusions would such an approach lead to in the transport sector at large and how would electric passenger transport fit into such a context? This was the general foundation behind the roadmap and its more specific purpose was to investigate **how and under what conditions electric vehicle systems could contribute to a fast transition to sustainable passenger transport in Southeast Sweden**. This purpose was translated into four research questions:

- (1) What could a sustainable vision for passenger transport in Southeast Sweden look like?
- (2) What could be a milestone goal for 2030?
- (3) What is the current reality in relation to the 2030 goal and the vision?
- (4) How could the gaps between the present, 2030 and the vision be bridged?

Method

In response to the purpose and research questions, the GreenCharge research has been based on a Strategic Sustainable Development Methodology (FSSD).²

2. For more about the FSSD and its development, see Broman G.I. and Robert K.-H. 2017. A framework for strategic sustainable development. *Journal of Cleaner Production*, 140: 17-31.

Results

An Updated Sustainability Methodology for the Big Picture

An improved methodology was developed for how different stakeholders, representing different disciplines, sectors and perspectives, can cooperate towards sustainability through repeated use of the FSSD. Based on previous experiences, an in-depth working method was also provided for how the ABCD procedure of the FSSD can be supported by business modeling, sustainability evaluation and simulation. These are important part results from GreenCharge.

Answer to Question 1 – A Vision for Sustainable Personal Transport

A preliminary vision for sustainable passenger transport was developed. The vision is framed by the FSSD's sustainability principles and it is described through four important subsystems related to passenger transport (see Figures 2 and 3):



Figure 2. What a sustainable personal transport system could like. (illustration: Stefan Borell)

- **Politics and instruments.** Politicians reduce the need for transport and co-plan the transport sector with other sectors of society and with other land use to not violate the FSSD's above-mentioned basic sustainability principles.
- **Users and markets.** Users have biking/walking as first choice where possible and functional, with public transport and car services as a complement. Where biking/walking are not reasonable, public transport and car services are first choice. Own car is used where the alternatives are not functional, for example, in sparsely populated areas without public transport.
- **Vehicles and infrastructure.** Electric vehicle systems dominate. The electricity is supplied through batteries and/or fuel cells and/or electric roads.
- **Energy and materials.** The primary energy for the generation of electricity and fuels is renewable and sustainable (dominated by solar, wind, hydro and wave power) and material management takes place within the frame set by the sustainability principles.

Answer to Question 2 – Milestone Goal for 2030

By the year 2030, the following should have occurred in the four subsystems:

- **Politics and instruments.** The Swedish government's goal of a fossil-independent (70-80% fossil-free) transport fleet by the year 2030 may be compatible with the Paris agreement, but since recent evidence suggests that

more might be required to achieve the agreement's goals⁵ and since it is likely required to become a frontrunner internationally, Sweden's passenger transport should rather become completely fossil free by 2030. At the same time there are several other challenges of passenger transport (e.g. oil dependence at a time when oil will soon be in shortage, surface use, health effects and associated societal costs). To address these challenges, it would probably be a requirement for the introduction of powerful instruments by 2030. This could reduce transport, automobile and fossil dependence as well as capture greenhouse gases from the atmosphere.

- **The users and the market** have reduced their focus on their own car and rather favor public transport, car services as well as biking/walking.
- **Vehicles and infrastructure.** The fleet of vehicles consists of a mix of electric vehicles, biofuel-driven combustion engine vehicles and hybrids, and there is infrastructure supporting this.
- **Energy and materials.** Fossil primary energy in the form of oil and natural gas has been largely replaced by waste and biomass fuels as well as electricity from solar, wind and hydro. Taxes from the transport sector have to a certain extent been invested in new fossil-free primary energy and the use of materials is in higher proportion renewable and from well-maintained ecosystems. Metal recovery has increased, and the focus is on using metals that pose a low risk of causing systematic concentration to increase in nature.

Answer to Question 3 – Current Reality in Relation to 2030 and the Vision

A struggle between **politics and instruments** for and against fossil independence and sustainability leads to slower progress than is appropriate in view of the sustainability challenges of the passenger transport sector. This means that:

- **Transport-efficient community planning is counteracted by transport-intensive community planning.** An example is that primarily central parts of cities are planned for transport efficiency by short distances between housing, jobs, trade and service (densification and functional mix) while at the same time the car-transporting-intensive shopping areas in the city outskirts are allowed to grow and multiply.
- **Instruments for reduced car dependence are counteracted by instruments that increase car dependency.** An example is that both car use and public transport are subsidized. In addition, support for the transfer of traffic from private cars to car services and biking/walking is almost non-existent.
- **Instruments for reducing fossil dependence in the car fleet are counteracted by instruments that increase fossil dependency.** An example is that taxes on gasoline and diesel are combined with unpredictable increases and reductions in taxes on biofuels.

5. See, for example, evidence of a warming Arctic in the Arctic Report Card from Dec 2017 of the US National Oceanic and Atmospheric Administration. (<http://www.arctic.noaa.gov/Report-Card/Report-Card-2017>) (accessed 2018-02-20) and IPCC. 2018. Global Warming of 1,5 °C. An IPCC special report accepted by the 48th Session of the IPCC, Incheon, Republic of Korea, 6 October 2018.

Examples of sustainability challenges that arise from the lack of consistent political governance is that

- **users and the market** are dominated by private cars and needs for associated large-scale infrastructure that physically obstruct natural surfaces more and more (compare to the FSSD's SP3 above);
- **vehicles and infrastructure** are mainly dependent on fossil **energy** and non-sustainable **materials** that lead to increasing concentrations of carbon dioxide and other substances in nature (SP1 and SP2), and, deteriorating ability for people to meet their needs (HP4). The latter could happen through large distances to trade and service that restrict access for persons without their own car, through adverse health effects of emissions and traffic accidents, through inefficient material handling with a risk of shortage and through increasing societal costs that the above-mentioned sustainability challenges all cause.

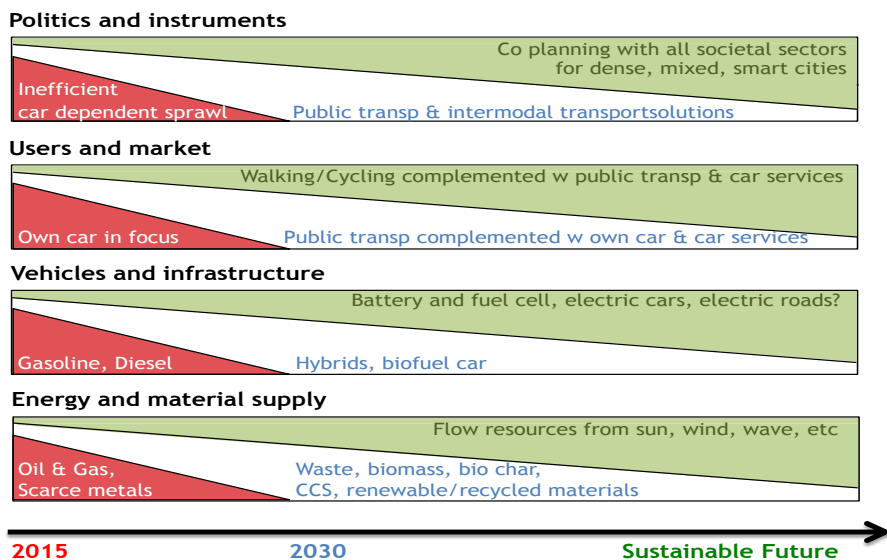


Figure 3. The road to a fossil-free and sustainable personal transport system. How the four identified subsystems can be developed to phase out fossil fuels by 2030 and pave the way for sustainability.

Answer to Question 4 – Bridging the Gaps between Current Reality, 2030 and the Vision

There is a need for powerful **politics and instruments** to reach the 2030 goal and vision. These include subsidies of various types that could be financed through a development into a sustainable transport system which is expected to provide savings of several billion SEK per year for Southeast Sweden alone. Subsidies can also be funded by taxes and fees, and there are indications that a good changing force could be achieved with a bonus malus scheme (i.e. support (bonus) for desirable phenomena and charges (malus) for less desirable or undesirable phenomena). Such a politics and instrument package can be made cost-neutral for the state. Organizations, regions and countries that take the lead in a shift to

sustainable transport systems also build up experience and skills that will be in demand increasingly, as sustainable transport systems need to evolve all over the world. Such experience and expertise thus give competitive advantages. From an overview perspective a politics and instrument package should include:

1. **Transport-efficient societal planning.** This includes building denser cities where housing, commerce and societal services are mixed in a way that reduces transport needs.
2. **Reduced car dependency.** This includes bonus malus instruments for transport services that favor transfer of some traffic from private cars to car services, public transport and biking/walking.
3. **Reduced fossil dependence in the car fleet and in its manufacturing processes.** This includes (1) a bonus malus instrument for new car purchases that favors renewable powered and rechargeable cars over fossil-fueled cars, other instruments for (2) conversion of fossil-fueled cars to renewable powered vehicles; (3) early phase out of old fossil-fueled cars; and (4) efficiency in the manufacturing processes and, (5) research and development of new technologies critical to the vehicle fleet's sustainability transition.
4. **Compensation for the remaining greenhouse gas emissions.** This includes research and development focused on, for example, biochar and other carbon capture and storage technologies (CCS), which may be needed later. However, it is important that this is not used as a means of delaying the phase-out of fossil fuels. Planning for safety margins in this regard may later prove to be decisive.

In order to achieve fossil-free Swedish passenger transport in time to 2030, the proposed politics and instrument package must have a strong impact on the other subsystems. For **users and markets**, however, it should be mentioned that, in addition to instruments and regional, national and international agreements, which develop relatively slowly due to the political complexity, knowledge sharing is also important. This would show market players the self-benefit of being proactive in the face of the necessary paradigm shift and how they can act effectively in line with this.⁶ At the same time, this study shows that **vehicles and infrastructure** in the short-term (5-10 years) probably would benefit more from new electric fast-charging infrastructure than from new highways, and that upgrading of existing railways would be preferable to new high-speed railways. At the same time, for **energy and materials**, new wind and solar energy would be preferable to new nuclear power as electricity sources.⁷

6. Robèrt, K.-H., Broman, G. 2017. Prisoners' dilemma misleads business and policy-making. *Journal of Cleaner Production*, 140: 10-16.

7. New nuclear power takes a long time to build, requires large investments and gives high electricity prices. Today's nuclear power is also associated with security and waste risks that many governments are not prepared to accept. Fourth-generation nuclear power is expected to be mature for use on a large scale in 20 to 30 years. This must also be assessed against flow energy (solar, wind, etc) with free fuel and installation costs that with current trends will be near zero in 30 years.

Discussion and Societal Consequences

At the detailed level, there are many possible visions of a future sustainable transport system and there are many possible ways of developing such a transport system. It is, thus, possible to change certain actions in the here proposed roadmap. However, if changes are attempted they need to be done from a strategic sustainability perspective, in sync with other measures, so that the new plan as a whole can still lead all the way to a sustainable transport system. However, the presented roadmap needs, as all strategic plans, to be continuously monitored, evaluated and adjusted, if necessary, to meet unexpected outcomes and new conditions in the outside world. A bigger evaluation of how well the politics and instruments manage to reduce the sustainability problems of passenger transport and accelerate the transition is therefore proposed to take place every five years.

The report has confirmed that **today's focus on fossil independence and climate measures must be broadened to cover the whole sustainability challenge** so that other sustainability issues are addressed and so that solutions to some sustainability issues do not create new ones. This means, for example, that bio-based vehicle fuels should be seen as a transitional solution until community planning, car rental services, public transport and bicycle systems have reduced car demand so that it can be met mainly with the more efficient electric engine systems at a scale that is within long-term constraints for metals⁸, biomass⁹ and other important resources.

The report also clarifies that **it is necessary, possible and economically advantageous for Southeast Sweden to make a faster sustainability transition of passenger transport** than what has been proposed in previous studies and investigations. This is supported by that such a development would likely create more jobs than it replaces in the old 'fossil' systems.¹⁰ A new more efficient and 'smart' transport system, supported by distributed renewable energy, will likely emerge, both in Sweden and in the rest of the world.¹¹

Also, geopolitical benefits are likely. The transport sector today is highly dependent on fossil oil that is associated with several of today's political and military conflicts,

8. See, for example, Kushnir D., Sandén, B. 2012. The time dimension and lithium resource constraints for electric vehicles. *Resources Policy*, 37: 93-103. and Sverdrup, H. U., Ragnarsdottir, K. V., Koca, D. 2017. An assessment of global metal supply sustainability: Global recoverable reserves, mining rates, stocks-in-use, recycling rates, reserve sizes and time to production peak leading to subsequent metal scarcity. *Journal of Cleaner Production*, 140: 359-372.

9. Plants are inefficient in transforming sunlight into chemical energy. The transformation to liquid or gaseous fuels is also inefficient with current technologies. The fuels also need to be distributed and finally burnt with a low efficiency in combustion engine vehicles. If the whole chain of events from energy source to movement in the wheels are included, sun energy-based electricity is therefore many times more efficient, distributed through the grid and used in electric vehicles.

10. See, for example, Blyth, W., et al. 2014. *Low carbon jobs: The evidence for net job creation from policy support for energy efficiency and renewable energy*. UK Energy Research Centre (UKERC).

11. See, for example, Rifkin, J. 2015. *The Zero marginal cost society: The internet of things, the collaborative commons and the eclipse of capitalism*. New York: Palgrave Macmillan.

which in many cases drive extensive refugee flows. **A global transition to transport and energy systems based on energy from freely available flow resources like sun and wind instead of fossil fuels would therefore likely reduce the conflicts risks in the world.** Restricted assets of lithium and platinum as battery and fuel cell cars depend on, and other metals needed for solar cells and wind turbines can, however, give rise to corresponding conflict issues. This roadmap report's recommendations on reduced transport needs and car dependency and its focus on resource efficiency counteract this by striking against underlying resource-driving mechanisms. Should this roadmap be translated into practical policies, the forthcoming transition would therefore likely be made considerably more 'future-proof'.

Recommendations for Coming Studies

Here are examples of several important areas for follow-up work and further investigations:

- Continue work on clarifying the prerequisites for **effective cooperation across sectoral and disciplinary boundaries**, where people use overarching methodologies for systematic cooperation in a sustainable direction.
- Continue to **break down the vision presented into more specific goals** for states, regions, municipalities, companies and individuals.
- Continue to **strengthen the identified overall measures to reach the vision** (i.e. transport-efficient community planning, reduced car dependence, reduced fossil dependence in the car fleet and in its manufacturing processes, compensation for remaining greenhouse gas emissions).
- Continue to **develop the FSSD and its repeated use** through new case studies in the transport sector (e.g. freight and other modes of transport such as air and sea) and other sectors (e.g. energy, agriculture and forestry).
- Continue to **integrate the transport and energy transition with a shift to sustainable smart cities**.
- Continue **research and development of technologies and solutions identified as being particularly important for the desired sustainability transition** (e.g. lithium-efficient batteries and platinum-efficient fuel cells, efficient lithium battery recovery, extraction of lithium from sea water, and carbon dioxide capture via biochar and CCS).
- Realize a broader perspective even in future work in other contexts, supported by **new cross-sectoral fora**, where basic principles of sustainability can be used by participants to support the modeling of cross-sectoral visions.

About the Appendices

A more detailed roadmap for Southeast Sweden is given in Appendix 1 and its likely consequences for passenger transport work, car fleet and sustainability challenges are presented in Appendix 2. Appendix 3 provides support for transition work on the municipal level focusing on the period until 2030.

Appendix 1 Roadmap 2030 Southeast Sweden

Here, the different parts of the roadmap are explained and justified (see Figure 4 for the timeline).

1. Transport-efficient societal planning and investments

1.1 Transport-efficient municipal planning. This includes densification, mixing functions in the built environment, etc. To change the focus within the built environment is a relatively slow process, which only partially can go through until 2030. This means that it becomes all the more important to get started quickly. It is not estimated to be more expensive to change the planning in this way.

From a societal point of view, it can even be cheaper because less roads are needed in a denser city.

1.2 Short-term infrastructure investment. This includes charging infrastructure for electric vehicles, public transport, bicycle roads, etc. Given that infrastructure for bicycles and buses is much cheaper than car-focused infrastructure, most of these investments are estimated to be possible through reallocation of funds from already planned road projects.

1.3 R&D and investment support for long-term infrastructure. This includes electric roads, speed trains, hyperloop, etc. These are more costly than the short-term infrastructure investments and cannot fully penetrate until 2030 when most of the emission reductions should have taken place. These long-term investments are therefore pushed forward so that faster road transport measures first can reduce emissions and social costs. In this way there will be a lesser need for track expansion.

2. Reduce car dependency

2.1 Bonus-malus - transport services. The bonus side supports car services (car pools, ride sharing, car rental, self-driving electric car taxi), public transport, biking and intermodal solutions. The malus side collects money from private cars (congestion taxes, parking fees, fuel taxes, mileage taxes, etc.). Based on the experience from Norway, the bonus side options should be at least 10-20 percent cheaper to give a change in behavior. At the five-year evaluations, bonus and malus levels can be adjusted based on experiences. This is expected to be cost-neutral for states, regions and municipalities if implemented in a synchronized way at each level. However, some extra weight on the Malus side may be justified to give more space to supporting other efforts in this roadmap.

3. Reduce fossil dependence in the car fleet and its supply chain processes

3.1 Bonus-malus - new car sales. This includes bonus for rechargeable and renewably powered vehicles and malus for fossil-fuel-driven vehicles. Again, the total cost difference should be at least 10-20 percent for behavioral change. This is expected to be cost neutral to the state or, if the malus side is given more weight, could help finance other support efforts in this roadmap.

3.2 Support for conversion from fossil-fuel-driven to renewable powered and rechargeable cars. Public support should be provided for rapid development and dissemination of conversion services.

3.3. Support for early disposal of fossil-fuel-driven cars. Public support should be given to speed up the phase-out of fossil-fuel-driven cars.

3.4 R&D and investment support for more efficient manufacturing. Public support should be given to speed up the efficiency of the entire production chain of the cars.

3.5 Support for R&D for strategically important technologies for the car fleet's sustainability transition. These include metal-efficient batteries and fuel cells, lithium recovery, lithium from sea water, electric roads, etc. Most of these technologies will take a long time to develop and will get through only after 2030. They are therefore counted as a further step toward full sustainability after fossil independence has been achieved. They should be scaled up only after a number of years when other more acute efforts are started.

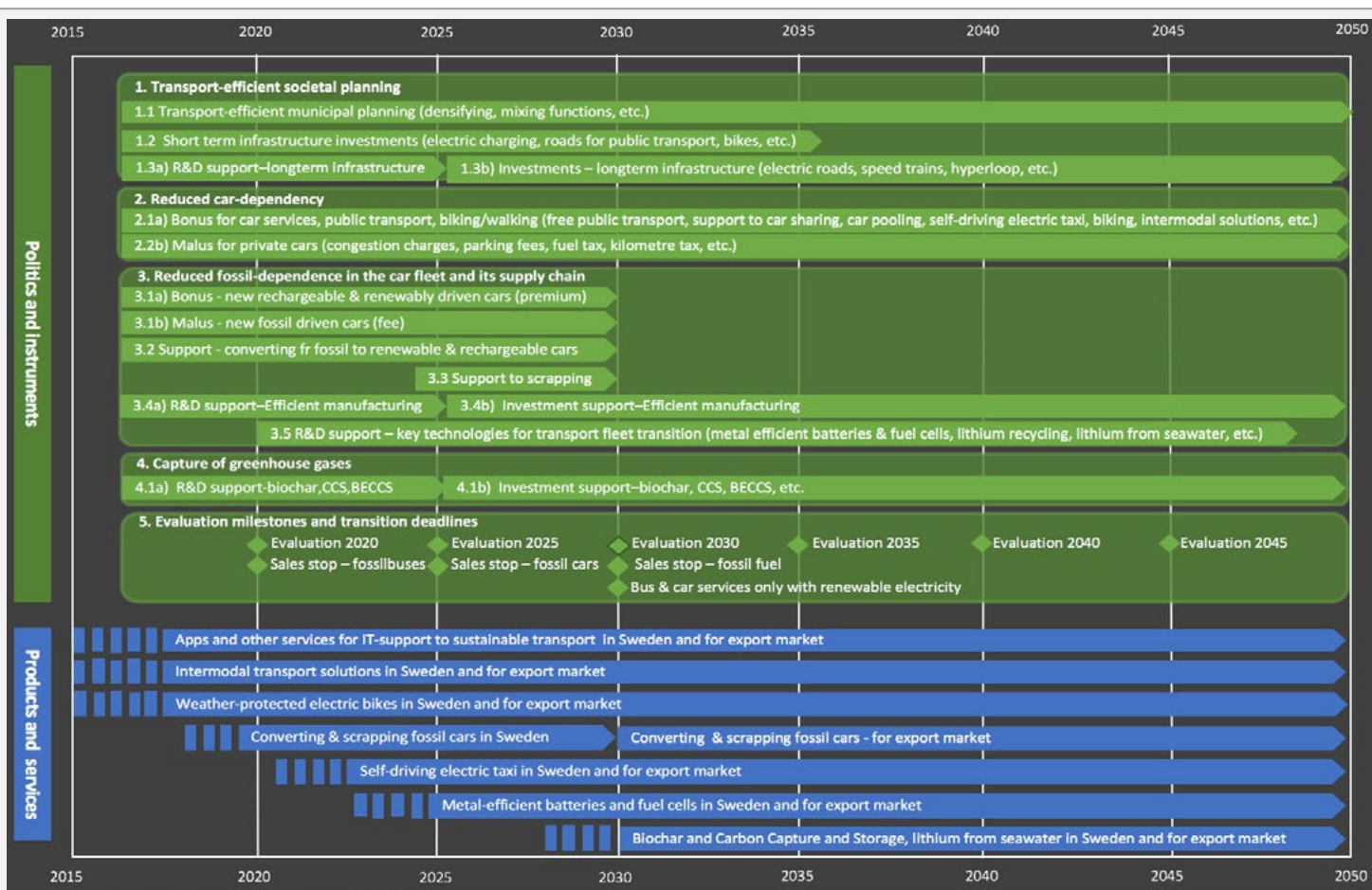
4. Greenhouse gas capture

4.1 R&D and investment support for biochar, CCS, BECCS and other technologies that, in the future, as a final measure, can reduce greenhouse gas levels.

5. Evaluation milestones and transition deadlines

Every five years, politics and instrument package impacts are evaluated, and any adjustments made. The sale of fossil-fuel buses is proposed to end by 2020, fossil cars by 2025 and fossil fuels by 2030.

Figure 4. Green Charge Roadmap for Southeast Sweden. Politics and Instruments and products and services.



Appendix 2. Consequences of the Roadmap

The roadmap politics and instrument package were implemented in a computer model for the simulation of the development 2015-2050. The simulations results indicate that the total transport work increased while private car transport decreased at the expense of car services, public transport (bus) and biking/walking (figure 5, top), that the car fleet at large was significantly decreased and fossil-fuel-driven cars (Fossil Cars) were replaced by biofuel-driven (BioFuel Cars) and rechargeable cars (Electric Cars) until 2030 (figure 5, middle). The biofuel-driven cars consisted initially, to a large degree, of converted fossil-fuel-driven cars (Conv. BioFuel and Conv. Plug-in cars) (figure 5, bottom)

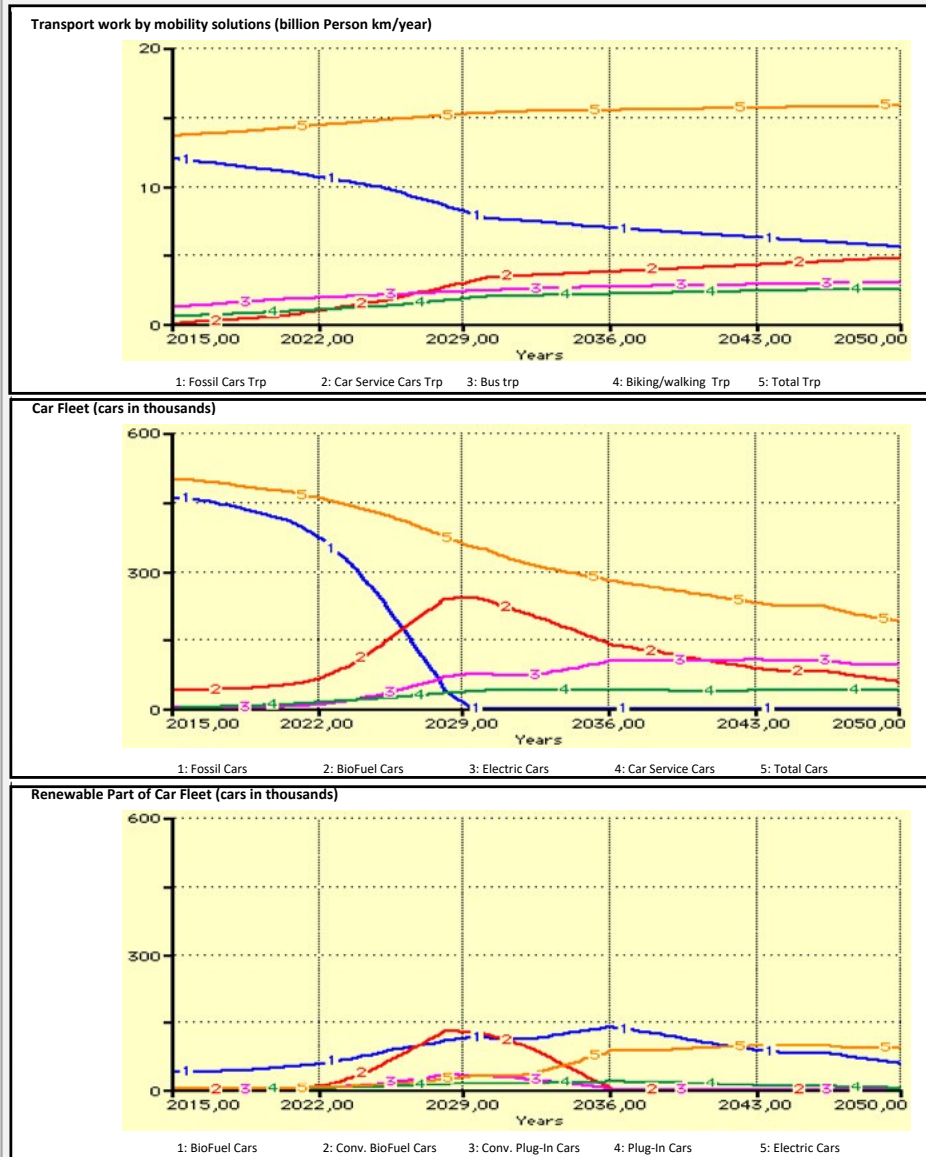


Figure 5. Likely consequences of the roadmap for the transport work (top), the car fleet at large (middle) and the renewable and rechargeable part of the car fleet (bottom).

The effects coming out of the simulations for the first three sustainability indicators can be summarized by the carbon dioxide emissions (figure 6, top), particles emissions (figure 6, middle) and surface use (figure 6, bottom) being all significantly reduced until 2030 and continuing to decrease thereafter, but at a slower pace (observe that 'Cars' here refers to the whole car fleet).

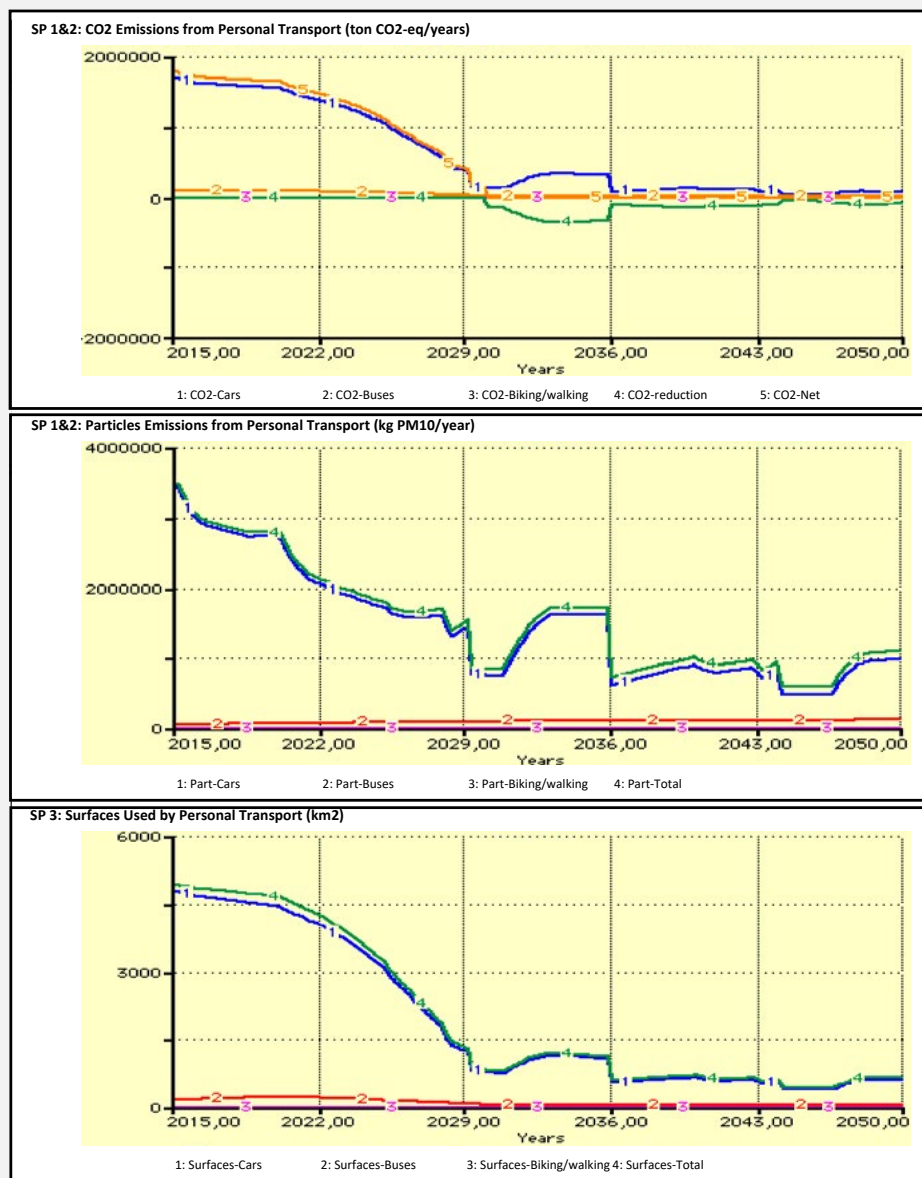


Figure 6. Likely consequences of the roadmap for the sustainability indicators carbon dioxide equivalents emissions (top), particles emissions (middle) and surface use (bottom).

The effects coming out of the simulations for the last two sustainability indicators (Figure 7) can be summarized by killed and severely injured dropping, mainly due to reduced emission-related injuries (Figure 6), and total societal costs more than halving (Figure 7, bottom). The latter could happen, much thanks to the fact that carbon dioxide costs decreased even more, despite the loss of revenues from fossil-fuel taxes (observe that 'Cars' here refers to the whole car fleet).

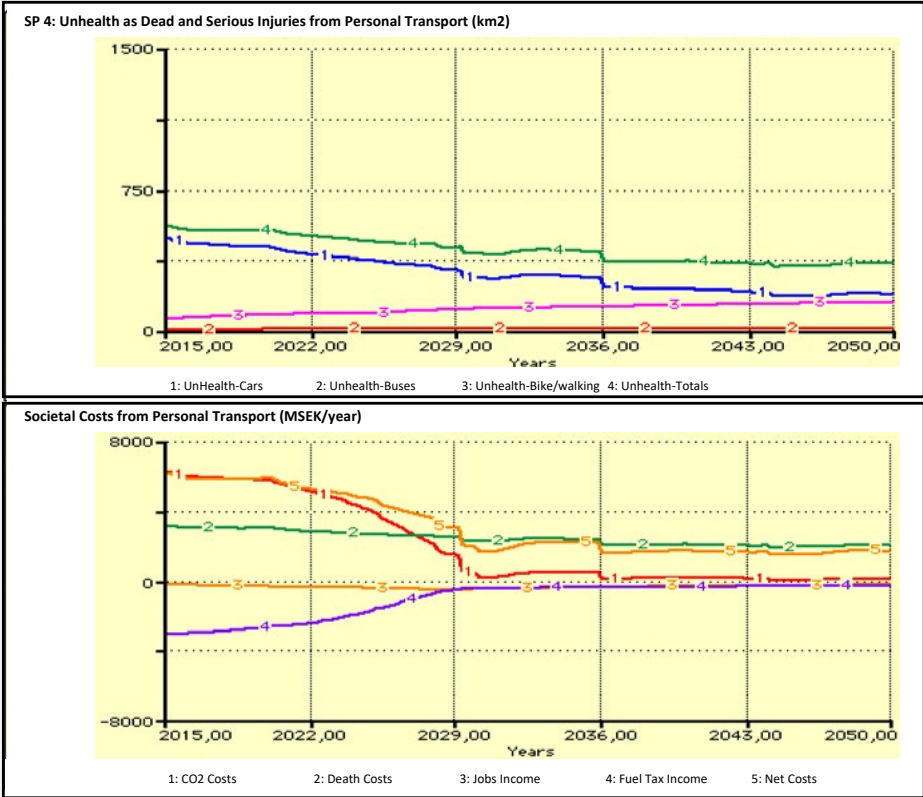


Figure 7. Likely consequences of the roadmap for the sustainability indicators killed and seriously injured (top) and societal costs (bottom).

Appendix 3. Support to Municipalities to 2030

1. Overarching work process for the transition

To keep up with the long-term restructuring work in the municipalities, an overall cooperation model for multi-stakeholder planning is recommended (Figure 8): This process is suitably facilitated by an external method expert and is performed in four steps, which are repeated over time:

- 1. The core team's ABCD.** Method experts drive and coordinate the vision building. The process begins with an overall ABCD study and presents a preliminary sustainable vision that other stakeholders can assume, criticize and continue to develop.
- 2. ABCD's by stakeholders and expert groups.** The preliminary vision is the basis for refining ABCD studies and informal dialogues within and between other relevant stakeholders and expert groups in appropriate disciplines such as resource base management, physical surface planning, technology choice and societal and organizational management.
- 3. Dialogue with the public.** The core team matches and refines visions (A), current reality (B), future solutions (C) and pathway selection (D) to the public.
- 4. Decision-making.** The basis for the decisions is compiled by the core team and goes to decision makers in the public and private sectors for the development and establishment of coordinated roadmaps for sustainability transition of the transport systems.

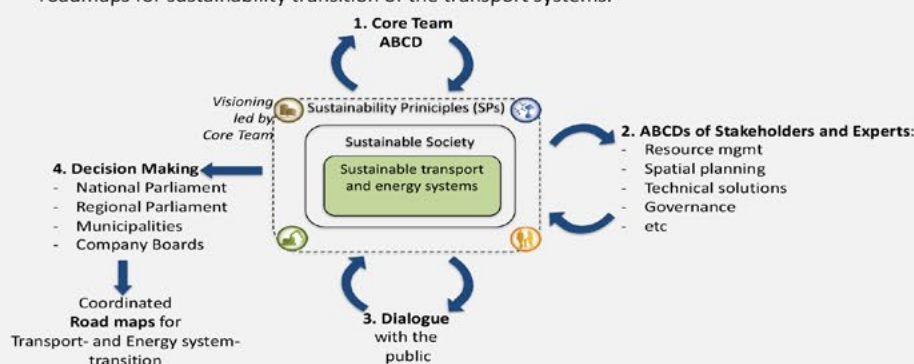


Figure 8. Multi-stakeholder planning for sustainability transition with the FSSD. How the FSSD can be used as a common mental model where the core team's vision of a sustainable transport system within the framework of sustainability principles (1) is refined by stakeholders and experts (2) and the public (3) and paves the way for well-established decisions (4) for coordinated roadmaps for sustainable transport systems.

2. Suggested measures for the municipal level

As shown in Appendix 1, the sustainability transition in municipalities is dependent on the fact that many strategically important decisions are taken at national level. However, a number of measures are possible to decide upon for municipalities, additional measures can be prepared in anticipation of likely national decisions, and municipalities can also press for such decisions. The idea is that the municipalities will apply the roadmap report in their own contexts and according to their conditions. For guidance, examples of concrete measures that the municipalities can implement until 2030 are presented below.

General measures:

- **Coordination and collaboration on goals and planning.** Use the above process to set goals, plan for sustainable transport while involving the inhabitants.
- **Information and education.** Provide education for municipal staff and municipal residents on sustainable transport and inform systematically about the municipality's transition plan.

Specific measures:

Below (Table 1) follow examples of specific conversion measures distributed over time. They have been divided into start-up (2015-2020), ramp-up (2020-2025), and finalization (2025-2030).

Table 1. Examples of municipality measures for transition to a fossil free 2030.

	Start-up Phase 2015-2020	Ramp-up Phase 2020-2025	Finalization Phase 2025-2030
1. Focus on transport-efficient societal planning	Societal Planning. - densify and increase the functional mix in built environment. - prioritize and expand bicycle, pedestrian and public transport at the expense of car traffic. Initiate sustainable transport infrastructure. - basic network of fast chargers for electric cars. - basic network of biogas filling stations. - replace the municipal car fleet for electric and/or biofuel-driven cars. - support long-term sustainable infrastructure (trains, highways, electric or bio-fueled boats and airplanes). - require sustainably sourced electricity and biofuels for municipality-owned cars. - plan and part-finance electric bus lines in city centers.	Societal Planning. - continue as before. Support sustainable transport infrastructure. - expand network of fast chargers for electric cars. - expand network of biogas filling stations. - fast chargers for larger electric vehicles (buses and trucks). - complement existing fuel filling stations with promising new fuels (e.g. hydrogen). - change obsolete roads into bike or pedestrian paths. - require sustainably sourced electricity or biofuels for all bus traffic.	Societal Planning. - continue as before. Support sustainable transport infrastructure. - continue as before.
2. Reduce car dependency.	Sustainable parking. - put car parking in garages. - park and charge electric cars and bikes at secure public transport nodes. - increase parking fees for fossil-fuel-driven cars. Car and bike sharing. - support and part-finance car pools. - open the municipality's car fleet for the public. - promote bike rental at public transport nodes. Reduce car use - municipality organization work travel primarily by public transport and/or bicycle. - congestion taxes in major urban areas.	Sustainable parking. - continue as before. Car and bike sharing. - continue as before. Favor private car alternatives - incentives for public transport, biking and walking and against private cars.	Sustainable parking. - continue as before. Car and bike sharing. - continue as before. Make city centers car free - car bans in city centers - commuter car parking and public transport nodes surrounding city centers.
3. Reduce fossil dependence in the car fleet and its supply chain.	Fossil-free municipal car fleet - require electric or biofuel-driven vehicles in procurements. Conversion of fossil vehicles - initiate conversion to electric/biofuel vehicles.	Promote sustainable fuels - buy only sustainably produced electricity and biofuels. Conversion of fossil vehicles - promote conversion to electric/biofuel vehicles.	Promote sustainable fuels - support a broad scale-up of sustainable electricity and biofuels. Conversion of fossil vehicles - continue as before.
4. Greenhouse gas capture	Compensate for the municipality organization's emissions invest in new renewable energy, biochar & tree planting.	Contribute to compensation of all municipality emissions continue as before.	Contribute to compensation of all municipality emissions continue as before.

About this roadmap and GreenCharge

This roadmap report is based on collaboration, demonstrations and research from the first GreenCharge project phase (2011-2015). It highlights suitable pathways for a faster transition to fossil free and sustainable passenger transport in Southeast Sweden. The focus lies on requirements for reaching the goal rather than on making forecasts of what is likely to happen. GreenCharge was founded by CGI Sweden, Blekinge Institute of Technology (BTH) and Miljöfordon Sverige (MFS). BTH became lead partner and responsible for research. MFS was responsible for the operational project management and CGI Sweden for the business network. The Jönköping County Board was added and became responsible for the administrative coordination. In addition, to support the implementation, the lead partner recruited a steering group with executive decision makers from all over the geographical area and from both public and business sectors. Minoo Akhtarzand, then Governor of Jönköping County, was chairman.

GreenCharge partners (Spring 2015)

Academia

Blekinge Institute of Technology
Linköping University

Municipalities

Alvesta
Borgholm
Bromölla
Eksjö
Emmaboda
Gislaved
Habo
Jönköping
Karlshamn
Karlskrona
Ljungby
Markaryd
Mullsjö
Mönsterås
Nybro Olofström
Oskarshamn
Ronneby
Sölvesborg
Tingsryd
Uppvidinge
Vetlanda
Värnamo
Växjö
Älmhult

County Administrative

Boards

Blekinge
Jönköping
Kalmar
Kronoberg

Regions/Counties

Blekinge
Jönköping
Kalmar
Kronoberg

Other Public Organizations

Blekingetrafiken
Jönköpings Länstrafik
Kollektivtrafikmyndigheten
i Västernorrlands län
Energy Agency Southeast
The Swedish Energy Agency

Energy Companies

Affärsverken
Borgholm Energi
Bromölla Energi & Vatten
Eksjö energi
Emmaboda Energi
Gislaved Energi
Jönköping Energi
Karlshamns Energi

Nybro Energi
Oskarshamns Energi
Ronneby Miljö & Teknik
Vetlanda Energi & Teknik
Värnamo Energi
Växjö Energi
Enkla Elbolaget
Ålem energi

Other Companies and Non Public Organizations

AB Volvo (Volvo Buss)
CGI Sverige
Chargestorm
GARO
German Solar
Hertz Sverige/Sunfleet
Holmgrens bil
IKEA
Innoventum
Liljas bil
Liros Power Solution
Miljöfordon Sverige
My Eco
Park & Charge
Schneider Electric
SunDrive
Volvo Technology Corporation
Växjö Fastighetsförvaltning
Wireless Maingate Nordic

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