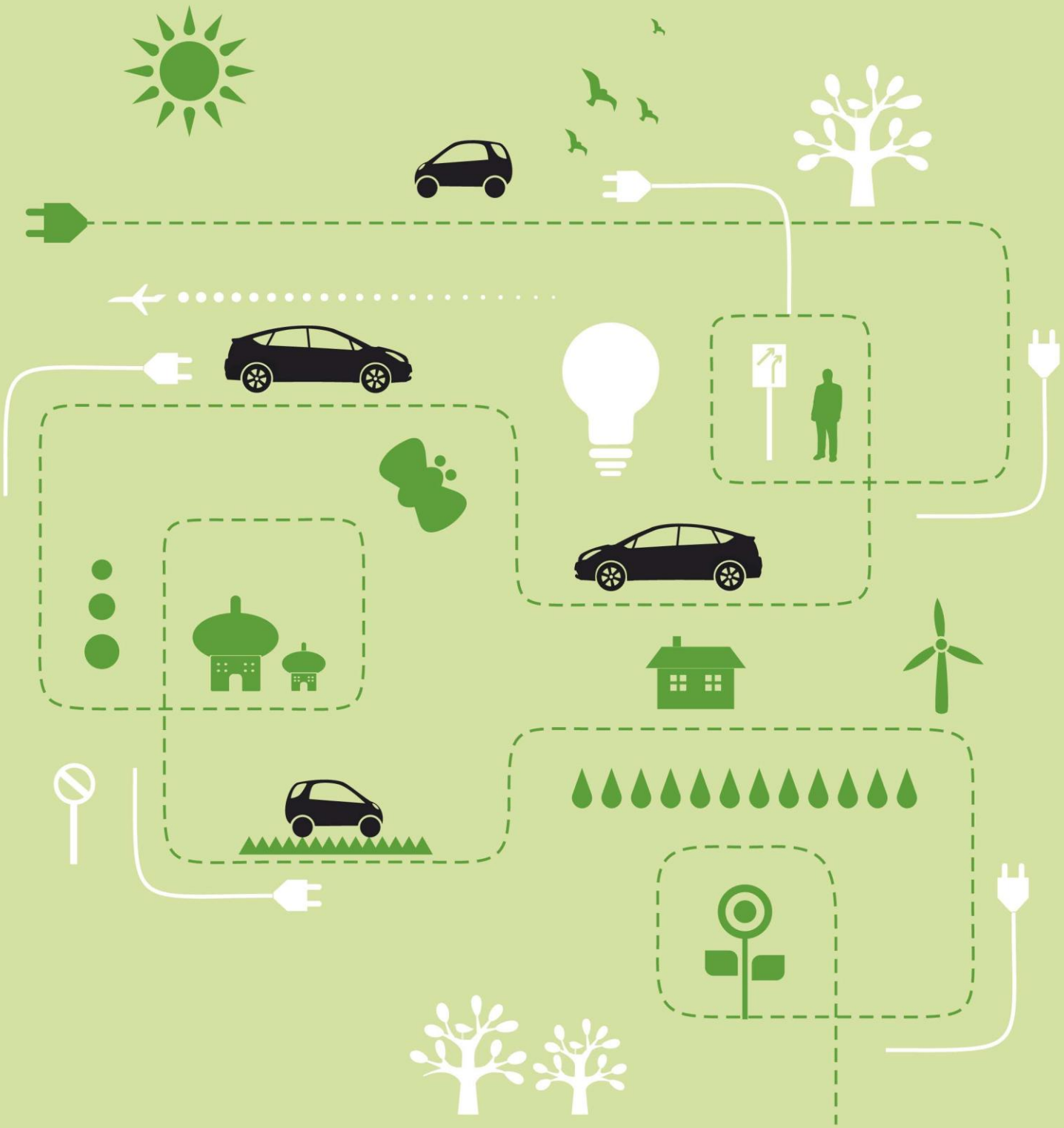

Action Plan for Electrification of Road Transport

Report from the Resource Group Convened by the Norwegian Ministry of Transport and Communications

Foreword

In December 2008, the Minister of Transport and Communications took the initiative to convene a resource group in order to draft an action plan for the electrification of road transport. The Norwegian Electricity Industry Association, known by its Norwegian acronym as the EBL, was tasked with chairing this work.

The resource group consists of the following organisations and persons:

- Bellona - Marius Holm
- BI Norwegian School of Management - Jørgen Randers
- Norwegian Automobile Importers' Association – Erik Andresen
- EBL- Norwegian Electricity Industry Association Steinar Bysveen (Chairman)
- EBL - Norwegian Electricity Industry Association Kristin Høyland/ Tom Wigdahl
- Hafslund Nett AS - Per Edvard Lund
- Norwegian Association of Local and Regional Authorities - Bjørn Johnsen
- Norwegian Automobile Federation - Christina Bu
- Norwegian EV Association (Nordstart) – Knut Wågsås
- Think - Richard Waitz
- Toyota Norge - Lars-Erik Årøy
- Norwegian Public Roads Administration – Erik Figenbaum
- Zero – Gøril Andreassen
- Ministry of Transport and Communications - Per Harald Sønstelid (observer)

Kristine Fiksen, from the firm ECON Pöyry, has performed the central office functions for the work.

The resource group has worked in accordance with the following mandate:

The resource group shall draft an action plan for the electrification of the transport sector. The action plan shall encompass in full or in part electrically powered vehicles based upon battery technology.
The action plan shall include proposals for measures involving:

- *Infrastructure*
- *Buying and use of electrically powered vehicles*
- *Other possible areas that are important for the electrification of road transport*

As a natural part of its work on an action plan, the resource group will also propose targets for the phasing in of electricity in road transport.

Summary

Electrification of road transport has been placed on the agenda as an important measure for reducing emissions of greenhouse gasses in Norway, the EU and other parts of the world. Rechargeable vehicles reduce greenhouse gas emissions both due to their being 4-5 times more energy efficient than vehicles today as well as because the power they use would be able to be produced from renewable sources. Issues involving sufficient availability of conventional oil and the growing challenges concerning local emissions will also contribute to driving increased progress in the electrification of road transport.

Proposal for ambitions concerning the percentage of rechargeable passenger cars in 2020

The climate agreement established that Norwegian greenhouse gas emissions must be reduced by approx. 16 million tons of CO2 equivalents in 2020, in comparison with a baseline where nothing is done to limit these emissions. This involves reducing the emissions by a nearly 25%. In order to achieve such a reduction for the fleet of passenger cars, the resource group is of the opinion that the ambition should be to have 10% of the cars being rechargeable in 2020. If rechargeable cars are put on the market on a large scale even earlier than is being presumed, or if attaining reductions in emissions from other parts of the transport sector becomes more difficult, increasing this level of ambition can be re-examined.

Phasing in of rechargeable cars will occur in two phases. During an initial non-commercial phase, it will be necessary to undertake measures to promote electrification. During the second phase, rechargeable cars will be widely available and price-competitive. The technology will be proven and a sufficient number of recharging points and service functions will have been developed in most places around the country.

Rechargeable cars encompass both electrical cars and rechargeable hybrid cars. Deliveries of power to these cars will not have any noteworthy effect on the overall power grid in Norway.

Proposal for action plan

The resource group proposes the following measures in order to kick-start the electrification of road transport, with an emphasis on passenger car transport, during the next few years:

- **A council should be established that will evaluate and possibly propose changes to these measures up to 2020.** The resource group proposes that the authorities evaluate the creation of a council that will closely follow the phasing in of rechargeable cars and provide input to the authorities annually up to 2020.

Measures associated with marketing efforts and the construction of recharging points:

- **A national network will be created for the electrification of road transport – Green Car Norway.** The need to get underway with the electrification of road transport along with the need for simultaneity in the phasing in of the cars and the

construction of recharging points, means that there will be a need for a national network that co-ordinates and drives the progress of changes on a national basis. The resource group thus proposes that the authorities consider creating such a national network.

- **A grant of NOK 100 million should be made for the construction of recharging points each year in the future.** Excepting recharging points associated with a private detached house, the resource group is of the opinion that expenses for the construction of new recharging points should be subsidised by the government.

- **Recharging points at new and existing parking lots.** The resource group proposes that the percentage of parking places with recharging points should correspond to the percentage of rechargeable cars in the country's fleet of cars, counting both existing parking places as well as new parking places.

- **Experiment with residential parking for rechargeable cars.** The resource group wishes to encourage urban municipalities to test arrangements with residential parking for rechargeable cars with associated recharging points.

- **Fast(er) rechargers will be built to a limited extent.** The resource group is of the opinion that it would be important to set some recharging stations up where cars can be recharged more quickly than with the ordinary power grid.

- **Standardisation of recharging points.** The resource group regards the standardisation of current/voltage levels and the recharging plug as a central task. This work has been begun in Europe and should be followed up on by Norwegian authorities.

Measures associated with the buying and use of rechargeable cars:

- **All measures that have already been implemented for electrical cars should be maintained**. The resource group is of the opinion that measures that have already been introduced to promote the purchase and use of electrical cars function well and should be continued.

- **Most of the established measures for the introduction of electrical cars also apply to rechargeable hybrid cars.** The resource group proposes that the measures that have been established for electrical cars should also apply for rechargeable hybrid cars, with the exception of driving in the public transport lane.

- **The fee system should be reviewed in order to ensure that rechargeable cars are attractive.** The resource group does not wish to perform a review of the fees for cars within the restrictive timeframe the resource group has. The resource group does however encourage the authorities to formulate a new fee system for cars before the state budget in 2011 which ensures the attractiveness of rechargeable cars in comparison with conventional cars and which stimulates the phasing in of new technology.

- **Support for buying of electrical cars and rechargeable hybrid cars**. The resource group proposes that NOK 30,000 be given in support to everyone who purchases electrical cars or rechargeable hybrid cars of class N1 and M1 (passenger cars and delivery vans) until there are 50,000 such vehicles in Norway.

- **Alternative to the proposal above: Support for purchasing advanced batteries**. As an alternative to the measure above, the resource group proposes that support be given for batteries with a density exceeding 70Wt/kg. The proposed support is then

NOK 1.8 per Wt that can be stored in the battery. The proposed support concerns batteries in new cars and replacement batteries in used cars.

- **Public sector purchases of rechargeable cars for internal use.** The resource group proposes that all cars owned by municipalities, the state or public sector enterprises should be rechargeable cars where such is practical and possible before 2020. Public sector enterprises may also pose requirements for the use of rechargeable cars by their subcontractors when outsourcing services.

- **State purchases of rechargeable cars for use via leasing companies, etc.** The resource group proposes that the state assess annually the purchase of a number of rechargeable cars that would be leased out via leasing companies or auctioned to end-users. The resource group proposes that such an arrangement be started with 2000 cars in 2009.

- **VAT on the leasing of rechargeable cars will be handled as for delivery vans (class 2).** The resource group proposes that VAT on the leasing of rechargeable passenger cars should be handled in the same manner as for delivery vans, class 2; that it be included in the VAT accounting of companies in the usual manner and that municipalities receive VAT compensation for this.

- **Reduction in the tax basis for company cars: 75% for electrical cars, 50% for rechargeable hybrid cars.** Electrical cars currently have a 50% reduction in their tax basis for calculating company car taxation. The resource group proposes that this be increased to 75%. The resource group proposes, furthermore, that this arrangement should also apply for rechargeable hybrid cars, but that the reduction in the tax basis here be 50%.

- **A VAT rate of zero for battery replacement and other maintenance of rechargeable cars.** In order to reduce the risk for the car owner with respect to new battery technologies, the resource group proposes that a zero VAT rate be introduced for battery replacement and for other maintenance/service connected with batteries.

- **Rechargeable cars written off in 1 year**. The resource group proposes that rechargeable cars be written off in 1 year. This will make purchasing rechargeable cars more attractive for companies.

Proposal for measures connected with R&D:

- **Creation of research centre for environmentally friendly energy (Norw. acronym FME) for electrification of road transport.** The resource group proposes that a research centre be established for environmentally friendly energy (FME) with an emphasis on the electrification of road transport.

Important findings and assessments from the resource group

Road traffic is increasing

Road traffic has been increasing for many years due to increased per capita concentrations of cars as well as population growth in Norway. Greenhouse gas emissions from road transport have increased correspondingly, and will continue to increase if no measures are implemented to limit the growth.

Over 2400 rechargeable cars are in use in Norway

Over 2400 electrical cars have been registered in Norway, primarily in and around Oslo. Measures that have already been introduced have been important here.

Daily usage of cars will be within the range of the battery for rechargeable cars
For most people, commuting and other types of daily driving would be able to be covered with the range provided by a rechargeable car. A car must however also be used for holidays and long trips. This can be covered by a rechargeable hybrid car, but not a purely electrical car without access to fast(er) recharging or battery replacement. For households with 2 cars, in many cases one of them could be a rechargeable car.

The use of a car in a job will often be inside the range of the battery for rechargeable cars
Everyone who drives less than approx. 2 hours (at 80 km/h) can use a rechargeable car and drive primarily using power from the battery. Examples of such are municipal home help services, smaller deliveries of goods and tradesmen.

Good terms and conditions for leasing will be important for phasing in rechargeable cars
A large percentage of all new cars enter the market via leasing companies. Purchases of electrical cars are at present exempt from VAT. In contrast, VAT is collected for leasing on the interest and depreciation expenses. The fee system currently favours owning rechargeable cars over leasing them. The leasing price for cars is based upon the resale value of the car after the leasing period. This is an unknown for rechargeable cars (and the battery). This also makes for increased risks for the leasing companies in connection with rechargeable cars.

Most people have access to parking both at home and at work
Nearly all car users have access to their own parking place at home and free parking at work. These would be obvious places to recharge the cars. In city centres a large percentage of people only have access to street parking and public parking both at home and at work, making this a challenge.

The possibility for recharging is a prerequisite for the use of rechargeable cars
The possibility for recharging would be a prerequisite for the purchasing and use of a rechargeable car. There will be a need for charging points at parking places in advance of the phasing in of rechargeable cars. Fast(er) recharging and/or battery exchanges will increase the range of purely electrical cars and increase the driving range on electricity for rechargeable hybrid cars

The automobile manufacturers are serving notice that they will launch rechargeable cars, but it is uncertain precisely when
Rechargeable cars are not available on the market today. Most of the large automobile manufacturers have served notice that they will launch rechargeable cars in future years, but it is uncertain when they will be produced in large volumes. Especially up to 2015, there may be limited offerings.

New types of batteries are coming on the market, and there is a need for continued development
Widespread use of rechargeable cars is dependent upon the rapid development of battery technology, primarily in connection with cost, performance and safety. The costs of new types of batteries will probably be reduced in the next few years due to mass production. New types of batteries with higher performances are still not in use in cars, and there is some uncertainty connected with the actual lifespan and performance of such batteries.

Public authorities will have a key role during an early phase
Municipalities and other public authorities should take the lead in the purchasing of rechargeable cars and the construction of recharging points. This will contribute to increased knowledge about rechargeable cars and provide experiences that are important when the use of rechargeable cars takes off. In addition, using purchasing programmes can

lead here to increased security for early manufacturers of rechargeable cars and contribute to multiple manufacturers selling cars to the Norwegian market.

Measures for electrification that have been commenced in several places
A number of Norwegian municipalities and companies have already purchased rechargeable cars and begun the construction of publicly available recharging points. A number of European countries have also started programmes prior to phasing in rechargeable cars.

There is a need to pick up the pace and for simultaneity connected with the phasing in of rechargeable cars
The need for simultaneity with respect to the acceleration of the distribution of rechargeable cars and the development of recharging possibilities will be a challenge that will require an effort in several areas simultaneously: marketing measures, infrastructure, exchanges of experience and information. This work must be nation-wide and well-coordinated. In order to ensure electrification of road transport picks up speed, there is thus a need for a national network to stimulate the market and develop the infrastructure.

The phasing in of rechargeable cars can provide opportunities for business development
Norway is relatively advanced with respect to the use and production of electrical cars. The early introduction of electrical cars would be able to provide business opportunities in the development of vehicles (cars, parts and batteries), recharging points and intelligent communication, as well as in the development of services. Norwegian companies have been established in all these areas that can be further developed and around which further commercial enterprises can be built.

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1 Why electrify road transport?

There are three primary reasons for electrification of road transport currently being a highly relevant theme. Firstly, the world is facing a climate crisis for which drastic measures must be commenced in order to attain national and international reductions in emissions of greenhouse gasses. Secondly, there are issues involving whether the world's oil resources and the rate at which they are extracted will be sufficiently large to meet the increasing demands of the global market. Finally, road transport comprises at present the largest local environmental problem in urban areas involving emissions of CO and NOX. These points will be described in further detail in the paragraphs below.

Road transport is responsible for 19% of the greenhouse gas emissions in Norway (ssb.no, 2009). Due to expectations of increased volumes of transport in the future, the emissions of greenhouse gasses from this sector is expected to increase as 2020 is approached despite more efficient vehicles. It thus will be necessary to implement special measures to reduce greenhouse gas emissions from road transport. Continued to increase the efficiency of petrol-powered vehicles, the introduction of biofuels and the electrification of vehicles are the most relevant measures for reducing greenhouse gas emissions up to 2020.

A car with an electrical motor is 4 to 5 times more energy-efficient that a car with an internal combustion engine. Due to this, the total greenhouse gas emissions from all the elements (”well to wheel”) involved for an electrically powered car will be lower than for present-day cars, even if the electricity is produced in coal-fired generation plants. In Norway, where fossil fuels can be replaced with renewable electricity, the effect of electrification of road transport would be greater than in countries where the electricity is produced by coal-fired generation plants.

According to the IEA (2008) sufficient oil reserves probably exist to cover the demand up to 2030. However, it will become more difficult to find good quality oil with low extraction costs. At the same time, it is uncertain whether investments in and extraction from new fields would be able to occur as quickly as the increases in demand. The price of fossil fuels will thus be extremely unpredictable for the next 20 years. In summary, these comprise important grounds for transitioning to another and more climate-friendly fuel for transport.

Local emissions from vehicles are a problem in all urban areas. In Norway, emissions of NO_x and particles pose particular problems, resulting in health-related problems. In addition, road transport is an important cause of increasing noise-related nuisances. An electrical engine does not produce exhaust, and thus releases no emissions of NO_x and particles from the vehicle. An electrical engine is also a great deal quieter than an internal combustion engine; so noise from road transport would also be radically reduced with the increased use of rechargeable cars.

2 Goals and ambitions for reductions of greenhouse gas emissions from road transport

The Climate Consensus that was entered into on 17 January 2008 between most of the parties in the Storting has established goals for reductions of greenhouse gasses of 25% in comparison with the Reference Scenario.[1]. Based on this, the resource group proposes a level of ambition of 10% rechargeable cars in 2020, something that in conjunction with more efficient cars and the phasing in of biofuels would lead to passenger car transport bearing its share of the greenhouse gas reductions.

The majority of the potential for making internal combustion engines more efficient will have been exercised by 2020. In order to achieve further reductions, and zero emissions at the end of the period, further rationalisations of road transport will be necessary through greater percentages of rechargeable cars by 2030 and still later dates.

How demanding it would be to attain the level of ambition of 10% rechargeable cars in 2020 depends upon how quickly the automobile manufacturers start large-scale mass production of rechargeable cars. If this occurs quickly, the level of ambition for the introduction of rechargeable cars by 2020 could be set higher.

2.1 Norway's goals for reductions in greenhouse gasses from road transport

Via the Climate Consensus (2008) it was established that 15-17 million tons of climate-related reductions will be carried out in Norway. This involves a reduction of 25% in comparison with the Reference Scenario.

A goal was set to reduce the emissions from road transport by 2.5 – 4 million tons of CO_2 equivalents in comparison with the 2020 Reference Scenario. This includes the sectors involving road, air, rail, etc. This objective has currently not been specifically defined for road transport. This will first be done once expenses for measures in each sector have been assessed.

Furthermore, Norway will facilitate global emission reductions by 2050 that correspond to total Norwegian emissions. If a global and ambitious climate agreement is entered into, Norway will facilitate emission reductions by 2030 that correspond to Norwegian emissions.

The EU also has several directives that will contribute to reducing greenhouse gas emissions from passenger cars and which could be relevant for Norway. These are shown in Appendix 1.

[1] The Reference Scenario for emissions of greenhouse gasses up to 2020 has bee defined in the State Budget 2007 (Norwegian Pollution Control Authority, 2007)

2.2 Proposal for level of ambition for electrification of passenger car transport in 2020

Selecting a reasonable level of ambition for the electrification of passenger car transport is a demanding task. The goals set by the authorities require a reduction in greenhouse gas emissions in all sectors. On the other hand, it is uncertain as to when the automobile manufacturers will start production of rechargeable cars in large volumes. The resource group is of the opinion that the most important thing now is to adopt clear and strong measures that ensure that rechargeable cars are phased in as quickly as possible. It will be easier in a few years to see the contours of the trends in technology and the offerings on the market, and hence easier to set clear goals for electrification in 2020.

The resource group is of the opinion that *road* transport ought to bear its proportional share of Norway's climate-related reductions, i.e. a reduction of 25% in comparison with the 2020 Reference Scenario. Furthermore, the resource group believes that *passenger car* traffic should also bear its part of the emissions reductions. In the figure below we show that it is possible to attain such a reduction in emissions from passenger car transport if a goal is set for 10% of passenger cars to be rechargeable by 2020.

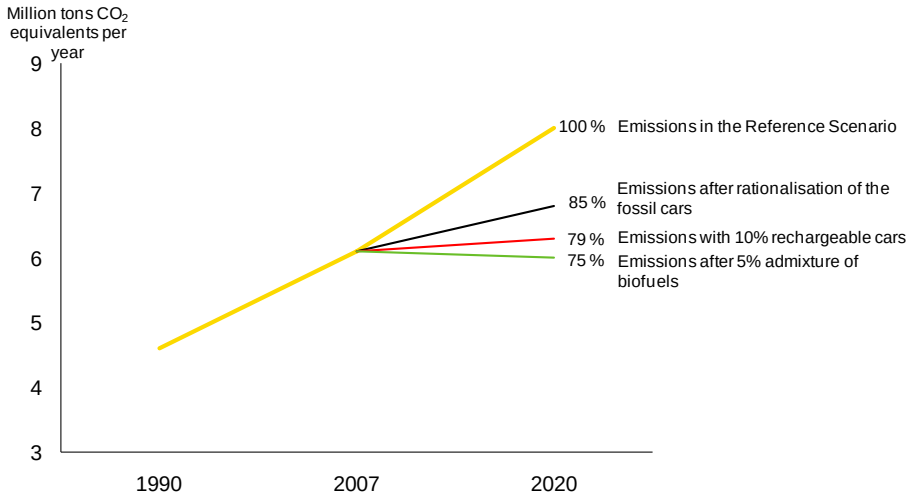


Figure: Reductions in relation to the Reference Scenario for different measures.[2]

As the figure shows, governmental requirements for significantly more efficient fossil fuels will be the measure that is most useful in reducing emissions of greenhouse gasses by 2020. In order to achieve a reduction of 25%, this is however not sufficient. The phasing in of both rechargeable cars as well as biofuels must occur in order for sufficient climate-related reductions to be achieved from passenger cars.

A total of 10% rechargeable cars in 2020 will need electricity comprising approx. 0.7 TWh per year.

[2] The numbers in the figure have been corrected for new cars driving somewhat further per year than older cars. This will have an effect when new cars are significantly more efficient than the average car in the national fleet. Rechargeable cars are divided up with approx. one-third being electrical cars and two-thirds being rechargeable hybrid cars. The hybrid cars are presumed to drive 60% of their annual mileage on electricity. It is assumed that the production of electricity for use in the cars uses only renewable sources. A 5% reduction in greenhouse gas emissions has also been included in consequence of the phasing in of biofuels. If this fuel is not 100% renewable, a greater percentage of biofuels must be phased in so as to obtain a greenhouse gas reduction of 5%.

2.3 A percentage of 50% rechargeable cars will give a reduction in greenhouse gas emissions of 36% in comparison with a fleet of cars efficiently powered only by fossil fuels

Electrification will be a significant part of the solution for passenger cars by 2020, but the rechargeable cars will provide a far more important effect after 2020 and in the end contribute to zero emissions from transport in 2050. Increased efficiency of petrol/diesel cars is limited, making it necessary to phase in new technology and new energy carriers in order to achieve zero emissions from road transport.

The anticipated trend in emissions from new cars is shown in the figure on the next page.

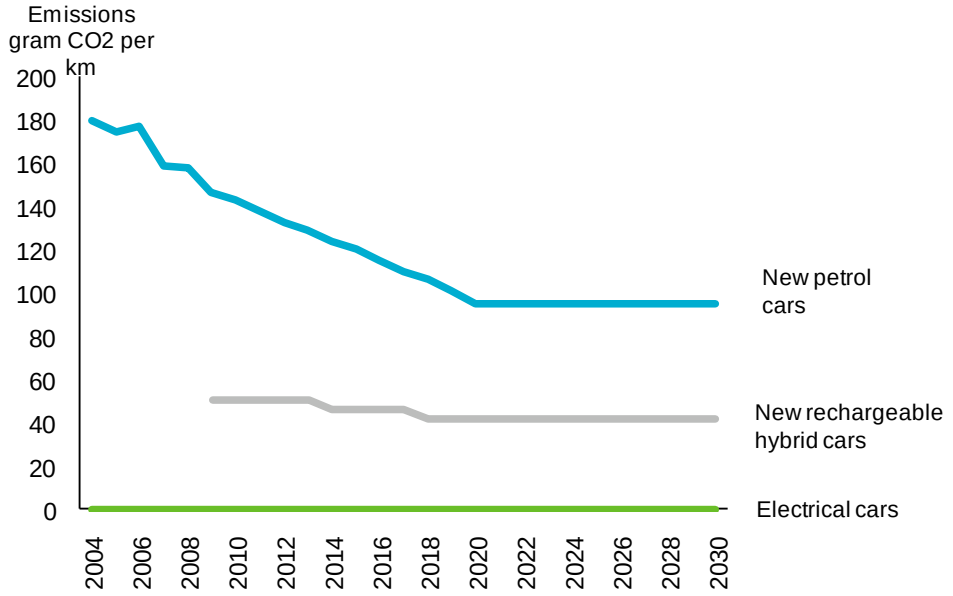


Figure: Anticipated trend in emissions from new cars up to 2030. Electricity used in rechargeable cars is presumed to come from renewable sources.

As the figure shows, the emissions from rechargeable cars will be significantly lower than the emissions from efficient petrol/diesel cars. An increase in rechargeable cars would however contribute to further reductions in the emissions from road transport.

If 50% of the cars are rechargeable cars, this would give a reduction in emissions of climate gasses in the transport sector of 36% in comparison with the alternative where all cars are efficient petrol/diesel cars (95 g CO_2 per km). The assumptions are otherwise the same as in the preceding chapter.

2.4 Levels of ambition for other parts of road transport have not been assessed

The levels of ambition, means and other assessments in this report are primarily connected with passenger car transport, which is responsible for the greater part of all vehicles and over half of the greenhouse gas emissions from road transport.

It is self-evident that delivery vans can be phased in at the same rate as passenger cars provided that rechargeable delivery vans become available on the market to an extent greater than they are today. Delivery vans could thus contribute their share of greenhouse gas emissions on a similar footing to passenger cars.

Use of electrical vehicles and electricity in other large vehicles has not been assessed by the resource group. If these groups of vehicles cannot attain their shares of greenhouse gas emissions in the transport sector, it would be possible to envision passenger cars having to shoulder a share of the reductions larger than 25%.

3 Action plan

In this chapter, the resource group will present measures that we believe will be important to the electrification of the transport sector. The use of measures to achieve sufficient electrification by 2020 and continuing thereafter will however not be able to be firmly established in 2009. Developments will take place in batteries and vehicles, and new models of cars will be launched. If the proposals that are given in this action plan are followed, increased use of rechargeable cars will be seen in the future. This will provide new experiences and new possibilities that are unforeseen at present. This trend and the effects of the measures ought to be evaluated in order for further work on electrification to be goal-oriented.

The resource group envisions that electrification will take place in 2 phases. The first phase is *until* rechargeable cars are fully available, price-competitive and a sufficient number of recharging points and service functions have been built at most places around the country. It is difficult to quantify how many rechargeable cars must be on the market before a transition is seen to phase 2, a *commercial phase* in which rechargeable cars compete on an equal footing with other automotive technologies. Different segments of the automobile market will go over to phase 2 at different points in time. The measures of the action plan will primarily be relevant during a phase 1 period.

The uncertainties that are described above comprise the background for the resource group's first proposal for a measure:

A council should be established that will evaluate and possibly propose changes to these measures up to 2020

The resource group proposes that the authorities evaluate creating a council to follow developments and provide input to the authorities on an annual basis up to 2020.

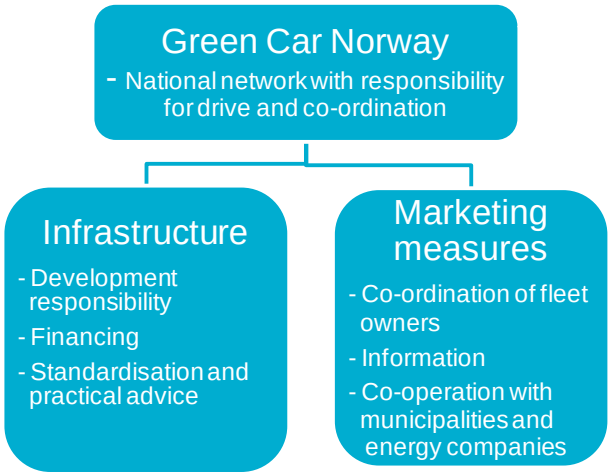
The other measures are divided up into three different categories:

- Measures associated with marketing efforts and the construction of recharging points
- Measures for the purchasing and use of rechargeable cars
- Measures connected with R&D

3.1 Measures associated with marketing efforts and the construction of recharging points

A national network will be created for the electrification of road transport – Green Car Norway

The resource group is of the opinion that the need for progress in the electrification of road transport along with the need for simultaneity in the dissemination of cars and the construction of recharging points means that there will be a need for a national network that co-ordinates and drives the progress of changes on a national basis.



The resource group proposes that the authorities assess the creation of such a national network.

A grant of NOK 100 million should be made for the construction of recharging points each year in the future

The resource group supports the creation of Transnova as a body that contributes to more climate-friendly transport. A total of NOK 50 million of Transnova's funds for 2009 have been earmarked for the construction of infrastructure for recharging. The resource group is of the opinion that this is an extremely important measure and that the construction of recharging stations should be continued and strengthened in the future. The proposal is that NOK 100 million be granted for such each year. Excepting recharging points associated with a private detached house, the resource group is of the opinion that expenses for the construction of new recharging points should be subsidised by the government.

Requirements should be posed for laying cable-pulling conduits for the recharging points that receive support, so that any possible needs for increasing the power at a later point in time can be implemented with reduced excavation costs.

Recharging points at new and existing parking lots

The resource group proposes that the percentage of parking places with recharging points should correspond to the percentage of cars that are rechargeable cars. With a level of ambition of 10% rechargeable cars in 2020, the level of ambition for the percentage of parking places with recharging points will also be 10 %. In order to not incur expenses that are too large too early, the resource group proposes a gradual escalation of the level of ambition in advance of the phasing in of rechargeable cars:

- 2010: 1 %
- 2015: 4 %
- 2020: 10 %

For new parking lots, and the development of new residential/commercial areas, the resource group recommends that the municipalities pose requirements that some portion of the spaces have recharging points. This can be done with a legal basis grounded in the Norwegian Planning and Building Act.

Experiment with residential parking for rechargeable cars

The resource group wishes to encourage urban municipalities to test arrangements with residential parking for rechargeable cars. These spaces must then have associated

recharging points. Car owners would thus be ensured a parking space at home where they can recharge their cars during the course of the night, which is a prerequisite for the acquisition of rechargeable cars.

Fast(er) recharging would be installed to a limited extent
Recharging from the normal electricity grid would be the most important form of recharging in the immediate future. Despite this, the resource group is of the opinion that it would be important to set up some recharging stations where cars could be recharged more quickly. The speed of the recharging (and thus the strength of the current and voltage) ought to be adapted to the needs where they are set up. During the first phase of electrification, publicly available recharging stations and stations that serve for example taxis or other fleets of vehicles ought to receive support from Transnova.

Standardisation of recharging points
The resource group views it as being important that all recharging points can be used by all rechargeable cars. Standardisation of current and voltage levels, as well as the recharging plug are thus a central task. Work on standardising the recharging points has begun in Europe. This work should be followed up on by the Norwegian authorities.

3.2 Measures for the purchasing and use of rechargeable cars

All measures that have already been implemented for electrical cars should be maintained
A number of measures have already been implemented to promote the purchase and use of electrical cars, which have led to there already being 2,400 electrical cars on Norwegian roads. The resource group believes that these are good measures and proposes that previously established measures be continued.

Most of the established measures for the introduction of electrical cars also apply to rechargeable hybrid cars
The resource group proposes that the measures that were established for electrical cars should also apply for rechargeable hybrid cars, with one exception: ability to drive in the public transport lane.

The fee system will be reviewed in order to ensure the attractiveness of rechargeable cars
It is not being proposed that the fees for 2010 be changed. Electrical cars have an exemption from the Vehicle Import Duty, and the rechargeable hybrid cars on the market in 2010 will be extremely limited. The resource group views it as being important that the fee system be predictable and robust, and thus does not desire to perform a review of the fees within the limited timeframe that the resource group has.

The resource group does however encourage the authorities to formulate a new fee system for vehicles prior to the 2011 state budget. Changes to the fee system must take into account cars that are still not on the market and it must be ensured that rechargeable cars are not subject to higher fees than corresponding conventional cars, for example due to a higher weight or power rating. In addition, it should be assessed whether hybrid cars should be subject to preferential fees if such cars contribute to the electrification of the national fleet of cars through the technological development of batteries, etc.

Support for buying of electrical cars and rechargeable hybrid cars
The resource group proposes that NOK 30,000 be given in support to everyone who purchases electrical cars or rechargeable hybrid cars of class N1 and M1 (passenger cars and delivery vans) until there are 50,000 such vehicles in Norway. This would contribute to making rechargeable cars more competitive with corresponding cars with fossil fuels.

Alternative to the proposal above: Support for purchasing advanced batteries
As an alternative to the measure above, the resource group proposes that support be given for batteries with a density exceeding 70Wt/kg. The proposed support is then NOK 1.8 per Wt that can be stored in the battery. The proposed support applies both for batteries in new cars as well as in use cars that swap out all or parts of their battery packs.

Public sector purchases of rechargeable cars for internal use
Public sector cars should be climate-friendly as resolved in the Climate Consensus. The resource group thus proposes that all cars owned by municipalities, the national government and state-owned enterprises should be rechargeable cars where such is possible in practical terms by 2020.

Public sector enterprises may also pose requirements for the use of rechargeable cars by their subcontractors when outsourcing services. This could, for example, be via entering into contracts concerning transport (taxis, courier services, bus services, etc).

State purchases of rechargeable cars for use via leasing companies, etc
The resource group proposes that the national government assess purchasing a number of rechargeable cars (with requirements for max. emissions from rechargeable hybrid cars) each year in the future via a public tendering process. These cars could then be leased out via leasing companies or auctioned off to end-users. Doing this achieves two things. The risk associated with the resale value of rechargeable cars and the lifespan of batteries is assumed by the national government. This method results in more rechargeable cars being placed out in the market. In addition, it ensures that rechargeable cars are actually produced and provides increased predictability for manufacturers of rechargeable cars.

What the proper number of cars would be needs to be assessed each year in the future. The resource group proposes that 2000 cars initially be purchased via such an arrangement in 2009.

VAT on the leasing of rechargeable cars would be handled in the same manner as for delivery vans (class 2)
The resource group proposes that VAT on the leasing of passenger cars that are purely electrical cars or rechargeable hybrid cars be handled in the same manner as for class 2, delivery vans. In other words, that it be included in the VAT accounts for enterprises in the usual manner and that municipalities receive VAT compensation for it.

Reduction in the tax basis for company cars: 75% for electrical cars and 50% for rechargeable hybrid cars
Electrical cars currently have a 50% reduction in their tax basis for computing company car taxation. The resource group proposes that this be increased to 75%. The resource group proposes, furthermore, that this arrangement should also apply for rechargeable hybrid cars, but that the reduction in the tax basis then be 50%.

A VAT rate of zero for battery replacement and other maintenance of rechargeable cars
In order to reduce the risk for the car owner with respect to new battery technologies, the resource group proposes that a zero VAT rate be introduced for battery replacement and for other maintenance/service connected with batteries.

Rechargeable cars written off in 1 year
The resource group proposes that rechargeable cars be written off in 1 year. This will make purchasing rechargeable cars more attractive for companies.

3.3 Measures connected with R&D

Creation of research centre for environmentally friendly energy (Norw. acronym FME) for electrification of road transport

The resource group proposes that a research centre be established for environmentally friendly energy (FME) with an emphasis on the electrification of road transport.

Some areas the should be examined in greater detail are:

- Use of cars within different user groups
- Needs for infrastructure for recharging
- Effects of recharging on the electrical grid

3.4 Estimated effects on the state budget in connection with the measures are lower than the national government's annual revenues from CO_2 fees

The national government's revenues from CO_2 fees from mineral products (chiefly petrol and diesel) comprise NOK 4.7 billion in the 2009 State Budget. In addition, the Norwegian authorities have significant revenues from increased electricity prices as a result of CO_2 quotas. The resource group views it as natural that revenues from fees connected with greenhouse gas emissions be used to reduce greenhouse gas emissions.

Some estimates have been computed for the effects on the state budget connected with the introduction of the measures proposed. The explanations for the calculations are shown in Appendix 2.

Expenses for construction of recharging points

Expenses connected with the construction of recharging points for rechargeable cars are shown in the table below.

	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Support for construction	100	100	100	100	100	100						

Table: Effects on the state budget connected with the construction of recharging points

Expenses connected with purchasing rechargeable cars with a 10 % share of the passenger car fleet by 2020

The table below provides an overview of the estimated effects on the state budget connected with measures for purchasing rechargeable cars during the period up to 2020. Direct support for purchases is computed for the first 50,000 cars.

Figures in NOK million	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Support upon purchase	38	154	231	425	581	69						
Loss of Vehicle Import Duty for elec	80	322	403	565	647	648	649	650	651	652	653	654
VAT exemption for electrical cars	80	295	354	564	645	646	647	648	649	650	651	652
Total	2	6	11	20	33	47	62	79	97	121	147	176
Sum	201	777	999	1574	1905	1410	1358	1376	1397	1422	1451	1482

Table: Effects on the state budget connected with building the purchases and use of rechargeable cars

Costs connected with governmental purchasing of cars that will be resold or leased out have not been computed. Here, the expense will be connected with the difference between the purchase price and what is received via its resale or leasing arrangements.

Costs connected with the use of rechargeable cars

The table below shows an overview of the estimated effects on the state budget in connection with measures involving the use of rechargeable cars.

Figures in NOK million	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Annual fee	7	19	37	70	116	170	231	298	377	477	592	724
Fees for fossil fuels	7	34	70	130	205	290	379	470	570	690	819	951
Electricity fees	-1	-2	-4	-8	-13	-20	-27	-35	-44	-56	-70	-87
Toll gate money	6	17	34	65	106	156	211	272	345	436	542	663
State highway ferries	1	4	8	14	23	34	47	60	76	96	119	146
Free parking	0	0	0	0	0	0	0	0	0	0	0	0
Company car taxation – electric	1	2	3	5	7	9	11	13	15	17	19	21
Company car taxation – rechargeabl	0	0	1	3	6	11	17	25	34	47	62	80
Total	21	73	148	278	450	651	869	1103	1372	1707	2083	2498

Table: Effects on the state budget in connection with the use of rechargeable cars

The loss of parking revenues for municipalities from free parking for rechargeable cars at public parking areas has not been estimated. It is difficult to obtain an overview of the total revenues from parking because this is not centrally reported. Nordpark (2009) has estimated public sector revenues from parking at NOK 1 billion per year, but there is great uncertainty connected with the figures. At the same time, revenues from parking often only represent coverage of the costs incurred by the municipalities. Where this is the case, free parking for rechargeable cars will probably make it more expensive to park other cars.

Support for R&D and marked-related measures.

Support for R&D and market-related measures has not been estimated. This will be based upon individual applications in every single instance.

4 Road transport and the use of cars in Norway

In order to be able to say anything about how road transport would be able to be electrified, we must take a point of departure in how road transport and car ownership are at present. Parking conditions will also be important in that rechargeable cars will be recharged when they are parked. In this chapter we will present a top-level overview of this.

4.1 Greenhouse gas emissions from road transport have increased significantly

Road transport is one of the largest sources of greenhouse gas emissions in Norway and the rest of the world. At the same time, the transport volumes have been increasing for a long time, both for goods transport as well as for passenger transport. As a result of measures that have been initiated, including an increased Vehicle Import Duty for cars with high emissions of CO_2, emissions of greenhouse gasses per kilometre driven have been reduced for new cars being sold. This will contribute to growth in greenhouse gas emissions from road transport in the future, but it is not sufficient to reduce the emissions from the present level if the growth in the volumes of traffic continues.

The fleet of cars is increasing and the cars have become heavier

The number of passenger cars has increased by an average of 40,000 per year over the past ten years (Information Council for Road Traffic, 2009). This is due both to an increase in the density of cars (12%) and an increase in population number (7%) during the same period.

The percentage of busses and combined vehicles has been reduced in the past years due to these vehicles having become less attractive purely in terms of fees (Information Council for Road Traffic, 2009). Since minibuses no longer have access to public transport lanes, the percentage of such vehicles will probably become still smaller.

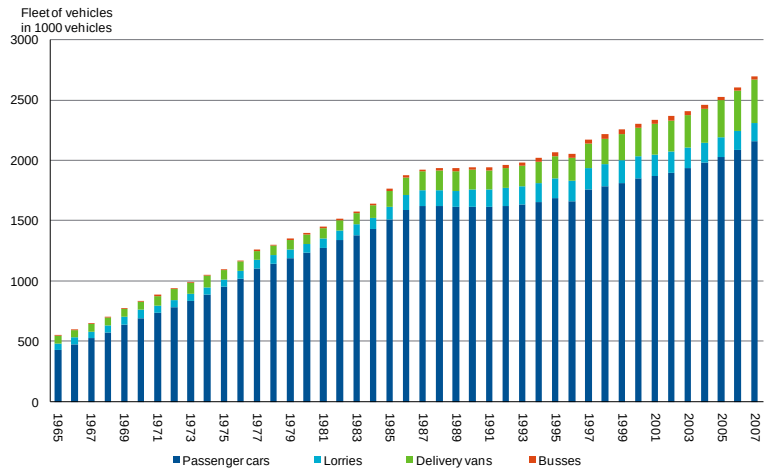


Figure: Fleet of vehicles in Norway 1965-2007. 1000 vehicles. Source: Information Council for Road Traffic (2009)

The number of vehicles per vehicle group in 2007 was:

- Passenger cars: 2,155,000
- Lorries (total weight less than 3,500 kg): 361,500
- Lorries (total weight more than 3,500 kg): 151,500
- Busses: 25,000

New passenger cars have been thoroughly heavier during the 2000s up to 2006, with an increase in weight of approx. 10% from 2002 to 2007. The reasons include the cars having received more comfort and safety equipment. After the fees were reorganised in 2007, the increases in the weights of new cars stopped (Information Council for Road Traffic, 2008).

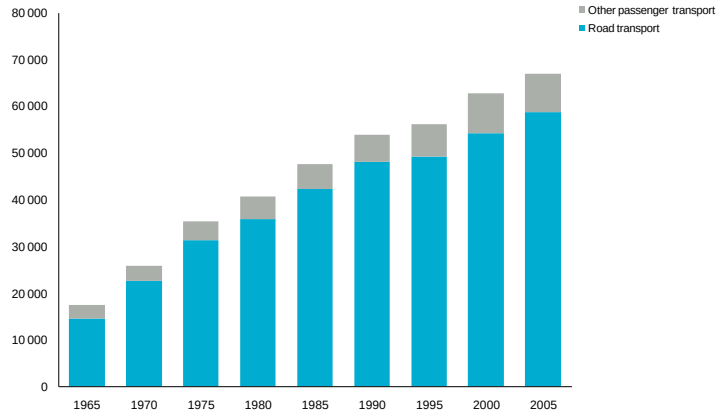
In recent years approx. 110,000 new cars have been sold, excepting the peak year of 2007 where 129,000 cars were sold. Approx. 35% of the purchases of new cars were made by the business community (Information Council for Road Traffic, 2008).
The table below shows how sales of new cars is distributed among different segments.

	2005	2006	2007
Mini cars	1	1	1
Small cars	13	12	14
Compact class	35	30	35
Medium-sized class	29	26	27
Large cars	6	7	7
Luxury cars	0	0	0
Multipurpose cars	1	2	2
All terrain cars	14	21	13
Sports cars	0	1	0
Other	1	1	1

Table: Segment trend 2005 – 2008. All figures in %. Source: Information Council for Road Traffic, 2008

Road transport is increasing

Road transport has increased significantly in the past 50 years, as the figure below shows, primarily due to an increased number of cars and increased goods transport.



Domestic passenger transport. Millions of transport kilometres. Source: Statistics Norway, 2009.

Annual distance driven (in millions of vehicle kilometres) per vehicle group in 2007 was (Institute of Transport Economics, 2008)):

- Passenger cars (incl. leased cars and taxis): 31,859
- Goods transport: 4,814
- Busses: 353

Transport with cars is increasing more than other forms of passenger transport. While passenger car transport increased by 13 percent from 2000 to 2007, the growth in total passenger transport was scarcely 1.5 percent during the same period (SSB.no, 2009).

The average distance driven per car has been relatively stable since the 1980s, comprising approx. 13,600 km (Information Council for Road Traffic, 2009). This allows us to see that the primary reason for increases in road transport is that the number of cars is increasing transport not that each individual car is driving longer than before.
Goods transport on roads have also contributed considerably to increased road transport. Measured in ton-kilometres, goods transport on roads has increased by 25% from 2000 to 2007 (SSB.no, 2009).

Greenhouse gas emissions from road transport will continue to increase if measures are not initiated

The emissions of greenhouse gasses from road traffic have increased from 7.7 million tons of CO_2 in 1991 to 10.3 million tons in 2007. This constitutes a growth of 34% since 1991 (SSB.no, 2009).

The table below shows the emissions of greenhouse gasses from road transport and passenger cars in 2007 and the emissions that are expected in 2020 as per the Reference Scenario (Norwegian Pollution Control Authority, 2007).

Millions of tons of CO2 equivalents	Actual emissions 2007	Reference Scenario 2020	Increase from 2007 to 2020
Total	55,0	59,0	7 %
Road traffic	10,4	13,6	31 %
Passenger cars (59%)	6,1	8,0	31 %

Table: The expected increase in greenhouse gas emissions for the Reference Scenario up to 2020. Source: Norwegian Pollution Control Authority (2007) and ssb.no (2009)

The Reference Scenario is based upon a straight projection of the growth in traffic and emissions of greenhouse gasses, including the cars becoming 1% more efficient each year. The Norwegian Pollution Control Authority (2007) estimates that if the quantity of traffic does not, in contrast, increase by more than what has been the case for the past 15 years, then the emissions from passenger cars will end at 7.3 million tons of CO_2 in 2020, which is 0.8 million tons lower than the Reference Scenario.

How the emissions of greenhouse gasses from road transport will actually trend in the future will be dependent upon the trend of the population, the general economic trends and precisely which measures are initiated in order to limit the emissions.

New cars have lower emissions and are driven more than old cars

Emissions of CO_2 from new cars have been dropping since 2004. The EU's goal is for the average emissions from new cars in 2020 to be max. 95g CO_2/km. This involves a reduction of over 30 % during the period. The average emissions from the fleet of cars will also drop during the period, and it will drop more quickly the faster the fleet of cars is replaced.

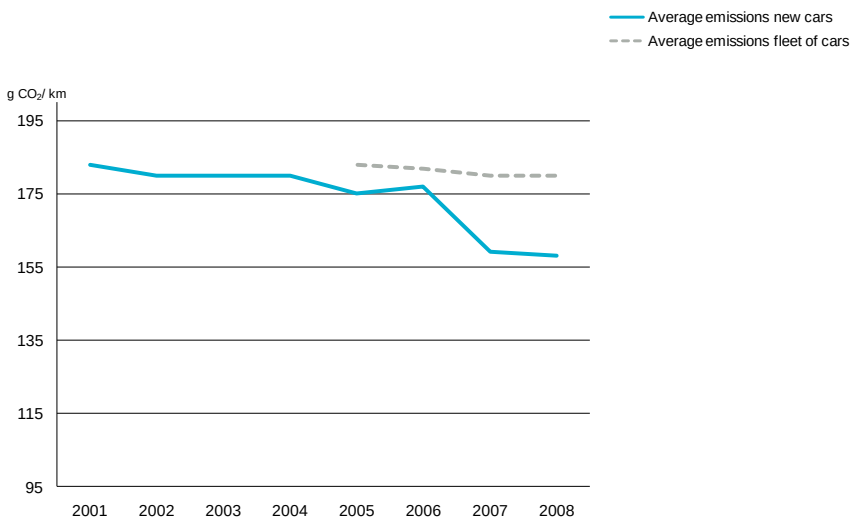


Figure: Average emissions of CO_2 per km from new cars and the fleet of cars (Information Council for Road Traffic, 2008)

New cars have a significantly longer distance driven per year than older cars. This is visualised in the figure below.

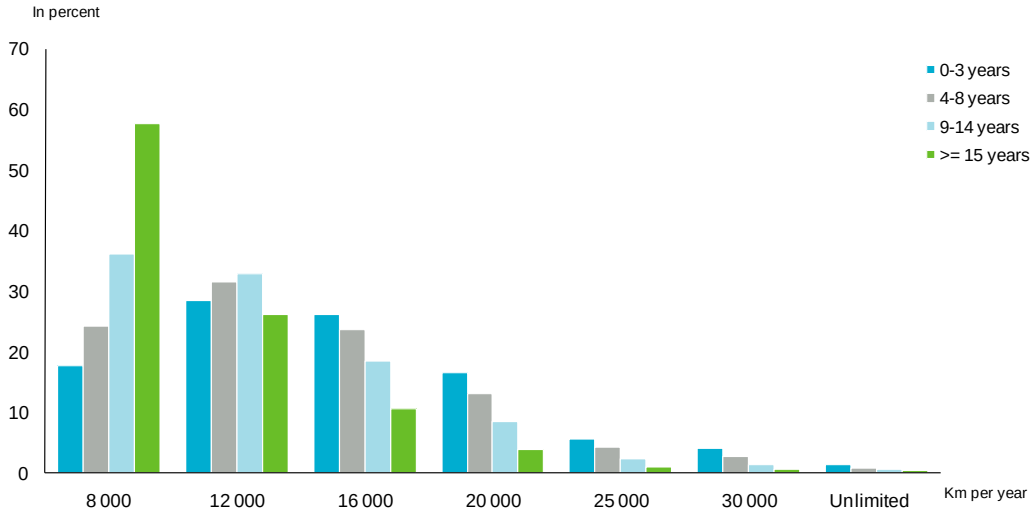


Figure: Insured distance driven for privately owned cars of different ages. Source: Information Council for Road Traffic, 2008 / If Skadeforsikring.

For company-owned passenger cars the trend is the same, but still clearer. This shows that the more efficient new cars will give greater reductions in greenhouse gas emissions than is indicated by considerations based solely on the average.

4.2 Most of the trips driven are relatively short, however the cars are also used for longer holiday trips and work-related journeys

Today's cars are not limited by the distance they can drive. An electrical car of the type that is currently on the market has, in contrast, a limited driving distance and limited room for passengers and baggage. A rechargeable hybrid car will, similarly to today's cars, not have limitations on the distance it can drive, however the distance it can drive using electricity will be limited to the capacity of the battery. In this chapter we will hence be looking at how today's cars are being used. This will form a basis for assessing precisely which users

can utilise electrical cars and how large a percentage of the length driven with a rechargeable hybrid car would be using electricity.

By far most people have a car at their disposition

In Norway, 87% of the people live in a household that has a car at its disposition and a total of 39% live in a household that has at least two cars (Institute of Transport Economics 844/2006).

Most of the trips using a car are short and with 1- 2 persons in the car

According to the Institute of Transport Economics (856/2006) the average length driven per day is 43 km. In 88 % of the trips by car, there are max. two persons in the car. Around 80% of all car trips are shorter than 100 km and over 40% are shorter than 3 km (EBL, 2008). This shows that most of the people with rechargeable cars will be covered by the capacity of the battery in their daily driving.

Cars are also used for longer trips and with several passengers

Over 80% of the trips of between 100 and 300 km are made using cars. For trips of over 300 km, this share is reduced to 38% (Institute of Transport Economics, 2005). For longer trips, there are also often more persons in the car as well as a lot of baggage. This is not compatible with today's electrical cars, which are often small and have little storage capacity. If rechargeable hybrid cars become available in most categories of cars, including larger family cars, they would be able to be used. However is cases where long distances are driven much of the trip would occur using the internal combustion engine of there is no possibility to recharge quickly or replace the batteries along the way.

Commuting is responsible for most of the distances driven and the average distance driven to work is 12 km

Driving to work, including to school and business trips, comprises the longest distance driven on a daily basis with 33% of the number of kilometres driven for a private individual. Here, the average number of persons in the car is 1.15 (Institute of Transport Economics, 856/2006). According to the Institute of Transport Economics (2008), the average distance to the workplace by road is 12.3 km. There are substantial variations in the average distance driven to the workplace, and we find the longest distances in Østlandet. In particular the working population of Akershus, Hedmark, Buskerud and Vestfold travel further than the national average. This is probably a result of commuting to Oslo. For the municipalities around Oslo, the average distance driven to work is over 18 km. Corresponding patterns exist for the municipalities around the other large towns.

These distances would be able to be covered by the capacity of the batteries in rechargeable cars. Around and inside the towns, most of the public transport lanes are also available for electrical cars. At the same time, commuting is responsible for a large part of the driving able electrification of the commuter traffic would thus be an effective measure for reducing greenhouse gas emissions.

Over 300,000 employees receive compensation for their use of a car in their work

A total of 13% of all employees receive compensation for their use of a car in their work. A total of 3% have a company programme under which all expenses are covered by the employer (Institute of Transport Economics, 856/2006). With a labour force of 2.6 million in 2008 (SSB.no, 2009), this comprises 338,000 and 78,000 persons respectively. Current measures in connection with increased fees per kilometre and discounts in company taxation would be able to influence them to choose a rechargeable car instead of a petrol/diesel car.

Taxis have a long length driven per day

In 2007 there were 8,728 taxis registered in Norway. A total of 1,012 of these were registered as busses (Information Council for Road Traffic, 2009). The taxis drove a total of

444 million km that same year (Institute of Transport Economics, 2008). This comprises an average of approx. 51,000 km per year per taxi. If one presumes that the driving is distributed equally across all days, this means an average of 140 km per day. There will probably be large variations here.
With such a large length driven per day, the possibilities for the use of today's electrical cars for operation as taxis will be limited. If it should become relevant to electrify a larger portion of the taxis, such would probably require systems for rapid recharging or battery exchanges.

The average daily length driven by tradesmen around and inside towns is probably approx. 110 km

Tradesmen are among those professional groups who undertake the most trips during their work. They take trips on most days and are dependent upon a having car for moving their tools and equipment. In addition, they are by and large alone in the car. A study was done of a random sample of tradesmen in Oslo and Akershus, which has been described by the Institute of Transport Economics (2008). A total of 83% state that they spend 2 hours or less in their car each day, of this approx. 40 % of the time in slow-moving queues. If an average speed of 70km/h is reckoned for normal traffic, and 30 km/h for slow-moving queues, this corresponds to a distance driven of 108 km per day. For tradesmen without a need for a capacity to haul particularly large loads, a rechargeable delivery van would thus be an alternative to today's cars. Queuing and parking were listed as a challenge for many of the tradesmen in their daily activities, access to the public transport lane would help them with the first of these. Possible reserved parking places for electrical cars would also be able to contribute to it being easier to find parking.

Use of cars by the public sector

Passenger cars used by municipalities comprise approx. 9000 cars. For example, home help services and administration, operation and maintenance areas where there is a need for a car for the service. Pistens are another example of a public sector fleet of vehicles. If you drive a rechargeable car with a battery capacity of 160 km, you can drive continuously for 2 hours at 80 km/h. All user groups that lie within this would be able to switch to today's electrical cars.

A large portion of the cars for commercial and public sector administrative use are leased

A large percentage of all new cars enter the market via leasing companies. The leasing costs for cars are to a large extent based upon the second-hand value of the cars after the end of the leasing period. This is unknown for rechargeable cars, and uncertainty is particularly associated with the value of the battery. Purchases of electrical cars are at present exempt from VAT. In contrast, VAT is collected for leasing on the interest and depreciation expenses. Leasing of rechargeable cars will reduce the risk for the user, however the fee system today favours owning rechargeable cars over leasing them.

4.3 Outside city centres, most people have access to their own parking spaces at home and park for free at work

Parking areas for the general public that are regulated with respect to the Road Traffic Act or civil law regulations comprise around 200,000 spaces (Norpark 2009). In addition, there are a number of parking spaces at companies, at schools, shopping centres, housing cooperatives and other locations that provide free parking without any form or regulation or which are reserved for specific groups. In cities and urban areas there are also a significant number of locations and streets where there are no restrictions in the form of parking regulations. These are not included in the figures.

Privately regulated spaces for the general public are estimated to comprise 60% of the total market. Private parking spaces that are designated as ”reserved parking” are substantial. It

is presumed that this offering comprises 50% of the parking spaces in the centre of the large cities in Norway (Norpark, 2009).

Of the households that have a car at their disposition, approx. 90% have access to their own garage or parking space. The percentage that have both a car and their own parking at their disposition is significantly lower in the centres of the towns. In Oslo, 70% of the households have a car with their own parking. This also varies a lot between the quarters of the city in Oslo, in the city centre only 30% have their own parking for their cars (Statistics Norway, 2002). Approx. 420,000 households have 2 cars (or more) and their own garage or parking. Approx. half of these are in urban regions (Statistics Norway, 2002).

Free parking is one of the most important explanations for the choice of the means of transport to work. In Oslo, 60% of the working population with a driving licence and access to a car have free parking with good places, whereas in the country outside the large towns the corresponding figure in contrast is 80% (Institute of Transport Economics, 856/2006).

On a national basis, by far the most have access to parking both at work and at home. This shows that is recharging points are built at work and at home, then by far the most will be able to have fully charged batteries both in the morning and in the afternoon.

Oslo has an on-going experiment with residential parking in the city. This is based upon all the residents of an area being able to apply for a parking card that is valid for the area. Cards will not be issued in excess of the number of parking spaces that are included in the arrangement, thus it ensures the residents of the area that they will always find a parking space. It is self-evident that such a test programme can be expanded to also include some spaces with a recharging possibility that are reserved for rechargeable cars. Car owners would thus be ensured a parking space at home where they can recharge their car during the course of the night.

5 Rechargeable cars – current use and trends in the technology

Rechargeable cars represent a change in the type of engine and the technology for storing fuel in relation to today's cars. In this chapter we will look in further detail at what rechargeable cars are and what causes them to contribute to reducing greenhouse gas emissions.

We will also look at the rechargeable cars that specifically are in use in Norway as well as glance at models that will probably be on the market in the future. Without measures having been established to stimulate the purchase of electrical cars, there would probably have been still fewer of such cars in use today. We will hence give an overview of the specific measures that currently exist.

Measures have been commenced to contribute to the increased electrification of road transport locally at several places in Norway and abroad. We will conclude this chapter by giving an overview of some of these measures.

5.1 Rechargeable cars comprise electrical cars and rechargeable hybrid cars

The cars that are included when we talk of electrification of road transport are those cars that can recharge their batteries from the electrical grid. That is to say, purely electrical cars and rechargeable hybrid cars. An umbrella designation for these cars would be rechargeable cars.

Purely electrical cars have an electrical engine that drives the cars with electricity from the battery. The range of the car will be dependent upon how large the battery is. A typical range for many electrical cars would be 100-180 km on a fully charged battery.

For rechargeable hybrid cars, two different technologies are primarily involved:

- *Rechargeable parallel hybrid:* The car is equipped with an electrical engine and an internal combustion engine that can drive the car simultaneously or each on their own. The car runs on electricity from the battery as long as there is power from it, subsequently the internal combustion engine takes over.
- *Rechargeable series hybrid:* The car is driven using an electrical engine, but it also has an internal combustion engine that drives a generator which in turn produces power for the electrical engine. The car runs on power from the battery as long as there is electricity in it, power is subsequently produced from fossil fuels.

Different variants exist within these two main categories. Most rechargeable hybrid cars would be able to recharge their batteries when braking the car and by use of the internal combustion engine.

Different technologies in rechargeable hybrid cars will give different distances driven for the battery and different emissions for driving with the internal combustion engine. The EU has developed a method for measuring emissions from rechargeable hybrid cars in a standardised driving cycle. This allows all rechargeable hybrid cars that are sold in the EU

to have defined emissions of CO_2 per km that can be utilised in the formulation of fee systems, etc.

5.2 An electrical engine drives a car 4-5 times more efficiently than an internal combustion engine

An electrical engine drives a car much more efficiently than an internal combustion engine. Much of the energy in an internal combustion engine is lost in the form of heat and idling. An electrical engine generates less heat and the engine stops when the car stops (no ”idling”). In situations where an internal combustion engine consumes a lot of fuel, for example during acceleration and cold starts, an electrical engine is much more energy-efficient. These are conditions that contribute to electrical cars being 4 to 5 times more energy-efficient than traditional internal combustion engines.

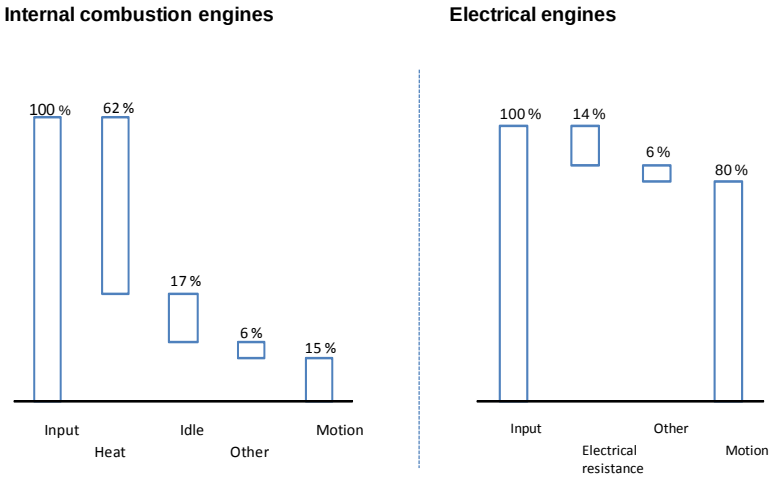


Figure: Electrical care are most energy-efficient, Source: Alliance Bernstein (2006)

According to King (2008) it is expected that new cars with internal combustion engines will become up to 30% more efficient by 2020. This represents a ceiling for how efficient purely petrol and diesel cars can become. Despite increased efficiency in petrol cars, cars that drive 100 % on an electrical engine will be at least 4 times more efficient that cars with internal combustion engines. In the winter, the efficiency of rechargeable cars will be marginally lower in that they use power from the battery to heat the car.

In many places, the production of electricity will bring about emissions of greenhouse gasses. If emissions of greenhouse gasses are included in the entire chain from the production of the fuel/electricity to its use in the car (”well to wheel”), the total greenhouse gas emissions from an electrically driven car will nevertheless be lower than from today's conventional cars. This also holds true if the electricity is produced from coal.

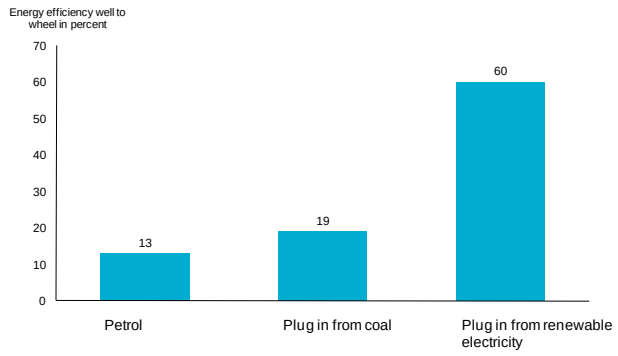


Figure: Energy efficiency from ”well to wheel” for different energy sources, Source: General Electric, Econ Pöyry

In Norway where fossil fuels can be exchanged for renewable electricity, the effect of electrification of road transport will be greater than in most other countries.

5.3 Rechargeable cars will make for better air quality and less noise

Despite strict European emission restrictions, road traffic continues to be the greatest source of local air pollution. Among other things, exhaust from vehicle traffic contributes over 90 percent of the levels of NO_2 concentrations. The portion of diesel cars is increasing in Norway, and these cars have higher emissions of NO_2 and particles than petrol cars. Boundary values for suspended dust and NO_2 are exceeded every year in Norwegian towns. Suspended duct from exhaust and NO_x causes health nuisances such as asthma and other air passage illnesses (www.miljostatus.no, 2009).

Noise nuisances in the town are increasing, and road transport is also the most important source in this case. Road traffic is also the noise source that is increasing the most. Noise comprises a risk factor for stress-related health problems (www.miljostatus.no, 2009).

Electrical cars and rechargeable cars that drive on electricity have no exhaust emissions. In addition, electrical engines are extremely quiet in comparison with internal combustion engines. The electrification of road transport will thus contribute strongly to a reduction in local air pollution and noise from road traffic.

5.4 A total of 2400 electrical cars are in use today, more models are coming on the market

In this chapter we will say something about the use of electrical cars in Norway today, as well as precisely which models of electrical cars and rechargeable hybrid cars will probably come on the market in the next few years. Delivery vans and busses will also be discussed.

Approx. 1,700 electrically driven passenger cars have been registered, half of them in Oslo, Asker and Bærum

In total nearly 1,700 passenger cars have been registered that are rechargeable cars. Half of the electrical cars are found in the municipalities of Oslo, Asker and Bærum. All of these cars are purely electrical cars, no rechargeable hybrid cars are currently being sold. Think dominates this market in Norway, with over 50% of the cars. The price of their new model, Think City, is around NOK 212,500 plus a monthly battery lease of NOK 1,200.

Several of the large automobile manufacturers will probably be producing rechargeable passenger cars in the next few years. BYD is expected to launch the first rechargeable hybrid in Norway at the end of 2010 or in 2011. It is expected that Mitsubishi's electrical car, the i-MieV, will be launched in Norway in 2011. For a more detailed overview, see Appendix 3.

A total of 664 electrical cars have been registered, with half of these in Oslo

City cars, or quadracycles, are registered as 4-wheeled motorcycles and are suitable for urban use. Around half of these cars are registered in Oslo. A total of 80% of the registered quadracycles are Buddy, the rest are Reva. These cars cost from NOK 132,000 and 123,000 respectively. Both cars have room for two people.

A total of 54 electrical delivery vans have been registered

A total of 54 rechargeable delivery vans have been registered in Norway. Eight of these are in Oslo and four in Bergen. Over half of the vehicles are Peugeot Partners.

Rechargeable delivery vans are on the market, however not all of them are type approved. Most of these vehicles are distributed by Enviro Elbilsalg and GoGreen. Their prices

depend upon their size, but lie in the range of approx. NOK 290 – 825,000 (EUR 33,000 to 94,000).

Busses

A total of 10 electrical busses have been registered in Norway, most of them are trolley busses that are used in Bergen. In Trondheim, a rechargeable bus drives shuttle traffic between the railway station / parking lot and the hospital, a distance of 1.6 km. It has room for 8 seated and 20 standing passengers. The bus was purchased from Tecnobus in Italy, where 50 equivalent busses are in operation. The bus is driven in traffic the entire day long, and its operation is based upon daily battery swapping. Swapping batteries takes approx. 15-20 minutes.

In Italy there are several manufacturers, including Technobus and Fiat (which is distributed by Micro-Vett). The former delivers busses to a number of countries in Europe. These are to a large extent smaller busses with relatively few seats, but also with room for standing passengers. There are also distributors for these busses in Norway. Prices of minibuses start at approx. NOK 1.1 million (EUR 122,000).

5.5 There is a need for further development of batteries for rechargeable cars

The costs of battery packs in electrical cars are large and often comprise approx. half of the production costs. Widespread use of rechargeable cars is dependent upon rapid development of battery technology, primarily in relation to cost, performance and safety (BERR, 2009). It is also important to ensure that used batteries are handled in an environmentally responsible manner.

Characteristics of different types of batteries

The table shows some battery types that are in use for rechargeable cars (or purely hybrid cars) today. Good batteries will have a high specific energy in relation to their weight such that one can drive as far as possible simultaneously with the total weight of the car being kept as low as possible. Based upon the figures in the table, we can see that it is lithium ion batteries that are the best with respect to this.

	Li-ion	Li-M-Polymer	NiMH	NA-$NiCl_2$	Lead
Specific energy (Wh/kg)	75-120	100-120	50-70	100-120	20-30
Specific power (W/kg)	1,000 – 3,000	200 - 250	1,000 – 1,500	NOK 180	200 - 500

Table: specific energy and specific power for different types of batteries. Source: BERR (2009)

Lead batteries have up to now been used in Think, Buddy and Reva. Lead batteries are a familiar technology, and there is a great deal of experiential data on their lifespans and performance over time. In hybrid cars, it is primarily NiMH batteries that have been used. Last year, Toyota sold approx. 430,000 hybrid cars (not rechargeable) with such batteries on a global basis (Løken, 2009).

Regardless, there is broad agreement that lithium ion (Li ion) is the type of battery that has the most promising combination of power and energy efficiency when it comes to expanding the use of both electrical cars and rechargeable hybrid cars (BERR, 2009). Think, Buddy and Reva are all now delivering cars with lithium batteries. Think will also be using a sodium battery. This is a battery type that has a higher specific energy than lead batteries, but with which we currently have limited experience with its use in vehicles.

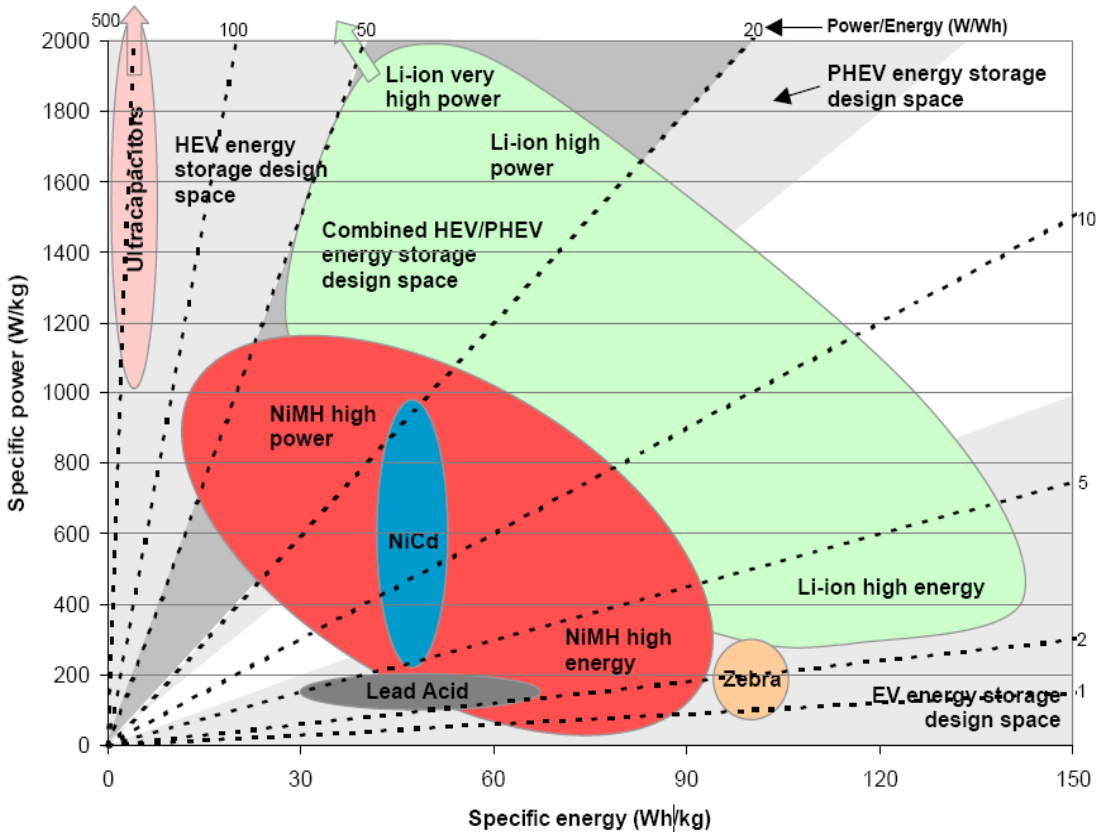


Figure: Challenges connected with physical properties of different batteries in relation to the needs for rechargeable cars. Source BERR (2009)

According to Løken (2009) several generations of vehicle batteries will probably be developed that will succeed lithium ion batteries in the broader course of development.

The costs of batteries will probably be reduced

The cost of battery packs comprises at present approx. half of the production costs of an electrical car. For many models of electrical cars being planned there continues to be uncertainty as to what the batteries will cost. Li-ion batteries being bought for Think today lie in the range of approx. NOK 5 - 5,500 ($7-800) per kWh stored in the battery. This cost, according to Mollestad (2009), is expected to be reduced to approx. NOK 3,500 ($500) per kWh of battery capacity during the course of 2-3 years. This will reduce the cost of a battery of 28 kWh (corresponding to the battery that is in Think City, with a range of 180 km) by NOK 49,000.

According to BERR (2009), battery manufacturers also believe that the cost of batteries will be reduced in a medium to long-term perspective. This is based upon the massive investments that are now being made in this sector and drops in the prices of mass-produced batteries for the consumer market.

Recharging of batteries can occur at different speeds

The time it takes to charge a battery from the ordinary electrical grid depends upon how large a capacity (and thus the range) the battery has. A battery with twice the capacity will also have twice as long of a recharging time if the battery is to be fully recharged from being completely empty. Examples of this are shown in the table below.

Battery size (KWh)	Recharging time (hours)	Range (km)
15	5	100
30	10	200
60	20	400

The recharging times for Buddy and Reva are 6-8 hours, which gives a range of 40-120 km. The batteries in Think City are fully charged in 7-10 hours, and have a range of 125 – 180 km.

If one chooses a solution where the batteries are recharged with a higher recharging power, the batteries can be recharged significantly faster. The recharging power increases when the value of the current and/or the voltage is increased. Rapid recharging, which is defined as 35 kW charging power in the figure, requires, for example, 400 volts and 50 amperes or 330 volts and 150 amperes.

Management of expired batteries

Batteries used in cars, consumer electronics and in industrial applications contain metals that can be hazardous to the environment if they are not managed in a responsible manner after they have been taken out of service. The EU has thus adopted a directive that poses requirements for the collection, handling and recycling of battery waste. The main points in this directive can be found on the Internet (EurActiv.com, 2009).

This directive establishes according to Batteriretur (2009) a ban on the deposition of vehicle batteries, and for electrical cars and hybrid cars a requirement that 50% of the battery's weight be recycled. Both this and a total ban on the deposition of hazardous metals are being complied with in Norway.

Toyota is currently accepting batteries that were being used in their hybrid cars. The batteries are being recycled such that some of the waste goes to the production of new batteries (Toyota, 2009).

5.6 Overview of current framework conditions for rechargeable cars

VAT

Electrical cars are exempt from VAT when they are purchased.

Vehicle Import Duty

Electrical cars are exempt from the Vehicle Import Duty.

The duty is computed on the basis of the vehicle's weight, power and CO_2 emissions. All three of the components in the fee are progressive. The fees are also included in the basis for the VAT charged on the vehicles.

Beginning 1 January 2009, the CO_2 component has been given an increased emphasis. Cars with documented emissions of less than or equal to 120 g/km will not pay the CO_2 fee component. At the same time, a deduction of NOK 500 is granted to the Vehicle Import Duty for each gram of CO_2 under 120 g/km that the vehicle does not emit. The total Vehicle Import Duty for a motor vehicle with CO_2 emissions under 120 g/km, vehicle scrap deposit duty not included, cannot be negative. At the same time, the Vehicle Import Duty increased significantly for cars with emissions over 250 g/km.

For hybrid cars, the power associated with the electrical engine is not included in the basis for the fee. The weight basis is reduced by 10% in order to take into account the weight of the electrical engine and battery. On the overall these changes involve, for example, a Toyota Prius with emissions of 104 g/km receiving a deduction in the Vehicle Import Duty of NOK 10,861 in relation to the Vehicle Import Duty for 2008 (Econ Pöyry, 2008).

Annual fee
Electrical cars pay a significantly reduced annual fee, with a rate of NOK 390.

Other measures
Electrical cars enjoy the following benefits:

- Able to drive in the public transport lane
- Reserved parking spaces with recharging in publicly regulated parking areas

Financial measures in addition to VAT and fees:

- Exemption from parking fees in publicly regulated parking areas
- Exempt from paying road tolls
- Free ticket on state highway ferries
- For business trips using one's own car, state employees receive a higher rate (NOK 4.00 /km) if they use an electrical car than for a normal car (NOK 3.50 /km)
- Only 50% of the basis of calculation is used for taxing companies on their electrical cars

Subsidies for recharging stations
A total of NOK 50 million has been earmarked in 2009 for expansion of the infrastructure for recharging rechargeable cars. At present, no decision has been made as to how this programme will be administered or who will receive the support. The support will be routed through Transnova.

The City of Oslo has introduced a subsidy programme in which housing cooperatives, jointly owned properties, shopping centres and the like are able to apply to the City Traffic Authority for subsidies for establishing recharging spaces. A requirement for support would be that it is possible to measure the energy consumption at the spaces. These spaces would be included when the goal of 400 recharging point in Oslo is to be reached (Elvehøi, 2008).

5.7 Overview of costs for construction of recharging points
In order to give an overview of the costs connected with building recharging points for electrical cars, we have collected figures from the construction of such in Oslo and Trondheim. Here, this involves recharging from the ordinary electrical power grid (230V/ 16A). Higher voltage or current levels will involve higher costs.

Recharging points in parking garages
Indoor recharging points in parking garages require that outlets (lockable) be set up and connected to existing fuse boxes. Figures from experiences in Oslo and Trondheim give a cost range of NOK 7,000 to 9,000 (incl. VAT) per recharging point in parking garages. The primary expense will be the hours worked by the electrician.

Recharging points outside at parking lots or on the street
Installations of recharging points in parking lots or on the street consist primarily of a distribution cabinet, posts and the recharging point itself. Based upon figures from experiences in the City of Oslo (2009) this constitutes from NOK 7,000 to 9,000 (incl. VAT) per recharging point.

Expenses for excavation are in addition to this and often comprise the largest line item. This expense will vary depending upon how far it is necessary to excavate in order to run power to the parking spaces. Figures for excavation expenses in the construction of

recharging points at two different parking areas in the centre of Oslo show a broad range, from NOK 14,000 to 25,000 per recharging point (incl. VAT).

Residential recharging point in the garage

The costs of setting up an outlet at home in the garage or on an exterior wall of the house will be limited. It will vary to some extent depending upon how far cables, etc. need to be run. One estimate given for this is NOK 2,000 - 4,000, per recharging point (elektrosentralen.no, 2009).

Costs connected with project costs paid to the grid owner

Project costs are a one-time fee that the grid company can demand from a customer to cover all or parts of the costs of connecting the customer to the distribution network. The amount of the project costs can vary from NOK 0 to a 6-digit amount, depending upon how comprehensive the reinforcements are to the grid that are necessary to create sufficient capacity for recharging.
This is not included in the cost computations above.

The project costs for reinforcements to the grid, where such are necessary, could stop the construction of recharging points at a number of locations. There will be a challenge in the building of recharging points in that some points will be relatively reasonable whereas other locations will be so expensive that their construction is impeded. When rapid recharging is being built, this complex of problems will become even more acute.

5.8 Effects on the electrical grid

The volume of electricity consumed for a car will be small in relation to the other power being consumed, and thus is of little significance to the overall electrical grid system. Another question that often arises is what would happen to the electrical grid if all the cars were to be recharging their batteries simultaneously. Today, this does not pose any problem, even though there could quite locally be a need for reinforcing the grid if it is fully engaged in areas where there is a desire to establish recharging points. The complex of problems will become more central at a later point in time with a substantially larger percentage of cars needing recharging.

In order to reduce the simultaneous load, time controls could be a possible measure. Furthermore, the introduction of 2-way communication in the electrical grid will enable time-variable tariffs, such that price signals direct the recharging to a point in time that is preferable with respect to simultaneity in the grid. Co-operation with the grid companies locally is important when establishing recharging points. In particular this applies for larger systems where several cars are to be able to be recharged simultaneously and in the establishment of rapid recharging requiring high voltage outlets.

5.9 A number of places in Norway have already initiated measures for phasing in rechargeable cars

The work on the electrification of road transport has been started on a small scale in a number of places. The projects can also provide important experience in the use of rechargeable cars that can be built upon when it is desired to escalate the electrification. A number of Norwegian municipalities have taken the lead by purchasing rechargeable cars and begun the construction of recharging points.

The City of Trondheim is testing 27 electrical cars and is building up to 300 recharging points

The City of Trondheim has decided to invest in electrical cars for its own fleet of cars as well as in the construction of recharging stations in the town. The city has 26 cars in an automotive pool at the city centre that has consisted of small petrol-powered cars. During the course of 2009, twenty of these will be replaced with electrical cars. In addition, the Administration, Operations and Maintenance Unit in the city has received 3 electrical

delivery vans (Fiat Fiorino Cargo) and 4 equivalent cars will be tested by the home help service for one year. The city is also investing in building recharging points in the town, 22 recharging points will be completed in 2009 and up to 300 before the end of 2011 (Berthelsen, 2009).

Two of the cars used by Trøndertaxi are electrical cars. The city has supported the project and the construction of recharging points for these taxis. In addition, there is an electrical bus driving shuttle traffic between the station and St Olav Hospital.

The City of Trondheim is participating in a regional project in which Sundsvall, Østersund and Trondheim are co-operating in projects that include climate-friendly transport. This project seeks to establish a ”green highway” in the region with recharging points for rechargeable cars along the way.

A total of 400 recharging points in Oslo by 2011

The City of Oslo has decided to build 400 recharging points by 2011. A sum of NOK 4 million has been set aside for this work. A total of 36 spaces have been established so far, and it is expected that a further 100 spaces will be established during the course of 2009. The city is also supporting the construction of recharging points at companies, housing cooperatives and other market participants (not private individuals) with up to NOK 10,000 per recharging point.

The City of Tromsø is buying 10 electrical cars this year and will build 100 recharging points by 2011

The City of Tromsø has 380 small and large municipal vehicles. In 2009, ten electrical cars will be purchased, and the same number will be purchased each year for the next 4 years (aftenposten.no, 2008). The ling-term goal is for all the cars to be electrical cars. In addition, 100 recharging points will be established for electrical cars by 2012 (itromso.no, 2009).

Bodø Energi et al will be establishing companies for leasing out 40 electrical cars and the construction of recharging points

In Bodø, a company is now being established that will arrange for rechargeable cars. The company will be called MovingCity and will be established in conjunction with Bodø Energi, Umoe iTet, Public Online and Avis Bilutleie. According to the plan, the company will initially purchase 40 cars for leasing to market participants in the Bodø area, including the city, Bodø Energi and the Norwegian Postal Service. In addition, the company will create recharging points for the cars (MovingCity, 2009).

In connection with the company, a practical research project will be established in conjunction with Bodø University College, with a focus on cost-benefit analyses and consumer behaviour research.

Eidsiva Energi

Eidsiva Energi has taken the initiative for a substantial offensive to organise the electrification of road transport in Innlandet. An important part of the project will be co-operation between owners of large fleets of vehicles, for example municipalities, large companies and the automobile industry. Eidsiva has built recharging points at Hamar and Lillehammer, and is also planning to build recharging points at Gjøvik and Kongsvinger. In addition, Eidsiva Energi purchased electrical cars and built a rechargeable hybrid car for demonstration purposes.

Municipality of Lærdal

Some other municipalities are also choosing to invest in electrical cars. The Municipality of Lærdal is buying one electrical car and will seek funds from Transnova to build recharging points in the municipality (nrk.no, 2009).

The company Move About will start a public solution for car-sharing using electrical cars

The company Move About has purchased 40 Think cars that will be included in carpool arrangements for companies in the Oslo area. DNV was their first customer, and has had 5 cars available for employees of the company since December of 2008. In addition, they are planning to launch a car-sharing programme using a concept corresponding to that used by public bicycles. The Oslo City Council has decided that they want such a programme and that the Municipality of Frogner will be a pilot project (Move About, 2009). A corresponding arrangement is being started in Gothenburg, and the desire is to take the concept to additional countries.

5.10 Measures have also been started abroad for the electrification of road transport

Reggio Emilia, Italy

Ten years ago, the Italian town of Reggio Emilia (approx. 167,000 inhabitants) was plagued by dense traffic and polluted air. The old town did not have the infrastructure that could tolerate modern traffic. This led to the municipality introducing a ban on the use of polluting cars in the town, only electrical cars and some other low-emission vehicles were allowed to drive into the centre. Three large parking lots were created outside the town, and busses depart from there that transport people into the centre of the town.

The fleet of electrical vehicles in the town consists of 500 cars, including passenger cars, garbage vehicles and delivery vans. The Italian government grants a subsidy of 65% of the purchase price when the municipality replaces its petrol-powered cars with electrical cars. In Reggio Emilia, a municipal corporation has been established that pays the rest. This company owns the cars, which are then leased out to municipal companies and bodies. In addition, the company builds and operates recharging points inside the town (aftenposten.no, 2008).

Sweden, 12 demonstration projects for the use of electrical cars – ”Wind in the tanks”

The purpose of the project is to accelerate the launching of electrical cars and the infrastructure for recharging them. In addition, the desire is to ensure that the fuel in the cars is maximally clean, and thus focuses on electricity from wind power. The project is supported by the Swedish Energy Agency and PowerCircle's many member companies in Sweden. The focus is not only on cars, but involves broad technical and commercial renovation of what is to be delivered to the end customers. This includes the delivery system for electricity to the car, the infrastructure for recharging, the production of batteries, electrical engines and other components. It addresses how business models should look and how the delivery systems should be expanded (PowerCircle.org, 2009).

At present, 12 demonstration projects have been created for electrical cars. The plan is for each place to find relevant users for electrical cars, build recharging points and create other functions, for example service that is sufficient for the number of cars that are included in the project. The goal of the project is to gain new knowledge about how electrical cars function in daily use, the performance of the cars and their needs for service, as well as precisely which business models are relevant for recharging the cars. The project will also provide broader experience for infrastructure for recharging and where cost-efficient cars are in operation (PowerCircle, 2008). The project's objectives are for 15% of the national fleet of cars in Sweden to be rechargeable cars by 2020, which equates to 600,000 rechargeable cars.

Places that are selected for the demonstration project must fulfil five conditions:

- There must be a focus on a well-defined user group in order to maximise the development of knowledge

- A clear regional strategy for conversion to renewable energy
- Energy companies in the area that desire to participate
- A local project manager
- The will to develop a new delivery system

One of these places is Kalmar, where the phasing in of 800 electrical cars has been planned by the end of 2012.

Denmark
Denmark has, similarly to Norway, high vehicle fees in general and full exemptions from fees for electrical cars. The authorities in Denmark have also launched a DKK 35 million programme to accelerate the electrification of their national fleet of vehicles. The Danish Energy Agency's programme is directed towards the local government sector as well as companies and aims to cover the incremental costs beyond normal automotive maintenance when parts of the fleet of vehicles are replaced with electrical cars. The Danish Energy Agency has also prepared a programme for surveying usage. The aim in total is to introduce 2-300 cars with this programme.

Austria
The authorities have established "Die Klima Energie Fonds" (along the lines of Enova/Transnova). The entire energy policy programme is affected. In the transport sector, the goal has been set of having 20% of the fleet of vehicles being electrical by 2020. This equates to 1.0 million electrical cars. This March they just launched the first of 4-5 large-scale pilot programmes for the use of electrical cars. The first programme, VLOTTE, encompasses 100 cars that will be used in the Bregenz region. The project is led by the local, state-owned power company Vorarlberger Kraftwerke. Think is the largest supplier of cars in the project. This project is being supported with EUR 4.7 million from Klima Energi Fonds.

The Netherlands and Spain
Both countries are launching this May respective EUR 10 million support programmes to accelerate the electrification of the transport sector. The Netherlands is emphasising the local government sector as well as companies. The means will be announced in May. The Netherlands have determined that they wish to have 1.0 million electrical cars in the road by 2020.

Spain has said that it will subsidise the introduction of the first 2000 electrical cars in 2009/2010 with its support programme of EUR 10 million. Local projects have also been initiated in Spain. The town of Soria is on UNICEF's list of cultural monuments. They have decided to close the town to petrol/diesel cars in order to protect the town from pollution and noise. An underground parking facility is being built for 1200 cars. Holding 600 petrol/diesel cars and 600 electrical cars. People who wish to go into the town park their petrol/diesel cars in the garage and rent an electrical car in order to drive into the town.

The UK and the US
With the Obama administration's visions we now see billions of dollars being made available for research, development and commercial acceleration of electrical cars.

6 Assessments of the resource group connected with the electrification of road transport

In this chapter we will describe and discuss the perceptions of the resource group as to what will be important measures for electrification. Our desire here is to elucidate complexes of problems that are relevant to the electrification of road transport and to provide a foundation for the measures that have been proposed.

The resource group has also identified some barriers that must be overcome in order to achieve the electrification of road transport to a greater extent:

- Acquisition costs
- Lacking knowledge about end experience with rechargeable cars among car purchasers
- Uncertainty connected with the performance and lifespan of batteries
- Purely electrical cars have a limited range
- The ”chicken and egg” problem connected with the introduction of rechargeable cars and the construction of infrastructure
- Not everyone has the possibility to recharge the car at home (parking on the street or in housing cooperative/co-owner)
- Project costs can limit the construction of recharging points, or contribute to recharging points being optimally placed in relation to the electricity grid, but not optimally in relation to their use
- Limited offerings of electrical cars during the next few years, and the uncertainty connected with when rechargeable cars will be produced on a large scale

Despite these barriers, the resource group is of the opinion that it is fully possible to start phasing in rechargeable cars in several segment groups now since the cars have been made attractive enough. This will be elaborated upon in further detail in this chapter.

6.1 Electrification of road transport should take place in different phases

The resource group believes that a first phase of electrification may occur without rechargeable cars being commercially competitive with conventional cars. More rechargeable cars must come onto the market, and battery production must be scaled up in order to get the costs down. In addition, service functions must be expanded for rechargeable cars; workshops, service, possible leasing company for batteries.

It is uncertain how many rechargeable cars there must be in Norway, or in the global market, before it is possible to move to a commercial phase. For service functions it will also be significant whether electrical cars are concentrated in urban areas or spread evenly across the entire country. The resource group has, regardless, suggested that a level of

approx. 50,000 rechargeable cars is needed before one can expect a transition to a commercial phase.

The resource group believes that it will be difficult to achieve a shift of technology from fossil fuel driven cars to cars that to a large degree are driven by electricity, as well as to accelerate access to rechargeable cars in Norway, without substantial use of governmental support for such a phasing in.

6.2 Progress in electrification requires that someone be assigned a national role as a co-ordinator and driving force

The need for simultaneity with respect to the acceleration of the distribution of rechargeable cars and the development of recharging possibilities will be a challenge that will require an effort in several areas simultaneously: marketing measures, infrastructure, exchanges of experience and information. This work must be nation-wide and well-coordinated. There hence is a need for a national network to stimulate the market and develop its infrastructure. Green Car is a concept that can contribute to stimulating the market and infrastructure, preferably with exchanges of experience with the Demo Sites project in Sweden. The Norwegian Electricity Industry Association is willing to assume an active leading role here if it is desired. In a concept such as Green Car, it is important to include a number of participants. What we have in mind here are environmental organisations and sales/leasing organisations, the Norwegian Association of Local and Regional Authorities and the Norwegian Employers' Organisation for Locally-owned Enterprises.

There will be a need for targeted efforts aimed at large users of cars

Co-ordination is needed in the ordering of rechargeable cars by professional automobile users in order to stimulate access to and demand for rechargeable cars in Norway. Such a collection of orders for plug-in cars would also be able to give car producers important security that the rechargeable cars they are planning to produce will be sold.

Zero, Hafslund, Think, LeasePlan and the Norwegian Electricity Industry Association came up with an idea at the Green Box event for how this could be solved through a project that they called ”Green Car”. The idea is that ”Green Car” will survey the needs and co-ordinate the ordering with the customers, and then transmit these needs to the manufacturers of rechargeable cars. Green Car will subsequently enter into framework agreements with different car manufacturers that the fleet owners can exercise with their orders. A leasing company is co-operating with the project for the purchasing and leasing out of cars. Green Car will not purchase the cars; it is the leasing company or the fleet owners themselves who will own the cars. Project Green Car has environmental visions, expertise and contact with the fleet owners, and can use this to create a focus on rechargeable cars in the market and with the manufacturers in a manner that leasing companies to a large extent do not do today. The players behind the idea are underway with a preproject that will be completed before this summer. The results of this preproject should be viewed in the context of a national role as a driver and co-ordinator.

The development of recharging points and service functions must lie on the leading edge of the widespread distribution of rechargeable cars

An important barrier to the increased use of electrical cars is the fear of being stuck with a flat battery and no possibility for recharging it. The consumer needs the security of there being an adequate possibility to recharge before purchasing such a car could be relevant. Access to a sufficient number of recharging points was highlighted as important by the car owners (ECON, 2006). This would also be an important point for rechargeable hybrid cars. The motivation for purchasing a rechargeable hybrid car would be slight if there were not adequate opportunities to recharge it.

Thus it will be important that a player is found who co-ordinates the development of recharging points and sees to it that these are in place before marketing measures are initiated to phase in rechargeable cars. Development of the marketing and the recharging points must take place in parallel.

There will be a need for information and exchanges of experience

At present, electrical cars comprise one thousandth of the total fleet of cars. Few people are familiar with rechargeable cars, how they work and what is required in the way of, for example, service. Many are probably worried about the range of the battery, where sufficient recharging points exist, the lifespan of the battery, the second-hand value of the car, etc. In order for the most people possible to gain better familiarity with rechargeable cars, the resource group believes that it will be important that they be allowed to see rechargeable cars in practical operation.

In addition, there will be a broad need for information and exchanges of experience on a national basis, supported by information pages on the Internet. As has been described, there are already a number of municipalities that have initiated measures whereby the municipalities themselves place electrical cars into service and build recharging points for their own cars as well as for use by the general public. It will be important to ensure that experiences from one place can be used at another place. This can involve everything from practical guidelines for the construction of recharging points, precisely where recharging points should be placed and how many are needed, how one informs and motivates the users of electrical cars working for the municipality, etc.

Governmental enterprises will receive an important role both in the purchasing of cars and in the construction of recharging stations

Governmental enterprises, and especially in this regard the municipalities, will receive a central role in the widespread distribution and visibility of rechargeable cars. In the opinion of the resource group it will be natural for the public sector to lead the way in the purchasing of zero emission cars as was established in the Climate Consensus. Rechargeable cars in use in all the municipalities in the country would cause familiarity with such cars to increase substantially.

The municipalities will be important for the development of the first recharging points in the municipality for their own electrically driven cars , at parking places operated by the municipality, its own parking places at the town hall, nursing homes, schools, etc.

The energy industry will probably be an important participant

Electrification of the road transport sector involves converting from fossil fuel to electricity, and it is then natural to ask specifically what role the energy industry will adopt during this process. There can be many different players who build recharging points or other installations, including the energy companies as the electricity suppliers and owners of infrastructure. The energy industry thus sees this becoming a commercial market that different players will find it interesting to participate in.

The energy companies are now assessing how they can contribute to the electrification. Some companies are already underway and are building recharging points, and have bought rechargeable cars. Most of the energy companies are owned by municipalities and county administrations. Co-operation between municipalities and county administrations will contribute both to developing the market for sales of electrical cars as well as to establishing infrastructure for recharging.

The energy companies wish to contribute to recharging points being built through arranging for them to be connected to the electricity grid. The Norwegian Electricity Industry Association is currently working on making guidelines for how energy companies and municipalities can proceed when recharging points are to be built. The batteries are, as was

mentioned previously, capital-intensive, which can be difficult for the manufacturers of the electrical cars to manage. Acting in a role connected with the financing of batteries could thus be relevant to assess for the energy companies.

6.3 The possibility for recharging is decisive for the purchasing and use of rechargeable cars

An electrical car must have power in the battery to be able to drive. A rechargeable hybrid car can also drive electrical power, but if a large part of the driving is done on petrol or diesel it is no longer economical or environmentally defensible to purchase such a car. Access to recharging points is thus crucial for all rechargeable cars.

The resource group is of the opinion that the primary focus during the first phase ought to be building simple recharging points with normal voltage and current values (230V/ 16A). In addition, the recharging points ought to be without complicated and price-raising payment solutions during the first phase. During phase 2 it will become more relevant to take payments for recharging rechargeable cars.

Car owners with parking on the street will not purchase a rechargeable car without receiving access to assured parking with recharging possibilities

The resource group believes that access to the possibility to recharge at home during the night is crucial for purchases of rechargeable cars. As described previously, most people have access to their own parking both at work and at home. There is however a large group in the cities who only have parking in the street without any fixed space. If it is desired that this user group acquire rechargeable cars, then they must be assured access to a parking place with recharging during the night. One possible solution to this would be arrangements with residential parking where there are the same number of parking spaces with recharging points as there are residents with rechargeable cars in the area.

There will be a certain need for developing rapid recharging

The resource group believes that recharging at home during the night will be the most important form of recharging, also from a longer-term perspective. With widespread distribution of rechargeable cars, there will nevertheless be a need for rapid recharging both in towns, on longer stretches of roads, at rest places and at excursion spots such as, for example, areas with holiday cottages. The possibility for rapid recharging will increase the assurances that the car owners will always be able to recharge their batteries if they due to various reasons have not had them recharged during the night, need to drive further than the range of the battery or do not have access to recharging where one has driven, for example at holiday cottages.

The development of rapid recharging will require a high current and/or a high voltage, and will be substantially more expensive than recharging points connected to the ordinary electrical grid. Due to this, rapid recharging will probably also be expensive to use in comparison with ordinary recharging. The resource group sees it as most natural that more widespread availability of rapid recharging will be relevant during a commercial phase 2, and that commercial players will handle this.

The resource group is of the opinion that the public sector, or the private with governmental support, will initially start with some of its recharging points having rapid recharging. Cable-pulling conduits should however be laid when all recharging points are built, such that the level of power can be increased as needed later without extra costs being incurred for reburying the cables.

Project costs can be a barrier for the construction of recharging points

Upon a need for increased capacity in the construction of electrical installations, a grid owner can demand project costs if there no longer is sufficient capacity at the nearest transformer of in the local lines. This will lead to an extremely large range in the expenses

for developing infrastructure for recharging, depending upon where in the grid the recharging stations are built. If the distribution of recharging points for rechargeable cars is to successfully become geographically independent of limitations in the electrical grid, then these expenses must be smoothed out. This is a complex of problems that must be handled by the authorities in co-operation with the energy companies.

6.4 Rechargeable cars will probably be on the market at full scale before 2020

There are strong drivers behind the electrification of road transport on a global basis. The trend in the price of oil, the reliability of the supply of oil and the strength of the climate policies will probably be key factors in how quickly technological developments that are more energy-friendly and climate-friendly will occur in the future.

Crisis packages in light of the financial crisis will also pose requirements for development in the direction of more renewable technology in the fleets of vehicles. The financial crisis has hit the automobile industry, particularly in the US, hard. The authorities are implementing measures to save the automobile manufacturers, but under certain conditions. Sweden has set aside SEK 28 billion, whereas in the US the crisis package for the automobile industry is all of USD 480 billion. What these packages have in common is that it is being demanded simultaneously that they stimulate new and environmentally friendly automotive technology (dn.no, 2009). President Obama has announced as a goal that there will be 1 million rechargeable hybrid cars on the road in the US by 2015. In this manner he is using the global financial crisis to force through environmentally friendly technology solutions that parts of the automobile industry have been reluctant to embrace.

Many large automobile manufacturers have given notice that they will be making rechargeable cars in the next few years, however the volumes are uncertain. The automobile manufacturers will normally go through several phases on the route to full-scale mass production of a new model of car. In this manner the solutions are developed and quality assurance is performed, as well as the costs reduced. Up to 2011 it is expected that rechargeable cars will be available in limited volumes from several manufacturers and that mass production will start after 2010. As 2020 is approached it is expected that there will be full market introductions of several models. The plans that are being launched now are primarily small and medium-sized cars. It is uncertain as to when rechargeable cars will be on the market for the larger models of cars.

See Appendix 3 for a more detailed overview of rechargeable cars that are expected to be on the market.

6.5 Practical drawbacks should be outweighed by practical advantages

The electrical car has a practical drawback associated with its range in comparison with both rechargeable hybrid cars and cars with internal combustion engines. The resource group is of the opinion that it is important to balance this with some practical benefits in that purely electrical cars will be the most environmentally friendly alternative.

The most important practical benefit the electrical car has today is the ability to drive in the public transport lane. The resource group desires to limit the use of the public transport lane to only be available to purely electrical cars (and possibly other zero emission cars).
If rechargeable hybrid cars gain access to the public transport lane, it will make for problems in the entry lanes more quickly, or the public transport lane will become less passable than what is desirable. This can, in turn, contribute to making taking the bus less attractive, which would be contrary to its purpose.

6.6 Few people today choose a car because it is environmentally friendly

There4 is little to indicate that people currently value environmental friendliness highly when they purchase a car. Even though this may change with an increased focus on the climate-related challenges, other factors will also have to be focused on in order to motivate the consumer to purchase rechargeable cars.

According to Gallup (2007) it was operating safety, traffic safety, the stamp of quality and driving characteristics that were the most important factors in the choice of a car. It will be important that rechargeable cars fulfil these requirements by the consumers. The uncertainty connected with battery technology as described in the next section will be important here. In addition, a familiarity with rechargeable cars through marketing measures would be able to have positive effects.

Also on Gallup's list are that the car is modern with new technology, good operating economics and low fuel consumption. At the same time, King (2007) maintains that the average driver has a tendency to underestimate a car's operating expenses by a factor of 2. The resource group thus wishes to point to the need for information connected with the lower operating expenses associated with the use of rechargeable cars and to reduce the risks associated with the operating costs of the battery. In addition, the acquisition cost and other visible advantages of rechargeable cars will be important.

At the end of the list are the car being particularly environmentally friendly, reasonable to purchase and having favourable fees. A report from ECON (2006) shows that neither do owners of electrical cars differentiate themselves as being more environmentally conscious than the population in general, even though the car owners state that environmental friendliness was important in relation to the decision to purchase an electrical car. Car buyers do not list low price and preferential fees are being important. At the same time, it is observed that changes in the fee system actually make a substantial difference in the specific cars that are chosen. The resource group thus believes that the fee system is an important means and that it must be ensured that rechargeable cars are competitive in terms of their purchase prices when compared with cars using fossil fuels.

6.7 There is uncertainty connected with the lifespan and performance of batteries

The battery in an electrical car comprises approx. half of the sales price of the car. A smaller battery in rechargeable hybrid cars would mean that it would comprise a smaller portion of the sales price. Batteries are expensive, and at the same time there is a certain amount of uncertainty connected with the lifespan and performance of the battery. This concerns especially new types of batteries that provide a longer range. The second-hand value for electrical cars is also uncertain, primarily due to the uncertainty connected with the value of the battery. This is a problem for the leasing of rechargeable cars in that the leasing price is based to such a large extent upon the residual value after the end of the leasing period. In the same manner, there is uncertainty connected with the maintenance costs of new types of batteries.

The development and commercialisation of batteries with a higher specific energy and longer range will contribute to an increased degree of electrification of road transport. At the same time, there is a technology risk for the consumer in purchasing cars with new types of batteries. Preferential terms for purchases of new battery technologies during a first phase of the electrification would be an important contribution to a solution to this set of problems.

Think has chosen to address this uncertainty by selling the car without a battery, and subsequently leasing the battery to the car owner. In this way the car owner avoids having

to think of the risk associated with the lifespan of the battery. Other players can also be relevant for owning and leasing out batteries for rechargeable cars.

6.8 Municipal and public sector use of cars, commuters and goods delivery in towns can be electrified with present-day technology

There will be many user groups who will have problems with utilising the rechargeable cars that are currently available; the purely electrical car. The primary reasons for this are that they have too short of a range using the battery, are too small as cars or do not have enough room for baggage.

There are however some user groups who can be electrified with the electrical cars that are available on the market today. These are users who do not have a need for a car with a long range, room for many persons or a large baggage capacity. The resource group wishes to point out three such user groups; public sector and municipal use of cars, commuters with two cars in the household and goods delivery/tradesmen in urban areas. Different economic incentives will be relevant for electrifying these user groups.

Public sector cars

The Climate Consensus establishes that public sector cars must run on CO_2-free or CO_2-neutral fuels by 2020 (Climate Agreement, 2008). In addition, there are requirements for low emissions of NO_x and suspended dust for national government purchases. In order to reach these goals the local governments and the national government must start the work on electrification of the fleet of vehicles now. Electrification of public sector vehicles will be of great significance to achieving critical mass for such cars and for harvesting experiences from their use.

Means for the increased electrification of this user group will be support in purchasing, removal of VAT on the leasing of rechargeable cars, support for the construction of recharging points and reduced risk associated with the lifespan of the battery by there being a zero rate created for the exchange of battery packs for rechargeable cars. Despite many measures, it may be demanding to achieve broad electrification in the municipalities and the public sector without there being a national role to drive it as described introductorily in this chapter.

Commuters with two cars in the household

Most people purchase a car that will cover all their needs. This generally means for daily associated and for use in longer trips and holidays. Many families have two cars because both adults have a need for a car to get to work or for business travel. In most cases it would probably be sufficient for one of these cars to be used for driving long distances beyond the range able to be covered by an electrical car. Such a second car that is primarily used for commuting and short trips would be able to be replaced by an electrical car. As shown earlier, there are approx. 400,000 households that have at least 2 cars and access to their own parking place at home. On the average, half of these will be replaced by 2020. It will be important to have incentives that could get these users to choose a rechargeable car when replacing their second car.

Important measures for electrification of this road transport would be a retention of the present measures, and in particular driving in the public transport lane, free passage through toll gates, free parking and reduced tax rates for rechargeable company cars. Support for the construction of recharging points at workplaces would be important to ensure that commuting with rechargeable cars can be done despite the limited range of the battery. In addition, creation of the VAT exemption and support for purchasing will stimulate the second cars being able to be electrical cars.

Delivery vans

The third and last group that we wish to highlight here are smaller goods deliveries and tradesmen in urban areas. As shown earlier in the report, there will probably be many people in this user group who do not have a distance driven per day that exceeds the range of electrical cars. There are delivery vans of different sizes that are electrical cars, primarily from Italy where such cars have been in use for a number of years.

Professional drivers will greatly appreciate being able to drive in the public transport lane associated with urban areas and to avoid queues in this manner. In addition, companies that invest in rechargeable cars will receive support for purchasing cars, support for the building of recharging points and free passage of toll gates.

Other groups

The possibility for rapid recharging will lead to an expansion of the relevant user groups during phase 1 beyond those that were described above. One can then envision the use of electrical cars in the taxi business, with courier vehicles and possibly other groups that drive for most of their day.

6.9 Possibilities for business development in Norway based upon increased electrification of road transport

If Norway is far ahead with respect to the electrification of road transport, it is possible to envision business development within three areas; the vehicles themselves (manufacturers or producers of parts), infrastructure and services connected with rechargeable cars and/or changes they bring with them in road transport.

Vehicles

Several manufacturers of electrical cars have already been established in Norway. Think has produced electrical cars in Aurskog for 10 years, and hence has substantial competence in the development and production of such cars. ElBil Norge has marketed electrical cars since 1992. The company began with sales and service of Kewet when the model was produced in Denmark. In 1999, Elbil Norge took over the rights to the product and the production equipment. Today, Buddy is produced at Økern in Oslo.

Miljø Innovasjon is establishing a battery factory in Porsgrunn, which will also convert cars from Tata to electrical cars. In 2010, the factory will produce 1000 cars, and the following year the factory will reach production of 3,000 cars per year. In total, the production of modern batteries and electrical cars will provide 80 new jobs (ta.no, 2009).

There are also importers of electrical cars such as Reva Norge and Enviro Elbilsalg. Enviro Bilsalg was established both in Drammen and at Nesbru, offering sales and service of electrical cars.

If Norway becomes a leading country in the use of rechargeable cars, it will contribute to the development of several such companies and ensure a basis for a significant Norwegian industry. Norway may become a centre for electrical car technology, in the same manner as Finland grabbed the possibility when the mobile telephone took off and as Denmark has captured the wind power industry. This can be done by harvesting the investments and work that has been put in place for 15 years. Think has all the prerequisites to succeed, with the most mature market, the most mature company, they are competitive in design and engineering and have an electrical car industry that is competitive in advanced components.

Norway has a high level of competence in materials technology and process industries, a prerequisite for battery production. In the same manner as Nokia produces the better part of its mobile telephones outside Finland, the majority of the production of electrical cars will in the long run take place outside Norway. However, in the same manner as Finland handled it, Norway can by utilising our current lead establish a large business cluster and

many competitive workplaces in design, engineering, marketing and production of high technology parts. This presumes that we will have in place at least one industry locomotive that the industry and the business activities can be built up around.

Infrastructure

The development and construction of recharging points for rechargeable cars represents an opportunity for players in electronics and ICT. There will be a need for communications systems between the car and recharging point, and between the recharging point and (intelligent) grid. Expansion of two-way communications in the electricity grid will open further possibilities within this area. In addition, there will be a need for payment solutions that can support different business models for the parking, recharging and possible leasing of batteries.

Scandinavian Electric and DEFA are Norwegian suppliers of recharging points.

Services

With increased electrification of road transport, needs will be able to arise for new services connected to the fleet of cars. Such can be connected to the battery, for example leasing of the battery, service or new uses or disposal of expired batteries. It may also involve services connected to professional operation of the fleet of cars for larger enterprises as regards recharging, battery exchanges and service on cars. Services may also be connected with outsourcing for the construction and operation of recharging points or new forms of carpools or services for leased cars. Carpools with rechargeable cars would be an additional possibility.

Move About is an example of the latter, and has already started up its carpool concept for companies. A solution for the private market is also being planned with a corresponding concept as exists today for city bicycles.

6.10 Comments from Norwegian Automobile Importers' Association (BIL)

BIL shares the goals of the report to the effect that the Norwegian fleet of cars should be as environmentally friendly as possible as quickly as possible. In recent years the automobile industry has made substantial progress in the area of the environment. This applies both in relation to more environmentally friendly production, and in relation to reduced emissions from usage.

The world's automobile manufacturers spend billions of kroner annually and thousands of man-years of work on the development of environmentally-directed technology. This work will continue with increased intensity in the future. BIL is thus sure that the vision that the fleet of cars will only consist of zero emission cars will be attained, due to a comprehensive focus and massive efforts in the field.

BIL cannot however lend its support to all the points in this report. Our objections are connected to the following points:

International regulations for product development

Norway is a small market for cars – both in a European and a global context. BIL wishes to point out that in this regard that the EU has posed strict requirements for emissions from cars. From 2020 the requirement is a maximum of 95 gram CO2 per km. This provides a clear basis for the research and development of new technologies by the automobile manufacturers and thus for precisely which models will be launched during the next 10 years. The time perspective has an interrelationship with the fact that it takes approx. 7 years to develop a new model of automobile. BIL is thus of the opinion that it is important that the Norwegian environmental measures be co-ordinated with the EU in order to have

the greatest possible effect. We believe that this does not emerge clearly enough in the report.

Unrealistic volume estimates

The International Energy Agency, the IEA, has performed a study to survey where electrical cars and rechargeable hybrids will penetrate the market. The study concludes on a much longer timeframe than what the project group has done in this action plan. BIL is of the opinion that the IEA's estimate is realistic. Furthermore, we have carried out a comprehensive study among our members concerning precisely which new automobile models will be launched in the future. The conclusion is that introductions of electrical cars and especially rechargeable hybrid cars in large volumes hardly will occur early enough to realise the volume estimates in this report. We cannot thus support the goals that this report outlines for 2020.

Technology neutrality

BIL desires a fee system based upon technology neutrality, i.e. that it is the environmental effects that must be evaluated, not how such effects are achieved technologically. There are many paths to reduced emissions and all of them ought to be rewarded equally, given the same size of the emissions. By altering the conditions radically in a short time, completely out of step with the rest of Europe, the risk is being run of subjecting the consumers, car manufacturers/organisations to substantial financial expenses without such being of benefit to the environment. This would be unfortunate.

Consequences to revenue

The report outlines the direct costs connected with the measures. However, the loss of vehicle import Duties, VAT, annual fees, etc. will take place in addition to more and more cars being sold in full or in part without these income streams. BIL is of the opinion that an overview must be made that shows the loss of revenues to the national government by sales being moved from cars with high fees to cars with lower/no fees. Such an overview would contribute to having the complete picture. It will not be possible to shift these lost revenues over to cars with fossil fuels.

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Appendix 1

The EU's goals for climate-related reductions in road transport

Norway at present is a leader in Europe both in terms of its percentage of renewable energy in its energy supply (60%) and it has an extremely high percentage of electrical cars in comparison with other countries. There are nevertheless some EU directives that indirectly or directly would be able to affect Norway's greenhouse gas emissions from road transport.

The Renewable Energy Directive's requirements for the transport sector

The EU has adopted the Renewable Energy Directive which will secure a 20% reduction in greenhouse gas emissions, 20% renewable energy and 20% increased energy efficiency by 2020. For the transport sector the Renewable Energy Directive contains a goal to the effect that each of the member states must cover 10 percent their energy needs for transport with renewable energy. Here , renewable energy encompasses biofuels, renewable hydrogen and renewable electricity for cars and trains. Electrical engines are extremely energy efficient, and even with a large contingent of rechargeable cars, the energy consumption of such cars will be relatively low and thus give a small contribution to the percentage of renewables. In order for rechargeable cars to contribute a ”legitimate” percentage of the energy consumption for transport, the consumption of electricity for transport is multiplied by 2.5 before one computes how much this contributes to the percentage of renewables.

Regulation of CO_2 emissions from vehicles

In December of 2008, the EU's summit meeting approved a measure in which by 2015 all new cars would have max. 120 gram CO_2 per kilometre in average emissions. This corresponds to a reduction of 25 percent in relation to the existing level of approx. 160 g/km.

Nearly the entire reduction (to 130 g/km) will come from new gains in vehicle technology. The remaining 10 g/km are expected to be obtained by improvements in other areas; tyres, biofuels and resource-efficient driving (eco-driving) and the like. A long-term goal was also established of 95 g/km in 2020 (EU, 2008)

The Fuel Quality Directive (FQD)

Suppliers of transport fuels (fossil, biofuels, electricity, hydrogen) must reduce their emissions of greenhouse gasses throughout the lifetime of the fuels by at least 6% by 2020.

In addition, an indicative goal of 4 percentage points has been set up. If this, it is presumed that a 2 percent reduction will come from electrical vehicles (not trains) or other climate-saving technologies and that 2 percent will come from the purchase of carbon credits. The goals will be revised in 2012, and the 4 percent goal may become obligatory in 2017.

Appendix 2

Assumptions for computation of estimated effects on the state budget are shown in this appendix. All figures have been computed including VAT.

Development of the number of rechargeable cars and fossil fuel cars that form the basis for the estimates

Figures in 1000	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Number of electrical cars	3	8	15	24	34	44	54	65	75	85	95	105
Number of rechargeables	0	0	1	6	15	28	44	62	85	118	157	203
Number of fossil cars	2267	2325	2380	2429	2472	2512	2549	2584	2614	2634	2648	2655

Support in purchasing
Support amount per new rechargeable car: NOK 30,000

Loss of Vehicle Import Duty for electrical cars
One Think City would have had the following Vehicle Import Duty based on weight, power and CO_2-emissions:
1392 kg * 76.37 NOK/kg = NOK 106,307
30 kW * 127.44 NOK/kW = 3,823
- 500 NOK/g CO_2 under 120g * 120 g = - 60,000
Total Vehicle Import Duty = 51,130
Incl. VAT; NOK 62,663

VAT exemption for electrical cars
This is based upon an estimated price for electrical cars of NOK 250,000.

Loss of VAT on leasing costs
Computed as the product of the estimated percentage of rechargeable cars and the total number of leased cars(estimated as the sum of 20% of new car sales during the past 4 years). Based on the leasing of a Think City with a battery pack, radio/CD and winter tyres at NOK 260,765 for 4 years (60,000 km), which gives VAT of 1355 per month.

Loss of company car taxation for rechargeable cars
The cost per electrical car is computed as the difference between a 0% and 75% reduction to the list price as new, for computing the tax basis for private use of a company car. Based upon an electrical car at NOK 250,000 (which gives a 30% basis for taxation), assuming a 2.34 % constant share of company cars of the total fleet of cars (where there is assumed to be the same share of electrical company cars of the total number of company cars as the share of electrical cars of the total fleet of cars) and a wage income of NOK 450,000 (which involves approx. 45% in marginal tax).

Loss of company car taxation for rechargeable hybrid cars

The cost per PIH is computed as the difference between a 0% and 50% reduction to the list price as new, for computing the tax basis for private use of a company car. Based upon rechargeable hybrid cars at NOK 250,000 (which gives a 30% basis for taxation), assuming a 2.34 % constant share of company cars of the total fleet of cars (where there is assumed to be the same share of electrical company cars of the total number of company cars as the share of electrical cars of the total fleet of cars) and a wage income of NOK 450,000 (which involves approx. 45% in marginal tax).

Reduced annual fee for rechargeable cars
The difference in annual fees for rechargeable cars and fossil fuel cars is NOK 2,350

Reduced fees for fossil fuels due to the transition to electricity as a fuel
The cost is computed as the difference between the fuel consumption without and with a 10% PIB. Based upon a 27% constant share of diesel cars of the total fleet of cars with an excise duty of 3.5 NOK/l and a CO_2 fee of 0.57 NOK/l plus VAT. And a 73% constant share of petrol driven cars of the total fleet of cars with an excise duty of 4.46 NOK/l and a CO_2 fee of 0.84 NOK/l plus VAT. VAT on the fees is included as a cost, but the loss of VAT due to reduced sales of fuel in general is not included.

Increased electricity fee due to transition from fossil fuel to electricity
The electricity fee incl. VAT is 13.53 øre/ kWh

A total of 60% of the fuel is reckoned for rechargeable hybrid cars on electricity

Loss of toll gate revenues
Computed as the product of the estimated share of PIB and the total toll gate revenues for the state (presumed to increase at the same rate as the total fleet of cars).

Loss of revenues from state highway ferries
Computed as the product of : estimated share of PIB, total for ferry revenues for the state (presumed to increase at the same rate as the total fleet of cars) and the percentage ticket reduction for PIB (presumed zone 7 for vehicles up to and including 6m).

Appendix 3

Rechargeable passenger cars that are expected to come on the market:

	Manufacturer/ Importer	Type of car	Production Start	Coming to Norway	Range	Number of seats
Car						
Smart		Electrical car	2008	?	120-150	2
Mini*		Electrical car	2008	?	240	2
Subaru		Electrical car	2008	?	80	2
Tesla		Electrical car	2008	?	280-400	2
Tata	Miljø Innovasjon	Electrical car	2009	2010	200	4
Tazzari		Electrical car	2009	?	150	2
i-MieV	Mitsubishi	Electrical car	2009	2011	160	4
i-MieV	Peugeot/ Citroen	Electrical car	2011			
Toyota	Toyota	Electrical car	2012/2013	?		
BYD	Subaru	Rechargeable hybrid	2009	2010-2011	120	5
Fiskar Karma		Rechargeable hybrid	2009	?	80	4
Opel Ampera	GM	Rechargeable hybrid	2010	?	60	5
Golf	WV	Rechargeable hybrid	2010	?		
BlueZero	Daimler Mercedes	Rechargeable hybrid	2010			
Metro	Audi	Rechargeable hybrid	2011			
Toyota	Toyota	Rechargeable hybrid	2012/2013	?		
XE30	Volvo	Rechargeable hybrid	2012	?		
200 C EV consept	Chrysler	Rechargeable hybrid	2010	?	64	
ZE	Renault	Electrical car	2010	?	?	
Fiat 500	Fiat	Electrical car	2009	?	100	

Source: SØT, (2009), Norwegian Public Roads Administration, (2009), various Web sites

Rechargeable city cars are expected to come on the market:

Car	Price	Type of car	Production Start	Coming to Norway	Range	Number of seats
Maranello	128,000-138,000	Electrical car, reg. as MC. Also as PIH?	2008	Yes, www.lcar.no	50-70	2
Elettrica	137		2007	?	110	

Source: SØT, (2009), Norwegian Public Roads Administration, (2009), various Web sites

Some rechargeable delivery vans on the market:

Delivery van	Price	Type of car	Production Start	Coming to Norway	Range	Load	No. Seats
Piaggio Porter etc	222,000-255,000	Electrical car	1995	Go-green holding	70-150 km	3 m3	
Iveco Daily	495,000	Rechargeable hybrid	2002	Go-green holding	25-100 km	7-10 m3	3,6 or 9
Iveco Daily		Electrical car	2002		100 km	7-10 m3	3,6 or 9
Fiat Doblo Cargo	480,000	Electrical car	2008	Go-green holding	100 km	3 m3	3,6 or 9
Fiat Fiorino Cargo	360,000-400,000	Electrical car	2008	Go-green holding	80-150 km	2,5 m3	2 or 5
Mega Multi Truck	£ 11.000	Electrical car	2008		40-95 km	3 m3	2
Berlingo First			2009		100	3 m3	2
Renaut Megane/Kangoo			2011				

Source: SØT, (2009), Norwegian Public Roads Administration, (2009), various Web s