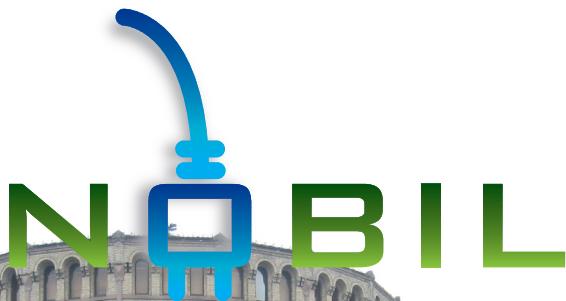


The Norwegian Charging Station Database for Electromobility



Introduction

How did Norway acquire a highly developed, easy to use database for charging stations, capable of real-time updates on availability, ready to be adopted by any interested country? Norway had the EVs on the road, and while the national charging infrastructure was being built, questions arose on how to maximize the benefit from it. Cooperation between the governmental entity Transnova and the Norwegian Electric Vehicle Association resulted in the development of an open, publicly owned database that allows everyone to build services using standardized data free of charge. The database underwent major improvements to prepare it for fast chargers and real-time updates. The close ties between the Nordic countries have generated a project set to expand the database for Nordic use. Other interested countries can adopt the database, with the requirement that they provide non-discriminatory data registration of publicly accessible chargers for their country.

The background

Charging infrastructure

In 2009 private companies and municipalities started working on a Norwegian nationwide network for public charging of electric vehicles. The governmental entity Transnova allocated €6 million to this effort. This was a result of a prompt response to the threatening financial crisis.

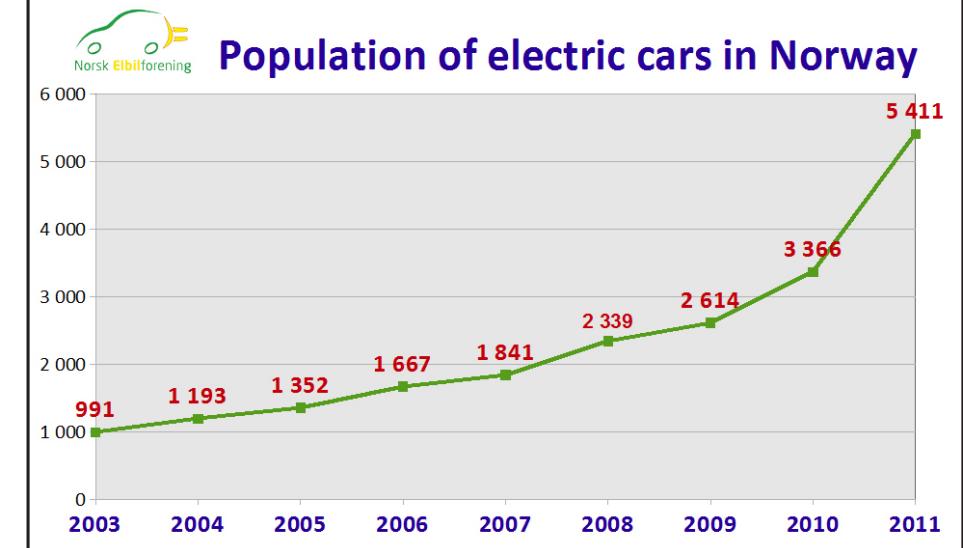
Apart the huge state support for chargers, the municipality of Oslo has been the largest player, and has allocated €2 million for building 400 charging points in the years 2008-11.

Together with contributions from private initiatives and other municipalities, the investments were expected to result in approximately 2,500 charging points by the end of 2010.

In the beginning of 2009 Norway had less than 200 public charging points. Infrastructure investments were looked to as the next effort to boost EV sales.

Norwegian incentives

During the last 20 years Norway has established a framework to promote the use of EVs and support Norway's former EV manufacturers. This was not introduced as a master plan, but expanded year by year to facilitate the market.



Main incentives today:

- No purchase taxes (in Norway such taxes are extremely high for ordinary cars)
- Exemption from 25% VAT when purchasing an EV
- No charges on toll roads (incl. congestion charge)
- Free municipal parking
- Free access to bus lanes

Situation for EVs in Norway

These radical incentives have contributed to a steady growth in use of EVs in Norway.

Lack of available EVs in the market has been the limiting factor. From 2000 to 2010 the market was served almost exclusively by small Norwegian manufacturers and by the import of used EVs. Even so, Norway became an exciting test lab for electromobility, and in recent years the Norwegian market for EVs has matured.

By the end of 2011 Norway had 5,411 electric cars in a population of 5 million. Both the number of EVs and last year's sales are by far the highest in the world per capita. Sales estimates for 2012 point in the direction of yet another 3,000 electric cars on Norwegian roads. The large majority of EV buyers are private individuals spending their own money to replace one of their ICE vehicles with a non-polluting electric car.

Unashamedly we describe Norway as a world leader for EV use and Oslo as the EV capital of the world, with the highest EV density of any capital city.

Given this unique situation with thousands of real EV users, we have had excellent conditions for testing out new measures to promote electromobility. One of these is the charging station database called NOBIL, which has given us considerable experience.

Key players

Transnova

Transnova, a state entity established in order to cut greenhouse gas emissions from transport, supports research and test projects and provides funding for EV infrastructure. Transnova is currently a unit within the Norwegian Public Roads Administration.



Norsk Elbilforening

The Norwegian Electric Vehicle Association was founded in 1995; with more than 3,000 members it organizes the majority of EV users in Norway. Although originally an organization composed of members with commercial interests, this association has transformed itself into a consumer association promoting and facilitating the use of chargeable vehicles. The association works in close cooperation with the authorities and the EV business sector, and manages and participates in several projects.



The challenges

Just as for all the other initiatives for promoting EV use in Norway, there was no master plan behind the establishment of the network of charging stations. The time elapsed from decision to implementation was minimal. Locations of charging stations were based on the principle "first ask, first served", due to regulations governing state subsidies. Or to put it in more favorable terms, we can define the process as market-driven.

This is the life of "early-movers". We cannot solve every detail in our plans, and we know we will have to adjust our activities along the way in any case, just like everyone else in the unpredictable development of the EV market. We enjoy the risks and the opportunities of being at the forefront of developments internationally.

The sudden development of an infrastructure required actions. There were several challenges:

- Choose the appropriate quality of the infrastructure within a tight time limit, giving the highest user value in return on investments.
- Acquire knowledge and create an overview of the locations and attributes for the charging stations.
- Create an appealing infrastructure to motivate more people to go electric.
- Disseminate knowledge and promote the charging network.
- Use these initial efforts to stimulate other entities to make their own investments in additional infrastructure.

Principles

The EV association responded to the situation and gave its advice for standardization of the charging points. It also proposed the development of a charging station database to secure a good overview of the infrastructure. But even more important, having this database would be a basic tool for promotion of the charging possibilities.

A well-organized database, which would make it possible to select and implement information about the most important attributes for the charging stations, would solve several of the challenges.

From the outset some basic principles were laid down for the charging station database (NOBIL):

- The database should have public ownership to ensure that it would include data from all owners of charging infrastructure without discrimination.



Charging station for 50 EVs, owned by City of Oslo. Free park & charge.

- The information should include key data which meet the needs of EV users. For this reason, EV users should be active in the development in order to make the database usable and attractive.
- Prioritize a high level of quality for the data, with a thorough verification process, instead of prioritizing registration speed. A database has to be reliable.
- Draw a clear boundary between the database itself and the services built on the data provided by the database. The services/applications were assumed to be commercially interesting. However, in an early phase they could be given funding to kick-start the activities and increase the value and awareness of the database.
- The data should be freely available for anyone aiming to create useful tools for owners of chargeable vehicles, to maximize the promotion effect and dissemination of the knowledge.

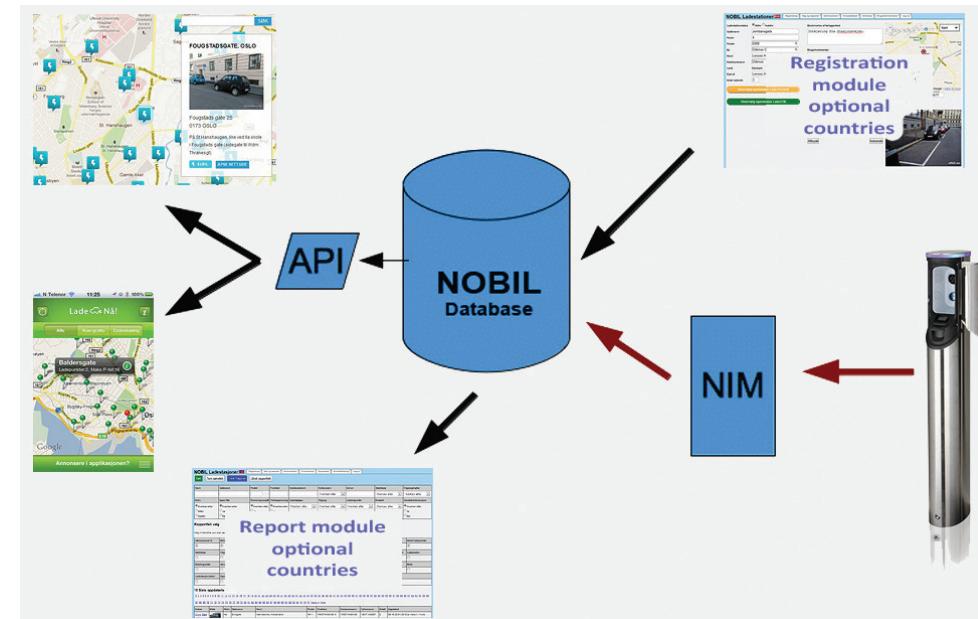
Development

The task of building the database was given to the EV association, which obtained relevant competence and user input from the community of EV users. The working group had broad, in-depth knowledge of electromobility and the latest internet and communication tools, with internal resources for programming.

During the first half of 2010 the technical solution was developed, and the database was launched on June 7, 2010 by the Norwegian Minister of Transport and Communications.

Technical solution

The EV association considered it necessary to avoid any barriers for others to continue



Sketch of the system architecture

developing the database if Transnova should decide to change suppliers. For this reason open source programming tools were chosen.

The database is SQL-based, with use of PostgreSQL and the extra module PostGIS for geographical queries.

All participants could easily enter data through the web-based user interface. Included were tools for automatically finding a city by zip code, municipality and region. Google Maps is an integrated tool in the database.

Also integrated are search and reporting tools filtering on multiple parameters for generating a variety of selections of charging stations, delivered as csv-files for further refining.

Content

A crucial aspect in the development work was to define the types of information to be included in the database, and to prevent other companies from accessing business sensitive information. Making it too complicated would limit the participation of charging station owners. This had to be balanced against the needs of the EV users and planners.

Basically we defined a charging station as the geographical location itself, and charging points as the number of reserved parking places for EVs with dedicated outlets for charging, minimum 220V/16A.

In summary, the following fields were included:

- Address
- Zip code & City/Town
- Name
- Municipality & Region
- Owner, when possible with the owner's ID for the charging station
- Number of charging points
- Payment
- Time limit
- Charging capacity
- Access to the connector
- Availability
- Type of location
- Any public funding
- Text fields for describing how to find locations and helpful user comments
- Contact info to owner/operator
- Text field internal comments (source)
- Uploading of photo

Distribution of data

The data is available for everyone through an API (Application Programming Interface). If you register as an API-user and accept the conditions under Creative Commons 3.0 Unported License, you receive a unique API-key.

All changes in the database are immediately updated in the API. Caching is included to handle high traffic (except the mapping, which is administered by Google).

By using HTTP call you can ask the service to return charging station data based on map references, either rectangular or radius, regions/counties, municipalities or specifically for a charging station.

The screenshot shows a mobile application interface for a charging station. At the top, it says "Hansteens gate, Oslo". Below that is a photo of a silver car parked at a charging station. The main section is titled "CHARGING STATION INFO" and contains the following data:

Location:	Street	Availability:	Public
Charging points:	4	Open 24h:	Yes
Parking fee:	No	Time limit:	16 hrs
Vehicle type:	All	Accessibility:	Standard key
Charging capacity:	16A	Connector type:	Schuko

If you arrive from Skøyen, you find the station on right hand after Drammensveien, just before the traffic light in H.Svartes gate.

At the bottom are buttons for "CONTACT INFO" and "ROUTE DIRECTION".

Simple charging station info.

Data collection

Transnova hired the EV association to collect and register the data. Several sources were examined and used:

- Website forums for reporting new (or changes to existing) charging stations.
- All recipients of public funding for charging stations were required to provide data. This covered around 80% of the total number of charging stations.
- Larger operators were given access to the database for maintaining their own infrastructure.
- Requests were sent to hotels, shopping centers, parking companies, municipalities, energy companies and more.
- The network of EV drivers was mobilized and encouraged to contribute.



The Minister of Transport and Communication opens a fast charger in Norway.

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The response was a fantastic, and proof that Norway is a living lab for electromobility. Nearly every day input is received on new stations, adjusted info, photos and more. The quality of the database is maintained and secured through crowdsourcing among the growing number of EV users.

Resources & funding

The cost of developing a high quality charging station database is a fraction of the total costs of the infrastructure. The net gain is thus relatively much higher.

Approximately €90,000 has been spent on technical development, or about 1/3 of the total costs of the project. The rest is invested in pilot services, in particular for data collection, maintenance and promotion of the database.

The activities in Norway have been funded by Transnova, securing their ownership of programming tools and all the data.

Transnova has decided to extend cooperation with the EV association for at least two more years, with an option for a further two years.

Promotion & services

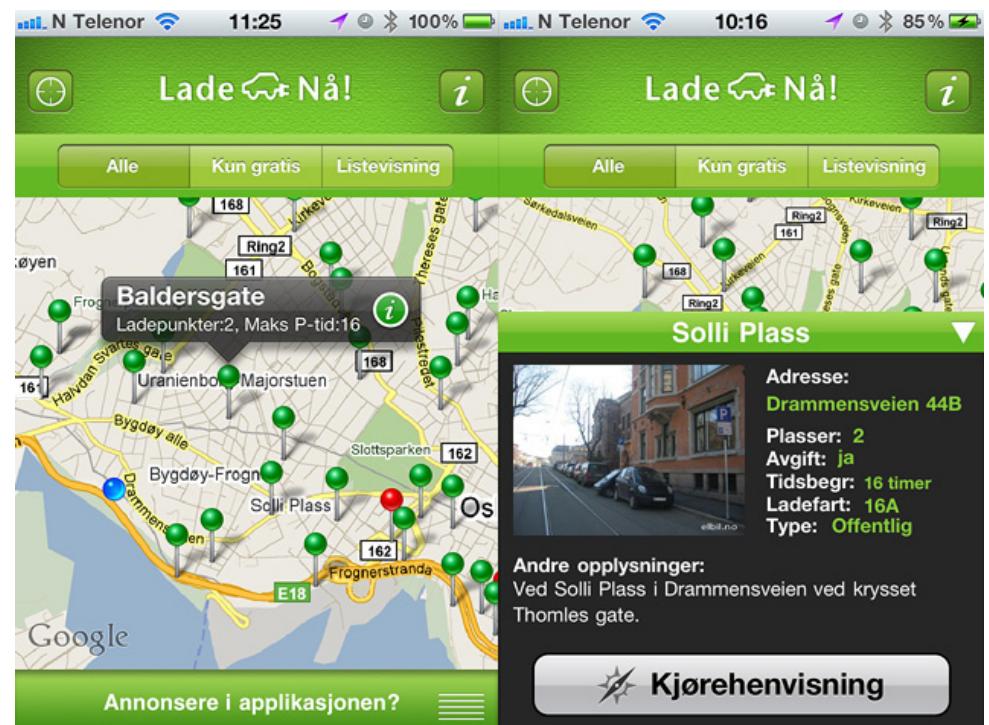
Promotion

A charging station database is primarily a practical tool, but it is also a useful tool for convincing people. NOBIL has been promoted in several channels for strengthening commitment to EVs.

Target groups include:

- EV users, who need it as a tool.
- Politicians, who need to be inspired by seeing results of their decisions to promote EVs.
- The public in general, in order to tempt more people to become EV users.
- Potential infrastructure builders, in order to get more charging stations built.

Ever since it was established, NOBIL has intensively promoted all the services using the data. A database in itself is not visible; the services are. They are the key to kindling enough enthusiasm and effort among those who participate in collecting and verifying data.



Example of a charging station app for both Android and iPhone.

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Throughout the project we have continuously created articles with news and information about the infrastructure, based on information from NOBIL.

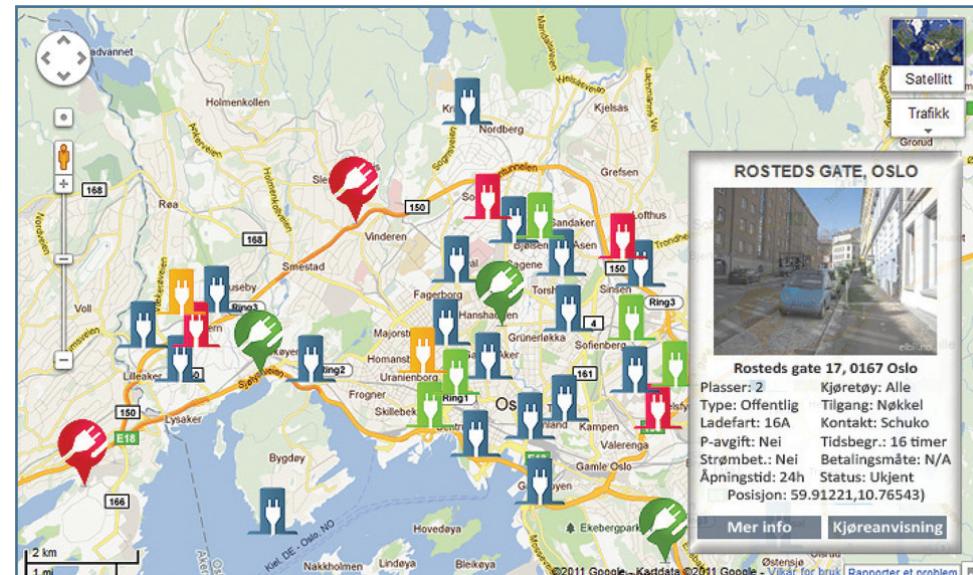
Services

Initially the project secured visible services by supporting the first providers:

- Internet
- Cell phones
- Files for GPS-navigators

This has been followed up by technical support to newcomers and has resulted in several internet-based services showing the way to the charging stations and various applications for both iPhone and Android.

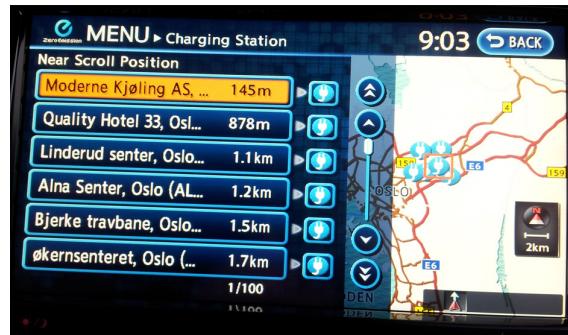
After a while we were "discovered" by the providers of digital map



Examples of internet-based services.

solutions. In the electric cars with the most advanced navigation solutions, NOBIL data is implemented in the digital maps as the POI for charging stations.

For others we deliver files to integrate in their standard navigation system. Hence, all new cars entering the Norwegian market can access reliable charging station data in their in-car navigation.



NOBIL in Nissan LEAF's navigation.

Further development

The world is changing – NOBIL too!

Country-independent

After the success in Norway it was soon decided to expand the activities to new countries. Transnova offered to make a new version of NOBIL which allows other countries to use the programming tool and build national databases.

Interestingly, this led to a project called EVR MAP. A program under the Nordic Council of Ministers is funding the realization of a Nordic charging station database, including collection of initial data in the other Nordic countries and establishment of sustainable maintenance and administration for the future.

The result will be a database including charging stations from 5 countries, each with their own language, zip codes, municipality codes etc., where service providers can connect to one API to receive standardized data.



The Nordic countries in light brown.

NOBIL Intelligent Module (NIM)

The charging infrastructure in Norway has been quite simple without monitoring and communication. Based on an expectation of a change, and demands from other Nordic countries, NOBIL has been redesigned to manage real time information. In general this makes the infrastructure more attractive.

Especially for the fast growing network of fast chargers (CHAdeMO-solution) in Norway, real time availability information is critical. During 2011-12 the state support for establishing charging stations has changed from slow to fast charging. During these two years Transnova will provide significant financial support to more than



Source: elbil.no, April 2012

50 fast charging stations, in total about €1.25 million a year. One requirement for everyone receiving this financial support is delivery of real time data from the fast chargers to NOBIL.

We believe the development of NIM functionality will encourage owners to update their existing slow charging stations with communication units, thereby increasing their value.

NIM is a function facilitating interactivity between the database NOBIL and communicative charging stations or back-end systems. The infrastructure pushes data over HTTP according to a defined XML which is standardized to other open protocols. NIM is a gatekeeper, only updating the database

with significant events.

Through the service providers EV users can receive information on status and availability. NIM can, depending on the charging infrastructure operator, receive info about energy usage, charging time and more for generating a database of usage patterns for infrastructure.

NIM can open a channel between the EV users and the infrastructure owners for reservation and payment. However, NIM and NOBIL are not instrumental in operations, nor are they involved in the business activities or processes of the infrastructure owner. The role of NIM and NOBIL is solely to collect and report data.



A typical charging station in the streets of Oslo, for people living in apartment buildings without own charging possibilities.

Jærhagen Kjøpesenter, Klepp

elbil.no

Solavegen 25, 4352 KLEPPE

CHARGING STATION INFO

Location	Shopping	Availability:	Public
Charging points:	5	Open 24h:	Yes
Parking fee:	No	Time limit:	No

CHARGING POINTS INFO

Status unknown:	4	Real time info:	1
Vehicle type:	All	Vehicle type:	All
Accessibility:	Standard key	Accessibility:	RFID
Charging capacity:	16A	Charging capacity:	DC fast
Connector type:	Schuko	Connector type:	CHAdeMO
Payment:	No	Payment:	Yes

Just outside the new shopping centre. A combination of one fast charger type CHAdeMO (for i-MiEV, iOn, C-ZERO and LEAF) and four normal chargers for everyone. For RFID access use contact info.

CONTACT INFO

ROUTE DIRECTION

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Expansion of the content

The real time functionalities called for a new data set and architecture. Data will be available on both the charging station and the point level. In addition, there will be more variation in charging and connector solutions, and more complex charging stations.

We have taken advantage of this opportunity to benchmark the database with the needs of professional users, including the providers of digital maps. Combining their requirements with our knowledge of the needs of EV users, we are confident that NOBIL covers what we can expect of demand in the coming years.

New attributes include among others:

- Vehicle type
- Opening time
- Real time information
- Connector type
- Charge mode
- Payment method

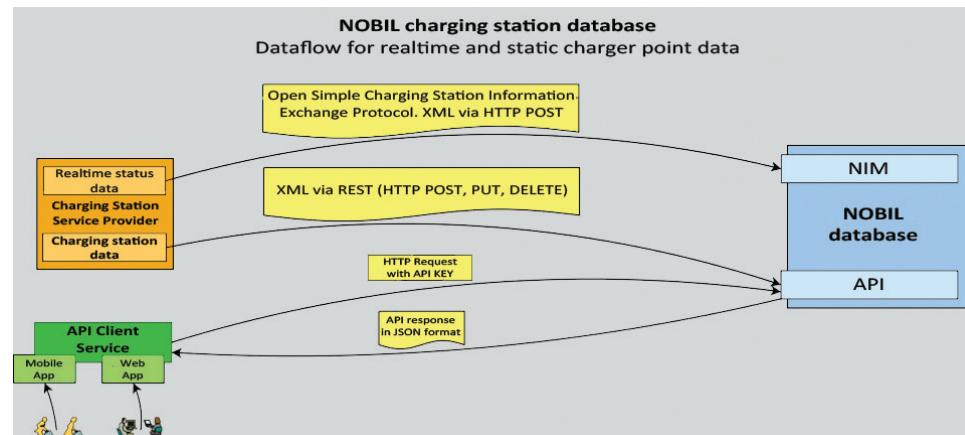
- Fixed cable
- Reservation possible
- Manufacturer

Interface to other databases

The most recent feature to be added to NOBIL is APIs between NOBIL and external databases owned by operators. Instead of manually updating NOBIL, we will have APIs connecting the databases, and under secure conditions have automatic updates of NOBIL whenever the operators make changes in their datasets.



Nissan LEAF fast charging in the snow.



Dataflow for real time and static charging point data.



Charging station with 1 CHAdeMO fast charger and 4 normal charging points.

Where will it end?

We believe easily accessible and reliable information about the charging infrastructure is crucial for the success of the electric vehicle. To achieve this, all players have to combine their good efforts. Cooperation is necessary to meet the needs of the emerging market. The government involvement in Norway, through Transnova, has inspired other actors to contribute.

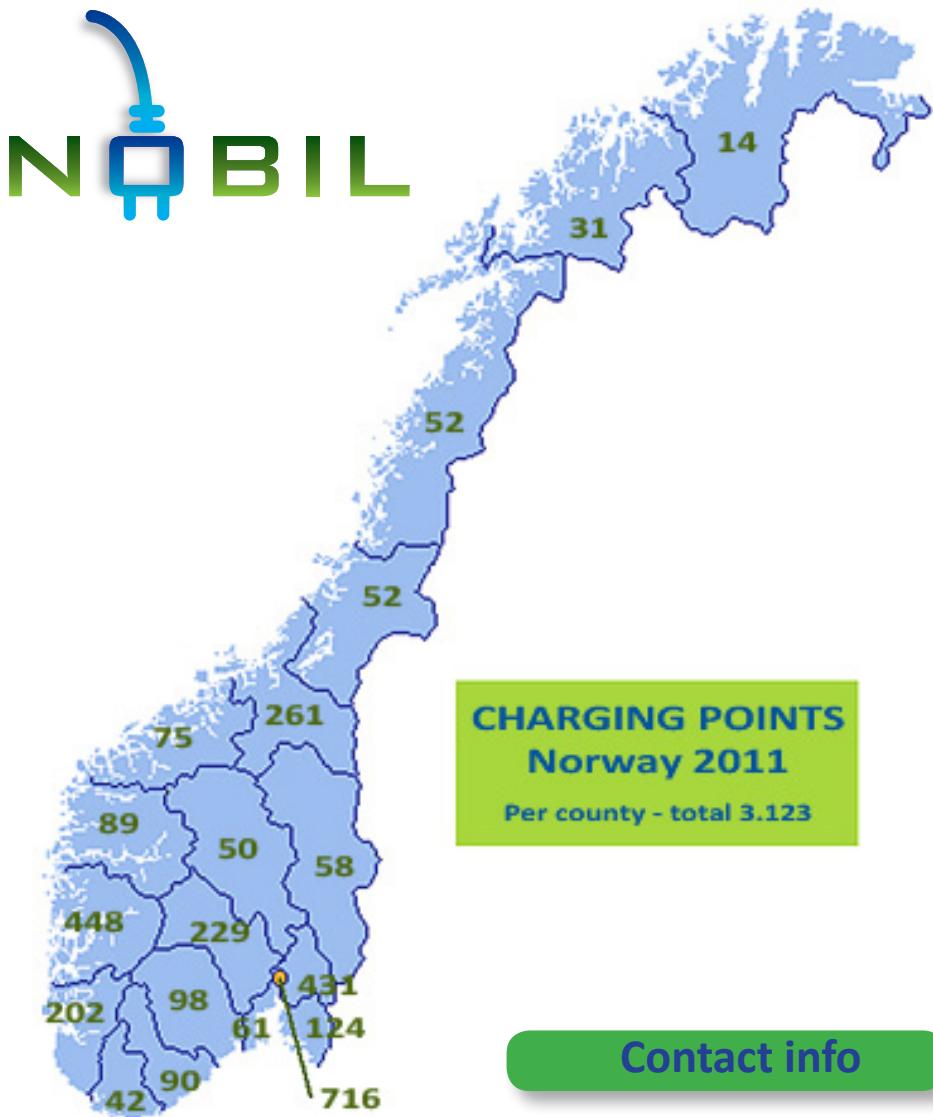
As of March 2012 Norway has 3,187 charging points at 946 charging stations, and these numbers are growing steadily. In addition, more than 70 fast chargers will be available by this autumn.

We will not be surprised if more countries follow the example of the five Nordic coun-

tries in NOBIL. If we can bring our experiences to others and be an inspiration, that adds value to our project. Standardization of data and data streams will be a key to simplify the work for others and make the information easily accessible.

Being pioneers and building overall substantial infrastructure, as we have done in Norway, will inevitably involve some mistakes. But having the complete overview of the infrastructure, and being able to communicate it widely, is definitely not a mistake. It improves the appeal and usefulness of the infrastructure, thereby increasing the use of EVs. We intend to follow this up with new improvements in NOBIL and to continue our best practices. We think NOBIL is a brilliant solution ready to be implemented by others.





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