Inventory of demonstration and trail projects in sustainable energy and transport in Scandinavia

INNODEMO Work Package 2 Report

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INVENTORY OF DEMONSTRATION AND TRIAL PROJECTS IN SUSTAINABLE ENERGY AND TRANSPORT IN SCANDINAVIA

Technology and Innovation Management

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INNODEMO WORK PACKAGE 2 REPORT

EXECUTIVE SUMMARY

This report documents the work of work package 2 of the InnoDemo research project funded by the Research Council of Norway. Partners in the project are The Nordic Institute for Studies in Innovation, Research and Education (NIFU) (project leader), DTU Management Engineering at Technical University of Denmark, and CIRCLE at Lund's University.

From a state-of-the-art study in the project's work package 1, a set of characteristics have been specified to be collected in an inventory of demonstration projects and funding programmes. This data was collected in parallel in Denmark, Norway and Sweden in the second half of 2013.

The report presents the results of work package 2 in two parts.

First, a list of the 33 included funding programmes identified in Denmark, Norway and Sweden is presented with a short text. The programmes vary with respect of: technologies in focus, annual funding budgets and regional focus.

A total of 433 demonstration projects initiated in the period 2002-12 were identified in Denmark (224 projects), Norway (107 projects) and Sweden (102 projects).

7 of the Danish projects were funded by the EU, and these 7 projects are not included in all analyses comprised by the InnoDemo project.

In the database 97 (22%) of the identified projects relate to road transport. These include 30 projects in Denmark, 40 in Norway and 27 in Sweden. Most of these projects involve electrical mobility and biofuel/biogas.

INTRODUCTION

Transition towards more sustainability has been on the agenda of politicians, researchers, industry and concerned societal actors for a number of years. The oil crisis in the 1970s, environmental concerns related to decreasing biodiversity, depleted natural resources, cities polluted by emissions from road transport, and climate changes caused by greenhouse gas emissions, all these crises have contributed to a sense of urgency in political statements on the need for transition towards a sustainable society. Politicians have developed different types of instruments to achieve a development towards more sustainability. However, the design and proper mix of such instruments is still to be better developed, as is the knowledge on possible effects of these instruments. This applies also on *demonstration projects and programmes*.

The InnoDemo research group understand demonstration projects as experiments to overcome uncertainties, while uncertainties can be of different character, such as technological, costs, environmental, social, political, etc. Such projects exist at different scale, including a variety of types of actors, and they have different objectives and different types of outcomes. A comparative analysis of demonstration projects and trials has to ensure that projects are comparable according to objectives, organisational solutions, and technologies.

InnoDemo aims to further the understanding of the role of demonstration projects and trials towards sustainable transitions. Based the creation of an inventory of demonstration projects and funding programmes applying different conceptual frameworks, the following research questions are posed:

1. What are the main contributions of Scandinavian demonstration and trial projects and programmes to sustainable energy and transport transitions?
2. How should the governance of such projects and programmes be developed to further support their contribution?

Present report documents the activities of Work Package 2 of InnoDemo. The work package aims to create an inventory of past demonstration and trial projects and funding programmes for sustainable energy and transport in the Scandinavian countries.

The report is structured as follows: First, a terminology and definition of demonstration projects is established to align the data collection in the three involved countries, Denmark, Norway and Sweden. Second, the collection method is described. Third, the resulting inventory of the data collection is presented in terms of funding programme descriptions and demonstration project key numbers. Fourth, results and process is summarised.

DEMONSTRATION PROJECTS

AIMS AND EFFECTS OF DEMONSTRATION PROJECTS

Demonstration projects play three primary roles in supporting technologies getting closer to the market: 1) Testing a new technology in real-world conditions and gathering technical and economic performance data that can help refine the technology; 2) helping scaling up a technology, important for technologies requiring larger scale testing than usual laboratory tests; and 3) demonstrating the feasibility of the technology for the market and enhance confidence.

The research draws on taxonomy for demonstration projects and programmes according to their aims, as suggested in recent literature. The four established aims are 1) prove technical feasibility; 2) reduce building, materials, components, operating and maintenance costs; 3) prove feasibility in commercial applications and 4) hybrid projects.

Based on further literature, the InnoDemo research group adds six aims and renames the *hybrid project* aim to an '*other*' aim, for projects not encompassed by other aims. A second reason for removing the hybrid projects categorisation is that one project can have more than one aim at this stage of the research project, characterised by data collection and not analysis. The full list of aims is therefore:

1. prove technical feasibility
2. reduce building, operating and maintenance costs
3. prove feasibility in commercial applications
4. prove environmental feasibility
5. contribute to the formation of knowledge networks
6. improve public acceptance
7. introduce institutional embedding
8. expose system weaknesses
9. facilitate learning
10. other

The aims are elaborated in Appendix A.

ORGANISATIONAL SOLUTIONS

The research project seeks to classify projects in relation to how they are sought introduced and demonstrated by involved partners in order to fulfil initial objectives, such as those described in the past section. Defined as *organisational solutions* and identified as four primary approaches in literature as:

1. one-off high profile 'demonstrations' and competitions to create public awareness about the potentials of a new technology at an early stage;
2. coordinated 'programmatic demonstrations' to systematically measure, test, evaluate and characterise technology for a particular application, often comparing different models and technologies;
3. programmatic 'field trials' and tests to improve the performance and reduce costs, in the immediate run-up to commercial roll-out backed by subsidies and incentives, contributing to the development of installation know-how and the establishment of standards; and
4. permanent testing and demonstration facilities ('test centres'), providing a learning facility and knowledge resource, and supporting manufacturers in many ways, including product certification.

While demonstration projects are considered crucial on a system level for the emergence and diffusion of radical new technology, it remains less clear why and how individual organisations engage with such form of experimentation. On

the one hand they provide valuable stimuli to reduce the inherent uncertainty and risk associated with radical new technologies, while on the other they may help incumbents to innovate and/or imitate to prevent new technology to breakthrough. InnoDemo seeks to further the understanding of organisational solutions by including a tentative classification of the in the inventory of demonstration projects.

SOCIO-TECHNICAL SYSTEMS

InnoDemo adopts a systemic perspective on society in order to understand how system innovations and transitions take place. Transition can be characterised by the following: 1) co-evolution and multiple changes in socio-technical systems or configurations, 2) multi-actor interactions between social groups including firms, user groups, scientific communities, policy makers, social movements and special interest groups, 3) 'radical' change in terms of scope of change (not speed) and 4) long-term processes over 40–50 year periods. Other approaches are intended to be used in the project, e.g. Technological Regime, Strategic Niche Management and Large Technical Systems. In the creation of project and programme inventory, data on demonstration project sites, involved partners and their geographical location is therefore included.

METHOD AND DATA

Work Package 2 comprises the creation of an inventory of demonstration projects and funding programmes that can be of value to practitioners (e.g. policy-makers, firms or researchers) involved in piloting, demonstrating and commercialising projects of sustainable energy and transport technologies.

A gross list of projects funded in the period 2002-2012 was established containing data in the categories:

1) objectives of project

2) organisational solution of project

3) collaborating partners and geographical information

4) basic project and programme data

5) funding programme information

Category 4 includes data on programme subsidy and project budgets, project duration, project leader, type of technology and a short text describing the project, the latter to inform category 1 and 2. Category 5 involves information on number of projects, annual funding, objective and project leader information on the funding programmes.

See Appendix B, C and D for all data fields used in the inventory.

DATA SOURCES

The inventory of projects and programmes is compiled from national sources in the Scandinavian countries.

For Denmark, the inventory is based on projects funded by: 1) The Danish Energy Research programmes, published in cooperation between Energinet.dk, the Danish Energy Authority/EUDP-secretariat, Danish Energy Association, the Danish Agency for Science, Technology and Innovation, the EU Commission in Denmark and The Danish National Advanced Technology Foundation. 2) The Danish Transport Authority and the Danish Business Authority and 3) the six regional Growth Fora (Vækstfora).

For Norway, the inventory is based on project data provided by; ENOVA, a government energy agency owned by the Norwegian Ministry of Petroleum and Energy; Transnova, a government agency owned by the Ministry of Transport and Communications, the Environmental technology scheme under Innovation Norway and the Research Council of Norway.

For Sweden, the inventory is based primarily on data from the two institutions The Swedish Energy Agency (Energimyndigheten) and VINNOVA. Furthermore, projects from following institutions were included: The Swedish Agency for Economic and Regional Growth (Tillväxtverket), The Knowledge Foundation (KK-Stiftelsen), The Swedish Foundation for Strategic Research (Stiftelsen för Strategisk Forskning), The Swedish Transport Administration (Trafikverket), and The Foundation for Strategic Environmental Research (Mistra).

DATA CRITERIA AND COLLECTION

Following the focus of InnoDemo, projects *after proof-of-concept* are deemed relevant, and are addressed. Data collection concentrated on demonstration plants, field trials and test facilities, but not on pilot plants. However, in practice also well-established technologies that are beyond general proof-of-concept will be eligible for the database. For example, offshore wind energy or components or systemic projects (new types of foundation, or new technology

for power transmission), having significant traits of a proof-of-concept project aiming a proving technical or commercial feasibility.

Projects funded by such private foundations are not included, e.g. projects funded by the foundation created by the Confederation of Norwegian Enterprise (NHO), the NOX-fund.

The collection of data was conducted in parallel in Norway, Sweden and Denmark using a Microsoft Access database to store all data, with one version for each of the three involved countries.

RESULTS

The resulting inventory in the database is presented in two parts in this section. First, a comprehensive list of public funding programmes from Denmark, Norway and Sweden is presented and described in terms of focus and actual support of demonstration projects, as found in the data collection. Second, general statistics of the project inventory is presented to create an overview of e.g. total projects, objectives, funding, etc.

FUNDING PROGRAMMES

Following sections describe programmes identified to fund demonstration projects in Denmark, Norway and Sweden. The section is separated into three sub-sections, one for each country. In Denmark, 10 programmes were identified, with an additional 6 regional programmes contributing with few demonstration projects. In Norway, 6 programmes were identified. In Sweden, 11 programmes were identified.

DANISH FUNDING PROGRAMMES

The Strategic Research Council

The Strategic Research Council is administered by the Research and Innovation Authority under the Ministry for Science, Technology and Development. The energy-specific sub-programme titled Programme Committee for Sustainable Energy and Environment distributes research funds for three areas: future energy technologies, competitive environmental technologies, and climate and climate adaptation. The programme is not technology-specific and has no special priorities, but awards grants to basic and applied research in such areas as wind energy, bio-energy, fuel cells, solar cells, energy-saving technologies, wave energy, exploitation of waste, hydrogen-based energy systems, bio-fuels, solar heating and geothermal energy. On average, the entire programme has a budget between 500-800 million DKK annually.

EUDP

The Development and Demonstration Programme for Energy Technology (EUDP) supports the development of new, efficient and environmentally friendly energy technologies that can contribute to making Denmark free from fossil fuels by 2050. The programme is administered by the Danish Energy Agency. Supported projects must develop Danish business potential to benefit growth and employment. The programme prioritises demonstration of new technologies when basic research has been completed. All types of energy technology are supported. On average, the programme has a budget of between 300-400 million DKK annually.

ForskEL

ForskEL gives support to research in technologies for environment-friendly electricity production. The programme is administered by Energinet.dk and has a budget of 130 million DKK annually.

ForskVE

ForskVE is a programme for small renewable energy technologies such as solar cells and wave energy. Energinet.dk is responsible for the programme, which has a budget of about 25 million DKK annually. The programme provides support to new solutions, equipment and operations in wave energy plants, bio-gasification plants and certain types of solar cell plants. In addition, support is given to sales and information campaigns and communication of operating results.

ELFORSK

ELFORSK is a programme for research and development in efficient energy utilisation, led by The Danish Energy Association. The programme distributes about 25 million DKK annually among the areas focused on, such as Construction, Ventilation, Lighting, Cooling, Electronic effect and steering, industrial processes, and behaviour, barriers and means.

Green Labs DK

Green Labs DK supports the establishment of large scale test centres for demonstration of new climate technologies. The programme is administered by the Danish Energy Agency and founded on the vision that Denmark will become a 'Green technology laboratory', where firms have good conditions in the entire innovation value chain from basic research to research and development to market introduction. Green Labs DK has a budget a 70 million DKK annually for a small number of larger test centres.

The Danish National Advanced Technology Foundation

The foundation generally supports advanced technological development projects with big business potential. The foundation emphasises projects that both have scientific and educational element and business potential in the form of spin-offs and new technology that benefits society. The foundation has an independent board appointed by the Minister of Science. The foundation is not energy-specific, but energy and environment are named as one of six special focus areas. It can be argued that the foundation is directed more toward business development and implementation than on research and technology development.

Energiforskningsprogrammet

The 'Energy Research Programme was administered by the Danish Energy Agency and aimed to support sustainable energy technologies in a broad sense. A special focus area was realising Danish export potentials in within energy technologies. The programme had an average budget of 50 million DKK in the period 2002-2008, after which it was replaced by EUDP.

Fornyelsesfonden

Administered by the Danish Business Authority, Fornyelsesfonden (Foundation for Renewal/Change) supports innovation and the market maturing of green- and welfare technologies in addition to business support for entering vulnerable geographical areas in Denmark. The programme had a budget of 430 million DKK annually in the period 2010-12.

Centre for Green Transportation

Centre for Green Transportation functions as a competence centre working with projects, recommendations and rules for sustainable transport solutions. It is administered by the Danish Transport Authority. Tasks have a point of origin in environment, climate and noise, creating a link between research, vehicle knowledge and concrete initiatives to reduce CO2 emissions from road transport. The funding programme is a trial lasting from 2011-13 with an annual budget of 50 million DKK.

Regional Growth Fora

The five Danish Regions are represented by six different regional growth fora, which support social, economic and environmental development in a very broad sense. For example, example supported projects include tourism initiatives, educational programmes, technology development with municipal actors or wave energy test centres. The programmes support in the range of billions DKK, but very few projects are within sustainable energy and transport and eligible for the InnoDemo inventory.

NORWEGIAN FUNDING PROGRAMMES

Transnova

Transnova is a government agency administered by The Norwegian Public Roads Administration (Statens Vegvesen), established in 2009 by the Ministry of Transport and Communications. The parliament allocates funds to Transnova through annual state budget decisions. The main objective is to reduce greenhouse gas emissions from the transport sector in Norway. Transnova awards grants to projects mainly in the pilot- / demonstration phase, which contribute to a transition to sustainable modes of transport. That means a substitution of fossil fuel with alternative fuel or energy carriers with less or no CO_2-emission.

Enova SF

Enova SF is a public enterprise that is owned but the Ministry of Petroleum and Energy, established in 2001. Enova SF is financed via funds allocated from the Energy Fund, which is based on a small additional charge to the electricity bill. In addition, the Energy Fund has been allocated the proceeds from "The green fund for climate, renewable energy and energy efficiency measures". Enova SF works towards strengthening the work in converting energy consumption and generation into becoming more sustainable, while simultaneously improving supply security. The goals for the period 2012-2015 are: Enova promotes environmentally friendly restructuring of energy end-use and energy production, and contributes to development of energy and climate technology. Enova's two instruments are capital and people (expertise).

RENERGI / ENERGIX

The RENERGI-programme (Clean Energy for the Future) was administered by the Research Council of Norway, which is national strategic and funding agency for research activities. RENERGI was the Research Council's large-scale programme for energy research from 2004-2012. RENERGIs primary objective was to develop knowledge and solutions as the basis for environment-friendly, efficient and effective management of the country's energy resources, security of supply and internationally competitive economic development related to the energy sector. RENERGI covered a wide range of subjects, but prioritised renewable energy production, natural gas, hydrogen, energy systems, energy markets, energy use and energy policy and international agreements. The programme covered basic and applied research and social science research. The RENERGI-programme was followed up by ENERGIX, which will span for the next ten-year period, from 2013.

EMBA

EMBA (energy, environment and construction) was followed-up by RENERGI. The programme ended in 2004, and had a less clear focus on environment. Development of the welfare state and general value creation is stated as focus points. The programme was under the Research Council of Norway.

Miljøteknologiordningen (Environmental technology scheme)

Miljøteknologiordningen was introduced in 2011 and is administered by Innovation Norway, the government's most important instrument for innovation and development of Norwegian enterprises and industry. The programme has a distinct focus on pilot- and demonstration projects for environmental technology. Environmental technology includes more environmentally friendly products and production processes, more efficient resource management and technological systems that reduce environmental impact. The fund states that it should be seen in context with other public funding programmes like The Research Council of Norway, Enova, Transnova and others.

Oslo kommunes klima- og energifond (The city of Oslo's climate- and energy fund)

The programme is administered by the Agency for Urban Environment under the Municipality of Oslo. The fund was established in 1982 and supports a wide range of activities including research, pilots and demonstrations. Generally, the funding is considerably smaller than the national grants.

SWEDISH FUNDING PROGRAMMES

Fordonsstrategisk Forskning och Innovation - FFI

FFI is a research, development and innovation programme jointly owned by the Swedish automotive industry (Scania, AB Volvo, Volvo Personvagnar and FKG) the Swedish government through the agencies Energimyndigheten, Vinnova and Trafikverket (a so-called strategic collaboration programme). The programme is administered by the Swedish Innovation Agency (Vinnova). The focus of the programme is on safety and environmental issues (notably climate change, i.e. reduction of greenhouse gases) connected to transport. Funding is distributed within five areas: vehicle development, transport efficiency, vehicle and traffic safety, energy and environment, and sustainable production technologies. The purpose of the programme is to create collaboration between industry and universities; collaboration is a prerequisite for funding. The focus of the projects that has been granted funding has shifted from efficiency and safety towards environmental issues (especially during the current period 2013-2016).

Vindforsk

Vindforsk is a strategic collaboration programme, jointly owned by Energimyndigheten and companies in the area of wind energy. The focus of the programme is on collaboration between research bodies and industry to strengthen the knowledge about wind power in Sweden. It is an on-going programme, renewed every 3-4 years, and the focus of the financed projects has shifted somewhat from period to period but integration of wind power in the power system has been a reoccurring theme together with assessment of wind potential and planning for wind energy expansion.

Programmet etanol från cellulosa

This programme is administered by Energimyndigheten and has a narrow focus on ethanol from cellulose but range from production of cellulose rich biomass to ethanol production, basic research to pilot plant operations. The majority of projects funded have mainly been on production processes for ethanol production, such as combination of hydrolysis and fermentation, increased share of dry matter in the material, development of organisms for fermentation and pentose fermentation. The specific aim of the programme was to generate enough knowledge to be able to build a demonstration plant.

Energieffektiva vägfordon period 2011-2014

The aim of this programme is to put together all academic research projects on road vehicles funded by Energimyndigheten, but with an industrial connection. Demonstration and development of research results is thus central to the programme. Funds can be sought for all types of measures for increased energy efficiency in road vehicles; including electric, electric hybrid, and fuel cell vehicles as well as energy efficient internal combustion engines for both fossil and renewable fuels, and decreased weight and lower aerodynamic resistance.

SolElprogrammet

SolElprogrammet is an ongoing programme which is evaluated and renewed about each 3-4 years. The programme is a collaboration between Energimyndigheten and Elforsk AB (owned by the Swedish energy industry), the latter being the programme leader and administrator. The main aim of the programme is to increase knowledge and competence in using PV in the built environment in Sweden, why a strong emphasis is put on collaboration between universities and other research institutes, and industry. The programme has four main areas: grid connection and the role of PVs in smart grids, sustainable cities and building integrated Pvs, assessment and verification of services and products related to PVs and ``Photovoltaics in society''. The budget for the period 2003-2007 is only tentative (about 4 million SEK per year).

Bränsleprogrammet - Omvandling

Energimyndigheten grants funding for bio based fuels in a programme cluster of three parts: conversion, supply, and sustainability. The conversion programme has two areas: processing and conversion to heat and electricity < 10 MW.

The focus is on efficiency, sustainability, and the use of new raw materials. Production of vehicle fuels is not part of the programme.

Bränsleprogrammet - Tillförsel

The programme focuses on supply grants funding for projects on the production of new raw materials for biofuels and new cultivation methods and maintenance in forestry and agriculture. It i divided into three parts: higher efficiency in ``forest fuels'' systems, energy crops, and forestry for enhanced biofuel production. Funding is not granted for projects focusing on environmental issues or conversion since this is included in the other two programmes of the cluster.

Demonstrationsprogram för elfordon

The aim of this programme is to identify barriers for the introduction of electric and plug-in hybrid vehicles on the market from a user's perspective. The focus is on user behaviour and infrastructure demonstration as well as learning. By focusing on ``softer'' issues on user preferences for charging and vehicle performance, the programme is seen as a complement to the more technology focused programmes FFI and Energieffektiva vägfordon.

Forska & Väx

Forska & Väx is a continuous programme of Vinnova. This programme does not have a particular focus on renewable energy or transport, but gives funding to small companies that research, develop, or demonstrates a new technology or other type of innovation. The technology or service of the project has to have to be market based and a user demand clearly identified for funding to be granted. Vinnova only enlists partners that are co-financers. There might be subcontractors connected to many of the projects.

Grön Nano - nanoteknik till nytta för miljöområdet

Collaboration between industry and universities is conditional for being granted funding in the programme Grön Nano. As is given by the name of this programme the focus is on demonstrating nanotechnology that improves environmental performance and is less harmful for humans, compared to existing alternatives. The aim of the programme is to help commercialise new technology and stimulate collaboration between researchers, companies and society.

Innovationer för en hållbar framtid

``Innovations for a sustainable future'' focuses on four areas: sustainable use of natural resources, IT for the environment, sustainable urban development, and efficient energy use. The aim is to enable technologies or methods for more sustainable production and consumption as well as transport from a life cycle perspective.

DEMONSTRATION PROJECTS

For demonstration projects, a total of 433 projects was identified across Denmark (224 projects), Norway (107 projects) and Sweden (102 projects). 97 (22%) of these projects were concerned with transportation. 7 of the Danish projects were funded by the EU, and these 7 projects are included in all analyses comprised by the InnoDemo project.

GENERAL DEVELOPMENT

All projects were initiated in the period of 2002-12. Figure 1 and 2 illustrate the main development in number of projects funded by public programmes in the period and corresponding amount of funding. Budgets are expressed in € based on the exchange rate inserted in the Access database.

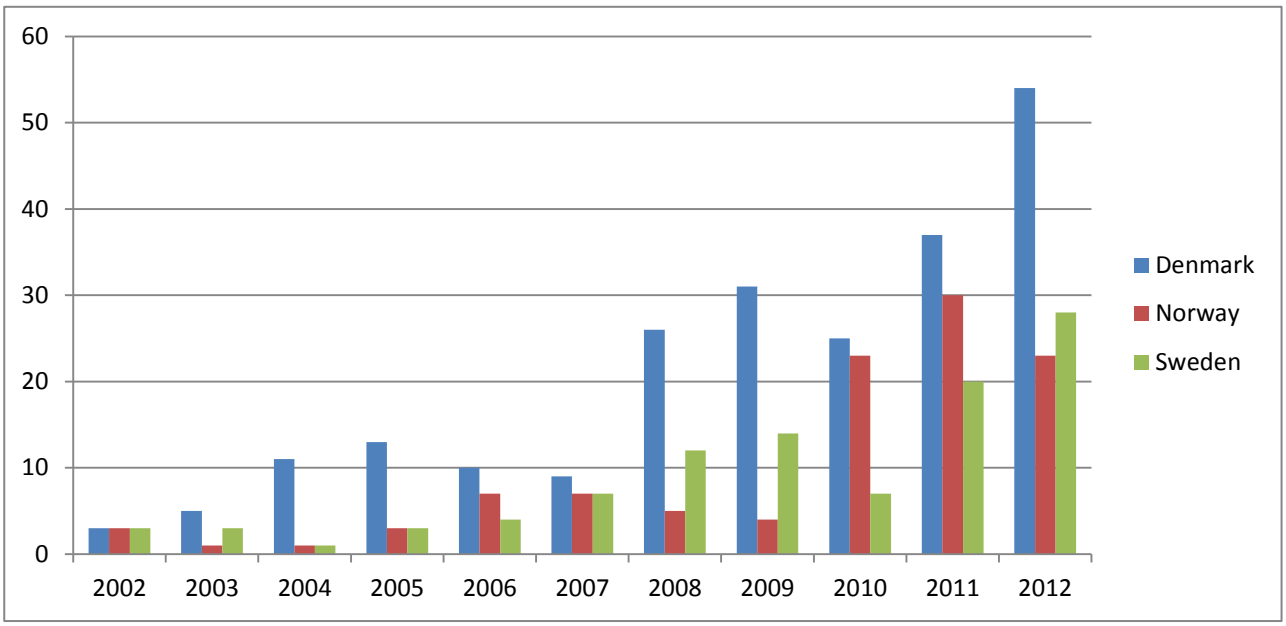

Figure 1 Number of projects in the database; distributed over starting years and countries. N=433.

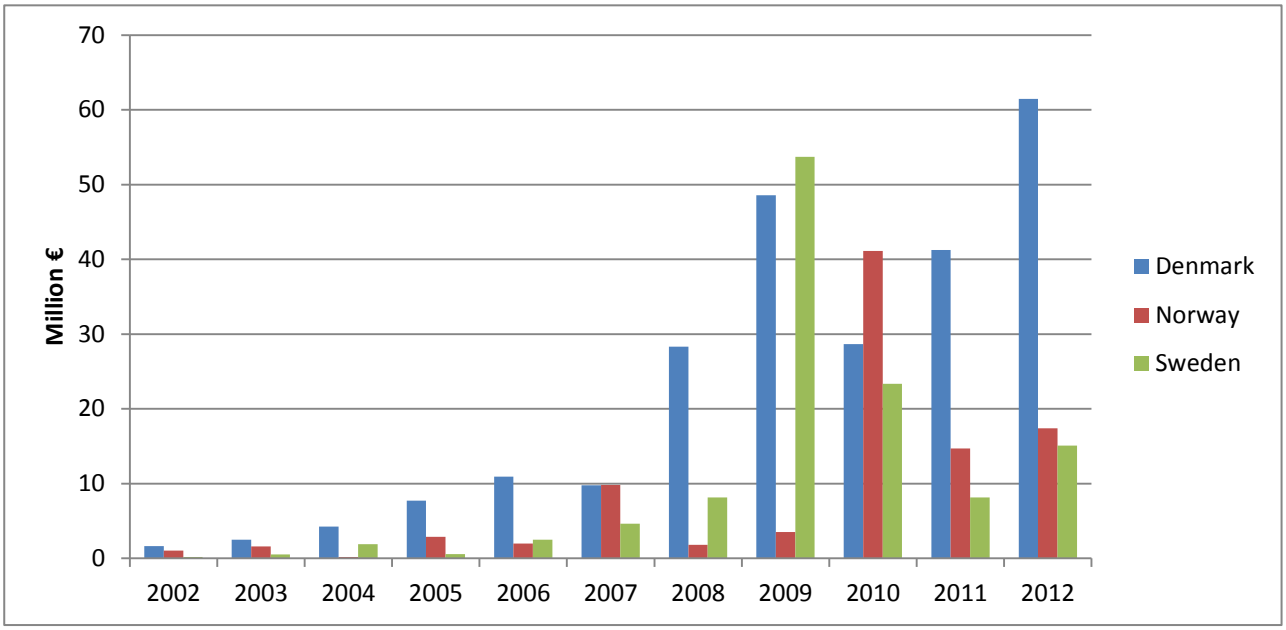

Figure 2 Funding of demonstration projects in the database; distributed over years and countries. Figures in millions of EUR. N=433.

The figures show a clear increase in projects and funding supporting demonstration projects by public programmes. This could be due methodological reasons; easier access to newer projects. This could also be due to actual changes in governments' priority setting for demonstration projects and/or for projects within renewable energy and transport.

Data from IEA RD&D statistics database suggest that the actually has been an increase in the funding for RD&D related to renewable energy. See figure 3. Concerning overall changes in government's priorities for demonstration this is illustrated in figure 4.

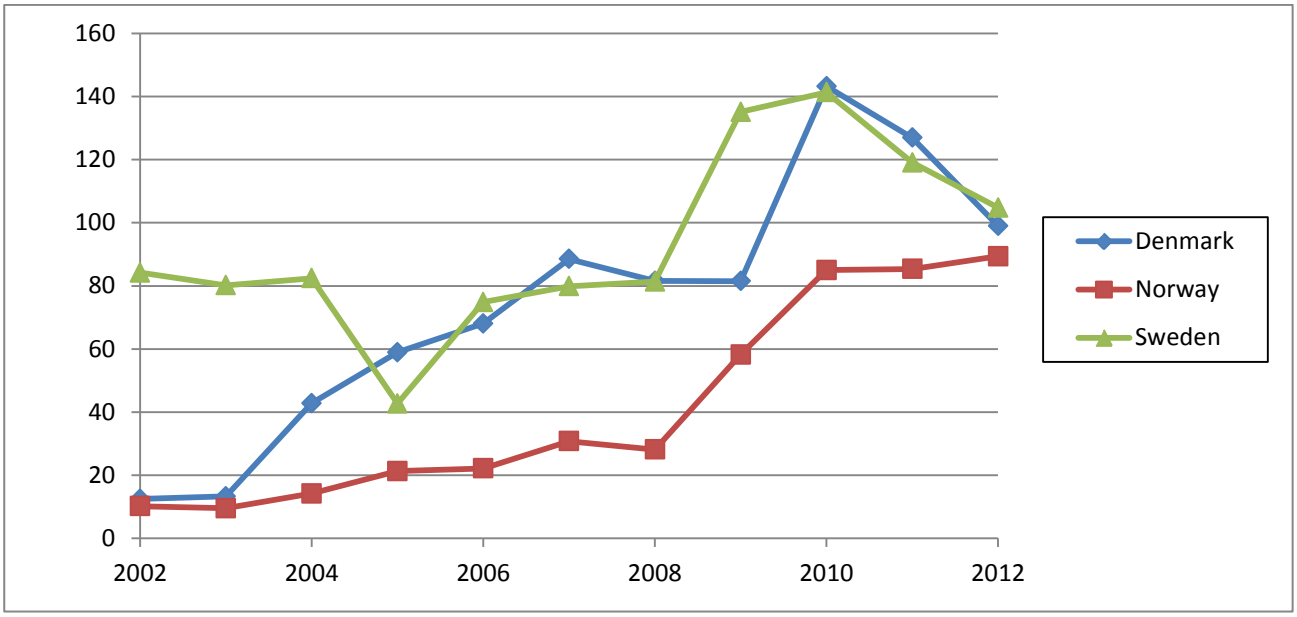

Figure 3 Development in the three countries' expenditures on three IEA technology groups 1: ENERGY EFFICIENCY, 3: RENEWABLE ENERGY SOURCES, and 5: HYDROGEN AND FUEL CELLS. Figures are in Million Euro in 2012 prices and exch. Rates. Source: IEA RD&D statistics Database, accessed January 2014.

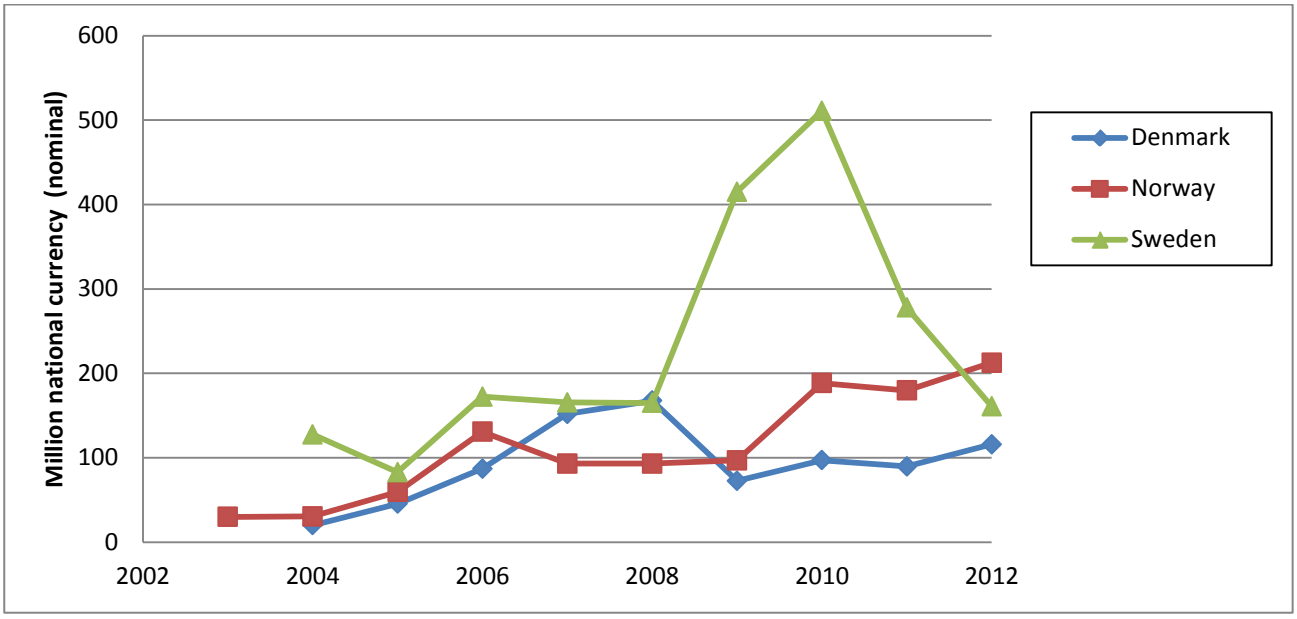

Figure 4 Development in the three countries expenditures on 'Demonstration' according to IEA's RD&D Statistics. Figures are in Millions of national currency (nominal). Source: IEA RD&D statistics Database, accessed January 2014.

IEA has more recently included demonstration projects in their statistics database, although demonstration is not included in OECD's Frascati manual for governmental R&D Expenditures. In IEA's database demonstration is defined as: '*Demonstration: the design, construction, and operation of a prototype of a technology at or near commercial scale with the purpose of providing technical, economic and environmental information to industrialists, financiers, regulators and policy makers*'[1]. This definition differs slightly from the definition applied in the InnoDemo project and

[1] IEA Guide to Reporting Energy RD&D Budgets/Expenditure Statistics. IEA June 2011 Edition.

this fact is an additional source to inconsistencies between the IEA data and data from the InnoDemo database. Another source of inconsistencies is listed in IEA's documentation document: '*From 2010 onwards, there is a large amount of budgeted expenditure in VII.2 Other. This is due to incomplete data available to the Danish administration*'[2]. However, IEA data supports the observation that governments in the three countries have increased their funding for demonstration projects. Hence, the IEA data supports the validity of the InnoDemo Database.

Finally, the data in figure 1 and 2 are combined in figure 5 and 6. Figure 5 shows the development of average size of projects in the database for each of the three countries. Figure 6 shows average number of partners in each project for the three countries.

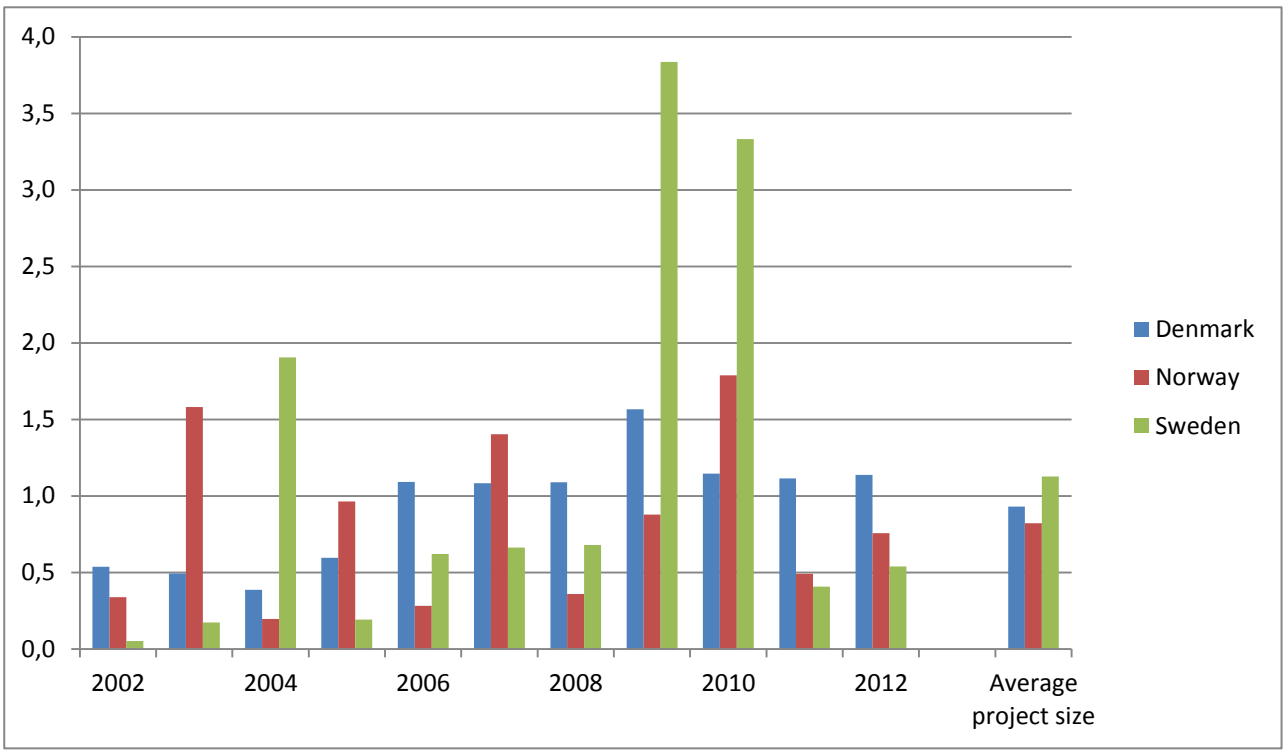

Figure 5 Average size of the public funding of each demonstration projects per year for each country. Figures in million EUR, current prises.

[2] ENERGY TECHNOLOGY RD&D BUDGETS: BEYOND 2020 DOCUMENTATION, 2013 edition. http://wds.iea.org/WDS/tableviewer/document.aspx?FileId=1443

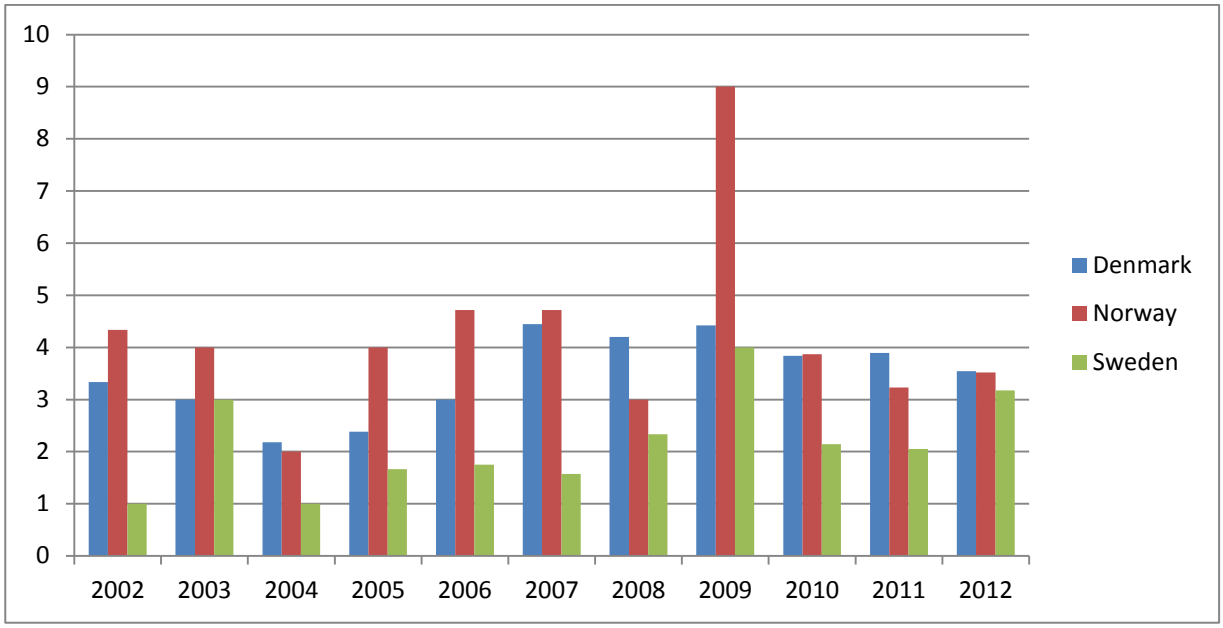

Figure 6 Average number of partners in each project in the database. N=433.

TECHNOLOGIES

All projects have been characterised by project's main type of energy technology. This was based on IEA Codes (IEA Guide to Reporting Energy RD&D Budget/ Expenditure Statistics), Appendix 1 from page 92[3]. Several projects have multiple categories according to this classification, e.g. a demonstration of cars with a fuel cell / electrical drivetrain and with fuel based on hydrogen produced by biomass. In each case the team assessed what should be considered as the most important characteristic. Transport is primarily included in Energy efficiency in the IEA scheme. Hence this categorisation in the database might differ from overviews from other sources.

No projects in the two groups '4 Nuclear' and '7 Other Cross-Cutting Technologies and Research' were included in the database. There is one Norwegian project in the group '2 Fossil Fuel' related to CCS.

[3] http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=KS-RA-10-028,

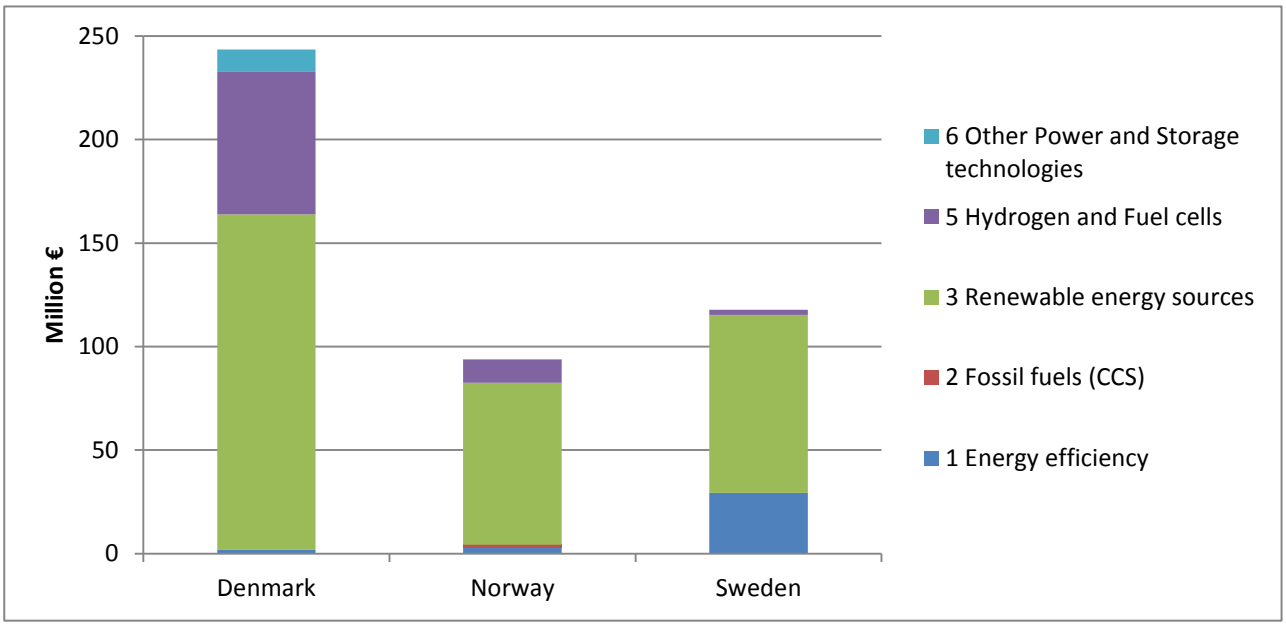

Figure 7 Distribution of government funding for energy technology projects in the database for the three countries. Based on IEA one digit codes for technology groups. Figures in Million Euro.

In the database a total of 97 projects relate to road transport. These include 30 projects in Denmark, 40 in Norway and 27 in Sweden. Figure 8 shows distribution of government funding for road transport projects in the database (started in the period 2002-2012) for the three countries. The overwhelming majority of these projects involve electrical mobility and biofuel/biogas.

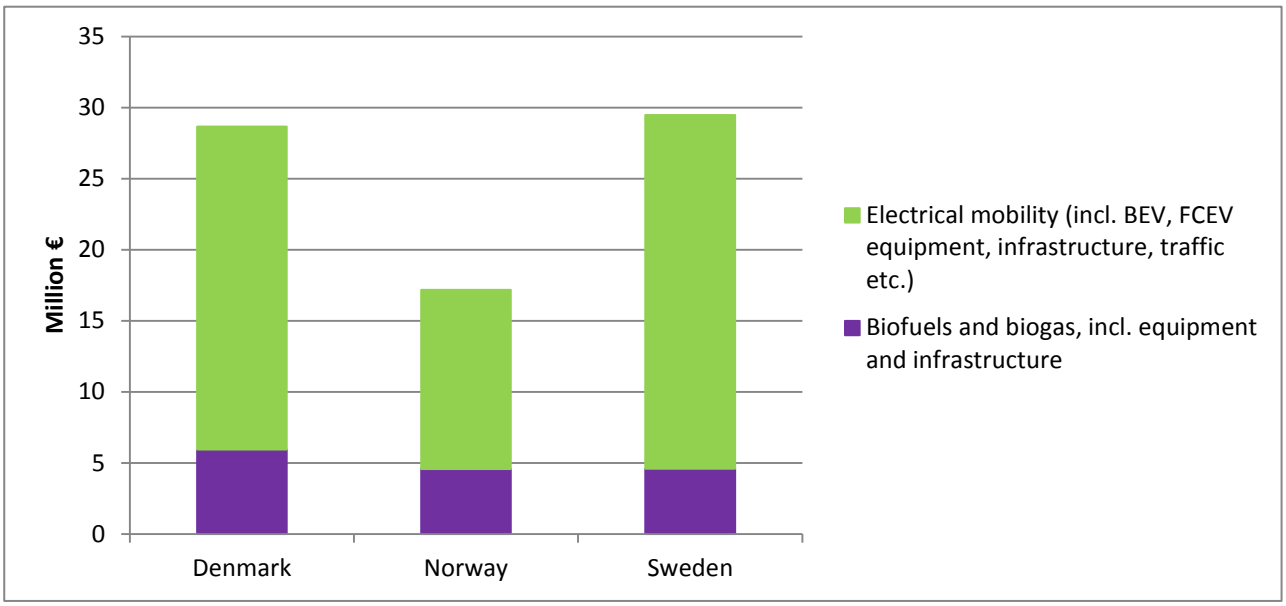

Figure 8 Distribution of government funding for road transport projects in the database (started in the period 2002-2012) for the three countries. Figures in Millions of EUR.

PROJECT AIMS

Throughout the data collection process, projects were marked with one or more project aims. The distribution of these aims is illustrated below in terms of number of projects with specific aims for each country. The process of designating aims for projects was based on a short descriptive text made by programme or project partners, and will be subject for further analysis in InnoDemo through the use of surveys, interviews and focus groups.

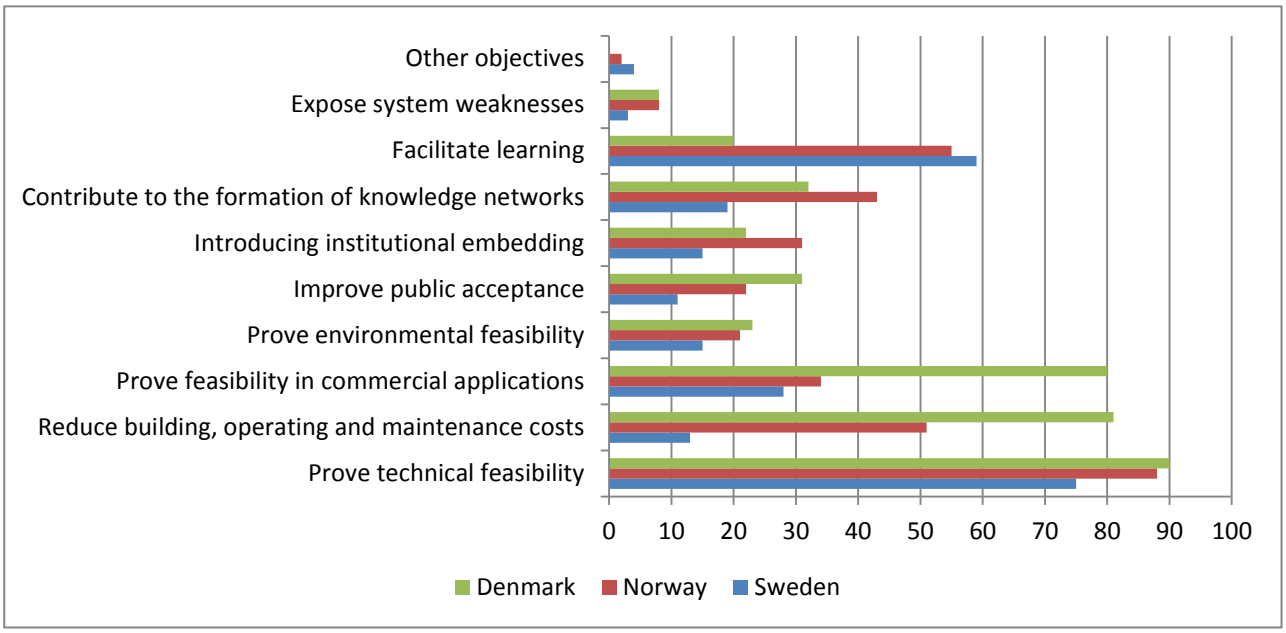

Figure 9: Number of projects with specific aims for each country. Note that each project can have multiple aims.

The dominant aim of projects was to prove technical feasibility, appearing in 58% of all projects. Other regular aims are: reduce building, operating and maintenance cost (33%); prove feasibility in commercial applications (33%) and facilitate learning (31%).

There are cases of variation in the distribution of aims across the countries, e.g. reduce building, operating and maintenance cost is relatively low in Sweden and facilitate learning is low in Denmark. This could be due to the short descriptive text to decide aims from, causing equivocality in interpretation.

ORGANISATIONAL SETUP

Similar to the projects aims; the organisational setup was decided based on the short descriptive text accompanying each project.

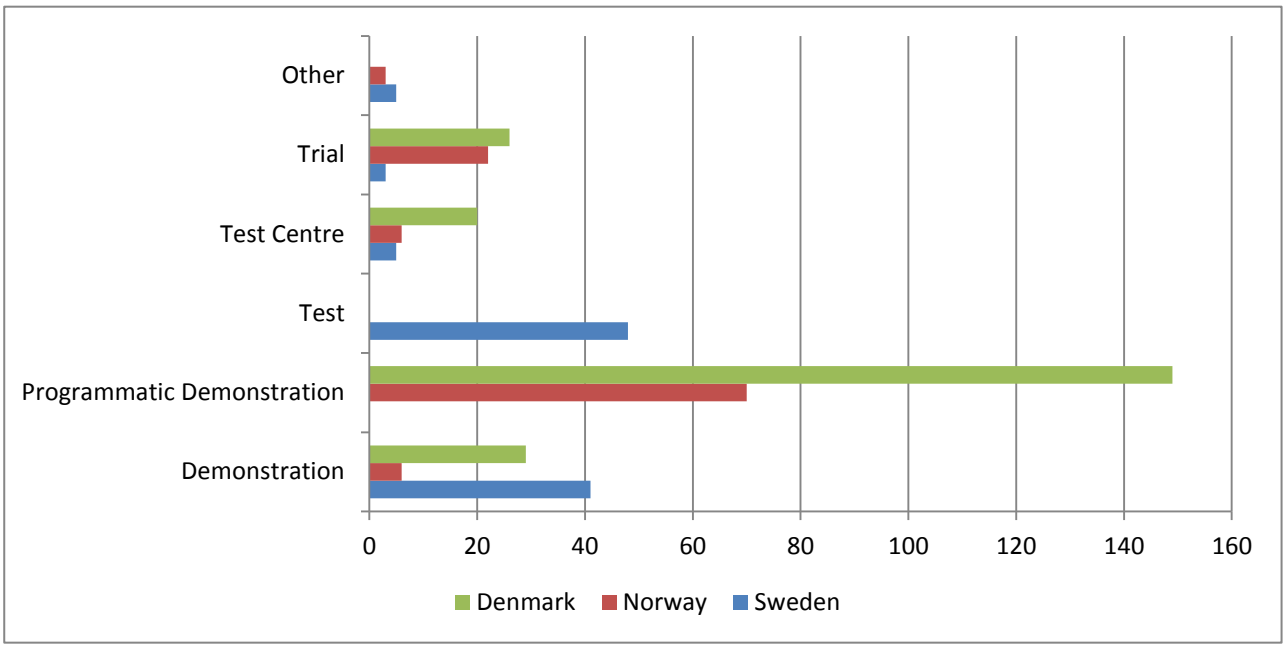

Figure 10 Distribution of organisational setup (type of project) of all projects and for each country. N=433.

Programmatic demonstration type projects accounted for 51% of projects, demonstrations for 18%, trials for 12%, tests for 11%, test centres for 7% and others for 2%. Similar to projects aims, variations across countries can be seen, e.g. by fraction of demonstration type projects in Norway being relatively low, tests only registered in Sweden, and programmatic demonstration projects totally missing in Sweden.

The domination of programmatic demonstration type projects that seeks to "systematically measure, test, evaluate and characterise technology for a particular application", corresponds to the interpreted aims of the projects that are dominated by aims towards technical feasibility, costs and further learning. This correlation between aims and organisational setup of projects based on the same short project description further highlights the need for an in-depth analysis of projects. This is planned to be carried out in later work packages of InnoDemo.

VALIDITY AND REALIBILITY OF THE DATA

Following section discusses briefly main considerations regarding validity/representability and reliability of the data.

VALIDITY

The aim of WP2 was to construct an inventory of past and on-going demonstration and trial projects for sustainable energy and transport in the Scandinavian countries. A key question is here: how many of the potential projects did we include in the database and – if not all projects - to what extend are the included project valid/representative for all projects.

Projects included in the inventory accounts for only a part of total technology projects within sustainable energy and transportation. For Sweden, about 30% of all projects reviewed were found relevant, and for Denmark about 10%.

Regarding the general validity/representativeness of data collected during work package 2, three issues are of particular importance.

First, it has been emphasized to gather data from all relevant funding programmes both at notional, regional and municipal level. Projects funded by national level programmes are assessed to be included to a very high extend for all three countries. Projects funded at regional level and in particular as individual projects at regional and municipal level have been difficult to identify.

Second, data availability differs between the three countries. Data availability is better in Denmark as in the two countries. In particular for Norway it has been challenging to collect all necessary data due to confidentiality for some major programmes.

Third, as data availability for the newer projects are better that for older ones, it is estimated that for all countries the inventory have a better coverage for the newer projects.

However, in general we assess that the projects included in the inventory are representable for all demonstration and trial projects for sustainable energy and transport in the Scandinavian countries initiated in the period 2002-2012. Based on the extensive data collection the projects included in the database are considered to have a satisfying degree of validity for the further analyses.

RELIABILITY

Funding data for projects are to some extent uncertain for three reasons.

First, due to budgeting of funding programmes, cases were found where funding to projects by the end of one year might not be used until the next. As a consequence, smaller inconsistencies can be found when comparing the exact budgets based on projects and programmes, respectively.

Second, variations can be found in project budgets from year to year and between application and report, particularly in projects with longer duration.

Third, as InnoDemo target projects funded by national governments, it is worth noting that some funding in-directly comes from international sources, e.g. EU.

In total, we do not estimate the funding data to be unreliable for the use of this project, as the above three variations are likely minor.

Project aims and organisational setup are based on the analysts' personal assessments based on the state-of-the-art study's definitions. A source of uncertainty with respect to the analysis of demonstration project aims and organisational setup is information present in available texts describing projects in the inventory as well as the analysts' assessment of this text. Three factors are important.

First, variations were present in the way and level of detail in which projects were described in the accessed material.

Second, most descriptions were from project applications and, therefore, reflect only intended aims and not actual results.

Third, interpreting and distinguishing between e.g. programmatic demonstration and trial type projects was difficult as existing literature does not specify these in great detail.

APPENDICES

APPENDIX A: DEMONSTRATION PROJECT AIMS

To prove technical feasibility of the technology or (most often) a new version, a new component, new systemic solution, etc.

To reduce building, operating and maintenance costs

To prove feasibility in commercial applications

To prove environmental feasibility

- Life cycle assessment of technologies in different stages of the life cycle in a value chain the demonstration project is integrated in, such as upstream, operation and downstream processes
    - Green House Gas emissions
    - Pollutants
    - Noise
    - Land usage
    - Water usage
    - Biodiversity impact

Contribute to the formation of knowledge networks:

- Involvement of knowledge based firms
- Involvement of important knowledge providers, such as universities and research institutes and other research and technology laboratories
- Improved linkages between nodes in the network
- Improved linkages to international knowledge network

To improve public acceptance, including creating or improving public awareness of the technology

- Raise public awareness of the technology
- Strengthen legitimacy of the technology

To introducing institutional embedding, including objectives related to 1) the development of complementary technologies and the necessary infrastructure, 2) sharing expectations 3) including a broad array of actors aligned in support of the technology – aligned network of producers, users, third parties, esp. government agencies.

Expose system weaknesses:

- Infrastructure weaknesses: lack of or poor condition of physical infrastructure, such as IT, roads, and science and technology infrastructure
- Lock-in/path dependency of the economy prevents transition to new socio-technical regime
- Missing standards
- Inconsistent or inadequate framework of regulations and the general legal system
- Lack of linkages between actors, both nationally and internationally
- Lack of absorptive capacity to learn about new technologies and adapt them
- Lack of new experts from education system or from outside the country

Facilitate learning: addressing learning of different involved actors and types of learning

- Technological learning by involved technological experts, designers and producers (learning by searching, learning by doing and learning by interacting)
- Stakeholder learning (learning by interacting)
- Customer learning (learning by using)
- Political learning (learning by interacting)

Others: objectives not covered by the above mentioned

APPENDIX B: PROJECT DATA FIELDS

Official title

English title

Omitted if no official English title is present

Start year

Included are projects started in the period 2002-2012. Actual starting year is preferred over planned starting year.

End year

Actual end year is preferred over planned end year. We also include projects with a planned end year later than 2012. In the later analysis we might cut off projects not yet finalised at that actual time.

Project URL

Specific project homepage is preferred over general project information (e.g. program homepage)

Project leader

We basically need this for contact purposes. More detailed information about organisations will appear elsewhere.

- **Name**
- **E-mail**
- **Telephone** (incl country code)

Demonstration site

If site for physical project site is available, otherwise omit.

- **Country**
- **Address**
- **Postal code**
- **NUTS code** (derived from Postal Code)

Type of Energy Technology

Typology based on IEA Codes (IEA Guide to Reporting Energy RD&D Budget/ Expenditure Statistics), http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=KS-RA-10-028, Appendix 1 from page 92.

I could be NICE to use a very detailed typology for type of technology, However, this is not NEEDed in relation to the research question. Use only the two-digit level of aggregation, e.g.:

11 Industry (Energy Efficiency)

12 Residential and commercial buildings, appliances and equipment (Energy Efficiency)
13 Transport (Energy Efficiency)
31 Solar energy
32 Wind energy
33 Ocean energy
34 Biofuels (incl. liquid biofuels, solid biofuels and biogases)
35 Geothermal energy
36 Hydroelectricity
37 Other renewable energy sources
39 Unallocated renewable energy sources
51 Hydrogen
52 Fuel cells
59 Unallocated hydrogen and fuel cells (use this for combined Hydrogen/Fuel cell projects)
Ect.

Please observe that transport is also partly included in this typology!

Type of Transport Technology

Beside the useful classification of energy technologies given by the relatively fine grained structure of the IEA classification we need also a classification regarding transportation. If not a dedicated transport project please leave blank.

Typology based on Eurostat Codes (selection from Illustrated Glossary for Transport Statistics, ISBN 978-92-79-17082-9), http://epp.eurostat.ec.europa.eu/portal/page/portal/product_details/publication?p_product_code=KS-RA-10-028

Use only two-digit level of aggregation, e.g.:

A.1 Railway Transport, Infrastructure
A.2 Railway Transport, Transport Equipment (Vehicles)
B.1 Road Transport, Infrastructure
B.2 Road Transport, Transport Equipment (Vehicles)
C.1 Inland Waterway Transport, Infrastructure
C.2 Inland Waterway Transport, Transport Equipment (Vessels)
D.1 Pipeline Transport
Etc.

Funding programme

Before funding programme can be chosen from the drop-down list, it needs to be defined in 'Scheme4 – Programmes' in Access.

Project objective

One or more of the following possibilities must be 'ticked off':

To prove technical feasibility of the technology or (most often) a new version, a new component, new systemic solution, etc.

To reduce building, operating and maintenance costs

To prove feasibility in commercial applications

To prove environmental feasibility

- Life cycle assessment of technologies[4] in different stages of the life cycle in a value chain the demonstration project is integrated in, such as upstream, operation and downstream processes
    - Green House Gas emissions
    - Pollutants
    - Noise
    - Land usage
    - Water usage
    - Biodiversity impact

Contribute to the formation of knowledge networks:

- Involvement of knowledge based firms
- Involvement of important knowledge providers, such as universities and research institutes and other research and technology laboratories
- Improved linkages between nodes in the network
- Improved linkages to international knowledge network

To improve public acceptance, including creating or improving public awareness of the technology

- Raise public awareness of the technology
- Strengthen legitimacy of the technology

To introducing institutional embedding, including objectives related to 1) the development of complementary technologies and the necessary infrastructure, 2) sharing expectations 3) including a broad array of actors aligned in support of the technology – aligned network of producers, users, third parties, esp. government agencies.

Expose system weaknesses:

- Infrastructure weaknesses: lack of or poor condition of physical infrastructure, such as IT, roads, and science and technology infrastructure
- Lock-in/path dependency of the economy prevents transition to new socio-technical regime
- Missing standards
- Inconsistent or inadequate framework of regulations and the general legal system
- Lack of linkages between actors, both nationally and internationally
- Lack of absorptive capacity to learn about new technologies and adapt them
- Lack of new experts from education system or from outside the country

Facilitate learning: addressing learning of different involved actors and types of learning

- Technological learning by involved technological experts, designers and producers (learning by searching, learning by doing and learning by interacting)
- Stakeholder learning (learning by interacting)
- Customer learning (learning by using)
- Political learning (learning by interacting)

Others: objectives not covered by the above mentioned

Text box

In the text box the objective or aim of the project (if electronically available) can be cut&paste'd in.

Organisational solution

[4] http://www.nrel.gov/analysis/sustain_lca_about.html

One of more of the following possibilities must be 'ticked off':

One-off Demonstration: If the project is a one-off high profile 'demonstrations' and competition where visibility and public awareness is important. Probably only few projects fall into this category – and it is a bit outside the scope of the InnoDemo projects.

Programmatic demonstration: If the project is a part of a coordinated 'programmatic demonstrations' to test, evaluate and characterise technology for a particular application.

Programmatic field trail and test: If the project is part of a programmatic 'field trials' and tests to improve the performance and reduce costs, in the immediate run-up to commercial roll-out backed by subsidies and incentives; and

Test Centre. It the project (a part of a) permanent testing and demonstration facilities.

Funding

Total budget: The projects total budget - in national currency.

Public subsidy: The actual public funding body's part of the total budget – in national currency.

Filled in using local currency and automatically converted to NOK and EUR in the database

Subsidy rate: Automatically calculated from the above numbers

Note Box

Notes should include comments on data uncertainties.

APPENDIX C: ORGANISATION DATA FIELDS

Organisation ID

Automatically assigned when created

Organisation name

Organisation acronym

Organisation number

The official organisation number (if available). Typically found on the organisation's homepage.
For Norway: Organisasjonsnummer; E.g.Statoil Fuel & Retail Norge AS: NO 914 766 451 MVA
For Denmark: CVR-nummer; E.g. Vestas: Cvr-nr. 10 40 37 82
For Sweden: ??

Type of organisation

- Firms, incl. Large, SME and micro entreprises, also including publicly controlled firms such as Statoil and DONG; and including both national and foreign firms.
- National government entities (ministry, agency, etc.; including public service entities clearly a part of the government structure, e.g. energy supply, information services etc.)
- Regional government entities (including public service entities clearly a part of the regional government structure, e.g. water supply, energy supply, information services etc. - please observe the very different governmental structure in the three countries)
- Municipal and city government entities (including public service entities clearly a part of a municipality, e.g. water supply, energy supply, etc.)
- Universities and other higher education institutions (e.g. colleges as Høyskolen I Ålesund)
- Research and Technology Organisation (e.g. Danish GTS institutions, FOI in Sweden, SINTEF in Norway)
- NGOs incl. industry association, environmental interests groupings, political parties, etc.)
- Others organisations (e.g. standardization bodies such as Dansk Standard or Norsk Standard, and international organisations such as EU Joint Research Centres – we expect very, very few of such partners)

Website

Country

Address

City

Postal code

NUTS code (derived from Postal code)

Notes

Notes should include comments on data uncertainties.

APPENDIX D: PROGRAMME DATA FIELDS

Programme ID

Automatically assigned when created

Official name

English name

Start

End, if ended.

Website

Owner (ministry, agency, or similar institutional anchoring)

Programme contact person (often key civil servant)

- **E-mail**
- **Telephone**

Country

Funding providing authority/agency/organization (if different from owner)

Geographical target (Global, Nordic, National, Regional, Local (Municipal))

Objectives of the programme

Programme follow-up on former programme?

Evaluation report of the programme

Planned or realized follow-up programmes

Annual funding + number of annual projects

As a separate sub-table

This report documents the work of work package 2 of the InnoDemo research project funded by the Research Council of Norway. Partners in the project are The Nordic Institute for Studies in Innovation, Research and Education (NIFU) (project leader), DTU Management Engineering at Technical University of Denmark and CIRCLE at Lund's University.

A set of characteristics have been specified to be collected in an inventory of demonstration projects and funding programmes. This data was collected in parallel in Denmark, Norway and Sweden in the second half of 2013.

A total of 433 demonstration projects initiated in the period 2002-12 were identified: in Denmark (224 projects), Norway (107 projects) and Sweden (102 projects).

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