EUDP GLDK

Energy Technology Development and Demonstration Programme

and

Green Labs DK

Strategy 2020-2030

June 2020

EUDP GLDK

Contents

I. The EUDP and GLDK - from research to market

The EUDP was established in 2007 to support development, demonstration and market introduction of new energy technology. In 2010, this work was extended with Green Labs DK (GLDK), which supports larger test facilities.[1] The two schemes have a common board, appointed by the Minister for Climate, Energy and Utilities for four years at a time. The board is served by a secretariat located in the Danish Energy Agency in Esbjerg.

The programmes are part of an overall public-funding system from research to market. Projects focusing on research in particular are usually funded by Innovation Fund Denmark. Projects focusing particularly on further development and demonstration to reach the commercial markets are funded by the EUDP. Larger test facilities are supported by GLDK.

Up to 2020, the EUDP and GLDK have funded around 1,000 projects with more than DKK 5 bn. In the same period, applicants have self-financed with the same amount. There have been applications for DKK 14 billion, for a wide range of projects. From small and often very technology-specific projects with a few participants; to larger projects with several partners and typically targeted more complex (system) solutions. The latter group also includes demonstration projects and test facilities that may be difficult or impossible to establish without public funding. By contributing to financing in this phase, the programmes help realise the commercial potential of more technologies.

The applications are assessed according to a number of criteria, including innovation height, climate impacts and potential for commercialisation. All projects are to be completed with a scientific report in which shareable results are published at www.energiteknologi.dk.

In addition, an annual report is prepared and published each year, with an overview of the portfolio of on-going and completed projects.

According to a 2019 evaluation, EUDP-funded enterprises perform better than comparable enterprises, in terms of exports, turnover and jobs. The EUDP has developed to be a significant source of funding for the ongoing development of green energy and climate technologies and system solutions, and has helped to ensure that Denmark continues to have a strong international position and many workplaces in the energy and climate sector.

[1] Consolidating Act on a Energy Technology Development and Demonstration Programme and on the Green Labs DK Programme (https://www.retsinformation.dk/eli/lta/2019/895).

Strategy for the EUDP and GLDK up to 2030

The purpose of the EUDP and GLDK is to underpin Denmark's energy and climate-policy objectives by funding development and demonstration of energy technologies and system solutions that can contribute to reaching the targets. The programmes also promote exploitation and development of business potentials in this area to benefit growth and employment.

The targets in the Climate Act of a 70% reduction in CO_2 equivalents by 2030 and climate neutrality by 2050 are the overall prioritisation framework for the programmes. There is widespread agreement that electrification and other coupling of sectors will constitute a primary track to achieve the goals by 2030 and will pave the way to meet the 2050 target. In simple terms, this means that electricity based on renewable energy (RE) should, as far as possible, replace fossil fuels, so that, as a society, we exploit our large renewable energy resources in the best way possible, and we increase energy efficiency in the overall energy system.

It is most energy-efficient to use electricity directly (direct electrification), as in heat pumps and electric cars, for example. However, electricity can also be used as a source of energy to produce hydrogen using electrolysis. Hydrogen can be used directly as a fuel in transport or in industrial processes. Alternatively, it can be refined into high-value electrofuels. These hydrogen-based technologies are known as “Power2X” or “indirect electrification”.

Power2X-technologies are still expensive and immature. However, at the present time, it is difficult to see other possibilities to replace fossil fuels with green alternatives for ships, aircraft and, in part, heavy road vehicles. Of course, other solutions may turn up in the future. But it takes time to develop and test immature technologies, and therefore it is necessary to focus on a broad palette of possible green solutions to meet the climate targets for 2030 and 2050.

The same applies for another group of immature technologies known as CCS and CCU. In these systems, carbon is extracted from waste incineration, power plants, etc. The carbon is then recycled, e.g. in Power2X technologies. Alternatively, the carbon can be deposited in the subsurface.

In its analysis from March 2020 on the reduction target of 70%, the Climate Council concluded that, as a society, we can reach a 60% reduction through known “elements of transition”, i.e. by using known technologies without necessarily changing our behaviour. In other words, by replacing oil-fired installations with heat pumps, a petrol-powered car with an electric car, etc. In order to achieve the final ten percentage points, according to the Danish Council on Climate Change it is necessary to develop and promote not yet mature technologies and to change behaviour.

Both business policy and energy and climate policy contain a number of obvious advantages for electrification. Denmark has a large, and far from fully utilised, potential for electricity based on renewable energy sources, particularly from wind and solar. Globally, Denmark is still among the leading countries in the field of offshore and onshore wind power, and Denmark has strong expertise in infrastructure and integration of large amounts of fluctuating electricity from wind and solar power in the overall energy system. We can go a long way with electrification, but we also have to recognise that electrification cannot stand alone. It will also be necessary to expand focus to include further development of CCS and CCU as well as a number of other technologies.

The important thing is ultimately whether the technologies and solutions displace fossil fuels, and whether they increase energy efficiency and can strengthen green growth and job creation.

In 2016, 73,400 people were employed in the energy sector, corresponding to around 3 % of the total number of people in full-time employment in Denmark. Of these, 43 % were employed within green energy. Furthermore, Danish exports of energy technology and services in 2019 amounted to DKK 122.6 bn., or 13.5 % of total Danish goods exports. This strong position in the Danish economy is not only the result of solid development of new technologies, however. It is also supported by political decisions which, among other things, aim to compensate for the absence of carbon emissions pricing or for low carbon emissions pricing. Therefore, political regulation will clearly continue to be crucial for whether completely new technologies, in particular, can be launched on local and global markets.

II. Challenges and focus areas

As a part of the preliminary work on this strategy, a technical workshop was held, with contributions from a number of experts and business leaders. The programme for the workshop is reproduced in an annex to this strategy (annex 1). In addition, we have naturally used the knowledge generated in the programmes over many years, as well as the many initiatives and analyses from the Danish Council on Climate Change, climate partnerships, universities, etc.

On this basis, we have decided to focus on eight areas which reflect the challenges society will be facing in the forthcoming period.

It is our assessment that the eight challenges described below very much correspond to the challenges facing the EU and other regions in their efforts to combat global warming. Therefore, it makes good sense to believe that funding from the EUDP and GLDK may help increase Danish exports of energy technologies and system solutions over the coming years.

We have chosen to let 2030 be the framework, but we expect to revise the strategy after four years, in light of any new knowledge we may have at that time.

1 More green electricity - and for more purposes

Today, wind covers approx. 50% of Danish electricity consumption. However, there is a need for expansion with much more electricity from wind and solar, in particular, if we are to replace oil and natural gas in transport, heating and process energy with green electricity. In round figures, comprehensive electrification requires a doubling of existing electricity consumption in the period up to 2030.

Even though wind power and solar energy are mature technologies, there is still a need for further development. For wind power, this includes new materials, durability, recycling turbine wings, better wind data, and scaling-up challenges. Developments for photovoltaic solar modules include, in particular, improving performance and lifetime, and reducing the costs of components and installation.

Biomass (waste, biogas, wood chips, straw, wood pellets) today accounts for approx. 17% of total Danish electricity production and two-thirds of total Danish consumption of renewable energy. Biomass plays a major role in district heating and in individual heating in particular. The political debate about the extent and sustainability of biomass used is far from over. However, with some caution, we believe that focus will increasingly include changing from biomass in heating to biomass for transport, including Power-to-X, and to upgrading biomass and more efficient use.

2 Energy efficiency

There is still huge potential in exploiting energy more efficiently, and Denmark and the other EU countries are obligated to carry out comprehensive improvements in energy efficiency. Therefore, there is also likely to be a large export market for enterprises which can supply components and overall solutions for more efficient use of energy. This applies not least in housing, buildings and industrial processes. In buildings and housing, improvements include the building envelope in new and existing buildings, but also very much fittings such as pumps, valves, performance electronics, total management systems, etc.

Furthermore, electrification very much entails more efficient use of energy, than is the case with fossil fuels.

3 Transport of people and light goods

Transport accounts for almost 30% of total Danish emissions, and this percentage is increasing. According to the Danish Energy Agency's baseline projection, in 2030 transport will be responsible for 34% of total Danish emissions.

Therefore, it is important that as large a proportion of passenger and goods transport as possible be moved from petrol and diesel vehicles to electric and plug-in hybrid vehicles. Denmark has no motor industry, and therefore, from a technological perspective, the development of components and integrated charging management and infrastructure, in particular, are where Denmark can make its mark on the electrification of transport of passengers and light goods; and area under rapid global development.

The heavy transport sector is responsible for about 1/3 of emissions from the transport sector, but direct electrification does not seem possible in the short term. Clearly, many urban busses and some ferries run on batteries. But a more comprehensive breakthrough in work on direct electrification of small aircraft, transport and long-distance coaches is required (e.g. e-highways). This is where Power2X comes into play.

4 Heavy transport and large-scale Power-to-X

The concept of Power2X covers a number of different technologies which can be used to replace fossil energy resources in aircraft, ships, heavy road transport and industry. Common for all these technologies is that they demand large quantities of green electricity to separate hydrogen from water (electrolysis), and that this process generates large amounts of heat. Therefore, an important part of further development is to ensure that heat can be exploited so that energy efficiency improves in the overall system.

Hydrogen can either be used directly in transport and industry, or it can be part of the further process to produce electrofuels (liquid or gaseous) for heavy transport, e.g. ammonia, methanol, etc. In most electrofuels, there is a need to use a carbon source, which, in principle, can come from carbon capture (CC). Electrofuels are still at an early stage in their development, and they are costly; currently three-times more expensive than diesel. Therefore, there is a need for further development in the entire value chain, and to maintain the possibilities for integrating alternative technologies at a later stage.

5 Heating and heat storage

Heat pumps also play an important role in work to convert the about 500,000 oil-and-gas-fired homes situated outside the current district heating areas to green heat. District heating is relevant for some of these homes, while others are so scattered that it is more cost-effective to invest in small heat pumps.

Large heat pumps could also play an important role in district heating and in industry, and they could contribute to strong improvements in energy efficiency. In general, the energy efficiency of heat pumps is significantly higher than the efficiency of heating based on fuels. In district heating, the further development of fourth-generation district-heating solutions with lower supply temperatures will also be able to contribute to less heat loss, cheaper pipelines and use of surplus energy from production and/or geothermal energy. Technological development is primarily driven by developments and demand from the district heating sector and industry. Within solar heating, development efforts will include solar heating plant, heat storage and integration of solar energy in the energy system.

Storage of thermal energy for the Danish district heating grid is a technology area in which Denmark leads globally. This applies in particular to storage of hot water in reservoirs, which is currently the subject of several demonstration projects. There are also great expectations for storing heat in the subsurface and storage media such as stone and liquid salt. These technologies have the advantage that they can store heat at a higher temperature, and this offers a significantly greater flexibility in the overall system.

6 Green process energy

There is still a need to develop more energy-efficient solutions in industry. Many industrial processes use heat and are based on fossil energy. Industrial processes can roughly be divided into low, medium and high temperature processes. At present, heat pumps can be used to replace fossil energy resources in low-temperature processes. Medium and high-temperature areas require further development, demonstration and tests to produce heat pumps that can gradually take over, while part of the heating demand is expected to be covered by biogas.

Heat from industry will also increasingly be integrated with district heating. This will be both by using district heating in processes where this is profitable, and by using surplus heat from data centres or production plants.

7 Flexible electricity use, grid expansion and digitisation

In line with massive electrification, there will be a need for flexible electricity consumption to avoid over-investment in more cables. Developments in flexible consumption are slowly starting, and new technological advances will ensure that more energy-consuming units are ready to react automatically to CO_2 forecasts or price signals from the electricity market, for example.

Advanced technologies can contribute to reducing CO_2 emissions by forecasting more intelligently maintenance of installations and infrastructure, optimising heating and cooling processes and utilising data for efficient energy consumption in buildings.

There is currently a trend to collect large amounts of data and use artificial intelligence and machine learning, for example, to develop algorithms that can analyse and forecast the condition of an energy system. Data opens up for opportunities that Danish enterprises must capitalise on to develop new solutions in combination with innovative business models.

Electrification and digitisation will increasingly entail that system solutions manage new challenges, e.g. to secure customer data.

8 Carbon capture, storage and utilisation

Carbon capture and storage will help compensate for the lack of reductions in other sectors and, if necessary, contribute to neutralising emissions of CO_2 from biomass-fired installations.

CO_2 from carbon capture will also be used to replace fossil carbon in liquid and gaseous electro-fuels.

The need for research and development within these technologies is linked to both the collection, chemical binding, exploitation and storage of CO_2. Generally, there is a need for cost-effective technologies. If the solutions can be developed and implemented, there may be large reduction potentials for major carbon emitters (cement works, waste incineration plants and biomass-fired CHP installations).

III. Who and what can receive funding

In this strategy we have focused on a number of challenges on the route to achieving the Danish climate targets. This means that we would like to see more applications for these areas. However, it is important to emphasise that this does not preclude applications which lie outside the focus areas. If the idea is good, and the project lives up to the requirements for all projects, the project may receive funding.

Funding from the EUDP can be applied for by enterprises, universities, GTS institutes (approved technological service providers), utility companies and public-sector institutions. Funding is available for small, technology-specific projects and broad collaboration across the value chain on innovative system solutions. Common for all the projects, however, is that they must be technologically and commercially rooted in the Danish business community.

Funds from GLDK can be applied for by so-called innovation clusters, which consist of a number of knowledge institutions as well as public or private enterprises wishing to establish common facilities at which enterprises can test and demonstrate new climate technologies under realistic conditions.

The programmes support development of Danish energy and climate solutions for local as well as global markets. The programmes also aim to help Danish researchers and enterprises implement the latest international knowledge to benefit Danish energy-technological innovation. This is both through funding for networks, e.g. under the IEA, and through funding for Danish participation in international projects.

IV. Further development of the programmes

In addition to the above areas, over the next two years the EUDP and GLDK will focus on the following initiatives to promote further development of the programmes and collaboration with other players in the area.

- Further to the evaluation in 2019, we will work to ensure continuous collection of data that can provide better knowledge about what is particularly important for whether a project is successful and generates value for enterprises and society. This will provide better knowledge about the extent to which there is a financing gap between the EUDP and financing via the Danish Green Investment Fund, the Export Credit Scheme, etc.
- We will also work to streamline the application process for applicants that have previously received funding for successful research and development, as well as for applications from small and medium-sized enterprises.
- The assessment of individual applications will be made on the basis of a number of criteria that are available to the public. Over the period, we will carry out a thorough assessment of whether there is a need to adjust these criteria, including the weighting of the individual criteria.
- Because of the likely significance of changed behaviour, we will look more closely at how the programme could work more deeply on the interaction between technology and behaviour.
- We will continue to apply the experience gained in recent years to work on helping to ensure that Danish enterprises, universities etc. get a share in international programmes of strategic energy-policy interest for Denmark.
- In general, we will enhance dissemination of what the programmes can be used for, and how society can benefit from the funds invested in the EUDP and GLDK.

Annex 1 - Programme for technical workshop

08:45 Breakfast and networking

Part 1: Defining the framework

9:00 Welcome and introduction to the workshop
Anne Grete Holmsgaard; chair of the EUDP

9:05 Current status for Denmark's climate targets and commitments. Recommendations from the Danish Council on Climate Change for the government
Jacob Krog Søbygaard; Head of Secretariat for the Danish Council on Climate Change

9.35 The energy system of the future
How far can we get with electrification? Focus on new energy technologies and systemic barriers in the short and the long terms
Hans Henrik Lindboe; Partner in Ea Energianalyse

Part 2: Thematic areas

Each of the following six items is composed of a presentation of 10 minutes and a possibility for
the EUDP board and moderator Hans Henrik Lindboe to ask questions for 10 minutes.

10:05 Wind power and Power2X
Technological challenges and business opportunities for Power2X
Michael Paludan-Müller Nylykke; Lead Business Developer at Ørsted

10:25 Sustainable fuels in the transport sector
Sustainable fuels that can replace fossil fuels at sea
Maria Strandesen; Portfolio Manager at Mærsk Line

11:15 The heating sector
Opportunities for more electrification of the heating sector
Bjarke Paaske; Engineer at PlanEnergi

11:35 How Aalborg Portland produces “green” concrete
New fuels, industrial symbiosis/sector coupling and carbon capture, storage, utilisation.
Thomas Uhd; Head of Sustainability & External Relations, Aalborg Portland

11:55 Electrification and grid expansion
Digitisation and commercialisation of smart grid solutions for the future
Jørgen P. Christensen; Development Director at the Danish Energy Association

12:15 Carbon capture, utilisation and storage (CCUS)
Technological challenges to mature and commercialise technologies within CCUS
Philip Loldrup Fosbøl; Associate Professor at the Technical University of Denmark

12:35 Final questions from the EUDP board and discussions in plenum and light lunch

12:55 Conclusion
by Anne Grete Holmsgaard