The EUDP Strategy 2017-19

JANUARY 2017

Contents

0 Background

At COP21 in Paris in November 2015, world leaders established a global climate agreement, the Paris Agreement, which sets the framework for global climate collaboration, and which is expected to have a great impact on global climate efforts. The agreement is a legally binding, global agreement, and more than 150 countries have submitted their greenhouse gas reduction contributions under the agreement. This corresponds to more than 90% of global emissions (the Kyoto Protocol covered less than 15%). The Paris Agreement therefore represents a huge step in the transition to a global society with significantly reduced greenhouse gas emissions, and initiatives and technologies to underpin this agenda are therefore expected to be afforded even greater priority in the future.

According to the IEA[1], new investments in energy will total up to USD 13,500 billion during the period 2015 to 2030 if the 150 countries under the Paris Agreement implement in practice the energy plans they have submitted under the agreement (their so-called INDCs; Intended Nationally Determined Contributions[2]). Furthermore, the most recent analysis of global trends in renewable energy[3](RE) investment from UNEP/Bloomberg shows that RE investment peaked at a record high of USD 286 billion in 2015 (excluding hydropower), despite an unfavourable dollar exchange rate and low coal, oil and gas prices. The year 2015 was also the first year in which investment in RE capacity was higher in *developing* countries than in *developed* countries.

Against the backdrop of this considerable potential, the board of the Danish Energy Technology Development and Demonstration Programme (EUDP) has set out its new strategy for the forthcoming period. With this strategy, the Board takes a larger and more global perspective than in previous strategies in order to arrive at the primary areas of initiative in which it makes best sense to invest in future years. This approach means there will be focus on those markets and technologies in which EUDP-subsidised projects are best positioned to realise their commercial potential and, thus, provide concrete outcomes for businesses in the form of revenues, exports, jobs and growth. The strategy for setting priorities and allocating funds is therefore also based on an analysis of the following three topics:

- Global trends and challenges in the energy area.
- The business potential and strongholds of Danish businesses in the energy area.
- Danish energy-area strongholds in research, development and demonstration.

The rationale behind this EUDP Strategy is therefore to invest in areas in which there is a particularly good match between global demand for new energy technology, on the one hand, and, on the other hand, Danish strongholds and business potentials; i.e. areas in which Danish businesses will most likely be well positioned to compete with other players. With regard to the EUDP, primary focus will be on projects to develop, demonstrate and scale-up technologies in Denmark with a view to exporting them to an ever growing market.

Furthermore, the strategy identifies a number of new assessment criteria and specific effect targets for the upcoming period. This is partly to indicate the direction and focus for the programme, applicants and relevant players, and partly to define how the programme should subsequently be evaluated.

[1] World Energy Outlook Special Briefing for COP21, OECD/IEA, 2015.
[2] INDC - Intended Nationally Determined Contributions. Used for the first time by the UNFCCC in connection with the Paris Agreement.
[3] Global trends in renewable energy investment 2016. Frankfurt School-UNEP/Bloomberg NEF, 2016.

1 Trends, challenges and framework conditions for the EUDP Strategy 2017-19

1.1 Objective of the EUDP

The EUDP Act states that the objective of the EUDP is to provide support for energy-policy targets for security of supply, Danish fossil fuel independence, global climate considerations and considerations for a cleaner environment and cost-effectiveness. Furthermore, the Act contains an objective to promote exploitation and development of business potentials in order to benefit growth and employment.

A main principle of the allocation of funding to support the objectives of the Act is moreover that allocation is to be subject to the following: "*Assessments of whether to provide funding shall be based on general criteria which, in addition to the general purpose of this Act, shall emphasise the professional quality of the project proposal as well as the managerial and organisational aspects of the project.*"

Furthermore, the Act states that: "*Assessments of applications shall also emphasize the areas for initiative that have been identified, and the strategies that have been prepared, within the framework of private-public collaboration.*"

In terms of energy-policy targets, a long-term objective is for Denmark to become independent of fossil energy. The energy system must be transformed to renewables, i.e. to being based on wind, solar, wave, biomass and geothermal energy. Furthermore, energy use must be made more efficient in all sectors, so as to ensure the highest possible value for the energy resources consumed and so as to reduce total energy consumption.

Since 2007, the EUDP has supported more than 600 RDD projects through funding of almost DKK 3 billion out of a total budget of almost DKK 6 billion. Of these projects, around 400 are ongoing and have been granted a total commitment of around DKK 2 billion.

1.2 Global trends and challenges in the energy area

- **Global investment in energy efficiency and renewables**

At COP21 in Paris in November 2015, world leaders established a global climate agreement, the Paris Agreement, which sets the framework for global climate collaboration, and which is expected to have a great impact on global climate efforts. The agreement is a legally binding, global agreement, and more than 150 countries have submitted their greenhouse gas reduction contributions under the agreement. This corresponds to more than 90% of global emissions (the Kyoto Protocol covered less than 15%). The Paris Agreement therefore represents a huge step in the transition to a global society with significantly reduced greenhouse gas emissions, and initiatives and technologies to underpin this agenda are therefore expected to be afforded even greater priority in the future.

Furthermore, the IEA (Ref1) has estimated the investment required for the 150 countries under the Paris Agreement to implement the energy plans they have submitted under the agreement (their so-called INDCs; Intended Nationally Determined Contributions[4]). The total investment required amounts to USD 13,500 billion, to be invested in solutions that promote energy efficiency and renewable energy in the period 2015 to 2030, corresponding to 40% of total expected energy-sector investment.

According to the most recent analysis of global trends in renewable energy[5](RE) investment from the UNEP/Bloomberg, RE investment peaked at a record high of USD 286 billion in 2015 (excluding hydropower), despite an unfavourable dollar exchange rate and low coal, oil and gas prices. The year

[4] INDC - Intended Nationally Determined Contributions. Used for the first time by the UNFCCC in connection with the Paris Agreement.
[5] Global trends in renewable energy investment 2016. Frankfurt School-UNEP/Bloomberg NEF, 2016.

2015 was also the first year in which investment in RE capacity was higher in *developing* countries than in *developed* countries. China, in particular, was a substantial player, investing USD 103 billion, corresponding to 36% of global RE investment.

According to Bloomberg's annual long-term projections of global power-generating capacity up to 2040[6], RE is expected to contribute just under 60% of the around 10,000 GW of new power-generating capacity expected to be added over the next 25 years. In its outlook, Bloomberg identifies a number of trends in energy markets, including that financial benefits, rather than policy, will be the driver of increased investment in RE capacity in the future. This is due to several conditions, however, in particular, to an expected reduction in all-in project costs by an additional 32% for wind, and 48% for solar PV, up to 2040, based on a learning curve effect and improved financing opportunities. Wind is already the cheapest form of new power capacity in Europe, Australia and Brazil, and it is expected to become the least-cost option globally by 2026, while utility-scale solar PV is expected to take over this position around 2030.

Another trend identified by Bloomberg is that developing countries are in the process of changing from traditional, centralised systems to more flexible and decentralised systems, which are considerably less carbon intensive. In the OECD, small-scale solar PV is expected to dominate with regard to capacity and new investments, and focus in the value change is therefore likely shift to consumers and the resulting opportunities for gaining new market shares. Over the next 25 years, 80% of investments in new power capacity will take place in non-OECD countries, and around half of these investments will be in renewables. Coal and utility-scale solar PV are expected to compete closely in developing countries, where factors such as domestic low-cost fuels (coal reserves) and lack air pollution regulation will have great significance for coal.

A global boom in solar PV installations is expected, broken down equally between small-scale and utility-scale installations, and large-scale installations are expected to outcompete wind, gas and coal in sunny regions. Furthermore, it is expected that Europe will see an increase in small-scale solar PV capacity from 6% in 2014 to 22% in 2040, as households and industry are expected to apply this strategy to keep high electricity prices at bay.

In terms of global investment in RE over the past 10 years, according to Bloomberg's analysis, wind, solar, biofuels and biomass/waste-to-energy have played the leading role, and of these, wind and solar have been the predominant technologies, accounting for 94% of the total investment in these technologies. RE investment in Europe fell by 21% in 2015, despite the fact that offshore wind set a record, with an increase in investment of 11%, reaching a total of USD 17 billion. It should also be noted that, in 2015, investment in biofuels fell to a tenth of the level in 2008, when investments peaked, while investment in biomass and waste-to-energy saw an increase, with investment amounting to twice the level for biofuels in 2015.

- **Global consumption**

With regard to global energy consumption, the IEA estimates [7] (New Policies Scenario) that consumption will increase by one-third up to 2040. This increase in energy consumption will primarily be driven by countries such as India and China, as well as the African continent, the Middle East and South-East Asia. The IEA also predicts natural gas to become the fastest growing fossil fuel, with growth of up to 50% compared with today, because of its relatively good properties (back-up, low carbon intensity), while Bloomberg is more hesitant about the increasing role of natural gas, merely assessing it to become a larger and lasting factor.

The IEA also estimates that end-use consumption of electricity at global level will grow to around one-quarter of final energy consumption in 2040, when the electricity sector will be setting the pace for decarbonisation of the energy system. Countries outside the OECD will account for up to 90% of an increased demand for electricity, and around 60% of investments in new capacity are expected to be in renewable energy technologies. Thus, the IEA expects renewable energy to make up 50% of capacity in 2040; 30% in China and Japan, and more than 25% in the USA and India. Energy efficiency improvements will be key to reducing the demand for energy at global level to one-third by 2040; especially so because global economic growth is expected to increase by 150%. Drivers of energy

[6] New Energy Outlook, Bloomberg New Energy Finance, 2015.
[7] World Energy Outlook, IEA, 2015.

efficiency improvements include mandatory targets in China, India and other countries, where policies are expected to become more widespread up to 2040.

In its Medium-Term Energy Efficiency Market Report for 2015, the IEA concludes that energy-efficient buildings constitute a large and growing market, worth USD 90 billion (plus/minus 10%) in 2014. Buildings in general account for more than 30% of global energy consumption. It has been estimated that global investment in energy efficiency improvements in buildings will increase to more than USD 125 billion by 2020, driven by more widespread use of political energy efficiency targets.

- **Challenges in the energy system**

Global challenges in the energy system will, in practice, depend on a large number of local factors such as the individual country's production and supply infrastructure, climatic conditions, relative wealth, current energy-policy framework conditions, etc. So the challenges will be different from country to country, although many of the solutions can relatively easily be adopted to match local contexts.

Focussing on wind and solar for new power capacity is a cross-cutting trend, and as wind and solar have their global breakthrough, there will be a need for flexible capacity, which can cope with peak periods which can be ramped up and down when solar fades away in the afternoon hours or when the wind varies. Similarly, we will be seeing more 'peaks' in electricity curves due to increased demand from households and the private sector and less available baseload. So, there will be an increased need for services such as demand-response, battery storage, interconnectors and control systems to match supply and demand. Furthermore, this means the energy system will become increasingly electrified, and e.g. much of current operation will become electrified in the future.

At the same time, there is increasing focus on energy efficiency improvements, which are often characterised by lower investments with relatively short payback periods, and which take place at the demand side. An expected upward trend in the price of electricity globally (phase-out of coal and phase-out of subsidies for fossil fuels) will have various effects but, all else being equal, it will promote more energy efficient solutions in heating, cooling, ventilation, climate control, heat pumps, industrial processes, etc.

Large parts of the European energy system will be challenged by an increased need to address how the energy produced is used. Efficient and intelligent energy use is crucial, e.g. in buildings, in production processes, at system level and in the transport sector.

1.3 Business potentials and Danish strongholds in energy technology and energy-related RDD

There is no clear definition of what constitutes Danish strongholds in research, development and demonstration (RDD) and technology in the energy area. The EUDP has therefore identified the following Danish strongholds based on a number of indicators (patents, publications, demonstration projects, available export statistics), as well as observations from relevant analyses and sector organisations[8].

Compared with other countries, Denmark is relatively strongly positioned in the following areas:

- **Wind power**

Denmark is a world leader in wind technology, with a global market share of more than 20% of newly installed capacity in 2014[9]. This position stems from a continuous Danish wind expansion effort since the 1980s, which means that a larger proportion of wind power has been integrated into the Danish energy system than in any other country in the world. Danish competences in wind energy are based on a network of large and small enterprises and a range of research and development centres, and in 2014 the wind power industry employed more than 27,000 people and exported for more than DKK 50 billion, according to the Danish Wind Industry Association (DWIA). DTU Wind Energy (Technical University of Denmark) has played a key role in this development and is today recognised as the world's leading wind energy knowledge centre. Denmark moreover owns a number of unique test facilities such as the Lindø

[8] This section is inspired e.g. by the Danish Energy Association, State of Green and the Quartz & Co. report *Energiindustriens historiske omstilling og betydning for Danmark (*report from 2015 on the historical transformation and significance of the energy industry for Denmark).
[9] The Danish Wind Industry Association (DWIA), MAKE Consulting, Navigant Research.

Offshore Renewables Center (LORC), the Test Center for Large Wind Turbines at Høvsøre, Østerild – National Test Centre for Large Wind Turbines, Powerlab DTU, and more. Denmark is also home to some of the world's largest wind turbine manufacturers, including Vestas Wind Systems and Siemens Wind Power. Furthermore, DONG Energy has driven the development of offshore wind technologies through the establishment and operation of offshore wind farms; an area in which DONG Energy is a world leader. Other large, leading enterprises within wind include Bladt Industries (offshore wind turbine foundations), LM Wind Power (turbine blades) and A2SEA (offshore wind turbine installation). However, in addition to the large, well-known players, Denmark also boasts a large number of smaller and very successful niche companies in the wind power industry.

- **District heating**

Denmark's stronghold in district heating has been shaped over a period of 100 years. Today, Danish district-heating plants are among the most energy-efficient CHP plants in the world: For example, the Nordjylland CHP plant has an efficiency of 91% and Block 2 at Avedøre Power Station has an efficiency of 93%. In 2015, around 63% of Danish households were heated by district heating produced at 2,000 heating plants with a 60,000km distribution grid. On the basis of Danish technology and Danish knowhow, Denmark exported DKK 5 billion worth of district heating technology in 2014. Moreover, the sector employs more than 7,000 people. There is strong demand abroad for Danish competences in this area. In a large number of situations, this extremely effective Danish CHP production provides support for unique collaboration partnerships with local enterprises connected to the district heating infrastructure. This applies to e.g. the Aalborg Portland concrete factory, which sells surplus heat to around 30,000 households in Aalborg. Over the past decades, as a response to developments, Danish CHP plants have gradually been converted to a high rate of biomass use, and have therefore gone from a biomass consumption of only 8% in 1980 to 43% in 2012. This has been possible, e.g. because Danish fuel taxes have only targeted fossil fuels. However, technological developments have also been a factor. The gradual conversion of the district heating sector also contributed to the build-up of the Danish knowledge and resource base, and this was established through close collaboration between plants, authorities, consultants and suppliers. Denmark therefore has strong competencies within the design and dimensioning of CHP plants, consultancy services and specialised production. Large enterprises in this area include Logstor, Danfoss, B&W Vølund, BWSC and large consultancy firms such as Rambøll and COWI. According to an analysis commissioned by the Confederation of Danish Industry, the Danish district heating sector holds the potential for 2,400 new jobs.

- **Efficient use of energy**

Efficient and intelligent energy use is crucial, e.g. in buildings, in households, in production processes, at system level and in the transport sector. Denmark is relatively well positioned within lighting, low-energy buildings, building materials and processes, as well as reduction of energy consumption in existing buildings. Comparative analyses of retrofitting of existing buildings versus raising new buildings in a sustainability perspective, including energy consumption for production, also place Denmark in a leading position. Relative to its GDP, Denmark has a low energy consumption, which means that Danish energy intensity is considerably below the EU28 average and Denmark is among the most energy-efficient countries in the world. This is a reflection of energy-policy instruments but also of energy-efficient technologies and processes in Denmark. Danish strongholds in this area have been established primarily through taxes and subsidy schemes as well as energy labelling of products; all instruments intended to reduce energy consumption. A large number of enterprises are in the markets for products within efficient use of energy and energy-efficiency improvements and optimisation. The largest of these include Grundfos (pumps), Danfoss (heat regulation), Velux (windows) and Rockwool (insulation).

- **Bioenergy**

The fact that Denmark introduced energy-policy requirements for alternatives to fossil fuels at an early stage, that it envisioned a supply sector supplied from several sources, and that Denmark focused on exploiting domestic fuels, led to the establishment of a solid platform for bioenergy in the 1980s and 1990s. This development involved both research and development activities and focused on the role of agriculture as a supplier of residual products and the role of the energy sector as a recipient of energy produced at CHP plants. A large number of local and decentralized biomass-fired CHP plants were built. Furthermore, a large number of large-scale and centralized CHP plants were converted to biomass (such as Amager Power Station, Avedøre Power Station, Studstrup Power Station, and more). By 2012, biomass such as straw, wood pellets, wood chips and organic waste accounted for 13% of total Danish electricity generation; more than three-times as much as the EU28 average. Developments in the area helped build the Danish stronghold position in the biomass area, including production of biomass-fired boilers (BWE, B&W Vølund); engineering consultancies' expertise in construction, operation and

maintenance (Rambøll, COWI); and the experience of Danish energy companies with bringing to maturation and realising biomass-related construction projects (DONG Energy). To this should be added the unique knowledge and technology development within biofuels and biogas; areas in which a number of concepts such as Inbicon (DONG Energy) are regarded as world-leading within advanced biofuels, and with Novozymes as a trendsetter with regard to the enzymes required for these processes. The biogas area[10] is experiencing a dramatic development, with expectations that biogas production will more than double and, perhaps, triple, while the use of biogas is becoming independent of local CHP plants, with distribution through the existing gas infrastructure, so that gas can be used in the CHP sector, in industry, in natural gas boilers in households, and in the transport sector. Biogas production has a number of derived positive effects in the form of increased fertiliser value of livestock manure and, thus, increased farming yields, and reduced odour nuisance and greenhouse gas emissions. Biogas plants are an effective platform to ensure appropriate recirculation of nutrients from households and industry to benefit future food supply. There is currently sharp focus on the use of straw in biogas plants, because it is possible to exploit the energy content while at the same time keeping long-term soil-carbon sequestration at the same level as when ploughing-in the straw. Biogas technology can also be defined as a Danish stronghold based on the number of reference projects abroad and the scope of research and development activities in Denmark. The largest Danish suppliers of biogas plants (e.g. Xergi, Bigadan, Lundsby, and Combigas) sell and construct around half of their plants abroad, primarily in countries like Germany, Sweden, the UK and the US. According to the Confederation of Danish Industry, the Danish bioenergy cluster comprised 1,200 enterprises and had exports of DKK 8 billion in 2015.

- **Smart grids and system integration**

Smart grids are a relatively new area, and they could be a future Danish stronghold. Denmark is among the European leaders within research and development activities in smart grids (a total of 89 projects had been launched up to 2014). For Denmark, smart grids are a particularly interesting area because of the challenge of integrating large amounts of intermittent wind power into the existing system, which to an ever greater extent is calling for ways by which to regulate electricity consumption relative to current production efficiently and intelligently. One element in this context is activation of consumers through hourly meter pricing and smart meters. Developments in this area received a boost when it was decided that all Danish homes must have remotely-read meters and hourly pricing by 2020. Another important element is the dramatic developments in digitalisation. Many other countries are undergoing similar developments and smart grids are therefore considered an emerging growth area for Denmark up to 2020. According to the Danish Energy Association, this area could provide 8,000 new jobs and increased exports of up to DKK 14 billion. While smart grids specifically address the problem of moving consumption to other times during the day and matching supply with demand, system integration is also a growing and very important area. The ability to promote system integration will be important when the energy system becomes considerably more dynamic in the future. At the same time, favourable synergies can be created between different parts of the energy system. Large-scale power plants used to supply the dynamic in the energy system. However, in the future, many factors will be competing to supply this dynamic: electric cars, electric cartridges, heat pumps, etc. System integration therefore also covers aspects relating to energy storage and smart energy. Smart energy is a broader concept than smart grids. It has to do with better exploitation of co-operation and coherent energy solutions throughout the process from production to use. Moreover, it covers several energy grids, energy types and sectors in the overall energy infrastructure (electricity, heating, cooling, gas, transport). Developments within system integration are therefore to a great extent a question of creating dynamic incentive structures which can incorporate different technologies and different parts of the energy system in an integrated interplay and in a cost-efficient manner, e.g. combining solar heating and heat pumps with gas or biomass in the district heating system. The challenge with regard to storing energy is to develop technologies and concepts that can store the energy from periods with high production and low demand (e.g. wind power) and save it for peak demand periods, or, alternatively, to convert the energy to other, high-value energy products (e.g. fuels). A large number of small and large Danish enterprises and utility companies operate in this area. These include Haldor Topsoe, which develops SOEC fuel cells for hydrogen production by electrolysis. This technology can be helpful with regard to incorporating large amounts of electricity from intermittent energy sources such as wind and solar into the energy system because the electricity can then be stored as hydrogen for use at a later stage.

[10] Biogas area here refers to biogas produced naturally as bacteria decompose organic material under anaerobic conditions and not thermal gasification of biomass.

- **Oil and gas**

The Danish oil and gas industry is founded on Danish exploration and recovery activities in the North Sea since the 1980s. Oil from the Danish continental shelf is not easy to access, and persistent focus on increasing the recovery rate and continuously extending the service life of Danish oilfields means Danish players have become world leaders in advanced oil extraction. This applies e.g. within horizontal drilling and injection. Danish strongholds within oil and gas are primarily an industry cluster of around 250 enterprises based at the Port of Esbjerg. The cluster includes large companies like Semco Maritime, Rambøll Oil and Gas, Bladt Industries, Maersk Oil and Gas and DONG Energy. Furthermore, in 2014 a *Centre for Oil and Gas* was set up at the Technical University of Denmark (DTU). The centre is financed by the partners in DUC (Dansk Undergrunds Consortium). The centre will provide support for research and development activities as well as highly specialised education and training in oil and gas technology and exploration, and it is expected to employ up to 100 people.

Finally, there is a category of other technologies, for which, so far, no large export revenues have been registered, but with regard to which Denmark is also relatively strongly positioned in terms of publications and demonstration projects, for example within heat pumps, fuel cells, geothermal energy and wave power.

2 Prioritisation and allocation of funds

Danish business potentials in the area of energy technologies are especially prominent in those areas which, over the next 5-10 years, will see a significant demand for specific technologies, and about which it can be said with relative certainty that there is a good match with Danish industrial strongholds and RDD activities. This assumes that Danish players, in one way or another, will have a headstart or an advantage compared to other countries due to an extensive knowledge and resource base, patents, knowhow, test facilities[11], organisation, etc. (all of which are entrance barriers for new players).

The rationale behind this EUDP Strategy is therefore to invest in areas in which there is a particularly good match between global demand for new energy technology, on the one hand, and Danish strongholds and business potentials on the other. The principle is illustrated in figure 2.1: First, global trends and challenges in the energy area are described, and, then, business potentials are identified by comparing the challenges and trends with the Danish strongholds. This approach forms the basis for focusing EUDP efforts.

With regard to the EUDP, primary focus will be on projects to develop, demonstrate and scale-up technologies in Denmark with a view to being able to export them - in other words, primary focus is on Technology Readiness Levels 4-8[12] in the value chain.

[11] For example, the internationally renowned Danish test and demonstration environment at the testing centre in Høvsøre, LORC, the Østerild Test Center, DTU Wind/wind tunnel, Green Labs, DanWec, and more.
[12] See the EU H2020 terminology for more about Technology Readiness Levels, which go from TRL 1 (basic principles observed) to TRL 9 (actual system proven in an operational environment).

Figure 2.1: Funnel model for focusing action areas

On the basis of a review of global trends and Danish strongholds in the energy area, the following observations are deemed of particular interest in the context within which the EUDP is to prioritise its funds:

- Expected greater focus on unsubsidised energy production in future.
- Expectations that onshore wind will be the cheapest new electricity capacity globally in the short term.
- Expectations that solar PV will be the cheapest new electricity capacity globally in the medium term.
- Expectations that roof-top PV installations combined with battery storage will relatively quickly become widespread in many countries throughout the world.
- Offshore wind investments have seen relatively large growth in the European market so far.
- Growing focus on energy-efficiency improvements globally.
- A larger share of intermittent RE (Renewable Energy) leads to greater demand for demand-response management technologies.
- A larger share of intermittent RE leads to greater demand for energy storage solutions. In this context, battery storage, in particular, is expected to play a significant role.
- Greater focus on the use of interconnectors between countries and energy systems globally.
- Investments in biofuels have declined over the past five years, while investments in bioenergy and waste-to-energy have increased. Biomass will probably increasingly have to be used to make high-value products, e.g. in those parts of the transport sector which are not so easily electrified (heavy goods transport, ships, aircraft).

In addition to the observations about global trends and Danish strongholds described above, the EUDP will apply a set of assessment criteria and effect targets in the allocation of funding. These assessment criteria can be applied both in connection with the selection of projects for funding and in connection with the conclusion of projects, while the effect targets will be applied on a continuous basis and in connection with future evaluations of the programme. Assessment criteria and effect targets are listed in table 2.1.

Table 2.1: EUDP targets and assessment criteria

The EUDP Act - underpinning energy-policy targets about:	**EUDP assessment criteria linked to the individual target**	**Effect targets for EUDP efforts up to the end of 2019**
1) Security of supply	The project contributes to security of supply, i.e. to the physical and financial reliability of either the total energy system or the electricity, gas, heating or transport systems.	Projects with an objective to contribute substantially to Danish security of supply must account for their contribution in qualitative terms. At least eight out of ten projects must lead to the result aspired to in the application, or an even better result.
2) Fossil fuel independence	The project contributes to limiting Danish dependence on fossil fuels, either in the form of reduced fossil energy consumption or through the use and incorporation of renewables.	Projects with an objective to contribute substantially to Danish fossil fuel independence must account for their contribution in qualitative terms. At least eight out of ten projects must lead to the result aspired to in the application, or an even better result.
3) Climate and environmental considerations	The project contributes to cutting greenhouse gas emissions and to limiting other factors detrimental to the environment.	Projects with an objective to contribute substantially to improving the Danish climate and environment must account for their contribution in qualitative terms. At least eight out of ten projects must lead to the result aspired to in the application, or an even better result.
4) Cost effectiveness	The project's unique value proposition (added value) relative to existing state-of-the-art technologies, based on efficient energy use and levelised cost of energy - i.e. the project can compete with existing technologies.	Projects with an objective to contribute substantially to Danish cost effectiveness must account for their contribution in qualitative terms or, if possible, quantitative terms. At least eight out of ten projects must lead to the result aspired to in the application, or an even better result.
5) Growth and employment	The project's effects on economic growth generated within 1-5 years of its completion, based on turnover, exports and employment.	The projects must have employment effects which, as a minimum, exceed the historical level in terms of the most recent evaluation [1.02 jobs per DKK million subsidies*]. The projects must have turnover effects which, as a minimum, exceed the historical level in terms of on the most recent evaluation [DKK 2.73 million per DKK million subsidies*]. The projects must have export-revenue effects which, as a minimum, exceed the historical level in terms of the most recent evaluation [DKK 1.95 million per DKK million subsidies*].
6) Research that improves energy-technology development and demonstration	High-quality research in connection with a specific technology development process.	The projects must have effects in terms of publications in peer-reviewed journals. These effects must, as a minimum, exceed the historical level in terms of the most recent evaluation [number/quality*].

*The 2015 evaluation of the EUDP by COWI, based on the sum of increased turnover/exports from conclusion of the project until the time of the evaluation (the time frame can vary from 1-3 years).

On the basis of the established effect targets, the EUDP will continue work to fine-tune and systematise data collection so that the effects can be documented. Furthermore, together with other RDD programmes under the Ministry of Energy, Utilities and Climate, the EUDP will continuously improve efforts in this area, wherever possible.

In this connection, the EUDP will prioritise:

- Within the context of the effect targets established, launching a process that will ensure the data sets required for the indicators. More specifically, this means that final reporting and evaluations must collect data for the key indicators. Establishing a baseline should be considered when launching new initiatives.

- Suggesting a more qualitative and descriptive approach, in the light of the issue that a minority of EUDP activities, especially in the international area, primarily lead to network and knowledge-acquisition effects.

3 Other important action areas

While the overarching principles for prioritising and allocating funds under the EUDP were addressed in the preceding sections, the following sections will look at the need to address a number of other action areas in connection with EUDP activities. The strategy defines three other action areas, which the EUDP sees as important priorities for the upcoming period. At the operational level, each year a plan will be made for efforts in the upcoming year. The efforts will be determined according to the size of the programme and the volume of current projects. The three action areas at the strategic level are defined level below.

3.1 Promotion of international collaboration - the EU, IEA and Mission Innovation

- **The EU SET Plan and the IEA Technology Collaboration Programmes**

Since its establishment, the EUDP has focussed on strengthening Denmark's international collaboration with a view to promoting Danish strongholds and the Danish energy technology knowledge and resource base. International collaboration under the EUDP is based on participation in the European Research Area Network (ERA-NET) under the EU Horizon 2020 programme; extensive involvement in IEA Technology Collaboration Programmes (formerly Implementing Agreements); as well as international participation in a number of specific EUDP projects.

The EUDP wants to further strengthen the international collaboration effort in order to attract the best international players to project consortia with Danish partners, providing that results are anchored in Denmark and create added value for Danish players. Furthermore, participation in international collaboration will also help promote Danish acquisition of knowledge about the newest trends and methodologies. The European Energy Union and the Strategic Energy Technology Plan (SET Plan) play an important role in this context. Furthermore, the IEA is currently strengthening efforts with regard to its Technology Collaboration Programmes (TCPs).
In this connection, the EUDP will prioritise:

- Participating in SET-Plan work in collaboration with the Danish Energy Agency in order to provide Danish input to the process and acquire relevant knowledge for use in implementation of the EUDP strategy and in the allocation of funding. The SET Plan is being implemented through Horizon 2020, and through the ERA-NET Cofund mechanism, which the EUDP is already making use of and to which the programme will continue to afford priority.

- Promoting international projects, knowledge-sharing, network building and knowledge acquisition, etc. through the IEA Technology Collaboration Programmes, wherever this is of strategic interest to Denmark.

- **Mission Innovation**

Denmark is taking part in the global Mission Innovation initiative, which was launched on 30 November 2015 in addition to COP21 in Paris. This initiative addresses strengthening research and development in clean energy technologies with a view to accelerating a cheaper green transition through continued cost reductions. A total of 20 countries are participating in the initiative. The initiative has two main components: 1) An ambition that participating countries double public funding for research in clean energy technologies over a five-year period up to 2020; and 2) Mobilisation of private-sector financing for clean energy technology research and development through the Bill Gates initiative, Breakthrough Energy Coalition.

Mission Innovation could influence the allocation of EUDP funds in two ways: 1) directly through the allocation of more funds in 2020, and 2) through the activities which the initiative launches with regard to collaboration between participating countries.

The overarching ambition of the EUDP is to promote Danish interests in the best way possible through the work suggested by Mission Innovation. For example, this can take place through increased international research and development collaboration at project level; collaboration at programme level; enhanced understanding of framework conditions for good innovation; and mobilisation of Danish and international players with regard to energy technology development in order to establish a basis for new and promising project consortia.

In this connection, the EUDP will prioritise:

- Participating in, and coordinating with, the Mission Innovation country group with regard to ensuring stronger international collaboration in the energy technology area.

- Serving as a facilitator for Danish players with regard to the private-sector element under Mission Innovation (Breakthrough Energy Coalition).

3.2 Follow-up and profiling ongoing projects

Since 2007, the EUDP has provided support to more than 600 Danish energy technology projects with almost DKK 3 billion out of a total budget of almost DKK 6 billion. Of these projects, around 400 are still in progress, with a total commitment of around DKK 2 billion (out of a total budget of almost DKK 4 billion) and require follow-up by the EUDP Secretariat, while new projects are continuously being launched. This follow-up constitutes a relatively extensive activity, involving a large number of tasks for the EUDP Secretariat, including establishing agreements at start-up, hosting kick-off meetings to gauge expectations of the process, ongoing management of payment requests, annual reporting from projects on project plans and milestones, etc.

These follow-up activities serve multiple purposes. Firstly, to ensure that the funds which have been granted are being used for the approved objective in accordance with the approved project description and the approved budget. Secondly, to ensure that progress in the projects and the milestones agreed on are being realised as planned or, alternatively, that they are reworded if developments in the project indicate that they cannot be realised. Follow-up on projects requires a high degree of insight into the project process. This insight is achieved partly through regular contact and partly through status reporting in connection with payment of funding. The more actively the EUDP can monitor a project with regard to the technical and scientific content of the project, the more insight can be achieved in the collaboration and development process. Experience shows that keeping close contact with projects can be influential with regard to preventing stopping projects prematurely, e.g. because any conflicts between project parties can be dealt with at an early stage; required changes to project plans can be carried out against an informed basis; and it is easier to respond early to inadequate accounting practice. Relatively close monitoring of projects is therefore beneficial for several reasons.

In addition to close monitoring of, and dialogue with, projects, EUDP projects should preferably be profiled to a greater extent than today. This is to spread awareness about the programme as much as possible, but also to create more insight into outcomes as well as the process with regard to the projects; insight which can thus provide inspiration for potential, new EUDP applicants.

The EUDP will prioritise:

- Carrying out systematic follow-up on all projects launched.
- Regularly re-assessing whether existing procedures for follow-up can be improved and streamlined.
- Seeking inspiration from other programmes and schemes, both nationally and internationally, in order to find inspiration for making follow-up more professional.
- Enhancing efforts to profile the EUDP through relevant news stories about projects, e.g. in connection with significant results.