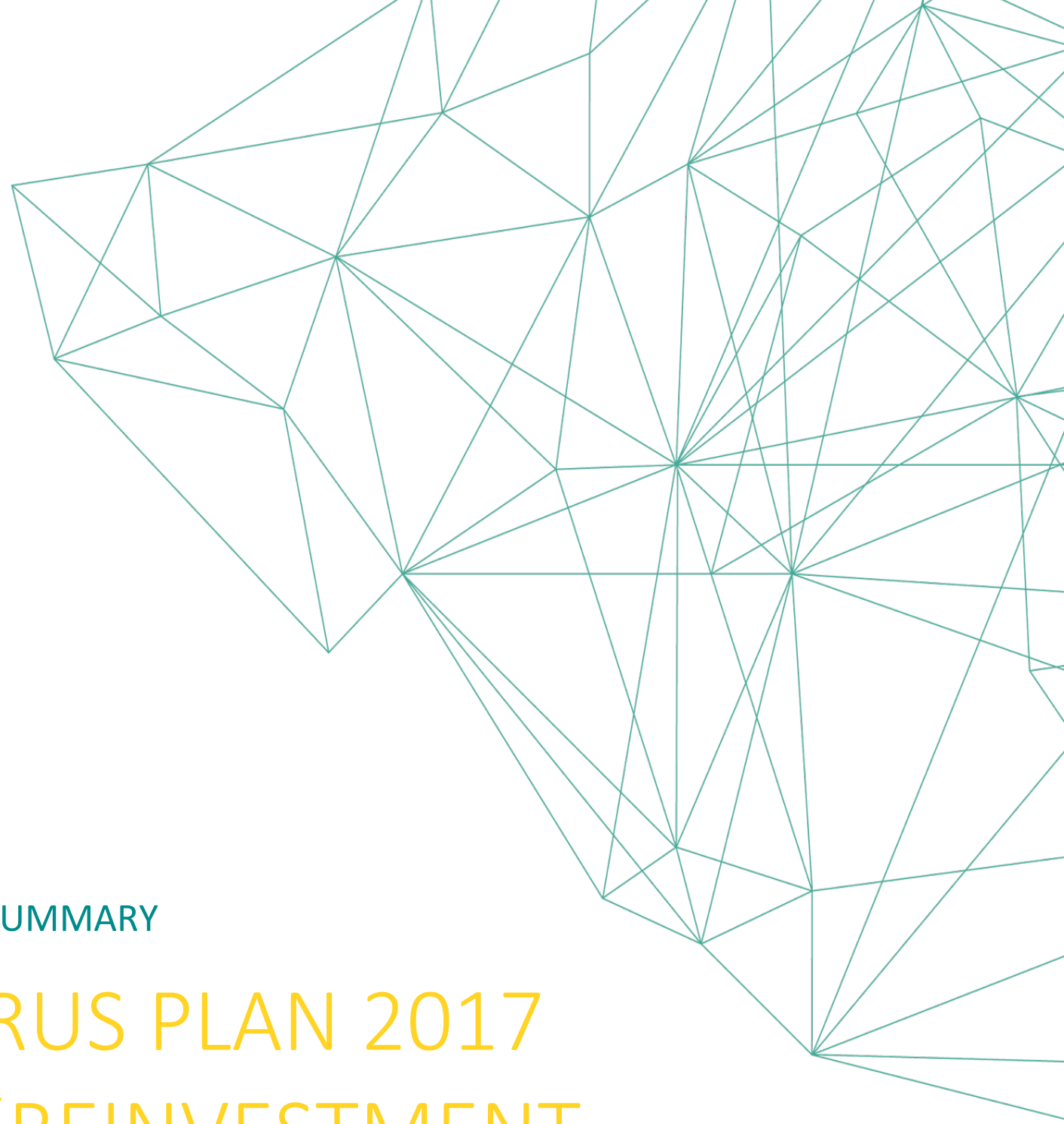


SUMMARY

RUS PLAN 2017 (REINVESTMENT, EXPANSION, RESTORATION) (RUS17)

ENERGINET

1. Summary

Energinet's RUS (reinvestment, expansion, restoration) plan is an overall plan for the electricity transmission grid, where the need for reinvestment, expansion, restoration, and re-engineering is mutually compared and coordinated. The plan covers the medium term for the next 10 years.

The plan has been prepared with the tools currently available in grid planning, which means that basically, grid expansion is used to remove the proven limitations. The RUS plan contemplates that specific maturation projects subsequently define a final solution, which may also involve market-based or operations-related solutions as alternatives to grid expansion.

The plan provides a coherent planning that helps to ensure a timely start-up of the detailed planning and establishment of future specific projects in the transmission grid. The plan is also an important input to Energinet's compliance with the legislation on preparation of plans and forms an important basis for cooperation with the distribution grid companies on planning.

The RUS plan shows an overall status of Energinet's projects in the construction, planning, and screening phases as from 1 December 2017. Unless otherwise specified, all prices in the RUS plan are stated in fixed 2017 prices.

Electricity transmission grid 2017

The overall AC grid consists of approximately 4,200 track km overhead lines and cables. Since on some routes there are more systems on the same row of towers, this corresponds to approximately 6,000 system kilometres. The distribution between the different voltage levels is shown below.

Track km	Overhead lines	Cables	Total
132 kV	753	476	1,228
150 kV	1,216	605	1,822
220 kV	40	84	124
400 kV	946	114	1,061
Total	**2,956**	**1,279**	**4,235**

In addition to the AC network, there are DC interconnectors to Germany, Sweden and Norway as well as between Funen and Zealand.

A total of approximately 250 transformers are distributed on 184 substations as shown below.

Number	Substations	Transformers
132 kV	75	112
150 kV	78	107
220 kV	5	5
400 kV	26	30
Total	**184**	**254**

The above statement includes only independent power transformers, which are part of the transmission grid. Additionally, Energinet owns a number of other transformers, such as auxiliary, pole, and generator transformers. These must be treated as part of the installation.

1.1 Framework for the plan

Energinet's RUS plan 2017 has been prepared in accordance with the political guidelines for cable laying and expansion of the transmission grid in Denmark, which was revised in connection with the political agreement on abolition of the PSO tariffs as from 17 November 2016.

The new principles mean that new 400 kV connections are established as overhead lines with the possibility of cable laying on selected sections and compensatory cable laying of the 132/150 kV grid in the vicinity of 400 kV overhead lines.

Furthermore, the new principles imply that the 2009 cable action plan is cancelled and replaced by the possibility of cable laying on selected 132/150 kV of overhead line sections through areas of natural beauty and urban areas. The specific framework for the realisation of this is being clarified, and as such, cable laying of selected sections in the 132/150 kV grid is not dealt with in detail in RUS plan 2017. Future editions of the RUS plan are expected to include status and indication of potential projects.

Status of the 2009 cable action plan and visual enhancement plans

Energinet's 2009 report on visual enhancement presented six projects in the 400 kV grid with a view to making the landscape more harmonious.

The visual enhancement projects Little Belt and Aggersund were completed in 2014 and 2015 respectively. The visual enhancement around Vejle Ådal is expected to be completed in 2017. The three other projects at the national park Kongernes Nordsjælland, Roskilde Fjord, and Årslev Engsø, which were put on hold until after 2020 as part of the political 2012 solar cell agreement, are resumed and planned for implementation after 2020. The final dates have not yet been set.

The last projects based on the cable action plan were initiated according to Network Development Plan 2013 which is the latest follow-up on the 2009 cable action plan. When the last projects in the cable action plan have been completed in 2019, approximately 25 per cent of the total 132-150 kV overhead line network has been dismantled. Of the total budget for implementation of the cable action plan, approximately 20 per cent will be realised.

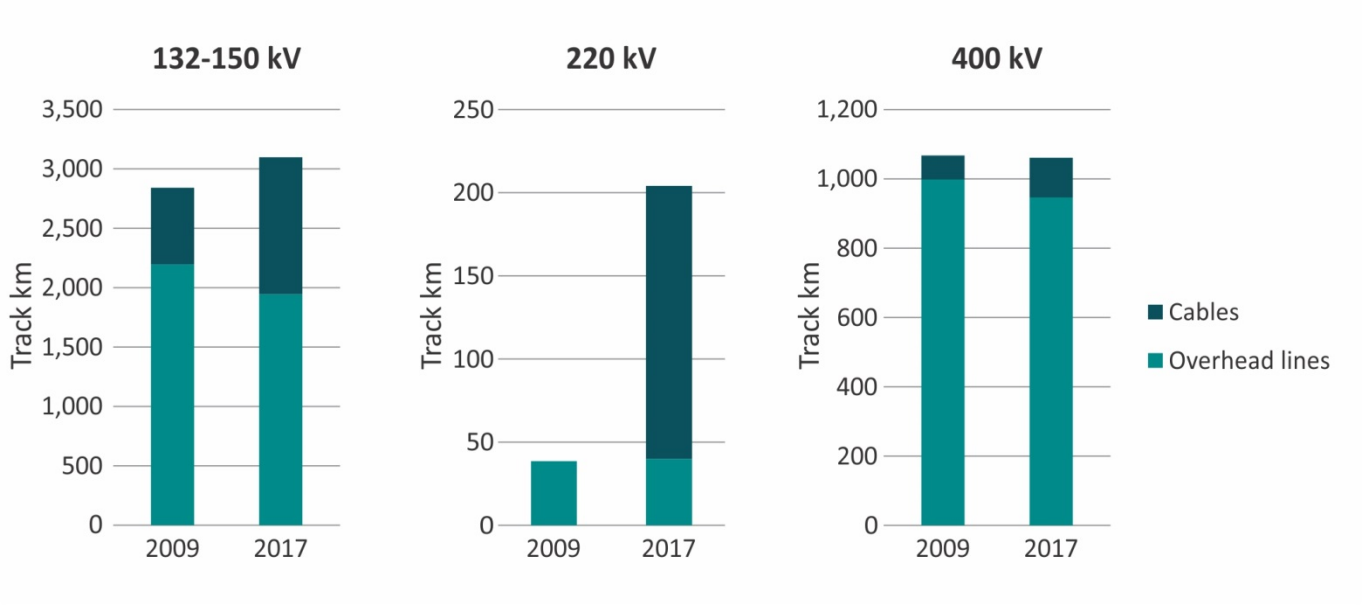
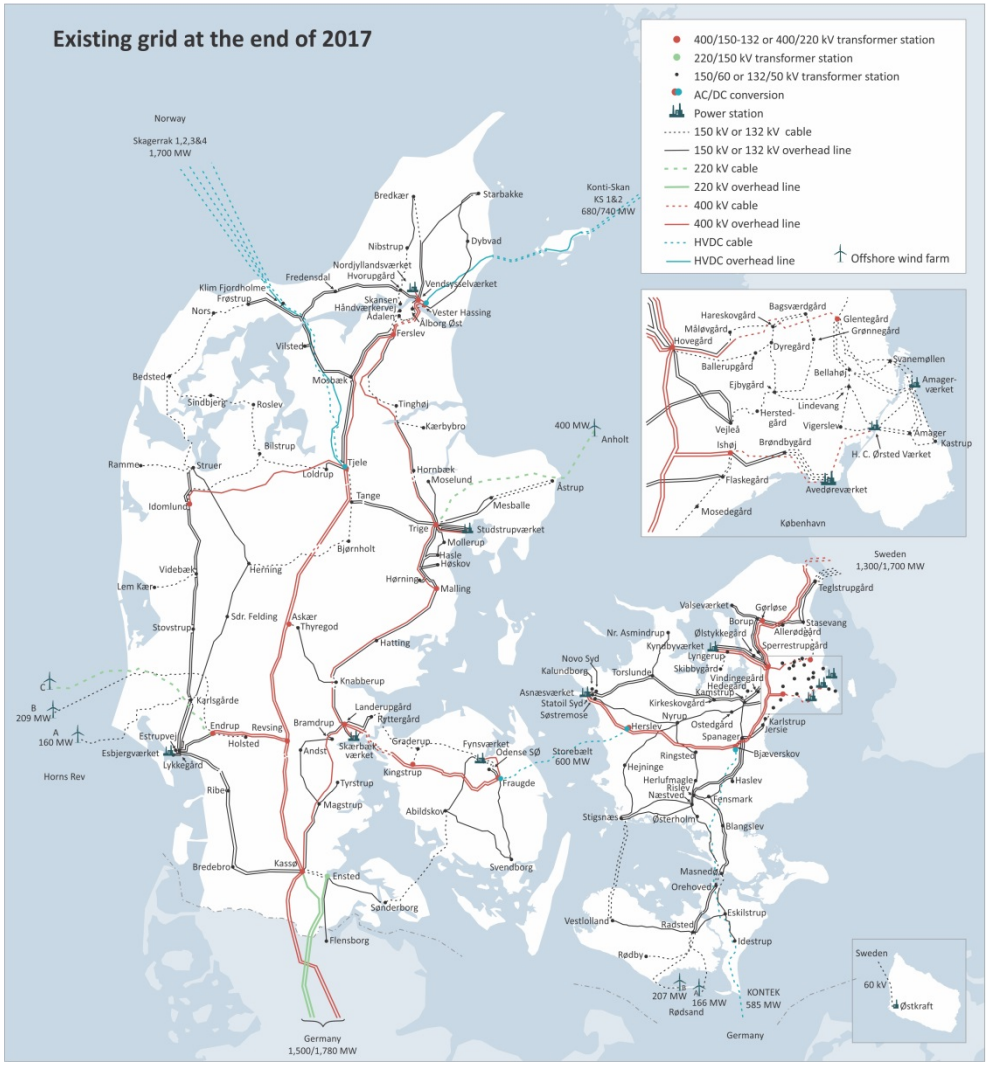


Figure 1 Extent of cables and overhead lines in track km before the initiation of the cable action and visual enhancement plans in 2009 and early 2017.

1.2 Long-term grid structure (up to 2040)

Grid development toward 2040 is characterised by expansion triggered to ensure exploitation of new interconnectors, integration of new renewable energy facilities and increase in electricity consumption as a result of new types of consumption.

The existing transmission grid and the possible long-term 2040 grid structure appear from Figure 2. The 2040 network is exclusively based on solutions through grid expansion. When determining the final solutions in connection with detailed planning, operational and market-based solutions may also be included in the assessment as alternatives to grid expansion provided that they are available.



a)

b)

Figure 2 a) Existing grid in Denmark and b) Possible grid structure in Denmark.

1.3 Medium-term grid structure (up to 2027)

The RUS plan has been prepared on the assumption that the projects in the planning and implementation phases are realized. The RUS plan shows possible projects that can be expected to be launched to support the future need, among other things as a result of the conditions of the facilities and the analysis assumptions.

Figure 3 Possible 2027 grid structure for the electricity transmission grid in Denmark.

In addition, the expected general development in electricity consumption and connection of renewable energy facilities trigger a need for reinforcement. This is particularly due to the transition of electricity from central power stations and local CHP plants to renewable energy facilities. As the renewable energy facilities are often located far from the major consumption areas, this may result in a need for grid reinforcement to be able to transport the electricity from the production facilities to the consumers.

400 kV grid development

In addition to the projects in the planning and construction phases, there is among other things a need for establishing a 400 kV connection from substation Tjele via substation Ferslev to substation Vester Hassing. This owes to the expansion of renewable energy in Northwest Jutland as well as an expected future increased combination of high production from renewable energy facilities and import via the DC connections from Sweden.

Though a number of reinvestment projects have been transferred to the planning phase, reinvestment in several parts of the 400 kV grid is still needed within the next 10 years. This applies to both the grid and the substations. In terms of the grid, reinvestment is needed in for instance foundations, suspensions, earth wire, phase wire as well as towers, cf. Figure 4.

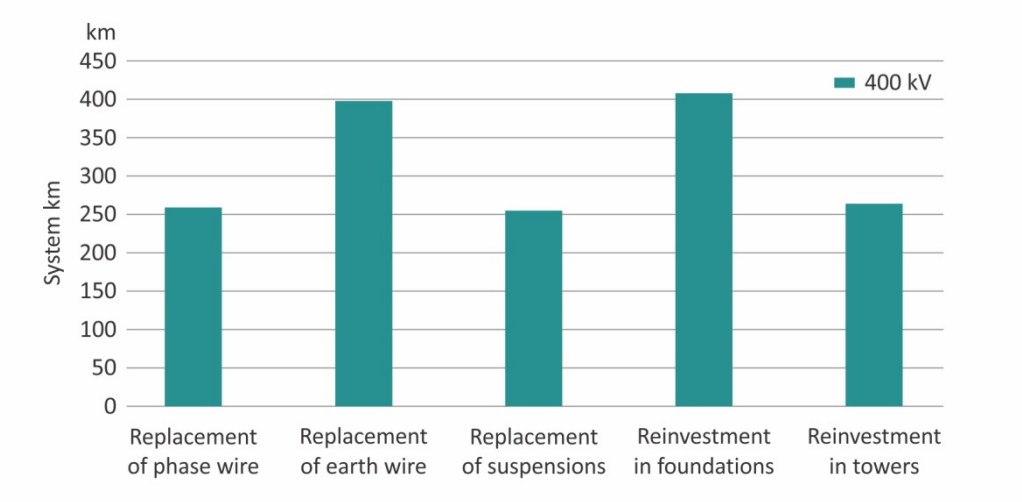


Figure 4 Expected volume of reinvestment in 400 kV transmission lines for potential projects up to 2027.

132/150 kV grid development

In addition to the projects in the construction phase, incorporation of several renewable energy facilities entails a need for additional reinforcement of the 132-150 kV grid toward 2027. Overall, there is a need for establishing approximately 650 kilometres of new 132/150 kV cable connections. In addition, there is a need for expansion of existing substations by a total of approximately 100 new bays, 25 new transformers, and 30 reactors.

Several reinvestment projects are in the planning and implementation phases; this among other things includes large parts of the substation area. However, as a result of the need for reinvestment in the 132-150 kV grid, many possible projects are still expected to be commenced within the next 10 years; this applies to both the grid and the substations. In terms of the grid, reinvestment is needed in for instance foundations, suspensions, earth wire, phase wire as well as towers, cf. Figure 5.

Reinvestments may require long outage times; therefore, it may in some cases be necessary to advance CAPEX to ensure sufficient transmission capacity during the reconstruction phase.

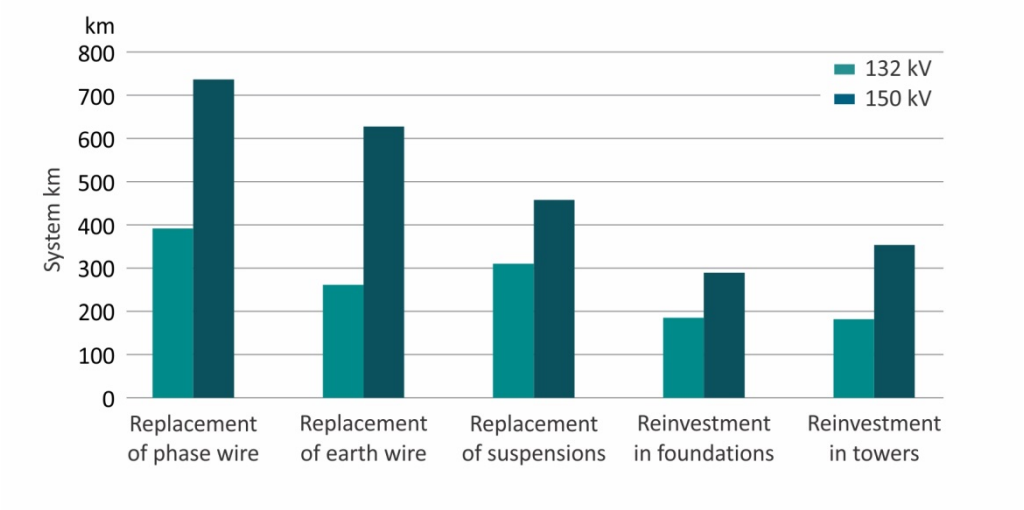


Figure 5 Expected volume of reinvestment in 132-150 kV transmission lines for potential projects up to 2027.

Volume of investment

The total CAPEX for projects with expected commissioning during the period from 2017 to 2027 is approximately DKK 40 billion, cf. Figure 6. The projects are divided into ongoing, planned, and potential projects according to their status as from 1 December 2017 and comprise co-ordinated reinvestment, expansion, restoration, and re-engineering in the transmission grid.

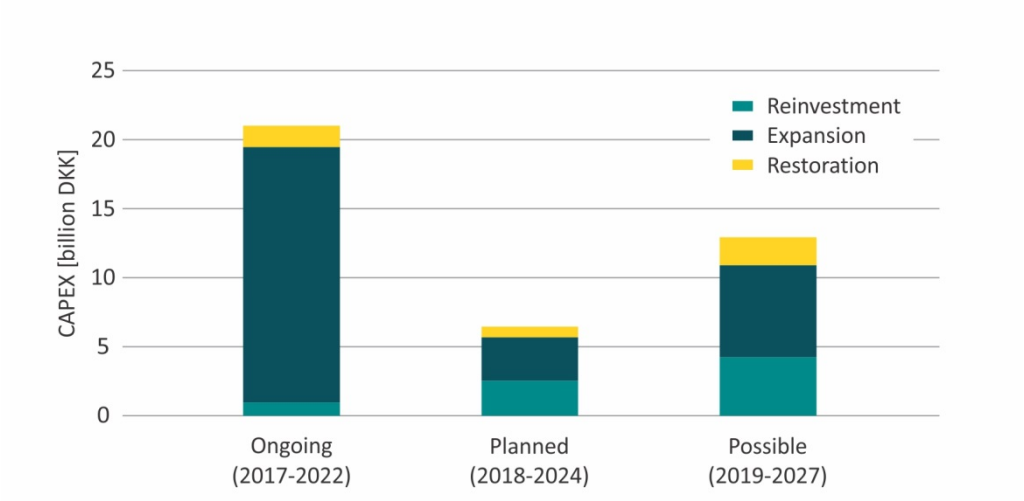


Figure 6 CAPEX for ongoing, planned, and potential projects with expected commissioning during the period from 2017 to 2027. CAPEX for a project is stated in the expected year of commissioning and represents the CAPEX to be amortized and financed via the grid tariff.

1.4 Projects in the construction phase

It appears from Figure 6 that Energinet has projects in the construction phase corresponding to a total CAPEX of approximately DKK 21 billion. Of this amount, projects concerning increased

exchange capacity to neighbouring areas[1] amount to approximately DKK 13 billion, while projects concerning grid connection of offshore wind turbines[2] constitute approximately DKK 3 billion. The remaining projects comprise reinvestment, expansion, and restoration of the internal transmission grid. Projects in the construction phase have been finally decided and have obtained the relevant regulatory approvals.

1.5 Projects in the planning phase to be decided on

In the planning phase, a number of projects have not yet been finally adopted. When the detailed planning has been completed, these projects must be approved by Energinet and the authorities. Whether a project has to be approved by the authorities depends on the nature of the project in relation to the size of the costs and its electrical engineering significance.

On an annual basis, Energinet and Danish Energy Agency review the projects' need for approval in accordance with guidelines provided by the authorities. These guidelines include an assessment on an indicative financial limit of DKK 30-40 million for expansion and DKK 80-100 million for reinvestment. If the projects are convened for approval by the authorities, Energinet will submit applications as the business cases are completed.

The projects in the planning phase are briefly summarised below.

Reinvestment

The reinvestment projects in the planning phase are expected to be commissioned during the period from 2017 to 2022. Projects with costs larger than DKK 80 million per project comprise:

- Reinvestment in the 132 kV cable network in Copenhagen
- Reinvestment programme for 132 kV and 150 kV substations
- Reinvestment in 150/60 kV and 132/50 kV transformers
- Reinvestment in the 400-150 kV combined overhead line between substations Kassø and Malling
- Reinvestment in the 400 kV overhead line between substations Fraugde and Landerupgård
- Reinvestment in the 400 kV GIS substation at Asnæs Power Station
- Asnæs Power Station and the transformer project comprising reinvestment in transformers in the Danish transmission grid.

Projects with costs less than DKK 80 million per project comprise:

- Reinvestment in 150 kV overhead lines (Bredebro-Kassø, Klim Fjordholme-Mosbæk, Ensted-Sønderborg)
- Replacement of GIS substation at Amager Power Station

1 Kriegers Flak Combined Grid Solution, COBRAcable, increase of the capacity between Jutland and Germany (Kassø-Frøslev), increase of the capacity between Jutland and Germany (west coast connection) as well as Viking Link.

2 Grid connection of 600 MW offshore wind turbines at Kriegers Flak, grid connection of a total of 350 MW near-shore wind turbines in the northern and southern parts of the North Sea respectively.

- Reinvestment in 132 kV overhead lines (substations Stasevang and Teglstrupgård, Statoil Syd-Kirkeskovgård-Torslunde, Stasevang-Teglstrupgård)
- Substation Vester Hassing: Reinvestment in automation.

Expansion

The expansion projects in the planning phase are expected to be commissioned during the period from 2018 to 2022. The following expansion projects have costs larger than approximately DKK 30 million per project and comprise:

- Measures to be taken to secure the supply of Copenhagen (including reinvestment in two 132 kV cables).

- Establishment of a sufficient grid structure for incorporation of wind power and/or interconnectors. The final solutions are defined in the planning projects and may among other things include the establishment of a new 400 kV cross connection in Jutland, possibly between substations Revsing and Landerupgård, an extra 400 kV system in Jutland between substations Idomlund and Tjele on the existing tower as well as a new 400 kV connection on Zealand between substations Bjæverskov and Hovegård.

- Establishment of new 150/60 kV transformers at substations Stovstrup and Idomlund.

In addition, a number of small projects have costs below DKK 30 million. These include upgrade of the operating voltage of the 60 kV cable to the island of Læsø, securing the reactive balance in substation Tjele, connection of electric boiler in substation Grønnegården, optimized utilisation of existing and new installations as well as connection of future consumers to a new 400 kV high-voltage substation at substation Kassø North.

Further, a planning project is examining a number of potential solutions for ensuring sufficient power on Zealand, cf. Energinet's Report on security of electricity supply 2017. The solution space examined in the project among other things includes operational initiatives, strategic spare capacity, and various interconnectors to Zealand from e.g. Western Denmark, Poland, Germany or Sweden. The final solution alternative and time of establishment have not been decided and are not included in the complete overview. Once a solution has been decided, it will be incorporated into the analysis assumptions and form part of a planning tool in future RUS plans.

Restoration and re-engineering

The three visual enhancement projects at Årslev Engsø, Roskilde Fjord, and the national park Kongernes Nordsjælland are resumed, and an expected commissioning date will be set – just as the previously chosen solutions have to be reassessed.

Out of consideration for third party, there are four major re-engineering projects in the planning phase:

- Re-engineering of the Kontek interconnector between Zealand and Germany owing to the Fehmarnbelt project
- Re-engineering of the 150 kV overhead line between substations Tange and Trige
- Re-engineering in Copenhagen owing to the light rail system
- Re-engineering on Funen out of consideration for the railway.

1.6 Projects for start-up in the planning phase

The RUS plan includes a number of possible projects based on needs assessments in relation to state analyses and analyses of limitations in the transmission grid as a result of changes in consumption, production, and exchange capacity.

As the need arises, the projects are transferred to the planning phase, where detailed planning is performed and final approvals are obtained.

Therefore, planning projects for a number of reinvestment, expansion and restoration projects are expected to be launched for commissioning in the period up until 2022. The projects are described in more detail in the appendix report on project descriptions. The individual projects are identified by a number which is used as a reference in the following sections. The RUS plan further includes descriptions of a number of projects which are expected to be established after 2022. However, so far, these projects are not expected to start up as planning projects.

In addition to the listed projects, further project may occur continuously, for example as a result of third-party inquiries or changed assumptions.

Reinvestment

The following specific reinvestment projects are expected to be recommended for detailed planning:

- Reinvestment in a number of 400 kV overhead lines (ID333, ID347, ID348, ID409, ID 493, ID494, ID495, ID496, ID497, ID531, ID532, ID534)
- Reinvestment in a number of 150 kV overhead lines (ID335, ID340, ID341, ID342, ID343, ID345, ID349, ID430)
- Reinvestment in a number of 132 kV overhead lines (ID433, ID467, ID533, ID536, ID537)
- Reinvestment in 400 kV substations Idomlund, Vester Hassing, and Hovegård (ID147)
- Reinvestment in a number of 132 kV cables (ID389, ID 434, ID708)
- Reinvestment in 132/30 kV transformer (ID585).

Expansion

Due to the general projection of consumption and wind power, the following expansion projects are expected to be recommended for detailed planning:

- The 400 kV and 132/150 kV grids in substations Tjele, Endrup, Bjæverskov, and Ørslevvester (ID119, ID385, ID60, ID17)
- Kamstrup-Spanager: Upgrade to high-temperature conductors (ID671)
- Malling-Trige: Increase in transmission capacity (ID658)

- Vestlolland: New phase shifter (ID149)
- Klim Fjordholme-Mosbæk: Upgrade of overhead line (ID684)
- Aggersund: Replacement of submarine cables (ID117)
- Ørslevvester-Radsted: New cable connection (ID472)
- Fynsværket Power Station-Odense South-east: Replacement and upgrade of existing cables (ID654)
- Fraugde-Odense South-east: Connection of overhead lines in Odense South-east (ID666)
- Stasevang-Teglstrupgård: Cable laying of overhead line (ID152)
- Lem Kær-Stovstrup: New cable connection (ID59).

In addition to this, in the period up to 2022, a number of expansion projects relating to integration of production from renewable energy will be connected to the distribution grid. The projects typically comprise a reinforcement of the transformer capacity between transmission and distribution. The development projects are a result of the general expected short-term influx of renewable energy and are therefore not necessarily based on specific projects for connection of renewable energy. The need for reinforcement must be analysed in detail, and the possible solutions must be viewed in relation to the ongoing planning project on the need for transformer reinvestment in Denmark (ID26, ID27, ID83, ID85, ID96, ID118, ID128, ID129, ID148, ID456, ID659).

Additionally, a number of specific expansion projects are expected to be recommended for detailed planning:

- Upgrade of substation components on selected connections by 2021 (ID693)
- Voltage variations on the 60 kV connection to Bornholm (ID84)
- Ensure adequate reactive resources in the 132, 150, and 400 kV grids (ID458, ID459, ID460, ID692).

Restoration and re-engineering

Planning of cable laying of the 132/150 kV grid in urban areas and areas of natural beauty must be commenced according to political guidelines (ID228, ID461, ID466). The specific framework for implementation of the above is being clarified.

Compensatory 132/150 kV cable laying in connection with the establishment of new 400 kV overhead lines must be determined in accordance with political guidelines (ID229, ID230, ID231, ID483).