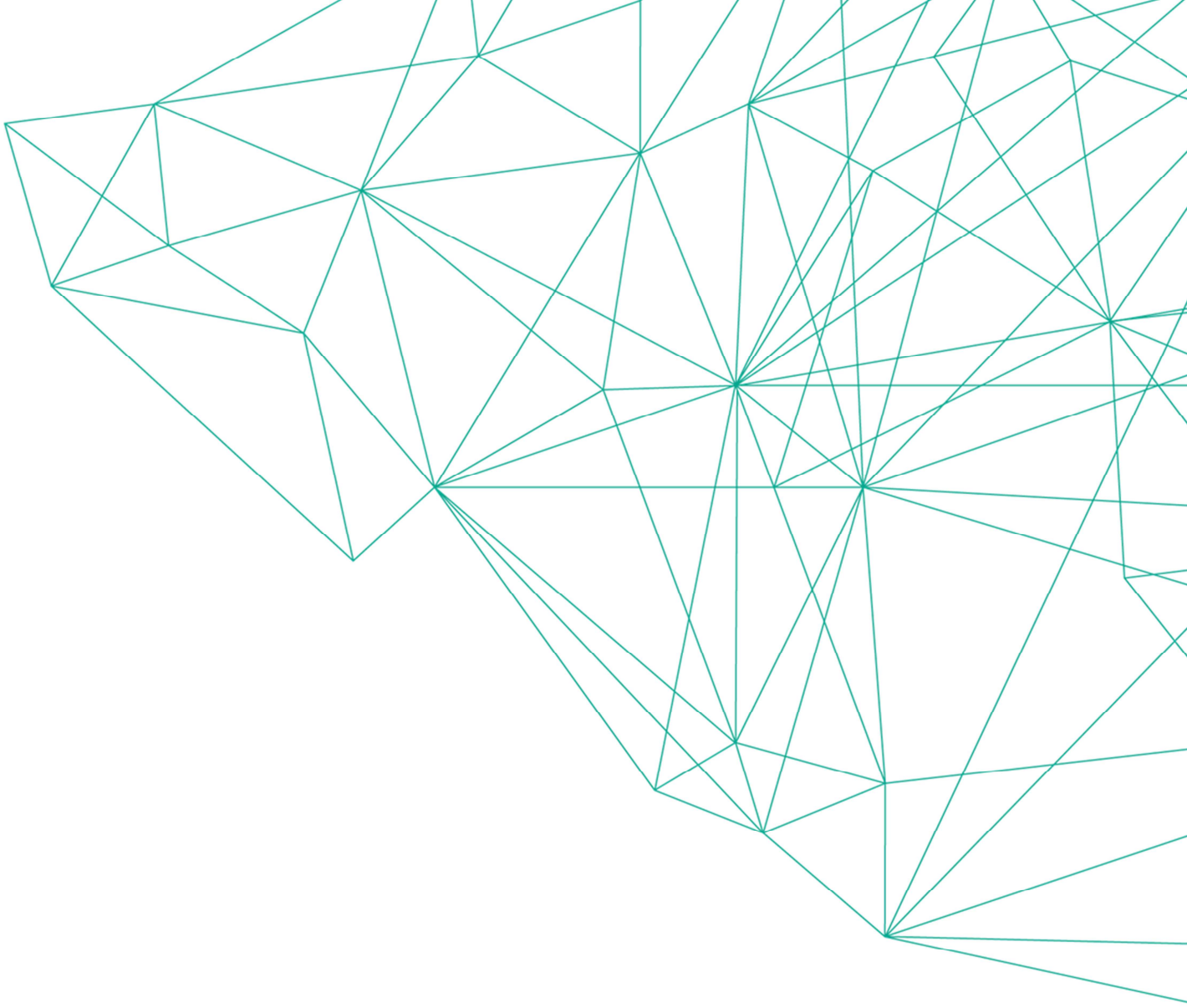


SUMMARY

RUS PLAN 2018 (REINVESTMENT, EXPANSION, RESTORATION)

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 focuses on the need for changes in the transmission grid in the medium term, which goes 10 years ahead. The plan provides suggestions for grid solutions in accordance with an extended, long-term transmission grid that supports a given development and ensures a coherent development. The possible long-term transmission grid is shown in Figure 1.

When specific planning projects are launched, a final solution will be decided on, which may also include market or operating-related solutions as an alternative to grid expansions.

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 Danish and European legislation for elaboration of plans and forms a significant basis for cooperation with the distribution grid companies on planning.

The 2019 electricity transmission grid

The overall AC grid consists of approximately 4,500 km overhead lines and cables. Since some cable routes have several 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.

Cable route distance	Overhead lines	Cables	Total
132 kV	742	570	1311
150 kV	952	935	1,887
220 kV	40	164	204
400 kV	946	178	1,124
Total	**2,680**	1,846	4,526

In addition to the AC grid, 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 187 substations as shown below.

Number	Substations	Transformers
132 kV	75	123
150 kV	81	126
220 kV	8	8
400 kV	23	34
Total	**187**	**291**

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 considered as part of the installation.

The RUS plan shows an overall status of Energinet's projects in the construction, planning, and screening phases as from 1 March 2019. Unless otherwise specified, all prices in the RUS plan are stated in fixed 2018 prices.

Figure 1 Possible long-term grid structure in Denmark.

1.1 Medium-term grid structure (up to 2028)

The RUS plan is based on a given grid reference comprising the existing transmission grid and the transmission projects which have obtained all relevant Energinet and regulatory approvals. Based on this, the RUS plan analyses 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 applied. Figure 2 shows the possible 2028 grid structure.

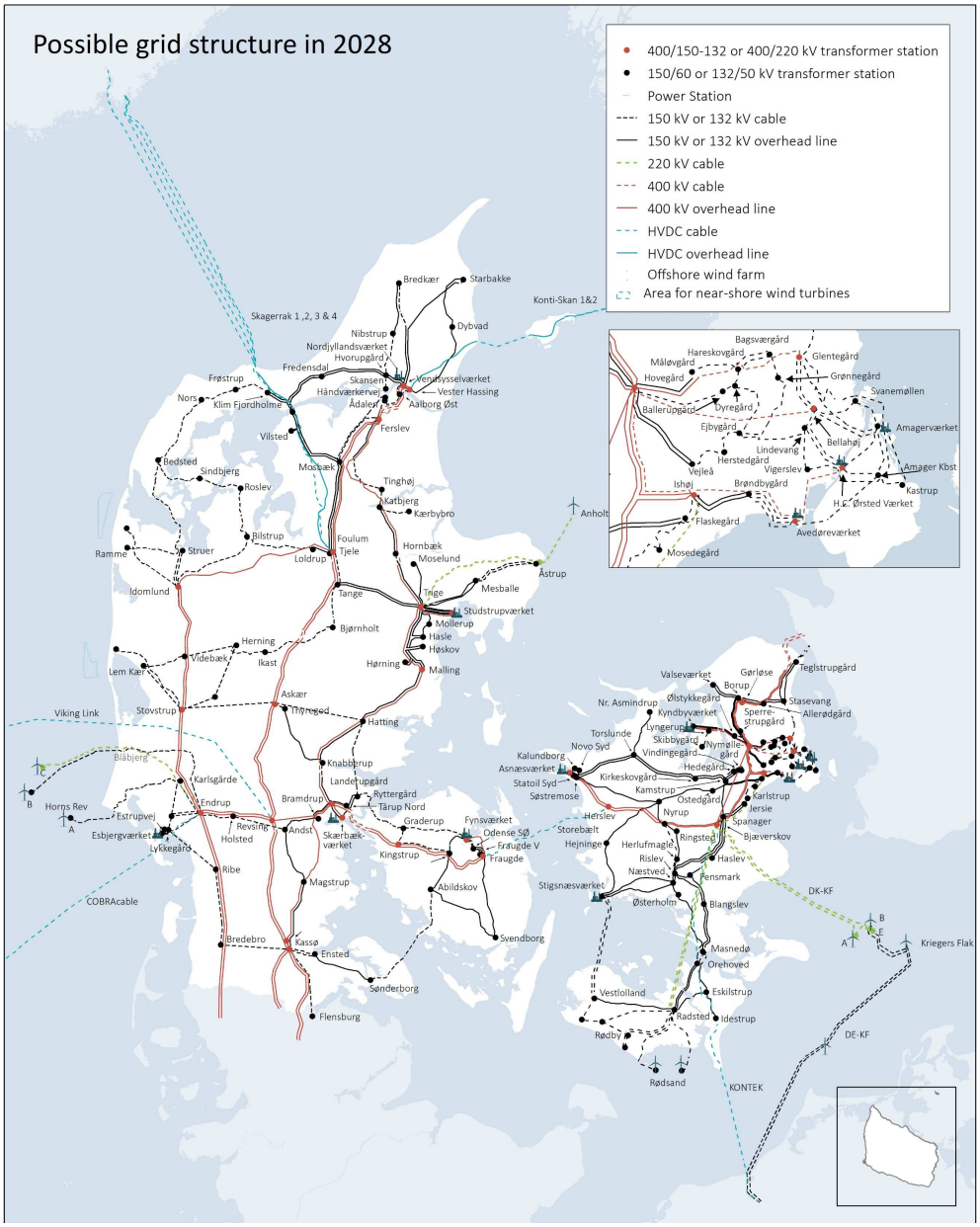


Figure 2 Possible medium-term grid structure in Denmark.

220-400 kV grid development

In addition to the projects in the construction phase, the next 10 years, among other things, require reinforcement of the overall transmission grid as a result of renewable energy expansion, increased use of trade relations, and consumption rise. The need can be solved by establishing 400 kV lines between substations Landerupgård and Revsing, Bjæverskov and Hovegård, Ferslev and Tjele as well as use of both 400 kV systems on the new overhead line between substations Endrup and Idomlund.

Further, there is a need for grid reinforcement between the Danish islands Lolland and Falster arising from renewable energy expansion, which can be realised by 220 kV cable connections.

The need for further expansion of the overall grid structure coincides with a growing need for reinvestment in the 400 kV grid.

132-150 kV grid development

In addition to the projects in the construction phase, especially incorporation of numerous renewable energy facilities entails a need for further reinforcement of the 132-150 kV grid toward 2028.

Large parts of the 132-150 kV grid are facing reinvestment within the next 10 years; this applies to both transmission lines and substations.

Uncertainties

The many grid modifications generally cause challenges in terms of space at several substations. As such, extensions may require major refurbishments of existing substations or construction of new substations.

The grid structure and possible projects are based on the applied analysis assumptions as well as the decomposition of these and are thus particularly vulnerable to changes. This particularly applies to the planned locations of offshore wind turbines, as no political decision has been made on the actual sizes and connection points. Further, wind farm sizes of the planned nearshore wind turbines are considerably smaller than projected in practice. This may give rise to either advance of grid expansion or establishment of additional reinforcement of the 132-150 kV grid.

In relation to the applied analysis assumptions, development currently seems to progress considerably faster than assumed for several areas. This applies particularly to renewable energy where the ongoing coordination process with the grid companies demonstrates a larger portfolio of possible connections of renewable energy facilities than stated in the analysis assumptions. This may give rise to establishment of new transformers and possible further reinforcement of the 132-150 kV grid. In addition, based on the analysis assumptions, the needs for the possible grid reinforcements may occur earlier than stated in the analyses assumptions.

Additionally, several possible large connection projects may be in the pipeline, particularly solar cell projects, where the plant owner wants to connect to the transmission grid on a very short-term basis, and where it is unrealistic for Energinet to implement connection to the transmission grid to the desired time.

These numerous uncertainties may thus lead to continuous changes in the proposed grid structure. At the same time, the speed at which renewable energy facilities are connected to the transmission grid may cause a period during which the grid cannot handle the expected amount of renewable energy. Since several reinvestment projects with outage needs in the existing grid are simultaneously implemented, an increasing need to introduce limits of production from renewable energy facilities may be expected – possibly combined with a need to make countertrade to maintain the Net Transfer Capacity.

Volume of investment 2019-2028

The total CAPEX for projects with expected commissioning during the period from 2019 to 2028 is approximately DKK 45 billion, see Figure 3. The projects are divided into ongoing, planned, and possible projects according to their individual status as from 1 March 2019 and comprise co-ordinated reinvestment in and expansion, restoration, and re-engineering of the transmission grid.

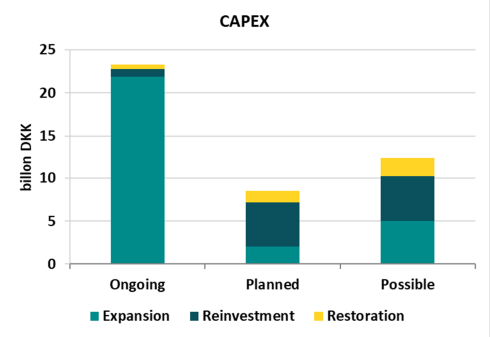


Figure 3 CAPEX for ongoing, planned, and possible projects with expected commissioning in the period from 2019 to 2028. CAPEX for a project is stated in the expected year of commissioning and represents the CAPEX to be amortized and financed via the grid tariff.

Figure 3 illustrates that Energinet has ongoing projects corresponding to a total CAPEX of approximately DKK 23 billion. Of this amount, projects concerning increased Net Transfer Capacity to neighbouring areas[1] amount to approximately DKK 14.5 billion, while projects regarding grid connection of offshore and near-shore wind turbines[2] constitute approximately DKK 4 billion. The remaining projects comprise reinvestment in and expansion and restoration of the internal transmission grid. Projects in the construction phase have been finally decided and have obtained all necessary approvals.

Planned projects account for a total CAPEX of approximately DKK 8 billion. These projects have not yet been finally decided. Upon completed detail planning, the projects must be approved internally at Energinet and by the authorities. Whether a project must be approved by the authorities depends on the nature of the project in terms of size of costs and its electrical engineering significance.

Possible projects account for a total CAPEX of approximately DKK 12 billion. Over the next few years, these projects must be reported to the portfolio management, prioritized and initiated as planned projects.

1.2 Projects in the planning phase for approval

On an annual basis, Energinet and the Danish Energy Agency review the planned projects' need for approval in accordance with guidelines laid down by the authorities. These guidelines include an assessment on an indicative financial limit of DKK 30-40 million for expansion and DKK

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.

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 costs of the below reinvestment projects are expectedly larger than DKK 80 million per project and comprise:

- Reinvestment in the 132 kV cable grid in Copenhagen, phase 1
- Reinvestment programme for 132 kV and 150 kV substations
- Reinvestment in 150/60 kV and 132/50 kV transformers
- Reinvestment in 400 kV overhead lines
- Reinvestment in 150 kV overhead lines between Vester Hassing-Dybvad-Starbakke
- Reinvestment in 132 kV overhead lines between substations Stasevang-Teglstrupgård

The costs of the individual sub-projects in the reinvestment programmes for 132-150 kV substations, 132-150 kV transformers, and 400 kV overhead lines are expectedly less than DKK 80 million.

Expansion

The costs of the following expansion projects are expectedly larger than approximately DKK 30 million per project and comprise:

- Measures to ensure supply of Copenhagen.
- Measures to ensure power transmission in the overall transmission grid as a result of renewable energy expansion, increased use of trade relations, and increased consumption. The final solutions are defined in the planning projects and may among other things include establishment of a new 400 kV cross connection in Jutland between substations Revsing and Landerupgård as well as a new 400 kV line on Zealand between substations Bjæverskov and Hovegård.
- New 132 kV substation Gloslunde on Western Lolland.
- 400 kV transformers in substations Askær, Tjele, and Endrup.
- Handling of voltage distortion as a result of 400 kV cables at Vejle Ådal.
- Better utilisation of the existing transmission grid by Dynamic Line Rating.
- New 150 kV substation at Aggersund relating to grid connection of an offshore wind farm at Nr. Kær Enge.
- Establishment of 150/60 kV transformers in substations Idomlund and Kærbybro.

In addition, there are a number of small projects with expected costs less than DKK 30 million.

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 must be set – just as the previously chosen solutions must be reassessed. Any technical issues relating to cabling of the sections in question must be analysed as mentioned in the technical report, which was prepared in connection with the project regarding the 400 kV overhead line from Idomlund to the Danish-German border.

In addition, it is a political decision that the 150 kV grid in Western Jutland must be placed underground resulting from establishment of the new 400 kV overhead line between Idomlund and the Danish-German border.

Furthermore, Energinet is presently processing a number of specific inquiries regarding possible restructuring of the existing transmission grid.

1.3 Projects for start-up in the planning phase

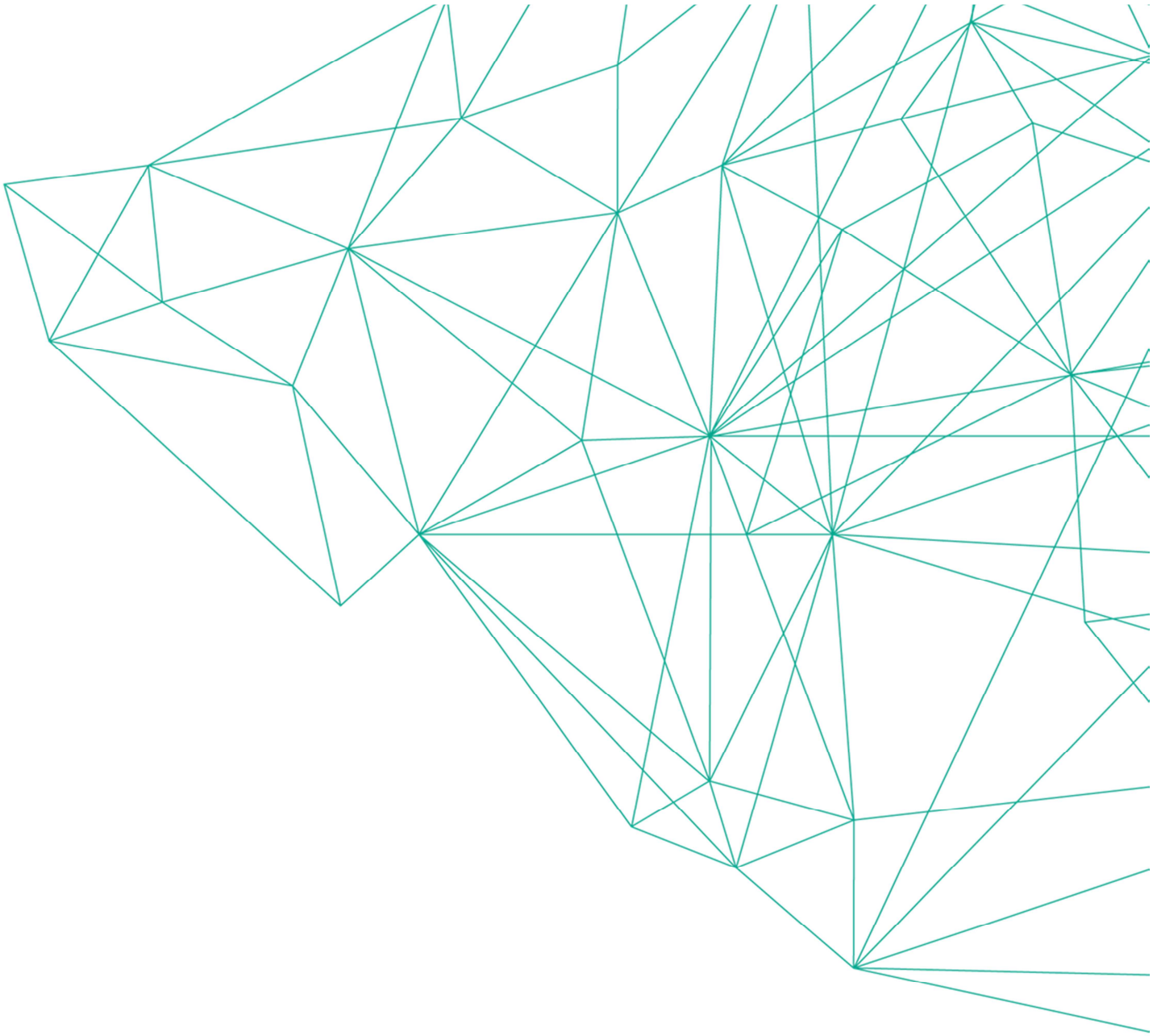
The RUS plan includes several possible projects based on needs assessments in relation to state analyses on existing facilities and analyses of capacity constraints in the transmission grid resulting from changes in consumption as well as in production and Net Transfer Capacity.

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

Energinet already has a large portfolio of projects under construction as well as a wide range of projects in the planning phase. In recent years, the number of projects has increased to an extent implying that due to Energinet's current resource capacity, the numerous possible projects cannot be realised to the planned commissioning date. Further, the large number of projects causes a challenge in terms of increasing outage times.

The RUS plan holds a project portfolio for the coming years, adjusted with a realistic assessment of which projects can be carried out in Energinet. This indicates that for some of the projects which have not yet been initiated in the planning phase, a delay of minimum two years may be expected compared to the needs assessment.

The individual projects are not mutually prioritised in the adjusted portfolio. Energinet will start this process in 2019, which among other things includes defining clear criteria for how to prioritise the projects and implementing an impact assessment of the delays.



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RUS plan 2018

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