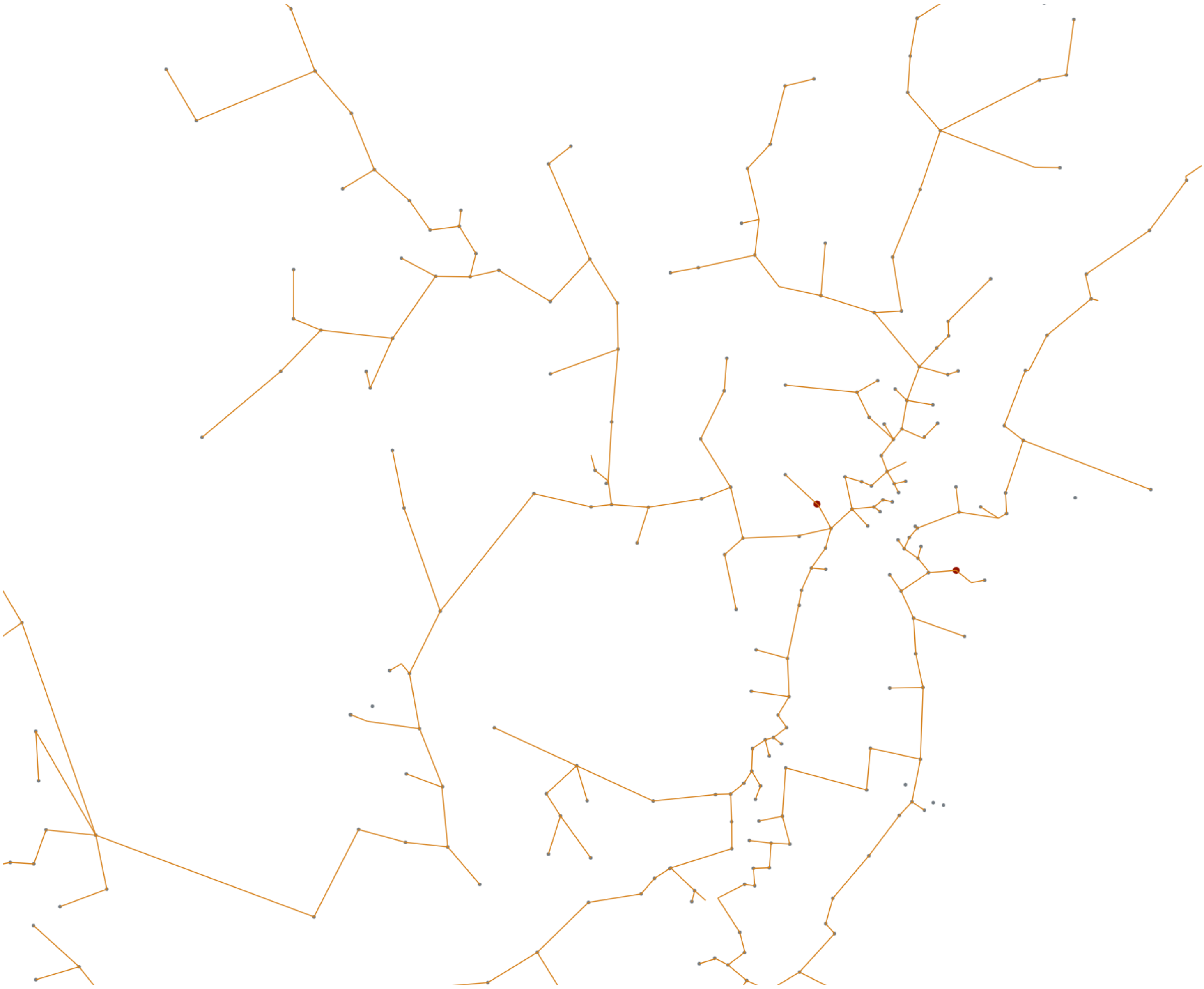
MENON ECONOMICS

SUMMARY

EVALUATION OF SYNTHETIC GRIDS IN CALCULATION OF POWER DISTANCE



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Preface

Menon Economics analyses economic issues and provides advice to businesses, organisations, and public authorities. We are a consulting firm operating at the interface between economics, politics, and markets. Menon combines social and business economics expertise in fields such as social profitability, economic impact, business and competition economics, strategy, finance, and organisational design. We use research-based methods in our analyses and work closely with leading academic environments in most fields.

This is the english summary from the published report *"Evaluering av bruken av syntetiske nett i måling av effektdistanse"*. The entire report in is available in Norwegian on our website www.menon.no

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Summary

Our analyses show that as of today, there are significant differences between the lengths of the synthetic and actual power grid among grid operators, and that the synthetic power grid more often passes through built-up areas and bodies of water than the actual grid. If adjustments for geographical and topographical conditions are necessary, we recommend making these after calculating the power distance, rather than during the construction of the synthetic grid. However, the quality of the data provided to us is too low to definitively assess whether these discrepancies are problematic. To be able to assess whether synthetic grids are suitable as a starting point for computation of power distance and what adjustments may need to be made, the data quality must be improved, new synthetic grids constructed, and the reasonableness criterion re-evaluated. Overall, the need for data collection is considered so great that RME (The Norwegian Energy Regulatory Authority) might be better served by using the actual grid in the calculation of power distance. However, the choice of calculation basis must be seen in close conjunction with the other task variables, and RME must make an overall assessment.

From a macro perspective, the synthetic grid appears very similar to the actual grid, both in appearance and in terms of which geographic areas the grids pass through. The synthetic grid largely exhibits the same behaviour as the actual grid. However, due to the way the grid is constructed, it is significantly shorter than the actual grid. This is not a problem, both because there are desired differences between the two grids (particularly regarding choices about redundant power lines in the actual grid to increase delivery reliability), and because length differences that are equal between Distribution System Operators (DSO) disappear when the regulatory model only compares relative differences between DSOs efficiency.

The challenge in assessing the suitability of the synthetic grid is that the difference in length between the actual and synthetic grid varies greatly between DSOs. This difference must be understood to determine whether the power distance based on the synthetic grid will reflect the task variables of the DSOs and yield reasonable results when applied to revenue regulation.

To understand the difference between DSOs, we have utilised detailed geographical data that describes both the synthetic and the actual grid, all substations and transformers. Our analyses show that although the synthetic grid in a macro perspective largely passes through similar geographical areas as the actual grid, there are significant differences when one looks at a micro perspective. Our findings indicate that the synthetic grid more frequently passes through built-up areas and tends to take more direct routes over bodies of water when compared with the actual grid. In addition, our regression analyses indicate that important natural heritage sites, forested areas, and steep terrain may explain some of the difference in length between the actual and synthetic grid. Consequently, DSOs operating in regions with a higher proportion of such features might receive systematically different calculated power distance compared to other DSOs.

The data available to us is not of sufficient quality to enable a definitive assessment of the proposed task variable “reasonableness”. Two main challenges stand out in this regard. Firstly, there are many instances where the basis for the construction of the synthetic grid is lacking. As a result, the synthetic grid is constructed inaccurately in several areas. When the data from which the synthetic grid is constructed is altered, the properties of the synthetic grid will also change. In one specific instance, we reintroduced transformers to a power system from which they had been omitted, resulting in a six percent change in the length of the synthetic grid. This is a significant change, and a deviation of six percent could result in unreasonably large impacts on revenue regulation. It is therefore essential that the data is improved, by collecting updated overviews of which substations and transformers are in use for each DSO, and that the synthetic grid is reconstructed, before being

put into use. It may be necessary to submit updated synthetic grids to the DSOs for consultation to minimize errors. Secondly, the data for the actual grid are also incomplete. Therefore, it is not possible to carry out a complete comparison with the synthetic grid. It is not feasible to provide a complete explanation of the differences between DSOs. Our analyses suggest that missing data is not a significant cause of differences between DSOs. However, this cannot be confirmed with certainty until all data are available. Due to these challenges, it is currently impossible to assess the suitability of a future synthetic grid constructed with correct input data. Consequently, RME should conduct a new assessment after the grid has been recalculated.

Regarding unwanted deviations between the physical and synthetic grids which arise from geographical factors, we conclude that there is no basis for establishing so-called "no build" zones where the synthetic grid is not allowed to pass through. Although the synthetic grid more frequently traverses certain types of land (particularly built-up areas and bodies of water), this does not mean the actual grid avoids such terrain. On the contrary, we observe that the current grid largely utilises the same areas. "No build" zones would therefore not contribute to a better grid configuration but would likely introduce more deviations and noise.

For the same reason, it will also be extremely challenging to develop parameters for area correction to be fed into the construction of the synthetic grid, with the aim of making it appear more like the actual grid. To achieve this, one must be able to select parameters that understand the context of grid planning, such as the characteristics of the different situations that lead to the synthetic grid choosing to go over water more in some places than the actual grid and what causes it in other situations to choose to go less over water than the actual. Without this level of precision, there is a risk, as with "no-build" zones, of introducing more noise. Such a level of precision seems unrealistic to achieve.

If, with updated baseline data, one still assesses that geographical and topographical conditions result in unreasonable outcomes in the calculated power distance, an alternative to correcting the construction of the synthetic grids is to later correct for the synthetic grid having chosen routes that the actual grid should not or cannot take. In concrete terms, one can develop correction factors that can be used to adjust the calculated power distance upwards where the synthetic grid exhibits unrealistic behaviour that impacts negatively on the task calculation. n principle, this correction mirrors existing adjustments for operating conditions, which utilize various exogenous factors to account for disparities in the prerequisites faced by different DSOs to achieve comparable cost efficiency. However, at present, it is not feasible to develop such correction factors.

There is a need for significantly more, and better data, for synthetic grids to be used to calculate the power distance for use in income regulation. The need for high-quality data increases as more task variables rely on the synthetic grid, because errors in the synthetic grid have greater consequences in income regulation when they affect multiple task variables. However, to assess the reasonableness of the task variable, one should also seek to increase the data basis related to the physical grid that is currently available. Overall, the need for data to construct and verify good synthetic grids can be so extensive that one might as well have used actual grids in the calculation of power distance. Our assessment is that power distance based on actual grids provides somewhat lower exogeneity and roughly the same transparency/understandability, but a more reasonable and fairer task variable. In addition, the instability in the synthetic grids over time, as new sub stations and transformers are added and removed, argues for using actual grids.

Overall, we assess that for use in the calculation of power distance, it may be more appropriate to utilise actual grids rather than synthetic, provided that power distance can indeed be calculated using actual grids. However, synthetic grids are also planned to be used in the calculation of other task variables. Whether actual or synthetic grids are best suited for the calculation of these is beyond our mandate to determine. It would be appropriate to use the same type of grid in the calculation of all these task variables, and therefore, RME should conduct an overall assessment of the suitability of the two grid types for all task variables combined.

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