UNIVERSITY OF CAMBRIDGE | Energy Policy Research Group

The value of flexibility: a cost benefit analysis of Merlin project

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About the Project

Joint work with Michael Pollitt and colleagues from Project MERLIN.

Scottish & Southern Electricity Networks | opusone solutions | Open Grid Systems | University of Cambridge Energy Policy Research Group

With thanks to energy regulators (ACM, AER, BNetzA, NVE, Ofgem), distribution utilities/ESOs (Ausgrid, Avacon, Enedis, Liander, NGESO, Stedin, Tennet,Tepco, UKPN, WPD), energy associations (Australia, UK), energy marketplaces (Cornwall LEM-Centrica, Nodes, Piclo), FfE, NYSDPS, Silicon Grid, energy experts.

MERLIN = Modelling the Economic Reactions Linking Individual Networks is a BEIS funded innovation project, under the Power Forward Challenge: Canada-UK Joint Challenge on Smart Energy Systems.

MERLIN
Modelling the Economic Reactions Linking Individual Networks

Project reports published at SSEN website. https://project-merlin.co.uk

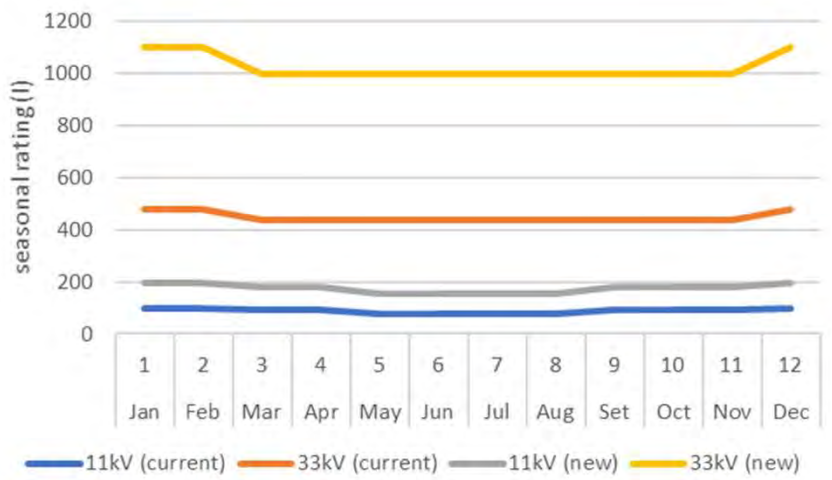
Reports:

- The first of which compares 13 use cases of DNO/DSO to procure flexibility.
- The second makes recommendations of what can be learnt from the cases.
- The third identifies key regulatory aspects for the development of local flexibility markets in 7 jurisdictions.
- **The four one involves a cost benefit analysis to value flexibility.**

Flexibility Requirements

- Constraint analysis made in Forth William region (Scotland), period 2026-2035.
- Flexibility requirements under both types of power flow analysis: realistic case (RC) and worst case (WC).
- Thermal violations identified in two lines 11kV, 33 kV (1 hour granularity).
- Thermal violations under the WC approach are identified in advance.

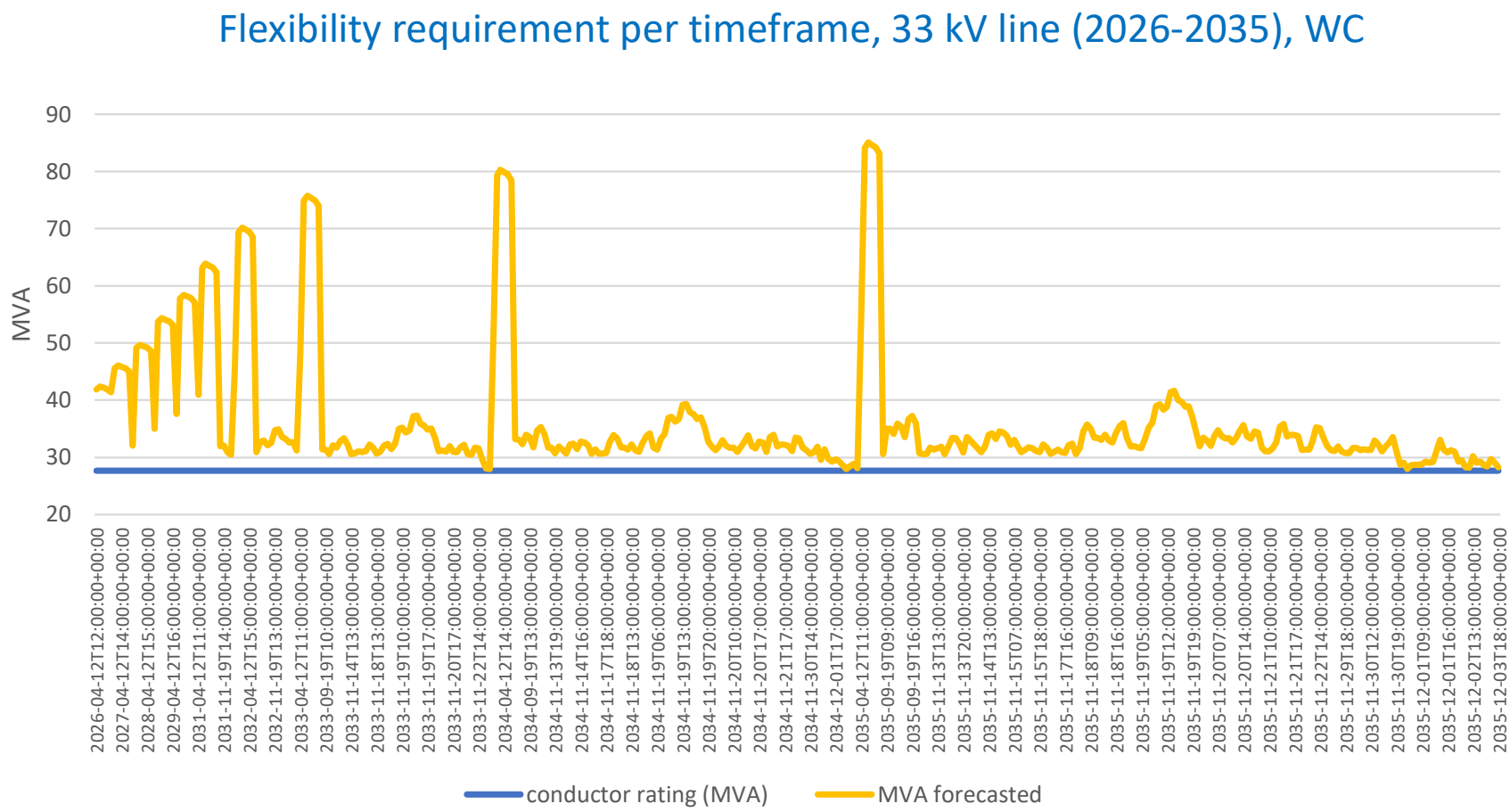
Conductors' rating (seasonal)



Flexibility requirement per year, 11kV line (2029-2035), WC

year	min (MVA)	max (MVA)	total (MWh)	hours	average MW/h per year
2029	0.15	0.15	0.15	1	0.15
2030	0.00	0.52	28.20	174	0.16
2031	0.00	0.76	1767.71	7150	0.25
2032	0.17	0.96	4214.85	8760	0.48
2033	0.39	1.24	6303.67	8760	0.72
2034	0.58	1.44	8079.55	8760	0.92
2035	0.73	1.61	9506.21	8760	1.09

Flexibility Requirements



Cost Benefit Analysis Methodology

- Savings are given by the NPV difference of the BAU and other alternative options.
- BAU solutions refer to the upgrade of two lines (11kV, 33kV).
- The alternative network intervention is given by deferring for one or more years the upgrade of the asset and contracting flexibility services during those years.
- CBA methodology is aligned with the Common Evaluation Methodology (CEM) CBA proposed by the Energy Networks Association (ENA) from UK, in line with RIIO ED2 Ofgem CBA tool.

Scenarios and Sensitivities

Summary of Scenarios

Scenario	Business as Usual	services from DER	Societal benefits/costs	Cost/benefit figures considered in the CBA
S0	yes			reinforcement costs, power losses, network performance costs of failure
S1 (*)	yes (with deferred investment)	yes		all the above plus bid costs (availability and utilisation payments & procurement costs)
S2	yes (with deferred investment)	yes	yes	all the above plus CO2e associated with losses, community credit generation

(*) utilisation payments for realistic case and both payments (utilisaiton and availability) for worst case

Summary of Sensitivities

Sensitivities	Central Case	Range of values analysed	RC	WC
over-procurement factor	7.5%	0%, 7.5%, 15%	yes	yes
utilisation payment	£50/MWh	25, 50, 75 £/MWh	yes	yes
availability payments	£25/MW/h	£25/MW/h	no	yes
utilisation rate	20%	20%	no	yes
NPV (year)	2050	2040, 2050, 2075 (+/-)	yes	yes

RC: realistic case, WC: worst case

Results

Realistic versus worst case approach

- Flexibility does not bring value at 11kV but at 33 kV (WC) due to higher reinforcement costs.
- We are evaluating the deferral of replacement conductors given that the existing (older) ones are performing increasingly poorly.
- The introduction of societal costs and benefits produces a small variation in the cumulative NPV

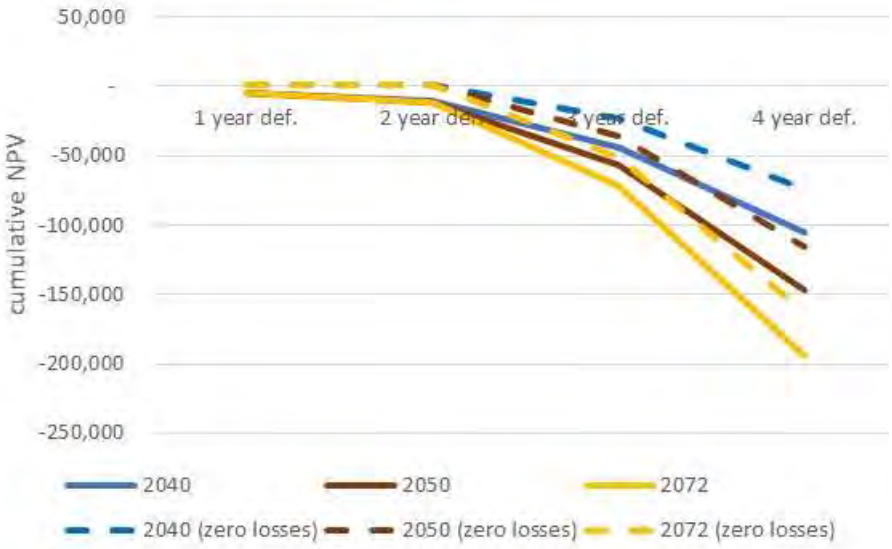
A comparison of cumulative savings by 2050 per type of approach and line, central case

Results

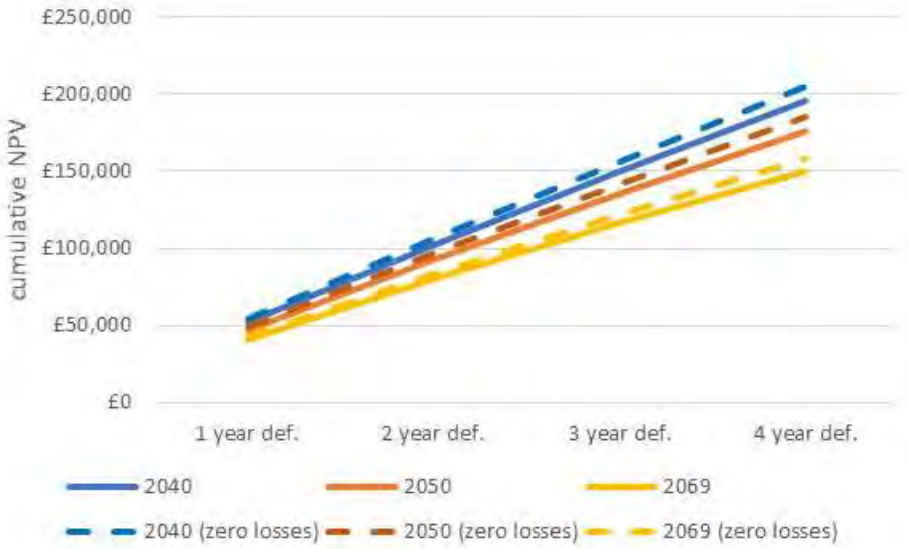
Power losses

- The exclusion of network losses in the CBA produces an increase in the cumulative NPV, but still most of the figures are negative for the 11 kV line (RC, WC), 33 kV line (RC).

S0 versus S1 with and without network losses (OPF=7.5%, UP=£50/MWh, AP=£25/MW/h), **11 kV (WC)**



S0 versus S1 with and without network losses (OPF=7.5%, UP=£50/MWh, AP=£25/MW/h), **33 kV (WC)**



Final remarks

- The size of reinforcement costs and flexibility, and the specifications of existing assets may influence the selection of alternative solutions to solve grid constraints.
- Results from the CBA suggest that flexibility services are preferred only to deal with constraints in the 33 kV line.
- An alternative setting where the quantity of flexibility required was low and the existing assets were performing better would make the NPV of a flexibility solution higher.
- Future work may consider the use of bid prices supported by live trials or well-designed surveys that help to capture flexibility providers preferences (i.e. utilisation & availability prices, etc.).

References

- Anaya, K.L., Pollitt, M.G. (2021a), The Role of Regulators in Promoting the Procurement of Flexibility Services within the Electricity Distribution System: A Survey of Seven Leading Countries. *Energies*, *14*, 4073.
- Anaya, K.L., Pollitt, M.G. (2021b), How to Procure Flexibility Services within the Electricity Distribution System: Lessons from an International Review of Innovation Projects. *Energies*, *14*(15), 4475.
- Baringa (2020), Common evaluation methodology and tool. Baringa, December 2018.
- BEIS (2019), Updated short-term traded carbon values used for modelling purposes. Department for Business, Energy & Industrial Strategy, April 2019.
- Defra (2021), UK Government GHG Conversion factors for company reporting. Conversion factors 2021 (condensed set). Department for Environment Food & Rural Affairs, June 2021.
- GB DNO – NIE (2021), DNO Common network asset indices methodology. Health & Critically – Version 2.1. GB Distribution Network Operators (DNOs) and Northern Ireland Electricity (NIE) Networks Working Group, April 2021.
- HM Treasury (2020), The Green Book. Central Government Guidance on Appraisal and Evaluation, HM Treasury.
- Lam, J., Williams, R. (2020), Milestone 2: 1.06 Flexible Service Valuation Mechanism. Scottish & Southern Electricity Networks, Opus One Solutions, July 2020.
- Ofgem (2021), RIIO-ED2 Cost Benefit Analysis template. Version 5.0. Office of Gas and Electricity Markets, March 2021.
- Pollitt, M., Giulietti, M., Anaya, K. (2021), Optimal Regulation for European DSOs to 2025 and beyond. A report to CERRE, Apr. 2021.
- SSEN (2021a), Project Merlin Milestone 6. Fort William Modelling Evaluation, Scottish&Southern Electricity Networks, July 2021.
- SSEN (2021b), Project Merlin Milestone 8. Fort William Modelling Evaluation – Worst Case Analysis vs Realistic Analysis, Scottish&Southern Electricity Networks, September 2021.

Thank you!