ENGINEERING RECOMMENDATION P2 REVIEW (PHASE 1)

WS8: Summary Report

For the Energy Networks Association

Report No.: 16011094/810, Final
Document No.: 16011094/810
Date: 25/08/2016

Project name:	Engineering Recommendation P2 Review (Phase 1)	DNV GL Energy Advisory
Report title:	WS8: Summary Report	PSP UK
Customer:	For the Energy Networks Association 6th Floor, Dean Bradley House 52 Horseferry Road London SW1P 2AF	Palace House 3 Cathedral Street London SE1 9DE Tel: +44 (0) 203 170 8165 04478894
Contact person:	D Spillet	
Date of issue:	25/08/2016	
Project No.:	16011094	
Organisation unit:	EA UK	
Report No.:	16011094/810, Final	
Document No.:	16011094/810	

Applicable contract(s) governing the provision of this Report:

Objective:

This report provides a summary of the key conclusions encompasing all the research, analysis and stakeholder engagement carried out during Phase 1 of the fundimental review of Engineering Recommendation P2/6. The purpose of this report is to act as a check point to position the work todate ahead of the DCRP consideration of the case for any phase 2 work.

Prepared by:	Verified by:	Approved by:
Richard Druce NERA	Goran Strbac Imperial College	Colin MacKenzie DNV GL

DNV GL Distribution:

☒ Unrestricted distribution (internal and external)
☐ Unrestricted distribution within DNV GL
☐ Limited distribution within DNV GL after 3 years
☐ No distribution (confidential)
☐ Secret

Keywords:
execution

Rev. No.	Date	Reason for Issue	Prepared by	Verified by	Approved by
001	25/08/2016	Draft issue to DCRP P2 WG for review and comment	R Druce	G Strbac	C MacKenzie
002	29/8/2016	Final incorporating WG comments from meeting on 26 August 2016	R Druce	G Strbac	C MacKenzie

Table of contents

1. OVERVIEW

This short report is intended to summarise the key findings from the fundamental review of Engineering Recommendation P2, which is currently being conducted by the Distribution Code Review Panel (DCRP) P2 Working Group and a Consortium of advisors comprising DNV GL, Imperial College London and NERA Economic Consulting. It recommends to the DCRP that there is a strong economic case for reform of P2, and that the review should continue to a second phase of work to develop a new standard and more fully appraise the economic case for its introduction.

2. THE ROLE OF P2

P2 is a planning standard that governs how the Distribution Network Operators (DNOs) plan and develop their networks to provide security of supply to customers.[1] P2 specifies "restoration times" within which Distribution Network Operators (DNOs) must be able to restore supply to demand customers following the failure of a network asset. Through these requirements, P2 effectively defines the level of resilience to asset failures that the network must be designed to achieve. Specifically, it requires DNOs to provide physical network capacity (i.e. redundancy) up to the point where the restoration times specified in P2 are met. The restoration times currently specified in P2 are shorter (and hence require more redundancy) following failures of those assets serving larger amounts of demand.

P2 and a related document, Engineering Report 130, also define how DNOs should define the demand that needs to be secured to the levels required by P2. They provide guidance on how DNOs should add to network capacity the support available to the network from Demand Side Response (DSR[2]) and embedded generation, before computing the level of network resilience to be provided through the provision of additional physical network capacity.

3. FINDINGS FROM THE FUNDAMENTAL REVIEW OF P2

Through the ongoing review of P2, the P2 Working Group has examined a range of analysis prepared by the Consortium. The work conducted leads to the overarching conclusion that – for a range of reasons discussed further below – there is a strong economic case for the reform of the current standard.

3.1. Updating the Levels of Physical Network Redundancy Required by P2

The evidence[3] presented to the Working Group includes techno-economic modelling that seeks to examine the economically efficient level of network redundancy in case of load growth, making a trade-off between the costs of providing physical network assets to secure demand, as compared to the operational costs/benefits associated with reducing/increasing reliability to end-users and change in

1 Because adherence to P2/6 is a licence obligation on DNOs, the obligations it imposes are legally binding, albeit DNOs can seek derogations from these obligations in certain circumstances.

2 EREP 130 allows DSR to be considered as either a reduction in group demand or as an increase in available system capacity.

3 This evidence primarily emerges from a techno-economic modelling exercise performed by Imperial College. The modelling aims to identify economically efficient investment patterns on representative distribution networks that have been calibrated to represent those in place throughout Great Britain. The data underpinning the analysis (e.g. in respect of network costs and characteristics) was provided by the DNOs through the P2 review process.

network losses and corresponding costs. Amongst other things, the modelling accounts for the cost of reinforcing network assets, the cost of demand curtailment (valued at the Value of Lost Load – VOLL), the failure rates of assets, regular and emergency repair times, performance and cost of alternative supply restoration measures, common mode failures, asset maintenance / replacement duration, use of smart grid technologies and operational measures, load profile, price of electricity and so on.

The modelling shows that, based on the value of VOLL widely used for reliability planning in the British electricity industry (£17,000/MWh), the current standard prescribes minimum levels of network redundancy that are higher than the economically efficient level.

Of course, the finding that P2 prescribes more network redundancy than is economically efficient does not hold in all cases; the Consortium's work indicated that it would be efficient to maintain the levels of redundancy currently required in P2 in some circumstances (e.g. customers connected to less reliable networks). However, the conclusion that P2 generally requires more network redundancy than is economically efficient is robust to extremely high levels of VOLL, orders of magnitude higher than the core assumption of £17,000/MWh and to a wide range of other assumptions of efficient investment. Hence, there is a strong economic case for reform of P2 to update the minimum levels of network resilience that DNOs are obliged to provide through physical network assets.

Alongside this analysis, the Consortium has estimated the potential quantum of savings from this reform under specific load growth scenarios considered by the Committee on Climate Change and former DECC, which may be very substantial, in the order of billions of pounds. However, given the limitations of the modelling conducted to estimate the benefits at the GB level from modifying P2, which was based on representative rather than real networks including a number of assumptions made that would need to be verified, it would not yet be safe to conclude on the precise quantum of savings to customers from this reform. However, the estimated savings appear to be orders of magnitude higher than the costs of developing and implementing a new standard.

3.2. Harnessing the Benefits of Distributed Energy Resources

The modelling examined the effect of distributed energy resources[4] on optimal network planning. These technologies may provide a more economically efficient means of providing supply reliability to customers than the provision of capacity using physical network assets, so incorporating them into network planning may reduce the need for conventional network reinforcement, and/or improve reliability for customers.[5]

The conclusion from this aspect of the modelling is that the contribution of distributed energy resources to network security can be markedly different from the contributions defined in the current standard. Specifically, the contribution of distributed energy resources depends on:

- The reliability of the network and the level of redundancy in the network to which they connect;
- For technologies such as storage, the amount of energy that can be stored and the duration over which it can be provided; and

4 Distributed energy resources include technologies such as demand side response, electrical storage and distributed generation.

5 The Consortium modelling determines the effective security contribution of non-network solutions, using a concept known as modelling the "Effective Load Carrying Capability" of distributed energy resources, which is an internationally established concept used to quantify the security contribution of different technologies.

- The reliability of distributed energy sources, risk of common mode failures in case of multiple distributed energy resources (that may be driven by failures of ICT systems) and relative size of connected distributed energy resources as compared to group demand.

Because these factors are not explicitly considered in the current standard, the analysis suggests there is a case for updating P2 to better represent the contribution of these non-network technologies to network security. This will be important for optimising the potential of these technologies in reducing overall network costs, and harnessing the benefits they bring through increased supply reliability for consumers.

3.3. Allowing DNOs to Make an Efficient Use of Operational Measures and Other Smart Technologies

Another aspect of the study has been to examine the role of other smart network technologies in system planning:

- *Automation:* By modelling the performance of real distribution networks, the Consortium has demonstrated that it would be cost-effective to increase the deployment of network automation to improve network performance. Hence, there may be a case for providing guidance on the use of automation to improve network performance in any new standard.
- *Mobile Generation*: The analysis carried out demonstrated that it could be economically efficient to increase the use of mobile generation at distribution sites to enhance network performance. Hence, reducing restoration times through the operational measures would enable further increase in utilisation of network assets and reduction in redundancy without compromise on reliability of supply.
- *Emergency Loading of Network Assets:* The modelling also suggests that in some circumstances emergency loading of network assets, both transformers and cables, could be utilised more widely as a means of providing additional network capacity in the short-term. In essence, the analysis shows that the cost of reducing the lives of assets that are overloaded in emergency conditions could be economically justified based on both the extra reliability provided to consumers and the avoided costs of providing the same levels of reliability through reinforcement. It may also be efficient to define network capacity in any new planning standard in a way that allows the use of dynamic rating technologies, as recent trials demonstrate they have significant potential. In addition, the definition of capacity in the standard may also allow and guide the use of dynamic line rating technologies, as work carried out within several Low Carbon Network Funding projects demonstrated they have significant potential.
- *Managing Network Overloads Through a Wider Use of Demand Side Management:* The modelling also shows that, if DNOs have the ability to manage network overloads through a wider use of demand side management,[6] the overall levels of security of supply can increase and the economic case for redundancy through physical network assets to secure overall demand reduces. The degree of flexibility that consumers will be willing to offer to DNOs and the compensation DNOs will need to offer customers in return for this flexibility remain uncertain at present, not least because enabling technologies such as smart meters have largely yet to be deployed. However, the modelling evidence shows the case for more fully incorporating these measures into planning standards to harness the benefits of these technologies as they emerge.

- *Advanced Voltage Management:* Increasing the use of advanced voltage management, or allowing voltage reductions beyond the limits prescribed by present standards, may also improve efficiency as network capability is frequently constrained by voltage rather than by thermal current limits,

6 This might arise through customers being willing to offer more extensive demand side response services to DNOs than they do at present, for example.

particularly in LV networks. However, the Consortium recognises that this finding is probably more relevant to potential reform of voltage standards than P2 which focuses on planning for security of supply. Any reform of P2 should therefore consider any potential future reform of voltage standards.

3.4. Accounting for Distribution Losses in Network Planning

The analysis has also examined the impact of accounting for distribution losses on optimal network planning. As discussed above in Section 3.1, the analysis has demonstrated that the minimum levels of network redundancy resulting from the current standard are higher than the economically efficient level. In essence, in the near-term this modelling shows it would be efficient for DNOs to delay reinforcement, "sweat assets" harder than is current practice, and use smart measures such as automation, demand side management, and distributed energy resources, to mitigate the effects on network performance.

The modelling shows that network design should increasingly be driven by the reduction in network losses. When network assets need to be replaced or reinforced, the modelling has shown that it will be efficient to materially oversize distribution network assets compared to the peak demand they are built to serve in order to achieve efficient levels of network losses. For example, the modelling demonstrates that an optimally sized LV cable would be operated at maximum demand no higher than 12-25% of its thermal rating.[7]

While oversizing of assets does not affect network reliability directly, the oversizing of assets would create a large amount of spare capacity in many network assets. In these cases, it will become economically efficient to use this spare capacity to increase redundancy of LV and HV distribution networks beyond the level currently prescribed by P2. As well as minimising overall costs by achieving an efficient balance between network costs and losses, this approach to network planning would materially increase network performance.

3.5. Ensuring Efficient Levels of Resilience During Construction Outages

The modelling has also demonstrated that there is a strong economic case for including some guidance for the levels of resilience that DNOs should provide during protracted outages, such as when they are replacing assets. In particular, the modelling demonstrates that it is economically efficient to mitigate the risks of customer interruption during relatively long-lasting asset replacement works, reducing the exposure of customers to the risk of prolonged outages during these periods.

3.6. Planning for High Impact Low Probability Events

The studies carried out demonstrate that Common Mode Failures and/or High Impact Low Probability (HILP) events could expose customers to severe risks of interruptions. In this context the modelling has shown that the concept of Conditional Value at Risk could be applied to limit the probability of severe outages. This may result in an increase in network investment, increase in cost of operational measures, increase in cost of applying non-network solutions such as distributed generation, while cost effectively

7 Note, there is a link between decisions by DNOs to oversize network assets compared to peak demand in order to achieve an economically efficient level of losses, and the connection charges faced by new network users. We do not discuss these interactions here as they are outside of the scope of this review of P2.

reducing the consequences of high impact outages. A number of options have been identified, including: robust design of distribution substations with a balanced portfolio of network and non-network solutions, deployment of emergency operation and investment actions to deal with HILP events. There is therefore a need to consider the incorporation of HILP events into any new standard.

4. CONCLUSIONS ON THE WAY FORWARD

For a wide range of reasons described above, the work conducted to date has demonstrated that there is a strong economic case for the reform of Engineering Recommendation P2. This recommendation will be forwarded to the DCRP to consider the timing and scope of any Phase 2 work.

About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener.