The Voice of the Networks

Energy Networks Association

Review of Engineering Recommendation P2/6

DCRP P2 Working Group Second Stakeholder Engagement Workshop - Phase 1 review.

Date 9th March 2016

Introductions

Steve Cox

DCRP P2 Working Group

The Distribution Code Review Panel P2 Working Group

Steve Cox- DCRP Chairman

David Spillet - (ENA Engineering Policy & Standards Manager)

Bob Weaver (Power Con)

Alan Creighton (Northern Powergrid)

Saeed Ahmed (GTC-UK)

Suzanne Huntley (NI Electricity)

Steve Cox (Electricity North West)

Chris Watts/ Martin Queen (Ofgem)

Nigel Turvey/ Peter Aston (Western Power Distribution)

Andy Beddoes/Alan Collinson (SP Energy Networks)

Stephen Tucker (UK Power Networks)

Mark Kilcullen (DECC)

Ben Marshall (National Grid)

Chris Marsland (AMPS)

Will Monnaie (SSE Power Distribution)

Joe Duddy (RES)

The Consortium

Colin MacKenzie - Project Manager

Alan Birch - Stakeholder Engagement Manager

Goran Strbac - Techno-economic lead

Richard Druce - Regulatory and economic lead

Governance

Governance

- P2/6 has a unique status – it is both a condition in the DNO licence, and an Annex 1 document in the Distribution Code.
- The Distribution Code governance requires that the DNOs consult with interested parties, and then that the DNOs propose any changes to P2/6 to Ofgem for approval; this is normal for D Code documents.
- However in this case, once Ofgem are minded to accept the proposal (unless it is for no change), they will have to consult on the effect of the proposal on the distribution licence.
- Condition 24 of the licence is specifically about compliance with P2/6; at the very least it could require a formal change to cite P2/7.
- Ofgem have a formal process including 28 days of formal statutory consultation for licence changes that will need to run consecutively following the DCRP proposals to Ofgem.

Workshop Agenda

10:20	Welcome and Introductions	Steve Cox
10:30	P2/6 Review Presentation • Wider context (Martin Queen) • P2 background and review process • Supporting studies and reports • Key conclusions and recommendations for reform	Martin Queen Colin MacKenzie
11:30	Coffee	
12:00	Overview of reference studies (Part 1) • Imperial College network planning and cost benefit analysis.	Goran Strbac
13:00	Lunch	
14:00	Overview of reference studies (Part 2) • Review of the broader regulatory framework. • Industry questionnaire response analysis.	Richard Druce Colin MacKenzie
15:00	Panel Session - Question and Answers	Steve Cox, Colin MacKenzie, Kieran Coughlan, Goran Strbac, Richard Druce
16:00	Concluding Remarks	Steve Cox
16:15	Close	Steve Cox

P2/6 Review Presentation

Review of Engineering Recommendation P2/6

Martin Queen

Colin MacKenzie

Workshop Agenda

energynetworks association

10:20	Welcome and Introductions	Steve Cox
10:30	P2/6 Review Presentation • Wider context (Martin Queen) • P2 background and review process • Supporting studies and reports • Key conclusions and recommendations for reform	Martin Queen Colin MacKenzie
11:30	Coffee	
12:00	Overview of reference studies (Part 1) • Imperial College network planning and cost benefit analysis.	Goran Strbac
13:00	Lunch	
14:00	Overview of reference studies (Part 2) • Review of the broader regulatory framework. • Industry questionnaire response analysis.	Richard Druce Colin MacKenzie
15:00	Panel Session - Question and Answers	Steve Cox, Colin MacKenzie, Kieran Coughlan, Goran Strbac, Richard Druce
16:00	Concluding Remarks	Steve Cox
16:15	Close	Steve Cox

P2/6 Wider Context

P2/6 Stakeholder Engagement Day

Martin Queen

09/03/16

ofgem Making a positive difference for energy consumers

P2/6 Context

I. Wide Ranging Systems Changes

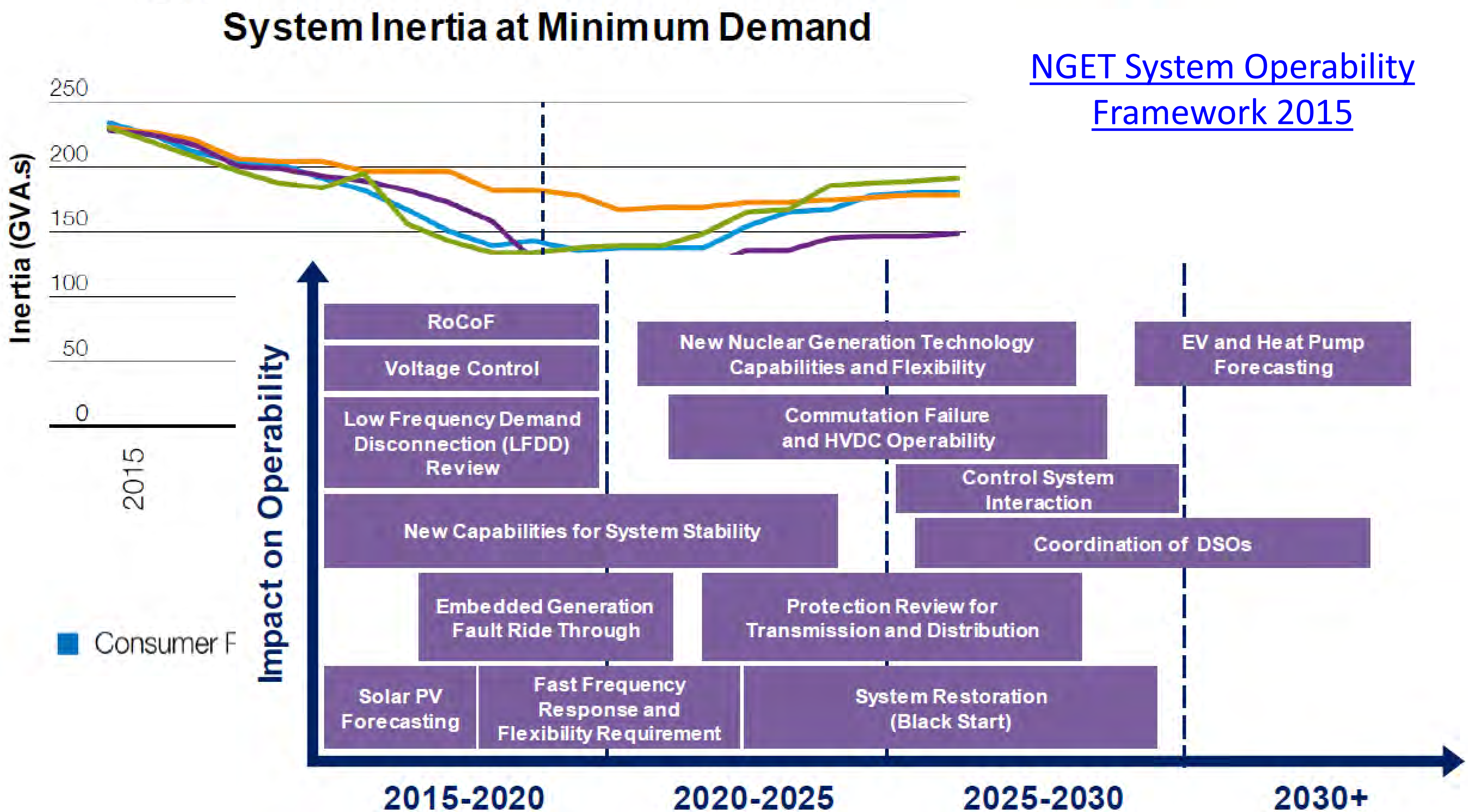
II. Low Carbon Technologies and DG Uptake & Impact

III. Changing Network Operation & Control

IV. Looking to the future of power systems in GB
   a. Flexibility/Smart Project
   b. Smart Grid Working Group
   c. Future Power System Architect

A Changing World

[NGET System Operability Framework 2015]



ofgem Making a positive difference for energy consumers

Flexibility/SMART Project

Flexibility/SMART Project

Clarifying the legal and commercial status of **storage**	Clarifying the role of **aggregators**	Encouraging the transition from **DNO to DSO roles**	Enabling increased **I&C participation in DSR** opportunities	Examining the evolution of **distribution tariffs**

Drivers for this work:

- Changes to supply and demand require different approaches to system operation
- Increasing non-synchronous generation reducing system inertia
- New technologies enable different business models that may need clarification in regulation/law

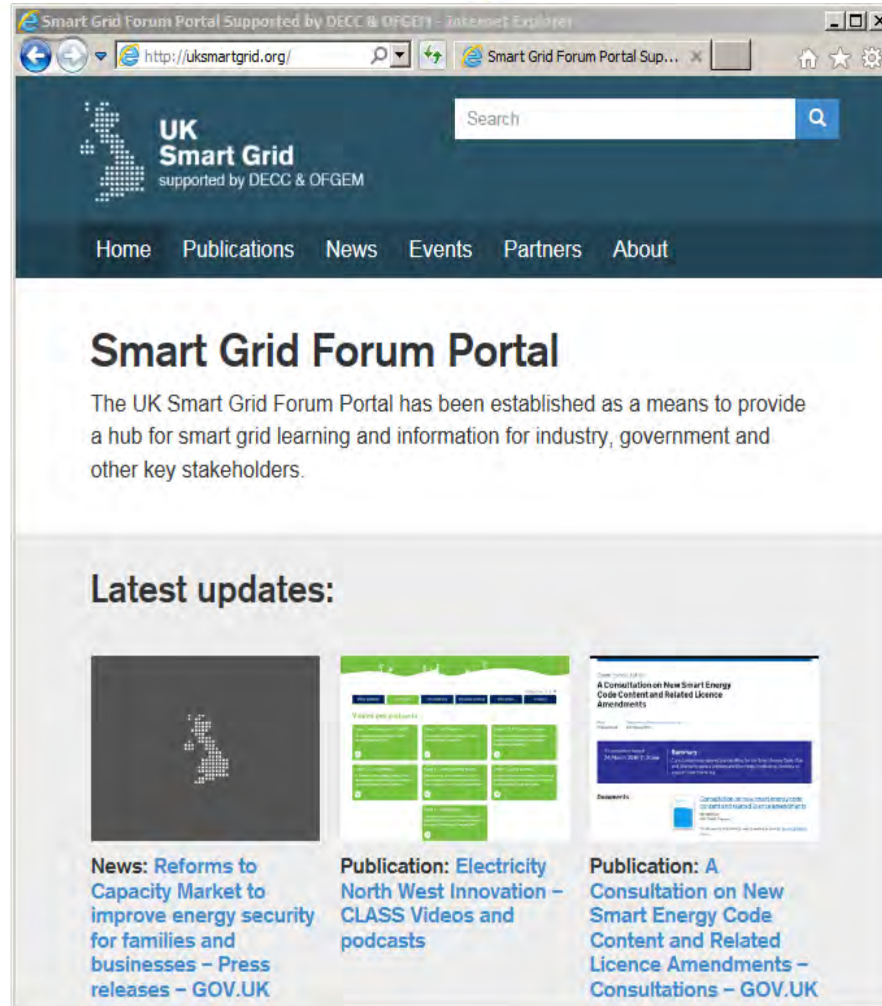
- Call for Evidence publishing in Spring, jointly with DECC

- Ofgem Flexibility position paper

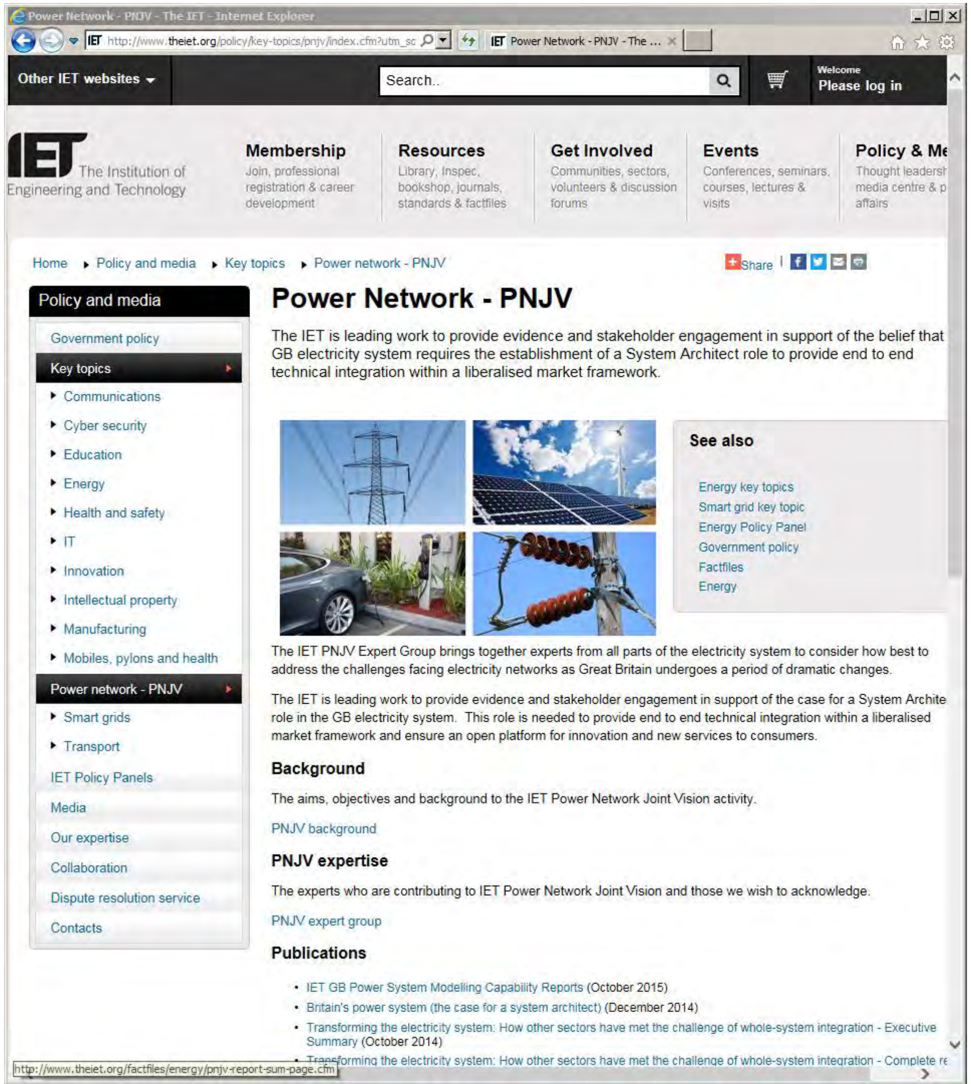
ofgem Making a positive difference for energy consumers

Smart Grid Forum

- Founded and supported by Ofgem and DECC
- Aims to identify future challenges for networks and system operation
- 9 separate work-streams ranging from future scenario creation to Supply chain and innovation needs
- Important learning on future operation/planning of the network out to 2030 and beyond
- [Smart Grid Forum site](http://uksmartgrid.org/)



Future Power System Architect



- IET and Energy Systems Catapult funded by DECC
- Identification and evidence for functions needed to improve the future power system
- New functions driven by changing technological and business landscapes in GB
  - Non-synchronous intermittent generation, DG, Electrification of heat and transport etc.
- Time horizon of 2030 but looking to 2050 too. Final report due soon.
- ESC FPSA site

Conclusion

I. The system is changing

II. How the system is being used is changing

III. Traditional methods of planning and operating need to be reviewed in light of these changes

IV. Ofgem and DECC are supportive of the P2/6 review

ofgem Making a positive difference for energy consumers

Ofgem is the Office of Gas and Electricity Markets.

Our priority is to protect and to make a positive difference for all energy consumers. We work to promote value for money, security of supply and sustainability for present and future generations. We do this through the supervision and development of markets, regulation and the delivery of government schemes.

We work effectively with, but independently of, government, the energy industry and other stakeholders. We do so within a legal framework determined by the UK government and the European Union.

P2 Background and review process

Colin MacKenzie

Background

- Engineering Recommendation P2 has been in place since the 1950s and has played a major role in the development of secure, reliable distribution networks.

- Notable changes have been the introduction of P2/5 in 1978, and the inclusion of DG through P2/6 in 2006.

- The most fundamental issue regarding the future evolution of the P2 standard is whether it continues to prescribe economically efficient investments, given the many changes affecting the energy market at present, including :
  - the (anticipated) prolific deployment of new and emerging technologies
  - and the changing role of the customer; demand, generation and prosumer customers.

- The Licensees recognise to the need for a fundamental review of the baseline philosophy of distribution network operation and design to ensure that the UK Government's energy policy objectives can continue to be met in a cost effective and pragmatic way.

Background

The Network Licensees believe that it is timely to undertake a comprehensive review of Engineering Recommendation P2 in relation to customer and system requirements and an understanding of what is required for the long term development of networks.

The review is split into two phases.

- **Phase 1** identifying what the best approach to addressing security of supply in distribution networks is, based on today's parameters. Identify the work needed to implement the final recommendations from Phase 1 that will be undertaken in Phase 2 including a high level work plan for Phase 2.

- **Phase 2** develop and codify the reformed standard based on the proposals and recommendations from Phase 1.

Process

The remainder of today's presentation relates to the progress made so far under Phase 1 of the review including:

- A brief reminder of the Phase 1 review process, where we have reached and what comes next.
- The key conclusions and potential recommendations for progress discussed by the WG at this stage of the review.
- We will then elaborate on the supporting work stream studies forming a large part of the evidence base of the review so far.

Process

- **Work Stream 1**; sets out the Phase 1 objectives and process, and included an initial engagement with all key industry stakeholders (1st May 2015 workshop).
- **Work Stream 2**; identifies, researches and evaluates options for a future UK security standard.
- **Work Stream 3**; engages with the DCRP P2 WG to examine the deliverables from WS 2 and agree the key conclusions and recommendations regarding the options for P2 reform.
- **Work Stream 5**; includes this industry wide workshop that focuses on introducing and discussing the outputs from WS 2 and WS 3.
- **Work Stream 6**; following on from WS 5, a formal industry wide consultation will seek and gather written feedback on some of the more pertinent issues and concerns associated with the proposed new standard options.
- **Work Stream 7**; develops a summarised and tabulated view of the WS 6 consultation question responses and identifies and structures actions to be taken with regards to the final Phase 1 Report.
- **Work Stream 8**; produces the final Phase 1 report that will lay out the arguments and all the supporting evidence for the development route for any new standard .
- **Work Stream 9**; scopes the work needed to implement the final recommendations from Phase 1 that will be undertaken in Phase 2.

Process Key Project Team Members

- **DCRP P2 WG**
  - Consortium Project Manager **Colin Mackenzie**
    - **Imperial College London**
      - Goran Strbac (IC PM and technical lead)
    - **DNV GL**
      - Alan Birch (Stakeholder engagement)
      - Colin MacKenzie (Technical/Operational lead)
    - **NERA Economic Consulting**
      - Richard Druce (NERA PM and lead economist)

Supporting Studies and Reports

Colin MacKenzie

Supporting Studies and Reports

Work Stream 2.1 to 2.6 Imperial College Technical and Economic Quantitative Analysis investigated the following:

- Cost effectiveness of the present network security standard
- Generation driven distribution network investment
- Contribution of Distributed Energy Resources and Energy Storage to network Security
- Value of automation
- Enhancing asset utilisation
- Impact of construction outages and asset replacement on distribution network design and planning strategies
- Resilience of distribution networks and robust network (HILP, CMF)
- Robust distribution network planning under uncertainty
- Smart management of network overloads through disconnection of nonessential loads - Towards consumer choice driven network design
- Long-term optimal design of distribution networks

"Review of Distribution Network Security Standards For the Energy Networks Association", February 2016.

Supporting Studies and Reports

Work Stream 2.7 NERA review of regulatory and distribution standards interfaces included:

- The Role for Regulation in Ensuring Efficient Network Planning
- Interactions with Regulatory Mechanisms to Promote Security of Supply
- Lessons from International Practice
- Appraising Options for Reform of P2/6

"Engineering Recommendation P2 Review Workstream 2.7: Alignment of Security of Supply Standard in Distribution Networks with Other Codes and Schemes, prepared for the Distribution Code Review Panel, P2 Work Group", 20 November 2015.

Supporting Studies and Reports

Work Stream 2.0 Qualitative Analysis

- Industry questionnaire containing a set of high level and more detailed questions that sought to gain the input of the many industry stakeholders regarding their opinions and views on the status, usability and adequacy of the existing P2/6 security standard and how this could be improved.

- Follow-up interviews with key users of the existing P2/6 standard to clarify statements and opinions and to provide additional details to their organisation's responses.

- Stakeholder responses have been analysed and reviewed to identify **key themes** that have been used as input to the consideration of the benefits and problems associated with a set of high level options for the successor to P2/6.

Consortium report "Findings of the qualitative review associated with the future development of the P2/6 distribution network planning security standard", report no. 16011094/290, rev 002, Nov 2015.

Supporting Studies and Reports

Work Stream 3.0: Options for future development of the distribution network planning security standard.

- The report sets out the potential high level options for the development of P2/6.
- The report sets out the assessment of the high level options for reform of P2/6 drawing on evidence from various quantitative and qualitative tasks carried out and inputs from a range of stakeholders including DCRP P2 WG members.
- The report will be followed by an extensive industry consultation prior to making final recommendations for P2/6 reform to the DCRP and setting out the high level plan for the Phase 2 standard development and codification works.

"Engineering Recommendation P2 Review (Phase 1) Options for future development of distribution network planning security standard", 16011094/290, March 2016.

Key conclusions and potential recommendations for reform

Colin MacKenzie

High Level Options for Reform

Work Stream 3.0: High level options for reform include:

1. *Retaining the present deterministic P2/6 standard without revision*.
2. *Retaining a deterministic planning standard, but with improvement.*
3. *Implementing a non-deterministic planning standard.*
4. *Implementing a high-level standard that obliges efficient investment, while retaining some deterministic elements,* ***represents a hybrid of options 2 and 3.***
5. *Abolition of the planning standard*.

Key conclusions

Retaining P2/6 without revision (Option 1)

- There is a strong desire amongst stakeholders to retain a **simple** deterministic standard.
- The Imperial College work concluded that the present security standard tends to be conservative, dealing with worst case scenarios and implies that the present security standard is only cost effective for “extreme” cases with networks characterised with high failure rates, long restore/repair times and low upgrade costs.
- In many cases, networks could accommodate demand growth by relaxing the current level of redundancy requirement up to the point where reinforcement becomes economically justified.
- The potential benefits of relaxing the security constraints at the GB level could reach 42% to 67% of the projected reinforcement CAPEX where there is significant load growth at LV and HV level by 2030.

Key conclusions

Retaining P2/6 without revision (Option 1)

- In terms of quality of supply there will be some increase in CI, CML and Electrical Energy Not Supplied.

- While the IC economic model accounts for the cost of increasing CI and CML, any proposals that intentionally reduce the present security of supplies to customers (demand and export) should be thoroughly reviewed by all stakeholder groups before a decision to change is taken. This decision is fundamental to all high level options 2 to 5 for reform.

- Introducing the concept of losses driven network design at the time of deferred reinforcement would introduce capacity well above peak demand, hence the potential reduction in supply quality would eventually be corrected and possibly improved.

- The IC work also concluded that the present standard should be modified to include all DER (DSM, DSR, DG and Energy Storage) when planning network security. This conclusion was also reflected in the qualitative analysis.

Key conclusions

Retaining a deterministic planning standard, but with improvement (Option 2)

- The option of improving P2/6 either through relaxing the level of redundancy or through the use of non-network technologies is sensitive to circumstances, which means it may not be practical to codify the optimal solution using simple deterministic rules.

- It may be feasible to achieve a more complex deterministic set of rules considering the main variables involved, this would require substantial analysis and time during the phase 2. There is a risk the rules developed do not cover all cases or that a complex deterministic standard is not practical to use.

- These factors may support the case for an alternative option that places more discretion for network planning in the hands of DNOs e.g. CBA analysis to identify appropriate investments.

- However, many stakeholders wish to retain the simplicity and transparency of a deterministic standard.

Key conclusions

Implementing a high-level standard that obliges efficient investment, while retaining some deterministic elements (Option 4)

- In principle, if DNOs were obliged or incentivised to undertake economic analysis to identify efficient levels of reliability and the least-cost means of delivering it, then they should achieve economically efficient decisions without placing additional deterministic requirements on themselves.
- However, setting requirements regarding the level of reliability could be codified as a deterministic standard for some types of investment if the level of economically efficient reliability rarely falls below a specific threshold. This could save the DNO the costs of conducting economic assessment through CBAs in many cases.
- To determine if there exists a *minimum* deterministic requirement that would provide economically efficiency investment would require a substantial programme of additional studies to be conducted at phase 2, and there is a risk this work may well confirm that a suitable potential *minimum* deterministic requirement cannot be achieved.

Key conclusions

Abolition of the planning standard (Option 5)

- For this option to be effective in promoting efficiency, the existing financial incentives provided to DNOs to improve reliability would need to be reviewed and strengthened if required to ensure that DNOs build and operate networks in an economically efficient manner.

- Potential benefits to consumers include:
  - » Allocative efficiency would increase, as the level of reliability provided by DNOs would get closer to the economically efficient level.
  - » The removal of the planning standard would enhance productive efficiency, as DNOs would be motivated by the financial incentive and by their revenue control to find the least cost means of providing reliability and potentially promoting innovation.
  - » Compliance cannot be tested, as there is no defined planning standard against which to test compliance. Instead, consumers' interests would be protected through the financial incentives.

Key conclusions

Abolition of the planning standard (Option 5)

- Security is not the only design consideration for developing networks and the removal process should include a review of all network development standards, policies and regulatory incentives e.g. quality of supply, losses incentives, interruption incentives etc.

- This would take some time to complete and a suggested target would be to have revised design standards, policies and regulation including all necessary incentives ready and understood by all parties for the business case submission for RIIO ED2.

Key conclusions

Implementing a non-deterministic planning standard (Option 3)

- An alternative to P2/6 and to deterministic planning standards in general, is to implement a non-deterministic planning standard that places an obligation on DNOs to perform economic assessment of delivering reliability through a combination of network and non-network solutions.
- The potential costs benefit could be as indicated in by Imperial College's modelling, although there will be some transitional costs and possible ongoing costs for DNOs moving to a non deterministic standard and possibly costs for the regulator.
- Compared with the option to remove the standard (Option 5), this option adds a regulatory requirement to undertake economic assessments e.g. through CBAs.
- The benefits are similar to Option 5 with the exception of the cost of regulation. However, some stakeholder argue that decision transparency would be lost compared with P2/6.

Key conclusions

Implementing a non-deterministic planning standard (Option 3)

- The introduction of a non deterministic planning standard to replace P2/6 will take a period of time to transition to. Although, DNOs are using CBA analysis at present, the level of prescription will require to be agreed between the various stakeholders.

- DNOs will also require time to revise internal policy, adopt new procedures, train staff etc. The regulator will also require revising regulatory policy, regulations and incentives mechanisms. A sensible timescale for adoption of a reformed standard may be alignment with the business plan submissions for RIIO ED2 similar to the option to remove the P2/6 security standard.

- Since a non deterministic standard is flexible by nature, alignment with other interfacing standards such as the NETS SQSS is unlikely to be problematic.

Further key conclusions

Further conclusions regarding a future security standard are:

Distribution Losses

- The enhancement of the present P2/6 deterministic standard, option 2, to include loss considerations in the design was in general not supported by respondents to the industry questionnaire.

- The consensus was that the interface between other industry standards/regulatory initiatives should be enhanced to ensure that any incentives work correctly in conjunction with the security standard to support its intent of ensuring the efficient provision of security of supply. This is also true of options 3, 4 and 5.

Potential recommendations for reform

The following are the potential recommendations reviewed by the WG that will form the basis for the set of questions to be addressed during the formal consultation process:

1. Based on the probabilistic techno-economic analysis carried out, the P2/6 standard in today's environment and looking to the future of network planning does not prescribe economically efficient levels of investment, and so may benefit from reform.

2. Relaxation of the present security requirement to improve overall economic efficiency will potentially reduce the supply security customers presently enjoy. It is recommended that this impact be thoroughly reviewed by all stakeholder groups including DECC, Ofgem and customer representative groups before a decision to change is taken.

3. Subject to the outcome of recommendation 2, improvements to the economic efficiency of the present standard through reducing the level of resilience it obliges DNOs to provide at the HV and higher voltage levels should be considered.

Potential recommendations for reform

4. Improvements to the present deterministic standard should also include the use of all non-network technologies including distributed generation (DG), demand side response (DSR), demand side management (DSM) and electricity storage where this can be demonstrated to be a suitable alternative to network redundancy.

5. The development of deterministic rules and associated look up tables for improved economic efficiency of future network security planning are to be carried out during phase 2 of this review and will consider both relaxing the present rules on network security and the use of non-network technologies (DG, DSM, DSR, Storage).

6. Recognising that there will be a trade-off between economic efficiency of new deterministic rules, and the network planning scenarios that can be covered, there will be a need for other economic analysis where new deterministic rules are not appropriate.

Potential recommendations for reform

7. Analysis would be required to set the level of prescription for any non-deterministic obligations, and the required level of transparency in (and regulatory oversight of) DNOs' economic analysis.

8. The option of moving to an entirely non-deterministic standard to regulate the level of reliability DNOs are obliged to provide (Option 3), or possibly removing the planning standard altogether (Option 5), should not be ruled out at this stage. Consideration of trade-offs between the improvements in economic efficiency that are feasible and any associated increases in costs would need to be considered by the regulator. Changes to other codes and schemes and potentially licence conditions may also be required.

Potential recommendations for reform

In addition to the main recommendations, it is also recommended that:

9. The new standard should provide guidance as to the methods for the treatment of construction outages separately from maintenance outages and unplanned outages.

10. In addition consideration at Phase 2 is to be given to the concerns raised by export stakeholders in reviewing the treatment of construction outage risks to export customers; this may require guidance from Ofgem and further stakeholder engagement to consider this at Phase 2 of the review.

11. Regarding High Impact Low Probability Failures (HILP) and Common Mode Failure (CMF) some forms of low cost mitigation should be considered at the network security planning stage and covered by a reformed security standard. Mitigation would require to be justified through some form of CBA analysis, the form of which could be prescribed by Ofgem.

12. Any new or reformed standard must take cognisance of the transmission system interfaces and the requirements set out in the National Electricity Transmission System Security and Quality of Supply Standards (NETS SQSS).

Coffee break.

Workshop Agenda

energynetworks association

10:20	Welcome and Introductions	Steve Cox
10:30	P2/6 Review Presentation • Wider context (Martin Queen) • P2 background and wider process • Supporting studies and reports • Key conclusions and recommendations for reform	Martin Queen Colin MacKenzie
11:30	Coffee	
12:00	Overview of reference studies (Part 1) • Imperial College network planning and cost benefit analysis.	Goran Strbac
13:00	Lunch	
14:00	Overview of reference studies (Part 2) • Review of the broader regulatory framework. • Industry questionnaire response analysis.	Richard Druce Colin MacKenzie
15:00	Panel Session - Question and Answers	Steve Cox, Colin MacKenzie, Kieran Coughlan, Goran Strbac, Richard Druce
16:00	Concluding Remarks	Steve Cox
16:15	Close	Steve Cox

Overview of reference studies (Part 1)

Network planning and cost benefit analysis

Imperial College

Goran Strbac, *Predrag Djapic, Rodrigo Moreno, Ioannis Konstantelos, Dimitrios Papadaskalopoulos, Jose Calvo, Danny Pudjianto, Simon Tindemans, Sana Kairudeen, Yang Yang, Hadi Karimi, Enrique Ortega, Marko Aunedi*

Key questions/1

- Is the present network standard cost effective?
- What should be the network redundancy for Distributed Generation?
- What is the value of automation ?
- What is the contribution Distributed Energy Resources to network security?
- What would be the benefit of smart emergency demand control to support management of network loading?

Key questions/2

- Can network utilisation be enhanced? How about voltage standards?
- What is the impact of construction outages ?
- Should network resilience be considered?
- How should network be planned under uncertainty?
- What is the long-term optimal design / redundancy of distribution networks?

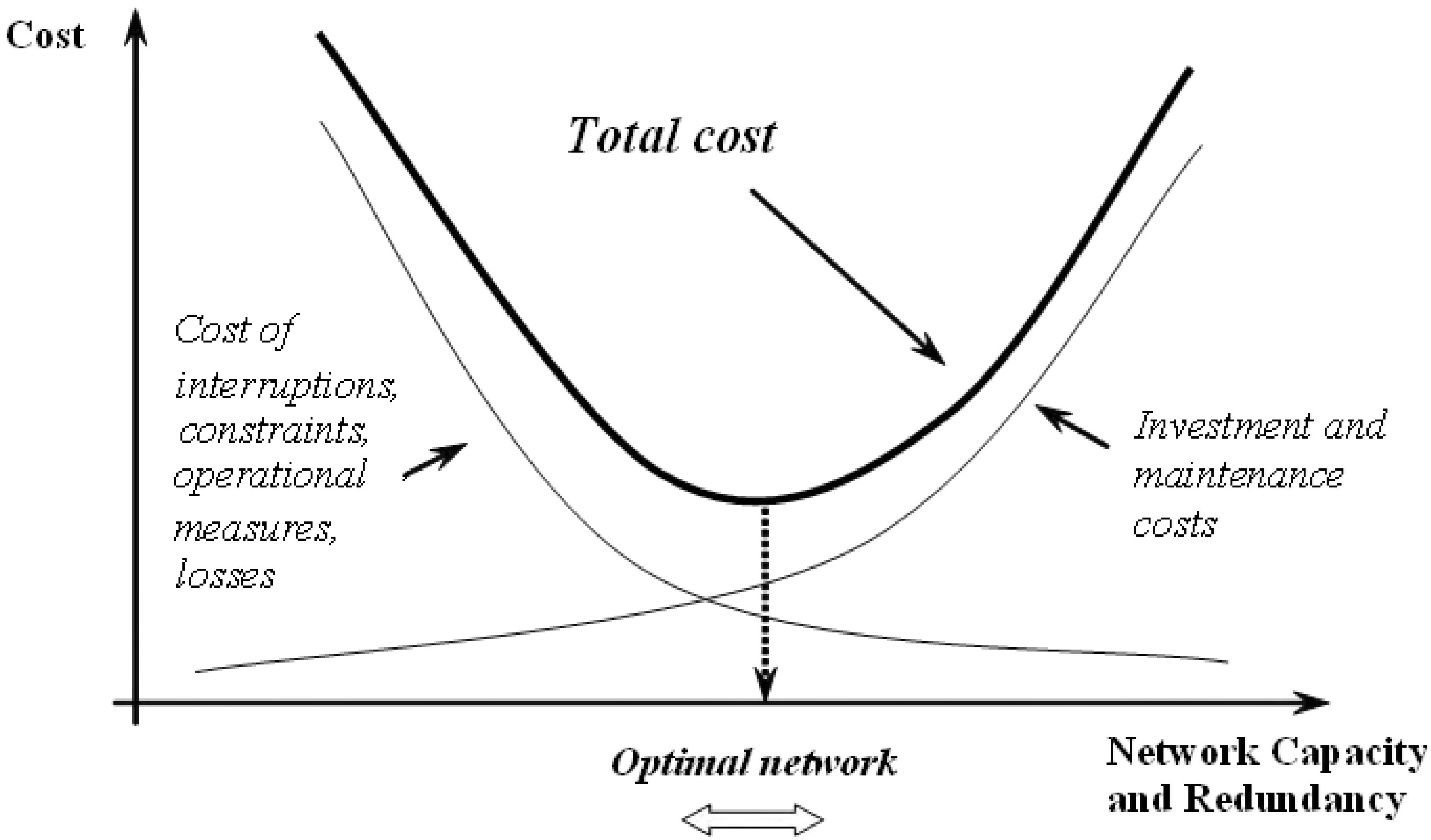
Potential weaknesses of the present standards

- ***Deterministic:*** The degree of security provided by the deterministic security criteria may not be optimal in individual instances – the deterministic nature of P2/6 constitutes also a strength, in terms of simplicity, transparency and consistency
- ***Binary approach to risk:*** system operation in a particular condition is considered to be exposed to no risk at all if the occurrence of faults, from a preselected set of contingences, does not violate the network operational limits; otherwise the system is considered to operate at an unacceptable level of risk
- ***Impact of construction outages:*** the lack of differentiation between construction and maintenance outages in the present distribution planning standards may present a significant problem given the expectation of considerable asset replacement
- ***Redundancy:*** In many cases, asset redundancy may not be a very good proxy for actual security delivered
- ***Impact of Common Mode Failures:*** The present standard does not consider Common Mode Failures (CMF) and High Impact Low Probability (HILP) events
- ***Non-network solutions providing network capacity:*** There is a significant potential for incorporating non-network solutions in the operation and design of future distribution networks
- ***Smart load management and user driven choice of reliability***: the roll-out of smart metering will provide a unique opportunity for smarter management by switching off *non-essential loads* when network is stressed while keeping supply of essential loads

Fundamental approach to determining optimal level of network security

Cost benefits analysis to determine trade-off

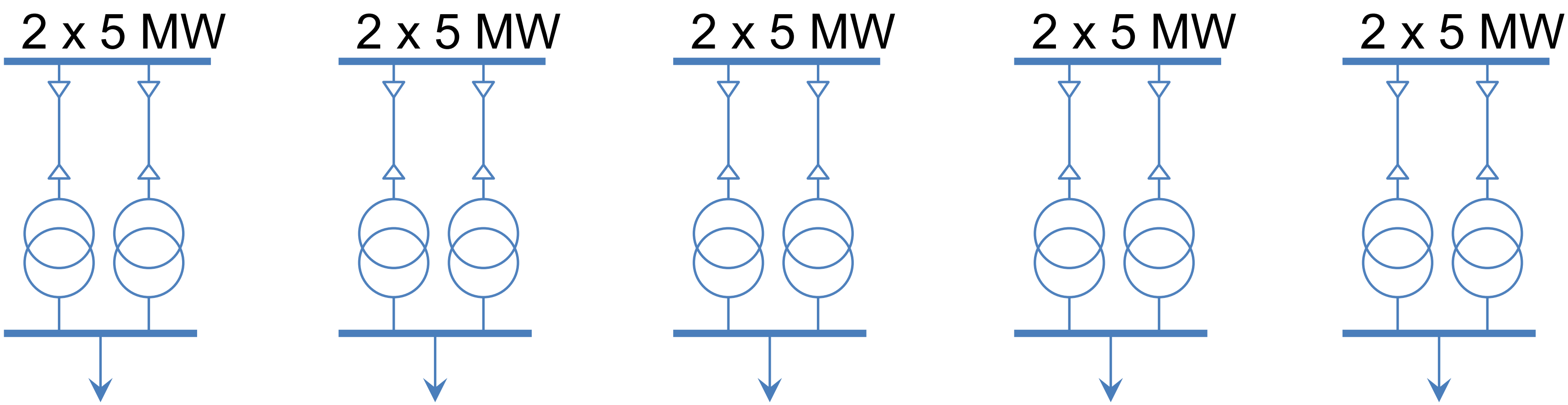
- **Cost of interruptions of supply**
- **Cost of additional investment**



Economically efficient network design - Incremental network reinforcement

- **Key questions**
  - In the short term, would it be economically efficient to follow existing P2 or further enhance the utilisation of the existing networks and delay network reinforcement driven by security?
  - What is the impact of:
    - *Network load ("group demand")*
    - *Network type (OH, UG)*
    - *Network failure rates*
    - *Restoration times - presence / cost of mobile generation*
    - *Repair times*
    - *Network upgrade costs*
    - *Load magnitude and profile*
    - *Cost of interruptions*
    - *Smart grid technologies*

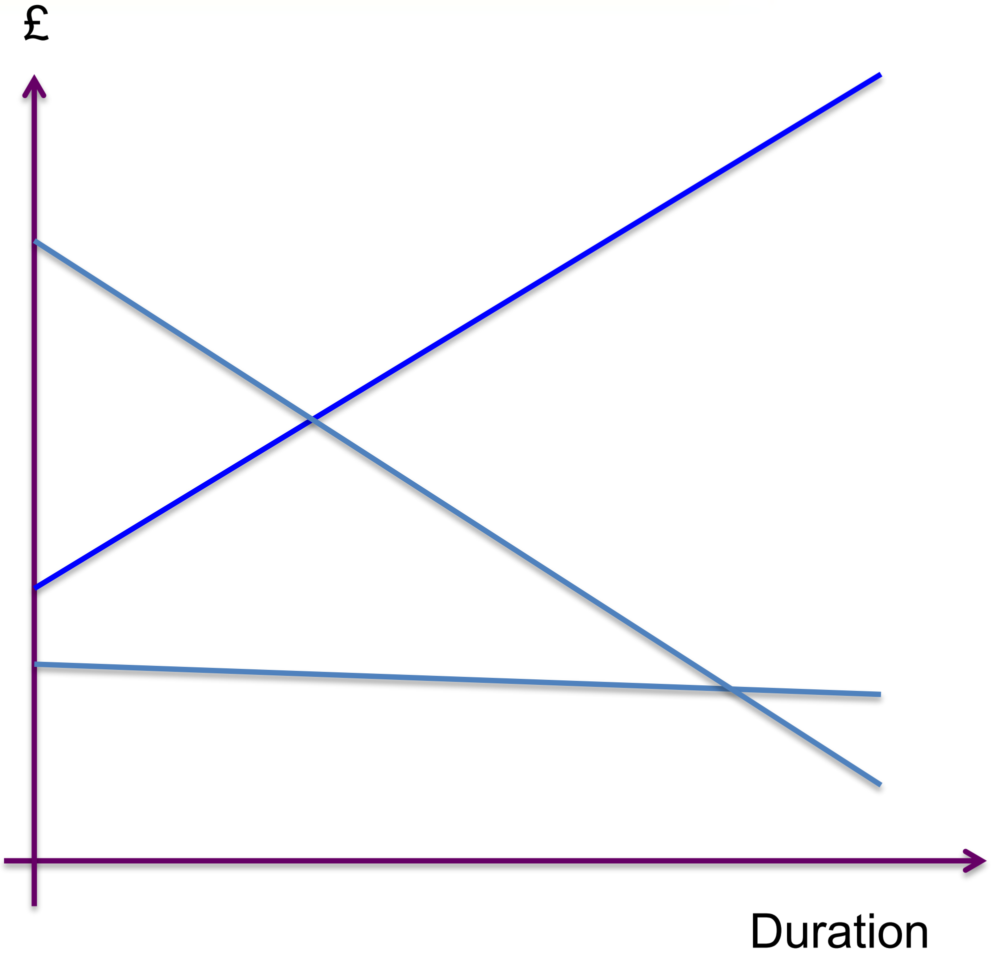
Degree of Redundancy



5 MW	6.25 MW	7.5 MW	8.75 MW	10 MW
N-1	**N-0.75**	**N-0.5**	**N-0.25**	**N-0**

Cost of interruptions

- **Very difficult to quantify . .**
- **Very customer specific**
  - *Industrial*
  - *Commercial*
  - *Domestic*
- **Very activity specific**
- **Duration specific**
- **Timing ….**



Customer Damage Functions & VoLL

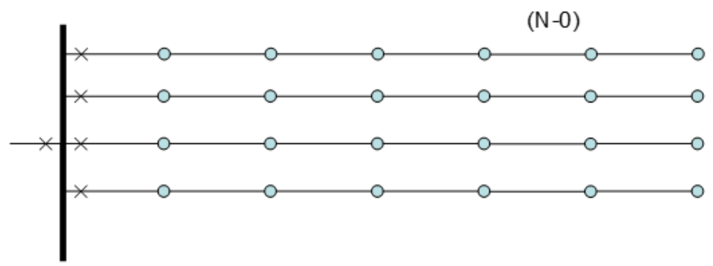
- Concept of **Value of Lost Load,** defining the cots energy not served, historically used for costing interruptions
- DECC & Ofgem use **VoLL = £17,000/MWh** for Energy Market Reform (based on comprehensive survey London Economics)
- Significant weaknesses of the concept well recognised . . . .
  - **No agreed** parameters for customer damage function
- Different **equivalent** VoLL can be derived for different type customers
- Conservative approach used: VoLL of £17k/MWh and £34k/MWh

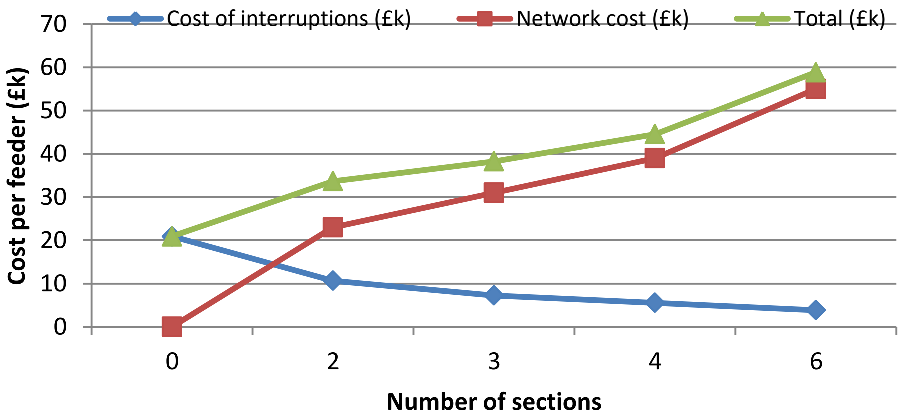
Recent UK Survey London Economics	VoLL (£/MWh)
Mix domestic and SME	16,940
Domestic	10,289
SME	35,488
Industrial	1,400

VoLL Sector – UK Survey 1990	60 minutes outage duration	1000 minutes outage duration
Residential	2,990	5,610
Commercial	47,376	30,848
Industrial	89,912	34,425
Large user	19,185	2,143

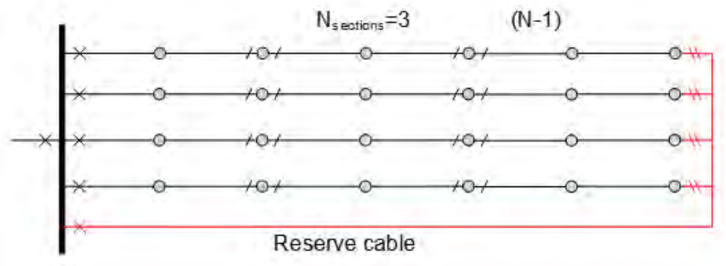
Importance of VoLL

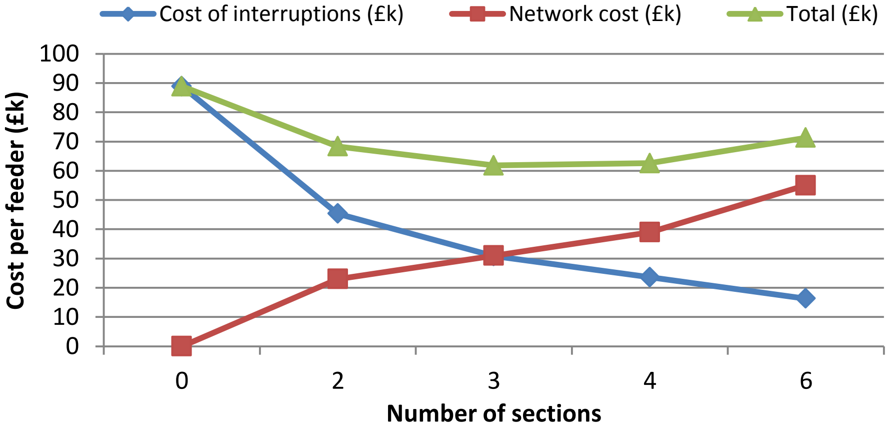
- **Network with no reserve cable**





- **Network with reserve cable**



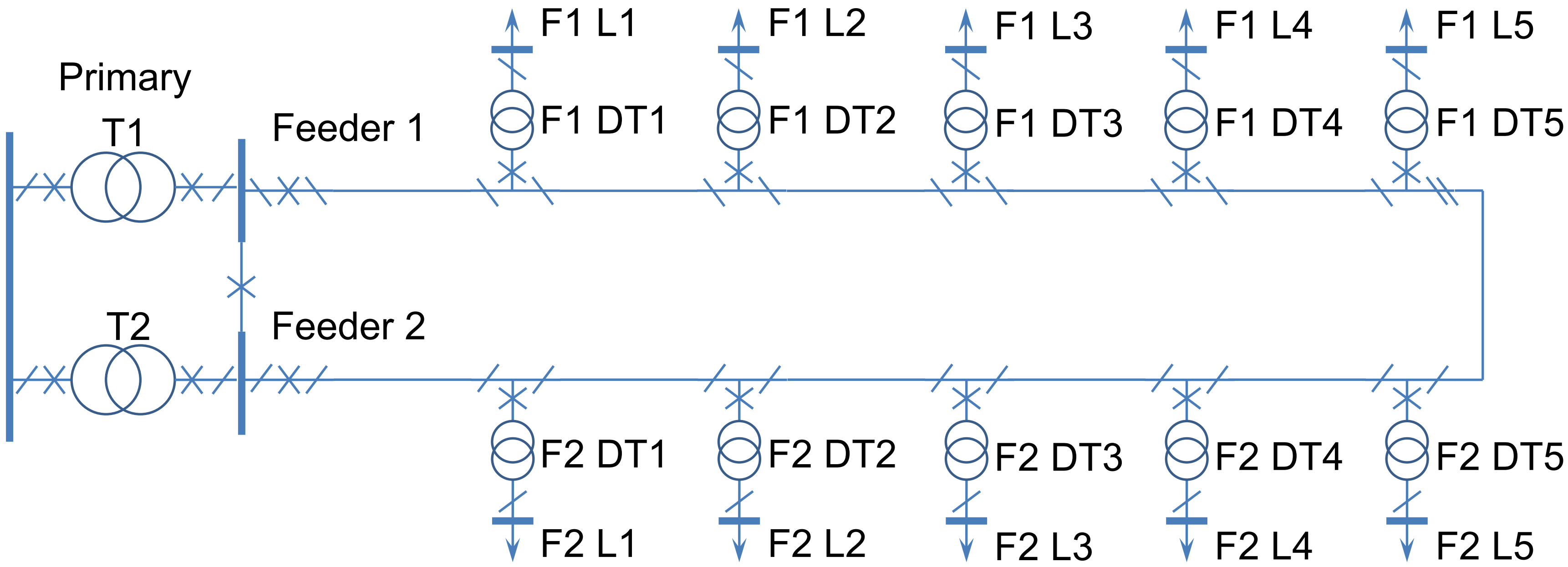


- **Economically efficient design will depend on the customer damage function adopted**

Cost effectiveness of the present network security standard /1

- **Key task: determine *breakeven VoLL* that would justify reinforcement according to present P2, and optimal level of redundancy**

Generic topologies considered which drive conservative results



Cost effectiveness of the present network security standard /2

Minimum value of VoLL (£/MWh) that would justify network reinforcement to N-1 (OH, MTTR 3/24 hours, 2,500 kW)

- ***Impact of (a) Load factor of demand and (b) network failure rate***

Demand Growth ↓

Degree of redundancy	Failure rate (%/km.year)	Low load factor	High load factor
N-0.75	*5%*	5,822,100	336,473
	20%	2,462,326	85,349
N-0.5	*5%*	928,626	38,581
	20%	251,237	6,605
N-0.25	*5%*	405,725	30,430
	20%	95,765	3,141
N-0	*5%*	117,881	6,148
	20%	21,462	0

Cost effectiveness of the present network security standard /3

Minimum value of VoLL (£/MWh) that would justify network reinforcement to N-1 (OH, FR 5%, MTTR 24 hours, 2.5MW)

- **Restoration time - important role of mobile generation (stock level limited, noise, pollution . .)**

Demand Growth ↓

Degree of redundancy	Restore time (hours)	Low load factor	High load factor
N-0.75	*3*	5,822,100	336,473
	12	1,348,185	82,920
N-0.5	*3*	928,626	38,581
	12	227,110	9,583
N-0.25	*3*	405,725	30,430
	12	100,444	7,567
N-0	*3*	117,881	6,148
	12	29,290	1,530

Cost effectiveness of the present network security standard /4

Minimum value of VoLL (£/MWh) that would justify network reinforcement to N-1 (OH, FR 5%, RestT 3 h, RepT 24 hours)

- **Larger demand – lower breakeven VoLL for reinforcement - higher degree of redundancy**

Degree of redundancy	Peak Demand (kW)	Low load factor	High load factor
N-0.75	*2,500*	5,822,100	336,473
	500	38,842,345	3,467,322
N-0.5	*2,500*	928,626	38,581
	500	6,654,313	549,738
N-0.25	*2,500*	405,725	30,430
	500	2,710,372	337,035
N-0	*2,500*	117,881	6,148
	500	921,565	152,047

Cost effectiveness of the present network security standard /5

Impact of reduced redundancy on CML

Parameter	Case A	Case B	Case C	Case D
Construction	Overhead	Underground	Overhead	Overhead
Failure rate (%/km.year)	5	10	20	5
Switching time (minutes)	2 and 30	2 and 30	2 and 30	2 and 30
MTT Repair (hours)	24	24	24	24
MTT Restore (hours)	24	24	3	3
Least-cost degree of redundancy	N-0.75	N-0.5	N-0.25	N-0

Case	Redundancy level	CML (min/cust.y)	
		ST=30 min	ST=2 min
A	N-1	8.4	~ 0
	N-0.75	9.8	1.6
B	N-1	17.2	~ 0
	N-0.5	39.5	23.7
C	N-1	33.1	~ 0
	N-0.25	46.8	17.1
D	N-1	8.4	~ 0
	N-0	14.9	7.7

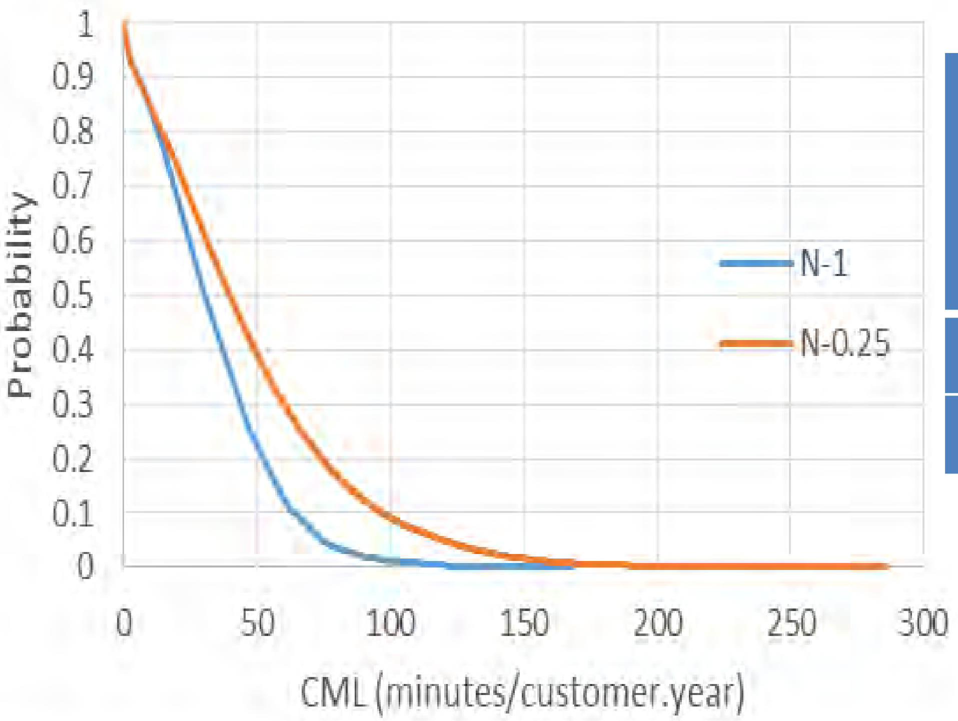
ST – switching time

Case	ΔCML, ST=30 minutes	ΔCML, ST=2 minutes
A	1.3	1.6
B	22.3	23.7
C	13.7	17.1
D	6.5	7.7

CML will increase when degree of redundancy is reduced

Cost effectiveness of the present network security standard /6

Cumulative probability of CML for case C and switching time of 30 minutes



Degree of redund.	Number of years in 100 years for which CML is above specified value in minutes/customer.year				
	20	***30***	***40***	***50***	***100***
N-1	**64**	**37**	**30**	**18**	**1**
N-0.25	**70**	**57**	**50**	**38**	**9**

Cost effectiveness of the present network security standard /7

Economically efficient level of redundancy vary significantly – from no redundancy (N-0) to N-1:

No single solution – significant impact of failure rates, restoration time, repair time, cost of network reinforcement, etc

Voltage level	Overhead lines	Underground cables
HV	N-0:N-1	N-0:N-1
EHV	N-0.25:N-1	N-0:N-1
132 kV	N-0.75:N-1	N-0.5:N-1

Cost effectiveness of the present network security standard /8

Potential savings of relaxing P2 requirements

Benefit/cost (£m)		HV network degree of redundancy			
		N-0.75	N-0.5	N-0.25	N-0
HV network		1,755 – 2,708	3,234 – 5,740	5,186 – 7,072	6,215 – 7,099
EHV and 132 kV networks		1,773 – 3,922	2,715 – 4,181	2,715 – 4,181	2,715 – 4,181
Losses		690 – 780	1,219 – 1,705	1,419 – 2,287	1,423 – 2,451
Customer outage cost	HV	11 – 17	219 – 389	978 – 1,334	1,172 – 1,339
	EHV and 132 kV	776 – 1,458	776 – 1,458	776 – 1,458	776 – 1,458
Total		2,051 – 4,375	3,249 – 6,855	3,860 – 7,042	4,531 – 7,060

Estimated potential savings of £2-7bn by 2030

42% - 67% reduction in LRE for HV at N-0.25

Generation driven distribution network investment /1

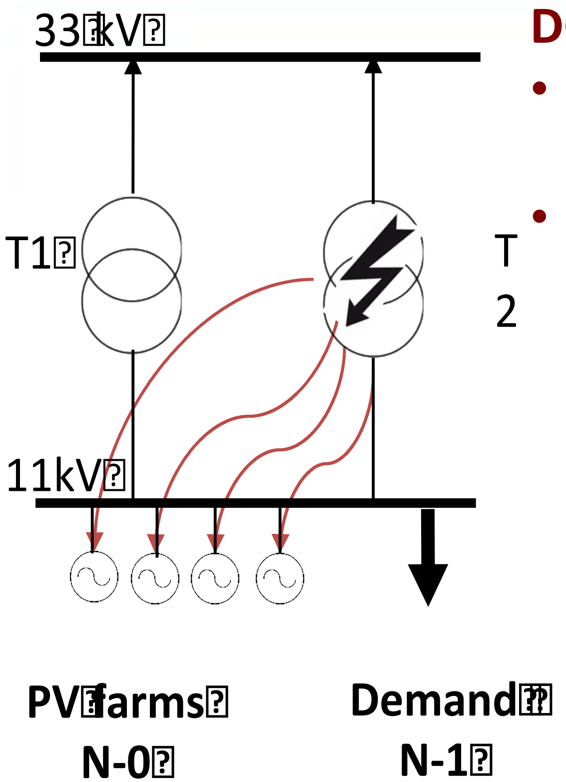
- **Cost of generation curtailment significantly lower than cost of demand curtailment**

VoLG = 100£/MWh << VoLL = 17,000 £/MWh

No redundancy for distributed generation connections

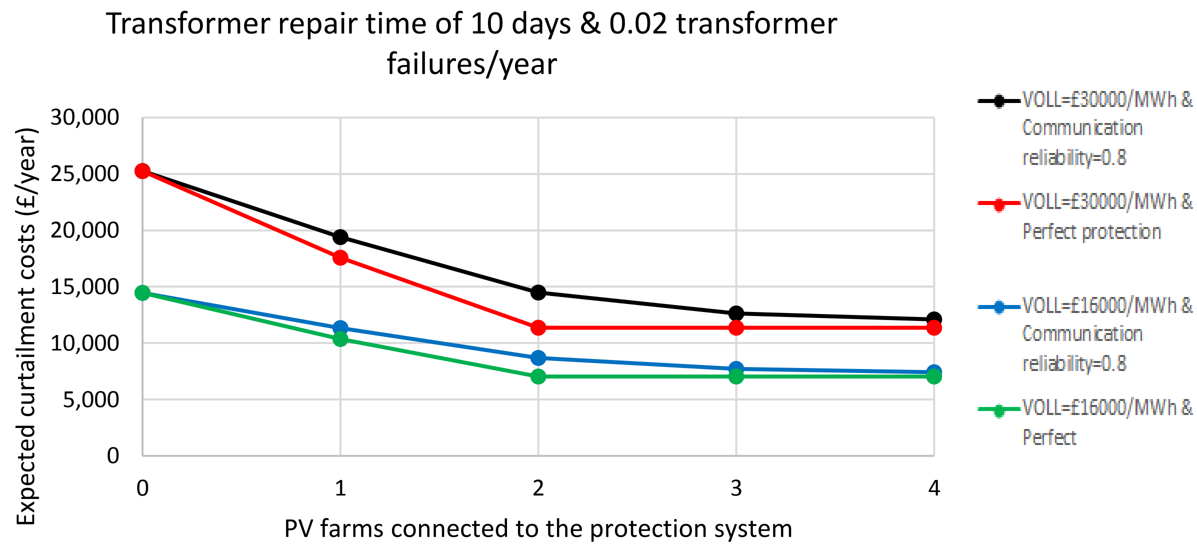
Voltage level	Overhead lines	Underground cables
HV	N-0:0.25	N-0
EHV	N-0:0.25	N-0
132 kV	N-0	N-0

Generation driven distribution network investment /2



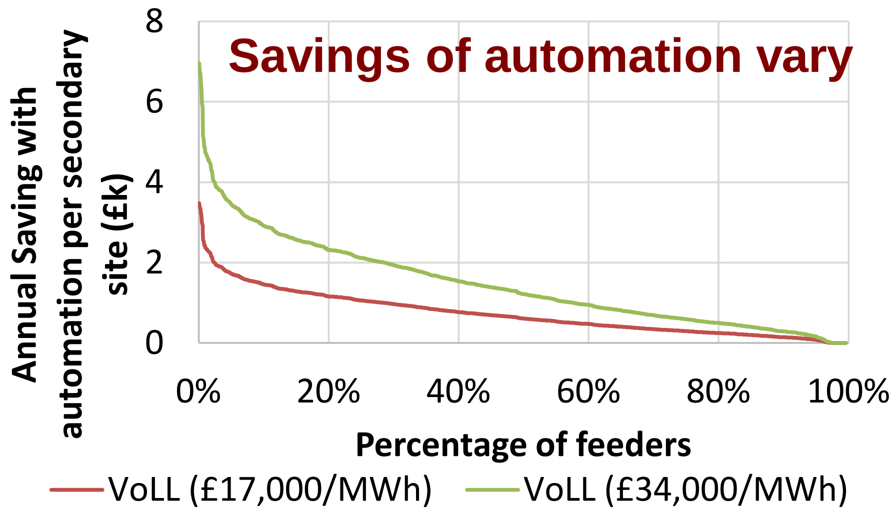
DG may reduce security performance of demand

- **Single outage may overload the network due to reverse power flows**
- **Special protection schemes deliver significant benefits**



- ***Redundancy in smart protection schemes increases demand reliability***
- ***When common mode failures dominate the curtailment costs (e.g. 10 days of repair time), relative benefits of smart protection schemes are modest.***

Value of Automation



Significant benefits of Automation

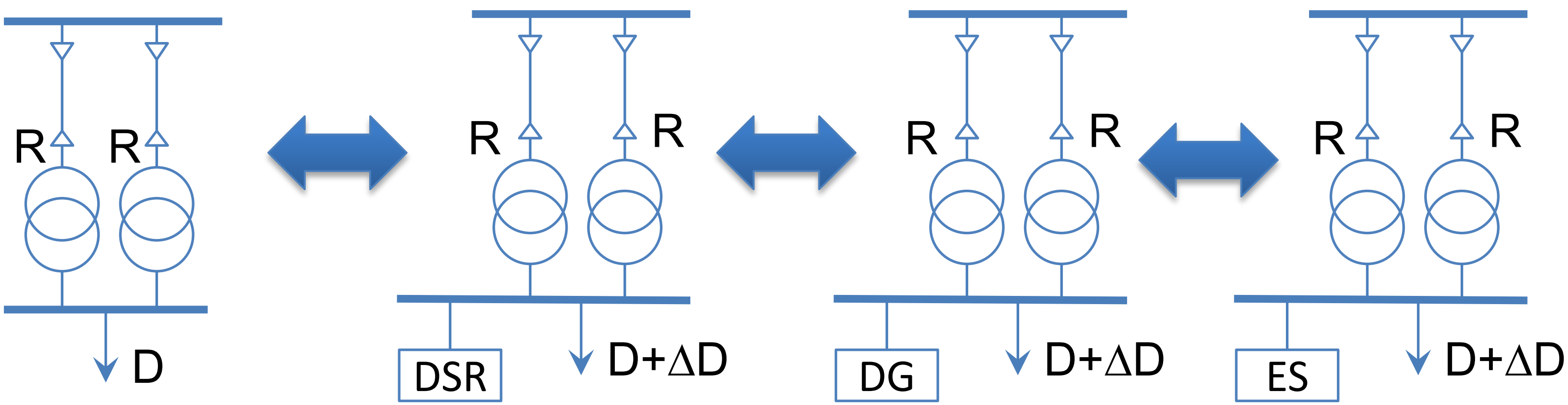
Indices	Manual	Automation	Reduction
CI	54	7	88%
CML	27	8	70%

Cost of automation per site (£k/year)	UG		OH	
	VoLL (£/MWh)		VoLL (£/MWh)	
	17,000	34,000	17,000	34,000
0.5	58%	80%	56%	83%
1	28%	58%	20%	56%
2	2%	28%	5%	20%
3	0%	2%	0%	12%

CBA for automation

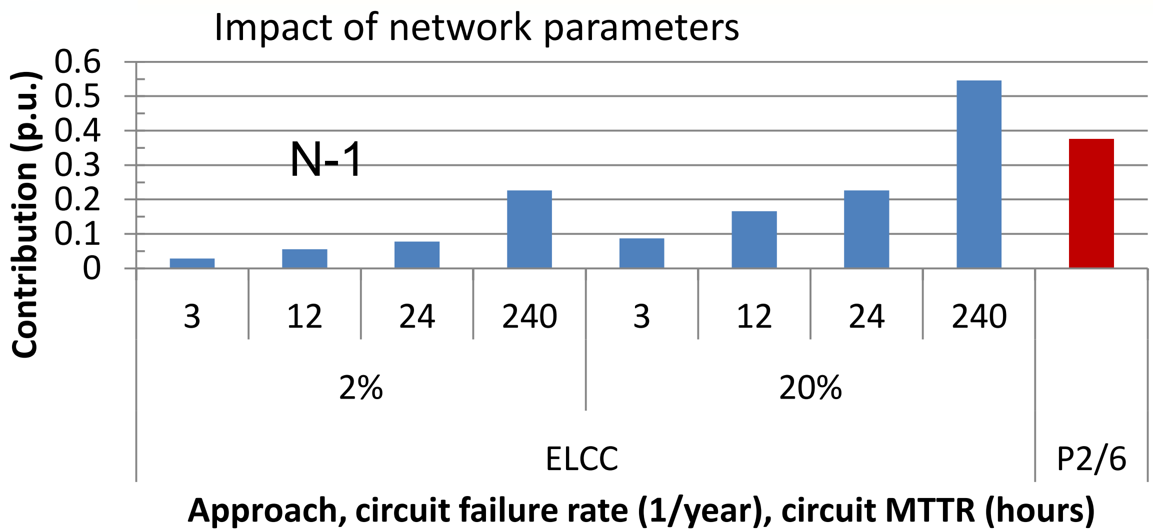
Contribution of DER to Network Security /1

DER can support network flow and voltage management and hence substitute for network reinforcement (if cost competitive)



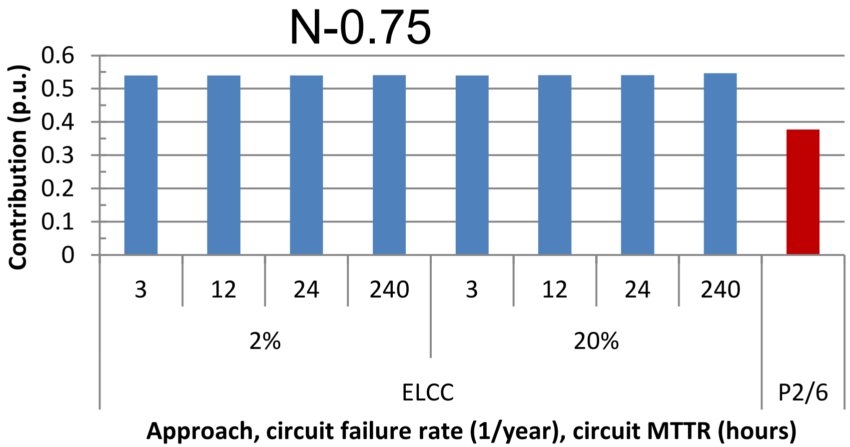
Same reliability delivered by network and non-network solutions

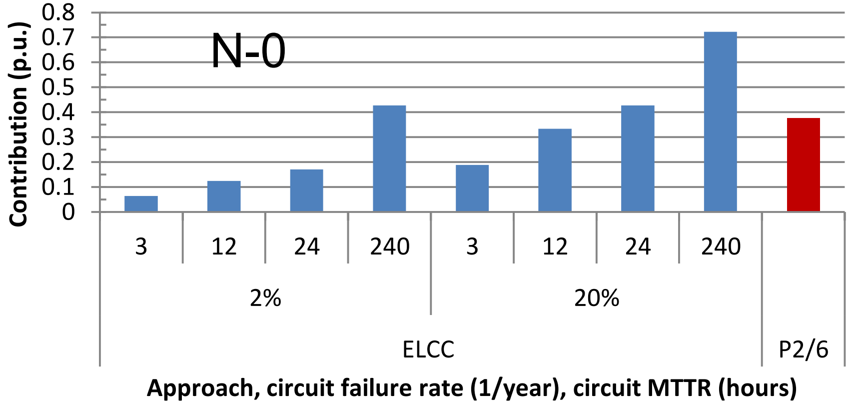
Contribution of DER to Network Security /2



Capacity contribution of DER depends on both underlying network reliability characteristics and DER parameters including availability, size, number of DER sites and technical characteristics

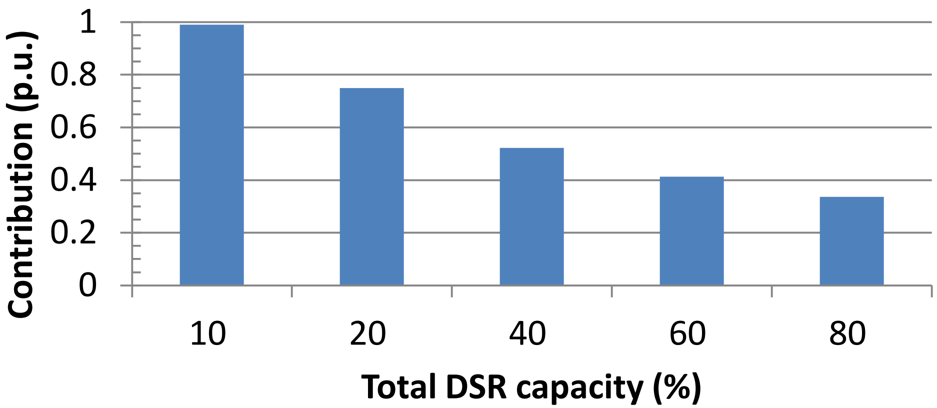
- *'P2/6 contribution' independent of network characteristics*

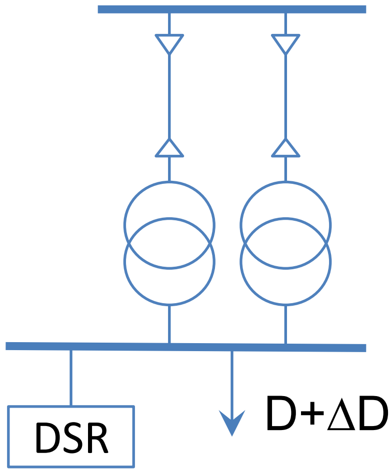




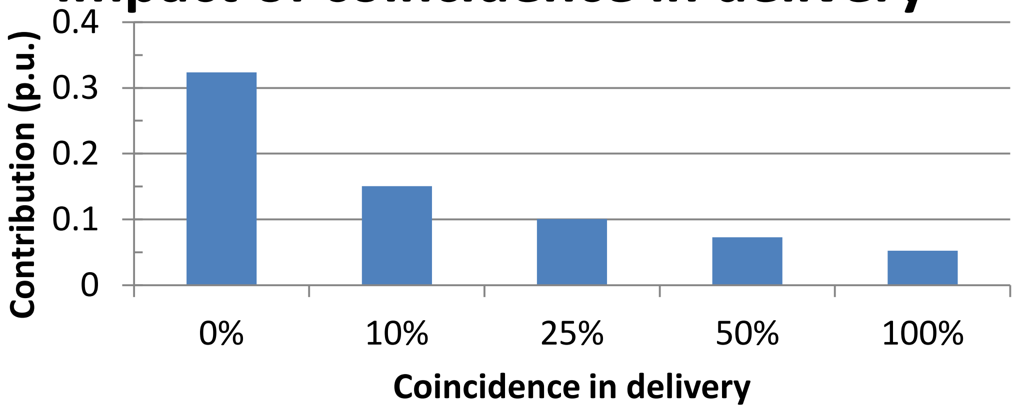
Contribution of DER to Network Security /3

Impact of relative size of DSR

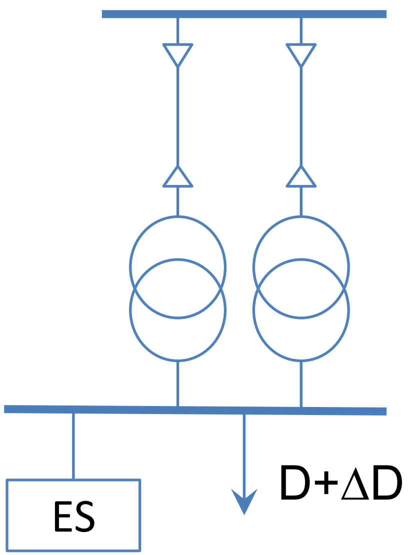




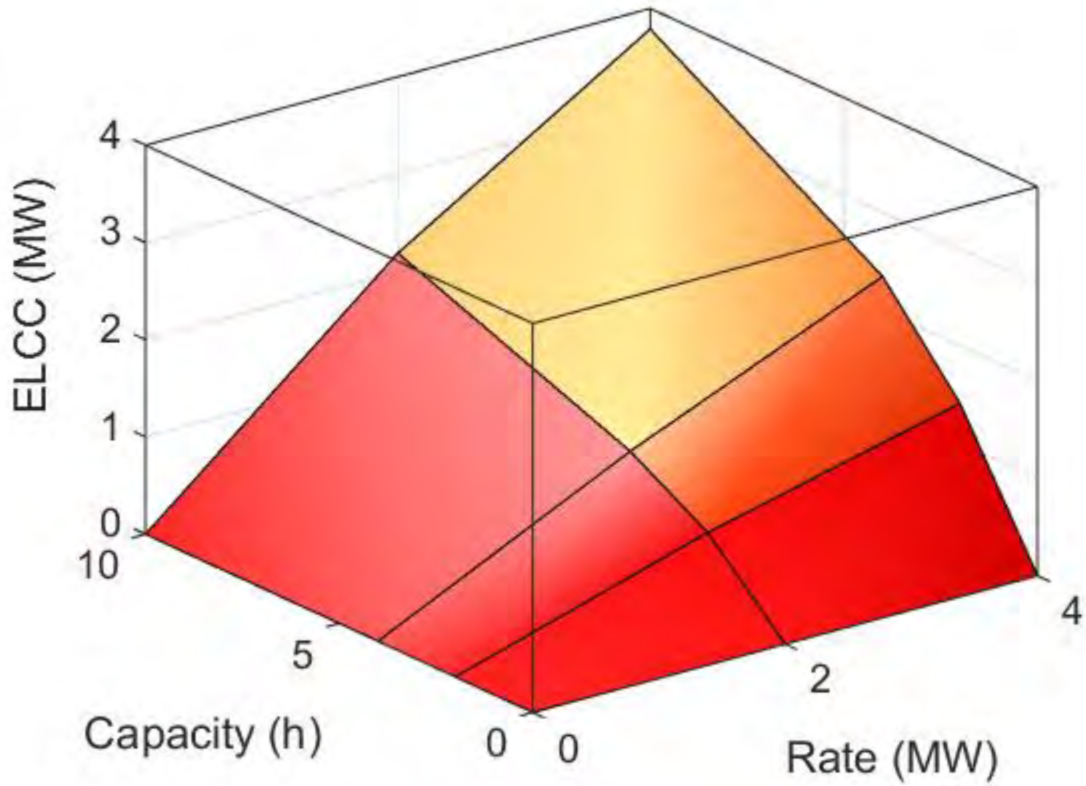
Impact of coincidence in delivery



Contribution of DER to Network Security /4



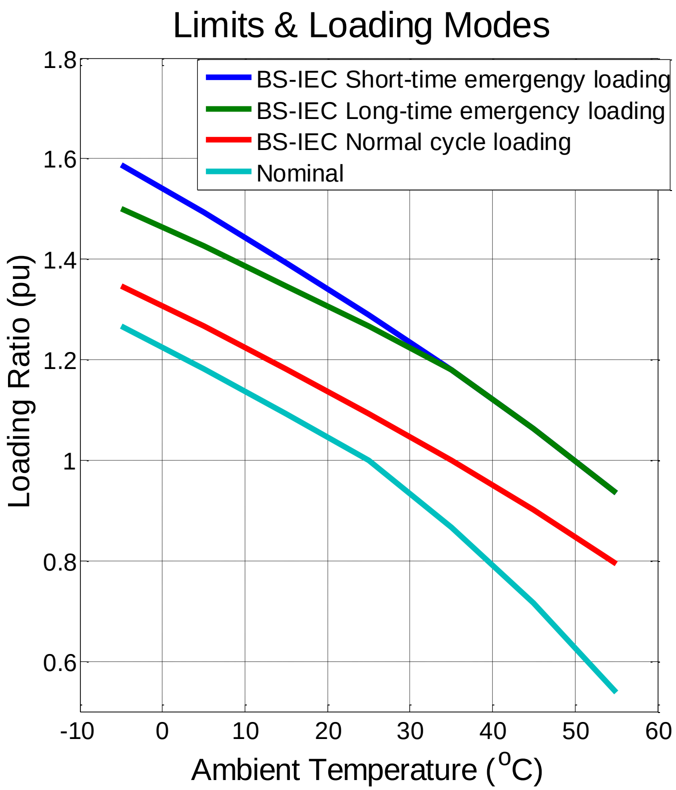
MTTR = **1 day**



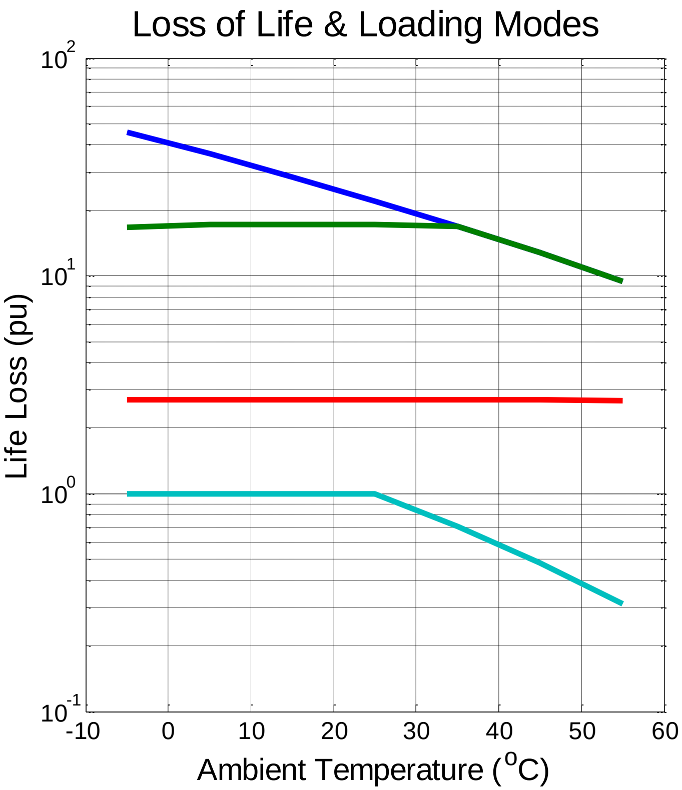
Amount of energy that can be stored will be a key parameter for determining the capacity contribution

Enhancing network assets utilisation /1

- **Maximum transformer's loading capability for various loading modes**



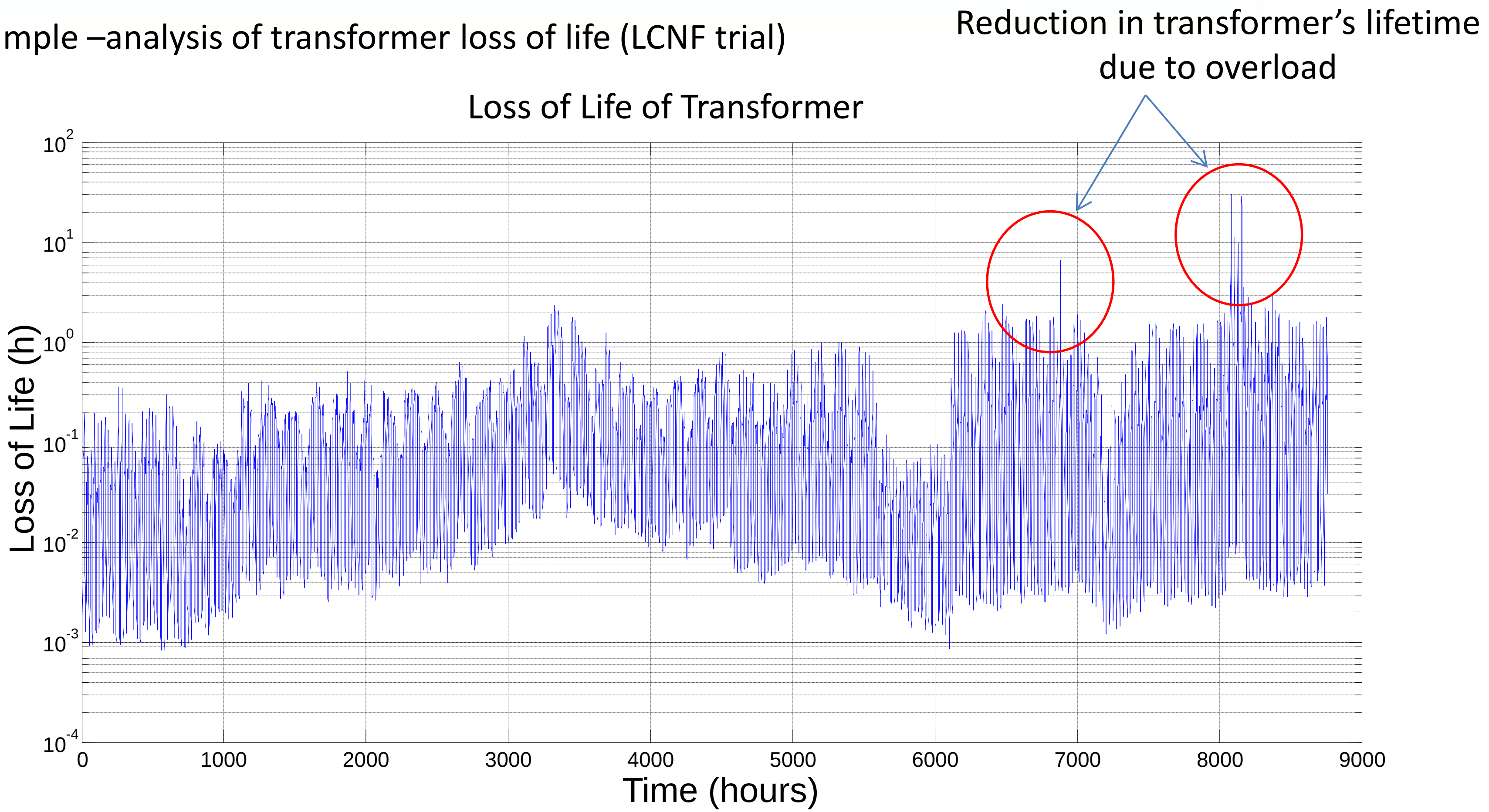
- **Life-loss of transformers for various loading conditions**



Overloading transformers during outage conditions considering loss of life, loss of life can be up to 50 times the normal ageing rate

Enhancing network assets utilisation /2

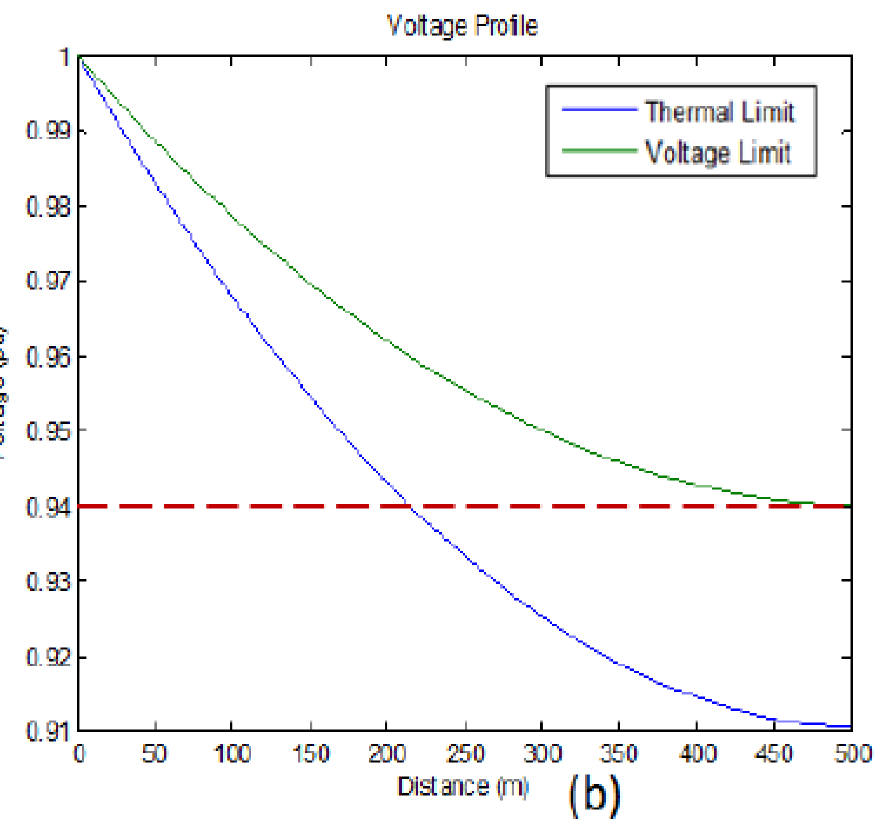
Example –analysis of transformer loss of life (LCNF trial)



Most of the time transformers are loaded below nominal loading, which "increases" their lifespan

Enhancing network assets utilisation /4

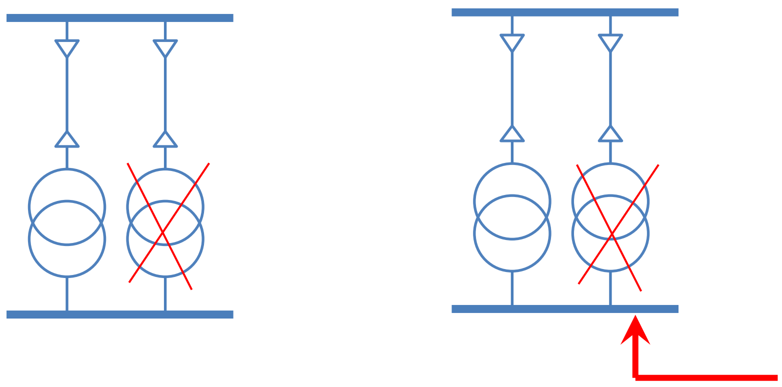
Voltage Driven Network Reinforcement

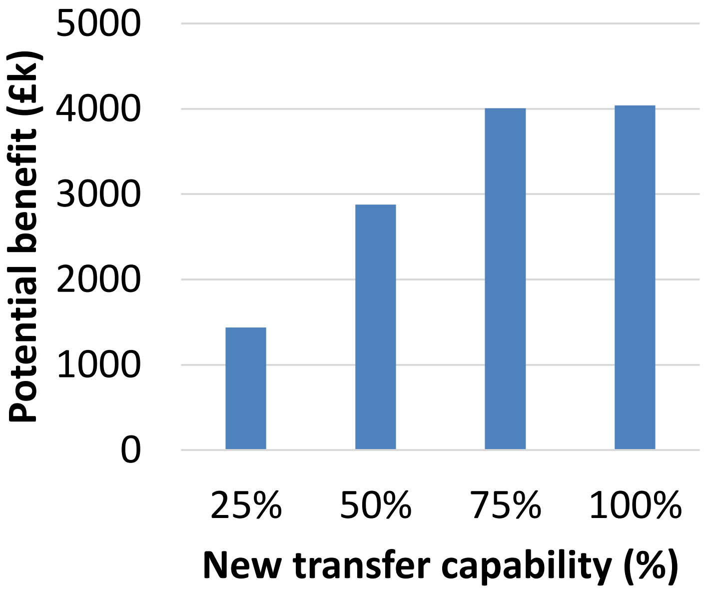


- **Allowing higher levels of voltage drop would release significant latent capacity**
- **Most of domestic appliances could safely operate at 85% of the nominal voltage**

Impact of construction outages and asset replacement

Potential benefit of provisional supply

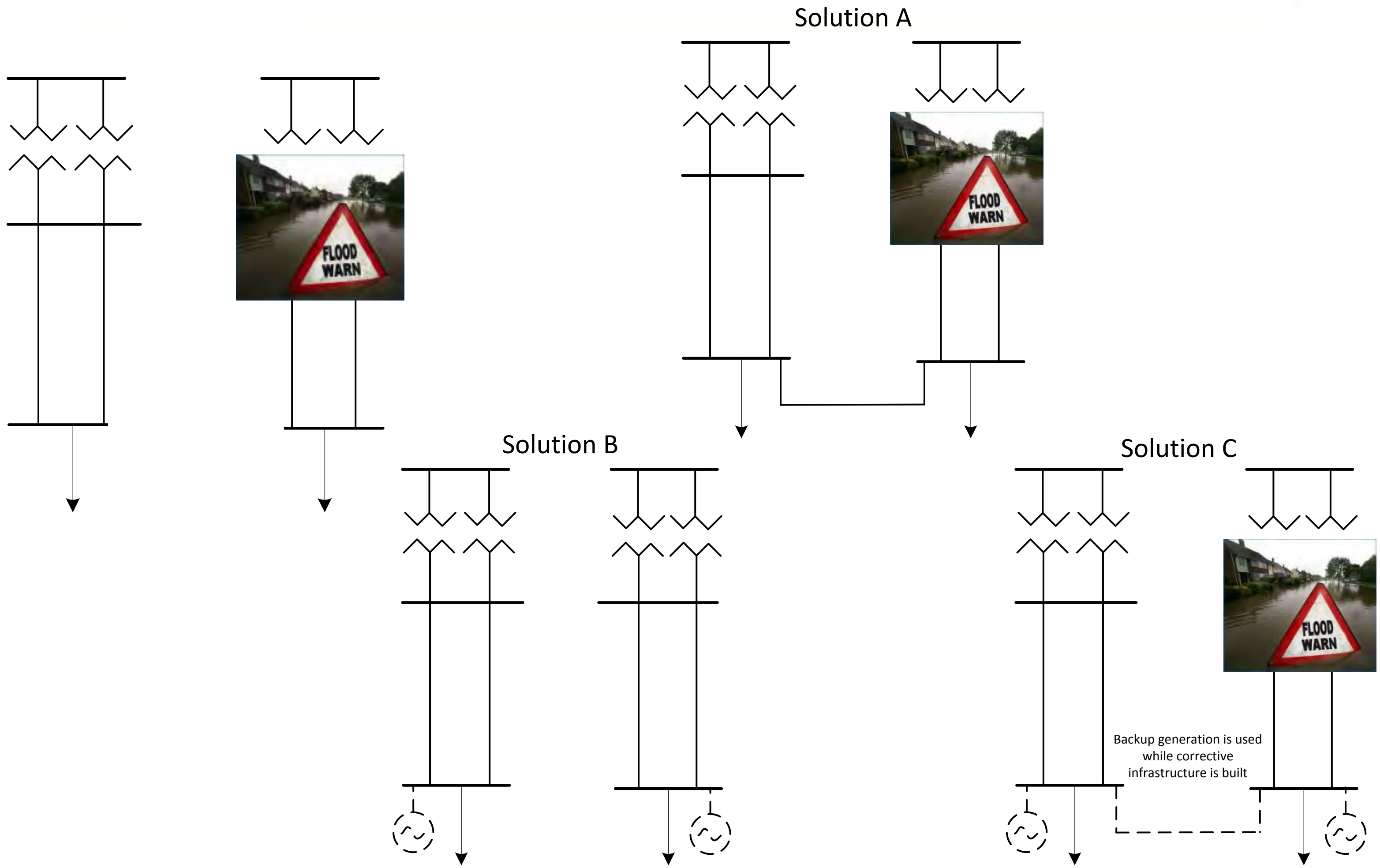




It would be economically efficient to provide provisional supply and reduce risks of consumer interruption during asset replacement

It might be appropriate to consider including guidance for asset replacement in future network security standards

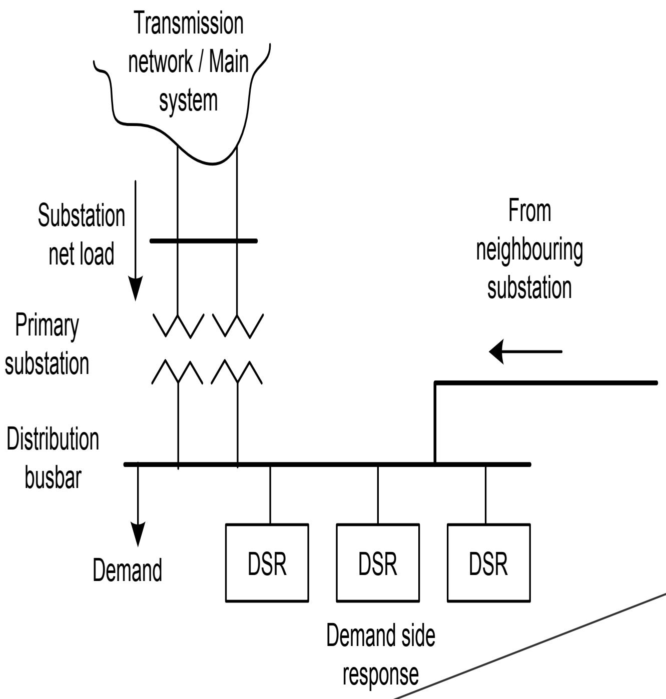
Distribution network resilience /1



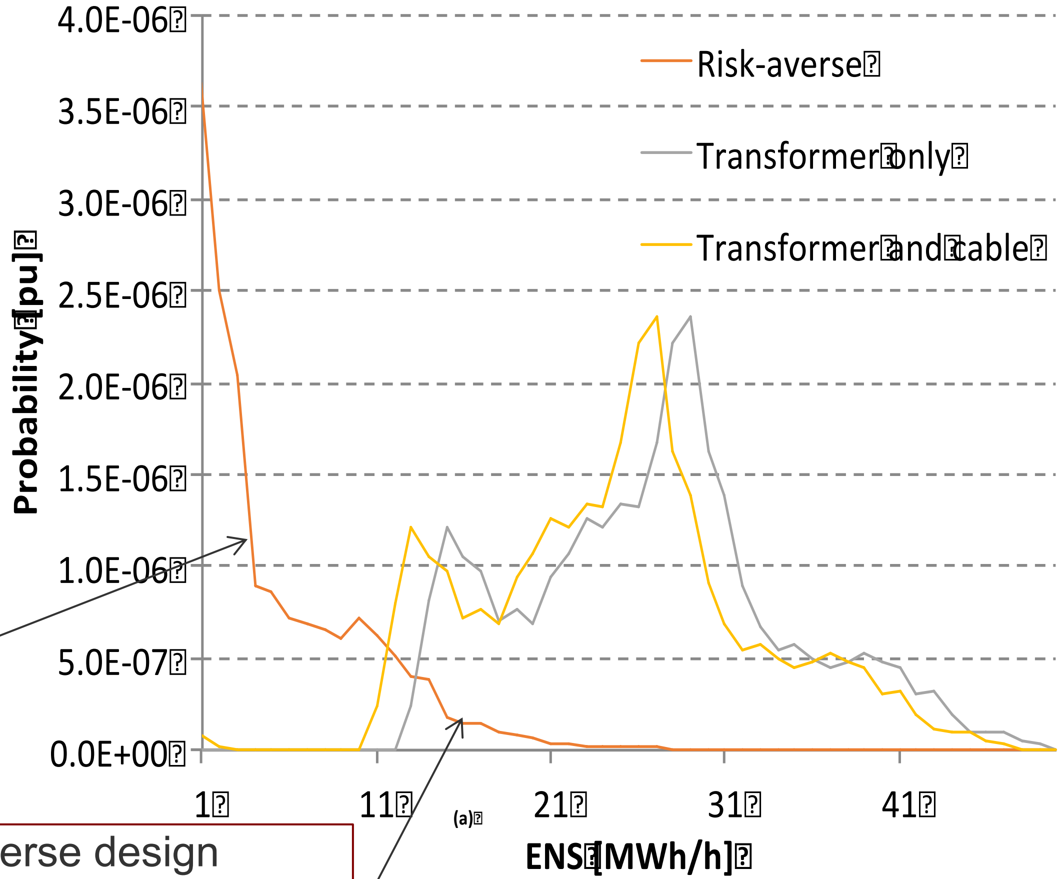
optimum portfolios of pre- and post-fault actions

Distribution network resilience /2

Risk averse against asset-only designs



Probability distributions of ENS



Risk averse design results in *higher frequency of small scale outages*

Risk averse design results in significantly *lower frequency of large scale outages*

Distribution network resilience /3

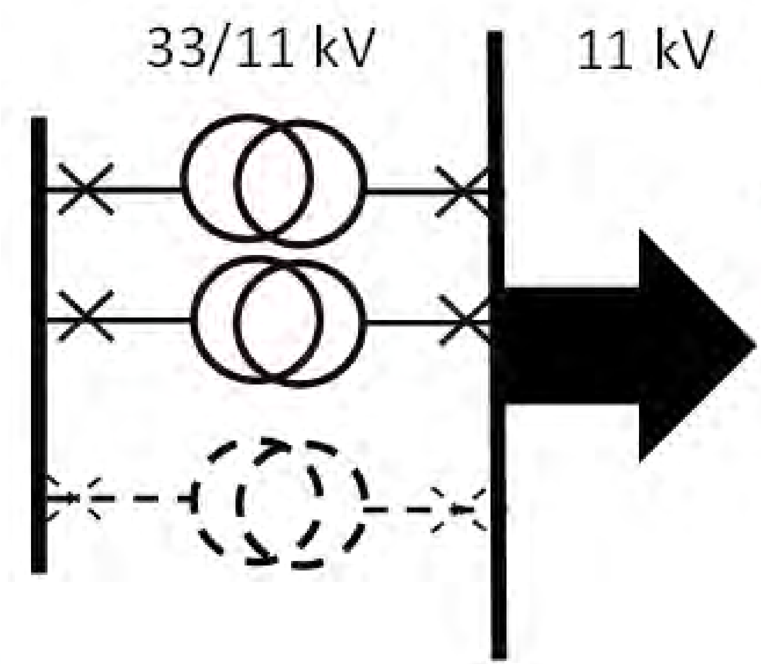
Network Reliability	HILP MTTR	No emergency supply		Emergency supply 3h		Emergency supply 24h	
		EENS (MWh/event)	Cost of EENS (£k/event)	EENS (MWh/event)	Cost of EENS (£k/event)	EENS (MWh/event)	Cost of EENS (£k/event)
No HILP	x1	1.33	22.6	1.26	21.4	1.32	22.4
HILP FRx10	x2	3.2	54.4	1.6	27.2	2.6	44.2
	x5	5.1	86.7	1.8	30.6	3.0	51.0
	x10	11.6	197.2	1.8	30.6	4.2	71.4
HILP FRx50	x2	15.4	261.8	3.2	54.4	11.1	188.7
	x5	55.2	938.4	4.7	79.9	19.2	326.4
	x10	157.8	2,682.6	5.7	96.9	27.2	462.4

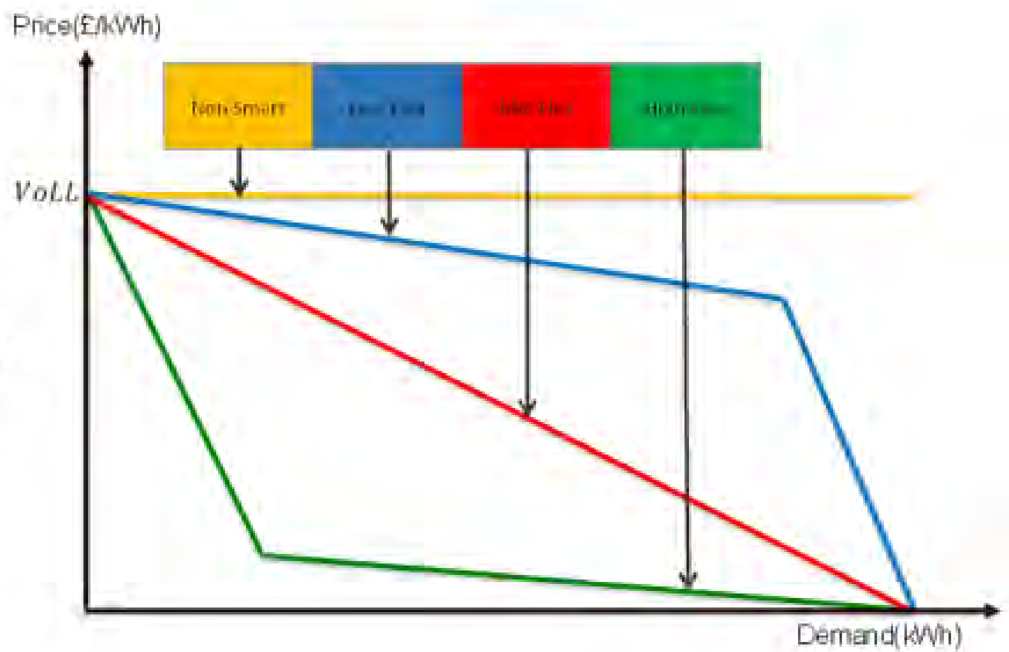
- **Use of emergency operation and investment actions (mobile generators and temporary transfer cables) can cost-effectively reduce the impact of HILP significantly**
- **Cost of under-grounding OH network analysed is 22km*£110k/km=£2.4m**
- **Resource constraints should also be considered especially during the supply restoration following HILP event**

Smart management of network overloads through disconnection of non-essential loads /1

- ***Roll-out of smart metering*** will provide an opportunity for smarter network management by ***switching off non-essential loads*** when network is stressed while ***supplying essential loads***

Case study: customers with different levels of flexibility





Smart management of network overloads through disconnection of non-essential loads /2

Minimum VoLL that would justify reinforcement

Network Reliability	Security Level	Non Smart	Low Flex	Mid Flex	High Flex
Low	N-0.75	8,800	36,700	141,700	875,000
	N-0.5	3,400	8,200	29,000	182,100
	N-0.25	1,500	3,100	9,200	59,000
	N-0	700	1,200	3,400	21,500
Medium	N-0.75	44,400	185,900	725,600	4,375,000
	N-0.5	32,300	56,700	196,200	1,275,000
	N-0.25	7,600	15,200	48,300	312,500
	N-0	3,500	6,100	17,300	113,300
High	N-0.75	90,200	386,400	1,487,500	9,296,900
	N-0.5	35,400	85,000	303,600	1,961,500
	N-0.25	15,200	32,700	101,200	625,000
	N-0	7,400	13,100	35,400	229,700

Higher network reliability - lower need for upgrade

Smart management of network overloads through disconnection of non-essential loads /3

- Significant enhancement of the reliability of supply delivered by the existing network
- **Price based demand control:** network loading controlled by ***scarcity pricing*** – consumers by making choices driving system development

Potential additional savings of £2-3bn at the GB level by 2030

Benefit/cost (£m)		Smart load reduction
HV network		1,767 – 1,331
EHV and 132 kV networks		1,522 – 2,278
Losses		200 – 550
Customer outage cost	HV	18 – 114
	EHV and 132 kV	151 – 684
Total increase		**2,073 – 3,372**

Long-term optimal design of distribution networks /1

Drivers for network reinforcement :

- **Connection of new customers**
- **Decarbonisation of transport and heat sectors**
- **Asset replacement**

Loss inclusive network design => capacity of networks should be significantly above peak demand

Asset		Economically efficient maximum network loading (%)
Cables	LV	12 - 25
	HV	14 - 27
	EHV	17 - 33
	132 kV	31 - 41
OH lines	LV	11 - 19
	HV	13 - 21
	EHV	16 - 25
	132 kV	27 - 32

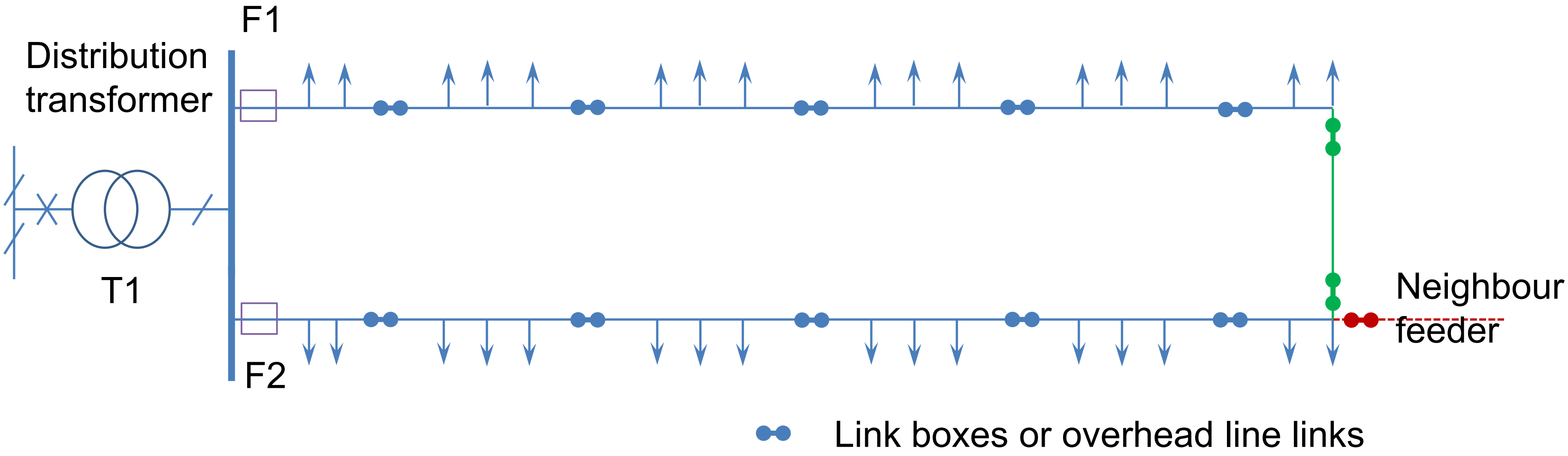
The economically efficient degrees of network redundancy should be greater than the minimum redundancy prescribed by the present standards

Economically efficient degree of redundancy

Voltage level	Overhead networks	Underground networks
LV	N-1	N-1
HV	N-0:N-1.75	N-1
EHV	N-1:N-1.75	N-1:N-1.75
132 kV	N-1:N-2	N-1:N-2

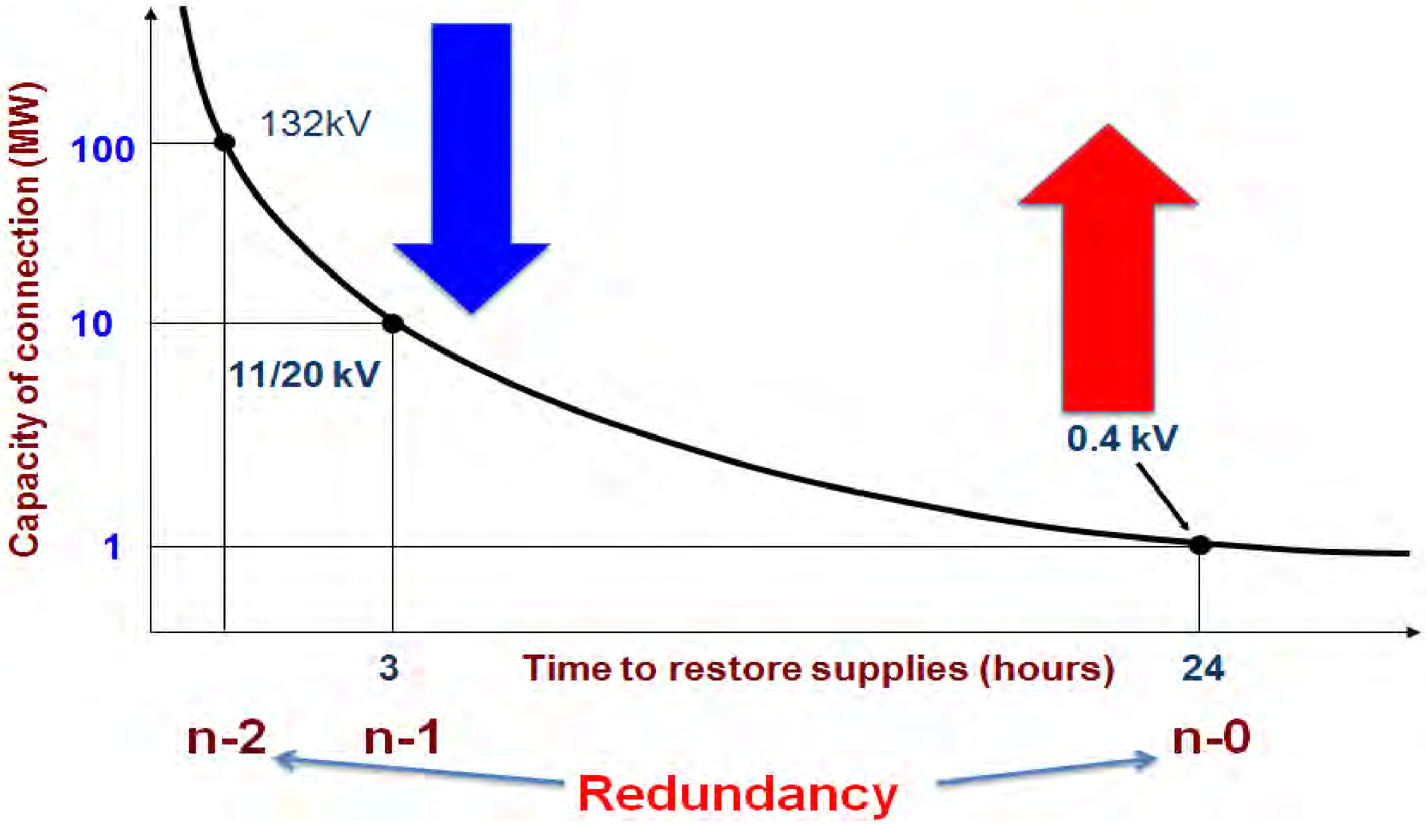
Long-term optimal design of distribution networks /2

It would be cost effective to potentially increase redundancy of LV and HV distribution networks beyond the level prescribed by the present standard



Case A: N-0
Case B: N-1
Case C: 'N-1.5'

Long-term optimal design of distribution networks /3



Smart district electricity networks **may facilitate the paradigm shift in delivering resilience from redundancy in assets and preventive control to more intelligent operation at the district level**

Key Findings /1

energynetworks association

Cost effectiveness of the present network security standard

- Network operation at N-0.5/N-1 redundancy level is economically efficient for
  - Long, less reliable networks with higher load level where lower load transfer is available, low upgrade cost
- Network operation at N-0 redundancy level is economically efficient for
  - Short higher reliability underground networks with lower load level and higher load transfer, high upgrade cost
- Potential savings of about £4-7bn at the GB level by 2030 by relaxing standard requirements (42%-67% LRE)

Generation driven distribution network investment

- No need for redundancy (N-0) as the cost of generation curtailment would be much lower than network reinforcement cost (VoLG << VoLL)
- Connection of significant amount of distributed generation may create reverse flows beyond the N-1 security limits, which may degrade demand reliability of supply
- Smart system protection scheme could significantly enhance demand reliability

Key Findings /2

Value of automation

– Improves network reliability performance and customer’s quality of supply
– For lower cost of network automation, more than 60% of HV feeders should be automated

Contribution of Distributed Energy Resources to network security

– DER can support network flow and voltage management and hence substitute for network reinforcement
  - Capacity contribution depends on both underlying network reliability characteristics and DER parameters including availability, size, number of DER sites and technical characteristics
  - For energy limited sources, such as energy storage, the amount of energy that can be stored will be an important parameter for determining the capacity contribution

Key Findings /3

Smart management of network overloads through disconnection of non-essential loads

- The roll-out of smart metering will provide a unique opportunity for smarter management by switching off *non-essential loads* when network is stressed while keeping supply of essential loads resulting in a significant enhancement of the reliability of supply delivered by the existing networks
- Opens up the potential for customer choice driven network design
- Potential savings of about £2-3bn at the GB level by 2030

Enhancing network assets utilisation

- It may be cost effective to increase the life-loss of the assets during emergency conditions as most of the time the assets are operated below the nominal rating – DNOs take the emergency loading into account, particularly in the case of transformers
- The use of dynamic line rating technologies demonstrated significant potential
- It may be efficient to review voltage standards

Key Findings /4

energynetworks association

Impact of construction outages and asset replacement

- It might be economically efficient to provide provisional supply and reduce risks of consumer interruption during asset replacement
- It might be appropriate to consider including guidance for asset replacement in future network security standards

Distribution network resilience, planning under uncertainty

- Diversity in the portfolio of technologies, network and non-network, will not only reduce the total system costs, but could reduce exposure to Common Mode Failures (CMF) and High-Impact Low-Probability (HILP) events, improving the distribution network resilience
- The concept of Conditional Value at Risk (CVaR) could be applied to limit the probability of large outages

Long term planning

Voltage level	Overhead networks	Underground networks
LV	N-1	N-1
HV	N-0:N-1.75	N-1
EHV	N-1:N-1.75	N-1:N-1.75
132 kV	N-1:N-2	N-1:N-2

Lunch

Overview of reference studies (Part 2)

- Review of the broader regulatory framework.
- Industry questionnaire response analysis.

Workshop Agenda

10:20	Welcome and Introductions	Steve Cox
10:30	P2/6 Review Presentation • Wider context (Martin Queen) • P2 background and wider process • Supporting studies and reports • Key conclusions and recommendations for reform	Martin Queen Colin MacKenzie
11:30	Coffee	
12:00	Overview of reference studies (Part 1) • Imperial College network planning and cost benefit analysis.	Goran Strbac
13:00	Lunch	
14:00	Overview of reference studies (Part 2) • Review of the broader regulatory framework. • Industry questionnaire response analysis.	Richard Druce Colin MacKenzie
15:00	Panel Session - Question and Answers	Steve Cox, Colin MacKenzie, Kieran Coughlan, Goran Strbac, Richard Druce
16:00	Concluding Remarks	Steve Cox
16:15	Close	Steve Cox

Overview of reference studies (Part 2)

Review of the broader regulatory framework.

Richard Druce

NERA has been responsible for developing an economic framework for assessing options and considering interactions with other regulations

energynetworks association

Our Fundamental Review of P2/6

- Quantitative Modelling to Compare Reform Options
- Economic framework for assessing reform options
- Considering other constraints on reform and unquantifiable factors (eg. simplicity, transparency)
- Recommendations

Overview of this Presentation

- Alternative regulatory mechanisms to promote economic efficiency in network planning
- An economic framework for comparing these options in reforming P2/6

Alternative Regulatory Mechanisms to Promote Economic Efficiency in Network Planning

The starting point for our work is the premise that regulation should encourage the "economically efficient" provision of reliability, which encompasses three concepts

energynetworks association

Allocative Efficiency

- As much reliability as customers are willing to pay for is provided by DNOs, ie. balancing the costs of provision and the value customers place on reliability

Productive Efficiency

- Reliability is provided using the cheapest mix of inputs, including network and non-network solutions

Dynamic Efficiency

- Productive and allocative efficiency should be achieved in the long-term, ie. trading off current and future costs and benefits

Our work assesses whether the current levels of reliability required by P2/6 are economically efficient, and whether reforms can improve efficiency

P2/6 is a form of regulation intended to promote the efficient provision of reliability

- Regulation to promote reliability is not used in most industries, so why here?
  - DNOs are natural monopolists, so competition does not motivate them to provide reliability efficiently
  - Reliability in distribution also has some features of "public goods":
    - Assets are shared between users;
    - Reliability cannot be provided to some users whilst excluding others; and
    - This leads to "free riding"
- Regulation is required to correct for these "market failures"

Part of our role has been to establish what type of regulation can best promote the efficient provision of reliability

There are two main approaches to regulating reliability in distribution

energynetworks association

Reliability Incentive Mechanisms:

- Use of financial incentives to encourage efficient outcomes (marginal incentive rate ≈ marginal value of reliability)
- DNOs are free to choose alternative means of provision
- Incentives usually target average duration and frequency of outages per customer over predefined area
- Aside from measuring interruptions, no need for regulatory enforcement

Reliability Design Standards:

- Legal obligations that place requirements on DNOs as to how much reliability they provide
- One approach is to mandate particular levels of reliability and/or specific means of providing it
- Other approaches are to require a specific process for selecting level of reliability and the means of provision
- Regulatory oversight to ensure compliance is required

Alternative measures include reputational incentives (probably supplemental), and the threat of ex post regulation (bad for investment incentives)

Distribution reliability is regulated in different ways across jurisdictions

Jurisdiction	Reliability standards	Incentive scheme (% of revenue at risk)	Guaranteed standards scheme	Planning standard	Detailed asset management plan	Separate treatment for "worst circuits"	Different standards for urban/rural
ACT	SAIDI, SAIFI	no, expected in 2014	no	no	no	no	no
NSW	SAIDI, SAIFI	no, expected in 2014	yes	deterministic	yes	yes - standards for individual feeders	yes
Queensland	SAIDI, SAIFI	yes (+/-2%)	yes	deterministic, internal only	yes	no - reporting only	yes
SA	SAIDI, SAIFI, maximum outage duration	yes (+/- 3%)	yes	deterministic, internal only	yes	no	yes
Tasmania	SAIDI, SAIFI	no, expected in 2012 (+/-5%)	yes	no	yes	no	yes
Victoria	SAIDI, SAIFI., MAIFI	yes (+/- 5% to 7%)	yes	probabilistic	yes	no - reporting only	yes
NT	no standards of any kind	no, expected in 2014	from 2012	no	no	no	--
WA	SAIDI, SAIFI, maximum outage duration	no	yes	no	yes	no	yes
New Zealand	SAIDI, SAIFI for investor-owned distributors	no	no	deterministic, internal only	yes	worst performing regions are highlighted	no
UK	SAIDI, SAIFI	yes (4%)	yes	yes, but in practice is exceeded	no	program to encourage investment	no
Netherlands	CAIDI,SAIFI	yes (5%)	yes	no	yes	no	no
Italy	SAIDI, SAIFI	yes (6.2%)	yes	no	no	yes; recently introduced	yes
California	SAIDI, SAIFI	yes	no	no	yes	yes	yes
New York	SAIDI, SAIFI	yes (+0/-1.4%)	no	no	yes	yes	yes

Not all jurisdictions apply deterministic planning standards

Source: Brattle Group

P2 interacts with a range of regulations, especially the RIIO settlements (including the IIS)

- ER P2/6 is a regulatory instrument that requires DNOs to achieve certain restoration times following the failure of a distribution asset.
- In practice, a range of other regulatory instruments also affect DNOs' decisions over what level of reliability to provide

An Economic Framework for Comparing these Options in Reforming P2/6

We have identified five high-level options for reform of P2/6

1

Retain P2/6 without change

2

Retain the nature of P2/6, but **update the deterministic requirements** to better achieve efficiency and to account for new technologies

3

Oblige DNOs to plan in accordance with CBAs, with no deterministic requirements

4

Apply **only minimum deterministic requirements**, and oblige DNOs to perform CBAs to justify further anything above this level

5

Abolish any formal planning standard

Option 1: The evidence we have prepared suggests some revision to the current standard should be considered

1

Retain P2/6 without change

What are the pros and cons of this option, and when would it be most appropriate?	What would be needed for implementation?	What are the key interactions with other aspects of the regulatory regime?
▪ This option would only be appropriate if the modelling had demonstrated that P2 prescribes efficient investment ▪ As Imperial's modelling shows, it does not. ▪ Hence, at the least, some revision to the deterministic requirements it imposes should be considered.	▪ The key advantage of this option is that no further work would be required to improve the standard. ▪ But the evidence on potential cost savings suggests this extra work is justified	▪ Little change required to current arrangements, but this option would not recognise the increasing prominence of customer engagement, CBA, etc, within the broader regulatory framework.

Option 2: Further work would be required to assess whether new deterministic obligations can be codified precisely enough to achieve efficiency

2

Retain the nature of P2/6, but **define new deterministic requirements** to better achieve efficiency and to account for new technologies

What are the pros and cons of this option, and when would it be most appropriate?	What would be needed for implementation?	What are the key interactions with other aspects of the regulatory regime?
▪ It may be possible to re-write P2 in a way that sets new deterministic requirements that prescribe more efficient levels of investment in resilience – New planning standard that tells DNOs how much resilience to provide and in what situations ▪ But, how accurately (ie. with what variance) can the "right answer" be codified?`	▪ Further work would be required to assess whether new deterministic rules can be codified to achieve efficiency ▪ Some aspects may be challenging, such as accounting for the impact of non-network technologies – The Imperial modelling suggests this varies enormously depending on circumstances	▪ As option (1), the change to other aspects of the regulatory regime would be modest, but the deterministic nature of the standard is not well aligned with the direction of travel for DNO regulation in GB.

Option 3: A range of approaches could be followed in implementing this option – further work would be required to develop it

3

Oblige DNOs to plan in accordance with CBAs, with no deterministic requirements

What are the pros and cons of this option, and when would it be most appropriate?	What would be needed for implementation?	What are the key interactions with other aspects of the regulatory regime?
▪ If it is challenging to codify the efficient solutions precisely (eg. non-network solutions) as deterministic obligations, a more flexible approach might be appropriate ▪ This requires a trade-off between the potentially significant efficiency gains vs. the extra burden this imposes on DNOs when planning. – "Cons" include less simple planning, etc – Some stakeholders cite lack of uniformity amongst DNOs as a "con", but this could be a benefit as well.	▪ As described on the next slide, a range of choices would be required to implement this option in practice. ▪ DNOs may also need some time to develop new planning practices ▪ Financial incentives may need to be strengthened to protect customers, new monitoring procedures, obligations to publish planning protocols, etc.	▪ Well-aligned with the "spirit" of RIIO, which already asks DNOs to do CBAs to justify investments. Also the flexible nature of the scheme means conflicts with other mechanisms are unlikely ▪ But, other elements of regulation that use common deterministic DNO planning standards may need reform: cost reflective charging, SQSS, comparative benchmarking…

There are a number of alternative ways to design CBA obligations (options 3 or 4)

Scope of the Obligation and Degree of Prescription

- At one extreme, it could simply oblige DNOs to “plan efficiently”
- But, it could specify assumptions, methods, factors to be considered, or even adherence to a particular CBA model
- Could oblige DNOs to tender for non-network solutions to substitute for conventional solutions (see Australian RIT-D)
- Could allow DNOs to factor in other benefits of network assets, eg. loss reduction

Regulatory Oversight and Compliance Verification

- Ofgem would need to monitor compliance, which may be more complex if more discretion is given to DNOs
- Ofgem could undertake ex ante approval of planning procedure statements, and/or oblige DNOs to publish CBA models, etc.

Option 4: In principle, this option strikes a balance between options (2) and (3), in particular as an interim measure before the price control is reset in 2023

energynetworks association

4

Apply **only minimum deterministic requirements**, and oblige DNOs to perform CBAs to justify further anything above this level

What are the pros and cons of this option, and when would it be most appropriate?	What would be needed for implementation?	What are the key interactions with other aspects of the regulatory regime?
▪ Applies a "baseline" below which resilience should never fall, which preserves some benefits of deterministic standards ▪ And requires CBAs in many contexts, which maintains some benefits of more flexible options ▪ But, if minimum efficient resilience levels are extremely low, would this instrument have any effect?	▪ As for options (2) and (3), further work would be required to calibrate minimum requirements and to define the nature and scope of CBA obligations.	▪ As for options (2) and (3), the use of CBA obligations is in line with the RIIO mechanism, etc. ▪ But the changes to other regulatory instruments that use deterministic obligations might be less than under option (3).

Option 5: This option would place much greater reliance on other mechanisms that regulate reliability, most notably the Interruptions Incentive Scheme

energynetworks association

5

Abolish any formal planning standard

What are the pros and cons of this option, and when would it be most appropriate?	What would be needed for implementation?	What are the key interactions with other aspects of the regulatory regime?
▪ This is the most flexible option for DNOs, requiring least continuous oversight by Ofgem. ▪ This option is otherwise very similar to option 3, which requires CBAs. The only difference is that companies would be incentivised, not compelled to do CBAs to determine optimal levels of reliability.	▪ This option would not require development of new rules, but new incentives.	▪ Although true under option 4 too, this option would make reform to other regulations (most notably IIS) essential – see next slide. – Very unlikely to be practical before RIIO-ED2 ▪ And as under other options, reform of mechanisms that use the current standard may be required

DNV·GL Imperial College London NERA Economic Consulting

Removing the planning standard entirely (option 5) only makes sense if other regulations can ensure the efficient provision of reliability

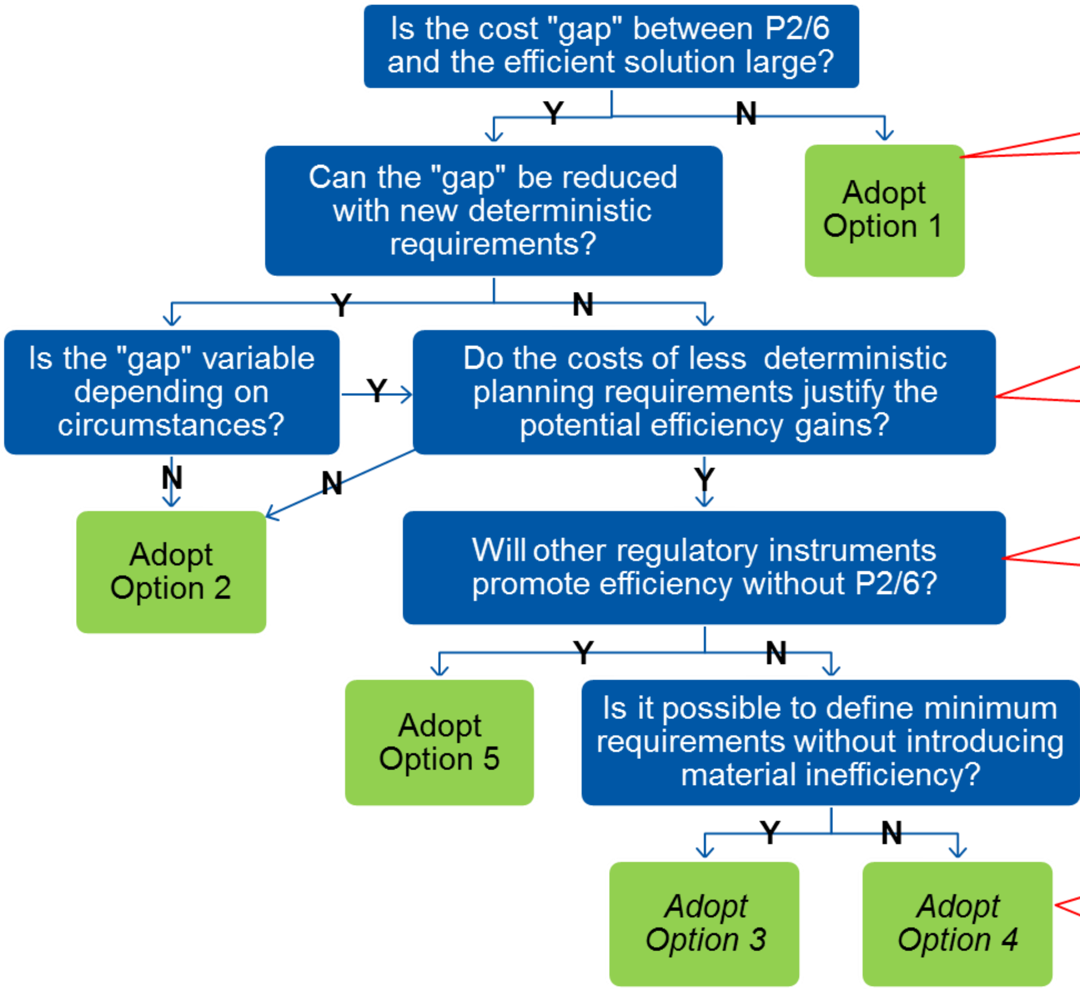
energynetworks association

- Absent P2/6, the IIS would be the key regulatory instrument for encouraging reliability investments, but it has limitations:

Limitations of IIS	*Possible Solution*	*Caveats*
• Caps/floors and removal of high impact events from CI/CML indices mutes incentives • Unpredictable resetting of targets at periodic reviews • Incentive rates motivate DNOs to provide less investments that required by P2/6 (efficient?) • No differentiation by customer type	• Remove caps/floors, and expose DNOs to high impact events • Establish defined procedures for calibrating the scheme • Raise incentive rates (if economically efficient) and differentiate by customer group	• Transfer of risk from consumers to the DNO (efficient for those controlling the risk to bear it?) • Impact on DNOs' financeability from shocks to cash flow in (eg) severe weather events? • Timing/feasibility of implementation?

Some other tweaks to RIIO may also be helpful, eg. reduce focus of output incentives on delivering asset-heavy solutions

A framework for assessing the options



The Imperial modelling shows this option is very unlikely to be the best alternative

Ultimately, following phase 2, a trade-off will be required between the qualitative benefits of a simple/deterministic obligation, as compared to more flexible options

Options 3/4/5 will also require development of new forms of regulation (CBA obligations) that interface closely with other regulations, notably the IIS

A minimum obligation combined with some elements of CBA obligations might provide a good interim measure before considering whether to develop even more flexible options at the next price review

Contact Us

NERA
ECONOMIC CONSULTING

Richard Druce

Senior Consultant
NERA—London
+44 20 7659 8540
richard.druce@nera.com

Overview of reference studies (Part 1)

Industry questionnaire response analysis.

Colin MacKenzie

Three main sections of the questionnaire

energynetworks association

3 SECTION 1 – DEVELOPING A BETTER UNDERSTANDING OF P2/6 STRENGTHS AND WEAKNESSES

In this section of the questionnaire, we seek views and feedback to aid a clearer understanding of the (perceived) strengths and weaknesses of the existing security standard.

Question 1.1:
Is the present network design standard e… Does it deliver value for money to all net… In other words, does it balance the cost … benefits delivered to distribution network…
Response:
Additional Comments:
Response Status (please indicate): ☒ Response to remain anonymous (defa… ☐ Share the response but without refere…

4 SECTION 2 – ALTERNATIVE APPROACHES TO SECURITY STANDARDS AND REGULATORY AND COMMERCIAL CONSIDERATIONS

In this section of the questionnaire, we seek views and feedback regarding potential alternative approaches to the existing (and any future) security standard and the impact of Regulation and commercia…

Question 2.1:
If P2/6 were enhanced to account fo… DSR/DSM), what types of changes t… implemented to achieve this, and wh… these alternatives?
Response:
Additional Comments:
Response Status (please indicate

5 SECTION 3: REAL TIME NETWORK OPERATION AND SECURITY OF SUPPLY

In this section of the questionnaire, we seek views and feedback regarding the changes in real time network operation and control that could be facilitated through new software applications and supporting ICT infrastructures that will be available to facilitate the transition to a "smart grid" paradigm, with specific focus on the impact on security of supply.

Question 3.1:
What are your experiences of the impact on security of supply as a result of changes in real time network operation and control in support of the deployment of "smart" devices on the network?
Response:
Additional Comments:
Response Status (please indicate): ☒ Response to remain anonymous (default). ☐ Share the response but without reference to company or project. ☐ Share the response with other respondents willing to share their information

Final section as a "catch all"

energynetworks association

6 SECTION 4: ADDITIONAL QUESTIONS AND POINTS FOR CONSIDERATION

Are there any additional points that you believe should be considered during the analysis phase of the project or included in the wider review?

These may include:

- Transparency and practicality of the future standard.
- Acceptability and application.
- Others related issues.

Please complete any additional tables as required.

Question 4.X:
Response:
Additional Comments:
Response Status (please indicate): ☒ Response to remain anonymous (default). ☐ Share the response but without reference to company or project.

Invited stakeholders

Stakeholders that make use of the ER P2/6 on a regular basis

Company Name
Electricity North West Limited
Northern PowerGrid
Scottish and Southern Energy - Power distribution
Scottish Power Energy Networks
Western Power Distribution
Uk Power Network
Northern Ireland Electricity
National Grid
Ofgem
DECC

Wider group of interested parties and industry participants

Company
GTC-UK
Energetics Electricity Limited
ESP Electricity Limited
Transmission Capital Partners
Power Con
GTC-UK
RES
SmartGrid GB
RenewablesUK
Scottish Renewables
Renewable Energy Association
British Hydro Power Association
British Photovoltaic Association
Solar Trade Association
Energy UK
Energy Storage Network
Renewable energy systems Ltd (RES)
UK Demand Response Association
Association of Decentralised Energy
Energy Innovation Centre
Primrosesolar
Smart Energy Demand Coalition
AMPS

Key Themes

1. **Embrace the strengths of the existing standard** – a strength of the existing standard is its simplicity. Many respondents suggested this **simplicity and transparency** should remain to ensure the usability of any future standard. Respondents suggested that any new sections should be clear and concise. Any new obligations placed on DNOs to undertake more complex planning exercises should consider the availability and cost of planning staff required to apply the new standard methodologies.

2. **Provide consistency with the regulatory framework** – the new standard should be developed in such a manner that it is consistent with the existing regulatory framework and flexible enough to adopt potential future changes without a major review of the regulatory system. The new standard will need to **align with, or accommodate regulatory incentives**, including the IIS. Some respondents discussed the possibility of delaying implementation of any new standard that imposes new obligations on DNOs until the start of the next control period.

Key Themes

3. **Remain sufficiently intuitive and easy to audit –** Some respondents noted as a benefit of the existing standard the **ease with which it can be explained in legal proceedings**, such as wayleave hearings or disputes, which can minimise dispute costs and delays. Further, it helps DNOs to demonstrate ESQC compliance.

4. **New network technologies must be fully represented** – it is clear from all parties that the revised standard **must consider both demand and non-demand sites** and other network technologies. This should **include (but are not limited to) energy storage devices, DSM, DSR and other commercial arrangements**. It is important that such devices and arrangements are included in the standard to enable them to be part of the network design process and provide their range of services to the market and the network. This will enable the future network work design to consider the benefits that are provided by such devices with a view to fully utilising their capabilities to maintain the required level of security while minimising the cost of such services to the network operator.

Key Themes

5. **Introduction of and clarity of definition in the use of "whole life costing"** - the new standard should promote the use of NPV cost minimisation supported by a clear definition of the terminology, to ensure networks are designed with more focus on long term efficient design and investment being central to the security standard.

6. **Provide a clear and consistent set of definitions** – some of the existing P2/6 statements are open to interpretation which leads to different views being formed of some of the statements and requirements, all terms in any new standard ought to be comprehensively and clearly defined, including the inclusion of a definition of Firm Capacity (if this term is used in any new standard).

7. **Reflect network user expectations** – the new standard should fully reflect all network user expectations (both demand and non-demand), be able to include customer willingness to pay for levels of security and meet their requirements as they evolve in the future.

Key Themes

8. **Introduction of Cost Benefit Analysis –** the requirement for CBAs should be introduced in the new standard to help inform decision making and guide optioneering but only as one component of the overall process and the method should be used within a closely defined context.

9. **Treatment of network losses should not be included –** Most respondents took the view that the security standard should not be adjusted to explicitly consider network losses, but suggested that the interface between other industry standards/regulatory initiatives should be enhanced to ensure that any incentives work correctly in conjunction with the security standard to support its intent of ensuring the efficient provision of security of supply.

10. **Statements of requirements should remain prescriptive** – Many respondents took the view that the description of the requirements imposed by the planning standard should be prescriptive, ensuring all DNOs are designing to the most economically efficient and stated common sets of planning methods. This will provide a level of supply security that offers the best value for customers but also balanced with adaptability to facilitate new/innovative methods of managing the network / network demand.

Key Themes

11. **Include the management of construction outages** – Some respondents expressed a desire for the new standard to provide guidance as to the methods for the treatment of construction outages that will provide a uniform approach for all DNOs to adopt and provide consistency across networks. This will become increasingly important as the shape of the network demand becomes more difficult to forecast as the penetration of new LCT increases as DNOs will have less choice of when to minimise the risk associated with a construction outage.

12. **Treatment of Extreme events** – extreme events (as characterised by HILP (high impact, low probability) should not be included in the new/revised standard as it is not efficient to include risk mitigation for them in a BAU process, such events should be treated within the regulatory framework. It was noted that a wider debate (which is outside the scope of this project) should be initiated across the industry to agree the most efficient way to treat such events.

Panel Session

Panel Session - Question and Answers

Steve Cox

Goran Strbac

Colin MacKenzie

Richard Druce

Kieran Coughlan

Workshop Agenda

10:20	Welcome and Introductions	Steve Cox
10:30	P2/6 Review Presentation • Wider context (Martin Queen) • P2 background and wider process • Supporting studies and reports • Key conclusions and recommendations for reform	Martin Queen Colin MacKenzie
11:30	Coffee	
12:00	Overview of reference studies (Part 1) • Imperial College network planning and cost benefit analysis.	Goran Strbac
13:00	Lunch	
14:00	Overview of reference studies (Part 2) • Review of the broader regulatory framework. • Industry questionnaire response analysis.	Richard Druce Colin MacKenzie
15:00	Panel Session - Question and Answers	Steve Cox, Colin MacKenzie, Kieran Coughlan, Goran Strbac, Richard Druce
16:00	Concluding Remarks	Steve Cox
16:15	Close	Steve Cox

Question

From the potential recommendations for reform of P2 what are the audience views on the following?:

1. The relaxation of N-1 redundancy.
2. Inclusion of DG, DSM/DSR and storage.
3. The inclusion of economic analysis where deterministic rules do not suit.
4. Removal of the security standard.
5. Introduction of a non-determinist standard (purely economic based standard through CBA).

Close

Closing Remarks

Steve Cox

Workshop Agenda

energynetworks association

10:20	Welcome and Introductions	Steve Cox
10:30	P2/6 Review Presentation • Wider context (Martin Queen) • P2 background and wider process • Supporting studies and reports • Key conclusions and recommendations for reform	Martin Queen Colin MacKenzie
11:30	Coffee	
12:00	Overview of reference studies (Part 1) • Imperial College network planning and cost benefit analysis.	Goran Strbac
13:00	Lunch	
14:00	Overview of reference studies (Part 2) • Review of the broader regulatory framework. • Industry questionnaire response analysis.	Richard Druce Colin MacKenzie
15:00	Panel Session - Question and Answers	Steve Cox, Colin MacKenzie, Kieran Coughlan, Goran Strbac, Richard Druce
16:00	Concluding Remarks	Steve Cox
16:15	Close	Steve Cox

Contact details

We would be grateful for your feedback during the project:

dcode@energynetworks.org

If you have any feedback on the workshop today or further thoughts on issues raised today, please contact us at the e-mail address above.

Close

Thank you for your attendance and participation