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An ENA Project

Review of Engineering Recommendation P2/6

DCRP P2 Working Group Initial Stakeholder Engagement Workshop

1 May 2015

Imperial College London

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NERA Economic Consulting

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Workshop Agenda

10:00	Registration	
10:30	P2/6 Review Presentation • Background • Governance • Project scope and definitions	Mike Kay Colin MacKenzie Richard Druce
11:30	Coffee	
12:00	Analysis approaches, methods and modelling	Goran Strbac
13:00	Lunch	
14:00	Panel Session - Question and Answers	Mike Kay Colin MacKenzie Goran Strbac Richard Druce
15:00	Concluding Remarks	Mike Kay
15:30	Close	Mike Kay

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Review of Engineering Recommendation P2/6

Mike Kay
Colin MacKenzie

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Workshop will include

- Introductions
- The Consortium
  - Member Companies
  - Roles & responsibilities for each organisation
  - The wider project team
- Project Definitions
  - Background
  - The Way Forward
  - The main Challenges
  - Consortium Approach to the Problem
- Review High-level process
- Techno-economic modelling considerations
- Stakeholder Engagement
- Programme
- Summary of outputs

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Introductions

The Distribution Code Review Panel P2 Working Group

Mike Kay - 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)

Tony Berndes (Western Power Distribution)

Steve Cox (Electricity North West)

Gareth Evans (Ofgem)

Alan Boardman (UK Power Networks)

Diyar Kadar (SP Energy Networks)

Ben Marshall (National Grid)

Mark Kilcullen (DECC)

Chris Marsland (AMPS)

Will Monnaie (SSE Power Distribution)

Joe Duddy (RES)

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Introductions

The Consortium

Alan Birch - Stakeholder Engagement Manager, DNV GL

Goran Strbac - Techno-economic lead, Imperial College London

Richard Druce - Regulatory and economic lead, NERA Economic Consulting

Colin MacKenzie - Project Manager, DNV GL

Background to the review of P2

- Engineering Recommendation P2 has been in place since the 1950s and has played a major role in the development of secure, reliable distribution networks.
- In its current guise, as P2/6, the basic philosophy and underpinning economic analysis is unchanged since 1978 (P2/5).
- P2 is a deterministic standard and is largely focused around ensuring sufficient capacity is available to meet the peak demand and that loss of supply is recovered within defined timeframes.
- P2 is risk based in its underlying analysis and also in that larger group demands have a higher level of security.
- The most fundamental issue regarding the future evolution of the P2 standard is whether it prescribes economically efficient investments, given many changes affecting the energy market at present, including the (anticipated) prolific deployment of non-network technologies and the changing role of the customer.

The Main Challenge #1

A fundamental review of the philosophy of distribution network operation and design is needed to inform the industry, consumers, regulator and government, in order to facilitate a cost effective delivery of the UK Government energy policy objectives. Overall, there are two key areas of interests:

- What is the level of security performance delivered to end user consumers by the present network design standard/practices? Is the present network design standard efficient? Does it deliver value for money to all network customers? In other words, does it balance the cost of network infrastructure with the security benefits delivered to distribution network customers?
- Given that the present network design standards require that network security is provided through asset redundancy, will this impose a barrier for the innovation in the network operation and design and prevent implementation of technically effective and economically efficient solutions that enhance the utilisation of the existing network assets and maximise value for money to network customers?

The Main Challenge #2

Under these two key areas, there are a significant number of more specific issues to consider:

- using generic rules applied to all situations, will not be optimal in individual instances.
- The binary approach to risk as in the present deterministic standard is fundamentally problematic.
- A lack of differentiation between construction and maintenance outages in the present distribution planning standard.
- Asset redundancy may not be a very good proxy for actual security delivered.
- The potential need to value reliability using either complex customer damage functions, or based on an assumed level of the value of lost load (VOLL).
- The present standard does not deal well with common mode failures.
- Interruptions Incentive Scheme is not explicitly recognised in the present planning standards.

The Main Challenge #3

- There is a growing interest in incorporating non-network solutions in the operation and design of future distribution networks.
- At present, the choice that network users (both demand and generation) can exercise in relation to their security of supply is limited.
- It may be desirable to extend the scope of the standard and consider cost-effective network planning under uncertainty, particularly taking advantage of smart grid technologies.
- In the longer time scale the introduction of smart metering may facilitate reliability-based choices of consumption.

Governance of P2/6

- 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.

The Way Forward

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. Network licensees have no preconceived approach to future security standards. The spectrum of possibilities ranges from a modification and update of the current arrangements, development of a completely new approach starting from first principles, through to recommending removal of any deterministic planning standard, relying instead on DNOs' regulatory incentives and other legislation to motivate efficient network design.
- **Phase 2** Codify the standard.

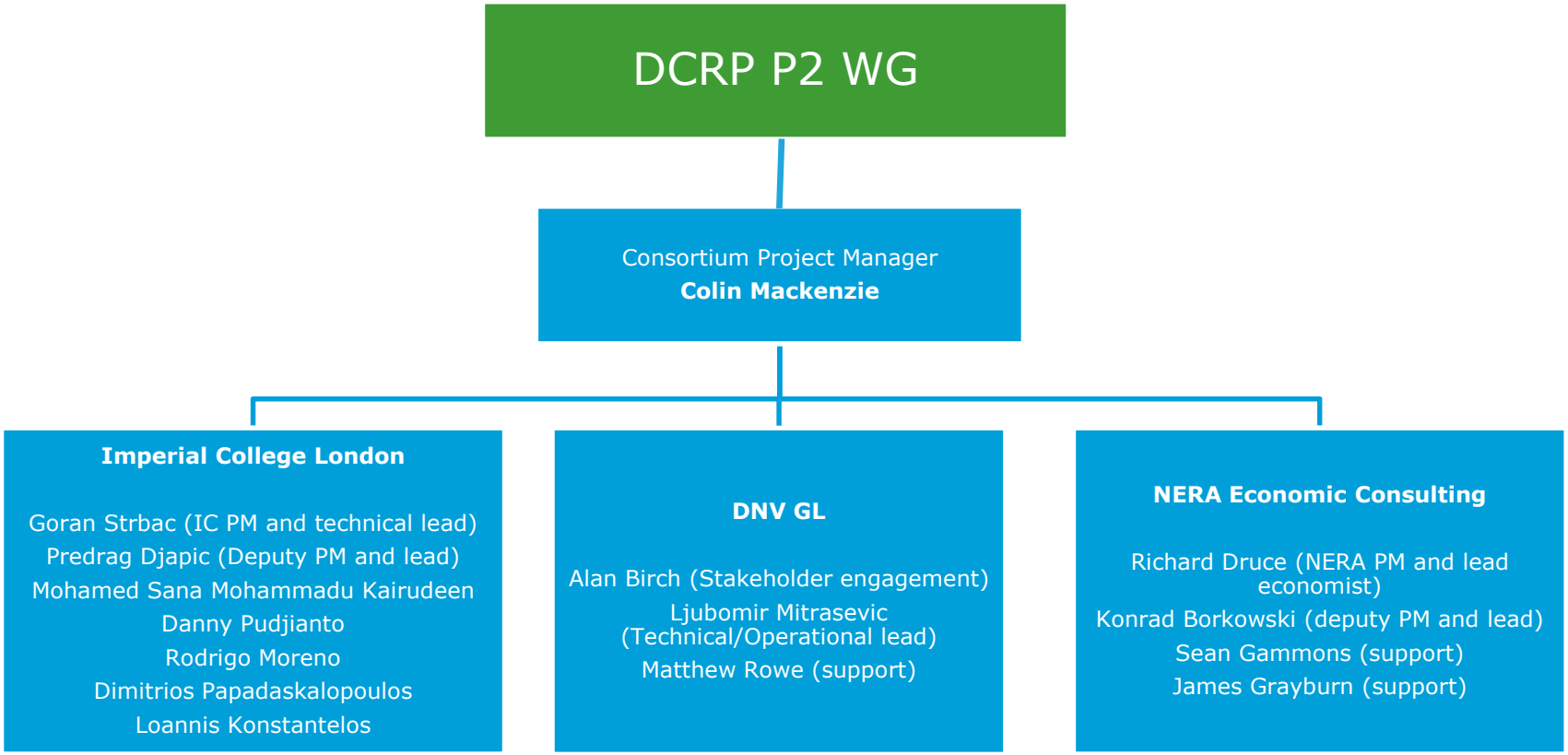
Consortium Members

DNV·GL	Imperial College London	NERA Economic Consulting
More than 3,000 experts in over 30 countries	More than 50 researchers and academics working in the Power Group	More than 600 professionals in over 20 offices
A heritage of nearly 150 years	UK and international leadership in the area of future development of transmission and distribution networks	More than 45 years of experience
A one-stop shop for energy advice	Excellent track record in publications	Combines rigorous economic thinking and quantitative analysis with practical experience
In-depth knowledge spans the energy value chain	Has provided evidence for industry, regulators, and government regarding the challenges associated with the transition to lower carbon future.	
Innovation is core to the business		

Organisation roles & responsibilities

DNV·GL	Imperial College London	NERA Economic Consulting
PMO activities • Project reporting/Risk Management • Running the process	Techno-economic modelling lead	Economic & regulatory knowledge
Technical knowledge Network planning experience	Assessment of P2/6 • Fundamental considerations • Current performance of the standard • Emerging options • Compare and contrast	Review of regulatory landscape • Interactions with other standards and industry codes • Interaction with wider market arrangements
Operational/practical perspectives		Advise on economic aspects of model
Stakeholder Engagement – proven techniques and track record		

Wider Project Team



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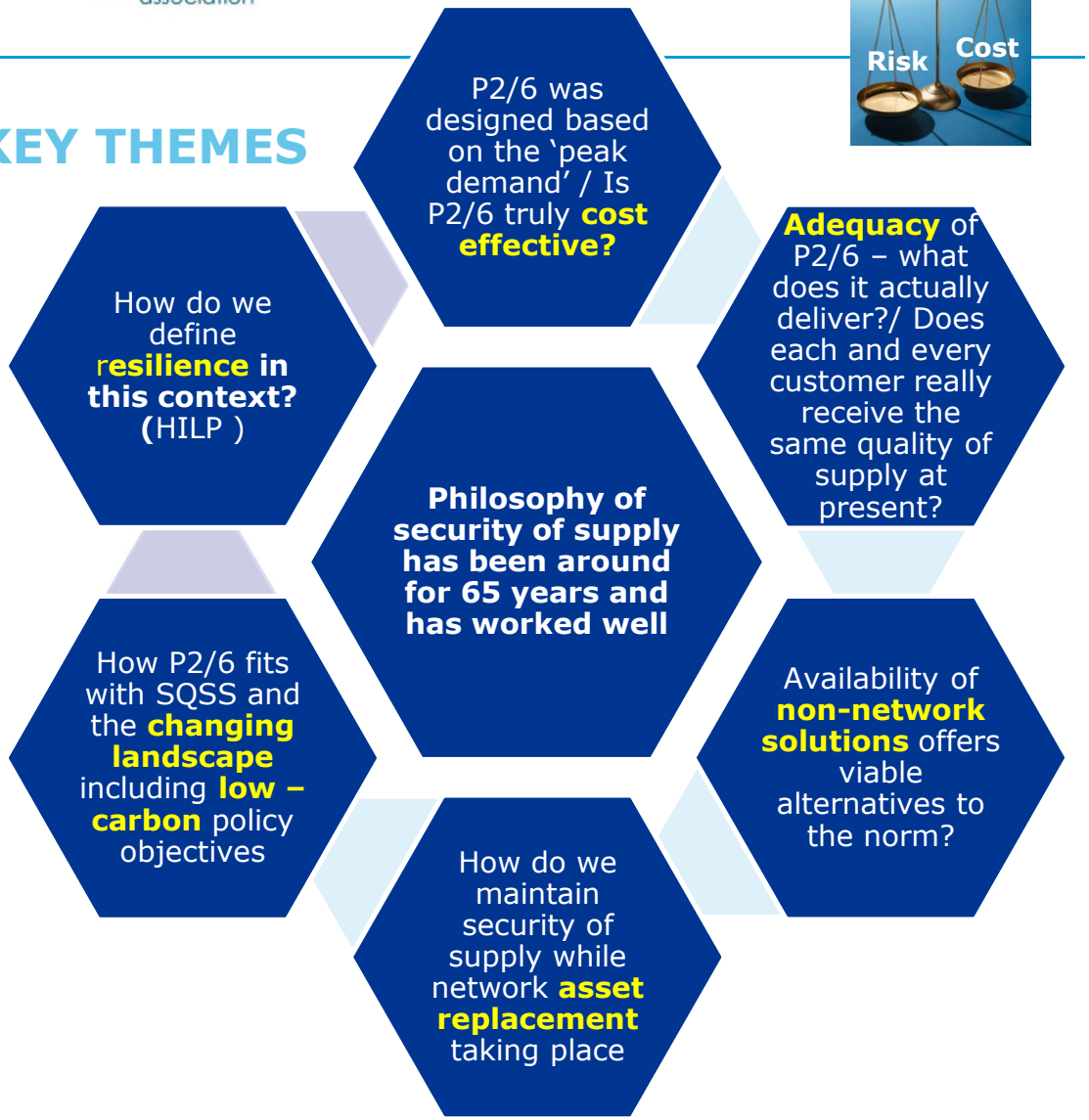
Themes and Principles

GUIDING PRINCIPLES

- A 'blank canvas' can offer a fresh perspective.
- Don't be afraid to challenge what has gone before.
- Recommendations must be evidence based.
- Must bring stakeholders along for the journey.
- Consult on and intepret the full ramifications of change before diving into it.
- Create something that lasts.

KEY THEMES



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Project Approach

The overall approach underlying the proposed work, in Phase 1 of the review, is to carry out a comprehensive research, modelling, engagement and consultation process.

LEGEND

1 Work Stream – Work Led by DNV GL

1 Work Stream – Work Led by Imperial College

1 Work Stream – Work Led by NERA

1 Work Stream – Work Led by all members of Consortium

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Techno-economic model (contributing factors)

TECHNICAL ASPECTS

- **Legacy planning and operations**
  - Outage management
  - Past events (and lessons)
  - What's in P2/6 for good reason?
  - Operational vs. planning tensions
  - Differences in interpretation
  - Demonstration of compliance
  - Deficiencies of P2/6
  - Capacity Mechanism & Balancing Service
- **Implications of smarter grids**
  - Energy storage
  - Impact of smart metering
  - Heat/Gas linkages
  - Electric vehicles
  - Changes in demand profiles
  - Demand side response
  - Monitoring and control
  - Generation mix
  - Islanding
  - Lessons arising from LCNF
  - Embedded Generation
- **External factors and interdependencies**
  - EU energy policy/network codes
  - Telecommunications
  - High impact low probability events
  - SQSS and National Grid
  - New market participants (e.g. DAs)

ECONOMIC ASPECTS

- **Economic landscape (existing and emerging)**
  - Cost of energy
  - Cost of distribution assets
  - Value of lost load
  - Cost of smart grids
  - Implications of new market structure(s) on financials
  - Value of a kW vs. a kWh
  - Impact of losses
- **Regulatory incentives and outputs**
  - Impact of RIIO
  - Impact of LCNF outputs on financial decisions
  - Load indices
  - DUoS arrangements
  - Interruptions incentives scheme
  - Areas for future innovation
- **New commercial arrangements**
  - Demand aggregators
  - 'Outsourcing network security to 3rd Parties
  - Quantifying the long term benefits
  - Public engagement
  - Unexplored domains

Key features of the techno-economic model

- We will model alternative planning and operational standards to perform quantitative cost benefit analysis
  - Modelling procedure estimates quantitative benefits of reforming P2/6

Modelling	Rationale/Procedure
Estimate the costs of "perfectly efficient" investment	• Optimise network operation and investment using cost, without imposing any formal planning standards at all • Estimate NPV power system costs
Represent investments prescribed by P2/6	• Estimate NPV power system costs associated with P2/6 • Comparison to the "baseline " shows potential savings of reform
Estimate the benefits of reforming P2/6	• Carry out investment modelling for alternative planning standards • We will identify where in the range between P2/6 costs and the baseline each case sits, to estimate the benefits of each possible alternative

factors (transparency, simplicity, ease of assessing compliance, etc.)

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P2/6 – Impact on Regulation, Codes and Schemes

Richard Druce

Imperial College London

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Alignment with other codes and schemes

- We will assess each proposal for reform of P2/6 for (in)consistency with various codes, schemes and regulatory/market arrangements

RIIO Framework

- Effective planning standards need to be backed-up by commercial incentives to invest efficiently
- Issues include (see following slide):
  - Replacement of losses incentive
  - IIS representation of interruption costs
  - Trade-offs between short-run and long-run costs and incentives for "smart"

Wholesale Trading Arrangements

Planning procedures need to account for behaviour of distributed technologies (storage, DSR etc.), and the impact on networks.

- The capacity mechanism and reformed from the balancing services SCR will alter the commercial incentives of distributed technologies to import/export power

Distribution Network Planning Standards

Network Charging

- Users' behaviour can be modified by tariff structures, so network planning needs to account for them
- Link to modelling: users may not make optimal trade-offs between energy consumption/ production and modifying behaviour to help minimise DNO costs

SQSS & EU Network Codes

- Possible conflicts between transmission and distribution planning standards
- Interface between transmission and distribution
- Need to account for changes imposed by EU policy
  - Hence, part of this assignment will be to review/analyse interactions with latest draft network codes.

Example: Interactions with RIIO framework

Revenue =

- Revenues are linked to delivery of outputs (safety, environmental impact, customer satisfaction, social obligations, connections, and reliability/availability)

+ Incentives

- Performance is incentivised through financial instruments (IIS, worst served customer), but are they appropriate/sufficient?
  - eg do the values placed on interruptions and minutes lost incentivise efficient investment?
- Financial incentives to trade-off operating (DSR etc) vs investment solutions.
  - Is totex-based IQI scheme sufficient?

+ Innovation

- Do obligations to consider “smart” solutions promote efficient uptake? Or just the bare minimum?
- Further developments of (and an expanded role for) a common appraisal framework?

+ Outputs

- Outputs based regulatory framework; remuneration depends on achievement of output standards
  - Following reform of P2/6, how will those outputs need to change?
    - Should the framework incentivise “improvements” in load, health and criticality indices?
    - Links to GSOP to define minimum levels of service
    - Obligation to reduce losses

P2/6 – Stakeholder Engagement

Colin MacKenzie

Stakeholder engagement process

- Designed into the project structure and central to its success
- To ensure the process of developing a revised standard is transparent
- To establish early buy-in from all relevant stakeholders
- To ensure industry consensus can be reached
- To give all stakeholders a chance to contribute to the outcome
- To make the implementation (following final recommendation) easier: as the rationale will be documented and clearly communicated

Stakeholder engagement activities

Work Stream	Activity
WS1	Industry briefing paper – who, why, how – what is required of them. Explaining why its necessary to ensure that risk vs. cost is reviewed at this juncture.
WS2	Stakeholder interviews – gather insights from different companies and different personnel (includes: DNOs, DGs, 3rd parties, Suppliers, NG, Ofgem, DECC etc.)
WS5	Stakeholder workshops to gain feedback on P2 options.
WS6	Go out to consultation on the options.
WS8	Make final recommendation visible, demonstrate what the work programme has delivered.
WS9	Brief industry on what will happen next (work programme).

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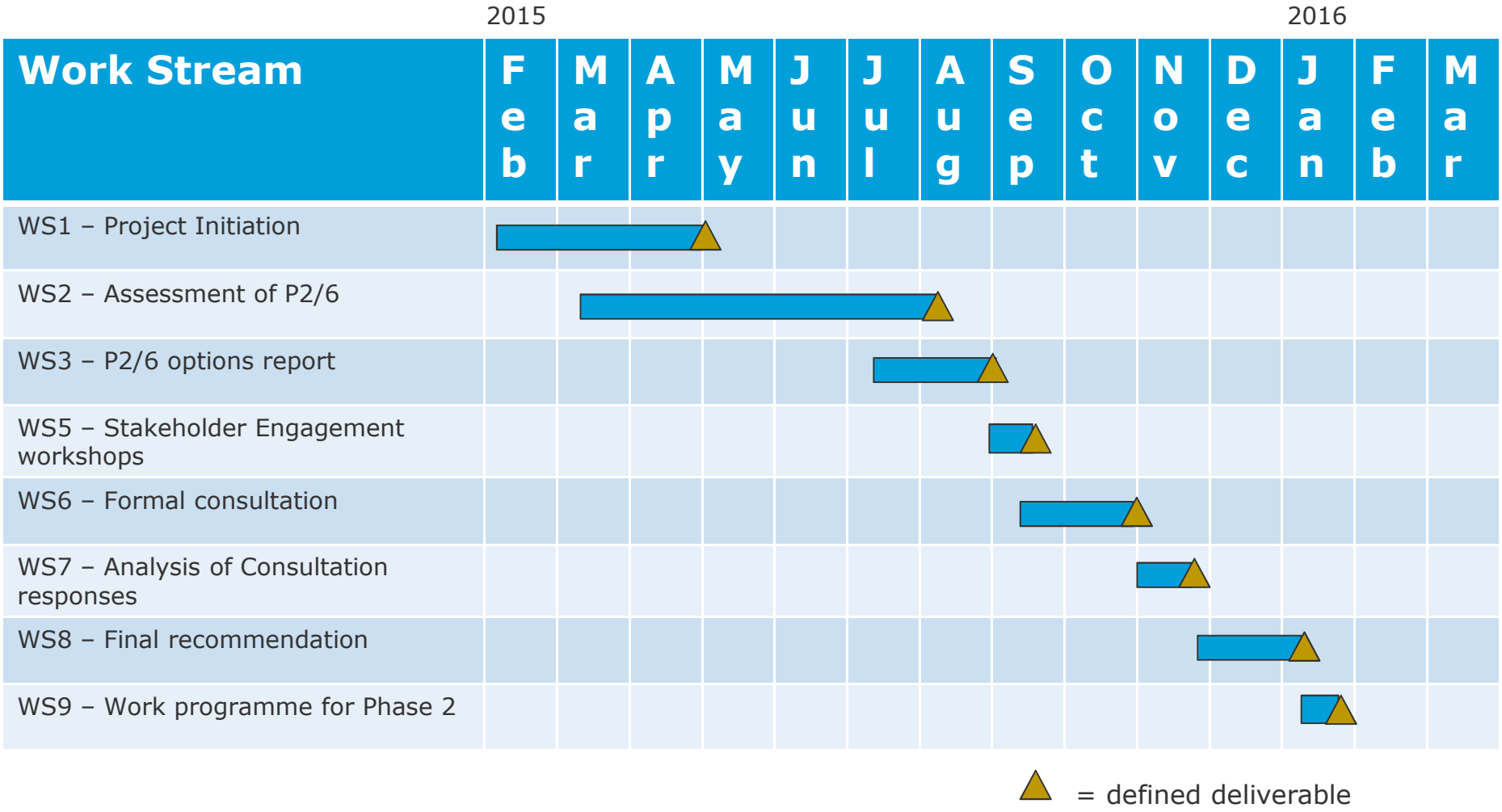
Delivery Programme



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Summary of Outputs

Work Stream	Deliverable(s)
WS1	Project Initiation Document, CBA (framework only), Industry briefing paper describing background and engagement activities.
WS2	Stakeholder interviews, Series of short reports covering techno-economic modelling inputs, 1st iteration of techno-economic model.
WS3	P2/6 options report.
WS4	Optional –2nd iteration of techo-economic model.
WS5	Stakeholder workshops and feedback update to options report.
WS6	Formal strategy consultation paper.
WS7	Collated consultation responses, Possible final iteration of techno-economic model.
WS8	Final project report.
WS9	Work programme for Phase 2.

PMO activity

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15:30	Close	Mike Kay

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P2/6 - Review of Analysis approaches, methods and modelling

Goran Strbac

Imperial College London

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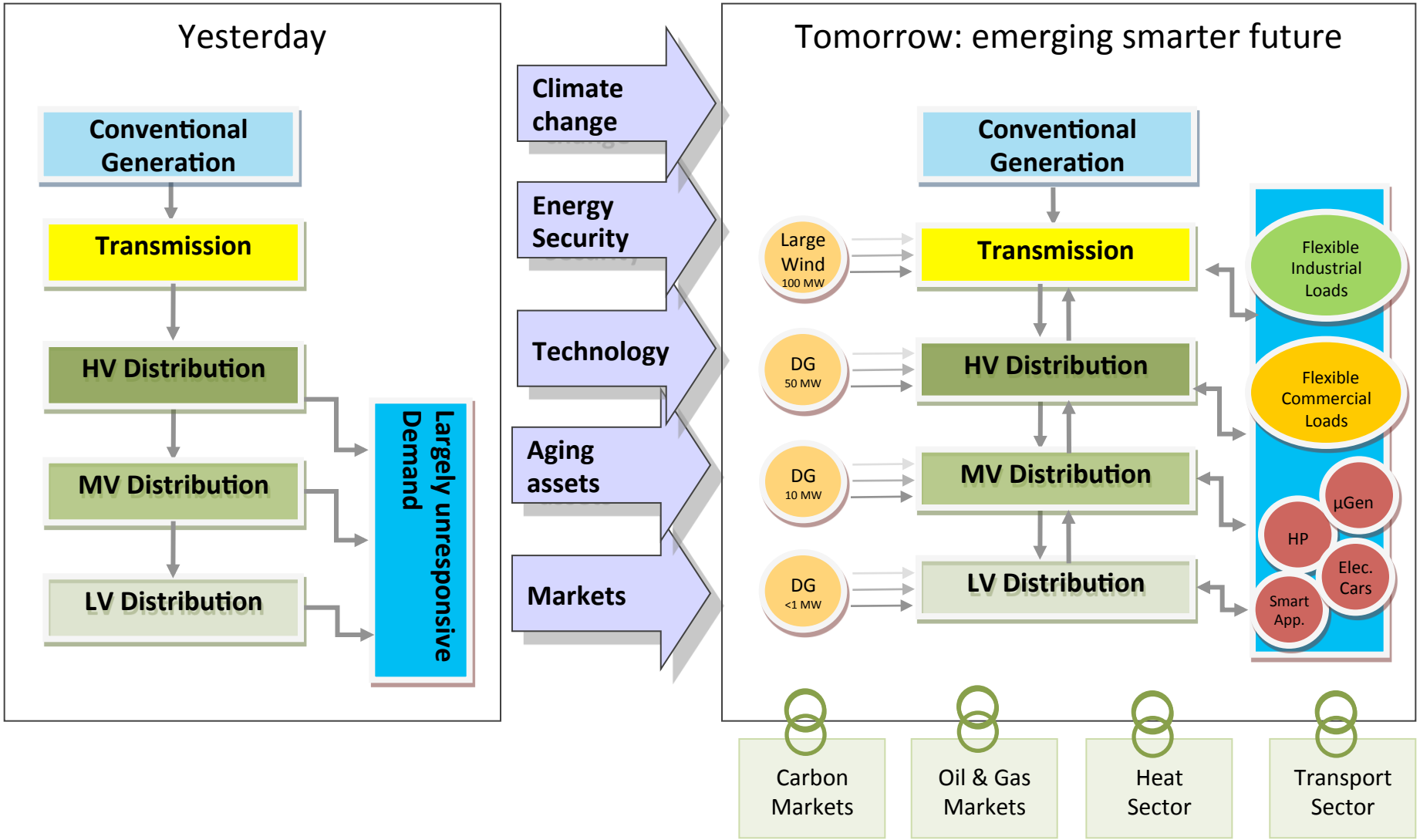
Research team

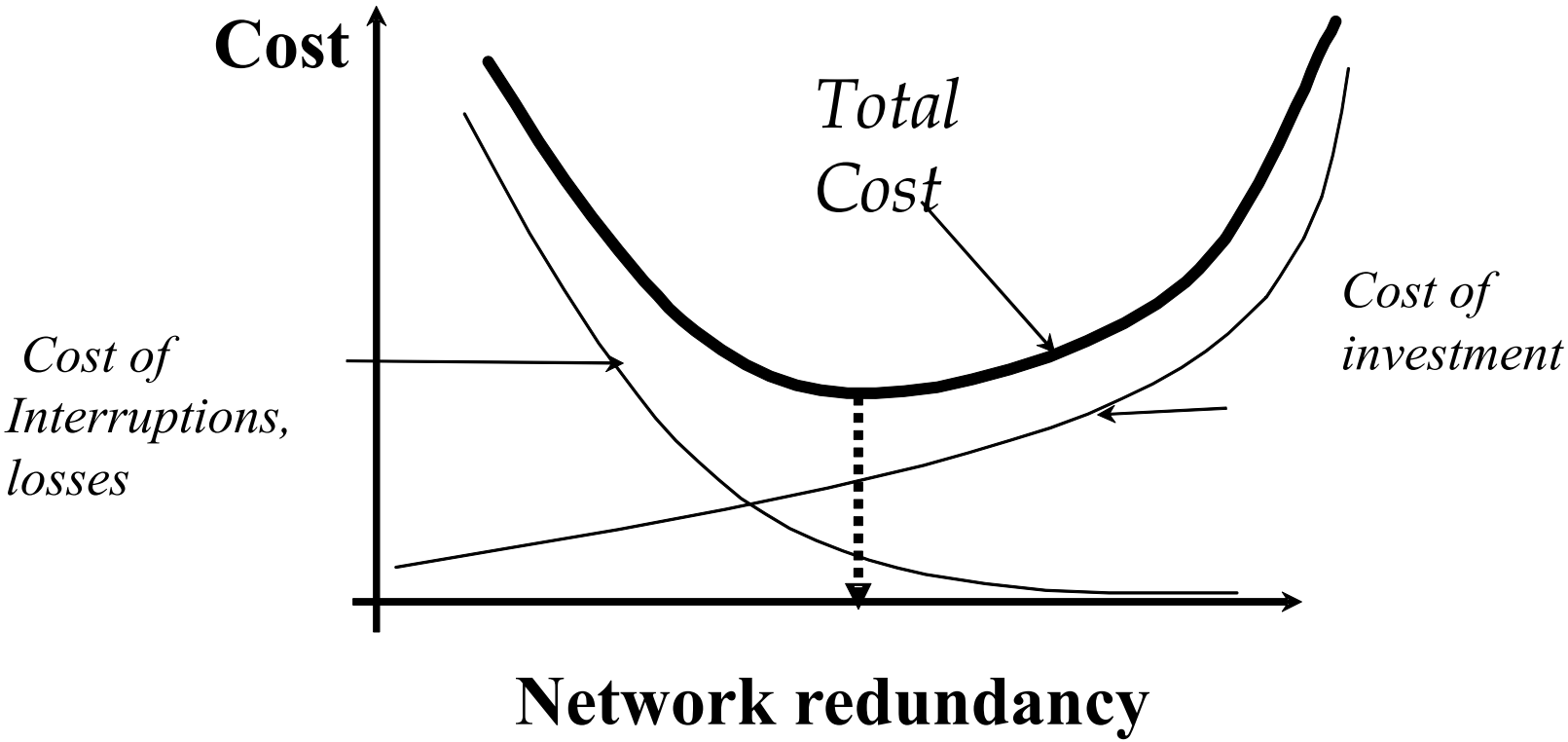
- Predrag Djapic
- Rodrigo Moreno
- Ioannis Konstantelos
- Sana Kairudeen
- Paola Falugi
- Goran Strbac

Challenges of unprecedented proportions



Optimal level of security?
Back to fundamental principles - CBA

- Trade-off
  - Cost of interruptions of supply
  - Cost of additional investment

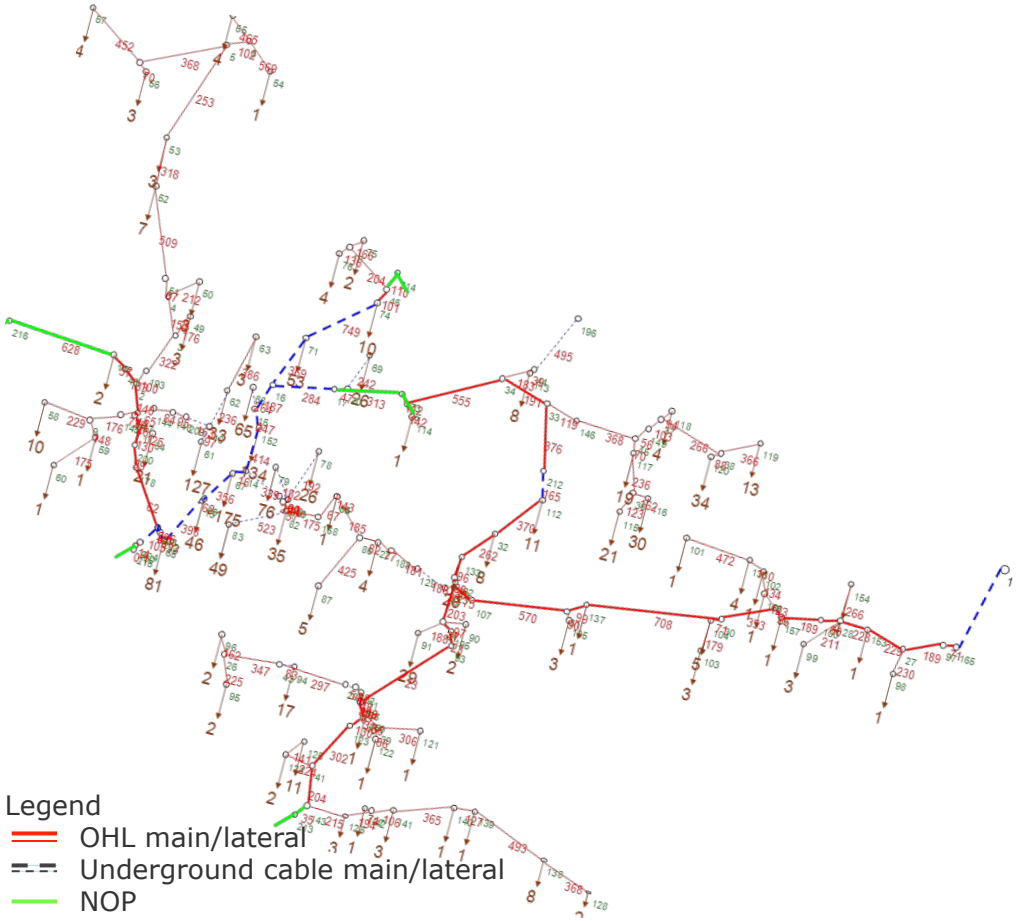


Need for cost-benefit framework

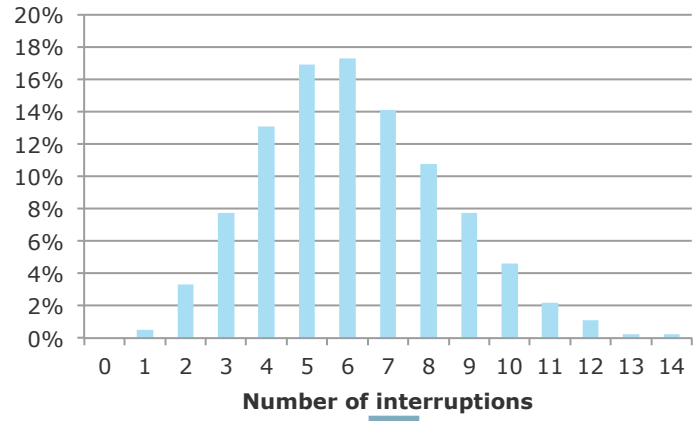
- Risk-based approach to security assessment will inform investment decisions process
- A measure of risk can account not only for the probability of an undesirable outcome, but also for the consequences of such outcome. This can only be achieved within a probabilistic framework.
- Probabilistic framework provides an opportunity for a range of alternative and non-traditional reliability enhancement measures to be considered
  - This should, in the long term, lead to an improved network reliability profile at lower costs.

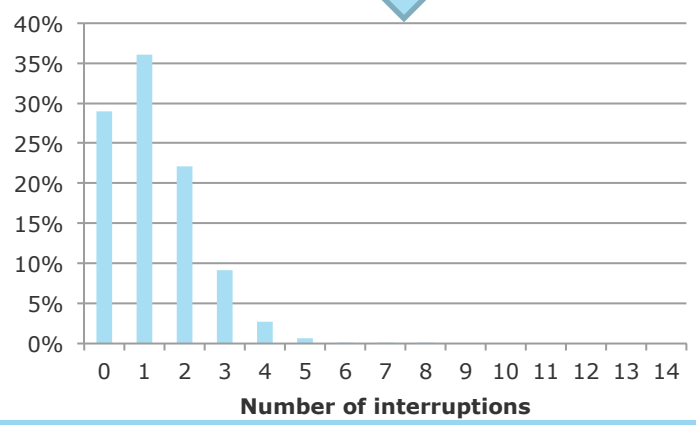
Does P2/6 deliver the same level of security to each and every consumer?

Improving performance through automation

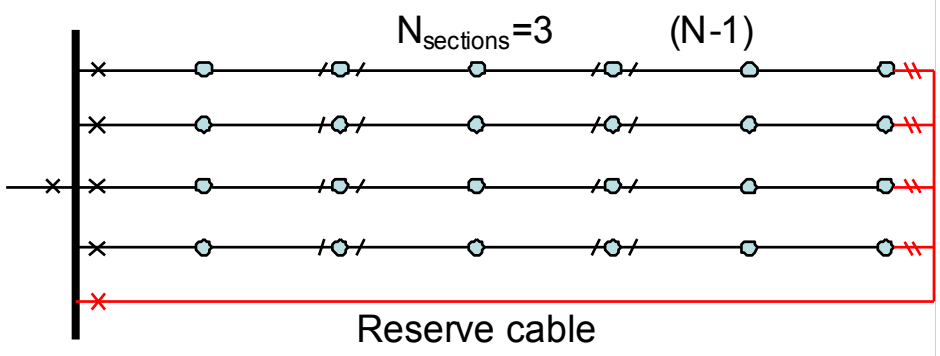


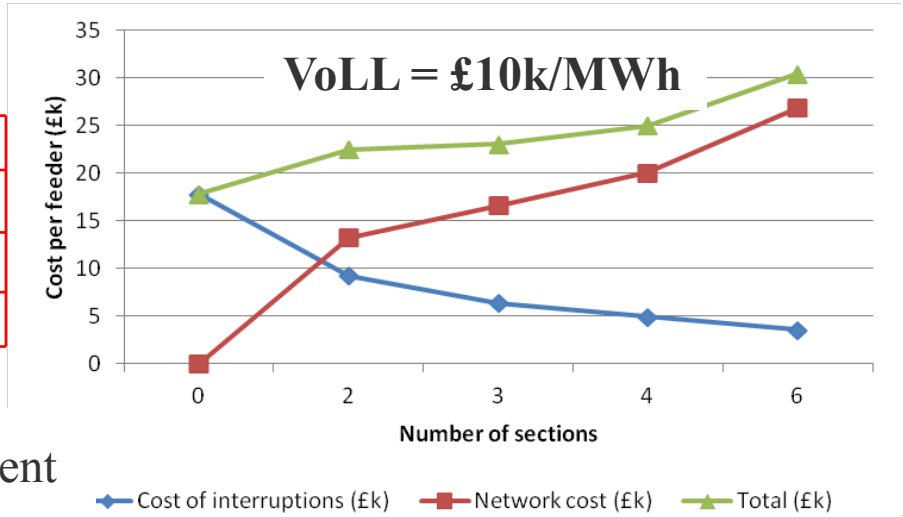
Legend
- OHL main/lateral
- Underground cable main/lateral
- NOP
- Distribution transformer
- 17 Number of consumers
- 297 Section length (m)
- 95 Node index

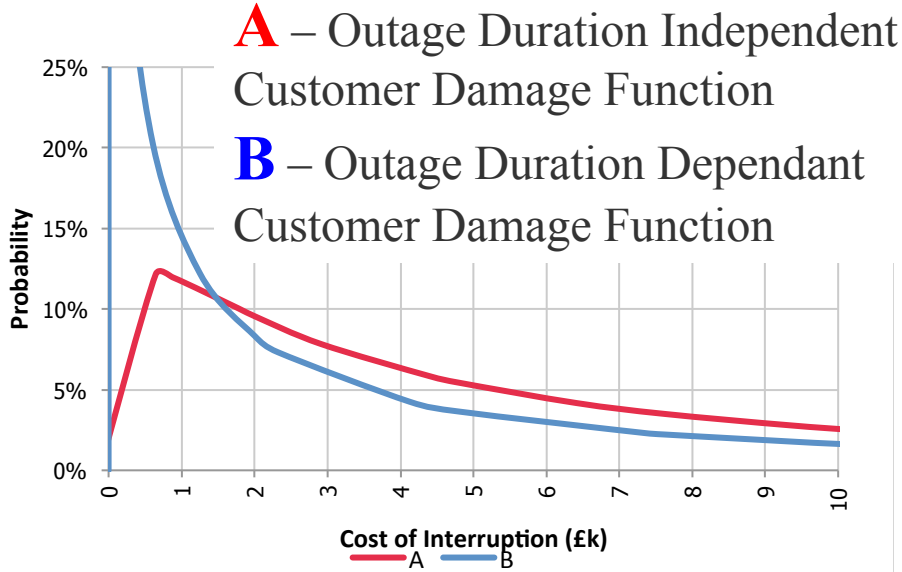


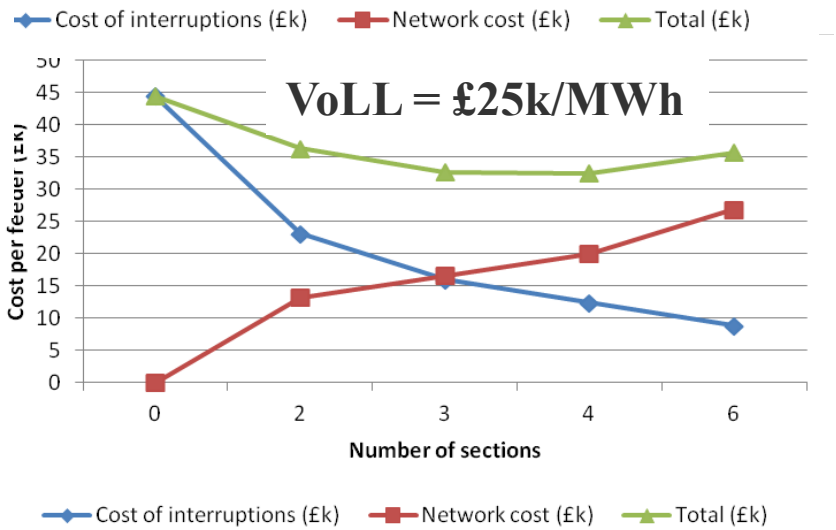


Is P2/6 cost effective?
Case for increasing LV network redundancy

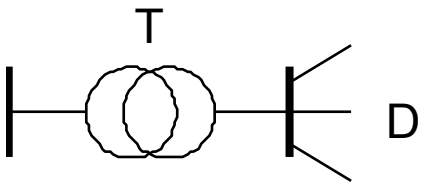




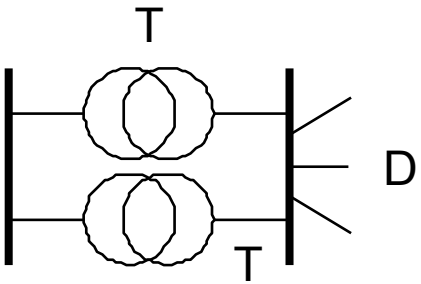




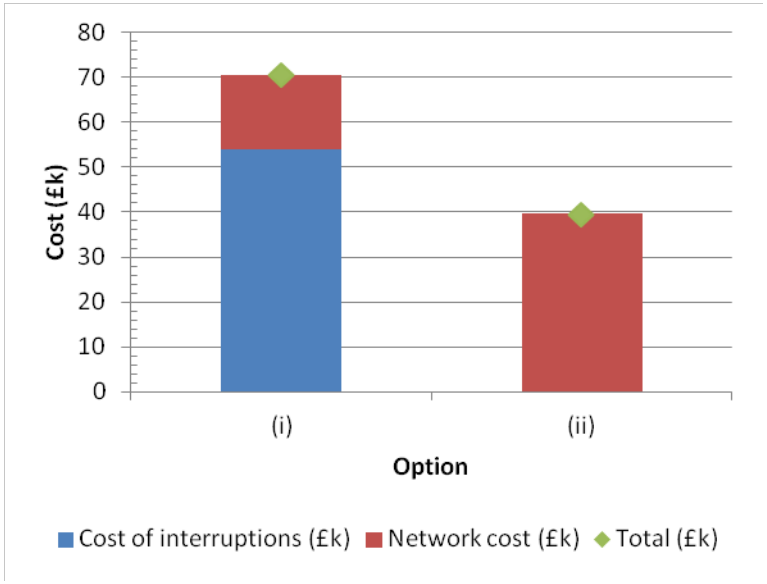
Is P2/6 cost effective?
Redundancy in Secondary Substations



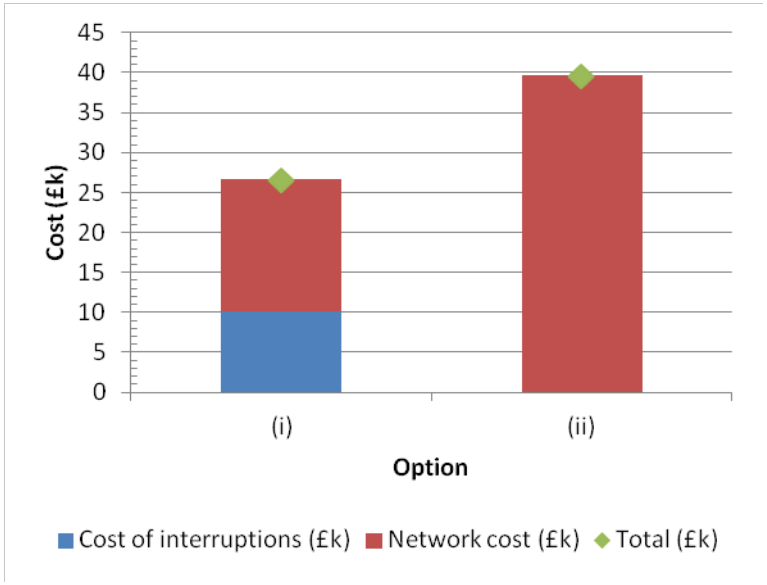
(i) (T=D)



(ii) (T=D)

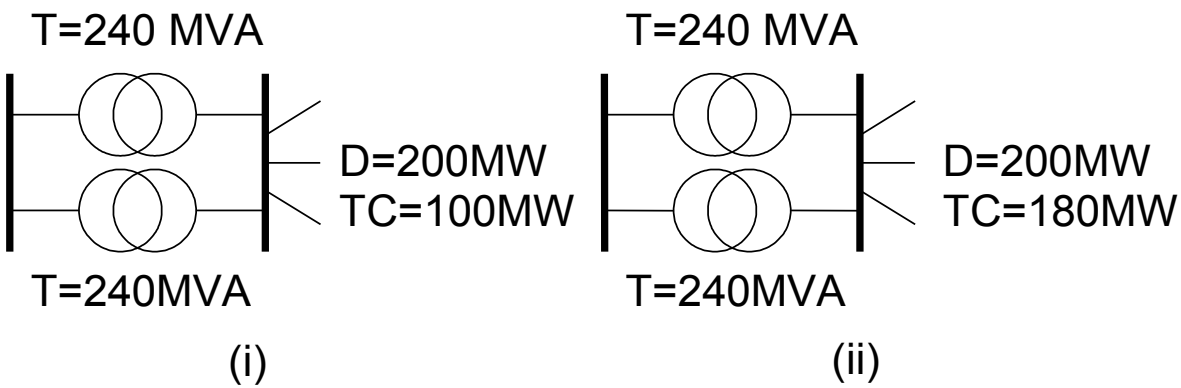


- Repair/replacement time = 20 hours



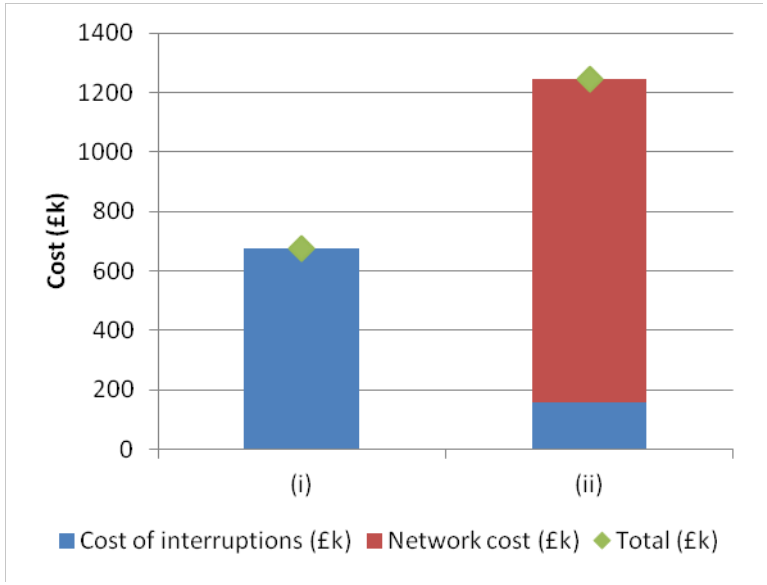
- Repair/replacement time = 3 hours

Management of construction outages

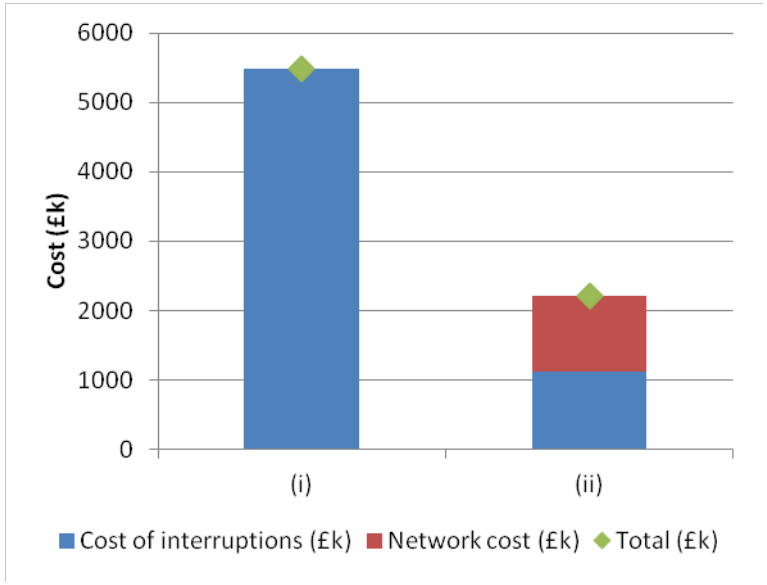


Provisional supply options

- (i): no provisional supply; Transfer Capacity ***TC=100MW***
- (ii): provisional capacity of 80 MW; total Transfer Capacity ***TC=180MW***



- Construction outage duration - 4.5 days



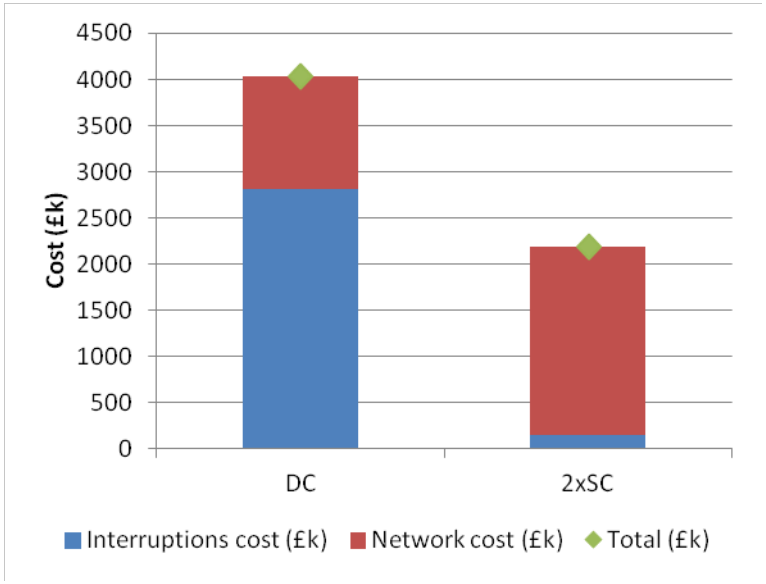
- Construction outage duration - 1 month

Common-mode failures

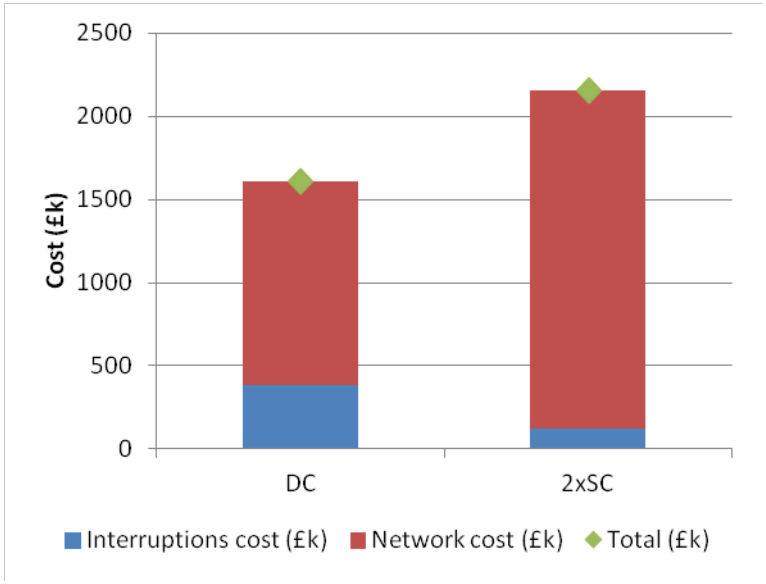
11 kV
2x10 MVA

D = 10MW

Design Options: Single Circuit (SC) or Double Circuit (DC)?

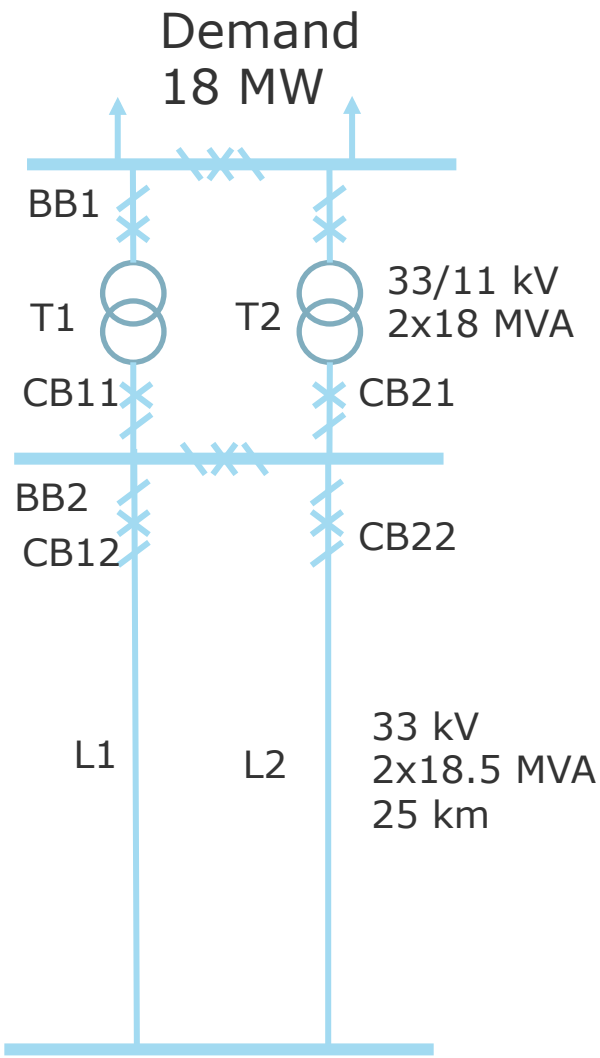


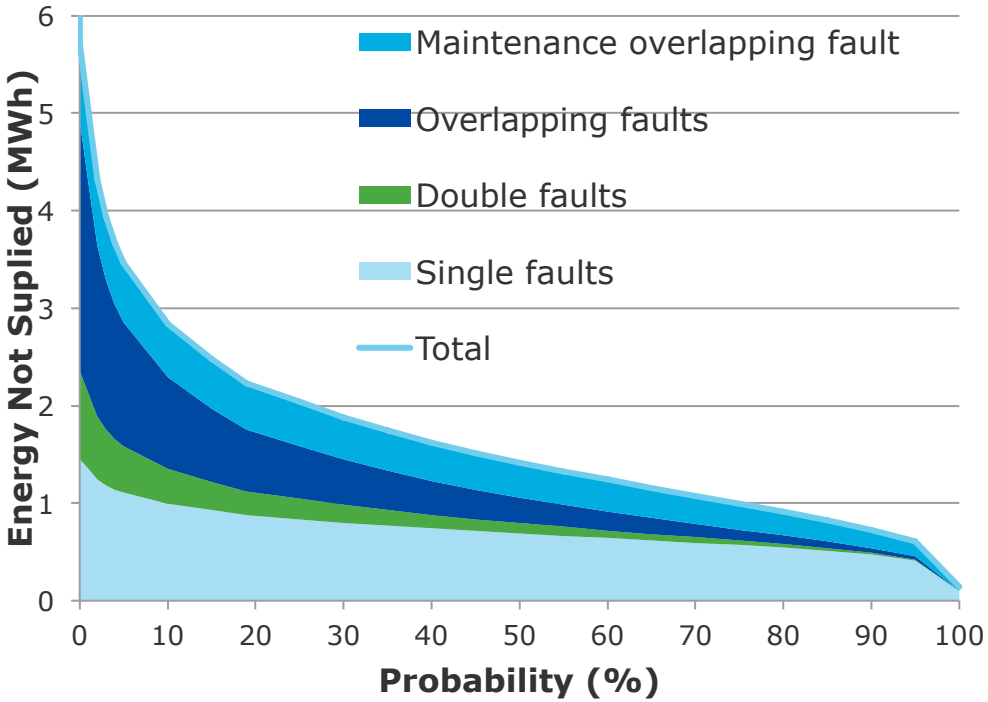
- 10% common-mode faults



- 1% common-mode faults

Risk profile of Security of Supply

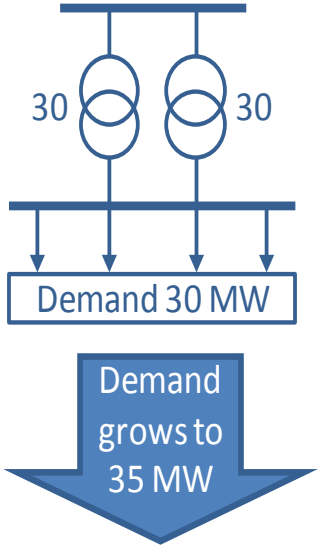


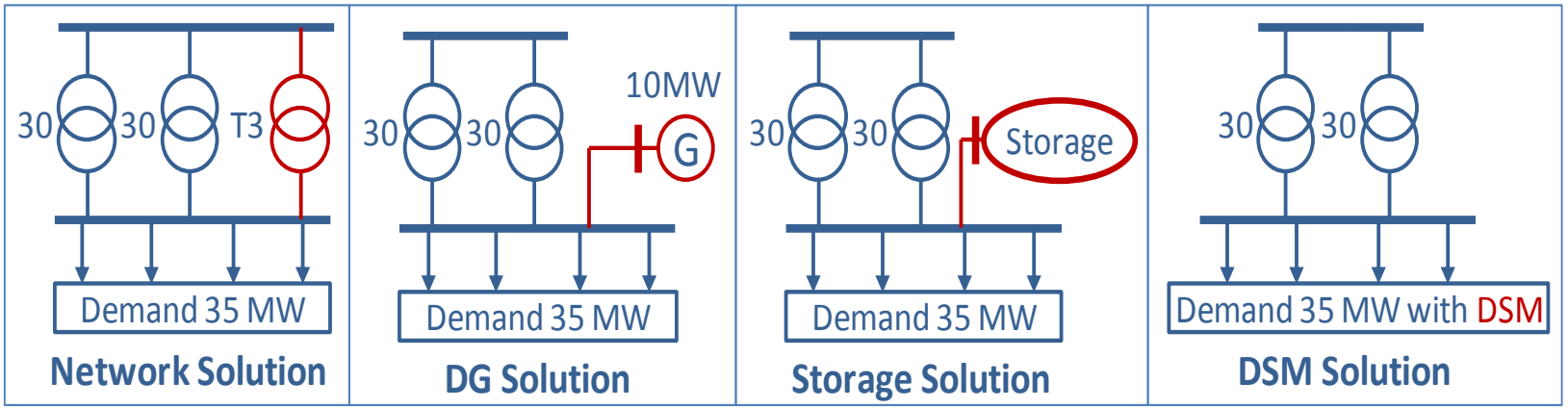


- Expected energy not served = 1.5 MWh, there is 5% risk of energy not served exceeding 6.5 MWh
- Informing plans for HILP events

Non-network solutions dealing with network problems

Can you really trust non-network solutions?

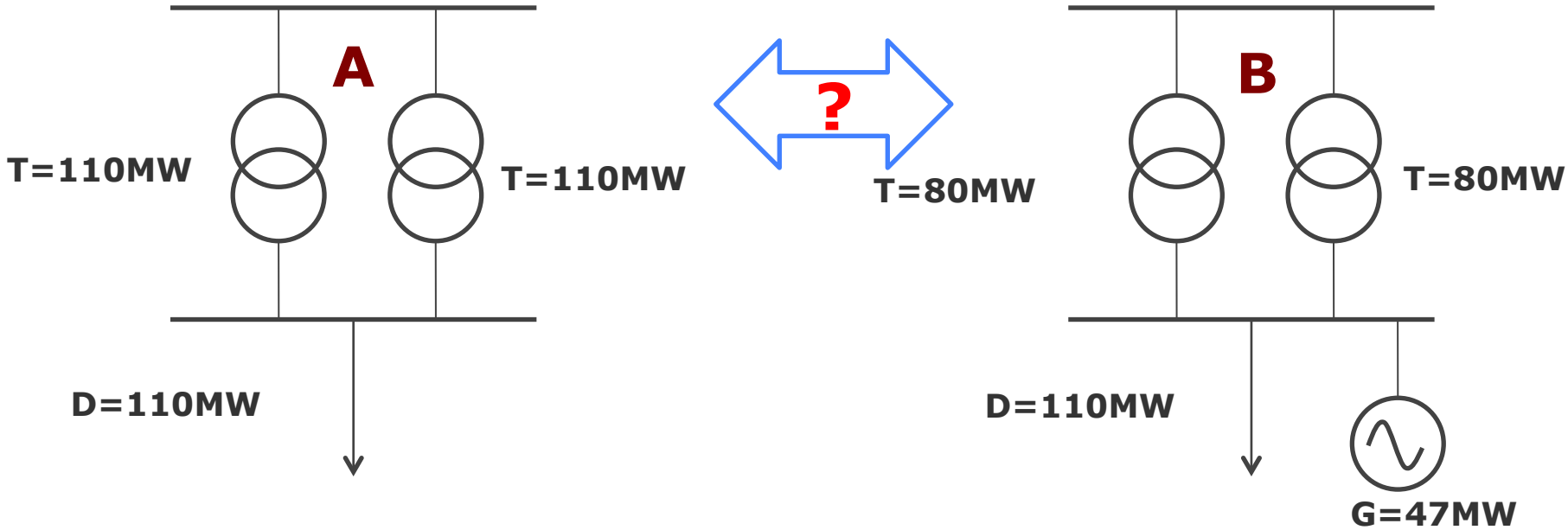




OK ? ? ?

Expected performance and Risk profile

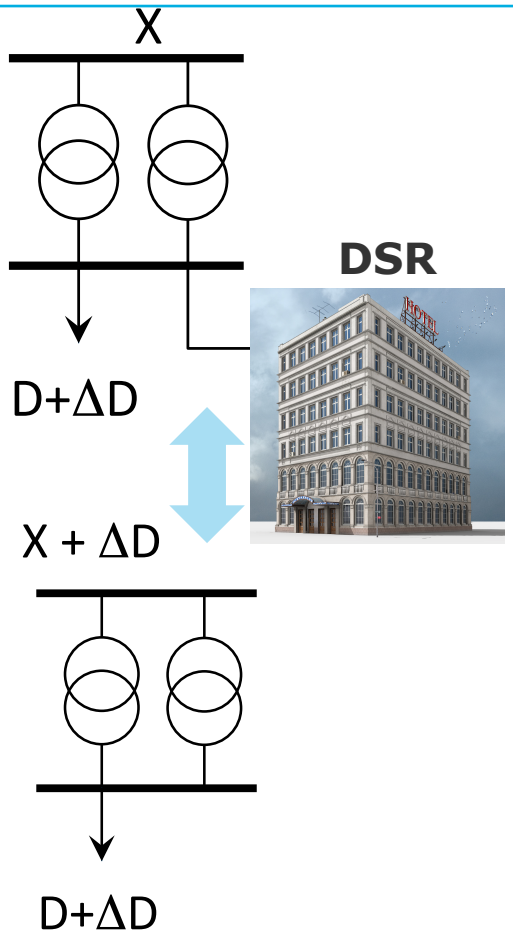
Two designs that are P2/6 compliant: How do they really compare?

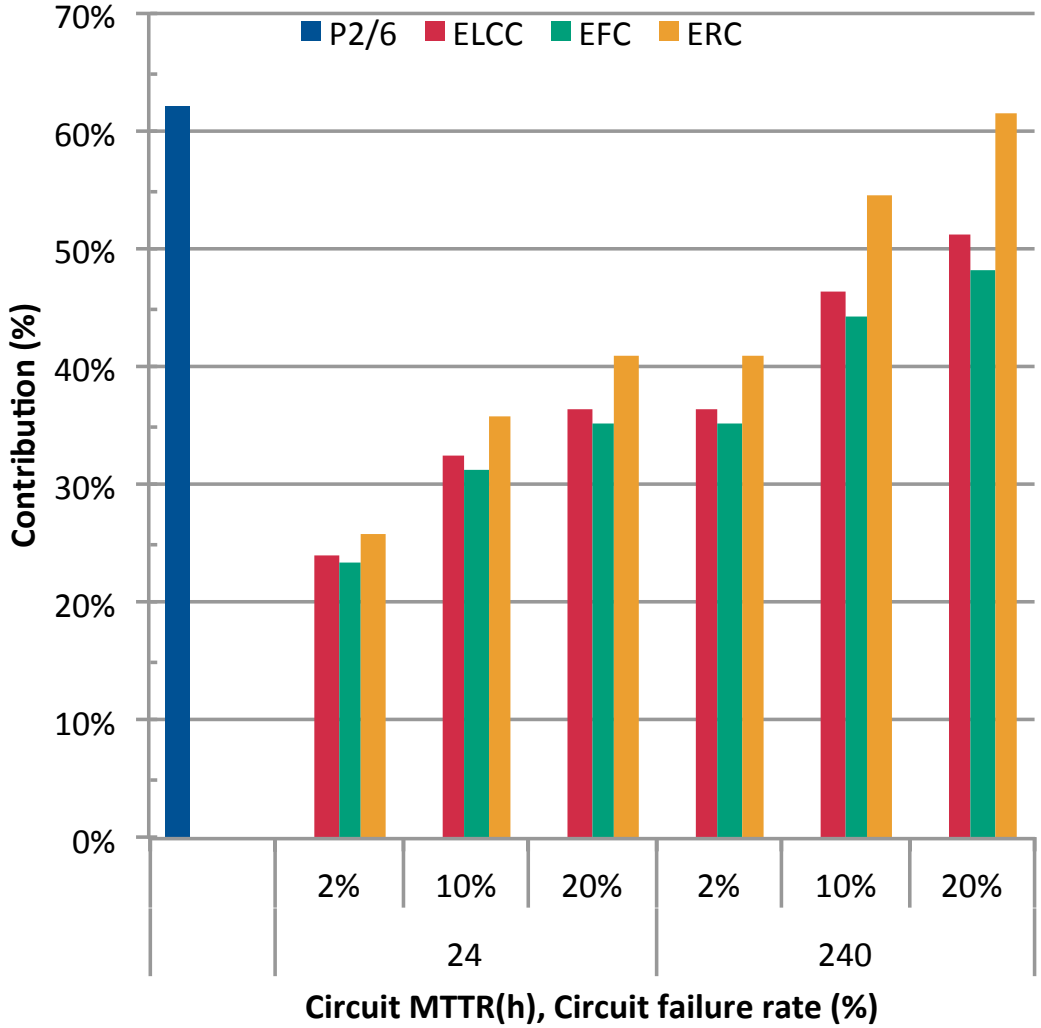


(1) *Expected* outage cost of solution A 35% lower than that of solution B

(2) *Worst-case* outage: A is potentially 5 times more risky than B

Contribution to security of supply:
Demand Side Response



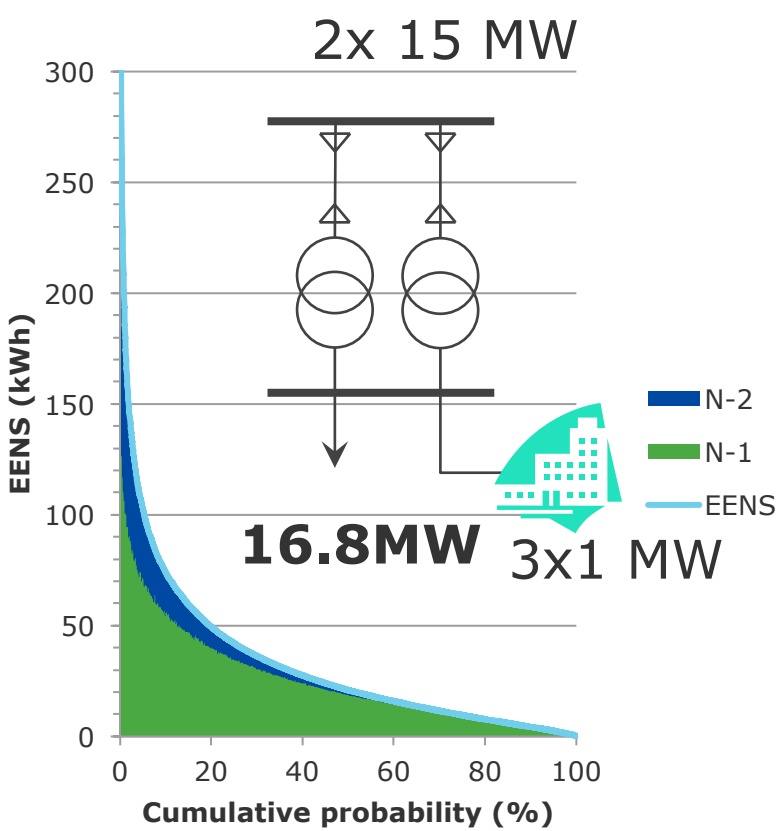


Reliability delivered by DSR against network reinforcement ?

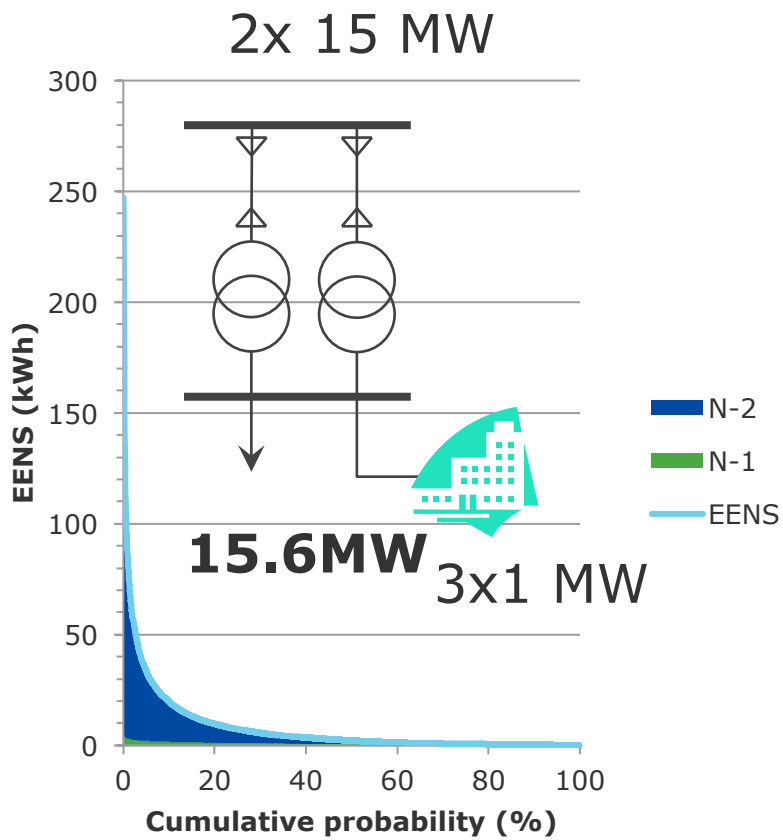
Approaches to assessing contribution of DSR to security of supply

P2/6

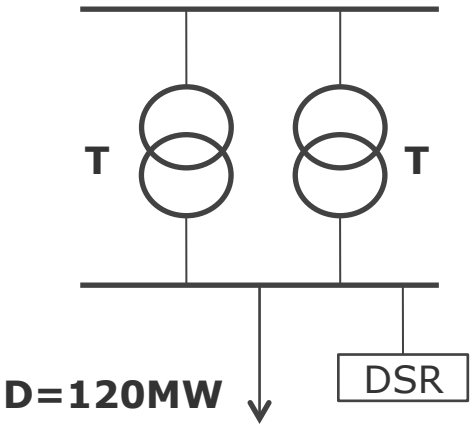
Contribution 60%



Effective Firm Contribution contribution 20%

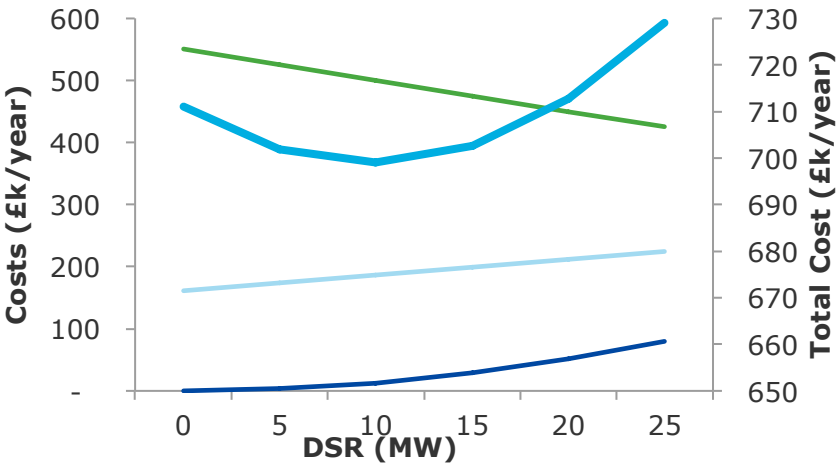


Cost Benefits Analysis of Demand Side Response

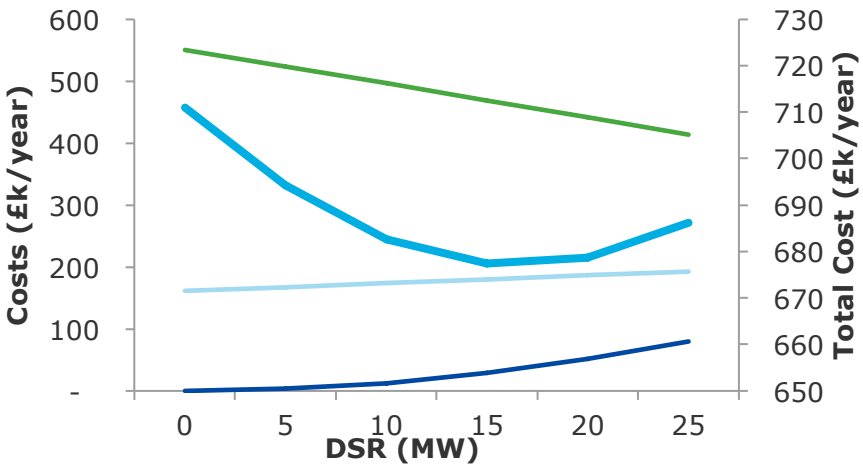


EENS cost
Substation cost
DSM cost
Total cost

DSR – single unit

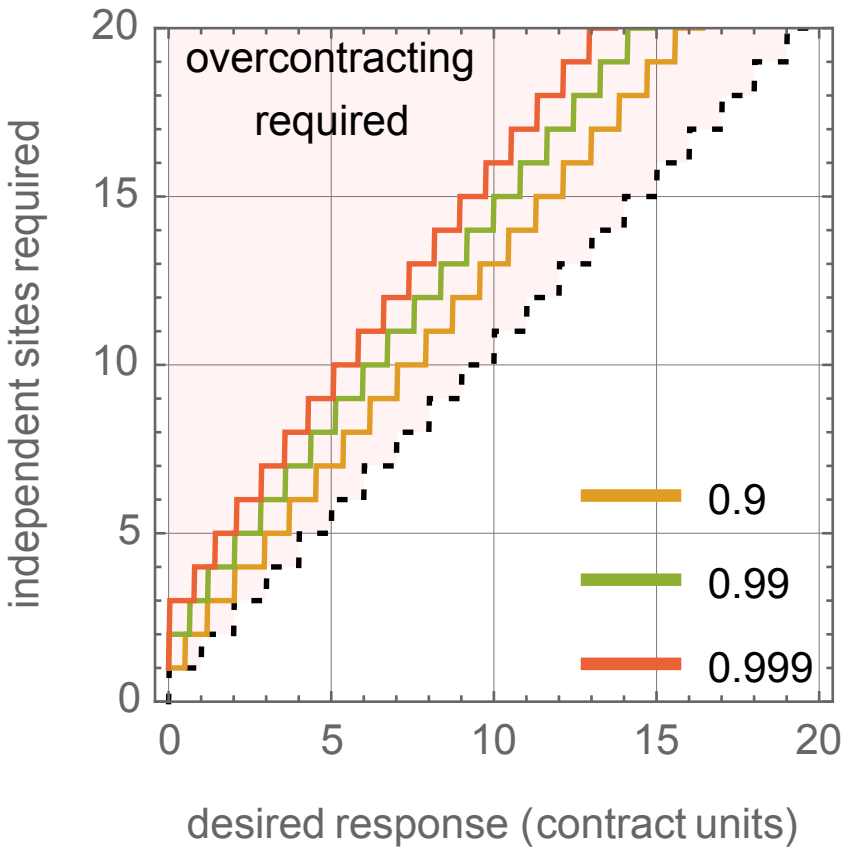


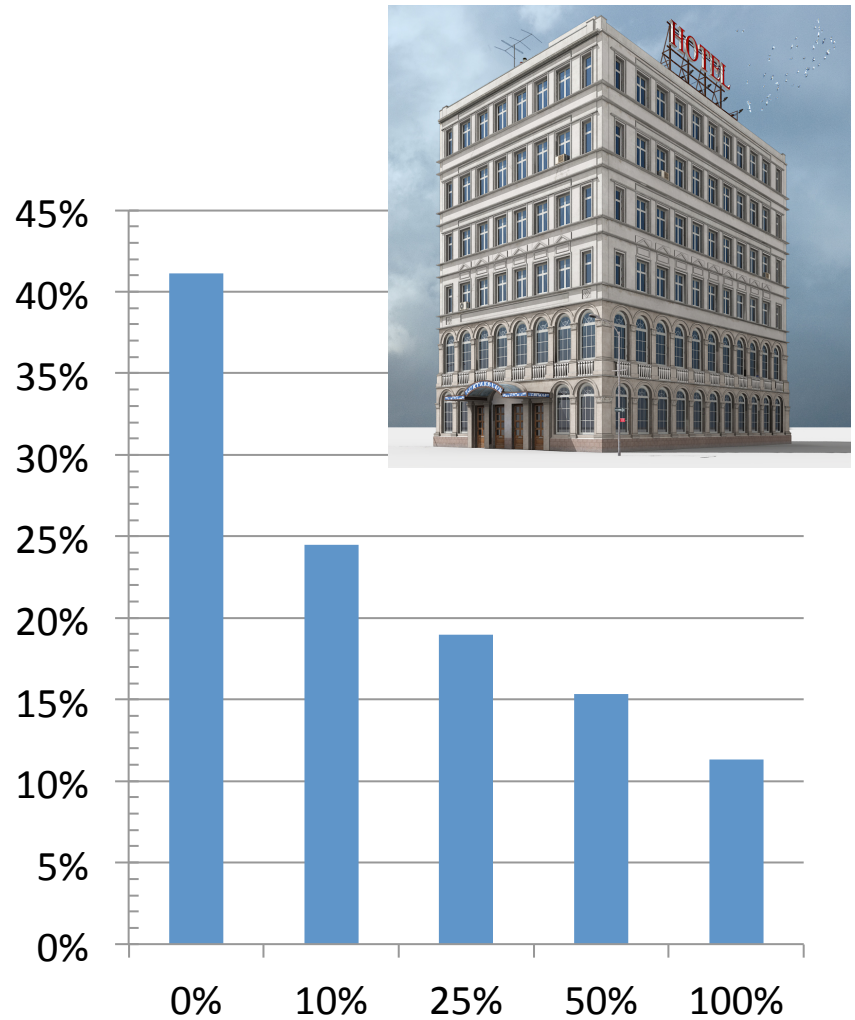
DSR- multiple units



Risk profile of smart solutions
Redundancy and Common mode failures

Redundancy to increase robustness

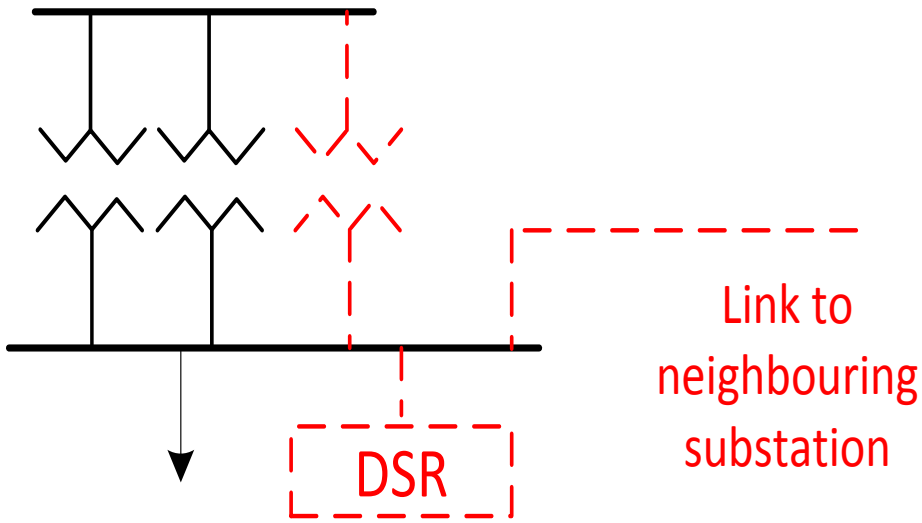


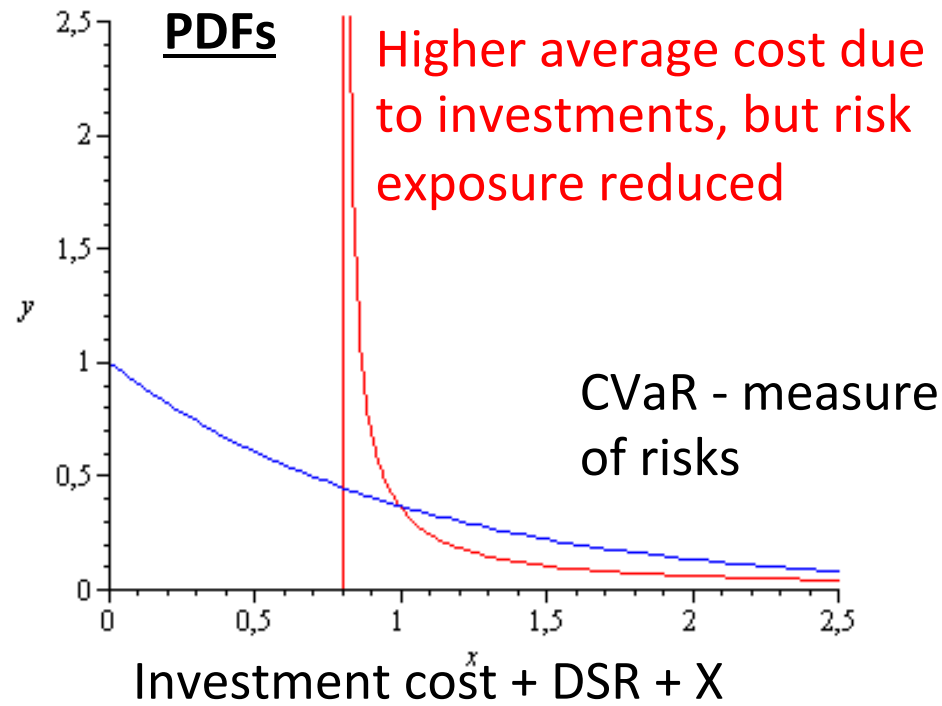


Common mode failure

Dealing with HILP – *Portfolio of solutions*

DSR or network reinforcement, or both ?





(1) Average cost approach:

- DSR - no need for network reinforcement
- How about exposure to ICT failures?

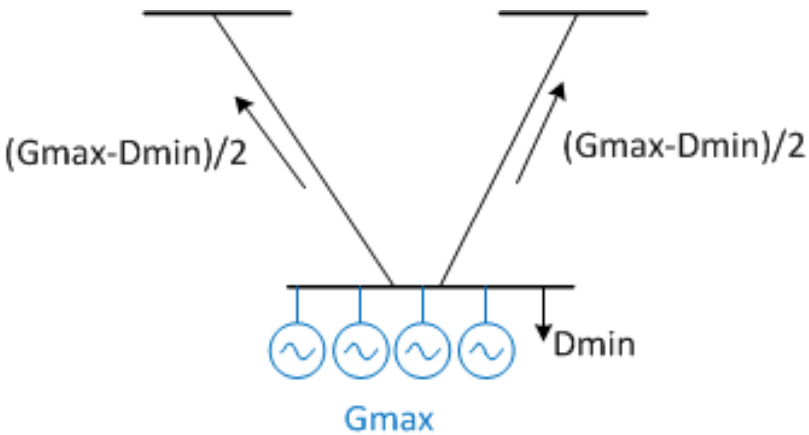
(2) CVaR approach:

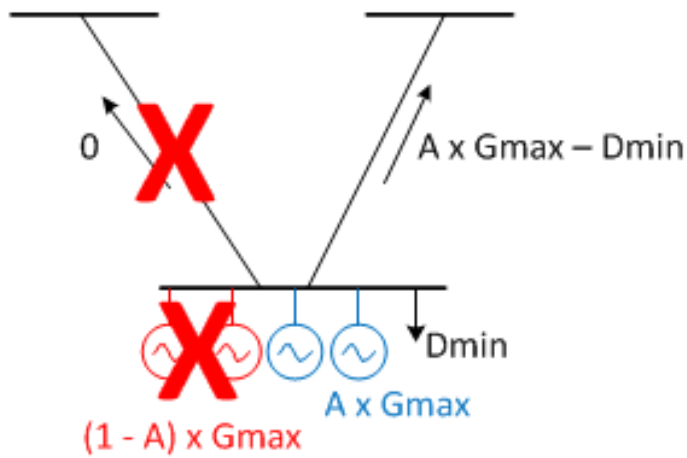
- ***Portfolio***: both DSR and network solutions
- Lower exposure for HILP

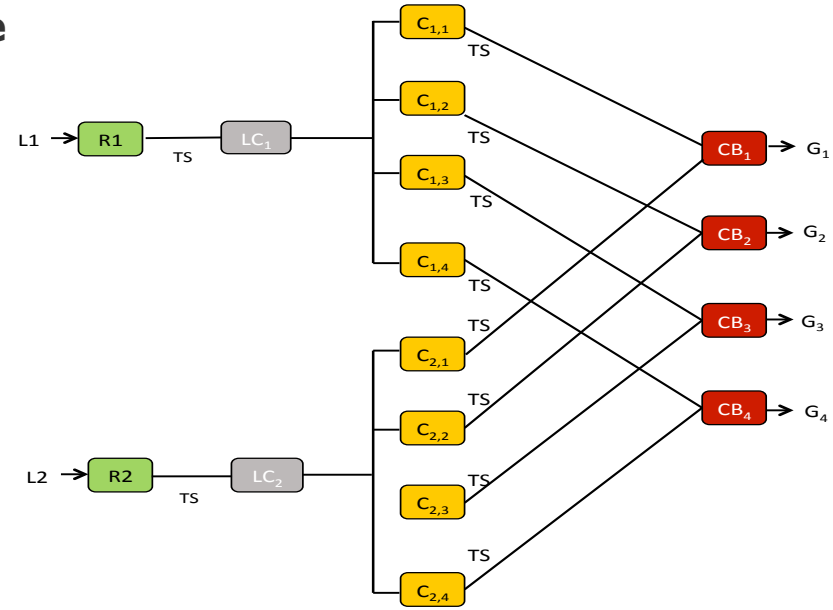
Generation driven network investment: corrective control

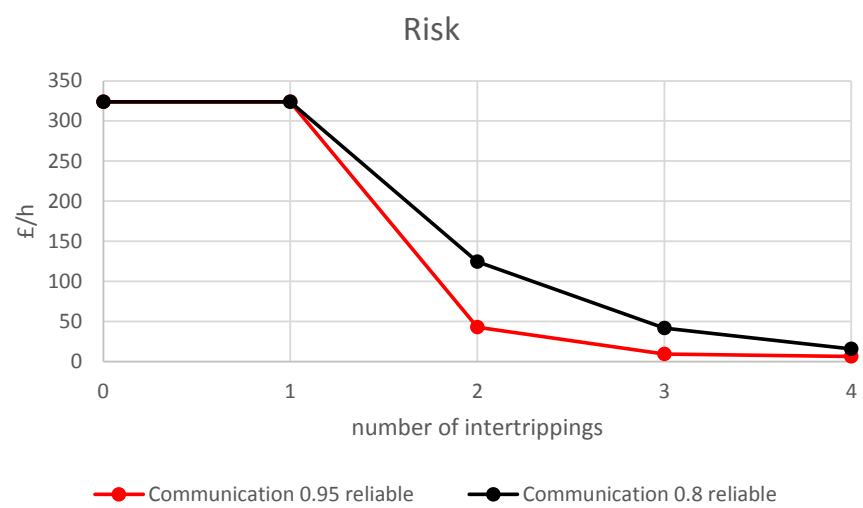
N – 1 secured through network infrastructure

N – 1 secured partially through inter-trips?

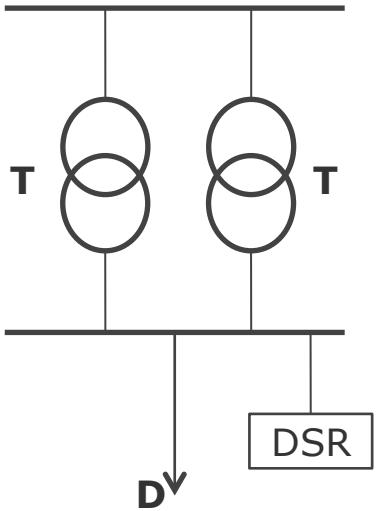






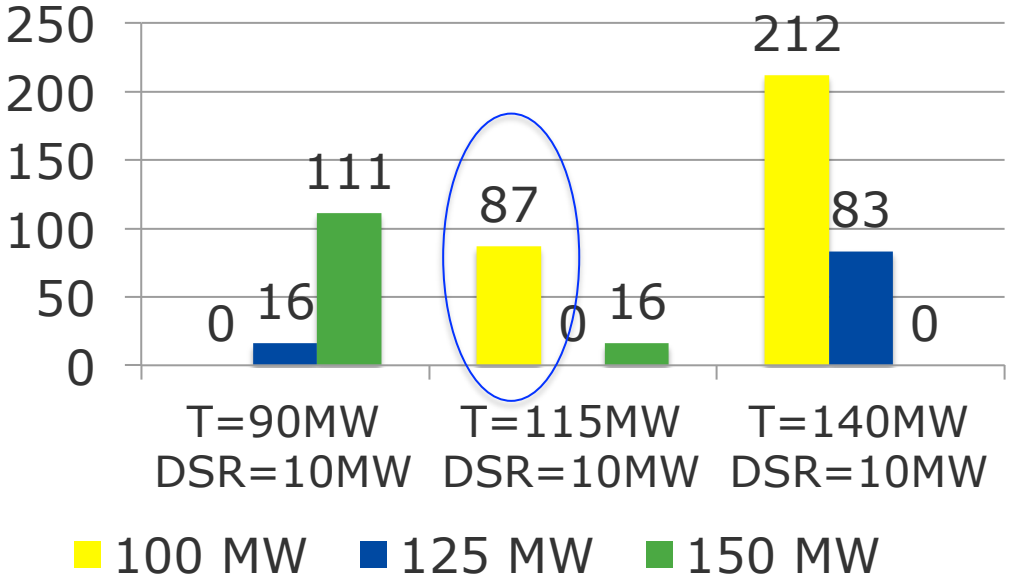


Planning under uncertainty ?



Three future peak demand scenarios:
100MW, 125MW, 150MW

What ratings of transformers and portfolio of DSR contracts will be cost effective?

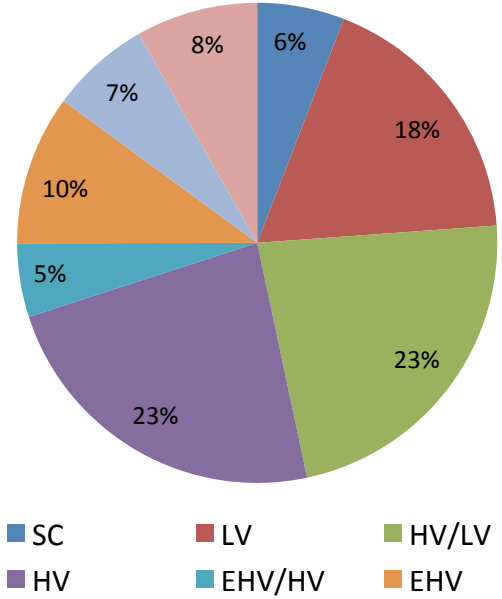


For each of the scenarios determine optimum design plan:

- **Find regret associated with each plan across all scenarios**
- **Choose solutions that minimises max regret**

Loss inclusive network design

About 50% -70% of network losses are in HV and LV networks



UG Circuit	Peak Utilisation (%)	Ratio of peak capacity and peak demand
LV	12 - 25	4.0 – 8.3
HV	14 - 27	3.7 – 7.1
EHV	17 - 33	3.0 – 5.9

-Present minimum asset cost approach to network design will increase costs to future consumers

- GB Distribution network losses above the economic value

- **Whole-systems approach joining energy, emissions & distribution network design needed**
- **Strategic versus incremental**

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Workshop Agenda

10:00	Registration	
10:30	P2/6 Review Presentation • Background • Governance • Project scope and definitions	Mike Kay Colin MacKenzie Richard Druce
11:30	Coffee	
12:00	Analysis approaches, methods and modelling	Goran Strbac
13:00	Lunch	
14:00	Panel Session - Question and Answers	Mike Kay Colin MacKenzie Goran Strbac Richard Druce
15:00	Concluding Remarks	Mike Kay
15:30	Close	Mike Kay

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Panel Session

Mike Kay
Colin MacKenzie
Goran Strbac
Richard Druce

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High Level Questions

Question 1

- What should be the key features of a new "P2/7"?

Question 2

- What are the pros and cons of removing P2/6 altogether?

Question 3

- What interactions do you see between P2/6 and other regulations and industry codes?

Question 4

- How do we understand how customers value security, do customers need greater security now compared with 10 years ago, will there be greater dependency in the future e.g. through electrification of transport

Question 5

- Will there be an impact from the deployment of smart meters on network security?

Question 6

- Approach for engagement with stakeholders

Question 1

- **What should be the key features of a new "P2/7"?**

- May wish to consider:
  - To better encourage the use of smart/innovative grid technologies
  - To better reflect the changing nature of distribution systems, for example more embedded/small scale generation
  - To better account for consumers' willingness to pay for enhanced reliability
  - Are there lessons we can learn from planning standards in other jurisdictions?
  - Others

Question 2

- **What are the pros and cons of removing P2/6 altogether?**

- May wish to consider:
  - Are the DNOs' regulatory incentives, plus the ability to contract with customers for the reliability they want, sufficient for ensuring efficient network design?
  - Would other obligations or regulatory mechanisms be necessary, eg an obligation to perform a CBA for network enhancements/expansions?
  - What has happened in other jurisdictions where planning standards have been removed?
  - Others

Question 3

- **What interactions do you see between P2/6 and other regulations and industry codes?**

May wish to consider:

- RIIO
- SQSS
- Treatment and impact of losses
- EU Network Codes
- Wholesale trading arrangements
- Low carbon subsidies
- Capacity mechanism
- Others

Question 4

- **How do we understand how customers value security?**
- **Do customers need greater security now compared with 10 years ago, will there be greater dependency in the future?**

May wish to consider:

- electrification of transport
- greater reliance on electricity
- Increased embedded generation
- local markets
- willingness to pay
- Others

Question 5

- **Will there be an impact from the deployment of smart meters on network security?**

- May wish to consider:
  - use of DSR
  - use of DSM
  - additional network data
  - improved understanding of demand characteristics
  - Other

Question 6 - Engagement

- **Stakeholder Questions**

- How could on-going communications be improved during the project?
- Have we missed anything?

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Closing Remarks

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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.

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Thank you for your attendance and participation

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