



Probability, Reason and Customers

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Connecting the North West



£12 billion of network assets



4.9 million



2.4 million



25 terawatt
hours



Living and working in the North West



The UK's second city

The world's greatest football club



One of the UK's busiest airports

World class universities



Transport systems

£1m investment every day 2015-23



The role of probability analysis



The world is uncertain !

Factors beyond our control influence our actions.

Change seems ever present

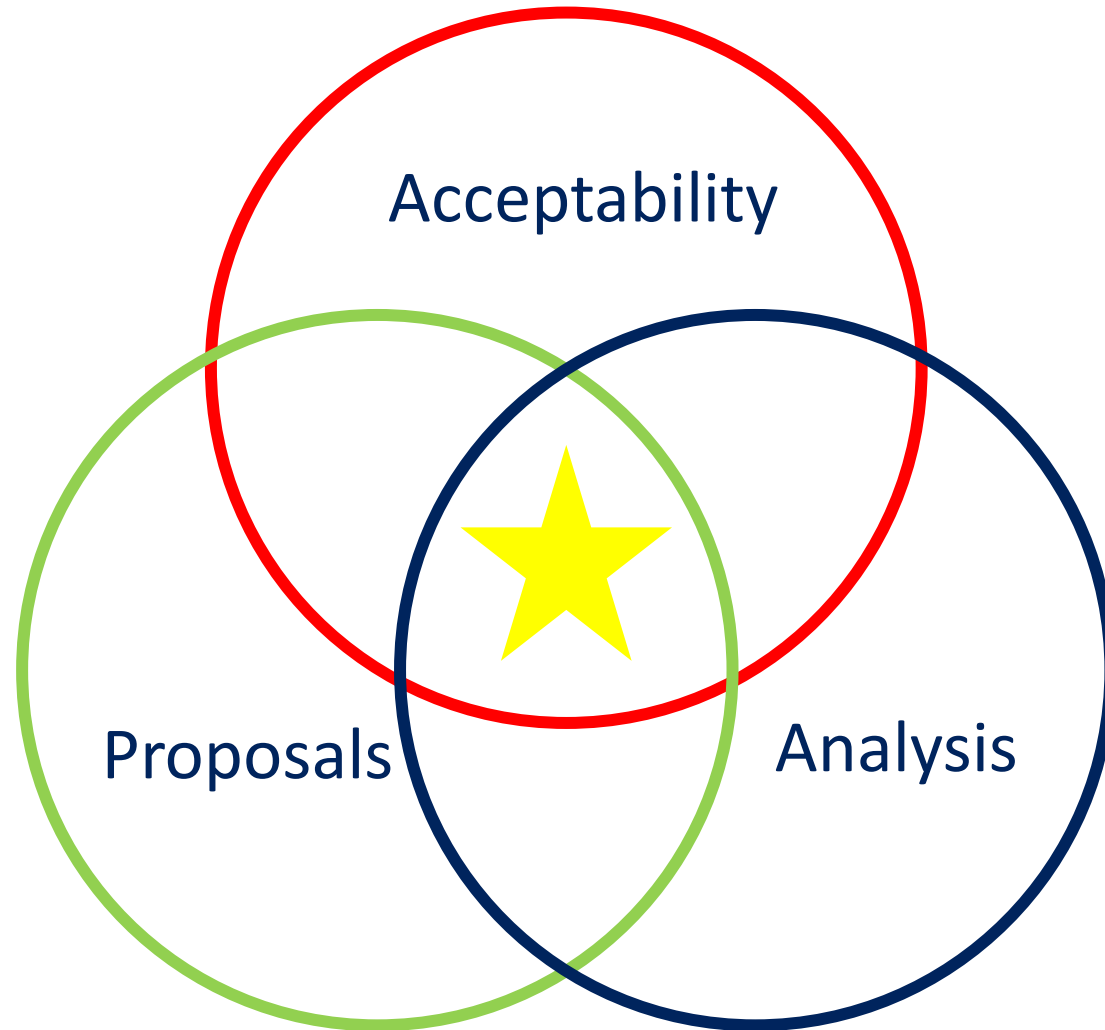
Technology increases our options

Analysis deepens our understanding of options

But how do we decide what will be acceptable to customers ?



Three Success Factors





In 2016 the GB Distribution Network Operators undertook a major review of the network security standard P2.

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

- Mandates the levels of security of supply by specifying required levels of capacity and redundancy
- P2 is commonly referred to as a deterministic or minimum standard
- P2 underpins ~ £400m of investment per annum.

The work undertaken by a consortium of academic and technical experts recommended that at 132 and 33kV the existing standard was excessively conservative. A methodology to define a per-site economically efficient design was proposed.

P2 workstream reached several conclusions



As load grows, it is economically inefficient to reinforce networks to n-1

- This means that 'capacity' derived security of supply will reduce
- Customers on reliable networks move to n – 0.25
- Customers connected to less reliable networks stay at n – 1
- Reduces Totex by £ several billion by 2035
- Increased interruptions (valued at VoLL) of £1.8- 2.8 billion

Full network roll out of automation justified

Investment in marginal High Impact Low Probability justified

Increased investment to reduce losses justified

All DG to connect at n – 0 standard

Additional sources of potential savings identified

- Non-essential load management ~ £2 billion
- Review of statutory voltage standards could save around £5 billion.

Status

X



X



?

X

Why were the conclusions not implemented ?



Customer acceptability has many dimensions but two are very significant.

Price

Whilst the macro level benefits were large, the impact on bills was not noticeable to the current generation of customers.

Inter-generational equity is a rational concept but not *'if I have to sacrifice'* now.

Reliability

Customers value supply reliability beyond measure.

Research can assign a notional monetary value such as VoLL ~ £20,000 MWhr

But once realised the value escalates significantly.

Eg 2022 Tanker driver shortage, August 2019 system event, storm Arwen 2021

Customer Power – Example 2



Network business across GB have been seeking to utilise customer flexibility in all its forms since 2007. All analysis shows this to be a hugely beneficial factor in grid balancing.

Time of Use Tariff
Peak pricing
Opt in Demand turn Down
CLASS
DER Connections

Status

Limited to commercial

Limited to commercial

Limited to advanced users

Grid scale.

Grid scale

Why?

Commercial customers, particular heavy power users are very price sensitive.

Residential customers pay ~ £90 pa for network charge which is insensitive to the delta

CLASS is invisible in operation to customers

At the point of connection DER customers are highly price sensitive.



Flooding

Flood level prediction and the protection of homes and businesses is a multi £ Billion industry. UK cost ~ £2.2 B per annum.

It is the focus of considerable work in scenario analysis and cost evaluation.

Application to Energy sector protection.

Various national standards enshrine the wisdom of the analysis and it is reflected in investment plans.

< 10,000 customer sites protected to 1:100 year level

< 50,000 customer sites protected to 1:1000 year level

Work shows these to be unquestionably the most efficient level of risk

The reality for customers



Storm Desmond 2016

Lancaster 1:1000 level exceeded by 2m ~ 1:10,000 level
Carlisle 1:1000 level exceeded by 1m

Numerous sites protected to 1:100 exceeded 1:1000 levels
100,000 customers off supply for over 48 hours.
All generators in the UK deployed.

Tens of thousands of customers stranded without heat, power,
communications, water, cash or electronic funds.

Political and customer reaction

The price of protective additional measures is insignificant versus
the impact on society. Our modern way of life cannot withstand
any large scale loss of energy.



How can we Act in an uncertain world ?



Why is this so challenging ?



Scenarios are just that ! why are we surprised when real life doesn't match ?

When rational risk turns into a reality it often exposes cascade damage functions that we never anticipated.

Monetising these cascade damage functions is so clear in hindsight but so challenging ahead of events.

The political or human perception of events is not easily rationalised.

Embracing this human dimension is critical to Engineering excellence



Understanding and delivering for Customers is true Engineering Excellence

