NERA
ECONOMIC CONSULTING

Methods for Planning Under Uncertainty

Vakhtang Kvekvetsia
Associate Director

Winter EPRG Conference, Cambridge

9 December 2016

Central planning becomes a dominant issue in UK energy policy

NERA ECONOMIC CONSULTING

Hinkley Point nuclear deal signed as Government admits gas would be cheaper

Source: Telegraph 29 September 2016

Government announces Capacity Market auction parameters

From: Department of Energy & Climate Change
First published: 8 July 2016
Part of: UK energy security

The Government has today set out how much electricity capacity it intends to buy in the forthcoming Capacity Market auctions.

The Government has today set out how much electricity capacity it intends to buy in the forthcoming Capacity Market auctions.

The Capacity Market is our main tool for ensuring that electricity remains available during times of high demand, such as dark winter evenings. It enables us to buy capacity in advance for use from 2017/18. It is the most cost effective way to guarantee that we have the full range of electricity infrastructure available to cope with unexpected peaks in demand.

Source: gov.uk

ofgem
Making a positive difference for energy consumers

Richard Smith
National Grid House
Warwick Technology Park
Warwick
CV34 6DA

Direct Dial: 0141 331 6008
Email: Kersti.Berge@ofgem.gov.uk

Date: 30 September 2016

Dear Richard,

Network Options Assessment methodology review and related direction

Thank you for submitting the second Network Options Assessment (NOA) methodology in late July as required under standard licence condition C27 of National Grid Electricity Transmission's (NGET) licence. We've reviewed the methodology against the requirements contained in the licence condition. This letter explains that the outcome of our review is to direct the System Operator (SO) to do further work on its methodology.

Based on our review, we think the SO has made good progress on introducing several new developments we requested in this year's NOA methodology. These include assessing reinforcement options against the competitive tendering criteria[1], reviewing the cost estimates of options, and identifying potential economic opportunities for interconnection.

We also note that in this year's methodology the SO has also resolved an issue we highlighted in our December 2015 letter[2] on the first NOA methodology. This related to the technical analysis of boundary transfer capability; specifically, our concern was that there might be accuracy issues due to the analysis being carried out using only the Gone Green (GG) scenario from Future Energy Scenarios (FES) and for winter peak demand. NGET scaled the GG results (ie approximated) for the other scenarios and seasons. This year NGET carried out a validation exercise that showed the loss of accuracy is not significant in most cases. We welcome the changes NGET has made to its methodology to address the circumstances when the loss of accuracy could be more significant.

However, we consider that this year's NOA methodology has not gone far enough to address the other issue that we highlighted last year in relation to the use of the GG scenario in the economic analysis of single-year Least Worst Regrets (LWR). For the reasons set out in the following paragraphs, we believe that the way in which the GG scenario is used in the economic analysis of single-year LWR (in particular its treatment as a scenario the occurrence of which is equally probable to the occurrence of the other FES)

Source: Ofgem

The planners use a combination of policy objectives and mathematical methods

NERA ECONOMIC CONSULTING

Policy and regulation

- Government policies
- Security of supply/service standards

Mathematical optimisation methods

- Deterministic models, scenario analysis
- Stochastic, single period
- Real options, decision trees, SDP
- Robust optimisation (including LWR)

Sources of Images:

Lenin and Electrification, Communism = Soviets' Power +Electrification, Shass-Kobelev - 1925

David Cameron – Mail Online

Rooftop Solar Shifts Power - Marcacci Communications, ttps://cleantechnica.com/2014/05/27/enlist-climate-victory-campaign/

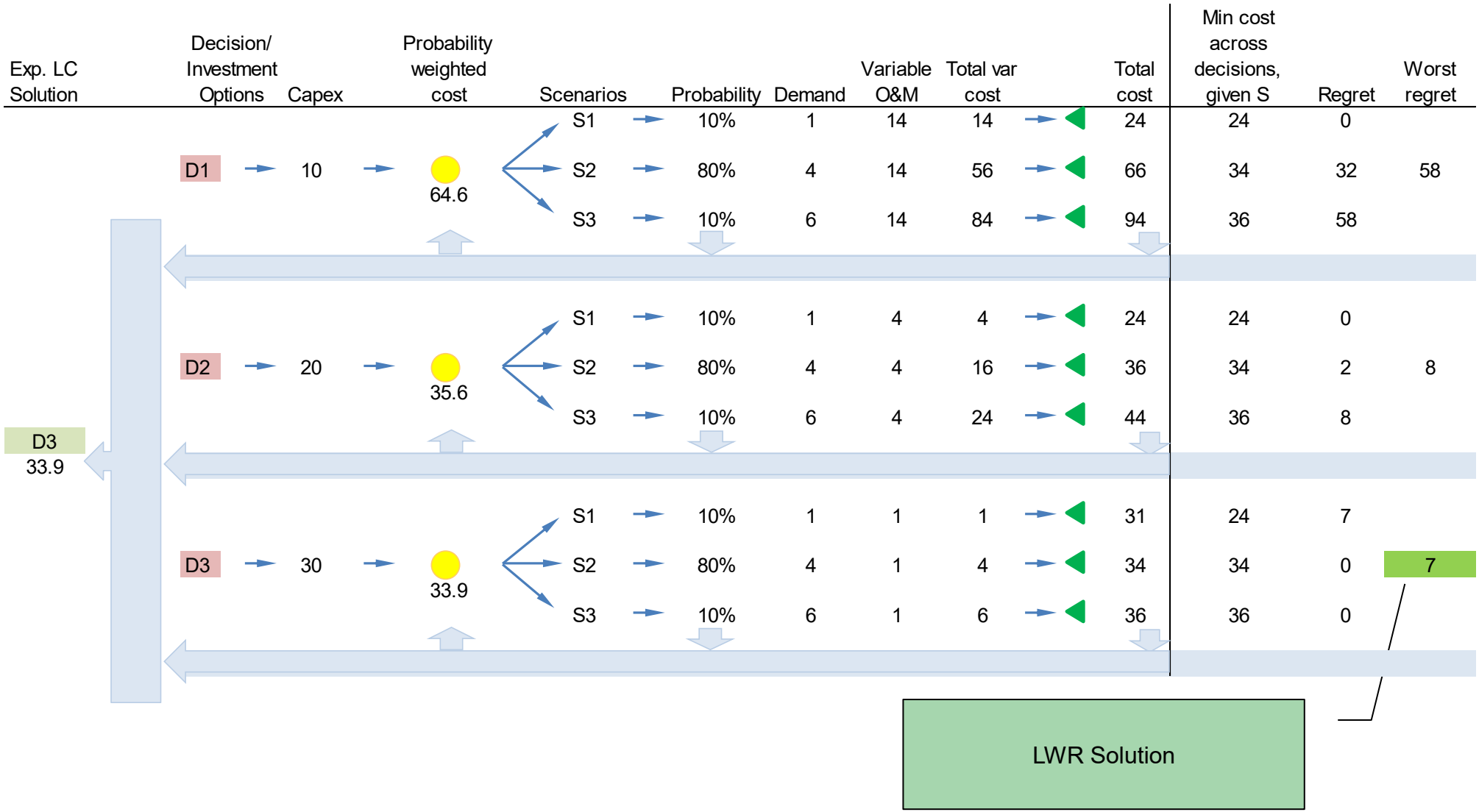
"Least Worst Regret" (LWR) has emerged as a planning method extensively used within UK electricity industry

NERA ECONOMIC CONSULTING

What is "regret"?	▪ In this context, "regret" is the difference in cost between the decision made and the optimal decision, given the realisation of a scenario – e.g. "We could have saved £100 million on transmission capacity had we known population wouldn't grow"
Where is LWR used?	▪ National Grid (Network capacity planning; capacity auction procurement, supplemental balancing reserve) ▪ DECC (Determining optimal flexibility on the system)
Why is LWR used?	▪ "[…] it is independent of the probabilities of the various potential future outcomes and therefore it can be used when the probabilities of these outcomes are unknown, providing that the cases considered cover a range of credible outcomes." –National Grid* ▪ Generates risk averse ("Robust") solutions to protect from the worst case outcomes
What are the downsides?	▪ Can lead to counterintuitive results (see next 2 slides) ▪ Cal lead to gold plating, given that unlikely scenarios can have an impact on planning decisions – Who decides what is a "credible outcome" that should be included?

*Source: National Grid 2015 Electricity Capacity report

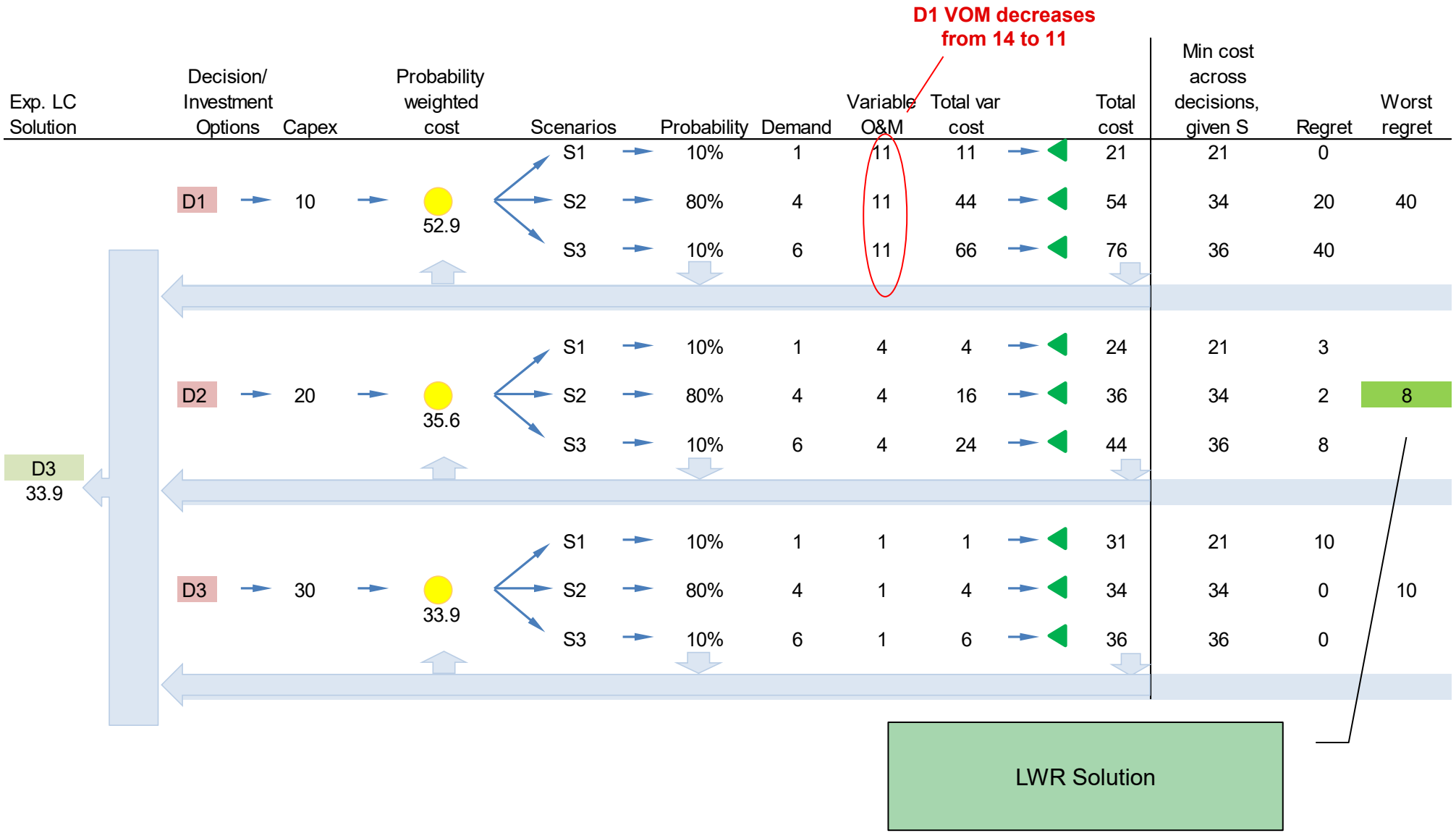
Illustrative examples of LWR and comparison with expected cost minimisation



In this example the two methods produce the same solution, however…

.. small change in an "unrelated" assumption affects the LWR solution

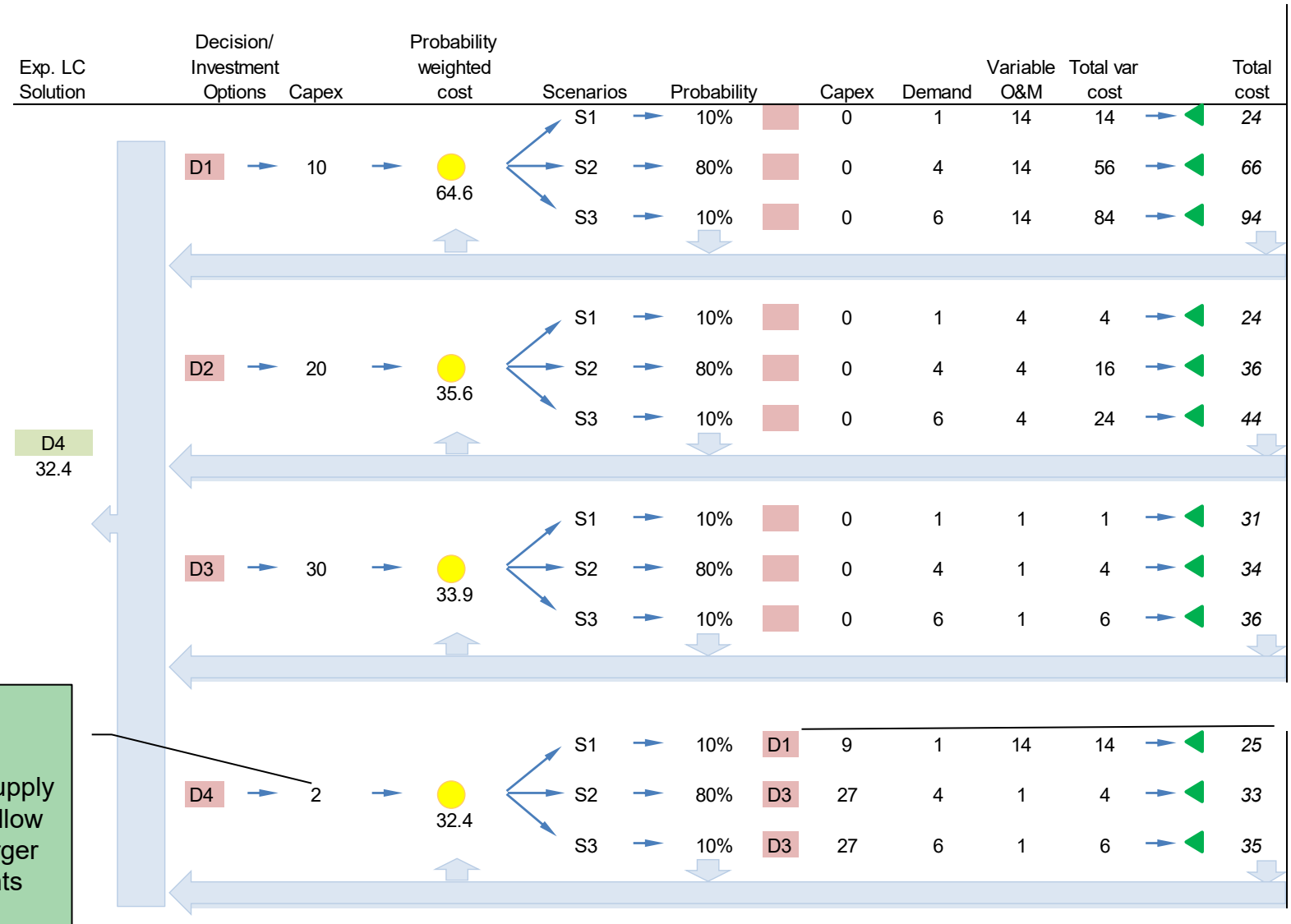
NERA ECONOMIC CONSULTING



Expected least cost solution remains invariant

Introducing multistage decision making could provide more efficient solutions

NERA ECONOMIC CONSULTING



Cost of alternative supply options to allow delaying larger investments

Invest optimally once the uncertainty is resolved

However, this will require introducing probabilities to the analysis

National Grid used LWR to choose to procure 53.8 GW of capacity for delivery in 2017/18

NERA ECONOMIC CONSULTING

Costs

Scenario	Decision 1 (51GW)	Decision 2 (52.8GW)	Decision 3 (53.8GW)	Decision 4 (55.6GW)	Min cost
S1	2,558	2,598	2,640	2,725	2,558
S2	2,734	2,651	2,664	2,730	2,651
S3	2,950	2,727	2,705	2,739	2,705
S4	3,863	3,050	2,871	2,788	2,788

D1 is optimal given S1; D2 is optimal given S2; etc

Regrets

	Decision 1 (51GW)	Decision 2 (52.8GW)	Decision 3 (53.8GW)	Decision 4 (55.6GW)
S1	0	40	82	167
S2	83	0	13	79
S3	245	22	0	34
S4	1,075	262	83	0
Worst regret	1,075	262	83	167

LWR option is Decision 3 (53.8 GW)

This approach does not consider the probabilities of the scenarios

Notes:
S1 = Warm weather; S2 = Base case; S3 = Cold Weather; S4 = Non-delivery of 2.8 GW
This is NG's simplification of the actual LWR exercise, excluding scenarios which did not impact the final decision
Source: National Grid 2016 Electricity Capacity report, tables 35 and 36

How does the LWR solution (=53.8GW) compare with the expected least cost solutions?

NERA ECONOMIC CONSULTING

Expected costs under assumed probabilities of scenarios

Probability of S4	Probability of S1-S3	Decision 1 (51GW)	Decision 2 (52.8GW)	Decision 3 (53.8GW)	Decision 4 (55.6GW)
5%	32%	2,803	2,678	2,680	2,734
15%	28%	2,915	2,717	2,700	2,740
25%	25%	3,026	2,757	2,720	2,746
35%	22%	3,138	2,796	2,740	2,751
45%	18%	3,249	2,835	2,760	2,757
55%	15%	3,361	2,874	2,780	2,763

When scenarios have similar probabilities, expected cost minimising solution matches the LWR

If S4 is very unlikely (<6%), then D2 is optimal (of the 4 choices)

If S4 is quite likely (>42%), then D4 is optimal (of the 4 choices)

- LWR is independent of the probabilities of the included outcomes, but highly dependent on whether the probability is high enough to warrant consideration.
- Ofgem criticised NG for including unlikely scenarios in its methodology (in the context of network planning):

  "[The Gone Green scenario] increasingly appears to be an overly optimistic scenario going forward, which in combination with the least worst regrets decision rule, could lead to inefficient network planning needs being identified." *

Disregarding relative likelihood of scenarios in LWR can result in inefficient planning and gold plating

*Source: Ofgem letter to National Grid, 8 December 2015

Will we regret using LWR?

NERA ECONOMIC CONSULTING

- Probably, unless we find a way of explicitly accounting for probabilities of different outcomes
- There are a number of ways available for eliciting probability from experts' judgment
  - Probability encoding
    - Psychological tricks which utilise man's ability to act as an "intuitive statistician" to overcome biases in experts' judgment
  - Expert aggregation
    - Statistical techniques which build a distribution of probability from the responses of experts
    - We can learn the level of agreement from expert responses
  - Prediction markets
    - Allows public to buy/sell "stock" in an outcome. Market price reveals traders' aggregated judgment of probability. (eg. Predit It, PredictWise, HyperMind, Betfair)

NERA
ECONOMIC CONSULTING

Contact

Vakhtang Kvekvetsia
Associate Director
NERA Economic Consulting
+44 (0)20 7659 8746
vakhtang.kvekvetsia@nera.com