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Transmission Planning with Variable Sources

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Planning with variability

- Current variability issues
  - Potentially, lots of wind to connect (how to do efficiently)
  - More interactions via interconnectors with other markets
- The network investment problem
  - Planning standards, cost benefits & making assumptions
- Making a decision

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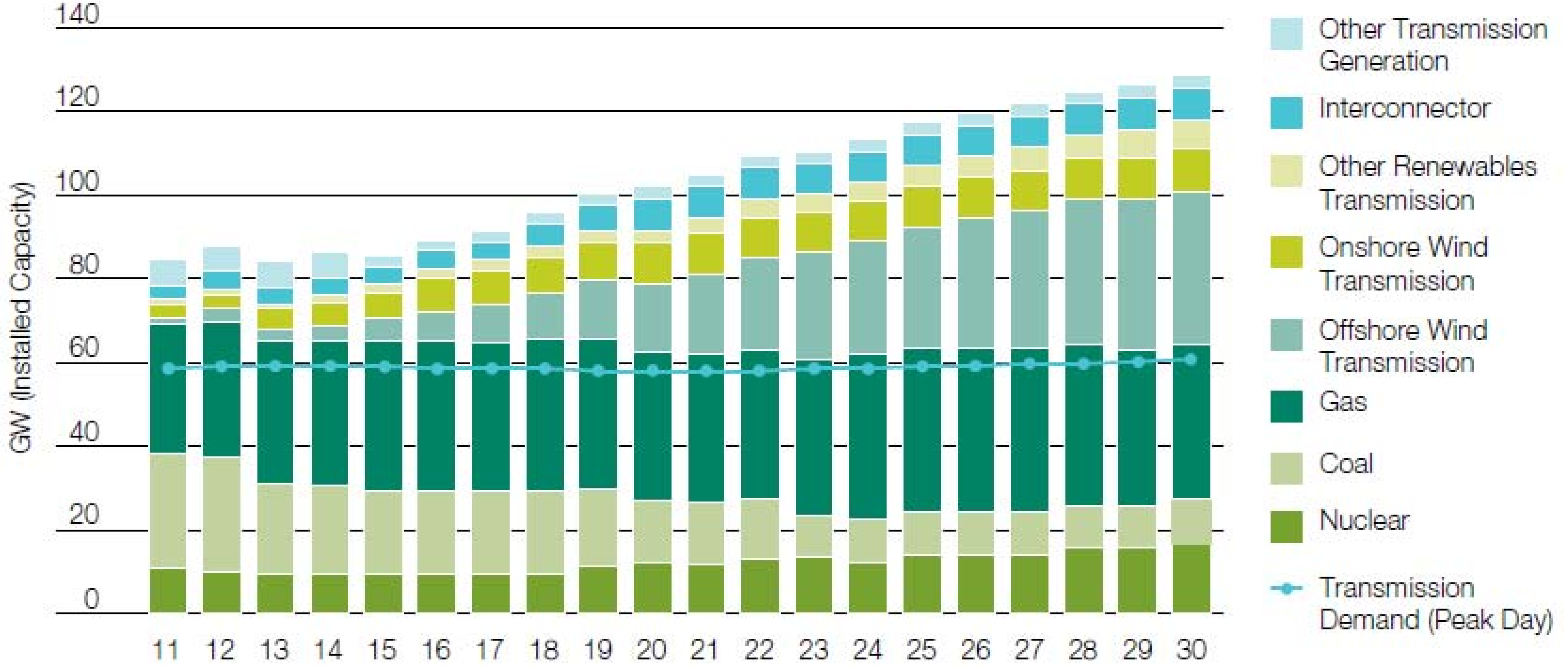
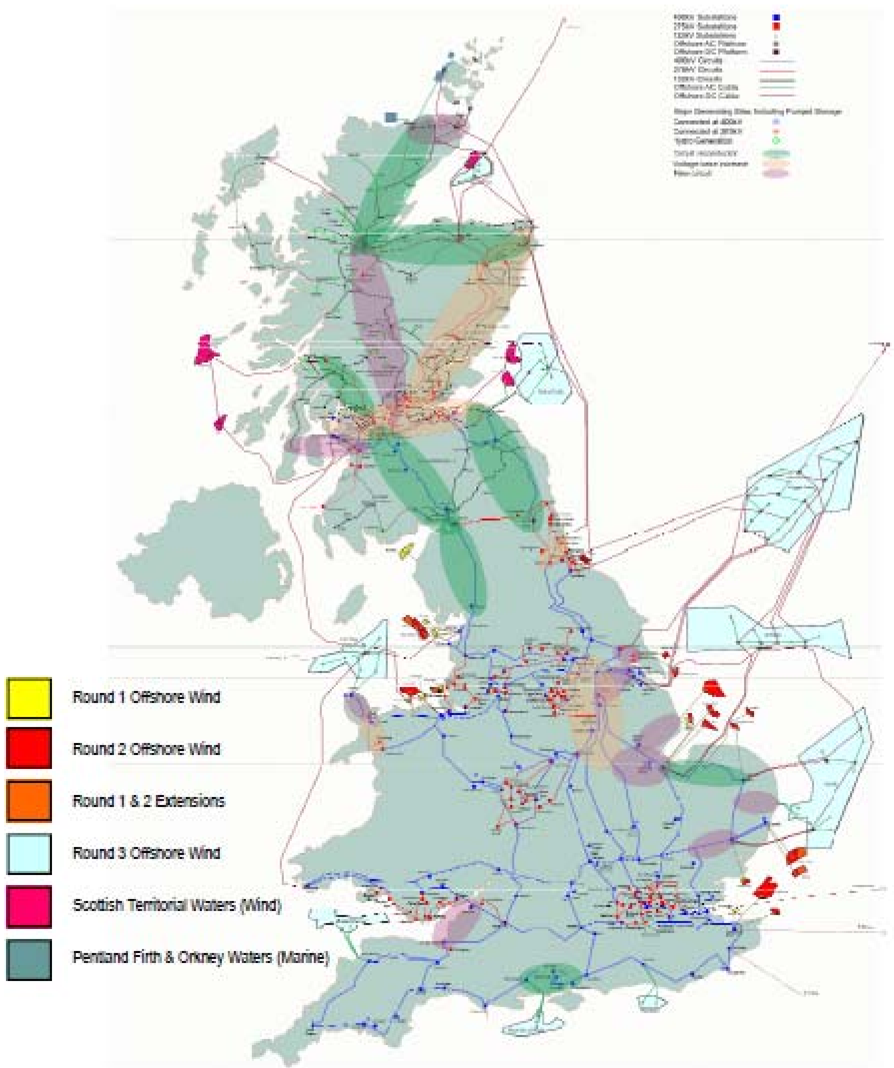
Potentially, lots of wind

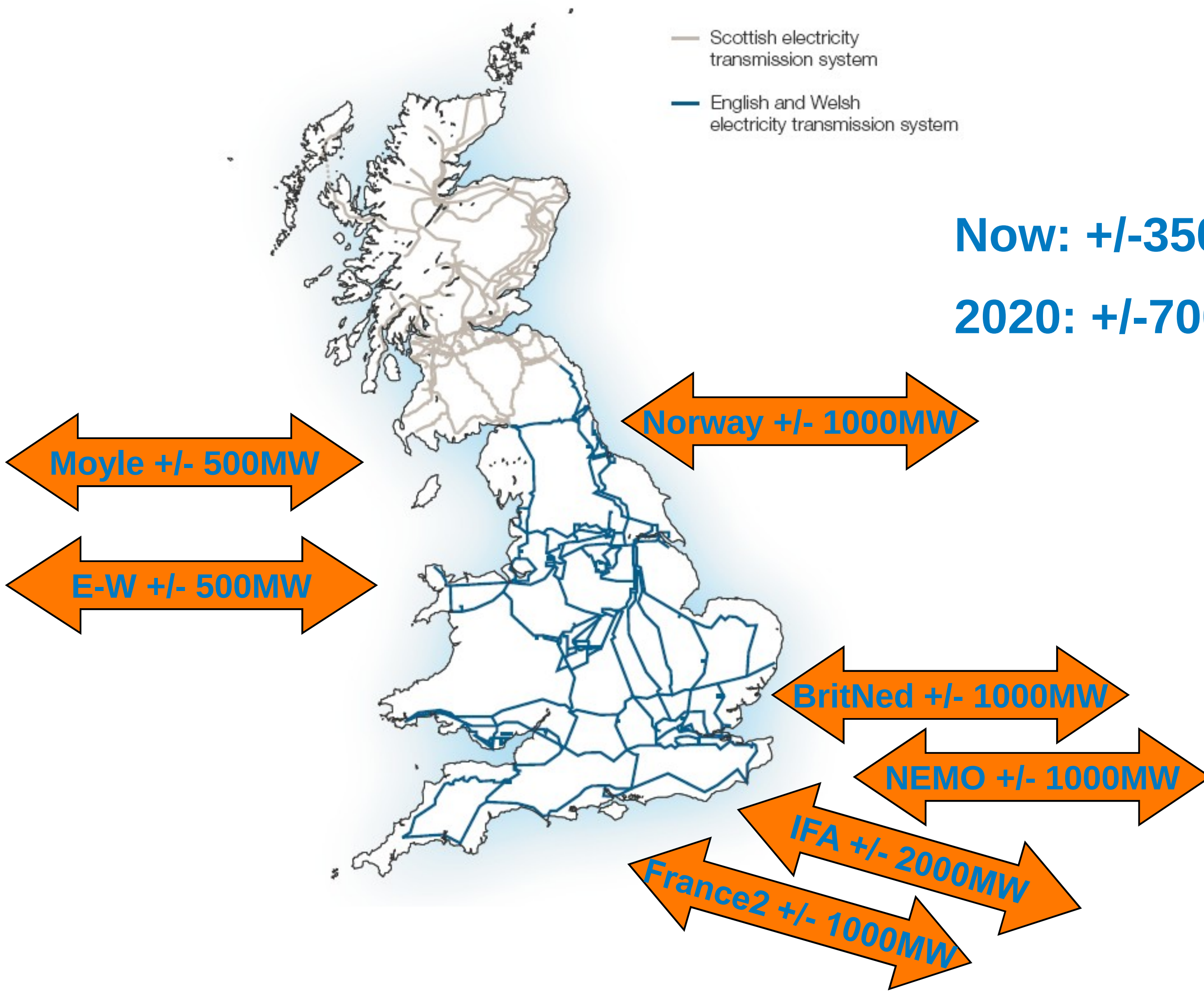
- E.g. Gone Green Scenario
  - Meet Government 2020 targets for Renewables largely with wind
  - Energy efficiency ~= new electrical load from heat pumps, etc



Potentially, major network developments



More interconnection



Now: +/-3500MW

2020: +/-7000MW

RIIO baseline plan expenditure (NGET onshore)

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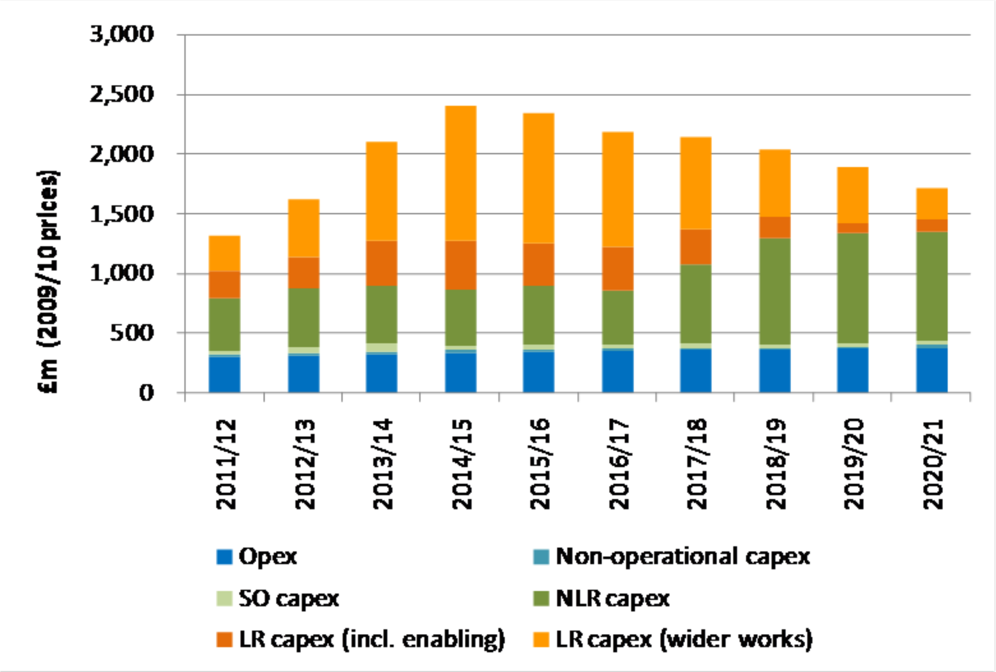

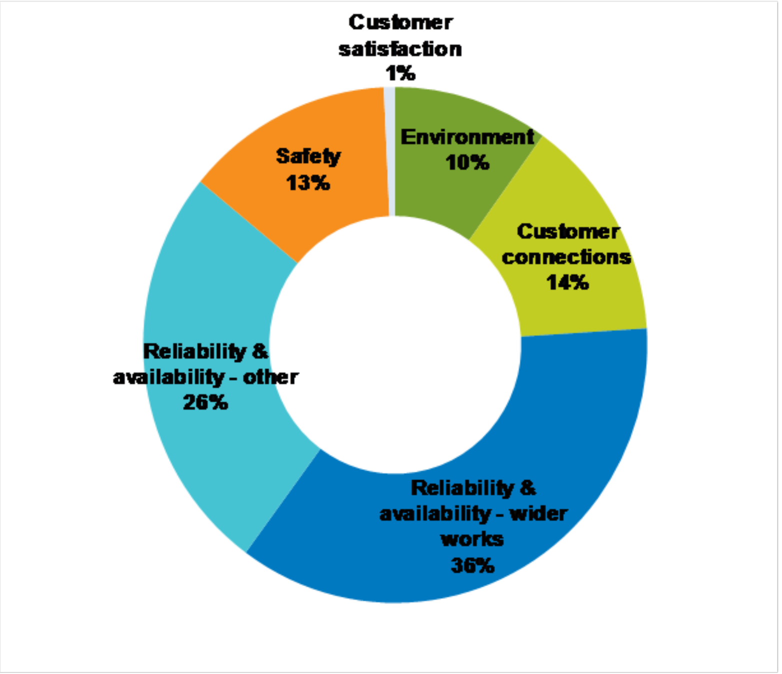

Capex		Opex		'Totex'
£14bn	+	£2.8 bn	=	£16.8 bn

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The network investment with variable generation problem

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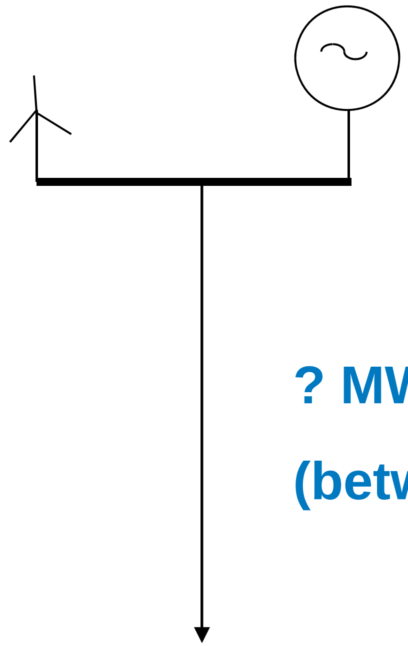
- In a nutshell - how much wire is needed?

1000 MW wind



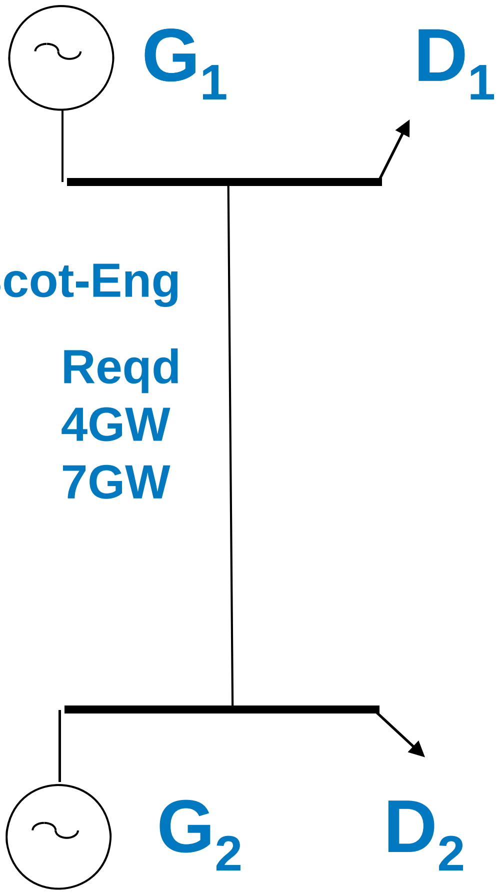
1000 MW conventional

? MW wire capacity

(between 1000 & 2000MW)

- How correlated/counter-correlated is the conventional plant with local wind?

How much wire? #1 – security approach



E.g. Scot-Eng

	Reqd
2013:	4GW
2020:	7GW

- Security standard approach:
  - Establish sufficient network so that gen G1+G2 can meet peak demand D1+D2
  - Define ‘average’ transfer to meet peak demand as
    = (k.G1 – D1) = -(k.G2 – D2)
    where k = (D1+D2)/(G1+G2)
  - Add interconnection margin for non average generation availability and demand distributions (fn of area size and network trip risk)
  - Add/remove capacity on basis of off-peak constraints (i.e. if merit order differences in G1 and G2 justify)

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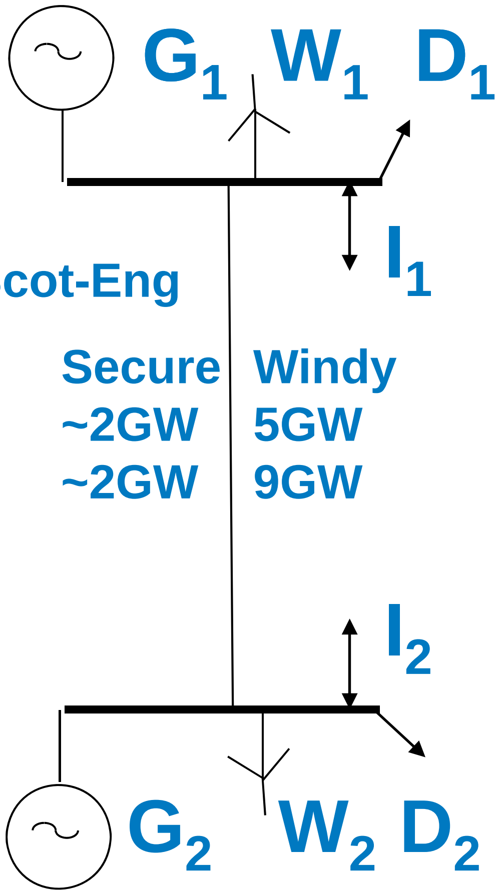
Issues with security approach

- What generation will actually build & close?
  - Discover from user commitments to pay cost-reflective charges?

    (More challenging if network reinforcement needed for many rather than few users)
- And should all generators be treated the same (and charged the same)?
  - Wind generators will not contribute the same as conventional plant to peak security
- What assumptions about wind backup (especially its location) should be made?
  - Simple scaling unlikely to be right
- How should interconnectors be treated (generators/demands/both/neither)?
- The CBA – When? How? (Does a security approach mean CBA ‘by exception’?)

How much wire? #2 – modified standard

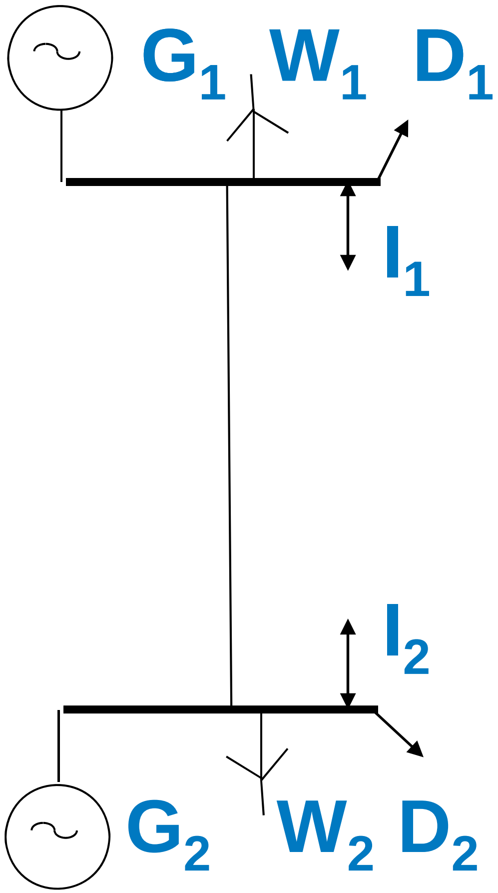


E.g. Scot-Eng

	Secure	Windy
2013:	~2GW	5GW
2020:	~2GW	9GW

- Modified security standard approach (GSR009):
  - Determine required network security capacity with W1=W2=I1=I2=0 (i.e. check GB demand can be met with conventional gen capacity G1+G2)
  - Then examine windy peak conditions with typical renewable, nuclear, pump-store availabilities & interconnection flows with other coal/gas plant scaled)
  - Select worst case as default requirement
  - Add/remove capacity if detailed cost-benefit justifies

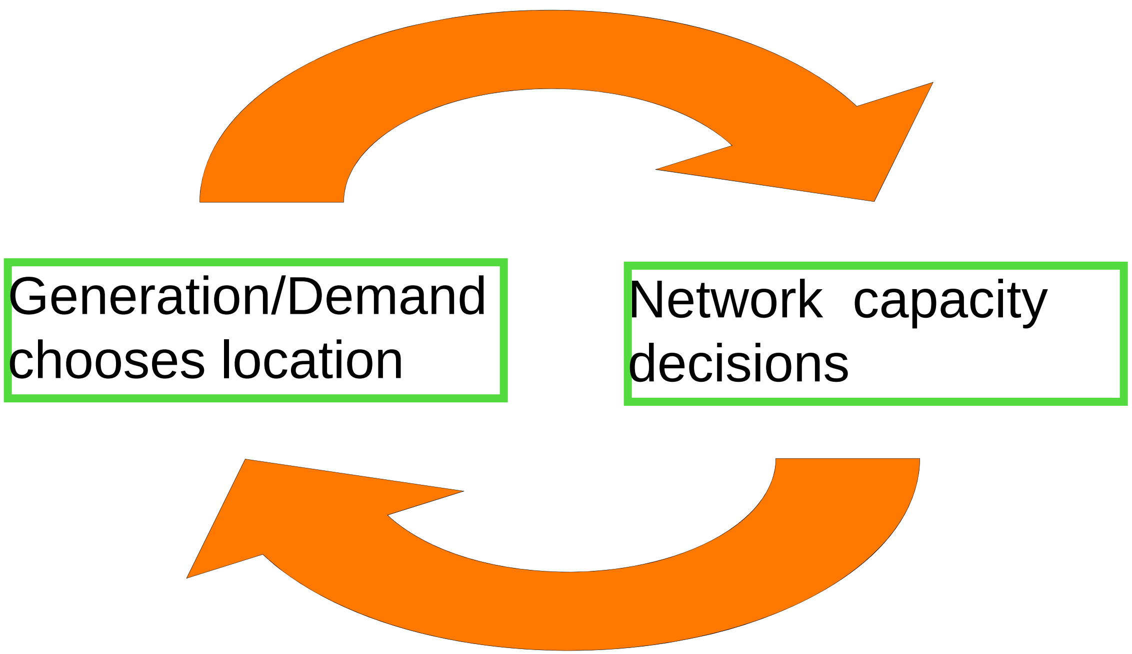
How much wire? #3 – stochastic CBA



- Wind variability and demand data available from central forecasting
- Project open/close info from user commitments (where possible)
- What future market behaviour?
  - Assume ideal cost minimisation?
  - Reflect what can be currently observed?
- Are there incentives for efficient dispatch and network sharing?
- Are resulting investment decisions justified, transparent, deliverable, financeable?

Discovering network value

(Future) transmission right prices and/or required volumes



Available capacity and/or locational prices

Which signals?

-Short-run marginal signals may encourage efficient sharing of existing network (LMPs, market splitting, etc)

- but network users (and developers) will require longer-term hedges

-long-run access products & associated prices require sharing assumptions (see Project TransmiT)

Short-run congestion–based charges currently prohibited onshore in GB

Agreeing network plans

- However, discovering information on ideal network sharing (with variable generation) is just one of many issues
- There are lots of other uncertainties:
  - EMR, developer choices, European interactions, TransmiT, future energy sources (shale), etc
- Also key questions about network design:
  - Capital & financing costs, speed of establishment, reliability, flexibility, losses, consenting, undergrounding, technical/smart developments & alternatives
- And wider questions about who should decide, who should build, who takes what risks? Should networks anticipate need in stated government policy or respond to actual projects?

So how to do?

Given the nature of the problem, we welcome Ofgem's RIIO approach:

- More focus and clarity on desired network outcomes
- Network companies given lead in developing and justifying plans
  - Spanning the key time frame up to 2020
  - Including the outcomes of engagement with stakeholders
  - Incorporating business suggestions on dealing with uncertainty, opportunities for new ways of working,
- Retaining and improving financial incentives

Some aspects of NGET's plan

- Base plan builds on ENSG joint industry working and consultations
- Detailed descriptions of design interactions, options and choices
- New efforts to improve transparency of CBA including tools for facilitating stakeholder exploration of CBAs and the quantitative discussion of scenarios, assumptions, options
  - Identifying individual's as well as collective implications (e.g. projected plant running, profitability & LMPs)
  - Separating fundamentals from market implementation aspects (facilitating parallel progress with EMR, TransmiT, etc)
  - Assessing alternative operational approaches (security changes, new storage, demand-side measures)
- Explicit modelling of plan risks, management actions and risk allocation implications
- Apply least regret decision making

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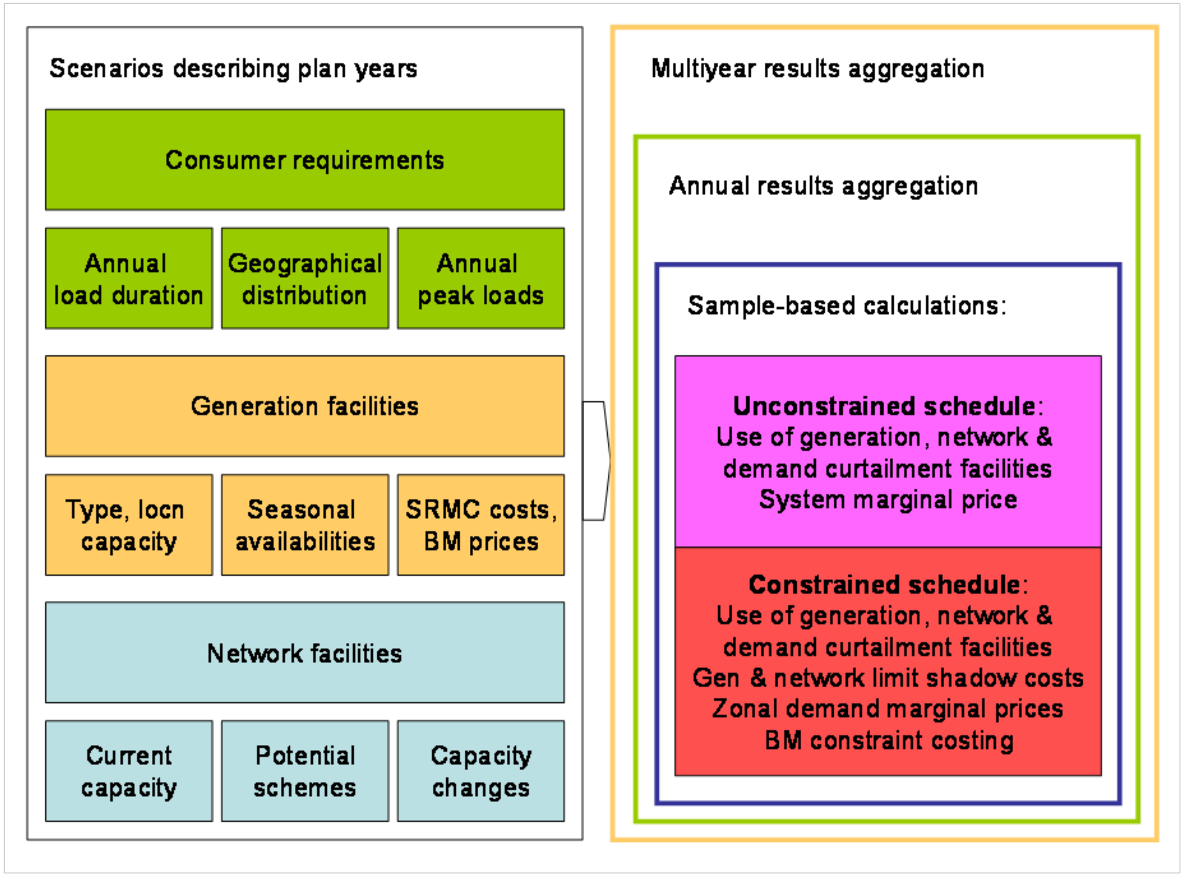
ELSI Modelling package

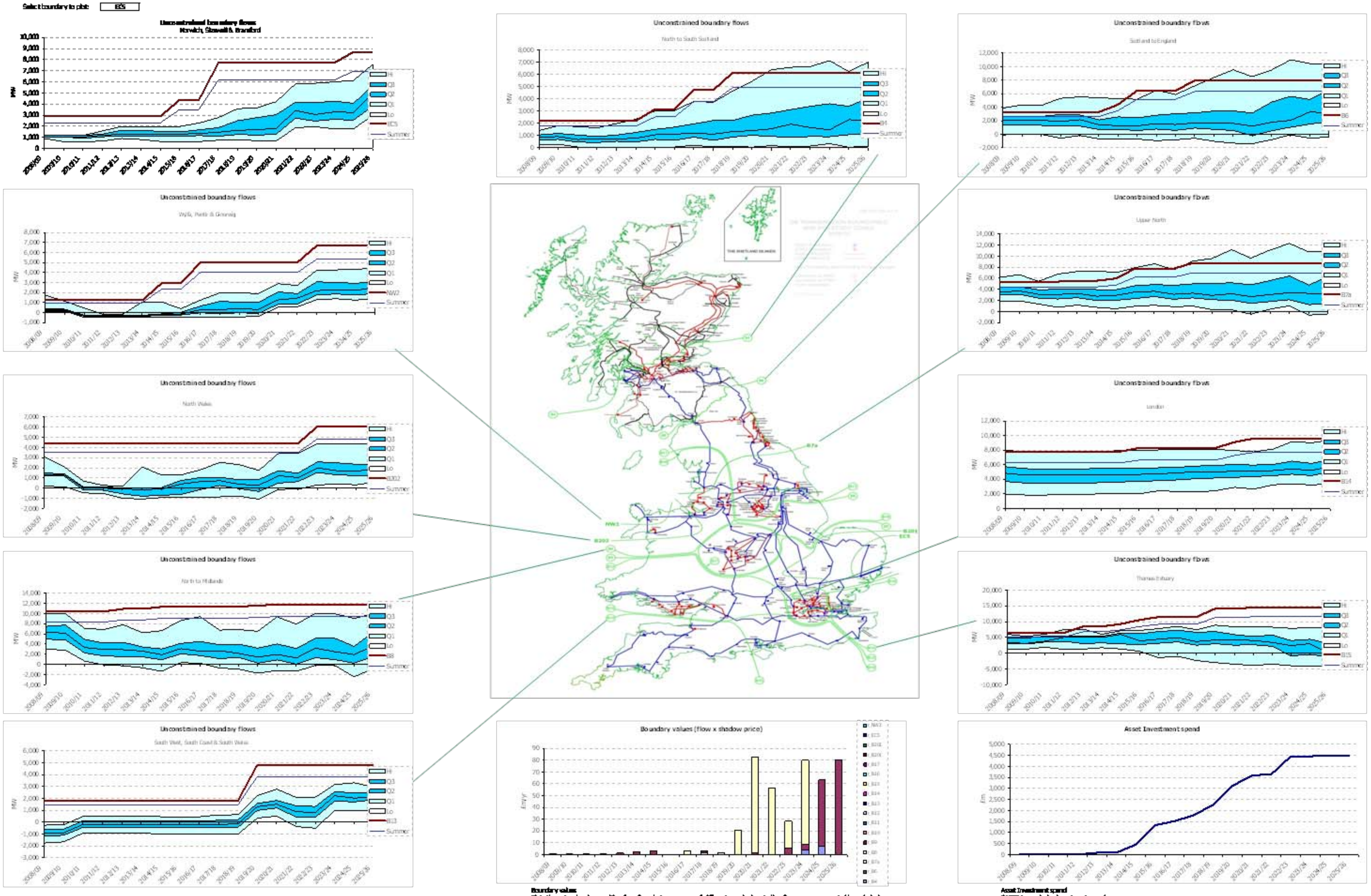
- ELSI is built to the principle "as simple as possible, but not simpler" and applies the 80/20 rule. E.g. seeking 80% of the answer from 20% of the potential detail
- It is free and requires no additional proprietary product or licences other than a copy of Microsoft Excel – www.talkingnetworkstx.com
- All workings (outside a simple linear program code) are shown. Hence it should be easily customised and extended by users.
- It includes NGET's Gone Green, Slow Progress & Accelerated Growth scenarios with illustrative cost and performance parameters. All can be customised and/or replaced by package users.
- It also includes a list of proposed network reinforcements in the form of a menu so that users can explore implications

ELSI facilities for representing variable generation



- Stochastic wind model
  - Seasonal days (maintaining diurnal correlations and seasonal variations) sampled from 10 year database
  - By default 4 wind areas
    - Scotland
    - England&Wales
    - Offshore East
    - Offhore West
- Optimal dispatch of generation, daily storage and interconnectors

Fan diagrams
Plots the range of network flows resulting from the national merit order dispatch (i.e. with no transmission limitations)
Flows arising at all times within a year are compared with network planned winter peak and summer capability
NB Magnitude of unconstrained boundary flows may be sensitive to model orderings if fuel costs are similar in each plant type

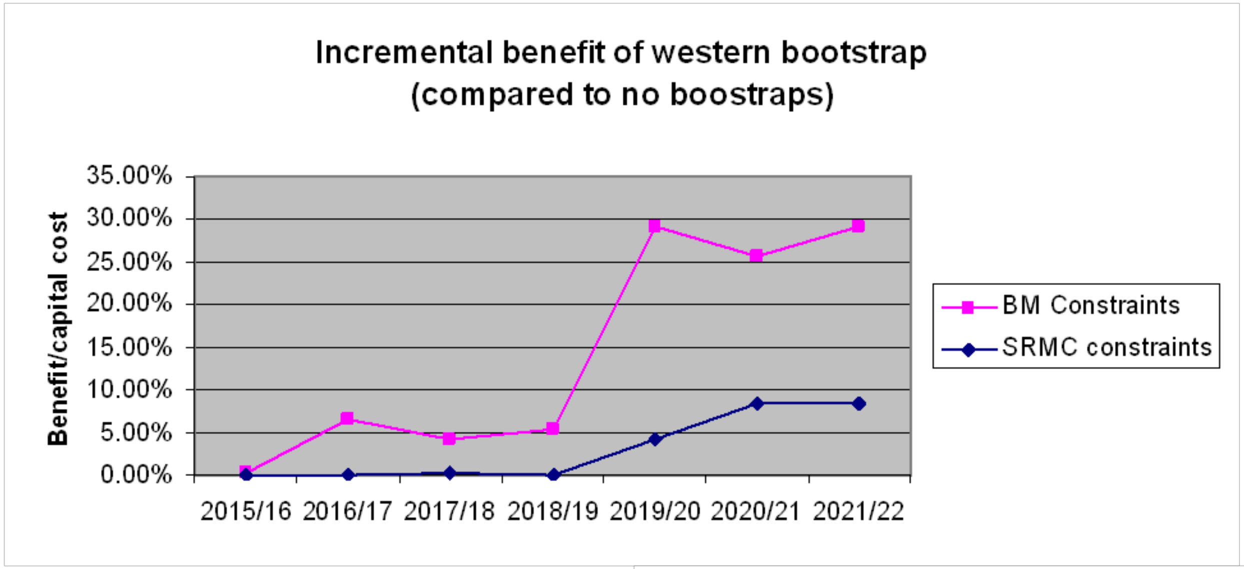


Boundary values
Plots the network value resulting from flows between zones of different marginal costs (i.e. flows across congested boundaries)
Helps identify boundaries that may benefit from further reinforcement

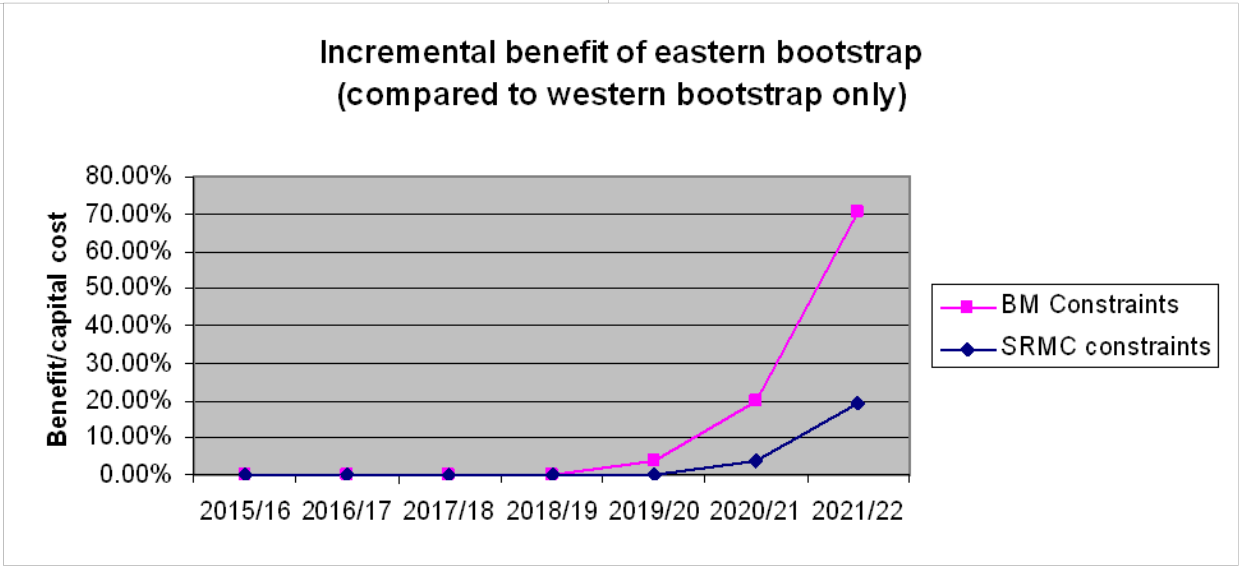
Asset Investment spend
CAPEX transmission investment spend

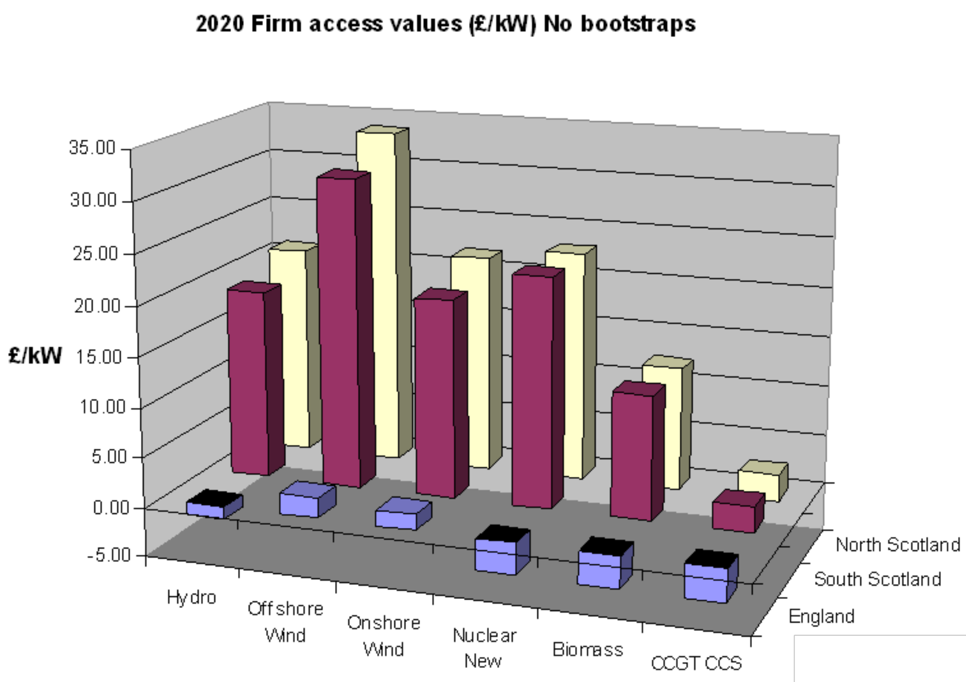
Ranges of network unconstrained system flows, flow limits and cost/benefit information

Illustration of bootstrap cost-benefits



Gone Green scenario





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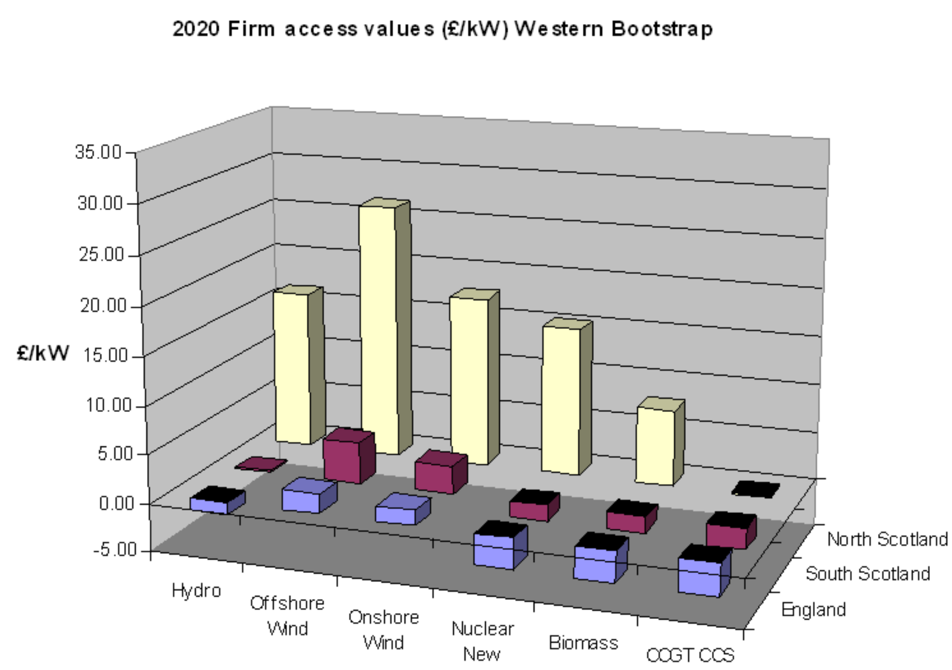
Gone Green scenario

Additional generator profits of national vs local access (value of transmission right)



Network requirements and capacity utilisation

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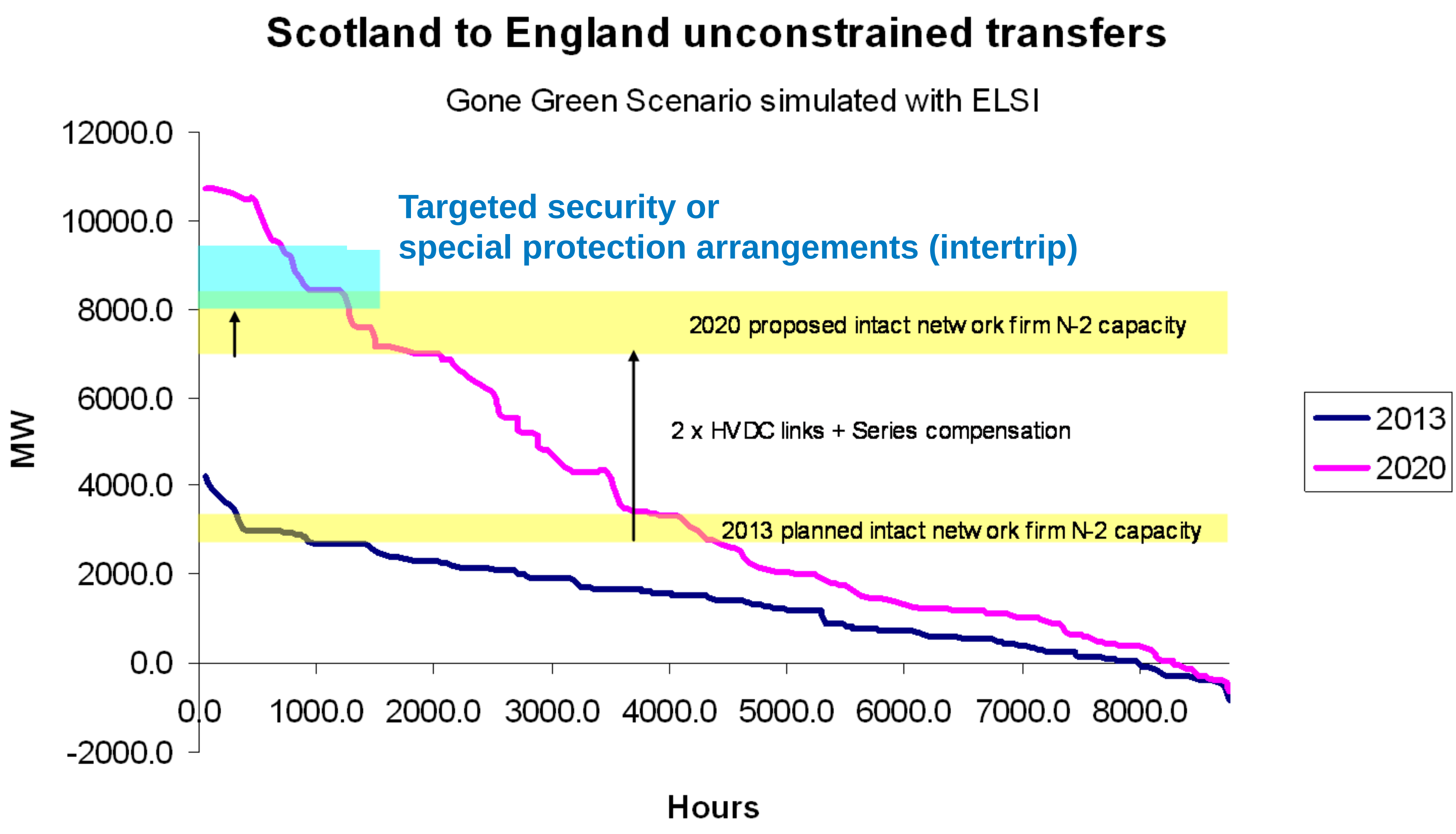
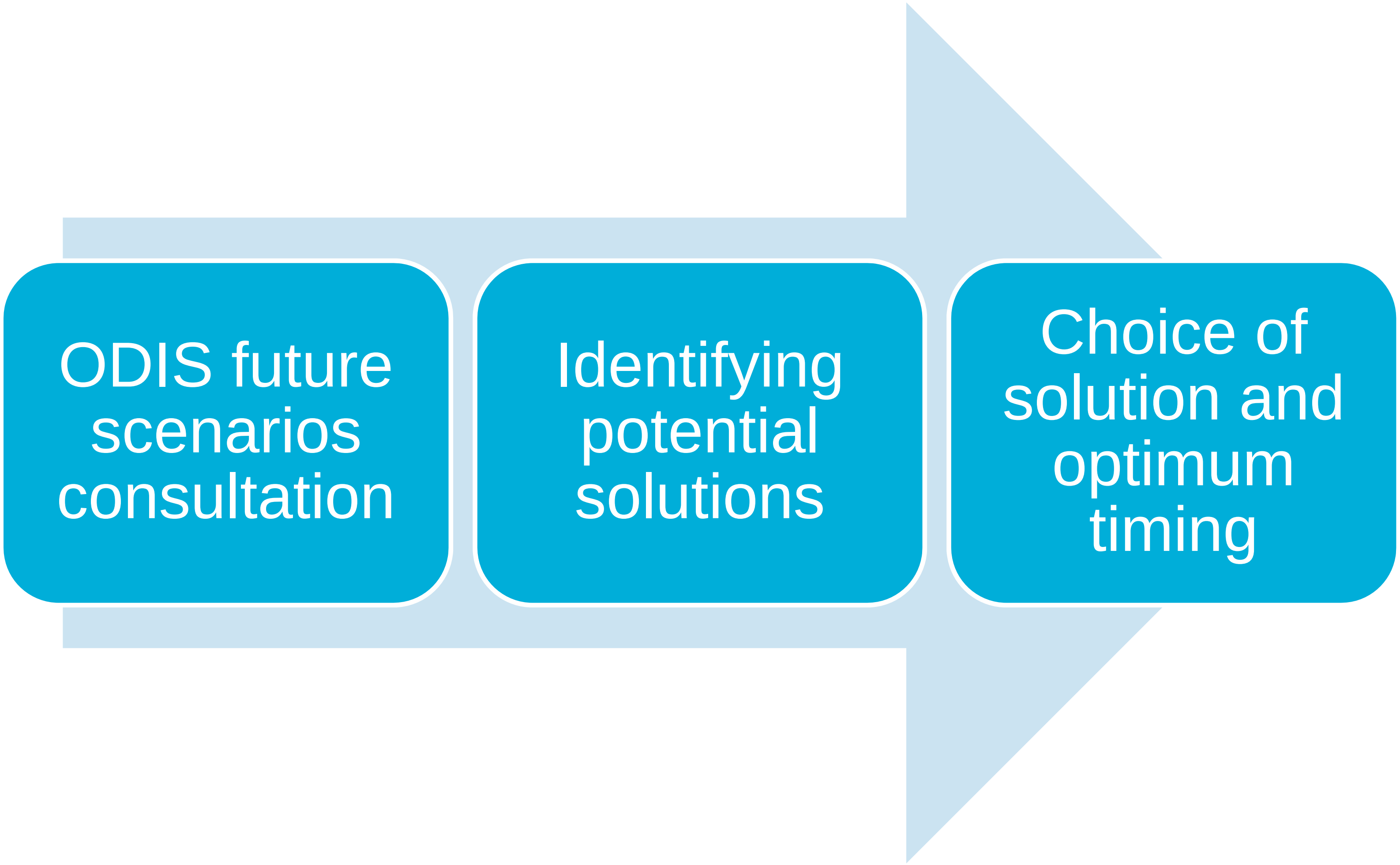


Decision making process



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ODIS Future Scenarios Consultation

Future Scenarios

Wider Stakeholder Engagement

Future Scenario Consultation
Consultation Period: February – April

Enhanced Information

Proposed Extension to Study Period

Additional Clarity on Development of & Assumptions Made

Compare, Align & Contrast
- Comparison and alignment against existing/alternative industry scenarios
- Compare/contrast against TEC

Register

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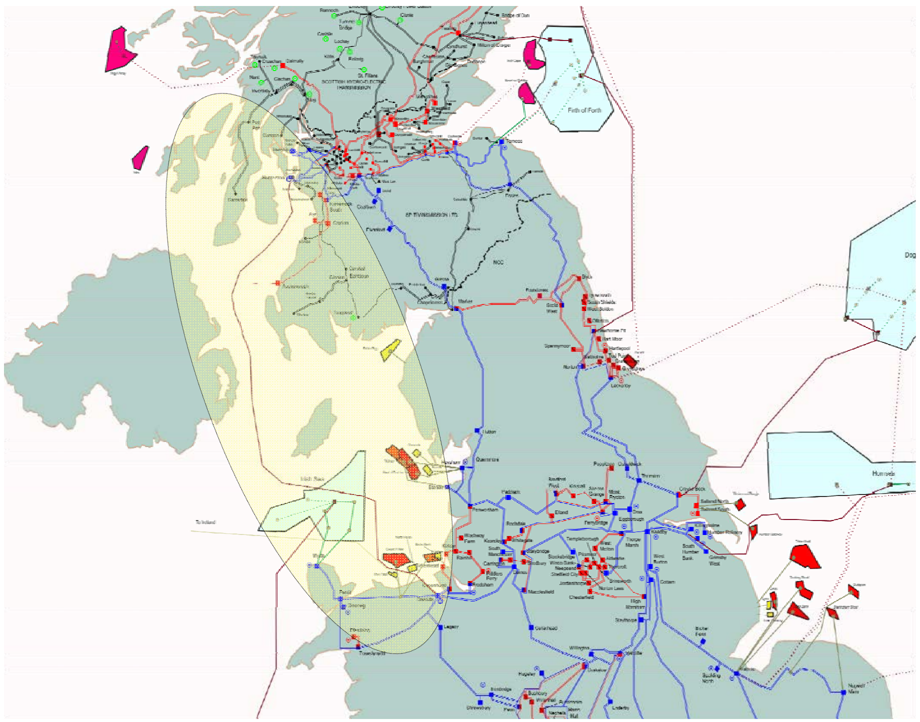
Identifying potential solutions

- Identify range of solutions with the application of the security standards to each of the scenarios and associated sensitivities
  - Reinforcements
  - Commercial alternatives (e.g. availability contract)
- For each potential solution, we establish:
  - Cost
  - Lead-time
  - Deliverability and planning requirements
  - System benefits (impact on security, constraints, losses, etc)

Choice of solution & timing
Example: Western HVDC link

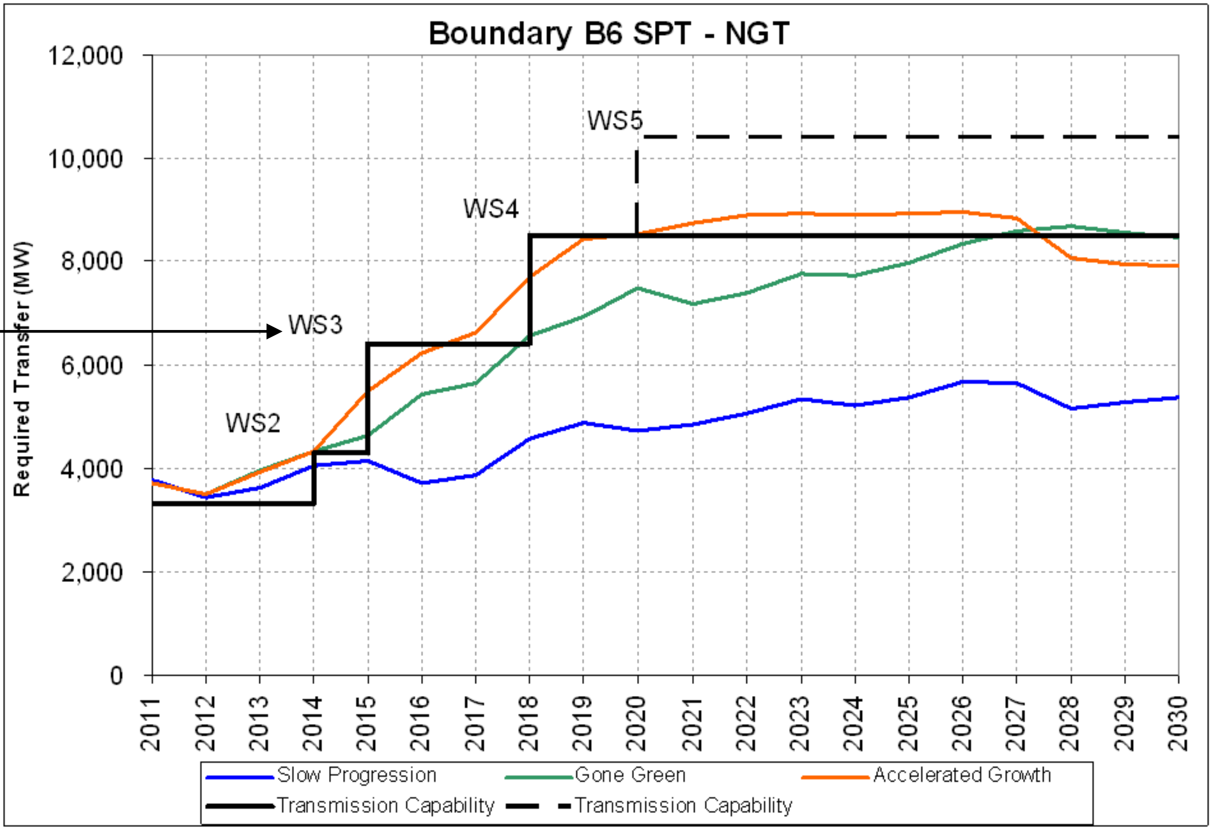


Basic Scheme details

- HVDC cable connection; 400km from Hunterston to Deeside
- New 400kV substation at Deeside
- DC converters Deeside and Hunterston
- 2.1GW capacity

Western HVDC Link
Applying the security standards

WS3 – Western HVDC link required in 2015/16 against "GG" and "AG"



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Western HVDC Link
Cost benefit analysis

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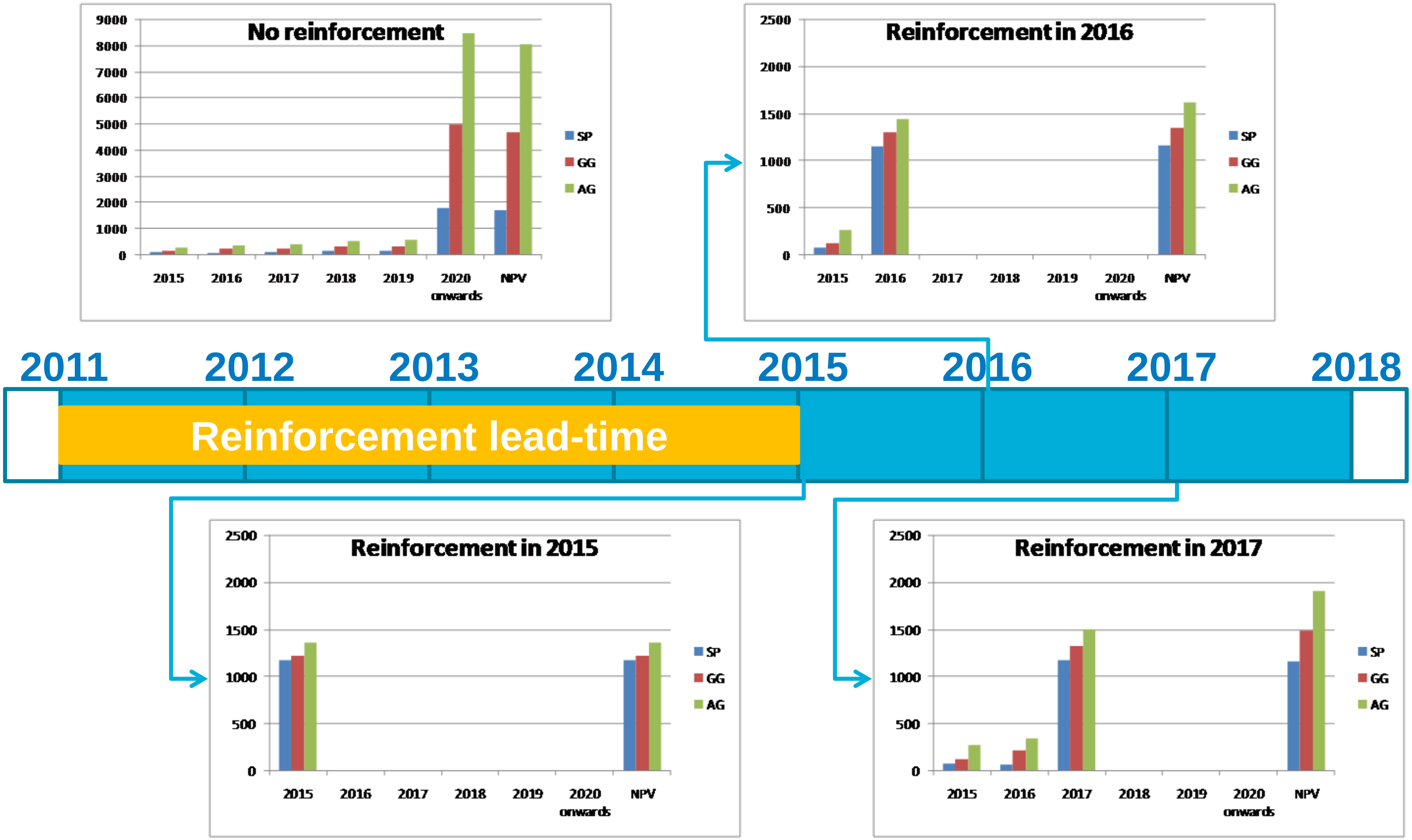

Western HVDC Link
Least regret analysis

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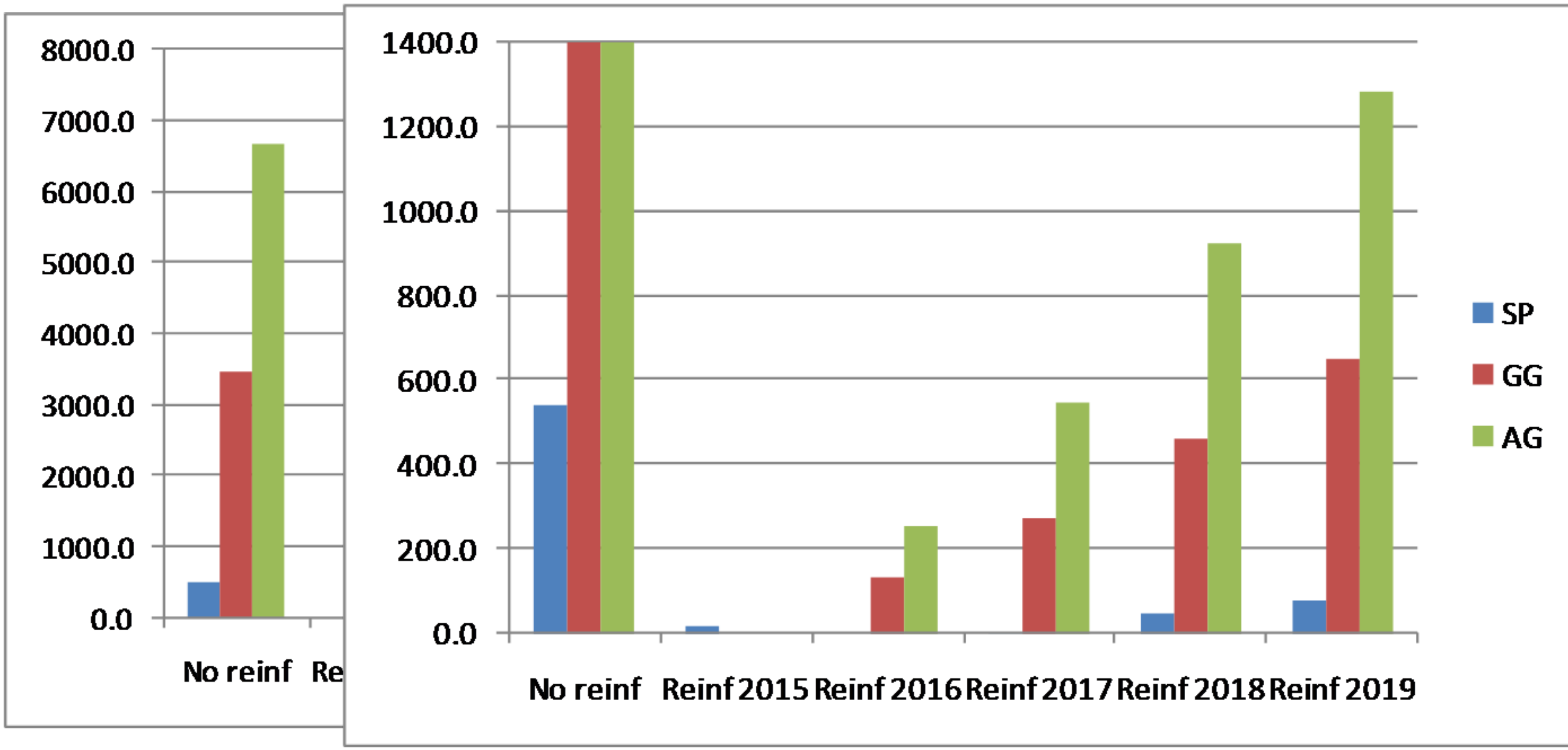
- Consider difference between what we would get and the best possible outcome if a different course of action had been taken



Identifying option value

- Least regret analysis also allows us to understand the potential for more reactive strategies

- For example:
  - The value of pre-construction work which will reduce project lead-times
  - The risks and opportunities associated with waiting for evidence (e.g. constraint costs) prior to initiating construction works

Conclusions – planning with variable generation

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- Lots more uncertainties than just when the wind will blow
- Current access arrangements are unlikely to discover efficient sharing of the network or fully drive network investment decisions
- However, the RIIO business planning and stakeholder engagement process is an opportunity for identifying candidate reinforcements, exploring their cost-benefits and agreeing decision points

- Questions welcome