Smart grid evaluation

Outline for the SGF

20 October 2011

- Aims and scope
- Modelling framework
- Next steps

Frontier and EA are working with WS2 to develop a framework for evaluating smart grid investment opportunities

This project has three main objectives

1. Understand what drives the value of smart grids, and what is the value of the flexibility or option value they may provide
2. Understand which parties will benefit through the value chain from smart grid solutions
3. Inform policy development in the face of uncertainty

Our framework will consider these questions at a high level

Timescale	2012-2050, but focussing on implications in the near term
Scope	Impacts on the electricity sector as a whole, GB level cost and benefits, costs and benefits to each party

We will deliver a practical tool to help inform RIIO-ED1 and policy decisions

Transparency	Allows understanding of what drives the value of smart grids under different scenarios and network types
Flexibility	Data and assumptions can be updated as new information arises

We will compare the costs of meeting high level electricity sector outcomes with and without smart grid technologies

Required outcomes to be achieved at least cost

Decarbonisation

- Facilitate connection and use of low-carbon plant, distributed generation, electric vehicles and heat pumps

Security of supply

- Maintain network standards
- Facilitate connection of required plant
- Keep system balanced

Means of achieving the outcomes

Smart

- Invest in smart distribution grid technologies

Compare costs (and ancillary benefits)

Conventional

- Invest in conventional network solutions
- Invest in peaking plant, large-scale storage etc

The model will help inform a range of policy questions

Net present value of alternative options 2012-2050

Near term decisions

Least regrets investments	Under what conditions will investments have a strong business case from a DNO perspective
	Under what conditions will investments have net cost to DNOs but a net benefit to the UK
Investments with option value that outweighs their costs	Under what conditions are investments worth undertaking because they increase the choices available in later periods
	Under what conditions are investments which allow deferral of capital-intense investments until new information becomes available worth undertaking

This work will help inform DNOs' choice of smart grid solutions to bring to Ofgem in RIIO-ED1

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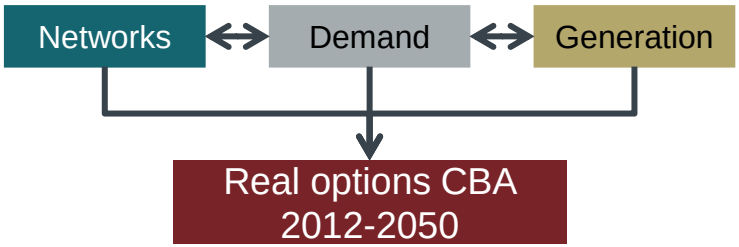
We intend to discuss five aspects of the analysis

1 Scope of model



2 Value drivers and scenarios

- EVs
- HPs
- PV
- Wind
- Efficiency

→ Scenario 1, Scenario 2, Scenario 3

3 Investment strategies

- Centralised smart grid
- Hierarchical smart grid
- Decentralised smart grid
- Business as usual

→ Different levels of flexibility to changing conditions associated with each strategy

4 Assessment of option value

Decision 1: Before state of world is known

→ Time
→ Information

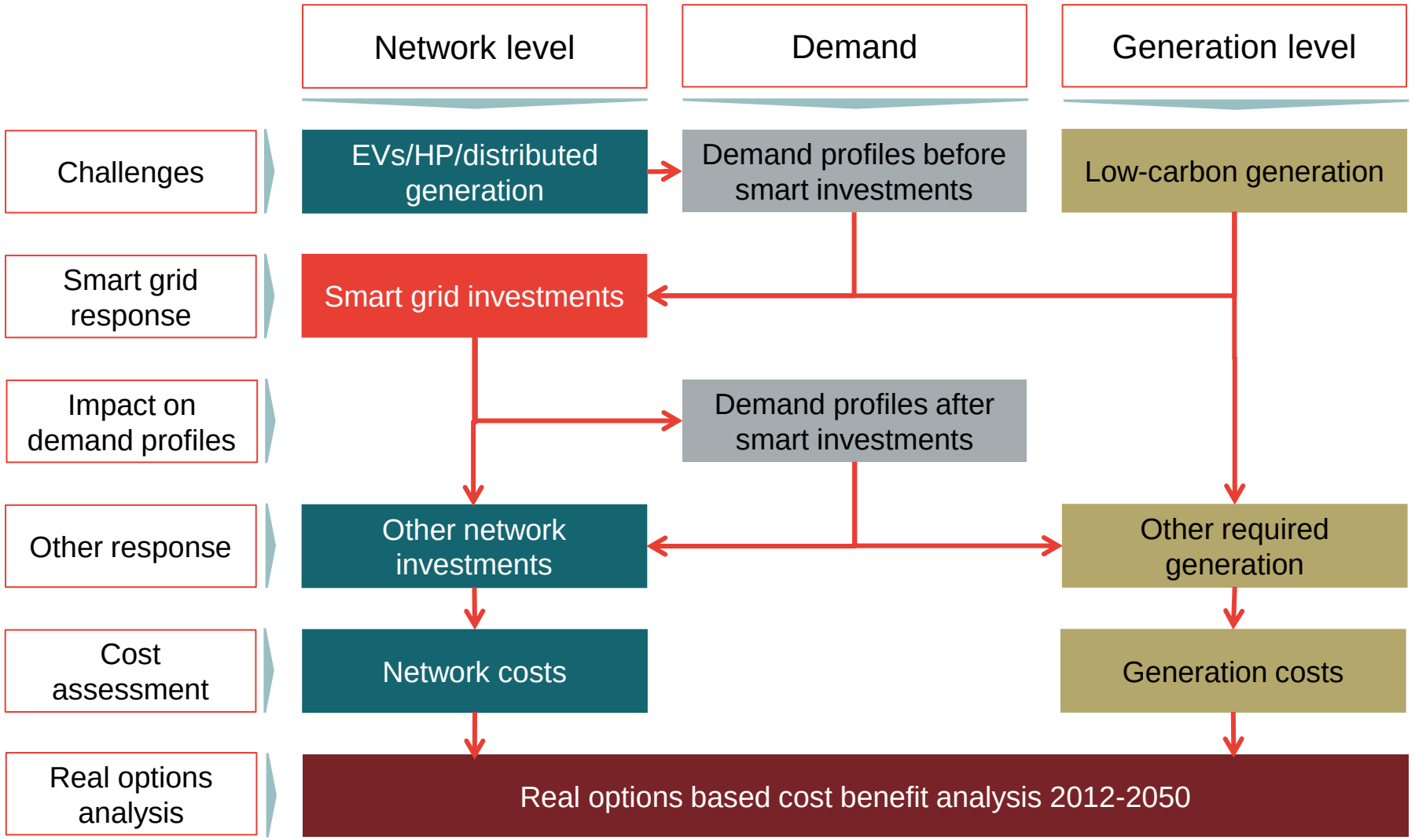
→ Decision 2: Options constrained by previous decision

5 Proposed simplifications

Make simplifying analysis where these do not strongly affect results

→ Transparency
→ Flexibility

The model will represent the electricity sector from 2012-2050



2a

We will look at three scenarios which will differ according to the level of smart grid value drivers

A set of challenges…

…will increase the demand for services which the smart grid can provide

We propose to vary the level of these challenges across three scenarios

Electricity sector challenges	Services smart grids can provide: Increase use of network capacity	Manage complex distribution network flows	Facilitate demand side response	Facilitate embedded storage	Provide data on the grid
Electrification of transport and heating	✓	✓			✓
Increase in distributed generation	✓	✓	✓	✓	✓
Increase in inflexible and intermittent generation	✓		✓	✓	
Ongoing need for network efficiency	✓				✓

Scenarios will be based on the work of WS1, and could include:

Scenario 1:
Rapid transport electrification

Scenario 2:
Rapid heat electrification

Scenario 3:
Less UK abatement, purchase of credits

2b

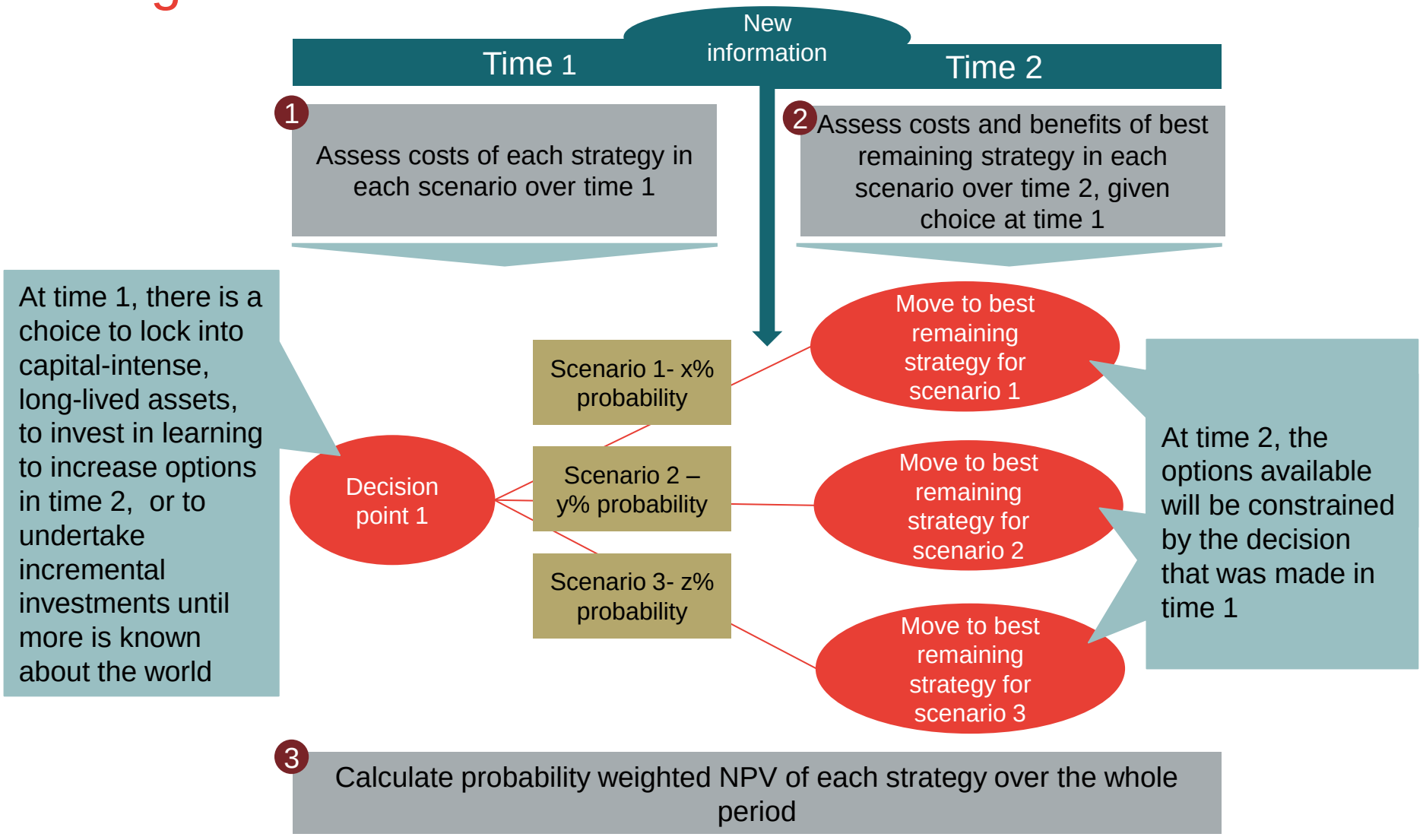
We will focus on the technologies which are likely to be the most important value drivers

	Technologies that will vary by scenario	Technologies not modelled
Demand side	**Heat pumps:** domestic and commercial **Electric vehicles:** domestic and car park	Plug in hybrid vehicles
Supply side	**Large scale generation:** Onshore and offshore wind, nuclear, CCS **Small scale generation:** PV, wind, CHP	Wave and tidal technologies The supergrid Other distributed generation

We will appraise four investment strategies against each scenario

Four strategies to deliver the same decarbonisation and security of supply outcomes…	Description	…each package has allows a different degree of flexibility in the face of uncertainty: Sunk costs	Lifetime	Lead times
Centralised smart grid investment strategy	• One overarching control structure • One solution for large network area (multiple locations)	High	Shorter	Potentially longer
Hierarchical smart grid investment strategy	• Distributed control with some supervision	Medium		
Decentralised smart grid investment strategy	• Multiple implementations of different structures • Can be adopted on an ad-hoc basis	Low		
Business as usual investment strategy	• Conventional investments only • Includes all existing policies, including smart meter rollout	High	Longer	Shorter

Our real options based approach will involve a two stage decision tree



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To keep the model flexible and transparent, we propose to make simplifying assumptions in four areas

Networks	• Three representative networks – urban, rural and suburban • Headroom and legroom • Priority solution stacks
Demand	• Demand response to reduce network costs and demand response to reduce generation costs • Demand can only be shifted within a day (means excluding some types of demand response, e.g. fuel switching with plug in hybrids)
Generation	• Derive summary statistics from more complex modelling and existing publications and include them in the model • Model wind using representative daily profiles and summary statistics
Uncertainty	• Up to three scenarios representing the range of uncertainty • Two time periods in real options based analysis

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We would welcome your comments on any aspect of this

We are here until 4pm to answer any further questions, or please contact us

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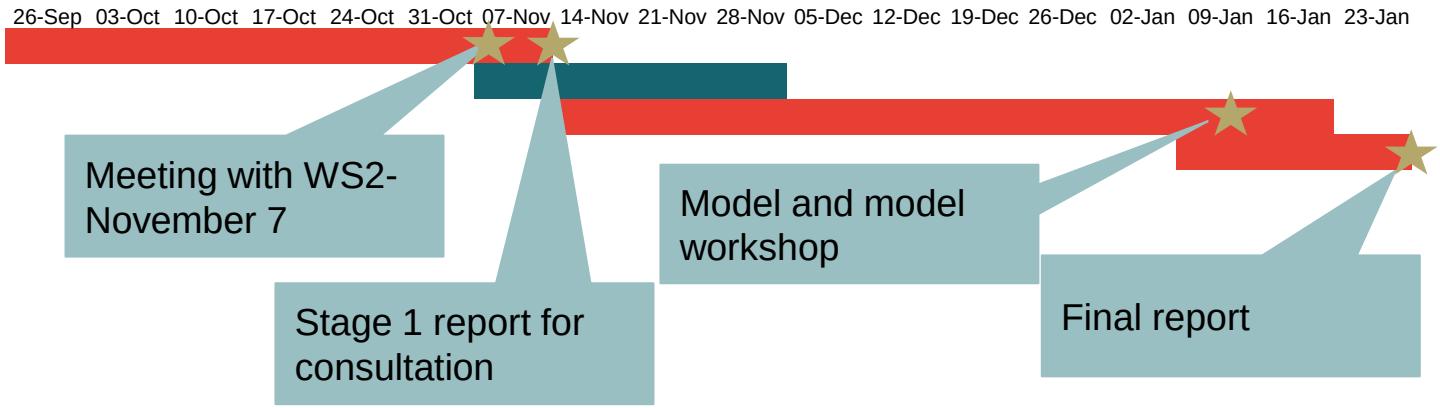
Timeline

Stage 1 : Initial evaluation Consultation
Stage 2: Model development
Stage 3: Produce final report



- Annex

Three stage approach

I Initial smart grid evaluation

- Identify smart grid value drivers
- Define scenarios varying by mix of value drivers
- Define smart grid technologies
- Understand distribution of cost and value
- Understand regulatory and policy issues
- Set out high level model specification

Key WS2 deliverable: interim report for consultation in early November 2011

II Model development

- Define smart grid solutions to fit each scenario
- Analyse factors which create option value (e.g. learning, investment lags, phased investment etc.)
- Evaluate costs and benefits of solutions
- Identify investment paths

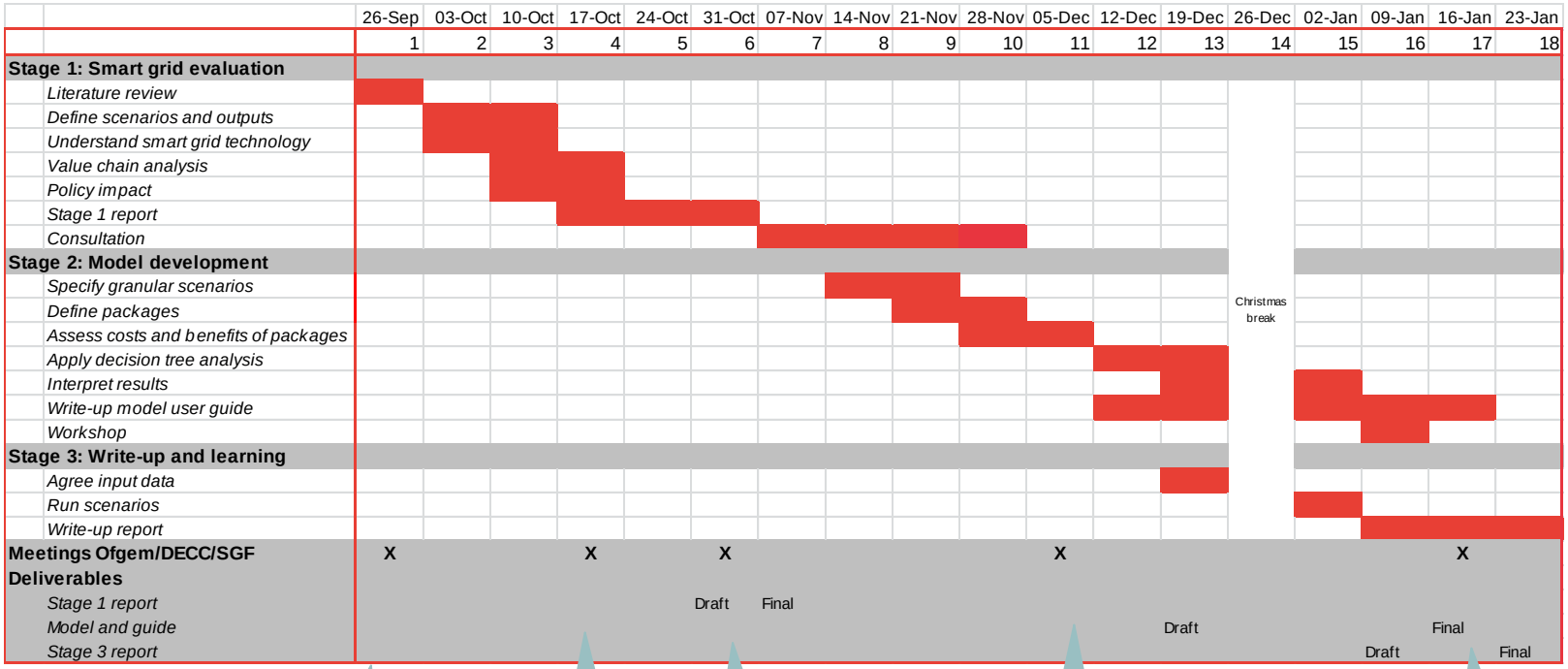
Key WS2 deliverable: working model and guide for industry use by mid January 2012

III Write up and learning

- Identify range of value of smart grid solutions
- Identify impact of uncertainty
- Identify investment and policy implications

Key WS2 deliverable: final report for publication in late January 2012

Overview of timeline



We have identified a number of potential meetings with Ofgem and the SGF

It will also be important to remain in regular contact with the other workstreams

Outline of stage 1 report

Our Stage 1 interim report will be divided into four sections:

1. Introduction and objectives	
i. Objectives	▫ What will the evaluation model be used for?
2. Context of the work	
i. Treatment of uncertainty	▫ What scenarios are being considered? ▫ How will the model deal with uncertainty?
ii. Smart grid functionality	▫ What are the technologies, costs, interdependencies and time lags associated with smart c/w BAU solutions?
3. Smart grid value drivers	
i. Value drivers of a smart grid	▫ In which areas may smart grid developments support sustainable development and long term customer value?
ii. Value chain analysis	▫ Which parties will be impacted by smart grids? ▫ What costs/benefits do they face?
iii. Impact of policy drivers	▫ What policies may impact on smart grid value and how will they do this?
4. Initial assessment of smart grid value	
i. Initial assessment of smart grid value	▫ What does existing evidence say about absolute / relative scale of benefits? ▫ What does our initial high level review say about where the likely greatest potential for benefit from smart grids is likely to come from?
5. Model specification	
i. Proposed model specification	▫ What is our proposed schematic for modelling the smart grid evaluation? ▫ Set out an options for consultation

…along with annexes that provide an overview of our literature review and data sources

This interim report will bring together the work carried out in Stage 1 and will be put out to consultation

The proposed assumptions and model spec in this report, along with industry feedback from the subsequent consultation process, will shape our approach to the modelling in Stage 2

Given this, the report will need to be of sufficient detail to build consensus on how the model should be developed and what functionality it should have

Summary of literature reviewed

Cost-benefit analyses and related work

ENSG (2010), *A Smart Grid Vision*

ENSG (2010), *A Smart Grid Routemap*

EPRI (2011), *Estimating the Costs and Benefits of the Smart Grid*

Pacific Northwest National Laboratory for the US Department of Energy (2010), *The Smart Grid: An Estimation of the Energy and CO2 Benefits, Rev 1*

Demand-side response

Ofgem (2010), *Demand Side Response – A Discussion Paper*

Pöyry, for DECC (2010), *Demand Side Response: Conflict Between Supply and Network Driven Optimisation*

Pöyry, for DECC (2011), *DSR follow on – final presentation*

Strbac, G et al (2010), *Benefits of Advanced Smart Metering for Demand Response based Control of Distribution networks*

Strbac, G (2008), *Demand-side management: benefits and challenges*

DECC Smart Meter Impact Assessment

DECC (2011), *Smart meter rollout for the domestic sector (GB)*

DECC (2011), *Smart meter rollout for the small and medium non-domestic sector*

LCNF Second Tier proposals

We have reviewed the proposals and supporting documents for all LNCF Second Tier projects.

Other documents

Element Energy, for UKPN (2011), *Modelling future load growth on UKPN networks*

CEER (2011), *CEER Status Review of Regulatory Approaches to Smart Electricity Grids*

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