REPORT

DNO RIIO-ED1 Business Plan Smart Grid Related Expenditure Assessment

Private and confidential

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Executive summary

This study has been instigated to assess whether the approach taken by Ofgem on the application of smart grid and smart meter benefits in the draft RIIO-ED1 (2015-23) determination for slow-track companies, August 2014, was correct. It provides key recommendations and evidence (where applicable) to ENA Member Companies on the arguments presented.

Four key areas for challenge have been identified:

1. **The approach taken by Ofgem in applying the benefits of smart grids, as taken from LCT related investment (from the Transform Model), to all forms of reinforcement is believed to be flawed based on the following points of justification:**

- It is appropriate to use the Transform Model to consider the reinforcement requirements associated with LCTs only, and to focus on the lower voltage networks.

- It is the opinion of EA Technology that the clarification document does not demonstrate with sufficient transparency the methodology employed by Ofgem. There still appears to be a lack of clear process and consistency in how the 25% figure has been arrived at. Furthermore, the use of the Transform Model to validate this figure is somewhat questionable. Indeed, EA Technology suggests that the application of a factor of proportionality, inferred by Ofgem through the Transform Model, to ALL forms of distribution network reinforcement is not coherent with the scope, applicability and use of the Transform Model.

- As shown in Table 1, LCT reinforcement is a relatively small subset of total reinforcement costs.

Table 1 Overview of all reinforcement for all DNOs taken from worksheet CV101

Total DNO Reinforcement Expenditure RIIO-ED1 (£m)	
General Reinforcement	**1472.2**
LCT related reinforcement	**499.7**
Fault Level related reinforcement	**156.1**
Total	**2128.0**

- It is noted that load related investments are driven by network expenditure incurred at higher voltages in contrast with the LCT related investments that are driven by network expenditure incurred at lower voltage levels. It is appropriate to use the Transform Model to consider the reinforcement requirements associated with LCTs only, and to focus on the lower voltage networks.

- Many of the solution sets used in the Transform Model are less applicable at higher voltages and less applicable to other types of reinforcement e.g. fault level.

- It can be observed in Figure 1 that load related investment in network assets at HV and LV levels constitutes only 23% of the total load related expenditure whilst network investments at the 132kV and EHV levels account for 77% of the overall load related expenditure.

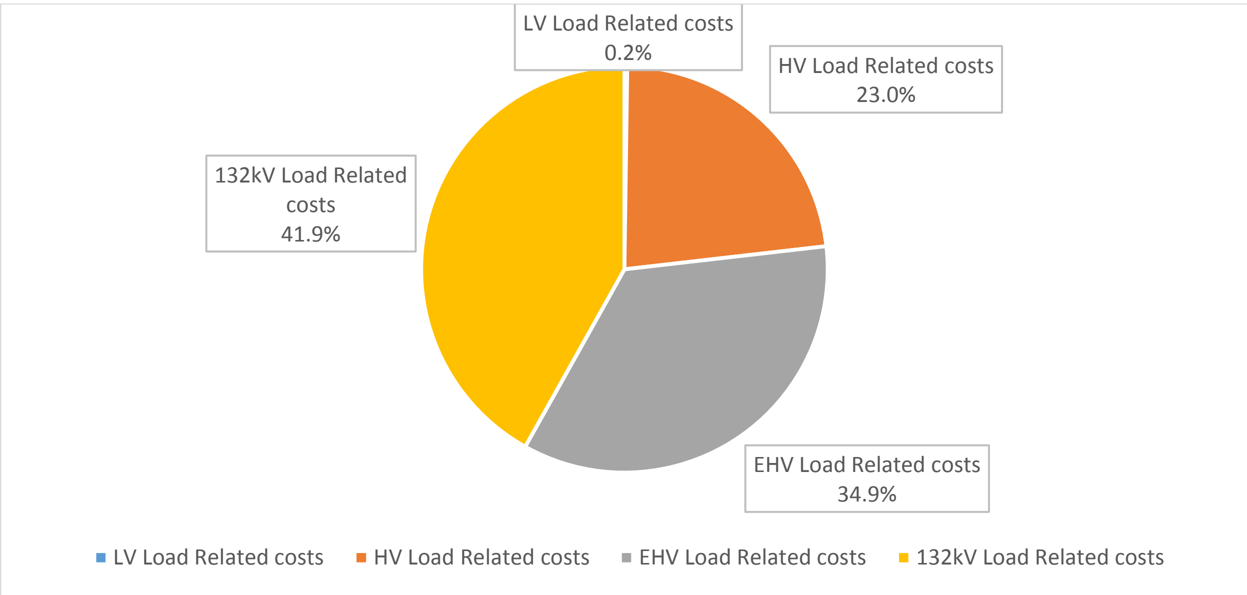

Figure 1 Load related reinforcement expenditure for RIIO-ED1 period

- EA Technology concludes that Ofgem should not have applied Transform savings to all reinforcement as this misrepresents the saving figures derived by the Transform Model.

2. Discrepancies on the evaluation of the 25% (or 23%) benefits figure for smart grid related investments

- It is appropriate to use the Transform Model to consider the reinforcement requirements associated with LCTs only.
- The modelled benefits completed for the GB Smart Grid Forum using the Transform Model show that benefits are highly dependent on: the scenario being modelled, the investment strategy chosen, the timeline over which the CBA is performed and numerous other factors.
- Presently it is not evident how Ofgem derived the figure of 25% as a benefit gained from smart grids for the RIIO-ED1 period.
- Furthermore, EA Technology believes that it is inappropriate to apply a uniform saving of 25% across all network reinforcement.
- The forecast savings figure calculated by each DNO will vary depending on specific local issues pertinent to each individual licence area, and on LCT uptake rates. It should be noted that greater benefits may be realised for higher uptakes of LCTs.

3. Ambiguous evaluation of SG_{other} benefits

- EA Technology believes that Ofgem's stance inconsistently assesses the DNOs definition of smart solutions. This assessment penalises DNOs who have assessed a solution (or one that sounds like it might be the same solution) as smart where the other DNOs are not implementing that solution or have not identified it as smart.
- Without carrying out an examination on a case-by-case basis to establish whether a like-for-like comparison can be made between DNOs, EA Technology feels that it is inappropriate to universally label a solution as 'non-smart'.

- EA Technology also believes Ofgem's approach in allocating other smart grid benefits to be inconsistent. EA Technology highlights that Ofgem appears to credit one DNO but not another when each DNO is looking to deploy some of the same types of solutions (automatic reclosers at LV) and are therefore likely to derive a comparable benefit.

- Furthermore, EA Technology can find no evidence for Ofgem's view that the level of benefit claimed by ENWL in total (£14.5m) should be translated to a percentage of DNOs' operating costs and then increased by another factor to reflect the level of other smart grid benefits that can be claimed.

- Ofgem states (section 11.20) that it considers 'savings in excess of this should be achievable' yet it offers no clear evidence or justification as to why in its determination it has decided that in order to calculate the amount of savings that would be reasonable for each DNO, it would be appropriate to multiply this by a further factor.

4. Smart Meter Benefits

- While smart meters (SMs) can provide a significant degree of granularity in terms of disaggregated load information at specific network points, this will contribute generally only to reinforcements on the secondary network which is a small portion of overall network reinforcement expenditure. Therefore, any reinforcements at EHV and 132kV would not receive any level of benefit from having access to smart meter data.

- Not all benefits associated with improved efficiency of distribution network operation and investment due to smart meters will be reflected in savings in DNOs' costs.

- The EA Technology analysis concurs with the lower end of the range of benefits arising from all uses of smart meters outlined in the ENA report[1]" (£47m – 80m).

A review of the revised DECC impact assessment figures and ENA analysis benefits figures broadly align in some of the DECC benefit categories, however for operational savings from fault fixing and reduced outage notifications calls these figures are quite disparate. The following list summarises these disparities:

- DECC analysis states that 33% of smart meter penetration by 2017 will allow DNOs to accrue the full smart meter benefit.

- Suppliers manage the roll out of smart meters, so benefits associated with locational requirements of smart meters cannot be guaranteed. Therefore it is EA Technology's view that there is insufficient evidence for the assumption that 100% benefits can be realised through 33% penetration of smart meters.

- Benefits DECC has attributed to DNOs in operational savings from fault fixing together with benefits accruing from improved IIS performance are not considered attributable to DNOs (£51.8m).

- DECC has not considered the benefit attributed to DNOs by SM data reducing guaranteed standard payments, details of which have been included in the ENA assessment. Compared to the other categories discussed, this has very little materiality (£2.1m).

- DECC has not accounted for additional customer enquiries related to SM data, and has assumed that telephony rates will reduce in comparison with an undefined base year.

[1] ENA, 2013. "Review of Analysis of Network Benefits from Smart Meter Message Flows", Energy Network Associations (July 2013)

- EA Technology notes that the ENA total expected benefit falls short of the £116m specified in the latest DECC impact assessment, and well less than £189m used by Ofgem as a base case for price control determination.

Contents

1. Introduction

The Great Britain (GB) regulator for gas and electricity markets (i.e. Ofgem) published on the 30th July 2014 the "Draft Determinations Consultation for the Slow-track Electricity Distribution Companies[2]" for the next price control period (i.e. RIIO-ED1). Generally, the document summarises Ofgem's proposals for the settlements (draft determinations) for five out of six electricity distribution companies for the RIIO-ED1 period which will come into effect in April 2015 and run for eight years until 2023.

Ofgem has published, together with the 'draft determinations consultation document', a series of supplementary annexes that provide further detail on their assessments. In particular, the "Business Plan Expenditure Assessment' document is of particular relevance for this project. This annex broadly describes how Ofgem assessed the 'Resources (efficient expenditure)'[3] criterion in slow-track assessment for RIIO-ED1. It also contains details of Ofgem's approach and key results from their analysis. Moreover, it includes details of refinements and changes since Ofgem's fast-track assessment as well as Ofgem's rationale.

In February 2014 Ofgem finalised ('settled') the price control of one company. The potential for early settlement is known as 'fast-tracking'. The remaining slow-track companies submitted revised business plans in March. The aforementioned documents summarise Ofgem's assessment of these plans and Ofgem's draft determinations for the electricity distribution network operators (DNOs).

The consultation process on the 'Draft Determinations for the Slow-track Electricity Distribution Companies' will close on the 26th September 2014, upon which Ofgem will publish the final determinations in November 2014.

The DNOs have sought specialist advisory support from EA Technology to: (i) investigate and describe the rationale and method used by Ofgem to derive the additional cost savings (or benefits) that the DNOs could achieve from the use of smart grids and smart meter data; (ii) identify and assess the main drivers of the projections for additional cost saving from smart grids and smart meter data inferred by Ofgem; and (iii) identify the range of stakeholders that may benefit from the cost savings accrued from smart grids and smart meters and to investigate and measure their individual benefits.

EA Technology has engaged with core divisions of its business in order to gather the knowledge and expertise required to address these requirements. Furthermore, EA Technology has brought to the project a wealth of experience acquired in the area of smart grids through its consultancy projects. In particular, through the development of the Transform Model that has been extensively used by DNOs as a network investment and planning tool to support the development of their business plans for RIIO-ED1.

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[2] Ofgem 2014. "RIIO-ED1: Draft Determinations Consultation for the Slow-track Electricity Distribution Companies". Office of Gas and Electricity Markets, 30 July 2014.
https://www.ofgem.gov.uk/ofgem-publications/89076/riioed1draftdeterminationoverview30072014.pdf

[3] Ofgem 2014. "RIIO-ED1: Draft Determinations Consultation for the Slow-track Electricity Distribution Companies – Business Plan Expenditure Assessment". Office of Gas and Electricity Markets, 30 July 2014.
https://www.ofgem.gov.uk/ofgem-publications/89068/riio-ed1draftdeterminationexpenditureassessment.pdf

2. Argument 1: Review of Ofgem’s framework to assess smart grid benefits

This section reviews Ofgem’s framework to assess the benefits to DNOs of using smart grids as a means to avoid or delay reinforcement in electricity distribution infrastructures. The analysis performed in this section was developed based on the business plan data that the DNOs submitted to Ofgem and on detailed data sets obtained from Ofgem’s own assessment of the business plans. The following analysis refer to the upcoming price control period, RIIO-ED1 (2015/2023).

2.1 Reinforcement related expenditure

The expenditure requirements associated with investment activities in electricity distribution infrastructure can be broadly divided into three main areas:

- **Network load growth or load churn related reinforcement**: this type of reinforcement is assessed based on known or likely reinforcement requirements during the period of analysis. It is normally location specific, based on local planning requirements, on economic growth, etc. Generally, the magnitude of reinforcement in this area is greater at the higher voltage levels.

- **LCT related reinforcement**: this type of reinforcement is principally derived from the uptake scenarios of LCTs defined by each DNO for its licence area. The need for investment in this area is triggered by behavioural changes of customers choosing technologies such as heat pumps (HP) electric vehicles (EV) or solar photovoltaic (PV) panels. Thus, most of the new constraints in the network occur at the lower voltage networks. This in turn, may lead to investment requirements at the higher voltage networks in order to ensure that sufficient network capacity exists to securely serve demand. The reinforcement strategies include the deployment of a mixture of conventional and smart solutions. The Transform Model developed by EA Technology as part of Work Stream 3 (WS3) of the Smart Grid Forum (SGF) was used by all DNOs in both fast and slow-track settlement stages to evaluate the network infrastructure requirements driven by LCTs. The LCT driven expenditure is provided in worksheet “CV103 – Reinforcement (LCTs)”.

- **Fault Level related reinforcement**: this type of reinforcement relates to the need to invest in equipment (e.g. switchboards) to overcome high fault level issues that could otherwise cause issues to circuit breakers. The fault level driven expenditure is provided in the worksheet “CV101 – Reinforcements & DSM”.

Traditionally, DNOs associate the reinforcement related expenditure with the voltage level at which network intervention is required, i.e. whether it relates to the primary or secondary network and with the type of equipment to be deployed in the network, i.e. whether it relates to substations (e.g. transformers) or circuits (e.g. overhead lines or underground cables).

The analysis of this subsection uses DNOs’ business plan own data from “CV101 – Reinforcements & DSM” worksheets to detail the magnitude of the total reinforcement expenditure for RIIO-ED1 period. Table 2 shows the total DNO reinforcement expenditure.

Table 2 Total DNO reinforcement expenditure for RIIO-ED1 period

Year	Reinforcement expenditure (£m)
2016	286.4
2017	293.3
2018	251.1
2019	250.7
2020	233.3
2021	256.3
2022	289.7
2023	267.4
Total	**2128.2**

Based on all the aforementioned areas of distribution network reinforcement, Ofgem has assumed in the 'Business Plan Expenditure Assessment' document[4] that the financial benefits attributed to smart grids are on average 23 to 25 per cent of the network reinforcement cost[5] achieved at GB level using a mix of conventional and smart solutions. Ofgem issued a clarification note to further explain the methodology used to arrive at this figure[6]. This note explained the fact that the methodology developed considered the savings arising through benefits from Low Carbon Network Fund projects and then using the Transform Model as a benchmark to confirm the level of savings. In this way, Ofgem suggests the 25 per cent figure that apportions the network reinforcement costs and consequently results in the benefits attributed to smart grids as an opportunity to avoid or delay reinforcement in electricity distribution infrastructures.

It is the opinion of EA Technology that the clarification document does not demonstrate with sufficient transparency the methodology employed by Ofgem. There still appears to be a lack of clear process and consistency in how the 25% figure has been arrived at. Furthermore, the use of the Transform Model to validate this figure is somewhat questionable. Indeed, EA Technology suggests that the application of a factor of proportionality, inferred by Ofgem through the Transform Model, to ALL forms of distribution network reinforcement is not coherent with the scope, applicability and use of the Transform Model.

This is because the Transform Model only covers network reinforcements driven by the integration of LCTs in the electricity distribution networks. In this respect, Ofgem's application of a factor of proportionality to ALL forms of network reinforcement implicitly assumes that the network solutions deployed to accommodate LCTs in the distribution network (i.e. predominantly deployed in the low voltage networks) are equally applicable to instances where other factors such as load changes stimulated by economic growth or energy efficiency and network faults drive the need for distribution network reinforcement. In other words, the network solutions deployed to accommodate LCTs are highly coincidental at all voltages levels and in all circumstances.

The next subsection provides further details on the applicability and use of the Transform Model to assess distribution network investment profiles associated with the integration of LCTs in the distribution networks.

[4] Ofgem 2014. "RIIO-ED1: Draft Determinations Consultation for the Slow-track Electricity Distribution Companies – Business Plan Expenditure Assessment". Office of Gas and Electricity Markets, 30 July 2014. https://www.ofgem.gov.uk/ofgem-publications/89068/riio-ed1draftdeterminationexpenditureassessment.pdf

[5] Refer to Paragraph 11.19, Page 105 of the "RIIO-ED1: Draft Determinations Consultation for the Slow-track Electricity Distribution Companies – Business Plan Expenditure Assessment".

[6] Ofgem, 2014, "Clarification of methodology for smart grids adjustment"

2.2 The applicability of the Transform Model to network reinforcement related expenditure

Distribution networks are planned to provide adequate levels of security and quality of supply in a cost-efficient manner. Considering the future energy outlook, there is a significant amount of uncertainty regarding the way in which customers will both consume and generate electricity. Thus, networks must be able to flex to meet the potential changes in demand that will arise through the likely deployment and maturity of new LCTs, such as heat pumps, electric vehicles and solar photovoltaic generation. This uncertainty is further intensified by the fact that the likely uptake of such technologies is largely outside the control of the DNOs and will be subject to market forces and governmental incentives. This means that it is fairly possible for uptake rates to increase significantly or gradually over a relatively short period of time and the networks must be prepared to overcome such challenges.

To address this objective, the Transform Model has been developed to assist DNOs. The Transform Model is a scenario driven model that allows users to explore the likely effects on network demands of increased levels of LCTs. The model allocates LCTs to various low voltage feeders via several mechanisms to allow for regional variations and local clustering effects. It then determines when the local network reaches its capacity limit and an intervention is required.

At this point, the Transform Model selects the most appropriate solution from a 'merit order'. This selection is informed by several parameters including the network type and the period of time the solution should be able to cater for future load growth without needing to be renewed or replaced. The solutions within the merit order for a 'smart investment strategy' are a combination of 'conventional' solutions (such as new transformers and cables) and 'smart' solutions (such as demand side response, real time ratings, energy storage etc.). By selecting the optimum solution for each intervention across the network, the Transform Model allows the construction of an investment profile, which represents the most cost-effective way to cater for the increase in LCTs on the network by adopting a range of both conventional and smart solutions. In contrast a 'conventional investment strategy' considers only those traditional solutions (transformers and cables)

By the nature of the problem that it addresses, the Transform Model needs to be a 'bottom-up' model as this is where the majority of LCTs will connect (at customer premises). Therefore, the majority of investment required is to solve problems arising on secondary networks (at low voltage (LV) and at high voltage (HV)) rather than grid and primary networks. Any reinforcement requirements at the higher voltages are likely to be handled via 'general reinforcement' and will be evaluated on a much more individual basis than the 'whole network' view that is taken by the Transform Model.

It is therefore appropriate to use the Transform Model to consider the reinforcement requirements associated with LCTs only, and to focus on the lower voltage networks. As such, inferences can be drawn for these reinforcements regarding the level of savings that can be made through the use of 'smart interventions' as opposed to solely deploying conventional solutions.

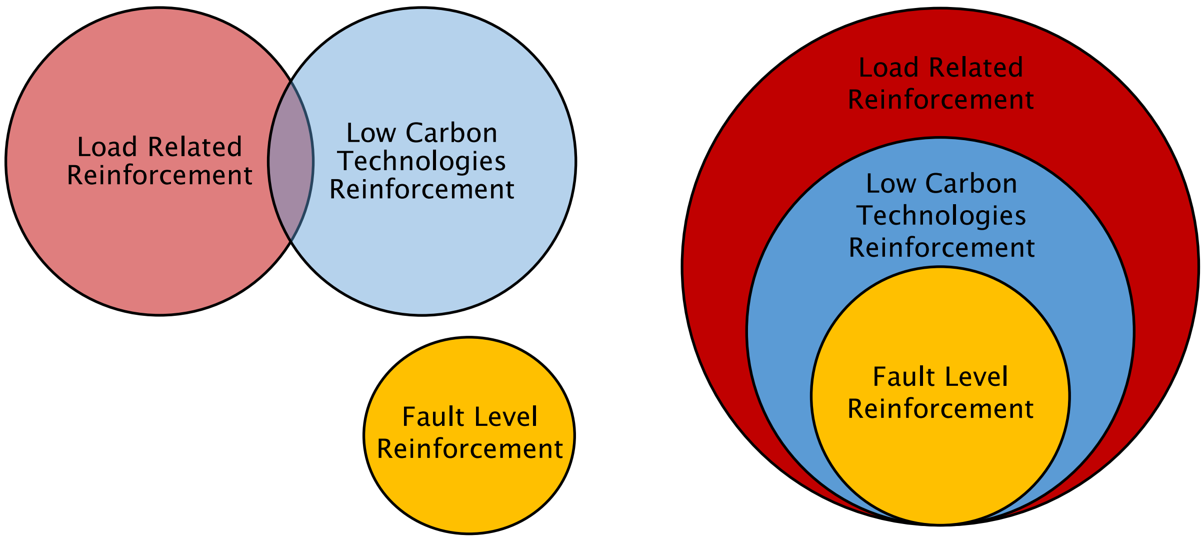
2.3 Discussion on Ofgem's framework to assess smart grid benefits

Subsection 2.1 described how Ofgem derived the 25 per cent factor of proportionality from the Transform Model and how it has been subsequently applied to all forms of distribution network reinforcement in order to quantify the benefits that DNOs can potentially achieve in their businesses from the use of smart grids. EA Technology has then suggested that the application of the factor of proportionality that has been derived from the Transform Model, to all forms of distribution network reinforcement is not coherent with the scope, applicability and use of the Transform Model. This subsection further addresses this discussion to promote a better understanding of Ofgem's use of the outcomes of the Transform Model.

In this respect, Ofgem's application of a factor of proportionality to ALL forms of network reinforcement implicitly assumes that the network solutions deployed to accommodate LCTs in the distribution network (i.e. predominantly deployed in the low voltage networks) are equally applicable to instances where other factors such as load changes stimulated by economic growth or energy efficiency and network faults drive the need for distribution network reinforcement. In others, the network solutions deployed to accommodate LCTs are highly coincidental at all voltages levels and in all circumstances.

Considering Ofgem's assumption as valid, it means that the network solutions deployed to enable a cost-efficient and secure integration of LCTs in the distribution network are equally cost-efficient and technically applicable to instances where other factors such as changes in demand and network faults drive the need for reinforcement in distribution networks. In this context, the assumption becomes invalid as the deployment of network assets to resolve network constraints is conditional to the type of network constraints, their severity, location, potential consequences, etc. In this sense, different network solutions may be more cost-efficient and technically adequate to resolve different network constraint problems than others as different network solutions exhibit different techno-economic benefits.

Figure 2 illustrates the previously described principles. In particular, Figure 2a illustrates the deployment of different network solutions to resolve different network constraint problems, whilst Figure 2b illustrates the deployment of the same set of network solutions to resolve different network constraint problems.



(a) Deployment of different network solutions to resolve different network constraint problems

(b) Deployment of the same set of network solutions to resolve different network constraint problems

Figure 2 Expenditure requirements associated with investment in electricity distribution infrastructure

Figure 2a exemplifies the strategy for the deployment of network solutions used in the DNOs' business plans to resolve network constraint problems. Different network solutions are deployed according to the type of network constraint that triggered the need for network reinforcement.

Figure 2b exemplifies the effect of the 'solution coincidence' approach, which appears to represent the position taken in the draft determination. In this view, the network solutions deployed to resolve network constraint problems associated with the integration of LCTs in a cost-efficient and secure manner are equally as efficient in resolving network constraints triggered by changes in other demand and fault levels.

The following subsection develops further analysis to highlight that distribution network reinforcement triggered by different types of network constraints problems are likely to require the deployment of dissimilar network solutions to attain techno-economic efficiency.

2.4 Breakdown of the network reinforcement related expenditure

This subsection uses DNOs' business plan submitted data to perform quantitative and qualitative analysis to highlight that distribution network reinforcement triggered by different types of network constraints are likely to require the deployment of dissimilar network solutions to attain techno-economic efficiency.

The analysis disaggregates the overall network reinforcement related expenditure, submitted by the DNOs to Ofgem, in the three (refer to subsection 2.1**Error! Reference source not found.** for further detail) main areas of reinforcement to provide a better understanding of the reinforcement implications. The LCT related reinforcement expenditure data has been extracted from "CV103 – Reinforcement (LCTs)" worksheet and the fault level related reinforcement expenditure has been extracted from "CV101 – Reinforcements & DSM".

In order to justify this argument, it is therefore essential to consider what makes up the three elements of investment outlined in Figure 2.

2.4.1 Low carbon technology related reinforcement expenditure

The LCT related reinforcement expenditure is presented in the format detailed by Ofgem for the expenditure assessment of DNOs' business plans. Thus, distribution network expenditure is categorised by primary and secondary networks as follows:

- Primary networks: Refers to network assets where the primary voltage is EHV or above (EHV – Voltages over 22kV up to, but not including, 132kV).
- Secondary networks: Refers to network assets where the primary voltage is HV or below (HV – Voltages over 1kV up to, but not including, 22kV).

Based on the data set provided by the DNOs in the "CV103 – Reinforcement (LCTs)" worksheets, Table 3details the LCT related reinforcement expenditure for RIIO-ED1 period disaggregated by primary and secondary networks for each of the DNOs.

Table 3 LCT driven reinforcement (assumed all from DNO Transform runs)

	Primary Network (£m)	Secondary Network (£m)	Total (£m)
ENWL	0.24	17.8	18.1
NPGN	0.36	16.2	16.5
NPGY	0.87	31.7	32.5
WMID	0.09	55.8	55.9
EMID	0.00	89.5	89.5
SWALES	0.00	11.7	11.7
SWEST	0.00	46.3	46.3
LPN	29.56	15.0	44.5
SPN	29.06	24.3	53.3
EPN	71.36	26.5	97.9
SPD	5.17	4.4	9.5
SPMW	2.59	10.3	12.9
SSEH	0.00	5.5	5.5
SSES	0.04	5.6	5.6
Total	**139.35**	**360.40**	**499.75**

Table 3 shows that the total LCT related reinforcement expenditure for GB is estimated to be £499.8m. It is seen that different DNOs incur dissimilar levels of network expenditure driven by the growth of LCTs in each DNO licence area and the deployment of conventional and smart network solutions to mitigate network integration challenges.

Figure 3 aggregates the data in **Error! Reference source not found.** to provide an overview of the LCT related reinforcement expenditure at GB level. The reinforcement costs are introduced for the primary and secondary networks as a percentage of the total LCT related reinforcement costs for GB.

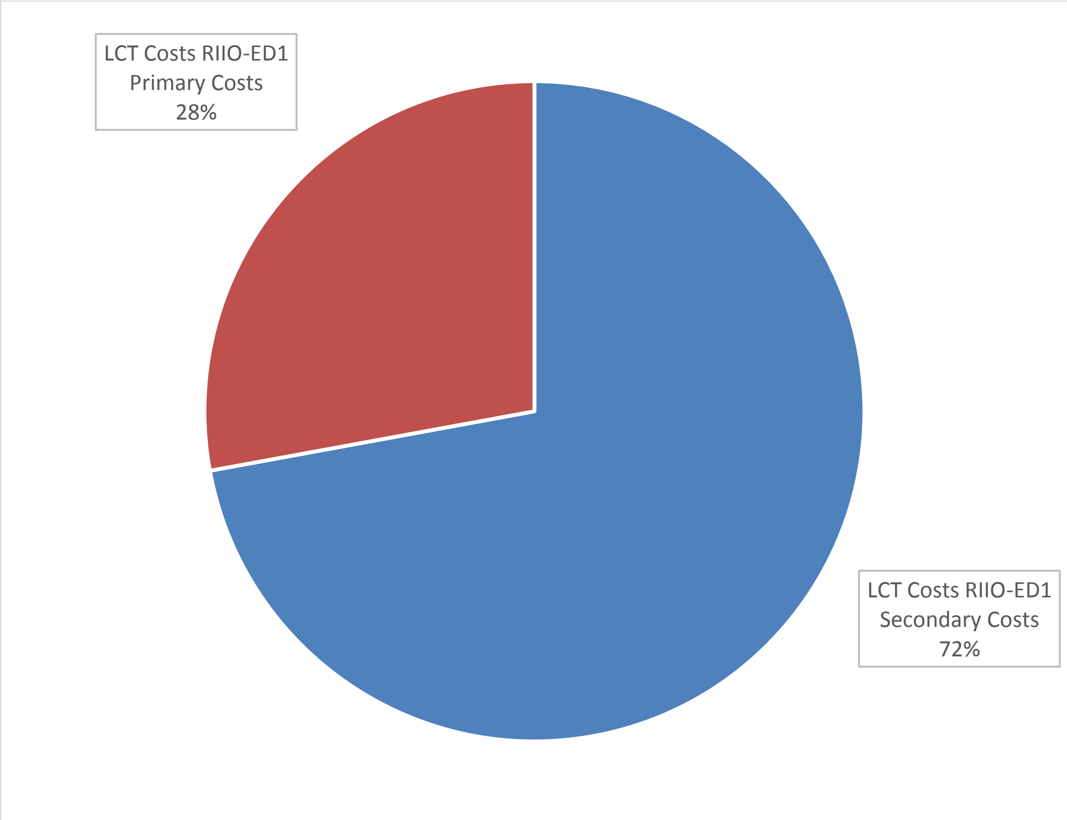


Figure 3 LCT related reinforcement expenditure for RIIO-ED1 period

Figure 3 indicates that 28% of the overall LCT network reinforcement expenditure is driven by the primary network (i.e. investment in network assets for 132kV and EHV networks) whilst 72% of the network reinforcement is attributed to the secondary network (i.e. investment in network assets for HV and LV networks). It is observed that network investment requirements in the secondary networks are substantially greater than those in the primary networks since LCT driven network investments are predominantly triggered by customers adopting the introduction of LCTs at the LV networks which subsequently may propagate towards higher voltage networks.

It is noted that network investments relating to the secondary network have not been further disaggregated into HV and LV as this information is not possible to be inferred from the data supplied.

2.4.2 Load related reinforcement expenditure

The load related reinforcement expenditure is quantified from the difference between the total network reinforcement expenditure and the sum of the LCT related reinforcement (from CV103) and fault level related reinforcement expenditures. Table 4 introduces the load related reinforcement expenditure for RIIO-ED1 period disaggregated by network type.

Table 4 Total load driven reinforcement expenditure per voltage level (as in "CV101")

Load Related Expenditure RIIO-ED1 (£m)	
LV Load Related costs only	3.3
HV Load Related costs only	338.0
EHV Load Related costs only	514.3
132kV Load Related costs only	616.6
Total Load Related Reinforcement Costs	**1472.2**

Table 4 shows that network expenditure requirements are driven by the need to invest in network assets at higher voltage levels such as 132kV and EHV (66kV and 33kV).

Figure 4 uses the data of Table 4 to display the load related reinforcement expenditure for the various network types as a percentage of the total load related reinforcement across GB.

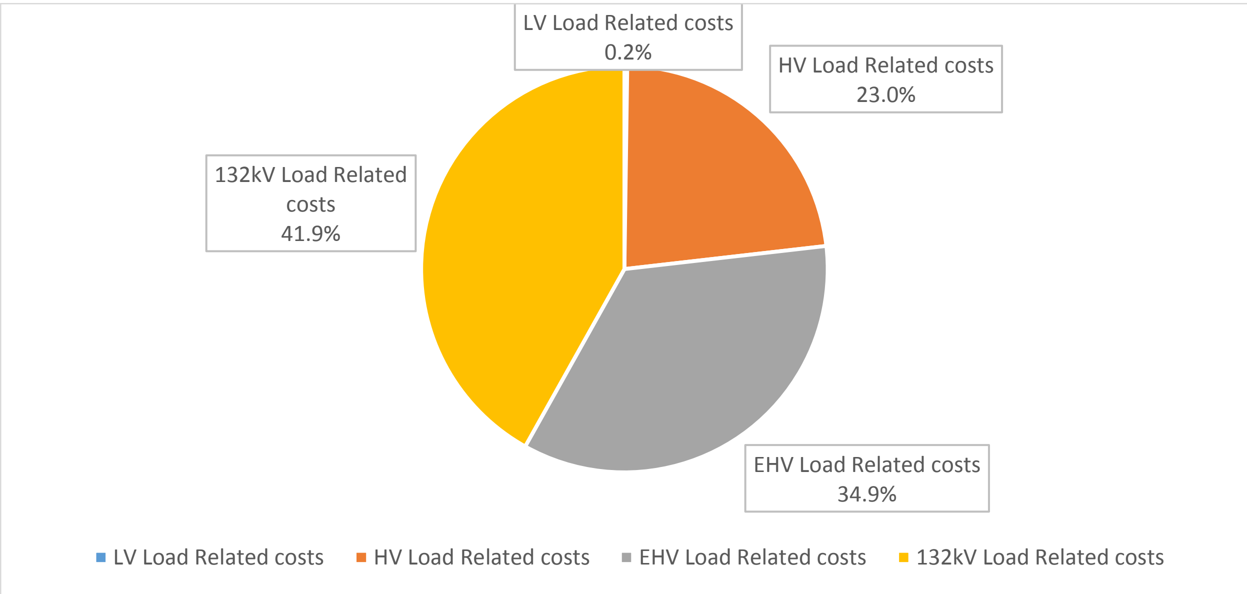


Figure 4 Load related reinforcement expenditure for RIIO-ED1 period

It can be observed in Figure 4 that load related investment in network assets at HV and LV levels constitute only 23% of the total load related expenditure whilst network investments at the 132kV and EHV levels account for 77% of the overall load related expenditure. The analysis demonstrates that network reinforcements driven by load are substantially more expensive at higher voltages than lower voltages due to the higher costs of equipment (ensuring adequate levels of network redundancy, security and quality of supply) and costs of intervening in the network.

It is noted that load related investments are driven by network expenditure incurred at higher voltages in contrast with the LCT related investments that are driven by network expenditure incurred at lower voltage levels. Load related investments are associated with relatively high costs of network equipment and intervention at higher voltages whilst LCT related investments are associated with the costs of network equipment and intervention at lower voltage levels to accommodate LCTs.

2.4.3 Fault level related reinforcement expenditure

The fault level related reinforcement expenditure has been extracted from "CV101 – Reinforcements & DSM" worksheet submitted by the DNOs to Ofgem. Table 5 presents the fault level related reinforcement expenditure for RIIO-ED1 period disaggregated by network type.

Table 5 Total Fault Level reinforcement expenditure from "CV101"

RIIO-ED1 Fault Level Reinforcement Costs only (£m)	
Total LV Fault Level reinforcement	0.0
Total HV Fault Level reinforcement	34.6
Total EHV Fault Level reinforcement	77.3
Total 132kV Fault Level reinforcement	44.3
Total Fault Level Reinforcement Cost	**156.1**

It is seen in Table 5 that the total fault level related reinforcement expenditure for GB is estimated to be £156.1m. The fault level reinforcement expenditure is primarily driven by the need to invest in network assets at higher voltage levels such as 132kV and EHV.

Figure 5 further expands the analysis of the data of Table 5 to express the reinforcement costs at each voltage level as a percentage of the total fault level reinforcement cost presented by the DNOs.

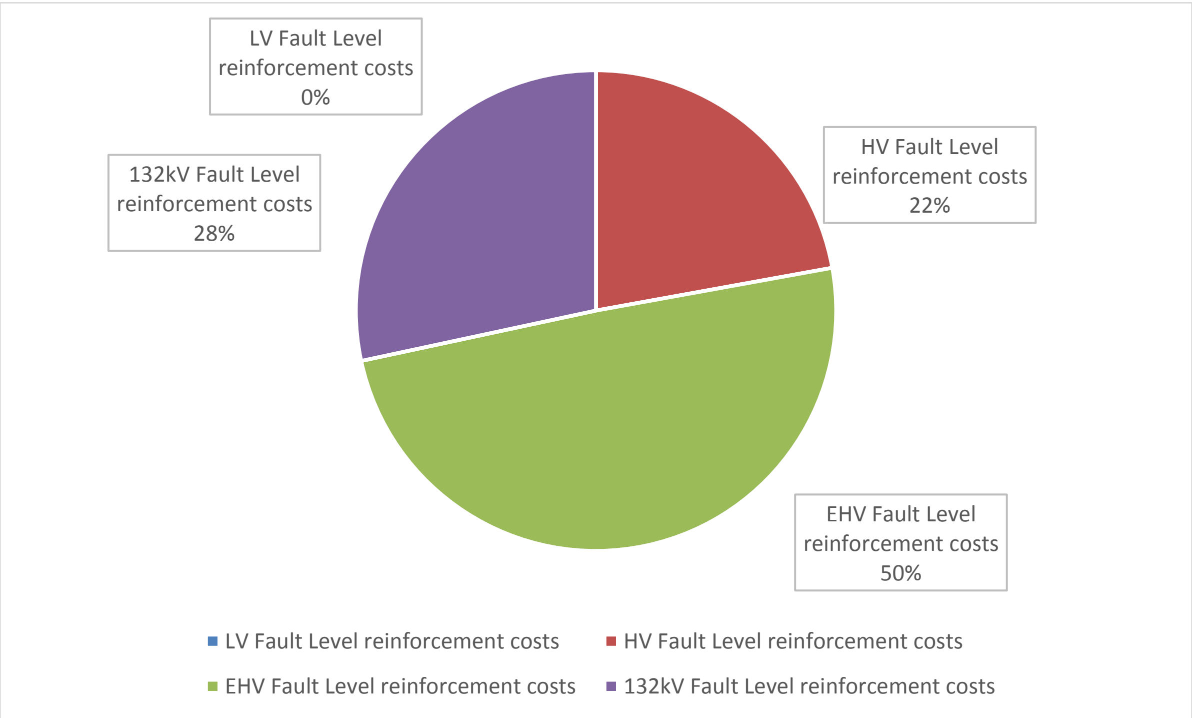


Figure 5 Fault level related reinforcement expenditure for RIIO-ED1 period

It can be seen in Figure 5 that the majority of fault level related investment (i.e. 78%) takes place on the EHV and 132kV networks, with a small amount of investment (i.e. 22%) on the HV networks and no investment occurring on the LV networks. The higher network expenditure requirements observed in the EHV and 132kV networks reflects the higher costs associated with network equipment and intervention to ensure adequate security and quality of supply.

2.4.4 Overview of reinforcement investment

This subsection highlights that the application of Ofgem's factor of proportionality derived from the Transform Model, to all forms of reinforcement misrepresents the benefits attributed to smart grids as an opportunity to avoid or delay reinforcement in electricity distribution infrastructures.

Error! Reference source not found. presents the reinforcement related expenditure submitted by the DNOs to Ofgem for RIIO-ED1 period. The reinforcement related expenditure is divided by three different types of reinforcement considered in the analysis.

Table 6 **Overview of all reinforcement for all DNOs taken from worksheet CV101**

Total DNO Reinforcement Expenditure RIIO-ED1 (£m)	
General Reinforcement	**1472.2**
LCT related reinforcement	**499.7**
Fault Level related reinforcement	**156.1**
Total	**2128.0**

It can be seen in **Error! Reference source not found.** that network reinforcement can be triggered by a variety of factors. Thus, different network solutions ought to be deployed accordingly to mitigate such factors. Since dissimilar costs and benefits are associated with each network solution, then different levels of reinforcement expenditure are required to resolve specific network constraint problems. For instance, **Error! Reference source not found.** shows that LCT related network reinforcement expenditure only constitutes a relatively small subset of total reinforcement expenditure.

It has been noted that load related investments are driven by network expenditure incurred at higher voltages in contrast with the LCT related investments that are driven by network expenditure incurred at lower voltage levels. It is appropriate to use the Transform Model to consider the reinforcement requirements associated with LCTs only, and to focus on the lower voltage networks. Many of the solution sets used in the Transform Model are less applicable at higher voltages and to other types of reinforcement e.g. fault level.

2.5 Declared Network Benefits from Smart Solutions

Ofgem has provided an assessment of the range of benefits to the DNOs of using smart grids and smart meter data. Based on the benefits explored, this section focuses on analysing the total cost savings (i.e. benefits) of using smart grids that will be achieved through avoiding or delaying work to increase the capacity of the network (i.e. reinforcement).

In this respect, the analysis uses the information submitted by DNOs to Ofgem as part of their business plans as well as Ofgem's analysis provided in the "Total smart benefits assessment-20140717-1_1" workbook. Consequently, Table 7 presents a summary of the DNOs' reinforcement benefits inferred from the "Total smart benefits assessment" workbook.

Table 7 DNO's Reinforcement benefits

Network Investment Benefits				
	Total Reinforcement	LCT Reinforcement[7]	Load Related Reinforcement[8]	Fault Level Reinforcement[9]
	£m			
ENWL	19.10	6.1	10.0	3.0
NPGN	29.61	10.6	19.01	0
NPGY	49.82	20.1	29.72	0
WMID	128.14	23.9	17.55	2.79
EMID		57.4		
SWALES		5.3		
SWEST		21.2		
LPN	46.90	13.0	33.9	0
SPN	40.30	17.6	22.7	0
EPN	44.90	19.5	25.4	0
SPD	20.50	6.8	13.7	0
SPMW	18.85	1.9	14.6	2.35
SSEH	56.05	4.9	49.02	2.13
SSES				
TOTAL	**454.17**	**208.30**	**235.60**	**10.27**

This analysis has been performed by considering the Total Smart Benefits table, as provided by all DNOs to Ofgem as SQ2.

Having established the levels of benefit associated with LCT reinforcement, it is now possible to determine the saving that each DNO is claiming as against the LCT reinforcement that would have been required using only conventional solutions.

Table 8 illustrates the total amount of LCT smart reinforcement being carried out by DNOs, together with the amount of reinforcement that would have been necessary using only conventional means. The difference between these figures is the LCT smart benefit (as previously illustrated in Table 7 above). The LCT smart benefit can therefore be calculated as the percentage saving made by DNOs through the adoption of a blend of smart and conventional solutions, as opposed to purely using conventional solutions.

[7] It has been assumed that if the investment is listed in CV103 and is defined as coming from Transform, then it is LCT driven reinforcement
[8] It has been assumed that if the investment is listed in CV101, then it is all forms of reinforcement
[9] Fault level reinforcement is assigned only if identified or if the technology is a form of fault current limiter

Table 8 EA Technology assessment of benefits based on information in SQ2 worksheets

Network Investments and Benefits				
	LCT smart reinforcement (£m)	LCT conventional reinforcement (£m)	LCT smart benefit (£m)	LCT smart benefit (%)
TOTAL	**499.7**	**708.1**	**208.3**	**29%**

It is shown in **Error! Reference source not found.** that the LCT related reduction in investment via the use of smart approaches by DNOs is on average around 29%. This forecast savings figure will vary depending on specific local issues pertinent to each individual licence area, and on LCT uptake rates. It should be noted that greater benefits may be realised for higher uptakes of LCTs. In addition, some DNOs are also strategically investing in enabling technologies ahead of time to enable them meet the increased demands on the network during future regulatory periods in a more cost efficient manner. Given the level of uncertainty that exists regarding these future LCT uptake rates, having the ability to flex to respond to changing demands is important, as previously discussed in section 2.2.

Figure 6 displays a schematic representation of the scale of smart grid benefits accrued by the DNOs through the deployment of smart network solutions to mitigate the integration challenges posed by LCTs in electricity distribution networks.

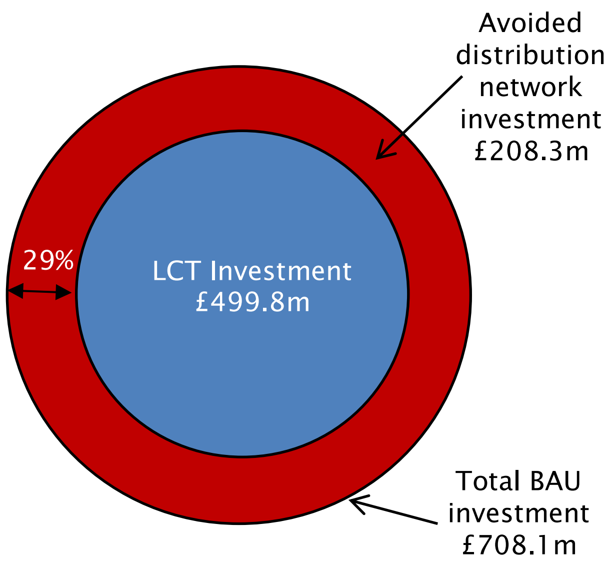


Figure 6 RIIO-ED1 investment levels declared for LCT related investment from the use of smart grids vs conventional solutions only

2.6 Solutions used for LCT related reinforcement

This subsection disaggregates the DNOs' declared LCT related reinforcement expenditure into the type of network solutions deployed to build future networks. In particular, the subsection details the number of smart solutions and their associated costs for RIIO-ED1 period.

Table 9 and Table 10 detail the number of smart solutions required to be deployed and the associated costs respectively, across all DNOs during RIIO-ED1 period. The tables have been produced from the information contained in “CV103” worksheets.

It can be observed in Table 9 that the total number of smart grid solutions deployed in the secondary networks over the RIIO-ED1 period is estimate to be 94,879 whilst the number of those for the primary network only reaches a total of 605. The number of smart grid solutions required to be deployed during RIIO-ED1 in the secondary networks is substantially greater than those in the primary networks since LCT driven network investments are predominantly triggered by customers adopting LCTs on the LV networks.

Table 10 supports the findings of subsection 2.4.1 highlighting that network investment requirements in secondary networks are substantially greater than those in primary networks since LCT driven network investments are predominantly triggered by customers adopting LCTs at the LV networks which subsequently may propagate towards higher voltage networks.

Table 9 Smart Grid solution volumes RIIO-ED1across all DNOs

	Volumes								
	2016	2017	2018	2019	2020	2021	2022	2023	RIIO-ED1
	RIIO-ED1								
Secondary network									
Active Network Management - Dynamic Network Reconfiguration	-	-	-	-	-	-	-	-	-
Flexible AC Transmission Systems	0.05	0.05	0.11	0.22	0.33	0.44	0.55	0.66	2.4
D/GSR	-	-	-	-	-	-	-	-	-
Embedded DC Networks	-	-	-	-	-	-	-	-	-
Enhanced Automatic voltage Control (EAVC)	0.56	1.56	117.11	2.23	68.34	5.45	5.57	6.68	207.5
Fault Current Limiters	-	-	-	-	-	-	-	-	-
Generator Providing Network Support	46.18	31.21	84.14	75.21	169.50	107.62	212.58	212.21	938.7
Intelligent control devices (EVs)	-	-	-	5.00	4.00	31.00	1.00	1.00	42.0
New Types Of Circuit Infrastructure	-	-	-	-	-	-	-	-	-
Meshing (permanent)	231.81	222.66	236.95	272.90	307.98	336.20	372.27	550.42	2,531.2
Meshing (temporary)	1.58	1.58	3.16	9.41	11.98	15.45	15.81	22.27	81.3
Real-Time Thermal Rating	56.36	56.36	112.73	225.46	340.19	473.13	568.64	728.85	2,561.7
Switched Capacitors	57.34	155.90	51.59	47.33	295.85	261.02	299.28	127.99	1,296.3
Conventional reinforcement	301.07	396.12	632.69	786.99	1,313.72	1,534.76	1,941.53	2,429.53	9,336.4
Electrical Energy Storage	-	-	-	-	-	-	-	-	-
Smart Enabler	677.17	906.64	1,259.17	1,119.30	2,620.63	2,451.38	3,069.83	2,776.65	14,880.8
Service Unbundling	29.00	117.00	264.00	470.00	734.00	1,057.00	1,439.00	1,880.00	5,990.0
Harmonics	2.00	7.00	15.00	26.00	41.00	59.00	80.00	105.00	335.0
Additional DNO solution type - type description in this cell	-	-	-	-	-	-	-	-	-
Unbundling of shared service cables (for PV)	7,169.00	7,345.00	7,634.00	7,418.00	8,195.00	9,318.00	5,909.00	3,688.00	56,676.0
opex associated with all solutions and enablers	-	-	-	-	-	-	-	-	-
	8,572.1	9,241.1	10,410.7	10,458.1	14,102.5	15,650.4	13,915.1	12,529.3	94,879.2
primary network									
Active Network Management - Dynamic Network Reconfiguration	-	-	1.04	-	-	2.04	4.26	2.00	9.3
Flexible AC Transmission Systems	-	-	-	-	1.00	-	-	-	1.0
D/GSR	-	-	-	-	-	-	-	-	-
Embedded DC Networks	-	-	-	-	-	-	-	-	-
Enhanced Automatic voltage Control (EAVC)	-	-	-	-	-	-	-	-	-
Fault Current Limiters	-	-	-	-	-	-	-	-	-
Generator Providing Network Support	-	0.31	1.04	-	1.31	2.04	4.35	1.00	10.0
Intelligent control devices (EVs)	-	-	-	-	-	-	-	-	-
New Types Of Circuit Infrastructure	-	-	-	-	-	-	-	-	-
Meshing (permanent)	-	-	-	-	-	1.00	-	1.00	2.0
Meshing (temporary)	-	-	-	-	-	-	-	-	-
Real-Time Thermal Rating	-	1.31	2.26	2.00	4.31	5.30	7.76	4.78	27.7
Switched Capacitors	-	-	-	-	-	-	-	-	-
Conventional reinforcement	63.67	75.93	74.64	52.56	53.01	67.20	78.13	67.74	532.9
Electrical Energy Storage	-	-	-	-	-	-	-	-	-
Smart Enabler	-	0.31	2.33	-	1.31	5.33	9.14	3.78	22.2
	63.7	77.9	81.3	54.6	60.9	82.9	103.6	80.3	605.2
									95,484.4

Table 10 Smart Grid solution costs RIIO-ED1across all DNOs

ED1 DNOs current "best view" - using current ir	2016	2017	2018	2019	2020	2021	2022	2023	RIIO-ED1
LCT Solutions	RIIO-ED1								(£m)
Secondary network									
Active Network Management - Dynamic Network Reconfiguratic	-	-	-	-	-	-	-	-	-
Flexible AC Transmission Systems	0.01	0.01	0.01	0.03	0.04	0.05	0.07	0.08	0.3
D/GSR	-	-	-	-	-	-	-	-	-
Embedded DC Networks	-	-	-	-	-	-	-	-	-
Enhanced Automatic voltage Control (EAVC)	0.01	0.02	0.20	0.06	0.18	0.12	0.15	0.18	0.9
Fault Current Limiters	-	-	-	-	-	-	-	-	-
Generator Providing Network Support	0.13	0.10	0.25	0.26	0.66	0.43	0.73	0.96	3.5
Intelligent control devices (EVs)	-	-	-	0.02	0.01	0.12	0.00	0.00	0.2
New Types Of Circuit Infrastructure	-	-	-	-	-	-	-	-	-
Meshing (permanent)	5.75	5.53	5.85	6.66	7.45	8.07	8.90	12.72	60.9
Meshing (temporary)	0.05	0.05	0.10	0.29	0.38	0.48	0.50	0.69	2.5
Real-Time Thermal Rating	0.18	0.19	0.37	0.73	1.14	1.70	2.01	2.59	8.9
Switched Capacitors	0.68	1.74	0.66	0.67	3.39	3.11	3.56	1.78	15.6
Conventional reinforcement	6.47	8.51	13.03	18.55	28.54	34.88	40.70	52.93	203.6
Electrical Energy Storage	-	-	-	-	-	-	-	-	-
Smart Enabler	0.95	1.22	2.20	2.14	4.51	4.47	5.16	5.99	26.6
Service Unbundling	0.04	0.15	0.34	0.60	0.94	1.35	1.83	2.40	7.6
Harmonics	0.03	0.10	0.23	0.42	0.65	0.94	1.28	1.67	5.3
Additional DNO solution type - type description in this cell	-	-	-	-	-	-	-	-	-
Unbundling of shared service cables (for PV)	3.15	3.21	3.31	3.19	3.50	3.96	2.49	1.54	24.4
opex associated with all solutions and enablers	-	-	-	-	-	-	-	-	-
	17.4	20.8	26.6	33.6	51.4	59.7	67.4	83.5	360.4
Primary network									
Active Network Management - Dynamic Network Reconfiguratic	-	-	0.07	0.01	0.02	0.14	0.27	0.10	0.6
Flexible AC Transmission Systems	-	-	-	-	0.22	0.01	0.01	0.01	0.3
D/GSR	-	-	-	-	-	-	-	-	-
Embedded DC Networks	-	-	-	-	-	-	-	-	-
Enhanced Automatic voltage Control (EAVC)	-	-	-	-	-	-	-	-	-
Fault Current Limiters	-	-	-	-	-	-	-	-	-
Generator Providing Network Support	-	0.01	0.02	0.00	0.02	0.04	0.08	0.02	0.2
Intelligent control devices (EVs)	-	-	-	-	-	-	-	-	-
New Types Of Circuit Infrastructure	-	-	-	-	-	-	-	-	-
Meshing (permanent)	-	-	-	-	0.03	0.04	0.00	0.03	0.1
Meshing (temporary)	-	-	-	-	-	-	-	-	-
Real-Time Thermal Rating	-	0.15	0.29	0.42	0.43	0.77	0.85	0.74	3.7
Switched Capacitors	-	-	-	-	-	-	-	-	-
Conventional reinforcement	17.41	19.91	19.19	14.38	14.07	15.68	17.93	15.29	133.8
Electrical Energy Storage	-	-	-	-	-	-	-	-	-
Smart Enabler	-	0.01	0.07	0.00	0.07	0.17	0.24	0.14	0.7
Additional DNO solution type - type description in this cell	-	-	-	-	-	-	-	-	-
Additional DNO solution type - type description in this cell	-	-	-	-	-	-	-	-	-
Additional DNO solution type - type description in this cell	-	-	-	-	-	-	-	-	-
	17.4	20.1	19.6	14.8	14.9	16.8	19.4	16.3	139.3
									499.8

2.7 Application of Smart solutions as used for LCT driven reinforcement to other areas

This Section demonstrates whether the smart solutions within the Transform Model can be applied to other types of reinforcement (in terms of relieving voltage and thermal constraints), other than LCT driven reinforcement. There are several solutions types used in the Transform Model. Variants of these solutions are considered in order to take into account the different costs and benefits of each solution at each voltage. The table below describes what these solutions are, and the voltages to which the variants are expected to apply within the timescales of the RIIO-ED1 period. The table does not represent any statement as to the cost-effectiveness or efficiency of the solutions; it merely describes their expected availability.

Table 11 Smart solutions taken from the Transform Model and their applied voltages

Solutions	Solution Description	132kV	EHV	HV	LV
Active Network Management - Dynamic Network Reconfiguration	Pro-active movement of LV network split (or open) points to align with the null loading points within the network in real time.	N	Y	Y	Y
DISTRIBUTION -Flexible AC Transmission Systems	Series or shunt connected static power electronics as a means to enhance controllability and increase power transfer capability of the LV network	N	Y	Y	Y
D/GSR	The signalling to customers (load for DSR, generation for GSR) to reduce demand or increase/reduce generation at certain times of day/year in order to manage network loads.	N	Y	Y	Y
Embedded DC Networks	The application of point-to-point LV DC circuits to feed specific loads (used in a similar manner to transmission 'HVDC', but for distribution voltages). A retrofit solution to existing circuits.	N	Y	Y	Y
Enhanced Automatic voltage Control (EAVC)	Additional automatic voltage control devices over and above those located at the grid and primary transformers.	N	Y	Y	Y
Fault Current Limiters	Superconducting materials use as a form of non-linear resistor, to clamp fault current levels at HV to within predefined limits.	N	Y	Y	N
Generator Providing Network Support	3-phase connected generator to be operated in PV (Real power and volts) mode rather than the conventional PQ (Real and Reactive power). The generator will draw VArs from the network at certain times, but ensure that the voltage on the network is not	N	Y	Y	Y

Solutions	Solution Description	132kV	EHV	HV	LV
	excessively raised at the point of connection.				
Intelligent control devices (EVs)	A novel monitoring and control solution to manage the supply of electricity to EVs connected to distribution networks, ensuring that the load of all EV chargers does not take the load above the rating of the LV circuit.	N	N	N	Y
New Types Of Circuit Infrastructure	Deployment of new, higher capacity, HV underground cables incorporating modern conductor types and designed in a way to minimise electrical resistance and reactance.	N	Y	Y	Y
Meshing (permanent)	Converting the operation of the network from a radial ring (with split points) to a solid mesh configuration.	N	Y	Y	Y
Meshing (temporary)	Converting the operation of the network from a radial ring (with split points) to a solid mesh configuration.	N	Y	Y	Y
Real-Time Thermal Rating	The use of measurement and ambient forecasting data to predict the rating (and hence current carrying capacity) of assets in a real-time mode.	N	Y	Y	Y
Switched Capacitors	Mechanically switched devices as a low cost form of reactive power compensation. They are used for voltage control and network stabilisation under heavy load conditions.	N	Y	Y	Y
Conventional reinforcement	Those solutions that are widely used in the design, operation and management of networks today.	N	Y	Y	Y
Electrical Energy Storage	Smaller-sized LV connected batteries, (e.g. serving 1 or 2 residential properties) deployed on a network to either deliver the peak demand, or absorb high levels of generation at key times of the day/year.	N	Y	Y	Y
Smart Enabler	Component part of a solution, but one that is not, in itself, able to provide headroom benefits. They are typically associated with monitoring, communications or control systems.	N	Y	Y	Y

Solutions	Solution Description	132kV	EHV	HV	LV
Service Unbundling	Assumed to be splitting of LV service cables back to the LV main.	N	N	N	N
Harmonics	Assumed to refer to solutions that help solve power quality (e.g. harmonics, flicker, etc). This would include active filters, etc.	N	N	N	N
Unbundling of shared service cables (for PV)	This is assumed to be the same as Service Unbundling	N	N	N	N
Opex associated with all solutions and enablers	As suggested, this is assumed to be the ongoing costs for managing solutions and enablers during the ED1 period.	N	N	N	N

Table 12 provides an overview of each of the solutions in terms of whether they can be used to provide reinforcement options (in terms of relieving voltage and thermal constraints).

Table 12 Smart Grid solution RIIO-ED1 qualitative assessment

Solutions	Applicable for load and voltage driven reinforcement	Comments
DISTRIBUTION -Flexible AC Transmission Systems	Y	D-FACTS devices could be applied with new connections in order to manage power flows and avoid new circuits having to be built. At higher voltages, the D-FACTS devices would be more expensive, and an optioneering study would generally be performed to assess whether this is the most cost effective solution.
D/GSR	Y	There are many variants of DSR and GSR that exist today. In order to avoid general reinforcement, this would typically be considered at EHV and 132kV only. The application at these higher voltages is highly customer and location specific, and would require detailed analysis to support.
Embedded DC Networks	Y	Embedded DC networks are unlikely to be of benefit in the RIIO-ED1 period due the lack of readily available technology at a reasonable capital cost.
Enhanced Automatic voltage	Y	EAVC solutions are applicable for general reinforcement where voltage is the driver for investment. This is likely to be at lower voltages (Secondary level) as the voltage is well

Solutions	Applicable for load and voltage driven reinforcement	Comments
Control (EAVC)		controlled at Primary level and above.
Fault Current Limiters	N	FCLs are not relevant for load or voltage driven reinforcement
Generator Providing Network Support	Y	This may be applicable, but would be highly location specific and subject to bespoke contractual conditions. Given this, it is not possible to consider this solution as a generic option.
Intelligent control devices (EVs)	N	This solution is only likely to be relevant for LCT driven reinforcement (EVs, with a potential application to HPs)
New Types Of Circuit Infrastructure	Y	Highly unlikely to be deployed in RIIO-ED1 due to the cost and availability of solution.
Meshing (permanent)	Y	This is a solution which is applicable, however meshing generally needs to be done on a zone by zone basis, and therefore would only be undertaken as part of a widescale roll-out. It's application would be case specific
Meshing (temporary)	Y	This is a solution which is applicable, however meshing generally needs to be done on a zone by zone basis, and therefore would only be undertaken as part of a widescale roll-out. It's application would be case specific
Real-Time Thermal Rating	Y	The applicability of this solution is case specific for higher voltages, as is dependent on local geography. It is likely to be cost probative at lower voltages in the ED1 period.
Switched Capacitors	Y	This would be applicable for voltage issues only. Application would be location specific at higher voltages.
Conventional reinforcement	Y	Business as usual solution(s)
Electrical Energy Storage	Y	Electrical energy storage could be used to manage power flow or voltage constraints, however the high capital cost means this is unlikely to be deployed in ED1 timescales.
Smart Enabler	N	Enablers do not deliver any voltage or thermal benefits - they are there to facilitate other solutions.
Service Unbundling	N	Unlikely to be used for general reinforcement. No expected benefit for voltage.

Solutions	Applicable for load and voltage driven reinforcement	Comments
Harmonics	N	Unlikely to be relevant to general reinforcement
Unbundling of shared service cables (for PV)	N	Unlikely to be used for general reinforcement. No expected benefit for voltage.
opex associated with all solutions and enablers	N	No expected benefit for load

The below table then considers each of the solutions within the Transform Model to determine whether they can be used to provide fault level reinforcement. This allows the analysis of whether solutions can potentially provide synergies to alleviate other reinforcement needs, along with the primary driver of relieving constraints imposed by connections of LCTs. It should be noted that some solutions (highlighted below) can have a negative impact on fault level.

Table 13 Applicability of solutions for fault level benefits

Solutions	Applicable for FL benefits	Comments
Active Network Management - Dynamic Network Reconfiguration	Possible	Fault level can be dynamically managed though the opening and closing of bus-section circuit breakers, although there is a notional cost to security of supply in so doing.
DISTRIBUTION -Flexible AC Transmission Systems	N	D-FACTS would not generally be deployed to solve a fault level problem.
D/GSR	N	- DSR would not yield a fault level benefit. - There is an argument for GSR providing fault level benefits, but this would require detailed negotiations with the generator about the time of year/day when generation would have to be curtailed.
Embedded DC Networks	Y	Unlikely to be available in the ED1 period.
Enhanced Automatic voltage Control (EAVC)	N	No benefit to fault level.

Solutions	Applicable for FL benefits	Comments
Fault Current Limiters	Y	This solution is applicable, but the costs of FCLs would have to be compared with other options on the market on a case by case basis.
Generator Providing Network Support	N	Unlikely to be used to resolve a fault level problem
Intelligent control devices (EVs)	N	No benefit to fault level.
New Types Of Circuit Infrastructure	N	Unlikely to be used to resolve a fault level problem
Meshing (permanent)	N	This would increase fault level, and is therefore detrimental to FL.
Meshing (temporary)	N	This would increase fault level, and is therefore detrimental to FL.
Real-Time Thermal Rating	N	No benefit to fault level.
Switched Capacitors	N	No benefit to fault level.
Conventional reinforcement	Y	Splitting of networks is the common way to manage fault level issues.
Electrical Energy Storage	N	No benefit to fault level.
Smart Enabler	N	No benefit to fault level.
Service Unbundling	N	No benefit to fault level.
Harmonics	N	No benefit to fault level.
Unbundling of shared service cables (for PV)	N	No benefit to fault level.
opex associated with all solutions and enablers	N	No benefit to fault level.

2.8 Conclusion

The concluding points from discrepancies on the evaluation of the 25% (or 23%) benefits figure for smart grid related investments section are as follows:

- It is appropriate to use the Transform Model to consider the reinforcement requirements associated with LCTs only.
- The modelled benefits completed for the GB Smart Grid Forum using the Transform Model show that benefits are highly dependent on: the scenario being modelled, the investment strategy chosen, the timeline over which the CBA is performed and numerous other factors.
- Presently there is insufficient clarity regarding the method by which Ofgem derived the figure of 25% as a benefit gained from smart grids for the RIIO-ED1 period.
- Furthermore, EA Technology believes that it is inappropriate to apply a uniform saving of 25% across all network reinforcement. The tables shown in section 2.7 (Table 11, Table 12, Table 13) conclude that all the smart solutions and their variants within Transform Model are not to be applied to higher voltage levels (e.g. 132kV).
- The forecast avoided investment figure calculated by each DNO will vary depending on specific local issues pertinent to each individual licence area, and on LCT uptake rates. It should be noted that greater benefits may be realised for higher uptakes of LCTs.

3. Argument 2: Discrepancies on the evaluation of the 25% (or 23%) benefits figure for smart grid related investments

3.1 Background

Presently there is insufficient clarity regarding the method by which an overarching figure of 25% has been derived as an expected benefit gained from smart grids for the RIIO-ED1 period.

The modelling completed for the GB Smart Grid Forum using the Transform Model shows that benefits from 29% to 46% can be achieved (out to 2050)[10], this benefit is highly dependent on:

- **The scenario being modelled**: whilst the % avoided investment can be higher for lower uptakes of LCTs, the magnitude of benefit is significantly higher for high uptakes of LCT.
- **The investment strategy chosen**: the avoided investment out to 2050 (the key focus of the SGF) are best for Selective Top Down in all but one scenario (Scenario 4: Credit Purchase). However in order to achieve this, the costs of rolling out enabler investment are borne in the ED1 / early ED2 period which results in a significant reduction (negative in some cases) in smart grid benefit for the ED1 period.
- **The timeline over which the CBA is performed**: All of the SGF model runs were looking out to 2050. Indeed the costs presented are almost exclusively based on the Present Value of the totex. This means that benefits in ED1 tend to be different.
- Plus numerous other factors including:
  - Scenario changes
    - Underlying energy efficiency assumptions
    - Level of clustering
  - Network parameters
    - The type of network, eg. Meshed Vs radial networks
    - Trigger thresholds for investment
  - Solution parameters
    - Cost curves of solutions in the ED1 period
    - Availability of solutions in the ED1 period

The key points are described in the pages below.

3.2 Scenario Analysis

3.2.1 DNO Cumulative Figures

The following figures are derived from DNOs' 'Best View' scenarios as presented to Ofgem. Each of the figures below shows the cumulative uptake of LCTs which appear on the secondary network. For the avoidance of doubt, the primary level LCTs have not been considered in this analysis.

[10] NB. A benefit of 25-30% was stated in the WS3 Phase 3 work (Analysis of Least Regrets Investments for RIIO-ED1 and supporting evidence [Issue 1.1], 7th April 2013) based on the model inputs and analysis performed at the time

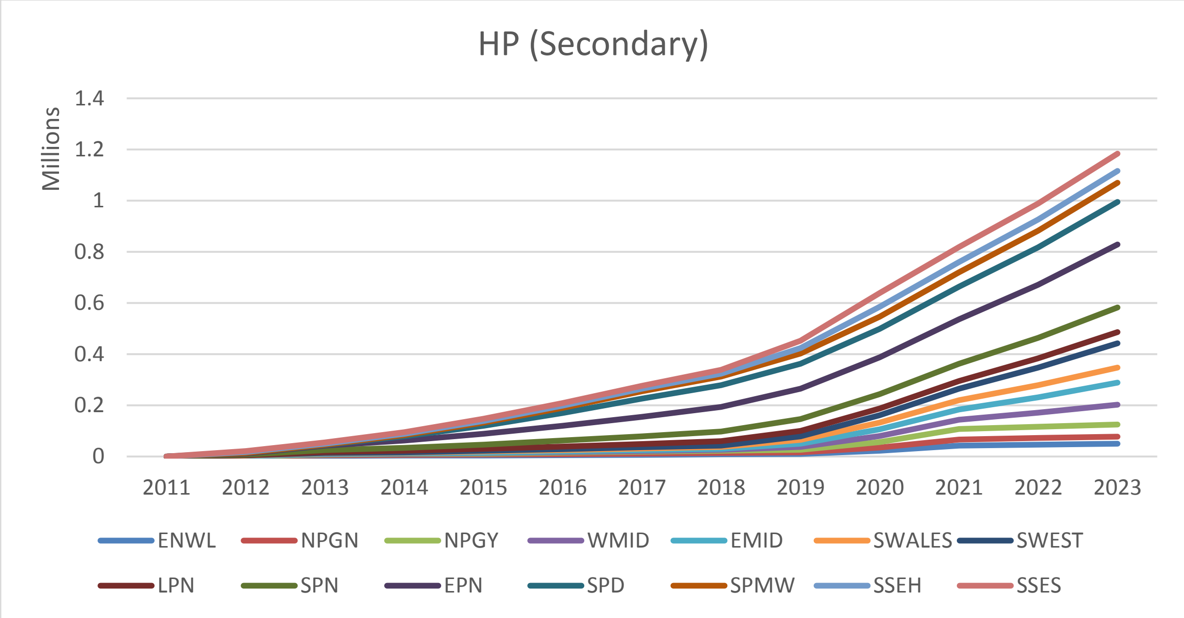


Figure 7 Cumulative rate of uptake of heat pumps (HP) for each DNO's licence area

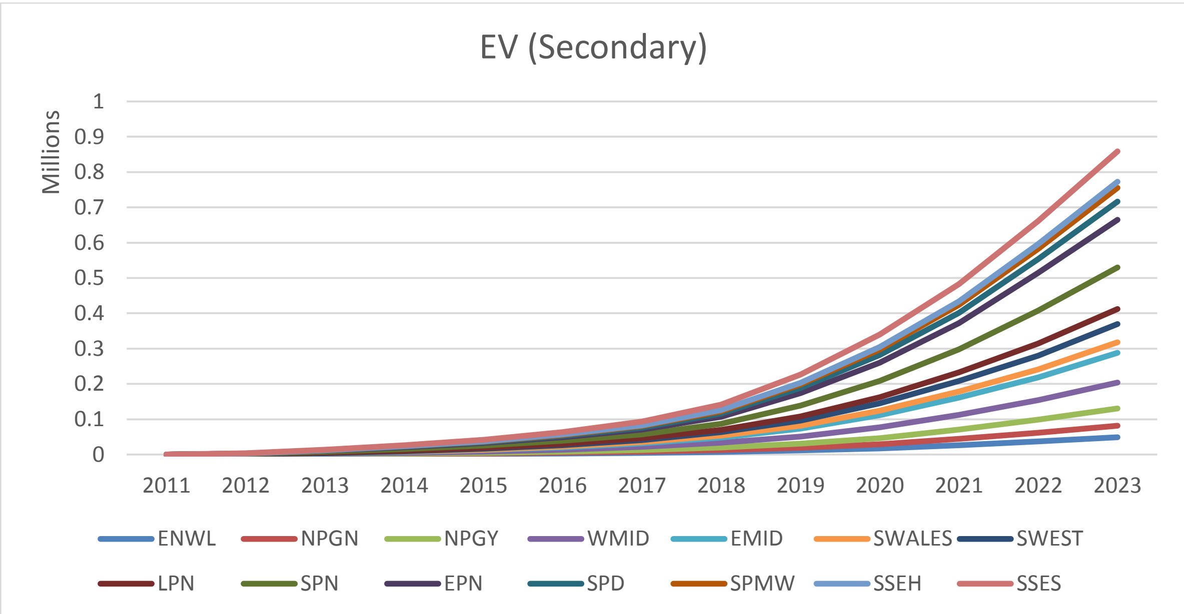


Figure 8 Cumulative rate of uptake of electric vehicles (EV) for each DNO's licence area

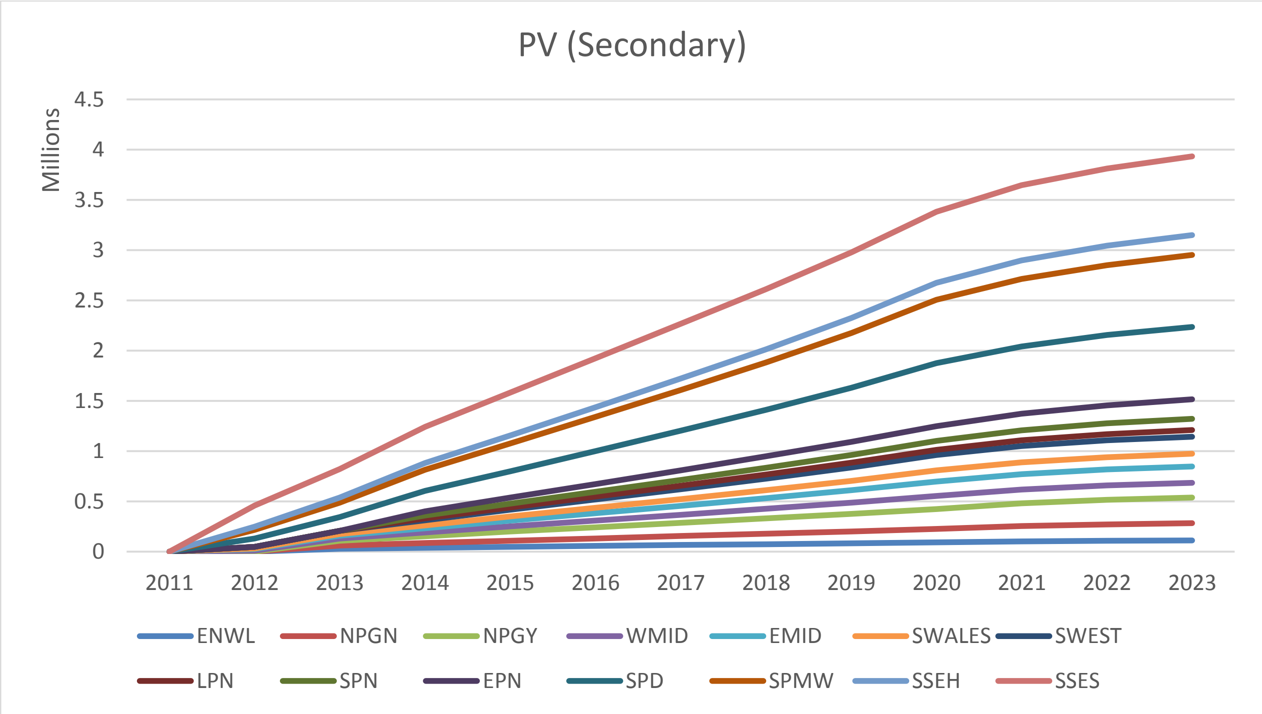


Figure 9 Cumulative rate of uptake of solar photovoltaic (PV) for each DNO's licence area

3.2.2 DNO cumulative compared with DECC's national scenarios

The DNOs' best view on the future trajectories for the rate of uptake of LCTs are combined to form the GB wide LCT trajectories. These in turn, can be compared with those developed by DECC as part of the work undertaken in the WS1 of the Smart Grid Forum. In this context, DECC has provided three distinct trajectories (i.e. "Low", "Central" and "High") for the uptake levels of each LCT and subsequently combined them to form four specific scenarios.

Figure 10,

Figure 11 and

Figure 12 establish the comparison between the trajectories for the rate of uptake of LCTs based on DECC's projections and the DNOs' best view in GB.

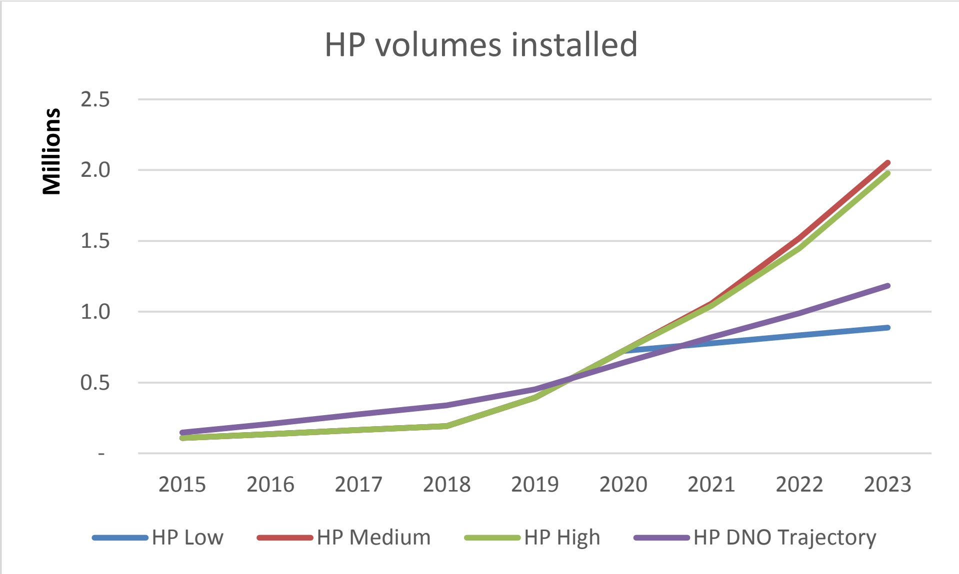


Figure 10 Great Britain rate of uptake of heat pumps based on DECC and DNOs' best view

It can be seen in Figure 10 that the GB wide trajectories for heat pumps built from the DNOs' individual best view follow closely DECC's Low trajectory.

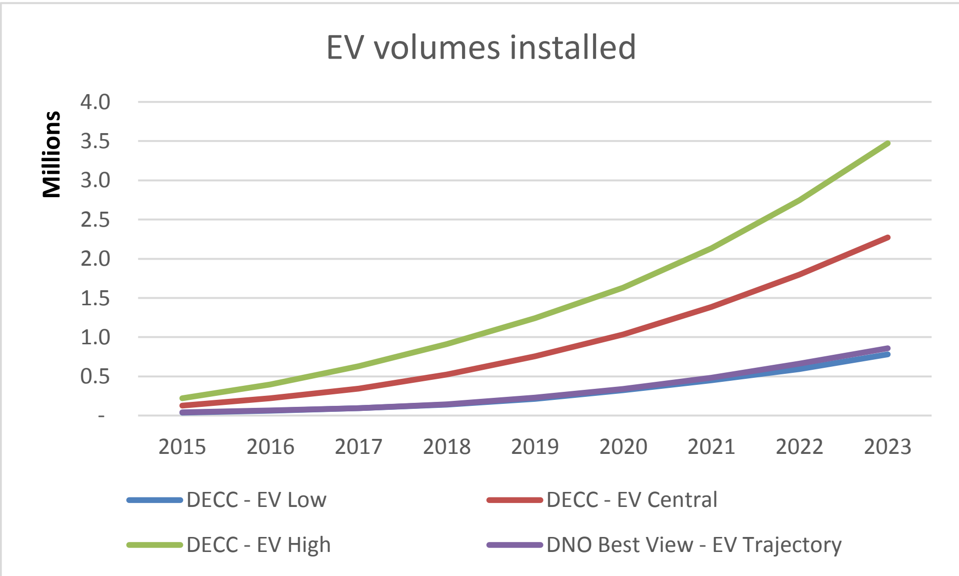


Figure 11 Great Britain rate of uptake of electric vehicles based on DECC and DNOs' best view

Figure 11 shows that the GB wide trajectories for electric vehicles built from the DNOs' individual best view follow closely DECC's Low trajectory.

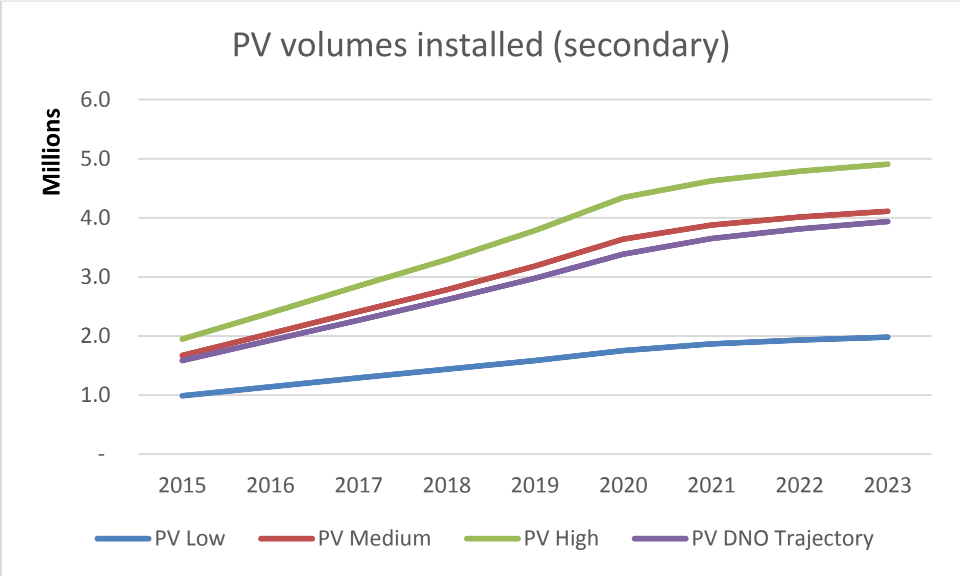


Figure 12 Great Britain rate of uptake of solar photovoltaic based on DECC and DNOs' best view

It can be observed in

Figure 12 that the GB wide trajectories for solar photovoltaic built from the DNOs' individual best view follow closely DECC's Medium trajectory.

3.2.3 Comparing the DNO best view to the composite scenarios

The various LCT profiles are combined to form composite scenarios as described below.

Table 14 Make-up of composite scenarios in the GB dataset of the Transform Model

		Scenario 1	Scenario 2	Scenario 3	Scenario 4
	Naming Convention	*High abatement in low carbon heat*	*High abatement in transport*	*High electrification of heat & transport*	*Credit purchase*
LV	*Load and generation scenarios*				
	PV trajectory	WS1: Average[1]	WS1: Average[1]	WS1: High	WS1: Low
	HP trajectory	WS1: High	WS1: Medium	WS1: High	WS1: Low
	EV trajectory	WS1: Medium	WS1: High	WS1: High	WS1: Low
	Energy Efficiency assumptions				
	Heating Demand	Applied indirectly via demand profile of electrical heating (direct and HPs)			
	Lighting Demand	Defra: Market Transformation (Policy scenario)			
	Appliance Demand	Defra: Market Transformation (Policy scenario)			
HV & EHV	*Generation scenarios*				
	Onshore wind (small - medium)	WS1: High	WS1: High	WS1: High	WS1: Low
	Biomass (small - medium)	WS1: High	WS1: High	WS1: High	WS1: Low
Transmission[3]	Onshore wind (large)	NG: 'Gone Green'	NG: 'Gone Green'	NG: 'Gone Green'	NG: 'Slow Progression'
	Coal with CCS				
	Coal				
	CCGT				
	Interconnector				
	CCGT with CCS				
	Biomass				
	Wind (offshore)				
	Nuclear				

1 DECC no longer produce a Central scenario for PV; this has been synthesised by using an average of the High and Low figures

2 NG - National Grid

3 Handled in the Value Chain side of the model developed by Frontier Economics - used in Transform™ to assess supplier led DSR

3.3 SGF WS3 Phase 3 Modelled benefits

Table 15 Transform benefits RIIO-ED1 shows for each of the four DECC scenarios the investment required to mitigate the demands imposed by LCTs on the network. It should be noted that the figures to 2022 represent the period 2015-2022 which is considered for this analysis to be representative of RIIO-ED1 given that the Transform Model works in calendar, rather than financial, years.

Given that the previous figures Figure 10 to

Figure 12 illustrated that the scenario that is most closely linked to the cumulative DNO best view is scenario 4, one can see that by adopting a combination of selective top down and incremental investment strategies across the country, it would be expected that a total of £264m - £752m would need to be spent on LCT reinforcement. This compares favourably with the £499.8m figure that has been calculated by the DNOs.

Table 15 Transform benefits RIIO-ED1

	Scenario 1 (£m)				Scenario 2 (£m)				Scenario 3 (£m)				Scenario 4 (£m)			
	BAU	Incremen tal	Top Down	Selective Top Down	BAU	Incremen tal	Top Down	Selective Top Down	BAU	Incremen tal	Top Down	Selective Top Down	BAU	Increme ntal	Top Down	Selective Top Down
2050	24,381	16,051	16,361	13,958	20,501	14,221	14,725	12,389	26,352	17,818	17,758	15,568	4,613	2,480	6,139	3,283
2030	9,273	5,046	7,037	4,811	7,229	4,140	6,525	4,268	9,457	5,416	7,330	5,244	1,113	648	3,828	1,422
2022	1,267	703	3,279	1,172	1,309	776	3,303	1,205	1,163	852	3,349	1,305	534	264	2,891	752

It should also be noted that previous analysis in this area has always accounted for optimism bias (66% applied to smart solutions and 10% to conventional solutions). Ofgem states that DNOs should well understand the cost of conventional solutions and has therefore reduced optimism bias to zero for these solutions. It is not explicit whether any change has been made to optimism bias for smart solutions, but the implicit assumption is that this has been left at 66%.

It is important to note that by making this change to optimism bias, the conventional solutions (representing the counterfactual position) in effect become cheaper. Therefore the level of benefit that could be derived by deploying smart solutions will be lower as the comparison is being made against a lower cost counterfactual position.

When considering the likely levels of benefits (such as the 25% figure) as against other analysis previously carried out using the Transform Model, this discrepancy must be borne in mind as previous analysis would favour a greater level of benefit, owing to the higher cost of the counterfactual position.

4. Argument 3: Ambiguous evaluation of SG_{other} benefits

4.1 Classification of solutions

As part of their business plans, DNOs have submitted a list of network solutions categorised as 'smart', 'BAU' or 'Only for trial'. This list of solutions is presented in Table 16 and has been extracted from Ofgem's "Total smart benefits assessment-20140717-1" workbook. The network solutions in bold in the Table 16 below are solutions that are also included in Ofgem's list of smart solutions.

Table 16 **Ofgem's collated list of solutions proposed by DNOs**[11]

	ENWL	NPG	WPD	UKPN	SP	SSE
Automatic fault restoration using LV autorecloser	Smart	Not in plan	BAU	Only for trial	Not in plan	Smart
Automatic fuse restoration after transient fault/ 'smart fuse'	Smart	Not in plan	BAU	Only for trial	Not in plan	Smart
Chromatic analysis of insulating oil	Smart	Not in plan	Not in plan	Not in plan	Not in plan	Only for trial
Condition Based Risk Management	Smart	Not in plan	BAU	BAU	BAU	BAU
DSM/DSR	Smart	Not in plan	Not in plan	Smart	Only for trial	Smart
Dynamic line ratings	Not in plan	Smart	Smart	Smart	Smart	Smart
Dynamic network automation and associated advanced load modelling	Smart	Smart	BAU	Only for trial	Smart	Smart
Dynamic transformer ratings	Only for trial	Not in plan	Smart	Smart	Smart	Only for trial
Ecoplugs	Not in plan	Not in plan	Not in plan	Not in plan	Not in plan	Smart
Energy efficiency	Only for trial	Not in plan	BAU	Only for trial	Only for trial	Smart
Enhanced automatic voltage control/ voltage regulators	Only for trial	Smart	Smart	Smart	BAU	Smart
Fault Current Limiter	Only for trial	Not in plan	Only for trial	Not in plan	Only for trial	Smart
Generator constraint management	BAU	Not in plan	BAU	BAU	Smart	Smart
Installation of power line carrier system for data comms	Smart	Not in plan	Only for trial	Only for trial	Not in plan	Smart
Intelligent control devices (EVs)	Not in plan	Not in plan	Only for trial	Not in plan	Only for trial	Smart
Network meshing	Only for trial	Smart	Smart	BAU	Only for trial	Smart
OLTC acoustic monitoring	Smart	Not in plan	Not in plan	Not in plan	Not in plan	Not in plan
Partial discharge monitoring	Only for trial	Not in plan	BAU	Smart	BAU	Smart
Phase shifting transformer	Not in plan	Not in plan	Not in plan	Not in plan	Smart	Not in plan
STATCOM	Only for trial	Not in plan	Only for trial	Only for trial	Smart	Smart
Switched Capacitors	Only for trial	Smart	Smart	Smart	Not in plan	Smart
Time domain reflectometry approach to LV fault finding	Smart	Not in plan	BAU	Not in plan	Not in plan	Only for trial
Transformer oil regeneration	Smart	Not in plan	BAU	Not in plan	BAU	BAU
Voltage gradient approach to LV fault finding	Smart	Not in plan	Not in plan	Not in plan	Not in plan	Only for trial
Wood pole condition monitoring	Only for trial	Not in plan	BAU	Not in plan	Not in plan	Smart

In order to achieve consistency across DNOs, and to limit the extent to which novel or innovative solutions are counted as smart, Ofgem has considered a solution to be 'smart' if none of the DNOs have listed it as forming part of BAU. However, there are some solutions that are listed as 'BAU' by some DNOs that Ofgem still recognises as being smart. This is an important point to note because there are good reasons why certain solutions, while remaining a key part of BAU for certain licence areas, may represent 'smart' innovations in others.

An example of this is network meshing. Networks in the LPN and SPMW networks have been designed to be operated in a meshed way and hence were designed and constructed with the various capital investments that meshed networks entail. As such, UKPN list network meshing as BAU in Table 16. However, to design a network to operate normally as a mesh, and to take a radial network and convert it to meshed operation are two very different propositions. The latter necessitates capital investment to retrospectively mesh the network and will also require the use of innovative technology to ensure the network operates efficiently without, in effect, having to build a meshed network from scratch. Therefore, EA Technology feels it is absolutely appropriate that this solution be regarded as 'smart' and agree with Ofgem's thinking on this point.

Based on this approach, Ofgem developed a list of solutions (refer to Section 11.14 from Ofgem documentation) that were deemed to be 'smart'. These solutions are listed in Table 17 below.

[11] Northern Powergrid's list of solutions is only those selected within the Transform Model specifically for LCT related reinforcement and is not an exhaustive list of all smart solutions that are intended to be deployed during RIIO-ED1

Table 17 Ofgem's list of smart solutions

DSM/DSR
Dynamic line ratings
Dynamic network automation and associated advanced load modelling
Dynamic transformer ratings
Energy efficiency
Enhanced automatic voltage control
Fault current limiter
Installation of power line carrier system for data comms
Intelligent control devices (EVs)
Network meshing
Phase shifting transformer
STATCOM
Switched capacitors
Voltage gradient approach to LV fault finding

In compiling this list, Ofgem has discounted several solutions that were deemed ‘BAU’ by at least one DNO and has also discounted three solutions that are not categorised as smart in Ofgem’s assessment detailed in Section 11.13 of the “Business Plan Expenditure Assessment” document.

When considering the various solutions, it is important to be aware of the varieties of those solutions which exist. For example, DSR is here listed by DNOs as being smart; a view that is supported by Ofgem. It could be argued that a form of DSR has long been enacted with large industrial customers at EHV (and hence forms part of BAU). However, DSR at the domestic level, and indeed some of the commercial arrangements now being entered into by DNOs with industrial and commercial customers as an alternative to network reinforcement are undoubtedly new and should be treated as ‘smart’. It is therefore of the utmost importance to consider the specific context within which the solutions will be operating, together with any novel technology types that could be used, when establishing whether a solution is in fact ‘smart’. In the instance of DSR, EA Technology again believes that the view taken by Ofgem that this is a smart solution is entirely correct.

It is noted that different DNOs implement different network solutions to mitigate specific network constraints. Consequently, DNOs select the optimal network solution set to maximise their smart benefit return.

Different network solutions may be more cost-efficient and technically adequate to resolve different network constraints than others as different network solutions provide different costs and benefits to the networks. As a result, each DNO’s smart solution set should be assessed independently, based on its merits. It is inappropriate to regard each solution as being homogenous across all licence areas and all technology types.

Table 18 presents the DNOs’ smart solutions that were considered as ‘non-smart’ by Ofgem.

Table 18 List of solutions not considered smart

Automatic fault restoration using LV autorecloser
Automatic fuse restoration after transient fault/ 'smart fuse'
Chromatic analysis of insulating oil
Condition Based Risk Management
Ecoplugs
Generator constraint management
OLTC acoustic monitoring
Partial discharge monitoring
Time domain reflectometry approach to LV fault finding
Transformer oil regeneration
Wood pole condition monitoring

It is vital to understand why solutions are considered as 'smart' within DNOs to ensure that the assessment of smart solutions is not unduly influenced. As an example, two DNOs have listed automatic fault restoration using LV autoreclosers as being smart, while one described it as BAU. Ofgem has determined that this solution be classed as 'non-smart' on this basis. However, it is necessary to examine whether the two DNOs claiming smart benefits were looking to use the solution in the same way as the DNO deploying this as part of BAU, or whether these DNOs were looking to adopt a different technology with enhanced functionality.

Without carrying out this examination on a case-by-case basis to establish whether a like-for-like comparison can be made between DNOs, EA Technology feel that it is inappropriate to universally label a solution as 'non-smart'. If this assessment is carried out, and it is found that DNOs are using the solution in an identical manner on identical networks, then of course the solution should be regarded as BAU, but EA Technology can find no evidence of this assessment having been carried out for each solution within Ofgem's document.

4.2 Calculation of SG_{other} benefit

From the available documentation, there is no clear evidence of Ofgem having engaged with DNOs on an individual basis to ascertain whether their smart solutions can be categorised as 'smart'. If this rigorous assessment has been carried out for each potentially 'smart' solution, then this is something to be welcomed. However, if the analysis has not been carried out at this level, it is EA Technology's view that some of these solutions could have been identically, similarly or differently interpreted by DNOs and therefore Ofgem's approach to savings associated with smart solutions in areas other than reinforcement (SG_{other}) seems to be inconsistent,

The lack of available coherent justification in accepting a solution as 'smart' suggests that DNOs are not assessed consistently on 'smart grid other' benefits, as smart solutions can be interpreted in different ways by different DNOs. DNOs planning to use the smart solutions, as defined in Table 16, would also be looking to deploy these to reduce the amount of time that personnel would have to attend LV transient faults, for example. It would therefore seem inappropriate to generically suggest that DNOs were not considering smart grid other benefit savings in other areas of their businesses.

Furthermore, there is no apparent evidence or justification in the Business Plan Expenditure Assessment (section 11.20) as to why Ofgem considers that 'savings in excess of this should be achievable'. Therefore, there appears to be a lack of transparency as to why, in its determination, Ofgem takes the approach that in order to calculate the amount of savings that would be reasonable for each DNO, it would be appropriate to multiply this by a further factor.

4.3 Conclusion

In conclusion EA Technology believes that Ofgem's stance inconsistently assesses the DNOs definition of smart solutions. Ofgem has recognised that certain solutions are 'smart' for some networks but not for others (such as meshing) and also acknowledges that solutions can be smart if they involve a different approach from those previously adopted (e.g. DSR) or technology. However, Ofgem does not provide any evidence that it has applied this method across all solutions regarded as smart by some DNOs to identify whether DNOs may be adopting a novel approach or technology in comparison to previous BAU policies. This assessment penalises DNOs who have assessed a solution as smart where the other DNOs are not implementing that solution or have not identified it as smart. It is EA Technology's view that, as presented, the approach taken in assessing other smart grid benefits to DNOs is inconsistent.

5. Argument 4: Smart Meter Benefits

5.1 Introduction

Ofgem uses DECC's impact assessment[12] for the roll-out of smart meters as evidence of the savings from the use of smart metering data that DNOs should be achieving through RIIO-ED1. The impact assessment identifies around £190m of savings accruing to DNOs over the RIIO-ED1 price control period (paragraph 11.17). However, it is further stated that this figure will not match up directly with those published in the DECC impact assessment as undiscounted value of benefits has been used, rebased to 2012-13 prices.

Table 19 details the assumptions and the approach adopted by Ofgem to evaluate the benefits associated with smart metering data for RIIO-ED1 period. Table 19 has been extracted from Ofgem's workbook "Total smart benefits assessment-20140717-1", "Smart metering" worksheet.

Table 19 Ofgem's assumptions and approach to evaluate the benefits associated with smart metering data for RIIO-ED1 period

Variable	Value	Notes
DECC impact assessment (£m)	181.9	Calendar year 2011 prices
RPI calendar 2011	235.2	Using Office of National Statistics CHAW RPI data
RPI 2012-13	244.7	Using Office of National Statistics CHAW RPI data
Inflator	1.04	
Smart metering savings from DECC impact assessment in 2012/13 prices (£m)	189.2	

Table 20 Revised DECC impact assessment figures to evaluate the benefits associated with smart metering data for RIIO-ED1 period

Variable	Value	Notes
Revised DECC impact assessment (£m)	112.2	Calendar year 2011 prices
Smart meter savings from revised DECC impact assessment for RIIO-ED1 in 2012/13 prices (£m)	116.6	

5.2 Applicability to RIIO-ED1 reinforcement investment

The roll-out of smart meters to all consumers will bring with it a range of possibilities for DNOs in terms of how they use the available data to manage their networks. Clearly, the increased level of visibility which network operators will have, brings with it the opportunity to target reinforcement (at lower voltages) more accurately and perhaps to manage networks more actively.

In order to attempt to quantify the level of benefit that DNOs will realise, it is necessary to examine the solutions that DNOs would look to deploy on their networks. While smart meters can

[12] DECC 2013. "Impact Assessment - Smart Meter Roll-out for the Domestic and Small and Medium Non-domestic Sectors (GB)", Department of Energy and Climate Change (January 2013)

provide a significant degree of granularity in terms of disaggregated load information at specific network points, this will contribute mainly to reinforcements at LV, given that DNOs already have access to data at an aggregated level at substations. Therefore, any reinforcements at EHV and 132kV would certainly not receive any level of benefit from having access to smart meter data.

There may be some benefits for HV reinforcement schemes. Given that most DNOs have monitoring as far as the outgoing HV feeder from a primary substation, smart meter data may allow reinforcements further along HV feeders or at HV/LV substations to be more appropriately targeted. However, it seems reasonable to suggest that by far the main area of benefit will be in LV reinforcement schemes where there is no existing monitoring (and hence a lack of detailed visibility) of network loads.

Of the various reinforcements proposed by DNOs, it is therefore only those relevant to the growth of LCTs (as these drive the proposed secondary network reinforcement) that are likely to benefit from the availability of smart grid data. As such, Table 21 below illustrates the solutions that DNOs are deploying over the RIIO-ED1 period and the likelihood of smart meter data making a positive contribution to their use. Green indicates that the solution could significantly benefit from smart meter data, amber that it may benefit, and red that it is unlikely to receive any benefit.

Table 21 Likelihood of secondary network reinforcements to benefit from smart meter data

Solution	Liable to benefit from smart meter data
Active Network Management - Dynamic Network Reconfiguration	Medium
Flexible AC Transmission Systems	Low
D/GSR	High
Embedded DC Networks	Low
Enhanced Automatic voltage Control (EAVC)	Low
Fault Current Limiters	Low
Generator Providing Network Support	Low
Intelligent control devices (EVs)	Medium
New Types Of Circuit Infrastructure	Low
Meshing (permanent)	Low
Meshing (temporary)	Medium
Real-Time Thermal Rating	Low
Switched Capacitors	Low
Conventional reinforcement	Low
Electrical Energy Storage	Low
Smart Enabler	High
Service Unbundling	Low
Harmonics	Low
Unbundling of shared service cables (for PV)	Low

It is clear that it is only a subset of the proposed LCT reinforcement that could actually make use of smart meter data to provide a benefit to the DNOs. Indeed the total levels of investment attributed to the solutions highlighted are shown below and represent 9% of the total proposed LCT related reinforcement based on smart solutions only.

Table 22 Total RIIO-ED1 secondary network reinforcement investment that is liable to benefit from smart meters

Solutions liable to benefit from smart meter data	Liable to benefit from smart meter data	Investment in RIIO-ED1 (£m)
Active Network Management - Dynamic Network Reconfiguration	Medium	0.00
D/GSR	High	0.00
Intelligent control devices (EVs)	Medium	0.15
Meshing (temporary)	Medium	2.54
Smart Enabler	High	25.25
	Total investment	**27.94**

It can be seen in Table 22 that from the LCT related investment expenditure across all DNOs for RIIO-ED1, £27.94m is estimated to be related to solutions that may benefit from smart meters. The total investment in these solutions will encompass capital expenditure and ongoing operational expenditure for monitoring etc. If smart meters were to be used instead of DNO monitoring, then some of this expenditure would be reduced. However, there would still be costs associated with procuring the smart meter data and there would still be some equipment that would need to be deployed. In this sense, the benefits accrued to DNOs from the use of smart metering data will only correspond to a relatively small proportion of this investment.

5.3 Assessing the reinforcement benefits

Having established that there are a number of investments that could benefit from smart meter data, DNOs would then undertake a cost benefit assessment to evaluate whether the use of smart meter data represents the best value. The reason for this assessment is that DNOs could choose to invest in their own monitoring technology (captured in the 'Enablers' line of the tables above). This would mean that DNOs own the monitoring equipment and can select its points of installation. The present value of investing in this equipment would need to be compared against the costs of procuring smart meter data via the Data Communications Company (DCC) for an equivalent network area.

When calculating this CBA, it is important to consider how much data is really needed. For example, would a representative sample of customers that can then be scaled up suffice? Alternatively, if the DNO were to install monitoring equipment at the LV feeder level, would this one installation be as valuable as having data for each of the, say, 50 customers connected to the feeder? Given that the DNO is interested in ensuring the feeder is able to supply the customers, the breakdown of demands between the customers may well be regarded as excess information that would require being aggregated by internal DNO processes. Therefore the cost of installing and operating one piece of monitoring equipment would need to be weighed against the costs of procuring the information for the 50 customers on the feeder (or a representative sample of these customers if this was felt to be sufficiently statistically robust) via the DCC.

This calculation would need to be carried out to evaluate the whole life cost of the monitoring expressed as a present value totex. Clearly the capital cost of installing proprietary equipment is significantly greater than setting up an arrangement with the DCC, but conversely the operating costs are likely to be higher for the DCC option.

This argument does not suggest that smart meter data should not be used by DNOs, rather it states that each instance (i.e. each feeder) should be treated individually and should be evaluated to ensure that the least cost option is being taken, whether this be via DNO monitoring or smart meter data, to ensure customers receive the best value. EA Technology assumes that the stated smart meter benefit is contingent upon DNOs adopting its use as a 'default' option and it therefore seems likely that the true benefit will be lower, given that it will only be used in a portion of cases.

5.4 Other smart meter benefits

The analysis is expanded to quantify "other" benefits that could be associated with the roll-out of smart meters and with the respective use of the smart metering data. Since different types of benefits can be attributed to different stakeholders, the analysis associates the type of benefits from smart meters with the stakeholders that directly accrue such benefits. One such benefit that would accrue to DNOs would be through supplier time of use tariffs, which are discussed below.

5.4.1 Supplier time of use tariffs

The benefits of smart meters will not necessarily be confined to the identification and prioritisation of reinforcement schemes on the secondary network as described in the previous section. Through smart meters, suppliers will be able to incentivise customers to use energy at different times of day according to price signals. This will likely mean that demand will be incentivised at times of cheaper electricity production (e.g. when wind generation is plentiful) and prices will be higher at other times to discourage customers from using as much electricity when costs to the supplier are higher.

There is of course no guarantee that the interests of the supplier will align exactly with those of the DNO. For example, if electricity happens to be cheap at 18:00 owing to large amounts of wind generation, then the supplier would incentivise customers to use electricity at this time. However, at this time of day, networks experience their peak demands and hence the DNOs would experience a negative benefit from this use of smart meter data.

Notwithstanding this, a previous piece of work undertaken by EA Technology for ENA[13] identified the likely benefits to network operators of such supplier led DSR. It concluded that across GB under Composite Scenario 4 (Credit Purchase), which was shown to be the scenario closest to the DNO 'best view' scenario earlier, the likely benefit to DNOs arising from the use of DSR brought about by smart meters would be £9m over the course of RIIO-ED1. This figure is presented in discounted totex terms and is the total for Great Britain over the eight year period.

5.5 DECC/ENA Smart Meter Benefit Comparison

This section describes the review and comparison of the revised DECC impact assessment figures published Tuesday, 9 September 2014 with the ENA review of analysis of network benefits from smart meter message flows published July 2013.

[13] 'Reviewing Network Benefits of Smart Meter Message Flows', EA Technology (April 2013)

Table 23 DECC/ENA Smart Meter Benefit Alignment

DECC Benefit Category	Revised DECC NPV £m RIIO-ED1 2012/13	ENA RIIO-ED1 Benefit £m 2012/13	DECC/ENA Alignment
Avoided investigation of voltage complaints	11.2	6 - 17.4	YES
Operational savings from fault fixing	51.8	2.1	NO
Reduced outage notification calls	9.7	2.7	NO
Better informed re-inforcement investment decisions	31.5	24.4 - 31.4	YES
Avoided investment from ToU (distribution/transmission)	12.5	12 - 26.1	YES
TOTAL	**116.7**	**47.1 - 79.7**	

The DECC values presented in the above tables are discounted values over the RIIO-ED1 period. These figures cannot be directly compared to the ENA figures, as ENA figures are undiscounted. EA Technology does not have sufficient information to identify the yearly breakdown of benefits accrued by DECC, thus a qualitative assessment has been undertaken.

The DECC analysis upon which these figures are based, assumes a 33% penetration of smart meters by 2014 (section 3.4.3.2 DECC IA)[14]. However DECC has also assumed that the full benefit of having smart meters installed will also be available at this time in terms of customers interruption reductions/telephony system etc. As suppliers will be managing the roll out of SMs, there is no guarantee that this roll out will allow DNOs to detect substation fuse failures as alluded to in DECCs report.

DECC also makes the assumption that SMs will be rolled out in a way that allows DNOs to detect all substation fuse failures with only one third of smart meters rolled out, due to occur in 2014. It then goes on to state that the SM benefit will be realised in full in 2014. The revised figures presented above and comments received from a SGF WS6 subgroup meeting indicate that DECC has reviewed when SM benefits are accrued to certain solutions such that these benefits are now available in 2017, rather than 2014 as indicated in the impact assessment.

For power outage management benefits, encompassed by operational savings from fault fixing and reduced outage notification calls in the DECC report, DECC states that their benefits will be fully realised in 2014. At that time, DECC assumes one third of the SMs are rolled out. The apportionment of benefit across all of DECC's analysis, period 2015 to 2030, should for outage management be split in the same proportion as the outages that affect single or multiple premises (detailed by DECC as 25%/75% of all outages). Therefore, the RIIO-ED1 benefit realised by outage management according to DECC's analysis should be apportioned 75% in RIIO-ED1 and 25% in RIIO-ED2, not the 30% benefit in RIIO-ED1 as currently stated.

5.5.1 Operational savings from fault fixing

The DECC report discusses the operational savings from fault fixing (section 3.4.3.2, 2. Reduction in operational costs to fix faults), however the benefits outlined in this section are not attributable to DNOs. Therefore the £51.8m worth of benefit from operational savings from fault fixing is not

[14] EA Technology understands that since publication of the Draft Determination, these figures have been revised by DECC and were presented at a SGF WS6 subgroup meeting, indicating a revised 33% penetration of smart meters by 2017

in line with the ENA analysis. On this point, it is important to note that DECC does not consider the benefits gained by reducing guaranteed standard payments which is considered in the ENA analysis (£2.1m of investment). DECC's analysis also does not account for customer complaints/issues arising from customers having more SM data available. The installation of SMs will allow DNOs and customers to identify further network issues that may/may not have previously been easily identifiable and this will lead to a rise in operational costs to fix additional faults.

5.5.2 Reduced outage notification calls

DECC has made the assumption that there will be a 15% reduction (section 3.4.3.2, 3. Reduction in calls to faults and emergencies lines) in the number of telephone calls due to the installation of SMs but does not detail a base year as to when this 15% improvement will start to occur (i.e. 2014/2020). It has been assumed that this figure aligns with the required threshold for smart meters, assumed 33% (previously set at 2014, now assumed as 2017).

The ENA analysis in RIIO-ED2 assumes large smart meter volumes accruing to a total benefit of £5.5m across RIIO-ED2 for a total benefit of £8.2m across RIIO-ED1 and RIIO-ED2 for the avoided voltage complaints and administrative costs due to the installation of SMs. So by realising the full benefit of smart meters (at only 33% penetration) as completed in the DECC report in 2017 (previously 2014), DECC is effectively realising the benefit of reduced outage notification calls in RIIO-ED1 that would practically be realised in RIIO-ED1 and RIIO-ED2. This assumption that benefits accrue over both periods aligns with the ENA analysis and results.

5.6 Conclusion

EA Technology believes that the smart meter benefits figures (£47m – 80m) presented in the ENA study ("Review of Analysis of Network Benefits from Smart Meter Message Flows[15]") are appropriate.

A review of the revised DECC impact assessment figures and ENA analysis benefits figures broadly align in some of the DECC benefit categories, however for operational savings from fault fixing and reduced outage notifications calls these figures are quite disparate. The following list summarises these disparities:

- 33% of smart meter penetration by 2017 may not allow DNOs to accrue the full smart meter benefit
- Suppliers manage the roll out smart meters, so benefits associated with locational requirements of smart meters cannot be guaranteed
- EA Technology considers that benefits DECC has attributed to DNOs in operational savings from fault fixing are not considered attributable to DNOs (£51.8m)
- DECC has not considered the benefit attributed to DNOs by SM data reducing guaranteed standard payments, details of which have been included in the ENA assessment
- DECC has not accounted for additional customer enquiries related to SM data, and has assumed that telephony rates will reduce in comparison with an undefined base year

EA Technology notes that the ENA total expected benefit falls short of the £116m specified in the latest DECC impact assessment, and is significantly lower than £189m used by Ofgem as a base case for price control determination.

[15] ENA, 2013. "Review of Analysis of Network Benefits from Smart Meter Message Flows", Energy Network Associations (July 2013)

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