Annex 4

CONFIDENTIAL REPORT

Prepared for:
Energy Networks Association

Smart Grid Forum
Work Stream 3 – Phase 3.5

Review of Tipping Point Analysis

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Summary

This short report details the results of a full run of the Transform™ model to identify the results of the Tipping Point Analysis work performed by Grid Scientific (GS). It builds on the concurrent work by Smarter Grid Solutions (SGS) on reviewing the Enablers and Solutions in the model.

The new tipping point framework proposed by GS has been applied to the Transform™ model. The GS approach has provided a thorough review of the timelines and effort required to implement the Smart solutions and enablers proposed within the Transform™ model. The output from this is a model which provides early indications to DNOs of timelines for preparing for new smart solutions. Further work will be required to refine the model, particularly ensure that the threshold values proposed are appropriate for each of the solutions and enablers.

The benefit of the GS approach is that it now provides an excellent framework for a sophisticated user of the model to gauge the impact and timeline of future technologies. However, to use this framework successfully the user will need to provide their own estimates for both threshold values and impacts of tipping points. If a user requires a “vanilla” model to calculate spending patterns then it may well be recommended to turn the tipping points analysis off in the first instance and only use this aspect of the model once fully experienced in its application.

It is now for the Network Operator’s to review this output for inclusion in the next version of the Transform™ model.

Contents

1 Workstream 3 Timeline

The following diagram shows where this report (highlighted in red) fits into the overall work program for the Workstream 3 activity. The top of the diagram indicates the various documents produced throughout the WS3 activity while the middle describes the changes to the model that have been incorporated as scenario data and parameters have been updated, the bottom indicates model releases.

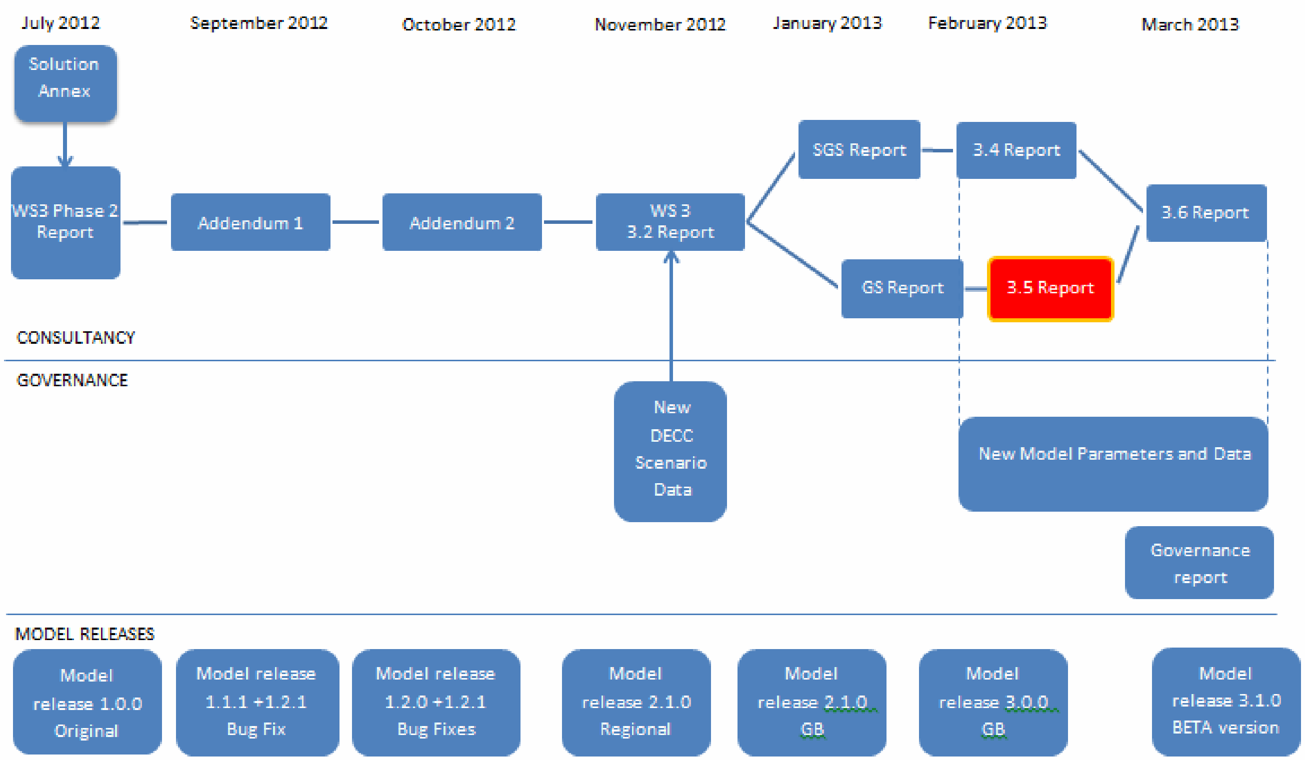

Figure 1 Workstream 3 timeline and documents produced

2 Model rerun with Tipping Point Analysis

This short report details the results of a full run of the Transform™ model to identify the results of the Tipping Point Analysis work performed by Grid Scientific (GS). It builds on the concurrent work by Smarter Grid Solutions (SGS) on reviewing the Enablers and Solutions in the model. As such, this report should be read in parallel with the GS report "Tipping Point Analysis Report" dated 13/2/13.

The Tipping Point Analysis introduces an enhanced framework for identifying tipping points, trigger points and business impacts of smart solutions and enablers. The concepts behind the framework are briefly summarised below and then the results of a run of the GB model with the Tipping Points are presented. It is important to note that the Tipping Point analysis does not intend to provide automated estimates of exact spend for smart solutions, rather it provides a framework to allow the sophisticated user of the model to build up a picture of the impact of tipping points using their own estimated data.

2.1 Terminology within the tipping point analysis framework

Firstly, it is important to consider the key issues used within the tipping point analysis. The definitions below are intended only to aid the reader. For a fuller explanation the reader should refer to the GS "Tipping Point Analysis Report":

Tipping Point – The point in time when an enabler or solution reaches a critical number of uses. This implies a change in any of a number of attributes of the enabler, including cost, linked enablers required to deliver the solution, impact on business systems.

Threshold Value – The estimated cost outlay on a solution or enabler at which time the tipping point occurs

Trigger Point – The point in time when a business should start preparing (with input of time and resources) for a future tipping point

Business Impact - The impact of employing the enabler or solution on the business in terms of Complexity Disruption, Enterprise Criticality, Risk and Benefit, assigned a numerical value of low (1) to high (5), together with an associated estimate of the manpower required from the DNO to implement the tipping point.

To illustrate how this now works within the model we have run the framework initially using the following assumptions:

Threshold Values – These are maintained at the same level as in WS3 Ph2 but these values are acknowledged to require revision

Tipping Point Impact – Two sets of analyses carried out:

- At the tipping point the cost of the solution or enabler remains the same but the cost curve is reduced, i.e. cost curve 1 changes to cost curve 2 etc. For cost curve 5 a reduction of 10% of cost is applied.
- At the tipping point, the cost of the solution or enabler that has tipped is reduced by 10% (in line with the approach taken in WS3 Ph2) and no change to cost curve is applied

It should be noted that it is for the user to determine these assumptions based on the knowledge of their own network and it should also be noted that, in line with the description in the GS report, it is possible to apply up to two multiplication factors and two cost curve changes. Only a simple approach has been taken in this brief report (one cost curve or one multiplication factor) for ease of understanding.

3 Model Results

The results below demonstrate the outputs achievable from the model using Tipping Point Analysis. All the results are taken using the 'High Electrification of Heat and Transport' scenario (scenario number 3) incremental investment strategy. The model flags both solutions and enablers where enablers are required to deliver solutions that are identified as being used.

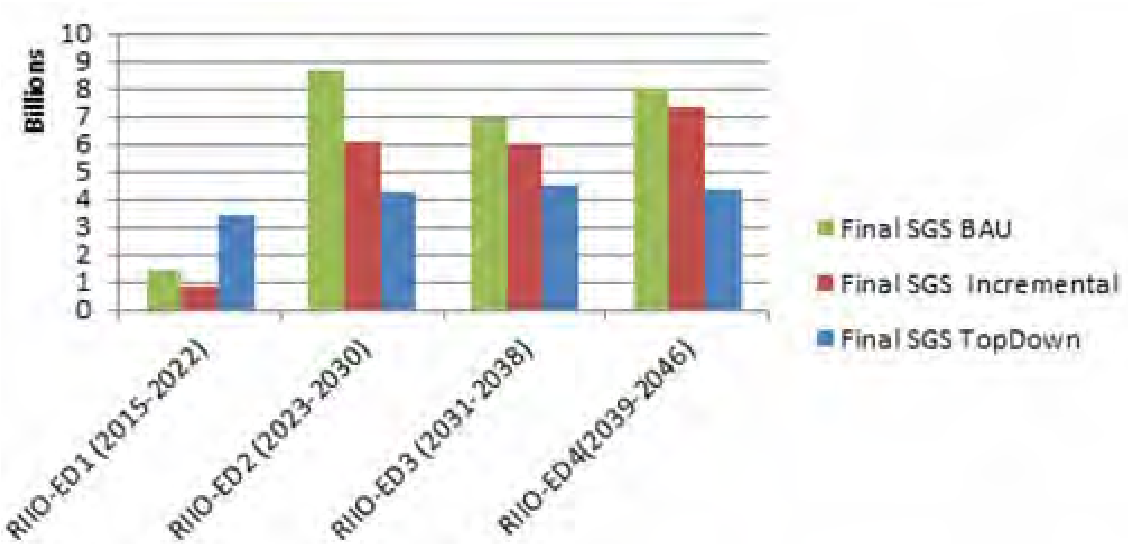

Figure 2 Gross Cumulative Investment by RIIO-ED period for the 'High Electrification of Heat and Transport' scenario

3.1 Triggers and Tipping Points

The table below gives us the model output for Tipping Points and Trigger Points predicted to occur during ED1 to the end of 2022. The colour coding identifies the business impact, as described in the report by GS. Thus red = 5 (high), amber = 4, grey =3, blue =2 and green =1 (low). The model provides these tables as outputs for each ED review period.

Table 1 Tipping and trigger points for solutions and enablers in RIIO-ED1

Solution and Enabler	2015	2016	2017	2018	2019	2020	2021	2022
EAVC - LV PoC voltage regulators		Trigger	Trip					
Local smart EV charging infrastructure_Intelligent control devices							Trigger	----
Permanent Meshing of Networks - LV Urban						Trigger	----	Trip
Permanent Meshing of Networks - LV Sub-Urban							Trigger	----
Communications to and from devices - LAST MILE ONLY							Trigger	----

Thus the model is estimating that there will only be two tipping points occurring during ED1:

- EAVC - LV PoC voltage regulators
- Permanent Meshing of Networks - LV Urban

However it is also noting that the DNO should be investing Time and Resources into three further Tipping Points which will occur after 2022 and in the case of smart EV charging infrastructure it is flagging this as high business impact. Two of these are smart solutions and one is an enabler which is required to deliver the smart EV charging solution. The same table can be produced for ED2 showing a much higher incidence of Trips and Triggers:

Table 2 Tipping and trigger points for solutions and enablers in RIIO-ED1

Solution and Enabler	2023	2024	2025	2026	2027	2028	2029	2030
Fault Current Limiters_HV reactors - mid circuit						Trigger	Trip	
Generator Providing Network Support LV					Trigger	----	Trip	
Local smart EV charging infrastructure_Intelligent control devices	Trip							
Permanent Meshing of Networks - HV		Trigger	----	Trip				
Permanent Meshing of Networks - LV Sub-Urban	Trip							
RTTR for EHV/HV transformers		Trigger	----	Trip				
RTTR for HV Overhead Lines		Trigger	----	Trip				
Switched capacitors - HV						Trigger	Trip	
Temporary Meshing (soft open point) - HV					Trigger	----	Trip	
Advanced control systems - HV					Trigger	----	Trip	
Communications to and from devices - LAST MILE ONLY	Trip							
EHV Circuit Monitoring		Trigger	----	Trip				
HV Circuit Monitoring (along feeder)		Trigger	----	Trip				
Link boxes fitted with remote control							Trigger	----
LV Circuit Monitoring (along feeder)				Trigger	----	Trip		
RMUs Fitted with Actuators		Trigger	----	Trip				
Dynamic Network Protection, 11kV		Trigger	----	Trip				

It can be seen that activity will be much more intense during ED2, which correlates with the investment levels shown in Figure 2.

3.2 Business Impact

For each of the tipping points analysed an estimate has been made for the trigger point and for the resources required to prepare for this tripping point. The GS report gives more detail on each of the solutions and enablers and for the reader's convenience, a relevant extract is provided in section 0 of this report. Here we show the impact for ED1.

Table 3 Manpower estimate for solutions and enablers reaching their tipping and/or trigger point in RIIO-ED1

Solution and Enabler s	Manpower Estimate (Man years)
EAVC - LV PoC voltage regulators	0.5
Local smart EV charging infrastructure_Intelligent control devices	17.5 (x 0.66[1])
Permanent Meshing of Networks - LV Urban	8.25
Permanent Meshing of Networks - LV Sub-Urban	8.25 (x 0.66[1])
Communications to and from devices - LAST MILE ONLY	17[2]

Thus the tipping point analysis is estimating that the DNO will need to invest over 30 man years of effort during ED1 to prepare for and deploy Smart Solutions during ED1. Again for ED2 the activity will be much more intense:

Table 4 Manpower estimate for solutions and enablers reaching their tipping and/or trigger point in RIIO-ED2

Solution and Enabler	Manpower Estimate (Man years)
Fault Current Limiters_HV reactors - mid circuit	2.3
Generator Providing Network Support LV	8.3
Local smart EV charging infrastructure_Intelligent control devices	17.5 (x 0.33)
Permanent Meshing of Networks - HV	8.25
Permanent Meshing of Networks - LV Sub-Urban	8.25 (x 0.33)
RTTR for EHV/HV transformers	11
RTTR for HV Overhead Lines	11
Switched capacitors - HV	12
Temporary Meshing (soft open point) - HV	8.25
Advanced control systems - HV	0[3]
Communications to and from devices - LAST MILE ONLY	17[4]
EHV Circuit Monitoring	12.8
HV Circuit Monitoring (along feeder)	12.8
Link boxes fitted with remote control	12.8 (x 0.66)
LV Circuit Monitoring (along feeder)	12.8
RMUs Fitted with Actuators	12.8
Dynamic Network Protection, 11kV	10.3

[1] For two of the solutions, the trigger point is reached during ED1 but the tipping point is in ED2 so not all the spend will be in ED1 – hence a factor of 2 years out of 3 (0.66) has been applied

[2] The business impacts were determined for all enablers listed in the original WS3 Phase 2 work. During the course of this phase of the WS3 activity, Smarter Grid Solutions have refined some of the enablers and the value presented here is the manpower estimate for the original 'Communications to and from devices' which has not been disaggregated into last mile, fabric and back-haul.

[3] The advanced control systems enabler (which has not been split by voltage level for this analysis) is regarded as a strategic enabler and is not subject to tipping point analysis. More detail on this can be found in the Grid Scientific report.

[4] As for the ED1 table (Table 1), this represents the manpower estimate for an overarching communications enabler that has not been split by last mile, backhaul and fabric

Thus the model is showing around 200 man years of work required during ED2, that is to say around 25 extra full time staff over the period of ED2 per DNO to manage the transition to smart solutions.

While these manpower estimates may seem high, they have been developed by Grid Scientific with some consultation with DNOs. It must be noted that in order to deliver the network reinforcements required to cater for LCT growth, it is highly unlikely that DNOs will be able to perform this with the existing staff levels. The development and deployment of new solutions invariably takes considerably more effort than might be first thought, and these numbers have been arrived at with this in mind.

The actual figures act as a starting point and are included as defaults in the spreadsheet provided with this report. DNOs are invited to review and provide comments on the figures which can then be examined through the Governance process.

3.3 Impact on Costs

We have run the model for the incremental investment strategy under the 'High Electrification of Heat and Transport' scenario (Scenario 3) using three alternate options for tipping points:

- No Tipping Points (Original)
- Tipping Points where the impact is a change of cost curve,1 to 2 etc (Cost Curve)
- Tipping Points where the impact is a 10% reduction in costs (10% reduction)

The graph below shows the impact on cumulative spend for these three alternatives

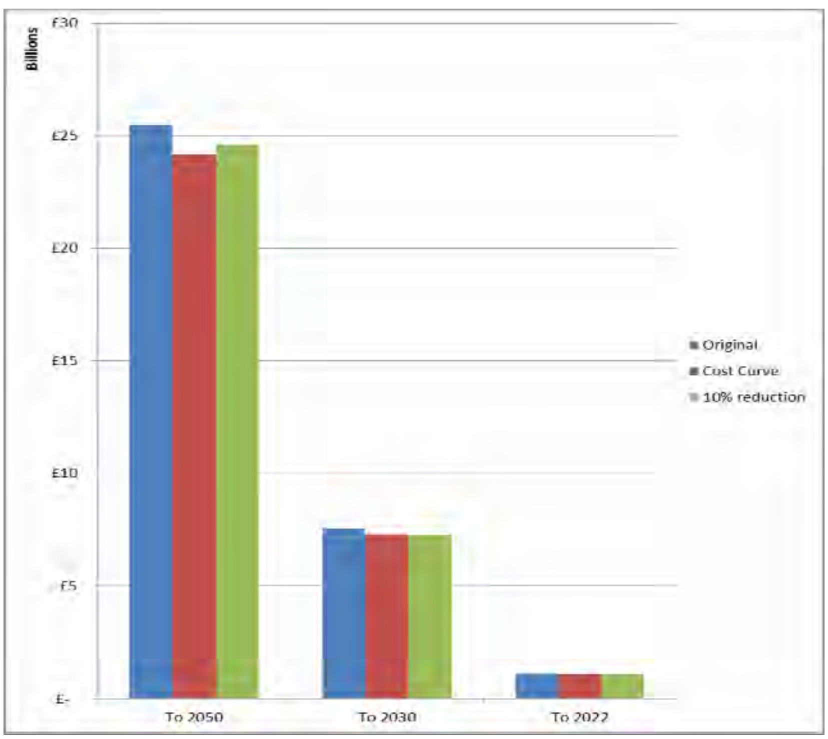

Figure 3 Discounted totex investment over three modelled periods when considering different tipping point implementations

It can be seen that for the level of Tipping Point impact chosen, the change in total investment requirement is small compared to total spend, especially in the early years. The difference in spend as a % of original spend for each of the two tipping point options modelled is as follows:

Reduction from Original	ED1	ED1 & ED2	To 2050
Cost Curve	1%	4%	5%
10% Reduction	2%	4%	3%[5]

This highlights that the benefits of the tipping point approach is found in flagging up the timescales where DNO's will need to respond to new smart solutions rather than as a tool for modelling costs.

It should be noted that the costs of employing the requisite number of staff to deliver this work is not incorporated within Transform. Rather, this is a flag to alert a user to the amount of effort that will be required to take a more centralised approach to the deployment of a particular solution or enabler. In this way, a decision can be taken whether to pursue such an approach by examining the costs and developing a business plan as appropriate offline from the model.

[5] The apparent reduction in saving here reflects the reduction in availability of smart solutions in the later years of the model as more conventional solutions start to be selected.

4 Conclusions

The new tipping point framework proposed by GS has been applied to the Transform™ model. The GS approach has provided a thorough review of the timelines and effort required to implement the Smart solutions and enablers proposed within the Transform™ model. The output from this is a model which provides early indications to DNOs of timelines for preparing for new smart solutions. Further work will be required to refine the model, particularly ensure that the threshold values proposed are appropriate for each of the solutions and enablers.

The results shown above are based on the standard assumptions within the model regarding solution parameters and tipping point thresholds which can, of course, be varied by a user. More detailed analysis of the outputs of the tipping point framework will be conducted as part of the work under Phase 3.6 to examine the least-regrets options for investment in RIIO-ED1.

The benefit of the GS approach is that it now provides an excellent framework for a sophisticated user of the model to gauge the impact and timeline of future technologies. However, to use this framework successfully the user will need to provide their own estimates for both threshold values and impacts of tipping points. If a user requires a “vanilla” model to calculate spending patterns then this would at first be achieved without reference to tipping point analysis (as has been done thus far by DNO users).

Once experienced in application of the model and when it is necessary to examine the effects of various strategic decisions regarding solutions or enabling technologies in which to invest, the tipping point analysis framework can be of significant aid to a user. It must be used, however, in conjunction with offline analysis and the model is not intended to automatically determine the best investment decisions for a user in this area.

Appendix 1 Extract from Grid Scientific Report

The following extract from Chapter 10 of Grid Scientific's report explains the development of business attributes, including reference to 'Trigger Time' and 'Trigger Effort'.

Business Attributes are defined for each solution and enabling technology. They provide a set of considerations that extend beyond technology to include operations, business, customer and commercial matters. These are captured in a form as provided in Figure 9.

Solution Overview	**Representative Solution:**	Temporary Meshing (soft open point)
	Variant Solution:	EHV - maximising latent capacity
	Description:	"Temporary meshing" refers to running the network solid, utilising latent capacity, and relying on the use of automation to restore the network following a fault

BUSINESS ATTRBUTES	**Impact Alert (1,2,3,4,5)**	**Trigger Time (months)**	**Trigger Effort (people months)**	**Example Considerations**	**Comments**
architecture				the solution architecture may no longer be appropriate, a change might be suggested, for example distributed/central; open/proprietary	
data				volume; source; sharing; consolidation; processing, reporting; storage, transport	
communications				architecture: point-to-point; routed; technology; new or upgrade; performance, reliability, security; protocols	
security				architecture; data; communications; applications; physical; assurance; compliance	
deployment				planning, build, commissioning, test, introduction into service	
operations systems/applications				capability; users, user interface, IT infrastructure; systems management; open interfaces; roadmap; standards; systems integration; data; communications; functionality; evolution; control centre upgrade	
operations processes				change; alignment - business, systems, tools; new; manual; automation; integration	
people and organisation				structure; skills; training; management	
enterprise integration				strategy; organisation; processes; systems; open interfaces: availability; roadmap; standards; systems integration; data; communications; functionality; evolution	
customer relationship/engagement				direct/indirect; increased number of transactions; increased complexity of transactions; dependency; negotiation; perception; interest commercial frameworks; new contract types; regulatory; innovation	
procurement				frameworks; open/closed; discount structures; strategic partnerships; support and maintenance; regulatory; innovation	
migration				network; operations systems/applications; data; customers; operations; organisation	
standards				international; national; imposed; best practice	
corporate business model				consolidation; regulation; in source, outsource	
SOLUTION	0				
Summary					

Impact Index	0			
Trigger Time	0	months		
Trigger Effort	0	person month	0.0	person years

1. Figure 4 - Business Attributes – Simplified

Each attribute is assigned an Impact Alert which seeks to indicate the impact of issues such as Complexity (business, operations, technical), Disruption, Enterprise Criticality, Reusability (DNO, many DNOs, GB, international, global), Risk and Benefit.

It should consider the role of all relevant stakeholders in the business and externally (if appropriate)

Impact should be considered across the lifecycle – from design through implementation and introduction into service.

The Impact Alert indicates the impact arising from the Tipping Point and includes the effects associated with the trigger period (in advance of the Tipping Point)

The possible Impact Alert values are:

- 5: Very High - the solution will have impact that will require substantial intervention, including management intervention
- 4: High - the solution will have impact that will require significant intervention, including management intervention
- 3: Medium - the solution will have impact that can be readily managed
- 2: Low - the solution will have some impact on the business
- 1: Very Low - the solution will have limited impact on the business

The Impact Alerts are used to generate an Impact Index for the overall solution impact.

Each Business Attribute has associated with it two other values:

- A Trigger Time which indicates the amount of time in advance of the Tipping Point (for that solution) work which addresses the particular attribute should begin
- A Trigger Effort which indicates the amount of effort that will be required to be expended over the trigger period.

The Trigger Time for the overall solution is taken as the longest trigger period for the solution.

The overall Trigger Effort for the solution is the total of that associated with each attribute.

The Business Attributes referenced in Figure 4 - Business Attributes – Simplified are referred to as the simplified version. This relies on a single Impact Alert. A more complex version has been considered as shown in Appendix C. It is proposed that use of Business Attributes – Full is a future activity which requires the experience of using the simplified version and the opportunity to learn from exercising the Tipping Point capabilities of the model.

- Phase 2 Implementation:
  - Not implemented
- Phase 3 Implementation:
  - A Business Attribute analysis is undertaken for each solution which captures information that describes the impact associated with the Tipping Point for the solution and hence the implications for a change in strategy. As noted above, the impact is ranked as an Impact Alert for each of several key considerations associated with the change. The highest Impact Alert score is then as taken as the impact of the overall solution.
  - The impact analysis should take into account the expected impact associated with any investment required before need. The start point for any such investment is the trigger

point. The analysis includes an estimate of the length of the trigger period associated with each of the business attributes and in addition, an estimate of the level of effort that would be required to undertake the work needed during the trigger period.

  - These factors are then used by Tipping Point Reports to inform the analysis and planning that would be undertaken to determine the most beneficial course of action beyond a Tipping Point.

- Benefits:
  - Explicit insight into the broad set of issues associated with a solution and the changes in strategy that may be implemented at Tipping Point.
  - A mechanism for understanding certain trade-offs that can be made
  - More information is gained that is supportive of investment planning.

- Default Data:

  Initial default population of the Business Attributes is provided for initial use in the TPA process. This should be reviewed and updated or refined as experience is gained in use of the Phase 3 model.

  A Business Attributes spreadsheet has been developed to manage the applied settings and is included in the additional set of Tipping Point tools that form an integral part of the Transform Model.

  A summary and a few examples have been included in Appendix C - please refer to EA Technology for the latest available version of the full Business Attributes spreadsheet tool.

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Annex 5

CONFIDENTIAL REPORT

Prepared for:
Energy Networks Association

Smart Grid Forum Workstream 3 - Phase 3 Governance Period 1 Review Documentation

Authors:
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Report No: 84170_1_1

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Delivering Innovation in Power Engineering

Project No: 84170

Smart Grid Forum Workstream 3 - Phase 3 Governance

Review Documentation

Version	Issue Date	Authors	Approved By	Comments
Review 1.0	19/2/13	A Birch, M Sprawson	D A Roberts	Draft proposals for review by DNO's
Draft 1.0	4/3/13	A Birch, M Sprawson	D A Roberts	Draft conclusions for final approval
Final 1.0	11/3/13	D Yellen, M Sprawson	D A Roberts	Final Approved Document

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Summary

The Transform™ model is a complex model of the entire GB distribution network. As such it is necessary to carefully control and document proposed changes and actual modifications to the model to ensure proper version control. To ensure that a well thought out approach to modifications, updates to datasets and bugfixes is in place, the model is subject to a strictly controlled "Governance process". In each Governance period, users and stakeholders are invited to propose modifications to the model which can then be peer reviewed and accepted where appropriate.

The following report summarises the 23 items submitted for consideration for possible changes to the Transform ™ model in the first full Governance period. These proposals have come from a number of sources:

- Improved data – from DNOs, National Grid and from DECC
- Requests for changes made via the WS3 Ph3 working group
- Requests for changes made via the eatransform.com website

An appendix is provided with supporting documentation.

The evaluation of each of the proposals was agreed during a teleconference on the 28th of February 2013.

Each of the changes has been labelled where possible using the agreed traffic light methodology to aid review. In some cases the requested changes, though sensible, are out of scope of the current work and are flagged for later consideration. These issues will be addressed in two ways:

Reporting proposals
EA Technology will prepare a large summary sheet within the model based on the reporting proposals received. The summary sheet will be in a form that will allow users to manipulate data and create customer reports using Pivot tables or other excel functions. It is unlikely that this enhancement will be available in the current governance period.

Functionality and Documentation Proposals
These proposals are beyond the scope of data governance. This does not reduce importance or potential benefits of the proposals. To ensure that these proposals are not lost they will be logged as part of data governance. EA Technology will present these proposals to the Work Stream 3 DNO sub group for consideration and discussion separate to the data governance process.

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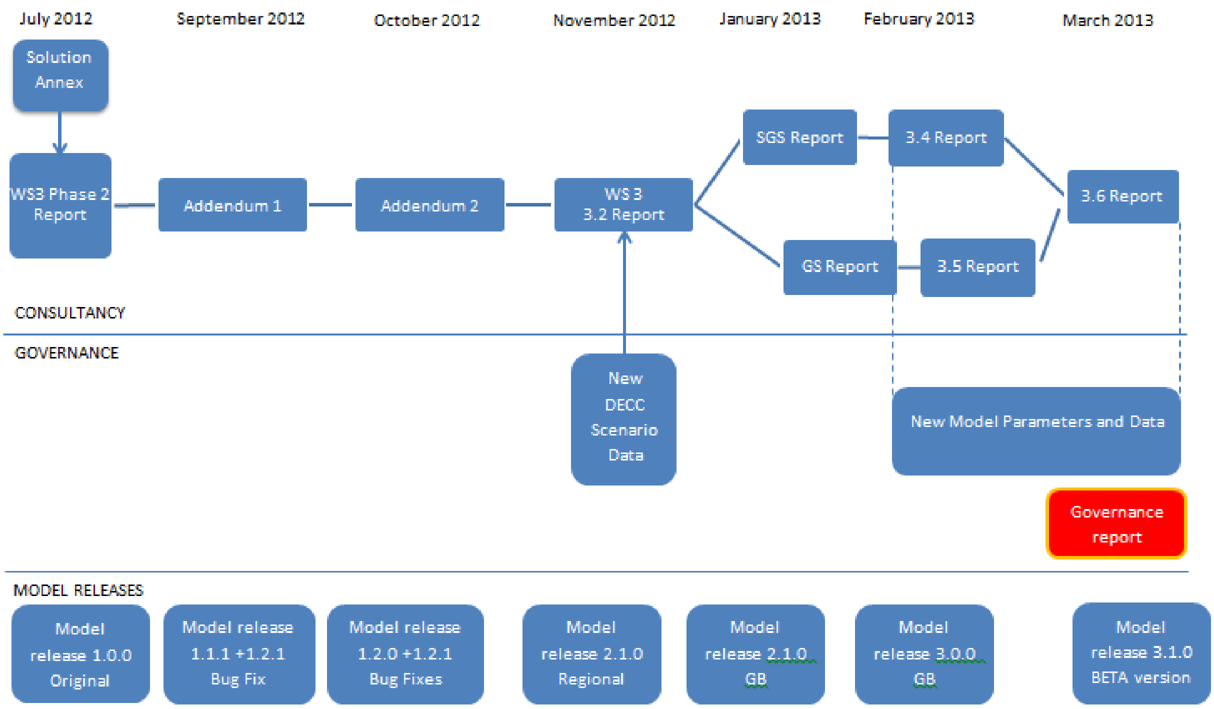
Page

1 Workstream 3 Timeline

The following diagram shows where this report (highlighted in red) fits into the overall work program for the Workstream 3 activity. The top of the diagram indicates the various documents produced throughout the WS3 activity while the middle describes the changes to the model that have been incorporated as scenario data and parameters have been updated, the bottom indicates model releases.



2 Introduction

It was anticipated that proposed changes to the Transform™ Model would come from two areas:

1. It was expected that DECC would be revising their scenarios within the early stages of the project. As these updates are incorporated into the model it is possible that they will drive significant changes to the model's predictions, even if no other changes are made.
2. Further changes were also expected from other sources such as DNOs and other key stakeholders.

Where the proposed data conflicts with published DECC scenarios incorporating them would require support and authorisation from DECC in order to maintain compatibility. Only highly important required changes are likely to be approved. As such, it is expected that overall, a minimal level of changes will result from this method, but it is likely that any implemented would have significant impacts on the model's outputs.

Where proposed changes do not conflict with DECC scenarios they require consideration by the WS3 Group.

EA Technology has evaluated each of the change proposals. As part of the evaluation proposals were allocated a RAG in order to aid prioritisation of effort by the WS3 Group.

1. **Red** – Will be utilised for proposals that suggest a fundamental change to the model, parameters that can be different across Distribution Network Operators (DNOs) networks or where multiple similar proposals require a common value to be assigned.
2. **Amber** – Will be utilised for proposals that had multiple possibilities or similar requests covering a large number of parameters where EA Technology has provided a suggested value. In this instance, the proposed value will be submitted for approval rather than extensive discussion.
3. **Green** – Will be utilised for proposals where EA Technology agree with the submission and recommend proceeding based on the information provided.

In addition to data related issues, proposals relating to other aspects of the model have also been received. To assist in the governance process all proposals have been classified into the following categories:

1. **Function** – proposed change to the internal functionality of Transform™.
2. **Reporting** – proposed changes to the results presented from Transform™, these changes take data that may have already been calculated and changes the way the outputs of the model are presented.
3. **Documentation** – production of material to assist in the understanding of how Transform™ functions and how it can be used.
4. **Data –** Proposed change to input data used by Transform™. These proposals are covered by the data governance framework.

The report presents an evaluation of proposals received for consideration by the working group.

3 Summary of Proposals with Final Evaluation

The summary of proposals was presented to the WS3 group for review and agreed as part of a teleconference on the 28th of February 2013.

Table 3.1 Summary of Proposals with Initial Evaluation

Proposal ID	Proposal	Source	Data Governance RAG	Classification
DNO 1	Updating of EV Charging Profiles	Scottish Power	Red	Data
DNO 2	Voltage vs Thermal intervention triggers	UKPN	N/A	Functionality
DNO 3	Greater visibility/outputs	UKPN	N/A	Reporting
DNO 4	Technical documentation	UKPN	N/A	Documentation
DNO 5	Utilisation profile	UKPN	N/A	Functionality
DNO 6	Conventional costs	UKPN	Green	Data
DNO 7	"Look ahead"	UKPN	N/A	Functionality
DNO 8	Energy Efficiency	UKPN	Green	Data
DNO 9	Smart solution applicability	Western Power	N/A	Functionality
DNO 10	Output broken down by voltage	Western Power	N/A	Reporting
DNO 11	Disruption factor review	Western Power	Red	Data
DNO 12	Lead times feeding into merit order	Western Power	N/A	Functionality
DNO 13	Annual remaining headroom	Western Power	N/A	Reporting
DNO 14	Clustering allowances review	Western Power	Red	Data
DNO 15	Output of threshold reached	Western Power	N/A	Reporting
DNO 16	Output of investment by solution types	Western Power	N/A	Reporting
DNO 17	Output of Clustering allowances reached	Western Power	N/A	Reporting
DNO 18	Feeder Allocation	EA Technology	Red	Data
PUB 1.1	Solution/Enabler Cost	SGS	Green	Data
PUB 1.2	Solution/Enabler Mapping	SGS	Green	Data
PUB 2	Renewable Development trajectories	DECC	Green	Data
PUB 3	Plug-in Vehicle Scenarios	OLEV	Green	Data
PUB 4	DECC Energy Efficiency Scenarios	DECC	Green	Data

4 DNO and other Stakeholder Proposals

The following proposals have been received through the www.eatransform.com website during the first governance period.

4.1 Requested changes

The Proposals received have been initially assed by EA Technology using the classification discussed preciously. Based on this classification as part of the governance process EA Technology will propose recommendations on how proposals should be addressed.

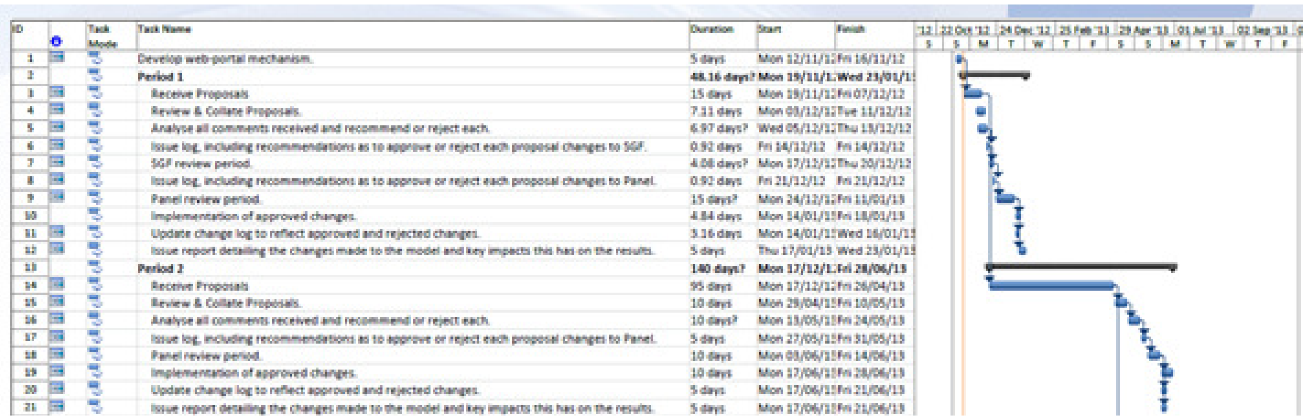
Some of the proposals received from DNO stakeholders involve work proposals that falls outside of the scope of the data governance work package. These issues will be addressed in two ways:

Reporting proposals
EA Technology will prepare a large summary sheet within the model based on the reporting proposals received. The summary sheet will be in a form that will allow users to manipulate data and create customer reports using Pivot tables or other excel functions. It is unlikely that this enhancement will be available in the current governance period.

Functionality and Documentation Proposals
These proposals are beyond the of scope of data governance. This does not reduce importance or potential benefits of the proposals. To ensure that these proposals are not lost they will be logged as part of data governance. EA Technology will present these proposals to the Work Stream 3 DNO sub group for consideration and discussion separate to the data governance process.

4.2 Timeline

The Governance period reported in this document was originally intended to last from September 2012 to December 2012 as outlined in the diagram below



ID	Task Name	Duration	Start	Finish
1	Develop web-portal mechanism.	5 days	Mon 12/11/1	Fri 16/11/12
2	**Period 1**	**48.16 days?**	**Mon 19/11/1**	**Wed 23/01/1**
3	Receive Proposals	15 days	Mon 19/11/1	Fri 07/12/12
4	Review & Collate Proposals.	7.11 days	Mon 03/12/1	Tue 11/12/12
5	Analyse all comments received and recommend or reject each.	6.97 days?	Wed 05/12/1	Thu 13/12/12
6	Issue log, including recommendations as to approve or reject each proposal changes to SGF.	0.92 days	Fri 14/12/12	Fri 14/12/12
7	SGF review period.	4.08 days?	Mon 17/12/1	Thu 20/12/12
8	Issue log, including recommendations as to approve or reject each proposal changes to Panel.	0.92 days	Fri 21/12/12	Fri 21/12/12
9	Panel review period.	15 days?	Mon 24/12/1	Fri 11/01/13
10	Implementation of approved changes.	4.84 days	Mon 14/01/1	Fri 18/01/13
11	Update change log to reflect approved and rejected changes.	3.16 days	Mon 14/01/1	Wed 16/01/13
12	Issue report detailing the changes made to the model and key impacts this has on the results.	5 days	Thu 17/01/13	Wed 23/01/13
13	**Period 2**	**140 days?**	**Mon 17/12/1**	**Fri 28/06/13**
14	Receive Proposals	95 days	Mon 17/12/1	Fri 26/04/13
15	Review & Collate Proposals.	10 days	Mon 29/04/1	Fri 10/05/13
16	Analyse all comments received and recommend or reject each.	10 days?	Mon 13/05/1	Fri 24/05/13
17	Issue log, including recommendations as to approve or reject each proposal changes to Panel.	5 days	Mon 27/05/1	Fri 31/05/13
18	Panel review period.	10 days	Mon 03/06/1	Fri 14/06/13
19	Implementation of approved changes.	10 days	Mon 17/06/1	Fri 28/06/13
20	Update change log to reflect approved and rejected changes.	5 days	Mon 17/06/1	Fri 21/06/13
21	Issue report detailing the changes made to the model and key impacts this has on the results.	5 days	Mon 17/06/1	Fri 21/06/13

The Governance period was extended to February 2013 to accommodate proposed dataset changes on DG and EVs provided by DECC. This has been the first Governance period for the Transform model and a number of observations can be made:

- The EATransform website went live in November 2012, it has had limited use to date
- The DNO's are all using the model as part of their RIIO ED1 planning
    - This has led to a lot more individual users
    - And has resulted in a large number of specific direct queries
- A significant number of changes have come from the work done by Smarter Grid Solutions and Grid Scientific in work reported separately
- DECC have revised their datasets for DG and EVs
- A separate meeting has been held with BEAMA and they are expected to contribute into the next Governance review period
- The overlap of the current Governance period with ED1 planning timescales has resulted in time pressures which should be avoided if possible in future Governance periods

4.2.1 Updating of EV Charging Profiles

Originator	
Name: Dr Alan Collinson Position: Technical Specialist Company: Scottish Power E-Mail: alan.collinson@sppowersystems.com	Data Governance - Red
Proposed Changes / Area of Model:	
EV Charging Profiles	
Change Proposed:	
Augment the existing EV charging profile with additional profiles which are more reflective of what may be encountered in the future (i.e. up to 2050). Trial data of the actual charging profile may not be the most appropriate, although trial data based on "journeys travelled" may well be - and in this scenario, the journey information does not need to be restricted to EVs. Charging profiles could then be synthesised, based on journey data, EV battery characteristics, EV vehicle characteristics and EV charging tarrif. It is therefore recommended that the EV charging trial data be augmented by work which is currently being carried within the academic community. There may also be useful data sources that could be useful from outside the UK.	
Justification for Change:	
The existing charging profiles, although based on the best information available, use a relatively small (UK) data set and it is not known how representative any data based on "today's" use of electric vehicles will be of the future use of electric vehicles. For example, currently available electric vehicles have a modest range and EV chargers are relatively low power. Does the demographic of the trial group match the demographics of the likely uptakers of electric vehicles? In summary, the existing EV charging profiles are not felt to be reflective of the range of charging profiles that is conceivable in the future, up to 2050.	
Supporting Evidence:	
Smart meters and Demand-side management are two of the key pillars of the future Smart Grid. EVs are one of the key LCT technologies and EV charging lends itself naturally to DSM, because an EV is parked most of the time - probably being used less than 10% of the day, providing a charging opportunity for the other 90% of the time. At the moment, the EV charging profiles, being based on existing trials, are not reflective of the Smart Meter environment of the future and the associated demand-side management opportunities that will exist.	
Governance	
Comments: No Alternative data has been provided. **Degree of model change to methodology:** None **Expected impact on model results:** Moderate **Options:** The working group should consider one of the following options: - Continue to use existing dataset. - DNO working group to propose new dataset. - Issue a tender for a third party to develop a revised dataset **Decision:** The model will continue to use the existing data until better data becomes available, hopefully from the new SSE LCNF Tier 2 project (I2EV)	

4.2.2 Voltage vs Thermal intervention triggers

Originator	
Name: Ross Thompson Position: Technical Development Engineer Company: UK Power Networks E-Mail: ross.thompson@ukpowernetworks.co.uk	Data Governance – N/A
Proposed Changes/Area of Model:	
Voltage triggered interventions (low volts)	
Change Proposed:	
Currently the model derives an equivalent kW figure that would indicate load growth is leading to voltage depression. This is based on the voltage legroom percentage on the “Network Details” tab and can only be changed on a “Network Type” basis meaning each type of network (LV1, LV2 etc.) will be treated the same (often 1000s of feeders). This means that for each Network Type the figures that the user inputs for cable thermal capacity and voltage legroom percentage will essentially predetermine whether all the feeders in that Type reach voltage or thermal constraints first. It is proposed that the voltage/thermal triggers could be dealt with in a proportional rather than a binary fashion. The computational complexity of any solution would have to be proportionate to the effect that solving this issue will have, but average line length of Network Types could be used as an indicator of how far down a feeder loads are likely to be connected.	
Justification for Change:	
Although the BAU approach to voltage and thermal issues is generally the same: overlay cables, smart solutions could offer much more cost efficient solutions to voltage issues. This means a more thorough approach to voltage related investment could affect the overall benefit seen from smart solutions and also have an impact on which specific smart solutions are identified as cost effective and therefore justifiable.	
Supporting Evidence:	
The current approach of the model does not take into account feeder length when considering voltage issues (high or low). It also assumes that for a given network type reinforcement will be triggered by either voltage or thermal constraints rather than a more realistic (for some feeder types) mix of the two. The position of the load on the feeder is the differentiating factor between whether a load will contribute to voltage or thermal constraints. Although it may not be practical for the model to take account of this explicitly, it could be dealt with in an “average” way in line with the model’s general approach.	
Governance	
Comments: This proposal concerns the functionality of the model and is therefore out of scope of the governance process. **Degree of model change to methodology:** High **Expected impact on model results:** Low **Recommendation:** Present to WS3 DNO sub group as a separate proposals **Decision :** Present to WS3 DNO sub group as a separate proposals	

4.2.3 Greater visibility/outputs

Originator	
Name: Ross Thompson Position: Technical Development Engineer Company: UK Power Networks E-Mail: ross.thompson@ukpowernetworks.co.uk	Data Governance – N/A
Proposed Changes/Area of Model:	
Overall transparency	
Change Proposed:	
Greater visibility of the “internal workings” of the model. Perhaps increase the parameters that are exposed through the “Results by network” files and also a tool to summarise these results.	
Justification for Change:	
How data flows through the model is currently very opaque. This makes it very hard to analyse the outputs and have confidence in them. The results by network files are not only impractical to analyse manually (1000s of sheets to interpret) but they do not expose all parameters. For example there is no visibility of how loads (domestic, commercial, LCT etc.) are being allocated to network types and is therefore hard to determine what is driving investment.	
Supporting Evidence:	
There are a few thousand “Results by Network” sheets. Suggested parameters: • Effectiveness of solutions (e.g. headroom released, cost benefit against BAU) rather than just numbers deployed • Impact of specific LCTs on load growth/required investment This list could be expanded if a change is to be made.	
Governance:	
Comments: This proposal concerns the Reporting capability of the model and is therefore out of scope of the governance process. **Degree of model change to methodology:** Moderate **Expected impact on model results:** None **Options:** To address the general reporting requirements EA Technology will prepare a proposal to improve the reporting components and submit it to the working group. **Decision:** EA Technology to include summary sheet in future release of model. It is unlikely to be available during this governance period	

4.2.4 Technical Documentation

Originator:	
Name: Ross Thompson Position: Technical Development Engineer Company: UK Power Networks E-Mail: ross.thompson@ukpowernetworks.co.uk	Data Governance – N/A
Proposed Changes/Area of Model:	
Technical Documentation	
Change Proposed:	
Release of technical documentation.	
Justification for Change:	
Beyond the WS3 Ph2 report and a brief User Guide there is currently very little detail available on how the model operates. It is unlikely explanation of source code would be useful but a technical description of the algorithms behind the way the model operates and makes decisions would allow users to understand certain behaviors and interpret results more reliably avoiding the need to “second guess” the model.	
Supporting Evidence:	
Governance:	
Comments: This proposal concerns the Documentation of the model and is therefore out of scope of the governance process. **Degree of model change to methodology:** None **Expected impact on model results:** None **Recommendation:** Present to WS3 DNO sub group as a separate proposals **Decision :** Present to WS3 DNO sub group as a separate proposals	

4.2.5 Utilisation profile

Originator:	
Name: Ross Thompson Position: Technical Development Engineer Company: UK Power Networks E-Mail: ross.thompson@ukpowernetworks.co.uk	Data Governance – N/A
Proposed Changes/Area of Model:	
Utilisation profiles for assets grouped in Network Types	
Change Proposed:	
Introduction of an asset utilisation profile/distribution similar to the clustering currently implemented in the model.	
Justification for Change:	
The model currently reinforces all assets in a particular Network Type at the same time when the average headroom is depleted in a particular cluster group. This often creates large steps in investment as thresholds are reached which is not realistic and can be particularly misleading when looking at short periods in time for example the 8 year period of ED1. In reality asset utilisation is a distribution across a group of assets with highly loaded assets that will require reinforcement early and lightly loaded assets that may not require reinforcement until later.	
Supporting Evidence:	
Unable to (easily) post graphs here to illustrate the point but the deployments of solutions show significant spikes in certain years when a threshold has been reached for a particular solution. This can be seen by graphing the cumulative deployment by solution outputs on the "Results graphs" of the GB Transform model. for example there is a jump in some LV solutions from ~250 in 2021 to ~2500 in 2022.	
Governance	
Comments: This proposal concerns the Reporting capability of the model and is therefore out of scope of the governance process. **Degree of model change to methodology:** Moderate **Expected impact on model results:** Moderate **Options:** To address the general reporting requirements EA Technology will prepare a proposal to improve the reporting components and submit it to the working group. **Decision:** EA Technology to include summary sheet in future release of model. It is unlikely to be available during this governance period	

4.2.6 Conventional costs

Originator	
Name: Ross Thompson Position: Technical Development Engineer Company: UK Power Networks E-Mail: ross.thompson@ukpowernetworks.co.uk	Data Governance – Green
Proposed Changes/Area of Model:	
Costs of BAU solutions	
Change Proposed:	
Confirmation of BAU cost constitution, specifically: • It is believed DR5 benchmark costs have been used which are in 2007/2008 prices. The prices should be in the same base year as the SGS revised smart prices. • Confirmation that the BAU costs used in the model have the same scope as the revised SGS costs. This is particularly important now that the revised SGS costs are much more comprehensive; are the BAU costs as comprehensive? • It would be useful to know the scope-of-works for the individual conventional solutions so that the WS3 output can be compared to other data sets such as business plans (within the known limitations of the model; averaging etc.). • BAU costs are broken down into a per feeder cost whereas some smart solution/enabler costs appear to be per substation. Is a consistent approach being taken to the costs?	
Justification for Change:	
The revised SGS smart costs have significantly reduced the benefit seen from taking an incremental smart approach to reinforcement. It is important that the comparison between BAU and smart is fair so that the right smart solutions can be chosen and the overall benefit of smart is a realistic estimate.	
Supporting Evidence:	
Governance	
Comments: Costs have already been updated in the model to 2012/13 prices. The scope of BAU costs have the same scope of" smart" solutions. Costs are being allocated correctly between feeders and substations. **Degree of model change to methodology:** None **Expected impact on model results:** None **Options:** No Changes required, included in version 3.0 of the model.	

4.2.7 "Look ahead"

Originator	
Name: Ross Thompson Position: Technical Development Engineer Company: UK Power Networks E-Mail: ross.thompson@ukpowernetworks.co.uk	Data Governance – N/A
Proposed Changes/Area of Model:	
Merit order	
Change Proposed:	
The current approach of the model only looks 5 years ahead (by default, adjustable) when determining solution merit order. This should be replaced with an approach that evaluates the cost of a solution over its whole life and also recognises the benefit (in DCF terms) of an interim solution that delays a large capital expenditure.	
Justification for Change:	
The model is currently choosing smart solutions that increase the overall investment figure when looking far enough ahead even to the point where the Incremental approach can be more expensive than BAU despite the fact that the model should stick with BAU if it is most cost effective. This also means that "OPEX heavy" solutions will be favoured by this approach particularly if they have relatively low CAPEX, but when considered over their entire lifetime prove to be cost inefficient.	
Supporting Evidence:	
Running the model with the BAU approach but including certain smart solutions in isolation (flagging them as not smart) causes the overall investment, when considered over a long enough period of time, to increase. This not only skews the decision of which options are chosen but also masks some of the overall benefit that can be seen from taking a smart approach since some of the smart options are increasing the cost which offsets the benefits produced by more cost effective solutions.	
Governance	
Comments: This proposal concerns the functionality of the model and is therefore out of scope of the governance process. Changing the model to include a full net present value option analysis would require fundamental changes to the model and significantly increase the complexity of the model. **Degree of model change to methodology:** High **Expected impact on model results:** Low **Recommendation:** Present to WS3 DNO sub group as a separate proposals **Decision :** Present to WS3 DNO sub group as a separate proposals	

4.2.8 Energy Efficiency

Originator	
Name: Ross Thompson Position: Technical Development Engineer Company: UK Power Networks E-Mail: ross.thompson@ukpowernetworks.co.uk	Data Governance – Green
Proposed Changes/Area of Model:	
Energy Efficiency	
Change Proposed:	
A user friendly function to control the energy efficiency scenario used by the model. For example: • Off (for sensitivity analysis) • Policy scenario • Reference scenario	
Justification for Change:	
Energy efficiency can have a large impact on the investment required on the network and it is not certain what levels of energy efficiency will be seen in the future. It therefore makes sense to be able to easily evaluate the differences various scenarios will generate. Current methods discussed with EA Technology seem cumbersome and error prone.	
Supporting Evidence:	
again, difficult to post images but: At 2030 the two scenarios have the following efficiency figures: Lighting: Policy: 73%, Reference: 38% Appliances: Policy: 42%, Reference: 22%	
Governance	
Comments: Energy efficiency scenarios have been added as per the DECC energy efficiency scenarios. The functionality to "select" an efficiency scenario has also been included. The energy efficiency methodology used in the model is described in Appendix 2 **Degree of model change to methodology:** **Expected impact on model results:** **Options:** No Changes required, included in version 3.0 of the model.	

4.2.9 Smart solution applicability

Originator	
Name: Ross Thompson Position: Technical Development Engineer Company: UK Power Networks E-Mail: ross.thompson@ukpowernetworks.co.uk	Data Governance – N/A
Proposed Changes/Area of Model:	
Smart solutions	
Change Proposed:	
Some smart solutions to be linked to certain types of load/conditions.	
Justification for Change:	
The model currently appears to use any available solution to release headroom. For example smart EV charging devices are chosen even for the "Low transport" scenario. Smart EV chargers will obviously not be able to tackle other types of load growth. It would appear that once the load is allocated to feeders and the load aggregated the distinction between various loads is lost and any solution can be applied to release headroom regardless of whether it is appropriate.	
Supporting Evidence:	
SGS pointed out that when running the less transport intensive scenario, smart EV charging was still a popular solution. Does the model take into account such connections between drivers and solutions?	
Governance	
Comments: This proposal concerns the functionality of the model and is therefore out of scope of the governance process. Although smart EV charging is a popular choice in the model it only has a small impact on the overall results. Therefore the impact of this issue is considered low. **Degree of model change to methodology:** Moderate **Expected impact on model results:** Low **Recommendation:** Present to WS3 DNO sub group as a separate proposals **Decision :** Present to WS3 DNO sub group as a separate proposals	

4.2.10 Output broken down by voltage

Originator	
Name: Stephen Quinn & Roger Hey Company: Western Power	Data Governance – N/A
Proposed Changes/Area of Model:	
"Results" sheet	
Change Proposed:	
Give all monetary outputs (capex, opex, DSM opex, totex) broken down by voltage level and asset type (fixed or linear) in each year.	
Justification for Change:	
Ease of use, needed for business planning and budgeting purposes.	
Supporting Evidence:	
time spent trying to do this by hand to meet existing need	
Governance	
Comments: This proposal concerns the Reporting capability of the model and is therefore out of scope of the governance process. **Degree of model change to methodology:** Moderate **Expected impact on model results:** None **Options:** To address the general reporting requirements EA Technology will prepare a proposal to improve the reporting components and submit it to the working group. **Decision:** EA Technology to include summary sheet in future release of model. It is unlikely to be available during this governance period	

4.2.11 Disruption factor review

Originator	
Name: Stephen Quinn & Roger Hey Company: Western Power	Data Governance - Red
Proposed Changes/Area of Model:	
Solutions and enablers	
Change Proposed:	
A review of the disruption factors and disruption costs given to all enablers and solutions (conventional and smart), and the effect that these are having on the merit order used to select solutions.	
Justification for Change:	
Current assumptions are not robust, and require evidence to back them up.	
Supporting Evidence:	
For example, "pole Mounted 11/LV Tx" solution has a totex of £1450, and a distruption cost of £30,000. This is based on table 13.11 on page 211, and lists items not generally relevent to this solution.	
Governance	
Comments: No Alternative data has been provided. **Degree of model change to methodology:** None **Expected impact on model results:** Low **Options:** The working group should consider one of the following options: - Continue to use existing dataset. - DNO working group to propose new dataset. - Issue a tender for a third party to develop a revised dataset **Decision:** Continue to use existing dataset for this governance period. EA Technology will review the values with input from DNOs. Any changes will be proposed as part of the next governance period.	

4.2.12 Lead times feeding into merit order

Originator	
Name: Stephen Quinn & Roger Hey Company: Western Power	Data Governance – N/A
Proposed Changes/Area of Model:	
solutions and enablers	
Change Proposed:	
Under task 3.6 (No Regrets) we believe that lead times for all solutions and enablers are being gathered. We think that these should also be used as an input to the merit order function, to exclude solutions with unacceptable lead times.	
Justification for Change:	
There is currently the potential for solutions to be selected that would not be deliverable on a timescale that is acceptable to the DNO or its customers.	
Supporting Evidence:	
Governance	
Comments: This proposal concerns the functionality of the model and is therefore out of scope of the governance process. It is unclear how a particular solution could not be deliverable on a timescale acceptable to an DNO or customer in a forecasting tool. If certain solutions are not felt to be appropriate then can be removed by setting the date available to post 2050. **Degree of model change to methodology:** High **Expected impact on model results:** Moderate **Options:** Continue to use existing data. **Decision :** Continue to use existing data. To be reconsidered in the next governance period after publication of report 3.6.	

4.2.13 Annual remaining headroom

Originator:	
Name: Stephen Quinn & Roger Hey Company: Western Power	Data Governance – N/A
Proposed Changes / Area of Model:	
Results/network parameters	
Change Proposed:	
We want to be able to see the total headroom (voltage, thermal and fault level) remaining, by voltage level, by year.	
Justification for Change:	
The current results are presented individually for each representative feeder (and cluster at LV). We want to see whether, as a whole, our networks are having capacity eaten away or created - within the model run period are we actually fixing problems, or just deferring them?	
Supporting Evidence:	
Governance	
Comments: This proposal concerns the Reporting capability of the model and is therefore out of scope of the governance process. **Degree of model change to methodology:** Moderate **Expected impact on model results:** None **Options:** To address the general reporting requirements EA Technology will prepare a proposal to improve the reporting components and submit it to the working group. **Decision:** EA Technology to include summary sheet in future release of model. It is unlikely to be available during this governance period	

4.2.14 Clustering allowances review

Originator:	
Name: Stephen Quinn & Roger Hey Company: Western Power	Data Governance - Red
Proposed Changes / Area of Model:	
Clustering	
Change Proposed:	
A review of the suitability of LCTs to be applied to specific housing and commercial building types, in the "Maximum number of profiles per building" table of the Clustering sheet.	
Justification for Change:	
We do not believe that these safeguards are currently in place.	
Supporting Evidence:	
The model currently allows: • 4kW of PV to be applied to every flat, • Commercial heat pumps to be applied to domestic buildings, • Charge at home EVs to be applied to commercial buildings, • Charge at work EVs to be applied to domestic buildings, • and several other unexpected combinations.	
Governance	
Comments: No Alternative data has been provided. **Degree of model change to methodology:** None **Expected impact on model results:** Low **Options:** The working group should consider one of the following options: - Continue to use existing dataset. - DNO working group to propose new dataset. - Issue a tender for a third party to develop a revised dataset **Decision:** Continue to use the existing data. EA Technology will produce s guidance document to discuss the assumptions better to allow greater transparency and understanding to the user.	

4.2.15 Output of threshold reached

Originator:	
Name: Stephen Quinn & Roger Hey Company: Western Power	Data Governance - Red
Proposed Changes / Area of Model:	
Network parameters/results by network	
Change Proposed:	
for each instance of investment triggered, it would be useful to have visibility of which threshold/constraint (voltage upper, voltage lower, thermal or fault level) has been breached to trigger investment. It would also be useful to have an overview or summary showing what proportion of investment in each year is due to each threshold/constraint.	
Justification for Change:	
We suspect that thermal constraints are causing most or all investment (this does not reflect current experience, especially with LCTs).	
Supporting Evidence:	
Governance	
Comments: This proposal concerns the Reporting capability of the model and is therefore out of scope of the governance process. **Degree of model change to methodology:** Moderate **Expected impact on model results:** None **Options:** To address the general reporting requirements EA Technology will prepare a proposal to improve the reporting components and submit it to the working group. **Decision:** EA Technology to include summary sheet in future release of model. It is unlikely to be available during this governance period	

4.2.16 Output of investment by solution types

Originator:	
Name: Stephen Quinn & Roger Hey Company: Western Power	Data Governance – N/A
Proposed Changes / Area of Model:	
Results	
Change Proposed:	
We would like to see all monetary outputs of the model broken down by: -Variant solution (i.e. the particular solution picked) -Representative solution (i.e. the technology picked, summed up from the variants) -Type of solution (conventional or smart, summed up from the representatives)	
Justification for Change:	
Ease of use, needed for business planning and budgeting purposes.	
Supporting Evidence:	
Governance	
Comments: This proposal concerns the Reporting capability of the model and is therefore out of scope of the governance process. **Degree of model change to methodology:** Moderate **Expected impact on model results:** None **Options:** To address the general reporting requirements EA Technology will prepare a proposal to improve the reporting components and submit it to the working group. **Decision:** EA Technology to include summary sheet in future release of model. It is unlikely to be available during this governance period	

4.2.17 Output of Clustering allowances reached

Originator:	
Name: Stephen Quinn Company: Western Power	Data Governance – N/A
Proposed Changes / Area of Model:	
Clustering/Results by network	
Change Proposed:	
We would like to be able to see if the values in the "Maximum number of profiles per building" table have caused LCTs/profiles to be cascaded down to lower clusters, broken down by year, network type, and LCT/profile.	
Justification for Change:	
There is currently no direct visibility of how the model is behaving in this respect, so it is not clear whether the LCTs we think are in a given profile are actually there.	
Supporting Evidence:	
Governance	
Comments: This proposal concerns the Reporting capability of the model and is therefore out of scope of the governance process. **Degree of model change to methodology:** Moderate **Expected impact on model results:** None **Options:** To address the general reporting requirements EA Technology will prepare a proposal to improve the reporting components and submit it to the working group. **Decision:** EA Technology to include summary sheet in future release of model. It is unlikely to be available during this governance period	

4.2.18 Feeder Allocation

Originator:	
Company: EA Technology	Data Governance – Red
Proposed Changes / Area of Model:	
Reconstituting the GB network dataset	
Change Proposed:	
• Review the GB dataset using the network input tables from each licensee, specifically, the number and percentage of each network type • Agree a new GB dataset • Ascertain whether there are any circuit types that can be omitted from future models (or of • any new ones that should be included) • Update this as part of the February 2013 Governance process, and in time for the 3.6 model runs in early March (there will be no additional cost for doing this analysis)	
Justification for Change:	
The parameters for the “GB model” were then based on this early analysis, but owing to gaps in data (not all DNOs were able to provide the full material in the tight timescales of the project), the ‘GB’ model was effectively scaled from real data taken from 5 licence areas. Whilst care was taken to ensure the model was calibrated to broadly align with the total number of feeders and the typical peak and average load in GB, there are clearly approximations in the method.	
Supporting Evidence:	
Governance	
Comments: DNO’s have been requested to provide updated data. Following receipt of the data, EA Technology will investigate whether or not the overall figures can be accepted. This will depend on the magnitude of change and its impact on the housing stock data and assumptions. **Degree of model change to methodology:** None **Expected impact on model results:** Moderate **Options:** The working group should consider one of the following options: - Continue to use existing dataset. - DNO working group to propose new dataset. - Issue a tender for a third party to develop a revised dataset **Decision:** Continue to use existing dataset EA Technology is addressing this but it will not be in model 3.1.0 as it will not affect the regional models and would delay publication of 3.1.0	

5 Published Data

The following proposals have been received through a variety of industry sources. The updated data provided is included as an appendix to this report.

5.1 Solution/Enabler Costs and Mapping

EA Technology and Smarter Grid Solutions (SGS) have each prepared reports that aim to enhance and improve the data behind the enabler and solution cost assumptions within Transform™.

Both reports were issued to the DNO's on the 18th of February 2013 (subject - WS3 Phase 3.4 SGS Report and Modelling Output summary).

Data Governance Status - Green

5.2 DECC Renewable Development Trajectories

The updated data from DECC has been updated and distributed to stakeholders via email on the 1/3/2013 subject WS3 Phase 3 Updated DECC data DG data.

Note on deployment projections for Smart Grids forum
Proposed Projections
The attached scenarios (see appendix) include a high and a low scenario in order to give an estimate of the possible range of deployment of small scale deployment in order to illustrate potential outcomes for the distribution network:

- **High:** EMR 100g scenario ('reference case') for large-scale + FITs High deployment scenario
- **Low:** EMR 100g scenario ('reference case') for large-scale (with lower onshore wind deployment) + FITs Low deployment scenario

The FITs Low/High scenarios are taken from the latest FITs Impact Assessments. This is different from the EMR 100g scenario (small-scale plus large-scale) where the central FITs scenario is used.

Explanation
The EMR 100g scenario is a point estimate of deployment over the coming decades. Smart Grids Forum scenarios are **illustrative** scenarios that are intended to provide an insight into the uncertainties facing the distribution network over the coming decades by showing a potential **range** for deployment on the distributed network out to 2030. **They do not represent a 'DECC view' of deployment.**

For most technologies, the low/high range is generated by Low/High FITs scenarios. However, the difference in wind deployment between the FITs high and low scenarios is insufficient to generate a range that captures future risks to delivery. We have therefore provided an illustrative scenario with lower large-scale onshore wind deployment (10GW in 2020 as opposed to 13GW in the high scenario).

Presentation

Deployment up to 5MW has been disaggregated according to the FITs tariff bands. Deployment of installations of greater than 5MW capacity has been aggregated.

Data Governance Status - Green

5.3 OLEV Plug-in Vehicle Scenarios

A) Scenarios

The scenarios presented here are those developed for the Autumn Strategy to deliver the Fourth Carbon Budget (CB4). Here we have looked at 3 scenarios for average new car and van emissions in 2030 (as set out in the table below). Current average emissions are 144gCO_2/km for cars and 196gCO_2/km for vans.

Carbon Budget Scenario	Scenario	Average new car emissions	Average new van emissions
CB4: Sc. 4	Low	70gCO_2/km	105gCO_2/km
CB4: Sc. 1	Medium	60gCO_2/km	90gCO_2/km
CB4: Sc. 2 & 3	High	50gCO_2/km	75gCO_2/km

Our approach has always been to be technologically neutral; enabling the market to develop the technologies it thinks will work best for consumers while hitting CO_2 targets. This has made the analysis difficult because to produce cost estimates we needed to model a specific technology mix. This is further complicated by the fact that as yet we can't do this fully because we are unable to model hydrogen fuel-cell vehicles due to a lack of data. This left us selecting mixes of EV (pure-battery-powered) and PHEV (plug-in hybrid) which are likely to be too high when considering the role hydrogen could play. Nevertheless they provide some indication of the numbers of ultra-low emission vehicles required to deliver the CO_2 reductions in transport necessary to meet our climate change commitments.

The analysis was 'top-down' and lacks granularity. We did not model the geographic dispersion of these vehicles. Nor did we model charging behaviour directly (either when, where or how). Both of these elements are important however when trying to understand local grid impacts. The limitations, uncertainties and contingencies of the analysis are discussed in more detail below.

Even beyond the many uncertainties surrounding this analysis, the way we have approached CB4 – focussing on average CO_2 emissions as opposed to specific technologies – means it is not possible for us to recommend a central or most likely case from these scenarios. At this stage we can not predict how the market will respond to future CO_2-reduction targets and the particular technology mix that will prevail.

January 2013 Update

However, the DfT has also been engaged in 'bottom-up' analysis of the potential for electric vehicles in the UK. We have built on the analysis undertaken for the Carbon Plan by combining economic models developed for the Energy Technologies Institute with probability simulation models to form a view on a 'base-case' level of uptake. This level of uptake can best be described as what the market is most likely to deliver **without further policy intervention**. It is this 'base-case' uptake level which we have used in our 'low' scenario described above. As this scenario marks the lower boundary of our range, this can be considered as the minimum level of uptake we currently expect. Over time, as policy is developed and implemented to increase the uptake of ULEVs in the 2020s to meet our CB4 target, this policy will be incorporated into our 'base case' projection, such that in future iterations of this note we expect our 'base case' projection to approach (and meet) the two higher, top-down projections developed for the Carbon Plan.

National

The detailed numbers are presented in the two tables at the end of the document. These show both the numbers of new vehicles as well as the total annual electricity demand (TWh) at a national level.

Sub-national (if available)

We currently do not have any sub-national data on the likely location of these vehicles. Many people expect electric cars to be most advantageous in an urban (possibly suburban) environment. However as PHEV and REEV are limited in range, there is no necessary reason why they should be more prevalent in a particular context. The one exception to this would be London where PiV currently benefit from congestion-charge exemption, providing a strong reason to expect to more of these vehicles to be located here, in the short-term at least. We are monitoring the locations of early uptake, and have explored methods of projecting the location of future uptake. We hope to share these location projections over by summer 2013.

B) Assumptions

- Economics - the EV/PHEV/REEV split.
  We have based this on recent research carried out by the Energy Technologies Institute and other studies investigating the relative merits of these technologies. The consensus view is that PHEV and, to a lesser extent RE-EV, will dominate because they are not limited in range. As such they could offer a much closer substitute to the vehicles people currently buy.

  In the case of vans, REEV are not considered because the evidence suggests that the larger battery would be too expensive and heavy (thereby reducing available payload) to be viable.

- Technological - efficiency of vehicle
  The efficiency assumptions which determine the amount of electricity consumed are drawn from recent studies developed for the ETI and the DfT.

- Behavioural (mileage)
  We use DfT data on average annual mileage (by vehicle segment) to determine the total annual electricity consumed.

C) Sensitivities / Uncertainties / Contingencies

There are many factors which will impact on the actual PiV uptake, including:

- Economics
  Future uptake will be heavily influenced by the relative price between electric and comparator vehicles, as well as running costs. Therefore the future evolution of battery costs will be critical to determining their cost competitiveness as will future oil prices. However, future improvements in the fuel efficiency of conventional vehicles will both reduce the relative benefit of an EV whilst reducing the share of fuel costs with the total costs of ownership. Other non-fuel costs such as maintenance and insurance, where EVs do not have an advantage, will become increasingly important.

  In addition the ‘utility’ offered by the vehicle is crucial in determining uptake. The primary concern is range anxiety, but for vans there are additional considerations around loss of payload. This may mean the market is more likely to adopt PHEV and RE-EV, which offer a closer substitute to existing vehicles without significant additional cost due to smaller battery sizes, than EVs. Early estimates of these 'utility' penalties suggest they are in the order of £, 000s, making the economic case that much more difficult. However over time, if the technology improves and consumers become more familiar with it, these biases against EVs should reduce.

- Policy
  Clearly the higher uptake scenarios of PIV will require significant policy intervention. The current system of vehicle and fuel taxation favours EVs, which are further supported through the Plug-in Car Grant. An obvious uncertainty for the future is, given the relative economics of EVs to conventional vehicles as discussed above, whether this support will continue and will be sufficient to support uptake.

  In addition the major driver of technological change within the automotive industry in terms of CO_2 emissions is EU regulation. As currently specified, the new car and van CO_2 regulations will deliver improvements in average CO_2 emissions of up to 33% by 2020 on current levels. The major uncertainty is the future of these regulations post-2020; specifically the target-levels which are set for 2025, 2030 and beyond. This is important because future targets could potentially require manufacturers to introduce (and be able to sell) significant numbers of zero-emission vehicles and plug-in hybrids, although it's uncertain which technologies manufacturers would actually choose. However as that future target levels would need to be agreed by all member states, presaging the outcome at this stage is clearly not possible.

- Behavioural (charging behaviour)
  Consumers, where they live, and how they use their vehicles, how far they drive, how often they recharge, how they recharge, where they recharge are vital pieces of information when determining the local grid impacts of any future EV uptake.

  The OLEV Infrastructure Strategy expects the vast majority of recharging to be undertaken at home, overnight, but the extent to which future consumers will use public infrastructure, and the speed of this recharge is uncertain. Equally recharging behaviour in the commercial sector is still uncertain, though the potential exists for price incentives to shift charging to desired times/locations.
- Development of the global industry
  Alone the UK is too small a market to drive the cost reductions required to make EVs mainstream. A key variable for future uptake is the action of other governments around the world to kick-start this market and for automotive companies to invest in these technologies, increasing volume, improving performance and ultimately lowering costs. Without this concerted action it is very difficult to see how high rates of EV uptake can be achieved.

- Technical and economic potential for other technologies, e.g. hydrogen
  The evolution of competitor technologies, particularly hydrogen fuel-cell vehicles, will have a critical bearing on the number of plug-in vehicles in the UK. The policy framework is focussed on CO_2 emissions not specific technologies so the support and imperative for EVs will apply just as equally for other zero-emission vehicles. If these competitors deliver a better deal for consumers in terms of cost and 'utility' then it may be that the market will choose these alternatives. As such uptake of vehicles with a plug will be much lower. We are currently developing our modelling techniques to include uptake projections of all future ultra-low emission technologies.

D) Post-2030 Scenarios

The scenarios post-2030 have been extrapolated to 2050 in three different ways.

70g scenario – the model runs suggest without further intervention that uptake will continue increase at a similar, slow rate post 2030 to 2050.

60g scenario – here we assume that the market for new cars and vans is virtually decarbonised by 2040 so that the UK can meet its 2050 GHG goals. We assume that this is achieved through a mix of zero-emission vehicles: hydrogen fuel-cell, battery electric and hydrogen fuel-cell range-extended vehicles.

50g scenario – again we assume that the market for new cars and vans is virtually decarbonised by 2040. In this scenario, we assume a breakthrough in battery technology, allowing much greater range at low cost, such that electric vehicles dominate the market. This is very much the upper limit to electric vehicle penetration.

E) Re-charging assumptions

The tables below split recharging by source and by speed. Though there is considerable uncertainty as to future recharging behaviour, the estimates here are based on a number of assumptions relating to: distance travelled vs. electric range; type of vehicle (EV, PHEV or REEEV); whether the vehicle is private, company or fleet, or in the case of vans, 2nd hand, or part of a small fleet or large fleet; the penetration rate of vehicle stock vs. proportion of households with off-street parking; and the impact of increasing battery range on the need for on-street recharging.

Slow, fast and rapid charging refer to 3kW, 7kW and 50kW draw-down rates. Initially we expect 3kW to be the norm but then this to make way for 7kW as private individuals and firms install dedicated charging units. On-street recharging is assumed to be fast under the assumption that consumers only use public infrastructure to continue their journeys (so that it makes sense for them to seek out rapid chargers). This is an oversimplification as one could expect some ‘opportunistic’ charging, utilising posts in supermarket car parks for example, but this is likely to make up only a small fraction of recharging. The exception comes in scenario 3 when the high electric car penetration rate requires people with no off-street parking to buy electric cars; in this case we assume they use on-street fast charging.

EA DIVISION, GTI
Department for Transport
January 2013

5.4 DECC Energy Efficiency Scenarios

The model will be amended to include four energy efficiency scenarios based around the 2010 Market Transformation Programme (MTP) “policy” scenario:

1. Policy
2. Reference
3. Best available Technology
4. Zero Efficiency

This is described in further detail in Appendix 1.

A note from DECC on lighting and appliance assumptions has been included as Appendix 2.

Data Governance Status - Green

Appendix 1 Energy Efficiency in Transform

Energy Efficiency Application Notes

- Energy efficiency measures are taken on the electrical appliances and lighting load only. There are no direct efficiency measures taken for heating demand and therefore different thermal insulation levels.
- All figures for electrical appliance and lighting load came from Defra's Market Transformation Programme, from which the central "Policy" scenario was selected (data is provided in Appendix A).
- The energy efficiency assumptions apply to domestic demand only. SME and I&C loads are excluded as it was not possible to assess the mix of loads used in a commercial or industrial setting at the time when the datasets for the model were developed.
- Housing insulation levels are indirectly applied to buildings with electrical heating (direct electrical heating or Heat Pumps) via the demand profile of those devices.
    - A single profile for direct electrical heating and Heat Pumps is applied in the model, regardless of size of property.
    - These profiles were based on trial data and modelling developed by GL Noble Denton as part of the WS3-Ph2 work. The profile datasets can be updated as better data becomes available (e.g. from current LCN Fund projects).
    - We are currently seeking to ascertain (from GL Noble Denton) the insulation levels of the properties used for both types of profile.

Table A2: Make-up of composite scenarios in the Transform™ dataset

		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*				
LV	PV trajectory	WS1: Average[1]	WS1: Average[1]	WS1: High	WS1: Low
LV	HP trajectory	WS1: High	WS1: Medium	WS1: High	WS1: Low
LV	EV trajectory	WS1: Medium	WS1: High	WS1: High	WS1: Low
LV	*Energy Efficiency assumptions*				
LV	Heating Demand	Applied indirectly via demand profile of electrical heating (direct and HPs)			
LV	Lighting Demand	Defra: Market Transformation (Policy scenario)			
LV	Appliance Demand	Defra: Market Transformation (Policy scenario)			
HV & EHV	*Generation scenarios*				
HV & EHV	Onshore wind (small - medium)	WS1: High	WS1: High	WS1: High	WS1: Low
HV & EHV	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'
Transmission[3]	Coal with CCS				
Transmission[3]	Coal				
Transmission[3]	CCGT				
Transmission[3]	Interconnector				
Transmission[3]	CCGT with CCS				
Transmission[3]	Biomass				
Transmission[3]	Wind (offshore)				
Transmission[3]	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

Annex: Further information on the energy efficiency datasets used in the model

Electrical Appliance and Lighting Demand Reductions

Uses Defra's Market Transformation Programme:

The Market Transformation Programme (MTP) supports UK Government Policy on sustainable products, by:

• Developing and maintaining a robust evidence base on impacts and trends arising from products across their life-cycles.

• Ensuring reliable product information is available and is used to inform policy decisions, consumer choices and instruments like public procurement.

• Working with stakeholders to harness their expertise to develop a robust evidence base for effective standards across product life-cycles and outcomes which stimulate innovation and ecodesign

The MTP data to derive annual efficiency improvement figures for lighting and appliances (ICT, domestic appliances and consumer electronics). These improvement factors derive from figures for the annual stock of appliances and the annual consumption. The MTP sets out 3 scenarios – Reference, Policy and Best Available Technology. For the WS3 model the central 'policy' scenario was selected.

Source: Defra (http://efficient-products.defra.gov.uk/)

Three scenarios have been developed as part of the Market Transformation Programme:

- **Best available technology** – an aggressive energy efficiency scenario
- **Policy** – energy efficiency in line with Government policy levels
- **Reference** – the base case

The dataset used for the model was based on information in the following table.

Table A3 **MTP figures for the three energy efficiency scenarios for electrical lighting and appliances**

Domestic scenarios																						
MTP lighting																						
Best available technology	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	0%	-10%	-20%	-30%	-40%	-44%	-48%	-52%	-56%	-59%	-63%	-67%	-68%	-68%	-69%	-69%	-69%	-70%	-70%	-71%	-71%	-72%
yearly efficiency improvement		-10.10%	-10.10%	-10.10%	-10.10%	-3.82%	-3.82%	-3.82%	-3.82%	-3.82%	-3.82%	-3.82%	-0.48%	-0.48%	-0.48%	-0.48%	-0.48%	-0.48%	-0.48%	-0.48%	-0.48%	-0.48%
Policy	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	0%	-7%	-14%	-21%	-28%	-30%	-32%	-34%	-36%	-38%	-40%	-42%	-45%	-48%	-51%	-54%	-58%	-61%	-64%	-67%	-70%	-73%
yearly efficiency improvement		-6.99%	-6.99%	-6.99%	-6.99%	-1.99%	-1.99%	-1.99%	-1.99%	-1.99%	-1.99%	-1.99%	-3.15%	-3.15%	-3.15%	-3.15%	-3.15%	-3.15%	-3.15%	-3.15%	-3.15%	-3.15%
Reference	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	0%	-7%	-14%	-21%	-28%	-29%	-30%	-31%	-32%	-33%	-34%	-35%	-35%	-35%	-36%	-36%	-36%	-36%	-37%	-37%	-37%	-38%
yearly efficiency improvement		-6.99%	-6.99%	-6.99%	-6.99%	-0.97%	-0.97%	-0.97%	-0.97%	-0.97%	-0.97%	-0.97%	-0.28%	-0.28%	-0.28%	-0.28%	-0.28%	-0.28%	-0.28%	-0.28%	-0.28%	-0.28%
Appliances																						
Best available technology	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	0%	-5%	-10%	-15%	-20%	-23%	-26%	-29%	-32%	-35%	-37%	-40%	-41%	-42%	-43%	-44%	-46%	-47%	-48%	-49%	-50%	-51%
Weighted averaged yearly efficiency improvement		-5.08%	-5.08%	-5.08%	-5.08%	-2.84%	-2.84%	-2.84%	-2.84%	-2.84%	-2.84%	-2.84%	-1.07%	-1.07%	-1.07%	-1.07%	-1.07%	-1.07%	-1.07%	-1.07%	-1.07%	-1.07%
Policy	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	0%	-3%	-6%	-9%	-11%	-14%	-17%	-19%	-22%	-25%	-27%	-30%	-31%	-32%	-34%	-35%	-36%	-37%	-38%	-40%	-41%	-42%
Weighted averaged yearly efficiency improvement		-2.84%	-2.84%	-2.84%	-2.84%	-2.67%	-2.67%	-2.67%	-2.67%	-2.67%	-2.67%	-2.67%	-1.19%	-1.19%	-1.19%	-1.19%	-1.19%	-1.19%	-1.19%	-1.19%	-1.19%	-1.19%
Reference	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	0%	-1%	-3%	-4%	-5%	-7%	-8%	-10%	-11%	-13%	-15%	-16%	-17%	-17%	-18%	-19%	-19%	-20%	-20%	-21%	-22%	-22%
Weighted averaged yearly efficiency improvement		-1.27%	-1.27%	-1.27%	-1.27%	-1.60%	-1.60%	-1.60%	-1.60%	-1.60%	-1.60%	-1.60%	-0.60%	-0.60%	-0.60%	-0.60%	-0.60%	-0.60%	-0.60%	-0.60%	-0.60%	-0.60%

Note 1: The table has been curtailed at 2030 for ease of reference, but data out to 2050 is used in the model.
Note 2: As the data is based on a 2009 reference, it has been recalculated with 2011 taken as the new base
Note 3: Only the Policy figures have been used in the WS3 model for Lighting and Appliances

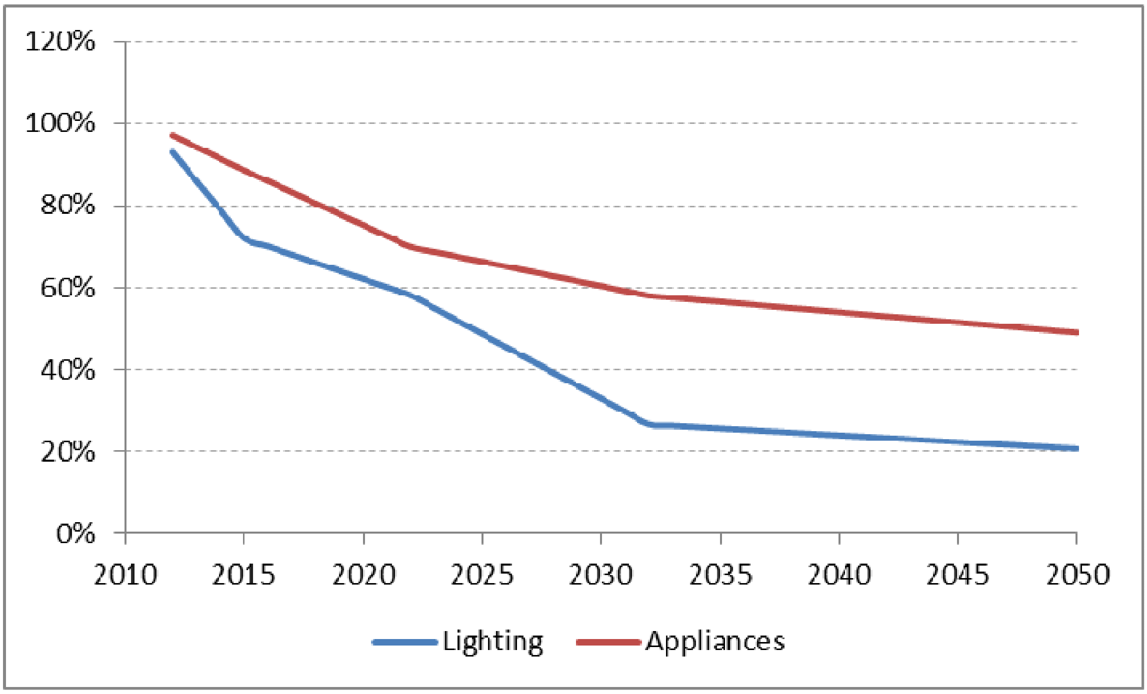


Figure A1 Chart showing the energy efficiency roll-off for the 'Policy' scenario as used in the Transform™ dataset

Heating demand reductions resulting from improved thermal insulation

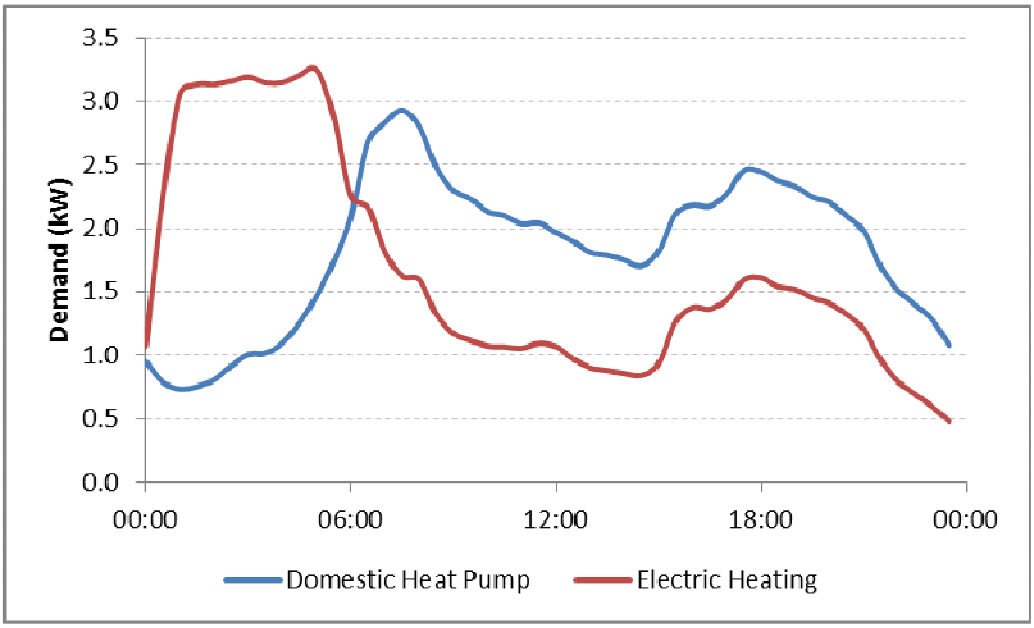


Figure 2: Demand profiles for direct electric heating and domestic HP currently contained in the Transform™ model

Appendix 2 Lighting & Appliance efficiency Assessment of the consistency between DECC's 4CB and Model Transform

Background

DECC was asked to confirm that its Fourth Carbon Budget (4CB) energy efficiency assumptions on lighting and appliances are consistent with the Defra Market Transformation Programme (MTP) 'policy' scenario[1], used in Smart Grid Forum's Model Transform.
DECC uses Defra's MTP 'policy' scenario within its Updated Emissions Projections (UEP) which forms the baseline for the 4CB scenarios. Defra provide aggregated products data (which includes lighting and appliances) that is tailored for DECC needs, so a direct comparison to the specific MTP lighting and appliance trajectories used in Model Transform is difficult.

However, DECC energy projections use outputs from Defra's MTP 'policy' scenario (with some caveats outlined below) and is therefore the most appropriate choice from the scenarios currently being considered by the Smart Grid Forum. DECC does not "endorse" any other particular scenarios but agrees they would be useful for sensitivity testing.

DECC's 4CB scenarios baseline – UEP

The UEP baseline does not include any explicit modelling of energy use for lighting and appliances. Instead energy use for lighting and appliances is subsumed within top down projections for total electricity demand and that for other fuels. These projections are based on econometric analysis of past trends in demand and potential drivers such as economic growth. The projections for total demand for electricity and for other fuels therefore cover all energy use, including, for example, heating and consumer electronics. These Business as Usual projections have then been reduced to take account of the impact of existing[2] energy reduction policies such as the EU minimum products standards and labelling requirements contained in MTP.

Consistencies

1. Modelling inputs – Both DECC and Model Transform use Defra's MTP model outputs from the 'policy' scenario. Defra provide DECC with output from the MTP including EU minimum product standards and labelling requirements. These consist of 2 tranches; Tranche 1 are standards that where negotiated by member states pre 2009; Tranche 2 are standards that have been negotiated post 2009, or are still in the process of voting/finalisation. More information on how this impacts on being able to reconcile DECCs 4CB scenarios and model transform is provided in the section on cautions below.

2. Lighting and appliance assumptions across DECC's 4CB scenarios do not assume different levels of lighting and appliance efficiency across the four scenarios. The baseline to all four scenarios is the October 2011 UEP[3]. Model Transform is consistent in that it also does not vary its lighting and appliance assumptions across its scenarios.

[1] http://www.defra.gov.uk/publications/files/pb13559-energy-products-101124.pdf
[2] Existing policies are policies where funding has been agreed and where decisions on policy design are sufficiently advanced to allow robust estimates of policy impacts to be made
[3] https://www.gov.uk/government/organisations/department-of-energy-climate-change/series/energy-and-emissions-projections

Cautions / why direct comparison is not possible

1. The MTP assumptions for lighting and appliances do not capture all the energy using equipment in buildings that DECC captures in its UEP model. For example, the UEP also includes consumer electronics.

2. Defra's MTP 'policy' scenario covers energy efficiency savings potential in products, regardless of which policy delivers them. The Products Policy analysis that Defra provide DECC for its UEP publication (based on MTP), aims to cover EU minimum product standards and labelling requirements only.

3. The MTP analysis was carried out in 2009 – There will have been different energy prices and economic assumptions, which may affect the level of energy savings and the trajectory (although this is a relatively small issue given the nature of the MTP model which does not fully take into account economic variables).

4. Tapering (reducing) of Defra's MTP 'Policy' savings in DECCs UEP Post-2022 – The MTP 'policy' numbers used by Model Transform assume a continued improvement relative to the MTP 'reference' scenario. When DECC uses the MTP data it "tapers" (reduces) the policy savings, on the assumption that some of the demand reduction would have happened in the absence of the policy, due to behaviour change over time.

5. Further caution factors applied to Tranche 2 for UEP - For UEP analysis, some further caution factors are applied to the EU standards data for Tranche 2. This is to reflect the scope, stringency and timing of these EU standards is still being finalised in a number of cases.

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Annex 6.1

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CONFIDENTIAL REPORT

Prepared for:

Energy Networks Association

Smart Grid Forum
Work Stream 3 – Phase 3.2

Development of a licence area level feeder model

Authors:

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Report No:
84170_2

Project No: 84170_2

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Summary

This report details work performed by EA Technology Limited and Element Energy in October and November 2012. The aim of the work was the disaggregation into 14 regions of the Transform Model developed in Phase 2 of this project (one for each DNO licence area). This has led to the creation of an updated version of the Transform™ model, which has been released to all Network Operators at the same time as this report.

The report gives a detailed explanation of the methodology used to disaggregate the data into 14 regions. Following on from this disaggregation by Element Energy the data has been independently checked by EATL and input into the Transform model. Additionally, the model has been adjusted to reflect the four scenarios from the Carbon Plan issued by DECC in December 2011. In developing this disaggregated model, no other changes have been made to the input data.

The model has been run using synthetic DNO data for three sample DNO regions and these results are presented to allow the reader a feel for the variability within the regions. Finally, the model offers 45 'moving parts' which it is possible for the individual DNO to vary. Recommendations are given as to which of these parameters should remain fixed and which can be varied.

Contents

1 Introduction

1.1 Scope

This report details work performed by EA Technology Limited (EATL) and Element Energy in October and November 2012. The overall aim of the work was the enhancement of and verification of assumptions within the WS3 model developed to generate the Phase 2 report: "Assessing the Impact of Low Carbon Technologies on Great Britain's Power Distribution Networks"2. The software model has since been registered as an EA Technology software package and renamed the **Transform™** model. For the purpose of this report, the model is referred to as Transform™ model.

Under the WS3 Phase 2 activity, the Transform™ model was created and currently consists of five regional variants. This report details how the model has been further disaggregated into 14 regions (one for each DNO licence area). This has led to the creation of an updated version of the Transform™ model, which has been released to all Licenced Users at the same time as this report.

The report gives a detailed explanation of the methodology used to disaggregate the data into 14 regions. Additionally, the model has been adjusted to reflect the four scenarios in DECC's Carbon Plan (December 2011). Following on from this disaggregation by Element Energy the data has been independently checked by EATL and input into the Transform model. In developing this disaggregated model, no other changes have been made to the input data.

The model has been run using synthetic DNO data for three sample DNO regions and these results are presented to allow the reader a feel for the variability within the regions. Finally, the model offers 45 'moving parts' which it is possible for the individual DNO to vary. Recommendations are given as to which of these parameters should remain fixed and which can be varied.

1.2 The Work Stream 3 Phase 2 LV network model

A key input to the WS3 model is the description of the LV network. This is in terms of a representative set of LV feeder types, each of which is defined by the number of customers connected and the mix of customer types, i.e. domestic connections of various house types and non-domestic connections. The LV feeder model comprises 19 characteristic LV feeder types, including rural, urban and suburban variants.

The LV network in an area is described by the 'feeder stock', the total number of feeders and the mix between the characteristic feeder types. In the Phase 2 version of the WS3 model, the feeder stock is disaggregated into five regions, as shown in the figure below. These regions are clearly rather broad, each covering multiple licence areas and geographies of differing character.

Region	Government Office Regions covered
1	Scotland
2	North West North East Yorkshire and the Humber West Midlands East Midlands
3	Wales
4	South West South East East of England
5	London

Figure 1, Map of the five regions defined in the Phase 2 version of the Work Stream 3 model

The definition of the LV feeder types was underpinned by a detailed analysis of actual LV network data for a representative sample of DNOs. This analysis identified the most common types of LV feeder, in terms of mix of customer types (i.e. profile class), and the number of customers of each type typically connected.

Once a characteristic set of LV feeder types had been defined, data from the Housing Condition Survey was used to populate the feeders with a representative mix of house types, where house types vary by type (detached, semi, terrace and flat), main heating technology (electric or non-electric) and age. This was done to reflect the differing housing stocks in each of the five regions. The overall size of the feeder stock was then determined such that the number of domestic connections in each region matched the size of the housing stock in each region, as reported by the Housing Condition Surveys.

This process is described in detail in the Work Stream 3 Phase 2 report[1] and is summarised in the schematic below.

[1] Assessing the impact of low carbon technologies on Great Britain's power distribution networks, July 2012, www.ofgem.gov.uk/Networks/SGF/Publications/Documents1/WS3%20Ph2%20Report%20Issue%203-1%20-%2031-Jul-12.pdf

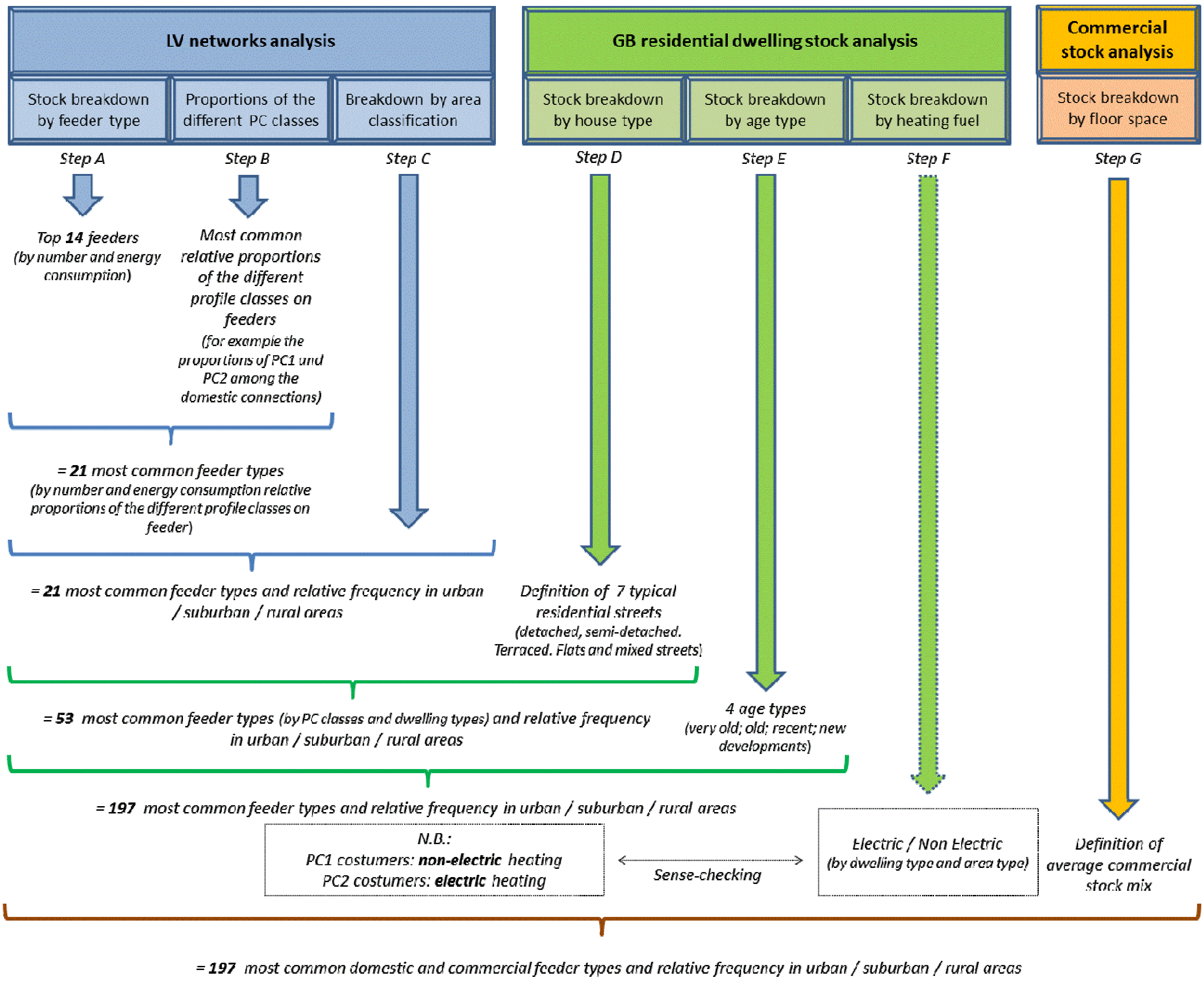


Figure 2, Schematic of the analysis applied to DNO network data and building stock data in Phase 2 of Work Stream 3, in order to develop the Standard LV Feeder types and feeder stock compositions for each of the five regions.

It is important to note that the 19 LV feeder types finally input into the WS3 model are a reduced list, based on a much larger set of common feeder types identified through the process of analysis of the DNO data and populating these with House Condition Survey data. This reduction in the number of feeders has been achieved by aggregating similar feeders into the 19 broad feeder types finally input into the model. This is important, as the larger number of feeders have again been used as the basis for determining the feeder stock in each of the licence areas. This greater number of initial feeder types provides greater flexibility to define the feeder stock in each of the licence areas.

2 Methodology

The main challenge of this work was to disaggregate the feeder stock to the licence area level, in terms of the number and composition of feeders. The intention was that the 19 Standard LV Feeder types contained in the Phase 2 model would be retained, so as to avoid major changes to the model code and input formats. However, as a result of the matching of the feeder stock to more disaggregated data on the housing stock, the number and mix of customer types on these 19 LV feeders varies by licence area.

2.1 Feeder stock composition

The most disaggregated data on the housing stock readily available is that contained in the Housing Condition Surveys. These surveys contain data on the composition of the housing stock, where the house types are described by a large number of attributes (such as size, type, tenure, main heating fuel, condition etc.), at Government Office Region (GoR) level.
The first step in the methodology was to define a feeder stock for each of the Government Office Regions. This was done by scaling the number of feeders (based on the larger number of common feeders) to match the size of the housing stock in each GoR and adjusting the feeder mix to ensure a good description of the composition of the housing stock within each GoR (the initial mix of common feeder types was based on the analysis of the DNO's network data, as described in detail in the Phase 2 report).
The second stage of the process was to then apportion the GoR level feeder stock between those licence areas that have coverage of each GoR.

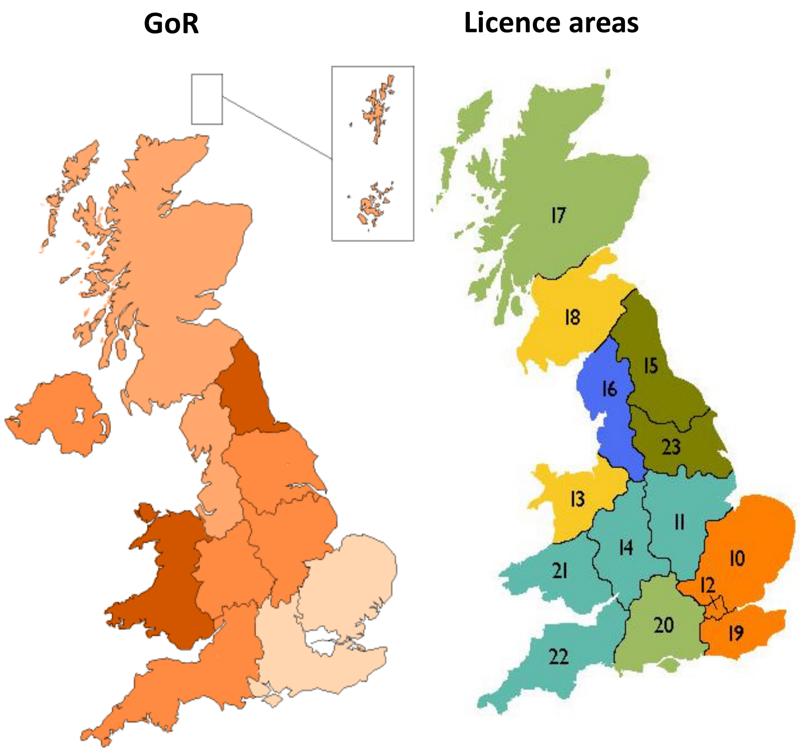


Figure 3, Comparison of the map of GB Government Office Regions with a map of the fourteen licence areas.

The splitting of the GoR level feeder stock into licence areas has been done on the basis of data provided by the DNOs on the coverage of their networks. This data was in the form of postcode addresses for each distribution substation in each licence area. In some cases, data on the number of customers connected to these distribution sites was also provided, enabling a more accurate split of the GoR level data.

Where a GoR is served by multiple licence areas, the methodology is effectively to pro-rata the feeder stock between each licence area. Distribution site postcodes have been matched to local authorities, in order to identify which distribution sites are located within each GoR. The number of customers connected to these distribution sites can then be used as the basis to apportion a fraction of the feeder stock in the GoR to that licence area. Where customer numbers connected to the distribution sites have not been provided, it has been necessary to assume an average number of customers for the distribution sites in that licence area and use this as the basis for the prorating.

2.1.1 New build rate

The existing housing stock is described within the model by house types that fall into three age categories – recent (post-1980), old (1919 – 1980) and very old (pre-1919). A further 'new build' house type is defined to describe homes built post-2010, which have load characteristics that reflect the higher standards of energy efficiency required by the recent Building Regulations. A new build and demolition rate is defined within the model. These rates are based on historical averages at GoR level, published by the Department of Communities and Local Government (data is available for the period from 2001 to 2010). The new build homes are assumed to be serviced by new feeders. Hence the number of feeders grows over time and there is a churn between feeders populated with the existing house types and the new feeders populated by new build house types.

The new build and demolition rates used in the Phase 2 version of the model have been kept unchanged, hence the rate of feeder increase and churn between existing and new feeders is identical to that assumed in Phase 2.

2.2 Commercial connections

The non-domestic connections within the model have been derived from the analysis of the DNO's data on their networks. This led to the identification of a number of 'mixed' feeder types, where the feeders serve both domestic and non-domestic customers, and a smaller set of fully non-domestic feeder types (typical of retail parks, business parks and central business districts of towns). The difficulty in representing the very diverse nature of the non-domestic stock in a limited number of standard feeder types was recognised during development of the WS3 Phase 2 model. As a result, the decision was taken to identify a limited number of the most common types of non-domestic premises, which could be represented by a set of characteristic load profiles. For each of the regions, a weighted-average commercial connection was then defined, based on a weighting of the characteristic load profiles to reflect the floor space composition of the non-domestic building stock in the region.

The concept of a weighted average commercial connection is retained in the more disaggregated licence area model. A weighted average commercial connection has been defined for each licence area on the basis of Valuation Office Agency data on the floor space of non-domestic premises at local authority level. This local authority data has been used to derive floor space data at GoR level and then, using the same process as used to apportion the feeder stock to licence areas, the GoR non-domestic floor space has been apportioned to the licence areas. The weighting coefficients specific to each local authority have then been derived from these floor space figures.

2.3 Low carbon technologies

The uptake of low carbon technologies (LCTs) in the WS3 model is predicated on a set of scenarios provided by DECC. In terms of the LCTs that will be connected at the LV level, these scenarios provide projections for the rate of uptake of photovoltaics (PV), electric vehicles (EVs) and heat pumps. These projections are provided at a GB-wide level, without any attempt to regionalise the uptake.

As part of the WS3 Phase 2 work, the DECC scenarios for technology uptake were disaggregated in order to define a rate of uptake in each of the standard feeder types. The uptake within each of the five regions could then be calculated by combining the feeder level uptake rates with data on the size and composition of the feeder stock within that region.

Care was taken in this process to ensure that when the uptake of each of the five regions was aggregated together, the initial DECC scenarios for national uptake were reproduced.

The disaggregation of the DECC scenarios to feeder level was achieved using a number of Element Energy's existing technology uptake models, which are each based on an understanding of consumer behaviour with respect to investment decisions in low carbon technologies (these models are underpinned by quantitative consumer survey work). In the case of heat pump and PV, these models predict the likelihood that a consumer in a certain house type will make a decision to invest in the technology, given the proposition presented to them (in terms of capital cost, payback period and also other attributes, such as their familiarity with the technology and perceived inconvenience associated with the installation). This enables an uptake rate to be defined per house type. In the case of EVs, the uptake model forecasts the uptake in particular demographic groups, which is used to develop a GoR level uptake rate on the basis of population data. The GoR level uptake is then prorated across the feeder stock. The prorating is weighted to favour uptake in urban areas and to favour detached and semi-detached house types, which are more likely to have a driveway suitable for home charging. The uptake rate per feeder generated using these consumer choice models was then calibrated to match each of the DECC scenarios.

The same methodology has been applied to disaggregate the DECC scenarios across the revised feeder stocks for each of the licence areas. Please note that at a GB-level, there has been no changes to the DECC scenarios for any of the technologies. The DECC uptake scenarios for each technology are included in Appendix A.

2.4 Data granularity

The licence area level LV feeder stock and associated LCT uptake rates has been developed based on a range of data sources at varying levels of geographic granularity.

The datasets used and the geographic level at which they have been applied is summarised in the schematic below.

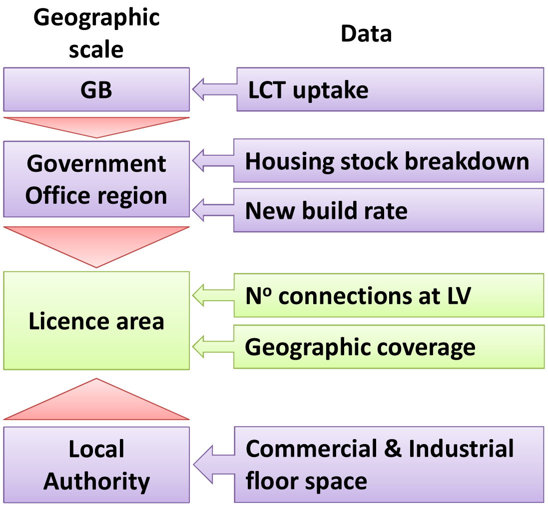


Figure 4, Schematic illustration of the various data sources used to generate the LV network data at licence area level and the level of geographic granularity at which they are available.

3 Licence area coverage

As discussed above, the fraction of the GoR level feeder stock apportioned to each licence area has been determined on the basis of postcode data for the distribution substations and customer number data, at distribution site level where available or using licence area level numbers. The resulting split of each GoR between the licences is shown in the chart. The percentage split by licence area is also shown in Table 3 in Appendix B.

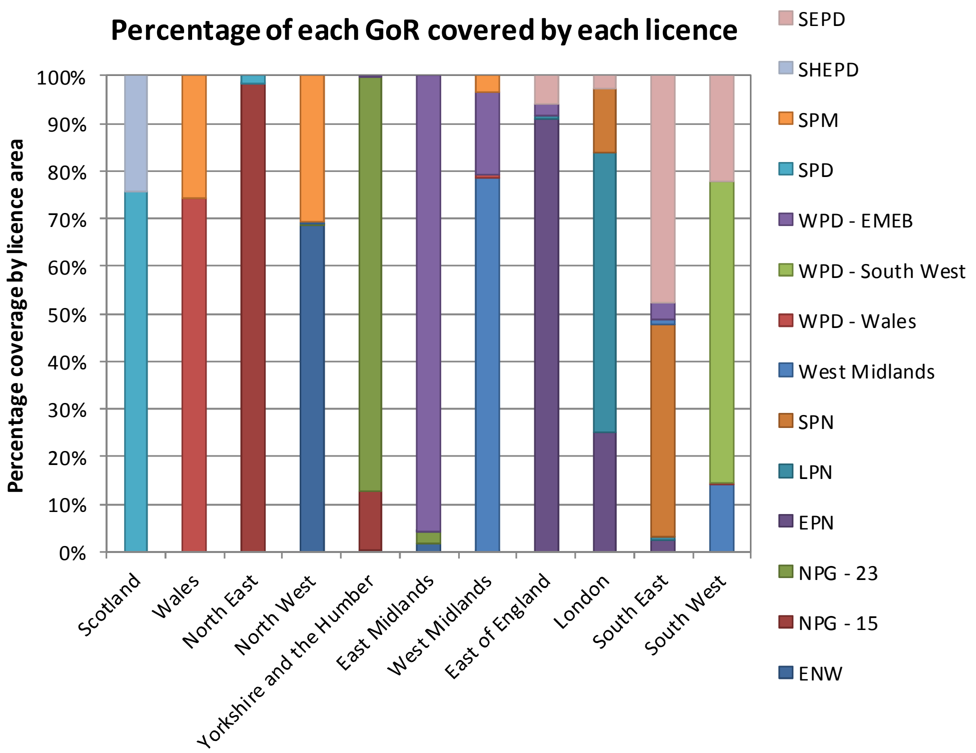


Figure 5, Chart of the percentage coverage of each GoR by each of the DNO licences.

Once the GORs have been apportioned between the licence areas according to the percentages shown above, we can then also derive the percentage of each licence area that lies in each GOR in terms of their feeder stock.

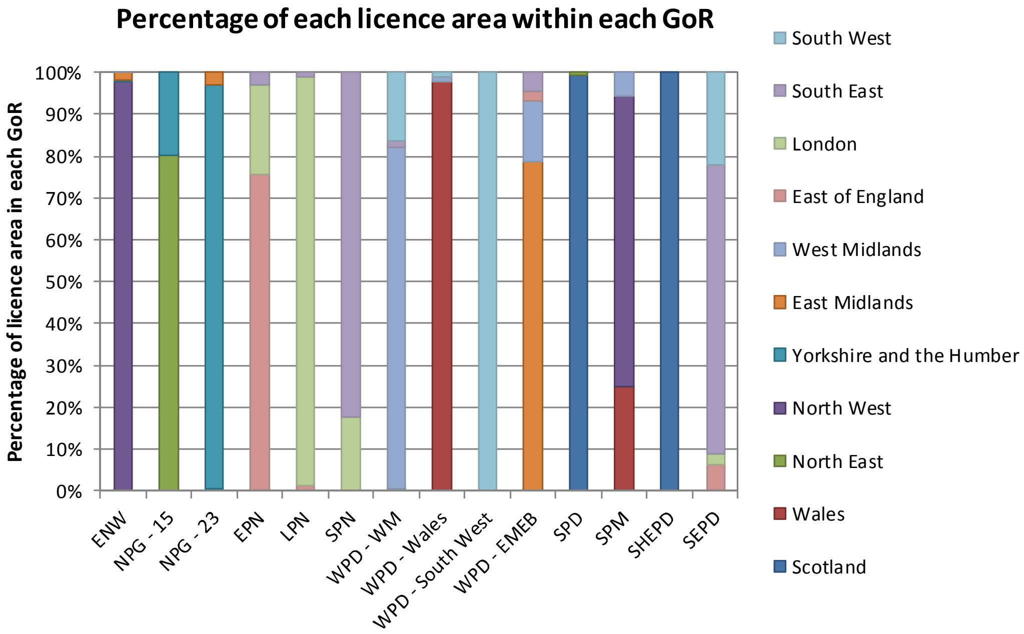


Figure 6, Percentage of licence areas that lie in each GoR as a result of the apportionment of the GoR level feeder stock

4 Licence area outputs

The detailed feeder stock data, in terms of the definition of the standard feeder types and composition of feeder stock in each licence area, is shown in the tables in Appendix C.
In most cases the strongest influence on the rate of uptake will be the overall number of feeders in the licence area. More populated licence areas, e.g. more houses or commercial properties, are likely to see greater uptake of the LCTs. The propensity of certain house types to take up certain technologies also has an influence on the split between the licence areas.

The strongest uptake of domestic heat pumps is seen in the EPN licence, which is consistent with the large housing stock in the licence area. Rural house types have a stronger propensity to take up heat pumps than urban house types. This can be seen in the strong early uptake of heat pumps in WPD's Wales's network and in the SPD network. Conversely, the uptake of domestic heat pumps in LPN is weaker than might be expected on the basis of the overall housing stock. This is a result of the very urban nature of the LPN licence area and the higher fraction of flats in the housing mix, which have a lower suitability for heat pumps. The lowest share of the heat pump uptake is expected in the SHEPD licence, which is a result of the considerably lower number of feeders compared to the other licences. Generally, the distribution of heat pump take up over the other licence areas is broadly consistent with the split of feeder numbers between the licences, with some relatively subtle differences as a result of the urban / rural character and house type mix.

In terms of photovoltaics, the distribution is again most strongly dependent on the scale of the housing stock, which is a proxy for the amount of roof area available for the installation of systems. There is also a geographic influence, with stronger uptake expected in the more southern regions due to the higher levels of solar insolation (although this is not a very strong influence, as the variation of solar insolation across the country is not huge). As might be expected on this basis, the largest share of PV is forecast to arise in the EPN, SEPN and WPD-EMEB licences. Similarly to the case for heat pumps, the share of uptake in LPN is somewhat lower than might be expected on the basis of the stock, as a result of the larger proportion of flats (less roof space per dwelling).

The uptake of electric vehicles at Government Office Region level was generated using a consumer choice model, based on the number of 'decision-makers' in each region (the population making a vehicle purchase decision), demographic data on the local population and a consumer survey into the purchasing habits of car buyers. These factors drive regional differences in the forecast uptake of electric vehicles. The further breakdown to licence area level is then achieved by prorating on the basis of the feeder stock, with a weighting applied to favour urban areas. Again the distribution of EVs is largely in line with feeder stock split, with the largest uptake forecast in the highly populated licences such as EPN, SEPD, WPD-EMEB and WPD-WM, and the lowest share in licences such as SHEPD and WPD-Wales.

5 Updating the Model

The previous sections have given a detailed explanation of the methodology used to disaggregate the data into 14 regions. This data has been taken and carefully validated by EATL before disaggregating the model. Additionally, the model has been adjusted to reflect the four DECC scenarios as set out in section 5.1. In developing this disaggregated model, no other changes have been made to the input data.

The model has been run using synthetic DNO data for three sample DNO regions and these results are presented below to allow the reader a feel for the variability within the regions. Finally, the model offers 45 moving parts which it is possible for the individual DNO to vary. Recommendations are given as to which of these parameters should remain fixed and which can be varied.

5.1 Alignment of DECC LCT uptake levels to The Carbon Plan,

The work under the WS3 Phase 2, published in July 2012, used a number of scenarios taking material provided by WS1 and DECC. In this work, only three scenarios (Scenarios 1-3) were included, as agreed with WS2 at the time of development. These were expanded under the WS3 Ph2 work to include a Scenario '0' ('All High': high heat and transport) and the model was re-dimensioned to accommodate four input scenarios. A reminder of the scenarios modelled in WS3 Ph2 and the current version of Transform™ is shown in Table 5.1 below:

Table 5.1: Overview of the modelled scenarios

Scenario 0	Scenario 1	Scenario 2	Scenario 3
High domestic decarbonisation	**Domestic decarbonisation to meet carbon budgets**	**Domestic decarbonisation to meet carbon budgets, with less DSR**	**Less domestic decarbonisation (purchase of credits)**
▪ High transport electrification (WS1) ▪ High heat electrification (WS1) ▪ "Gone Green" generation mix (National Grid) ▪ Medium levels of customer engagement with DSR	▪ Medium transport electrification (WS1) ▪ High heat electrification (WS1) ▪ "Gone Green" generation mix (National Grid) ▪ Medium levels of customer engagement with DSR	▪ Medium transport electrification (WS1) ▪ High heat electrification (WS1) ▪ "Gone Green" generation mix (National Grid) ▪ Low levels of customer engagement with DSR	▪ Low transport electrification (WS1) ▪ Low heat electrification (WS1) ▪ "Slow Progression" generation mix (National Grid) ▪ Medium levels of customer engagement with DSR
New for WS3	**As used in the WS2 model**		

Taking input from DECC, new scenarios have been created for use in the Transform™ model and the naming convention has been changed to add clarity and closer alignment of the Government's Carbon Plan.

Scenario make-up

The make-up of the scenarios is outlined below.

Table 5.2: Make-up of composite scenarios to align with DECC Carbon Plan

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
New Naming Convention	***High abatement in low carbon heat***	***High abatement in transport***	***High electrification of heat & transport***	***Credit purchase***
PV trajectory	Central	Central	High	Low
HP trajectory	High	Medium	High	Low
EV trajectory	Medium	High	High	Low
Onshore wind trajectory[1]	National Grid's 'Gone Green'	National Grid's 'Gone Green'	National Grid's 'Gone Green'	National Grid's 'Slow Progression'
Biomass trajectory	National Grid's 'Gone Green'	National Grid's 'Gone Green'	National Grid's 'Gone Green'	National Grid's 'Slow Progression'
Previous Name under WS3 Ph2	Scenario 1	N/A	Scenario 0	Scenario 3

[1]These datasets are likely to be replaced by DECC's DG scenario forecasts as information becomes available

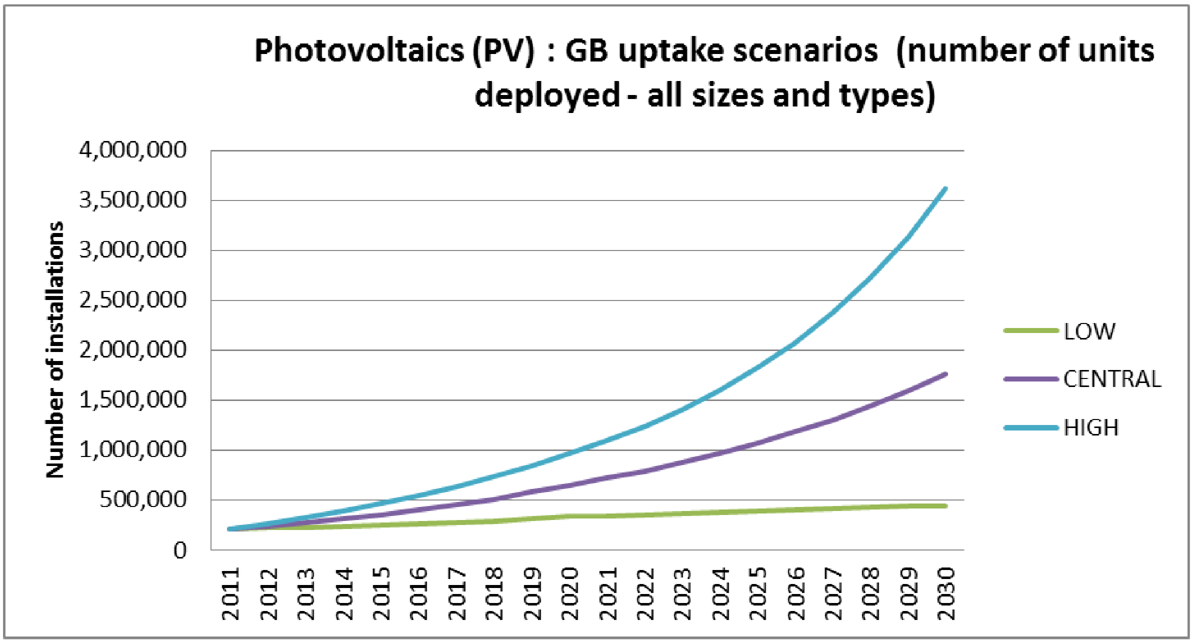
For the avoidance of doubt, the low uptake scenario of DSR (previously Scenario 2) from the WS3 Ph2 modelling has been removed from the GB Transform™ model to accommodate the 'High abatement in Transport' scenario.

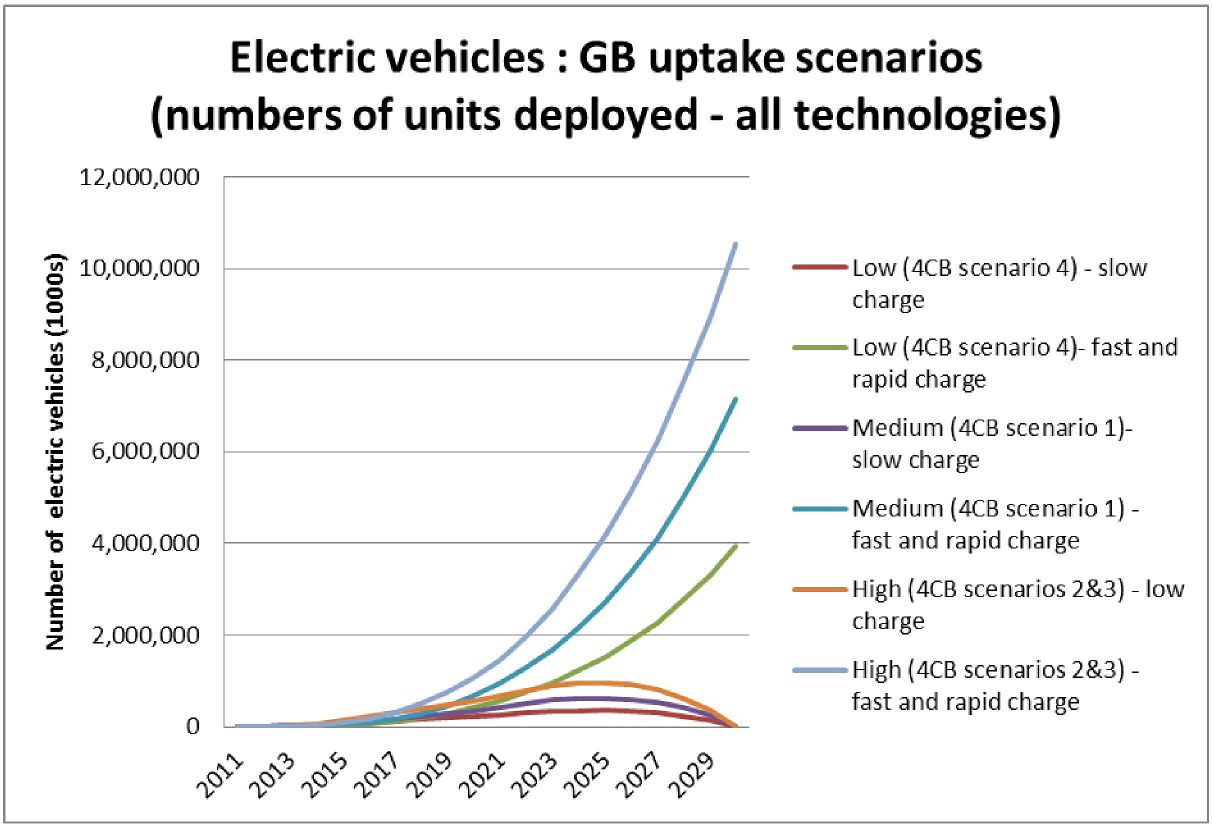
All four scenarios outlined in the Government's Carbon Plan have been developed to meet GB's national carbon targets. In scenario 3 the levels of solid wall insulation are lower (2.5m installations by 2030) than in scenario 1 and 2 (5.2 installations by 2030) and consequently abatement in both transport and heating sectors is needed to reach the emission reduction. Domestic energy efficiency is therefore an important factor in delivering the GB's carbon targets.

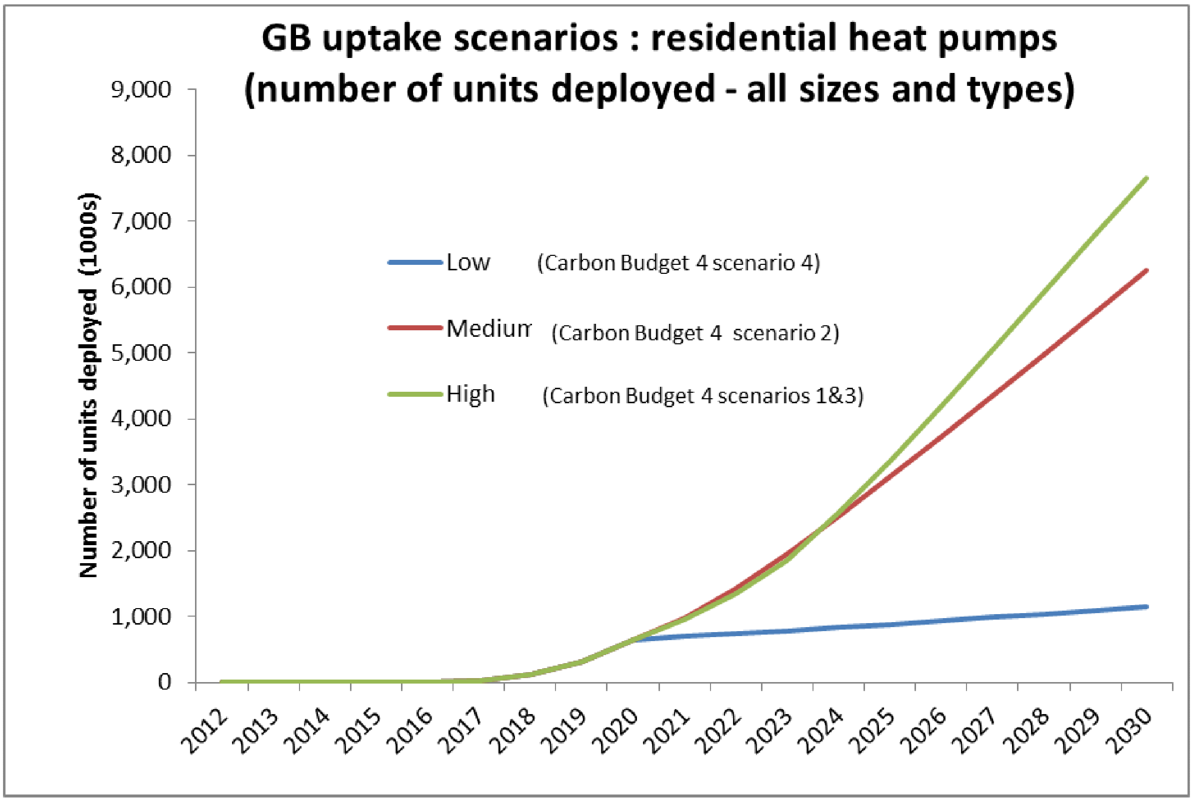
The current version of Transform™ only features a single energy efficiency measure, applied to all four scenarios. It is recognised that these assumptions, developed by partners in the WS3 Phase 2 activity, are closer to the energy efficiency levels required in Scenarios 1 and 2. Further to discussion with DECC it has been agreed that the energy efficiency measures should remain as is for the November 2012 'regional model' release. Further consideration will be given by DECC and EA Technology to adjust the energy efficiency assumptions of Scenarios 3 and 4[2] to make them more closely align to the Carbon Plan as part of the WS3 Governance process.

The following trajectories will be used in the November 2012 release of Transform™. Note that PV trajectories are due to be updated by the end of November 2012 (revisions will be included in the January 2013 release of the model(s)).

[2]NB. A scenario using a low energy efficiency strategy is likely to ***increase*** network investment, as the demand profiles on networks will be higher than in a high energy efficiency scenario – thereby triggering load driven reinforcement earlier.


Photovoltaics (PV) : GB uptake scenarios (number of units deployed - all sizes and types)
Number of installations
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
LOW
CENTRAL
HIGH


Electric vehicles : GB uptake scenarios (numbers of units deployed - all technologies)
Number of electric vehicles (1000s)
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
2011
2013
2015
2017
2019
2021
2023
2025
2027
2029
Low (4CB scenario 4) - slow charge
Low (4CB scenario 4)- fast and rapid charge
Medium (4CB scenario 1)- slow charge
Medium (4CB scenario 1) - fast and rapid charge
High (4CB scenarios 2&3) - low charge
High (4CB scenarios 2&3) - fast and rapid charge

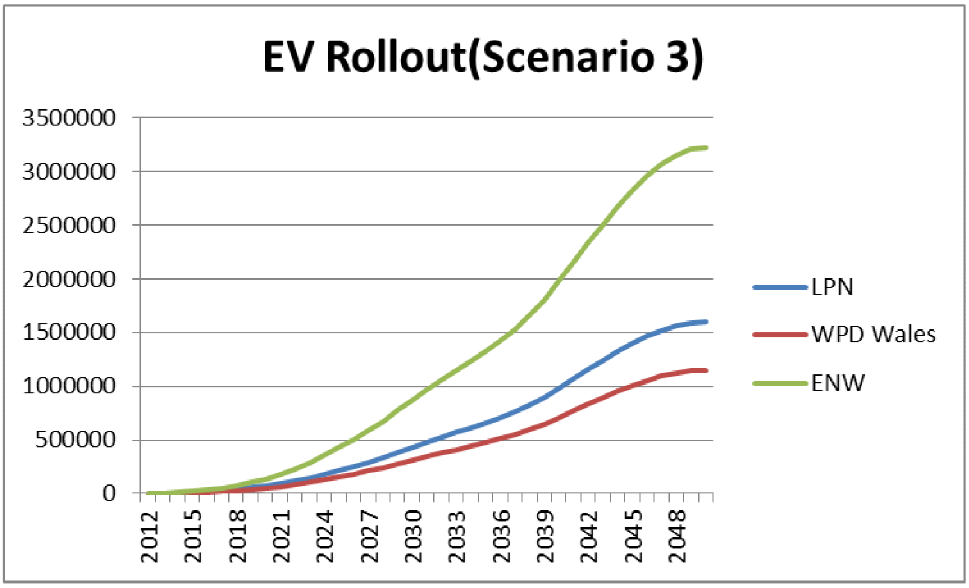


5.1.1 Adjusting the data for future scenarios

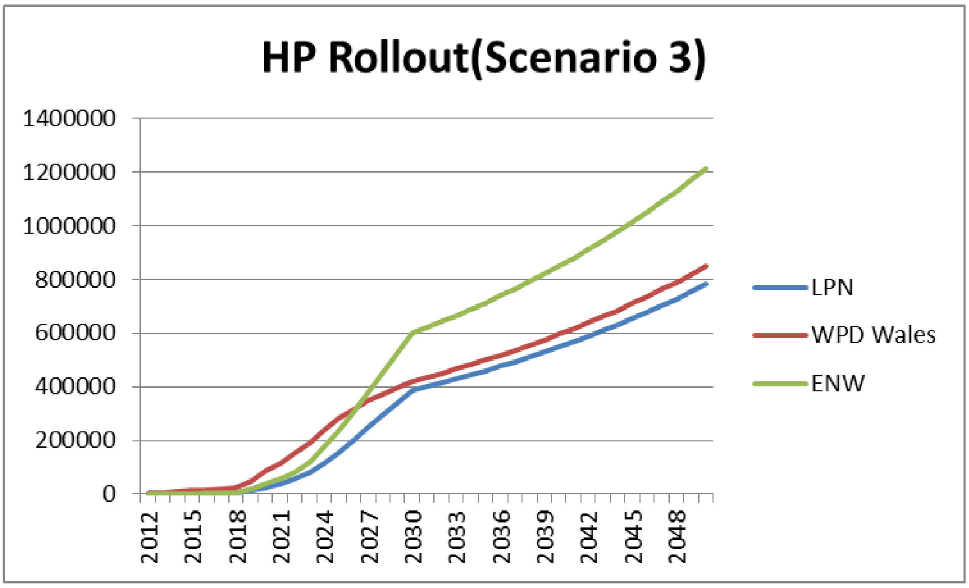
It should be noted that the actual data provided by DECC for these scenarios is expected to change shortly. In the scenarios modelled to date, the absolute number of each Low carbon technology has been calculated by Element Energy using a complex formula including factors for type of feeder, uptake rate and demographics. This means that the number of LCTs in each DNO area varies in a complex manor. To allow the data to be proportioned if the scenarios change EATL have calculated, Year, LCT and Uptake Rate for each DNOs LCT total and divided this through by the total number of that type of LCT installed in total. This gives an assignment factor for each DNO/year and each technology type which can then be used to split the total number of LCTs. This allows re-apportionment should DECC revise their LCT scenarios.

5.2 Sample DNO results

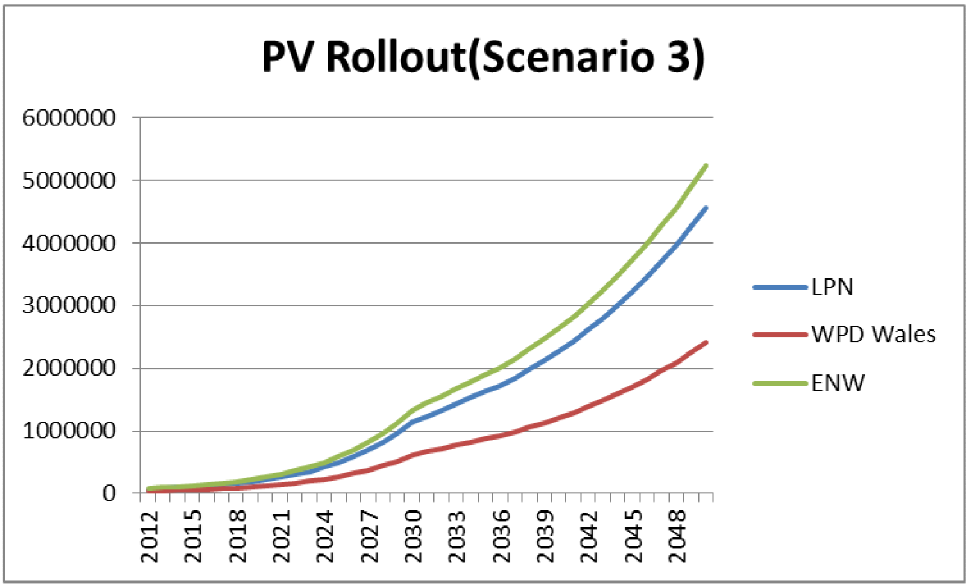
The disaggregated model has been run using **synthetic DNO data** for three sample DNO regions and these results are presented below to allow the reader a feel for the variability within the regions. Results are presented for individual LCT uptake and for investment. The three licence areas chosen were LPN, ENW and WPD Wales. These were chosen to give a good spread in uptake rates. The first graph below gives an estimate for EV uptake in DECC scenario 3 (high electrification of heat and transport). It can be seen that significant numbers of EVs are appearing on the network from 2020 and by 2050 ENW has over 3 million electric vehicles representing effective saturation of the market. The take up rates are lower in London and WPD for a variety of reasons including lower numbers of customers and lower car ownership rates.



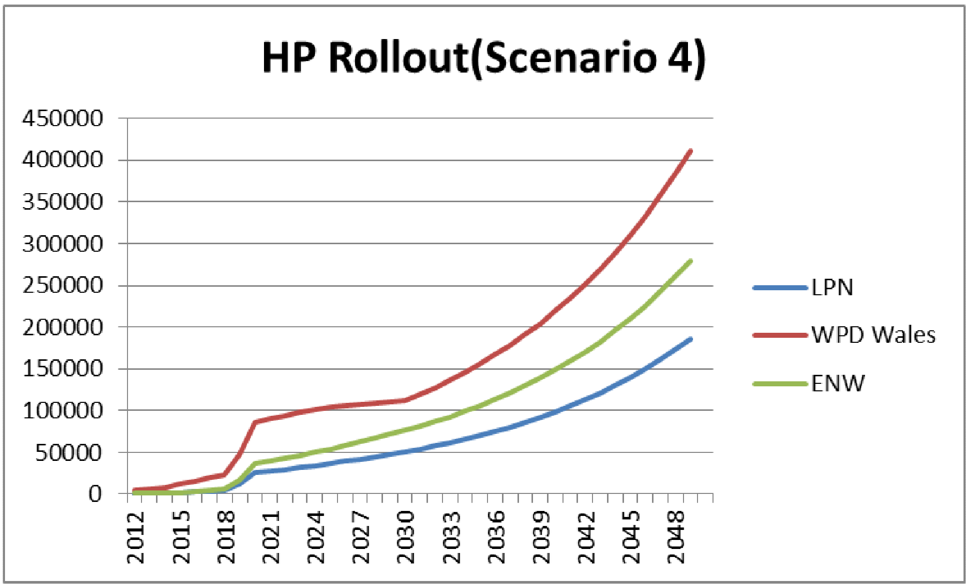
The next graph gives an estimate for HP uptake in DECC scenario 3 (high electrification of heat and transport). It can be seen that significant numbers of HPs are again appearing on the network from 2020 but in this case WPD Wales has the highest number of HPs installed in the early years as the larger number of off gas grid homes dominates early uptake. By the mid 2020's HP's are becoming the mainstream heating technology of choice and thus the larger number of customers in the ENW region dictates that there are more HP's in that licence area.



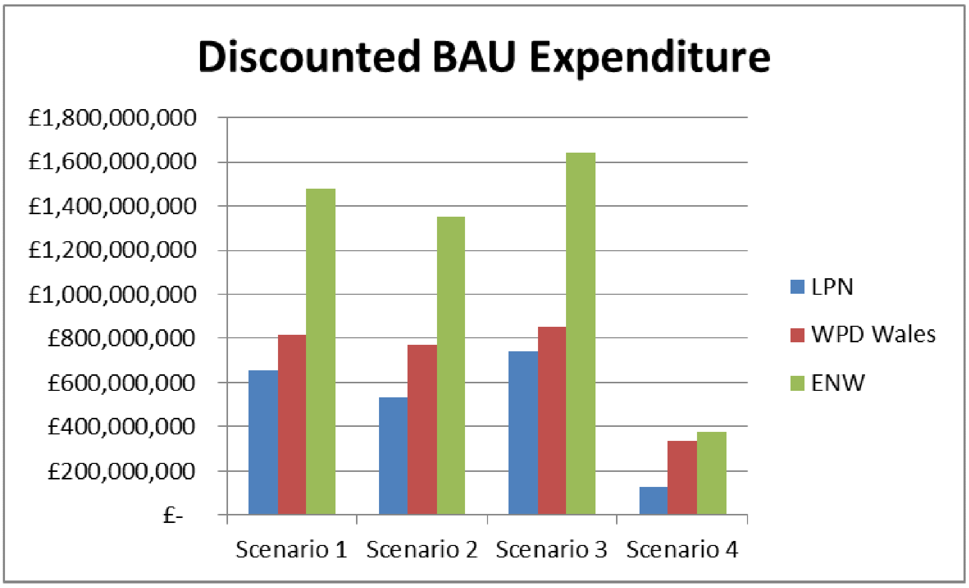
The final LCT graph gives an estimate for PV uptake in DECC scenario 3 (high electrification of heat and transport). It can be seen that again the larger number of customers in the ENW region dictates that there are more PV's in that licence area but in this case the demographics of LPN dictate that PV uptake is nearly as high in the two licence areas. WPD lags behind in uptake of this technology.

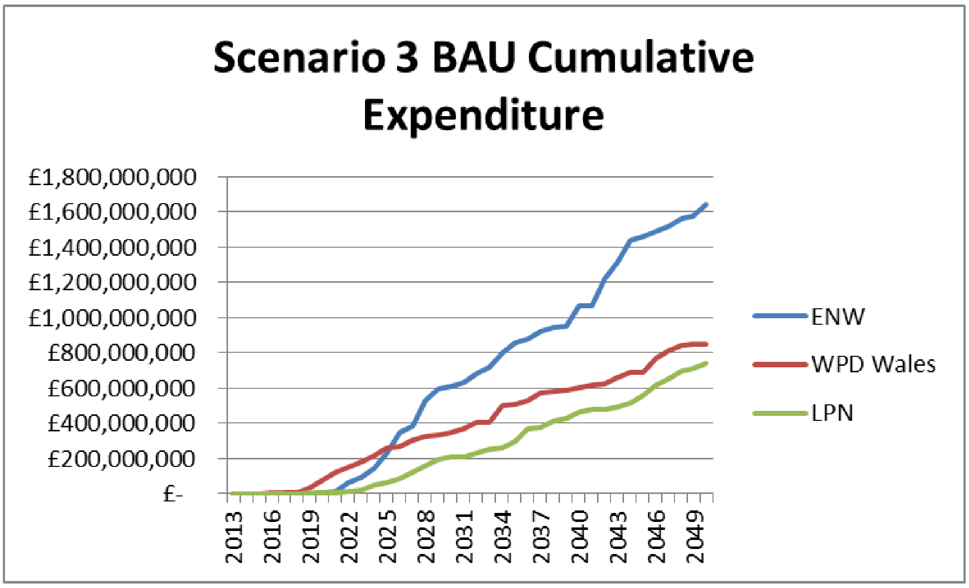


For comparison, the rate of roll out of heat pumps under scenario 4 (lowest uptake rates) is shown below. In this scenario, the rural narure of WPD Wales dominates over the entire period.



All of the data generated for these DNO's can be transferred across and the charts below give the estimate for expenditure over the investment period to 2050 for illustration only of the synthetic DNO model for scenario 3. :





As would be expected the investment is highest in ENW where the LCT uptake rate is highest, except for Scenario 4 where the more rural nature of WPD Wales dominates. To put these figures into perspective, these expenditures are of the order of £10 - £20 per household per year for the scenario 3 model.

The next step is now for the DNOs to take these disaggregated models and fine tune them to give a good representation of their own area. To this end the next section considers which parameters should be varied by the DNOs

5.3 Moving parts (variables) within the model

The following table provides a summary of the variables used within the Transform model, together with a recommendation from EATL as to whether the DNO's should consider varying the parameters. Three assignments are given:

- **Fixed** – It is very strongly recommended that this parameter is not changed

- **Variable** – These parameters can be freely varied
- **Tweak** – It is recommended that these parameters are left fixed in any initial use of the model and should only be varied in subsequent use after careful consideration.

Table 5.3 Summary of the variables and data sources used to populate the model

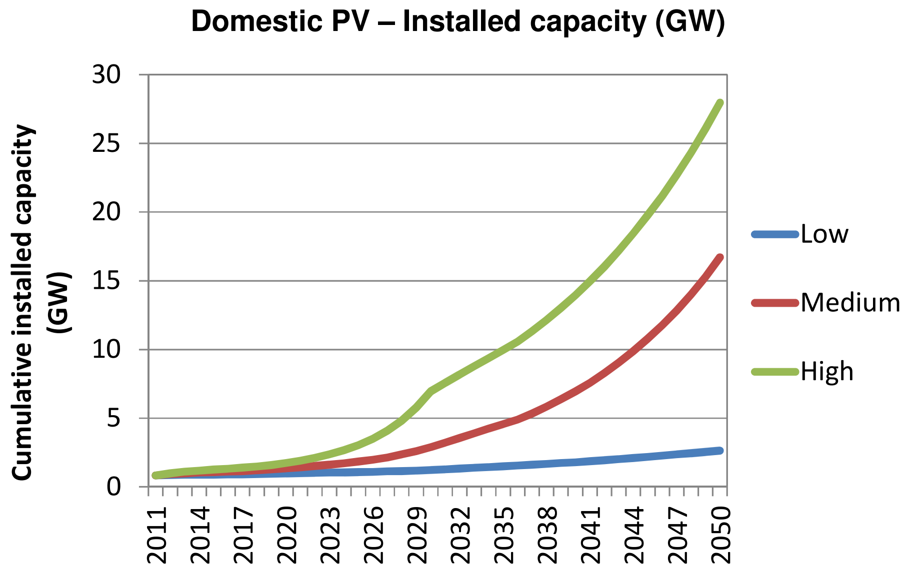
	What	Data Source	Recommendation
1	Ratings of circuits	○ Taken info from DNO networks ○ DNO community consulted on data integrity	Tweak
2	Number of circuits	○ Based on bottom up analysis of DNO licence areas (LV) ○ IIS return data for DNOs (HV) ○ Corroborated with LTDS data (EHV)	Variable
3	Apportionment of circuits between type	○ Probable combinations agreed with DNOs ○ Numbers reconciled against bottom-up data	Variable
4	Starting load and fault level on circuits	○ Info on individual building types ○ Summated along a feeder, based on bottom-up assessment of MPAN data from 4 DNO licence areas ○ Validated against GB demand ○ Fault level data obtained from LTDS data (EHV and HV) and engineering assumptions (LV)	Fixed
5	Load Diversity	○ Building profiles are fully diversified (suitable for EHV, HV and commercial LV) ○ Assumptions taken regarding domestic loads – (factor of 1.4) aligned to common DNO practice, and agreed with the DNO community	Fixed
6	Scaling of the network feeder types from representative DNO licences to form GB equivalent	○ High degree of correlation between feeder composition across the 4 analysed licence areas ○ Fully discussed and agreed with the DNO community	not applicable
7	Apportionment of industrial and commercial load by voltage level	○ Apportionment based on an assessment of DUKES data	Fixed
8	Assumption around the 'average' commercial load	○ Assessment of a number of agreed load types, and reconciled with total commercial demand ○ Discussed and agreed with the DNO community	Fixed
9	Apportionment of generation by voltage level and network type	○ Apportionment based on an assessment of DUKES data (Table 5.11)	Fixed
10	Number of days used in the model to represent different times of year	○ 3 days (winter average, winter peak, summer average) ○ Aligned with WS2 and agreed with the DNO community	Fixed
11	Assumptions around the ambient temperature	○ Model has capability and datasets for ±5°C for winter conditions (noting that demand is only sensitive to temperature in winter) ○ Base case is taken as -3°C winter peak and 0°C winter average for GB model	Variable
12	Feeder composition – number and types of buildings per feeder	○ Bottom up analysis of MPANS for the 4 sample DNO licences ○ Agreed with the DNO community	Fixed
13	Feeder composition – load per building type (e.g. demand profile for standard tariff Vs. Economy 7 [PC1, PC2, etc])	○ Bottom up analysis of heat loss profiles for different building types ○ Agreed with the DNO community ○ Validated against both Elexon data and academic research (University of Loughborough)	Fixed

14	Apportionment of feeder demand (high, medium and low) and distribution shape	○ GB model uses average as base-case ○ Normally distributed demand about an average case can be applied (e.g. three cases where demand is 1x 0.8x and 1.2x the normal demand)	Fixed
15	Energy efficiency assumptions into the future	○ Assumptions have been taken on energy efficiency of home appliances over time	Fixed
16	Assumptions around the number of smart appliances (for DSR)	○ Assumed no smart appliances until 2022 ○ After this, as appliances reach end of life they are replaced with smart equivalents	Fixed
17	DSR'able load	○ Analysis of individual load types (split domestic and commercial) with an assessment of when they can be moved from and to in half-hourly blocks across the day	Fixed
18	Roll off of electric heating and economy 7 type (storage heating) with the uptake of heat pumps	○ 12.5% roll off for electric heating for every HP deployed (i.e. 1 in 8 HP deployments go into houses previously on electric heating) ○ Until a limit of 50% (i.e. 50% of 2012 electric heating load continues until the end of the 2050 period)	Fixed
19	GB input data scenarios	○ WS1 (DECC) for EV, HP, PV penetrations and by type ○ National Grid for wind and biomass generation at HV and EHV	Fixed
20	Growth in LCT from 2030-2050	○ WS1 data generally stops at 2030, with the exception of EVs ○ Extrapolation has been undertaken (Element Energy) to expand the dataset out to 2050	Fixed
21	Regionalisation of scenarios	○ Bottom-up analysis of the England, Wales and Scotland housing condition surveys ○ Discussed with DNO community	Fixed
22	Size / number of all LCTs per installation and their fault level contribution	○ All based on 1 'unit' per household for EVs ○ Allowance made for up to 2 HP units for larger /older houses ○ Allowance made for up to 4 PV units per house ○ Fault level contribution for all LCTs is set to zero as a default, owing to the fact that it is envisaged they will be connected via power electronics	Fixed
23	Profile of EVs installations	○ Based on trial data from the TSB's initial findings from the Ultra Low Carbon Vehicle Demonstration project, Dec 2011 and modelling undertaken by EA Technology ○	Fixed
24	Profile of PV installations	○ PV data based on real installations in Kew testbed	Fixed
		○ Based on trial data and modelling	Fixed
26	Clustering of LCTs	○ All based on PV and FiT data ○ Sensitivities run for no clustering and high clustering	Fixed
27	Number of years for investment look-ahead	○ Set as default as 5 years ○ Sensitivities run based on 1 year and 8 years	Tweak
28	Investment trigger point	○ Variable trigger points depending on the network type and existing planning standards ○ Discussed and agreed with DNO community	Tweak
29	Cost of conventional solutions	○ Representative solutions agreed with the DNO community ○ Variant costs initially based on DPCR5 unit costs and adjusted following dialogue with the DNO community based on recently completed projects	Fixed
30	Cost of smart solutions	○ Representative Solutions agreed with the DNO community ○ Data taken, where existing, from LCN Fund projects or IFI projects ○ Where no data has been available assumptions have been made and stated in the report and the supporting Annex to this document	Fixed
31	Cost of enablers	○ Very little data exists for enablers: in most instances assumptions have been made and stated in the report ○ Differences between the enabler costs for top-down (i.e. up	Fixed

		front) Vs. incremental (i.e. feeder-by-feeder) deployment	
32	Linkage between enablers and smart solutions	○ Manually set based on engineering judgement of which solutions will require which enabler technologies	Fixed
33	Difference in enabler deployment between incremental and top-down	○ In top-down – all enablers are installed from 2015-2019 (inclusive), then replaced in 2035-2039 (inclusive) at a cost of 50% initial deployment ○ In incremental – enablers are only deployed as and when necessary (triggered by the solution deployment)	Fixed
34	Merit order 'cost function' for conventional and smart solutions	○ Factors (e.g. flexibility, cross-networks benefit, disruption) discussed and agreed with the DNO community ○ Assumptions made around the cost of these factors ○ Formula discussed with DNO community	Fixed
35	Merit order settings per Variant Solution	○ Initial data populated based on engineering judgement and iteration of network model to generate 'sensible' results	Fixed
36	Headroom release data for conventional and smart solutions	○ Based on engineering judgement for the benefits realised per solution deployment	Fixed
37	Availability of solutions (by year)	○ Assumptions made around when the solutions would be available	Fixed
38	Combinations of solutions (how many in a given year, which combinations are feasible)	○ Up to 5 solutions can be applied in parallel in the WS3 model ○ The feasible combinations of Variant Solutions have been tagged in the model	Fixed
39	Life expectancy of solutions	○ Based on estimates of typical assets	Fixed
40	Losses attributable to solutions	○ Based on engineering judgement relating to whether solutions will, for example, increase load on an asset (and therefore variable losses)	Fixed
41	Quality of supply benefits attributable to solutions	○ Assessment based on engineering judgement regarding the positive or negative effect that the solution will have on CIs and CMLs	Fixed
42	Nationally-driven DSR – payments to customers	○ Set as 20p/kWh on the basis that this is 2x a standard unit of electricity -	Fixed
43	Output costs	○ Only totex cost, for each year of the model ○ No disruption costs are brought out of the model	Fixed
44	Discount rate in model	All set to 3.5% in the model – user definable	Fixed
45	Optimism bias for conventional and smart capex and all opex	○ Aligned with UK Government guidelines and the approach taken for the WS2 report, all results apply an optimism bias of: 44% for conventional solutions; 66% for smart solutions and enablers ○ For operating expenditure a figure of 30% has been applied to all solutions (this is new for WS3, as was not applied in the WS2 model)	Fixed

Appendix A: DECC scenarios for LCT uptake

Photovoltaics



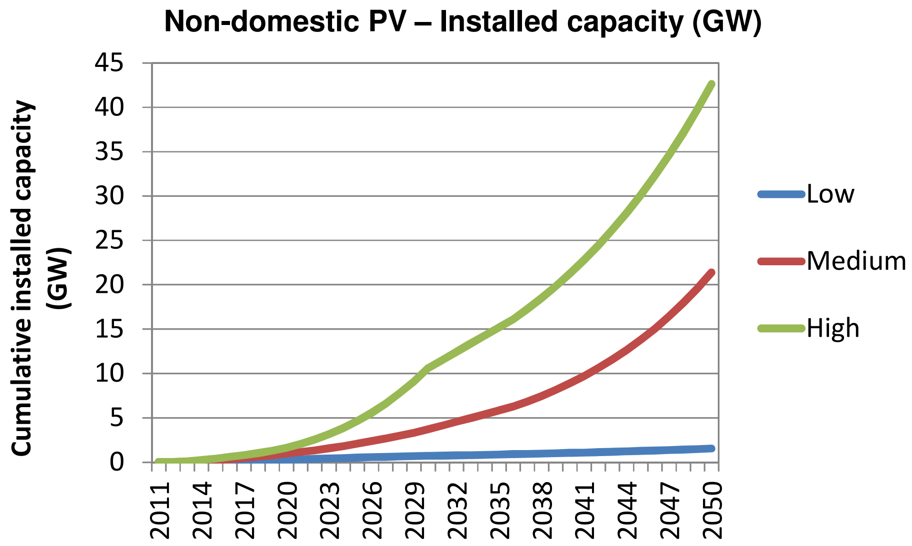
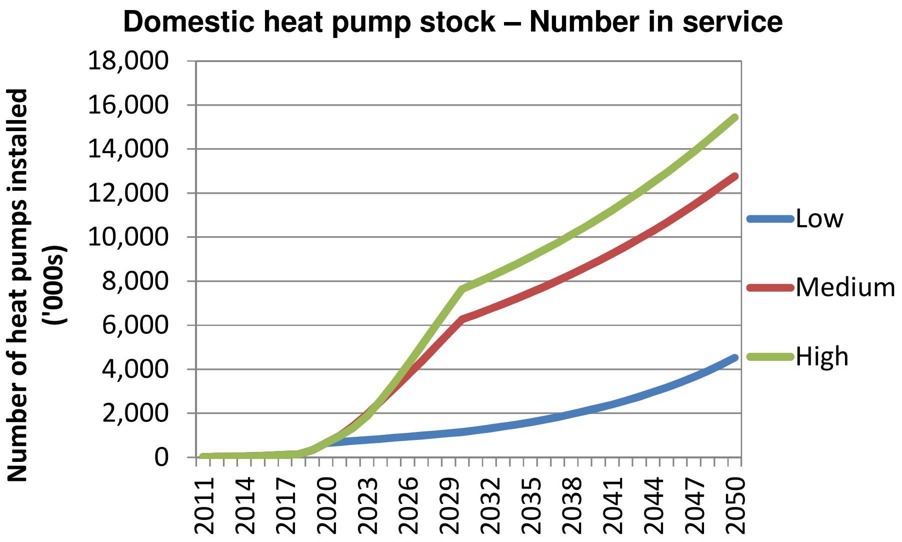


Figure 7, DECC scenarios for the uptake of photovoltaics (note: the DECC scenarios extend to 2030. The post-2030 scenarios are based on extrapolation of the pre-2030 growth rate)

Heat pumps



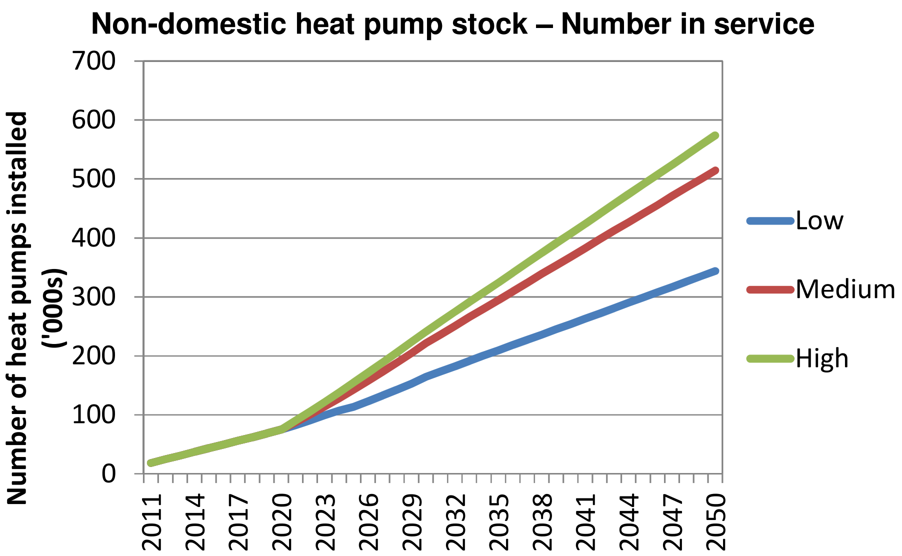
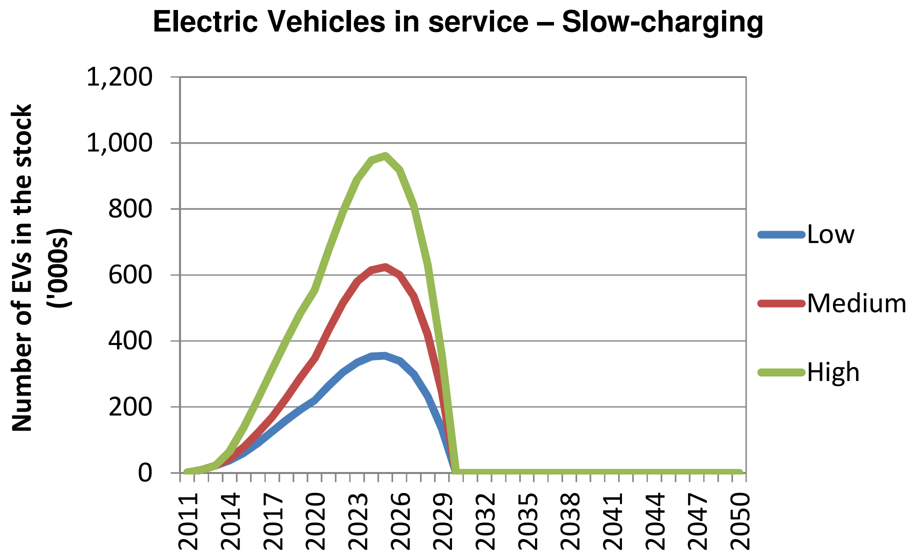


Figure 8, DECC scenarios for the uptake of heat pumps (Note: the DECC scenario extends to 2030. Post-2030 numbers have been derived by extrapolation of the pre-2030 growth rate)

Electric Vehicles



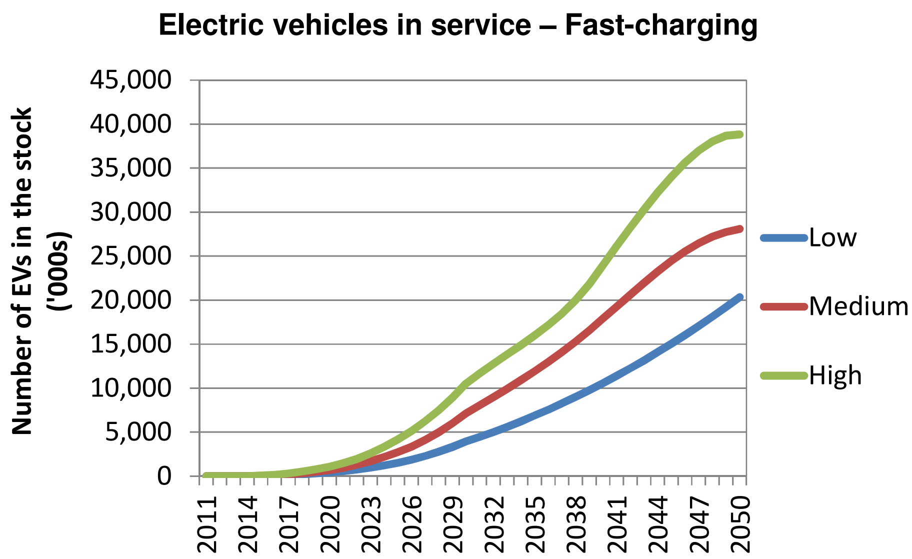


Figure 9, DECC scenarios for the growth of EVs in the car parc.

Appendix B: Apportionment of Government Office Regions

Table 3, Apportionment of the Government Office Regions between the fourteen licences

License areas	Scotland	Wales	North East	North West	Yorkshire and the	East Midlands	West Midlands	East of England	London	South East	South West
ENW	0%	0%	0%	69%	0%	2%	0%	0%	0%	0%	0%
NPG - 15	0%	0%	99%	0%	12%	0%	0%	0%	0%	0%	0%
NPG - 23	0%	0%	0%	0%	87%	3%	0%	0%	0%	0%	0%
EPN	0%	0%	0%	0%	0%	0%	0%	91%	25%	3%	0%
LPN	0%	0%	0%	0%	0%	0%	0%	1%	59%	0%	0%
SPN	0%	0%	0%	0%	0%	0%	0%	0%	13%	45%	0%
West Midlands	0%	0%	0%	0%	0%	0%	79%	0%	0%	1%	14%
WPD - Wales	0%	74%	0%	0%	0%	0%	1%	0%	0%	0%	0%
WPD - South West	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	63%
WPD - EMEB	0%	0%	0%	0%	0%	96%	17%	2%	0%	3%	0%
SPD	76%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%
SPM	0%	26%	0%	31%	0%	0%	3%	0%	0%	0%	0%
SHEPD	24%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
SEPD	0%	0%	0%	0%	0%	0%	0%	6%	3%	48%	22%

Appendix C: Detailed Feeder data

Existing Feeders

	ENW		NPG-15		NPG-23		EPN		LPN		SPN		WPD - WM		WPD - Wales		WPD - SW		WPD - EMEB		SPD		SPM		SHEPD		SEPD	
	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND
URBAN																												
Central business district (H)	-	2.65	-	3.01	-	3.00	-	2.89	-	2.81	-	2.90	-	2.65	-	2.91	-	2.69	-	2.94	-	2.66	-	2.70	-	2.66	-	2.89
Dense urban (apartments etc) (H)	42.06	0.85	41.24	0.81	41.17	0.78	41.74	0.90	41.91	0.94	41.71	0.91	42.07	0.88	41.19	0.75	41.76	0.85	41.44	0.83	42.37	1.01	41.69	0.81	42.37	1.01	41.59	0.87
Town centre (H)	1.40	2.64	1.45	2.99	1.39	2.98	2.97	2.87	6.84	2.80	2.89	2.88	1.39	2.64	4.88	2.83	4.60	2.64	0.94	2.93	4.76	2.67	2.07	2.68	4.76	2.67	2.33	2.86
Business park (M)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Retail park (M)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Suburban street (3/4b detached / semis) (M)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
New build housing estate (M)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Terraced Street (H)	48.29	1.94	46.67	1.65	46.40	1.63	47.54	1.76	49.03	1.90	47.72	1.77	47.82	1.89	45.46	1.58	44.72	1.58	46.74	1.70	49.30	1.99	46.96	1.77	49.30	1.99	46.28	1.66
Rural village (overhead)(L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rural village (underground) (L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rural farmstead / small holdings (VL)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SUBURBAN																												
Central business district (H)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dense urban (apartments etc) (H)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Town centre (H)	-	2.87	-	2.94	-	2.94	-	2.93	-	2.91	-	2.93	-	2.88	-	2.93	-	2.92	-	2.93	-	2.90	-	2.89	-	2.90	-	2.93
Business park (M)	-	2.87	-	2.94	-	2.94	-	2.93	-	2.91	-	2.93	-	2.88	-	2.93	-	2.92	-	2.93	-	2.90	-	2.89	-	2.90	-	2.93
Retail park (M)	-	2.87	-	2.94	-	2.94	-	2.93	-	2.91	-	2.93	-	2.88	-	2.93	-	2.92	-	2.93	-	2.90	-	2.89	-	2.90	-	2.93
Suburban street (3/4b detached / semis) (M)	34.12	2.28	33.86	2.31	33.86	2.31	32.69	2.20	33.29	2.20	32.64	2.20	33.66	2.25	32.66	2.19	30.95	2.05	33.75	2.31	32.69	2.16	34.00	2.27	32.69	2.16	32.27	2.17
New build housing estate (M)	33.53	1.09	34.08	1.13	34.00	1.13	33.06	1.04	33.95	1.02	33.02	1.04	33.33	1.07	32.28	1.02	30.99	0.92	33.96	1.13	33.20	1.00	33.44	1.09	33.20	1.00	32.55	1.02
Terraced Street (H)	33.99	1.78	34.02	1.85	34.05	1.85	33.00	1.68	33.09	1.68	32.99	1.68	33.63	1.73	33.07	1.70	31.93	1.51	33.93	1.82	32.74	1.60	33.90	1.77	32.74	1.60	32.78	1.65
Rural village (overhead)(L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rural village (underground) (L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rural farmstead / small holdings (VL)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RURAL																												
Central business district (H)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dense urban (apartments etc) (H)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Town centre (H)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Business park (M)	-	2.82	-	2.76	-	2.76	-	2.86	-	2.85	-	2.86	-	2.84	-	2.86	-	2.88	-	2.79	-	2.86	-	2.83	-	2.86	-	2.87
Retail park (M)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Suburban street (3/4b detached / semis) (M)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
New build housing estate (M)	28.06	3.54	27.98	3.39	27.95	3.44	27.57	3.61	27.66	3.59	27.62	3.62	27.93	3.65	27.60	3.66	27.52	3.71	27.91	3.54	27.75	3.51	27.88	3.59	27.75	3.51	27.59	3.64
Terraced Street (H)	24.59	2.23	24.91	2.30	24.95	2.33	24.84	2.30	24.91	2.28	24.95	2.29	24.67	2.25	24.75	2.30	24.78	2.28	24.90	2.31	24.84	2.24	24.64	2.25	24.84	2.24	24.90	2.29
Rural village (overhead)(L)	15.33	0.84	15.19	1.09	15.40	1.09	14.90	1.00	15.01	0.99	14.99	1.01	15.46	0.88	14.99	1.01	14.82	0.98	15.56	1.07	14.76	0.91	15.20	0.90	14.76	0.91	14.94	1.00
Rural village (underground) (L)	30.86	2.46	32.04	2.69	31.55	2.42	30.68	2.39	30.59	2.33	30.58	2.33	30.21	2.17	30.57	2.34	30.30	2.37	31.08	2.24	30.97	2.62	30.71	2.40	30.97	2.62	30.52	2.34
Rural farmstead / small holdings (VL)	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-

New build feeders

	ENW		NPG-15		NPG-23		EPN		LPN		SPN		WPD - WM		WPD - Wales		WPD - SW		WPD - EMEB		SPD		SPM		SHEPD		SEPD	
	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND	Dom	ND
URBAN																												
Central business district (H)	-	2.65	-	3.01	-	3.00	-	2.89	-	2.81	-	2.90	-	2.65	-	2.91	-	2.69	-	2.95	-	2.66	-	2.69	-	2.66	-	2.88
Dense urban (apartments etc) (H)	42.45	1.02	41.43	0.89	41.42	0.88	41.74	0.92	41.93	0.95	41.71	0.92	42.26	0.98	41.45	0.86	41.81	0.88	41.58	0.91	42.38	1.01	42.05	0.95	42.38	1.01	41.63	0.89
Town centre (H)	1.44	2.66	1.46	3.00	1.44	3.00	3.26	2.88	6.96	2.81	3.13	2.89	1.70	2.65	5.80	2.86	5.45	2.64	1.36	2.95	4.96	2.67	2.16	2.69	4.96	2.67	2.83	2.86
Business park (M)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Retail park (M)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Suburban street (3/4b detached / semis) (M)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
New build housing estate (M)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Terraced Street (H)	48.73	1.97	47.35	1.70	47.24	1.70	48.55	1.83	49.68	1.94	48.79	1.84	48.06	1.91	45.61	1.60	45.31	1.62	48.23	1.81	49.02	1.97	47.17	1.79	49.02	1.97	47.18	1.72
Rural village (overhead)(L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rural village (underground) (L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rural farmstead / small holdings (VL)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SUBURBAN																												
Central business district (H)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dense urban (apartments etc) (H)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Town centre (H)	-	2.87	-	2.94	-	2.94	-	2.93	-	2.91	-	2.93	-	2.89	-	2.93	-	2.92	-	2.93	-	2.90	-	2.88	-	2.90	-	2.93
Business park (M)	-	2.87	-	2.94	-	2.94	-	2.93	-	2.91	-	2.93	-	2.89	-	2.93	-	2.92	-	2.93	-	2.90	-	2.88	-	2.90	-	2.93
Retail park (M)	-	2.87	-	2.94	-	2.94	-	2.93	-	2.91	-	2.93	-	2.89	-	2.93	-	2.92	-	2.93	-	2.90	-	2.88	-	2.90	-	2.93
Suburban street (3/4b detached / semis) (M)	33.86	2.33	33.61	2.37	33.58	2.37	32.44	2.23	33.14	2.25	32.43	2.23	33.30	2.28	32.37	2.23	30.79	2.07	33.54	2.35	32.34	2.21	33.73	2.32	32.34	2.21	32.03	2.20
New build housing estate (M)	33.16	1.06	33.58	1.13	33.64	1.14	32.02	1.00	31.91	0.97	32.01	1.01	32.71	1.04	32.15	1.03	30.69	0.91	33.52	1.12	32.20	1.01	33.09	1.06	32.20	1.01	31.72	0.99
Terraced Street (H)	35.45	2.23	35.57	2.33	35.58	2.33	34.65	2.11	34.87	2.11	34.63	2.13	34.93	2.16	34.45	2.17	33.37	1.92	35.42	2.29	34.39	2.00	35.38	2.23	34.39	2.00	34.31	2.09
Rural village (overhead)(L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rural village (underground) (L)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rural farmstead / small holdings (VL)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RURAL																												
Central business district (H)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dense urban (apartments etc) (H)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Town centre (H)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Business park (M)	-	2.82	-	2.76	-	2.76	-	2.86	-	2.85	-	2.86	-	2.85	-	2.86	-	2.88	-	2.79	-	2.86	-	2.83	-	2.86	-	2.87
Retail park (M)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Suburban street (3/4b detached / semis) (M)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
New build housing estate (M)	28.56	3.34	29.85	3.57	29.14	3.31	27.93	3.14	27.75	2.96	27.57	2.95	28.65	3.44	28.94	3.58	28.23	3.36	29.53	3.50	28.17	3.28	28.62	3.39	28.17	3.28	27.74	3.05
Terraced Street (H)	26.26	2.87	26.71	2.88	26.64	2.89	26.48	2.88	26.65	2.78	26.56	2.85	26.42	2.89	26.41	2.90	26.46	2.87	26.53	2.88	26.52	2.79	26.28	2.87	26.52	2.79	26.54	2.86
Rural village (overhead)(L)	15.31	1.34	15.15	1.63	15.02	1.60	14.54	1.48	14.72	1.50	14.52	1.47	15.06	1.37	14.69	1.51	14.56	1.49	15.03	1.58	14.69	1.40	15.19	1.36	14.69	1.40	14.53	1.48
Rural village (underground) (L)	29.69	1.83	30.34	1.75	30.70	1.97	30.28	2.23	30.05	2.03	30.48	2.32	29.57	1.86	29.67	1.89	29.54	2.00	30.47	1.90	29.63	1.97	29.64	1.84	29.63	1.97	30.25	2.24
Rural farmstead / small holdings (VL)	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-	11.00	-

Feeder stock composition

NETWORK COMPOSITION - Existing feeders	1	2	3	4	5	6	7	8	9	10	11	12	13	14
URBAN	**ENW**	**NPG - 15**	**NPG - 23**	**EPN**	**LPN**	**SPN**	**WPD -WM**	**WPD - Wales**	**WPD - South West**	**WPD - EMEB**	**SPD**	**SPM**	**SHEPD**	**SEPD**
Central business district (H)	3.7%	3.5%	3.5%	2.5%	2.8%	2.5%	3.3%	2.5%	1.3%	3.5%	2.5%	3.4%	2.5%	2.2%
Dense urban (apartments etc) (H)	2.6%	2.7%	2.4%	5.0%	16.0%	4.9%	2.5%	5.8%	3.5%	1.7%	10.1%	3.4%	10.1%	3.1%
Town centre (H)	3.9%	3.6%	3.6%	2.7%	3.4%	2.7%	3.4%	2.9%	1.5%	3.5%	2.8%	3.6%	2.8%	2.3%
Business park (M)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Retail park (M)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Suburban street (3/4b detached / semis) (M)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
New build housing estate (M)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Terraced Street (H)	12.9%	7.3%	8.1%	8.7%	19.6%	7.7%	10.2%	34.3%	7.9%	6.8%	13.9%	18.2%	13.9%	6.2%
Rural village (overhead)(L)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Rural village (underground) (L)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Rural farmstead / small holdings (VL)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SUBURBAN														
Central business district (H)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Dense urban (apartments etc) (H)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Town centre (H)	1.2%	1.2%	1.2%	1.6%	1.5%	1.6%	1.4%	1.6%	2.0%	1.3%	1.6%	1.3%	1.6%	1.7%
Business park (M)	1.2%	1.2%	1.2%	1.6%	1.5%	1.6%	1.4%	1.6%	2.0%	1.3%	1.6%	1.3%	1.6%	1.7%
Retail park (M)	1.2%	1.2%	1.2%	1.6%	1.5%	1.6%	1.4%	1.6%	2.0%	1.3%	1.6%	1.3%	1.6%	1.7%
Suburban street (3/4b detached / semis) (M)	20.8%	24.1%	21.8%	14.1%	10.8%	16.7%	19.0%	5.8%	14.3%	19.8%	6.8%	17.0%	6.8%	16.7%
New build housing estate (M)	12.8%	14.3%	12.8%	8.9%	7.4%	10.5%	12.0%	3.4%	9.0%	11.9%	4.7%	10.5%	4.7%	10.5%
Terraced Street (H)	21.9%	25.1%	22.2%	21.6%	29.3%	23.2%	20.7%	7.3%	16.4%	16.8%	14.3%	18.4%	14.3%	20.7%
Rural village (overhead)(L)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Rural village (underground) (L)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Rural farmstead / small holdings (VL)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RURAL														
Central business district (H)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Dense urban (apartments etc) (H)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Town centre (H)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Business park (M)	3.4%	2.1%	2.1%	6.1%	5.3%	6.1%	4.7%	6.4%	10.6%	2.6%	6.9%	4.1%	6.9%	7.2%
Retail park (M)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Suburban street (3/4b detached / semis) (M)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
New build housing estate (M)	5.2%	4.6%	7.6%	10.1%	0.4%	8.1%	8.3%	10.7%	11.3%	12.4%	10.7%	6.6%	10.7%	10.0%
Terraced Street (H)	4.2%	4.6%	5.3%	6.5%	0.3%	5.4%	4.4%	6.2%	7.9%	5.9%	12.6%	4.6%	12.6%	6.8%
Rural village (overhead)(L)	2.1%	2.0%	3.1%	4.2%	0.2%	3.3%	3.2%	4.4%	4.6%	5.0%	4.4%	2.7%	4.4%	4.1%
Rural village (underground) (L)	2.3%	2.2%	3.4%	4.3%	0.2%	3.4%	3.5%	4.6%	4.8%	5.4%	4.7%	2.9%	4.7%	4.2%
Rural farmstead / small holdings (VL)	0.4%	0.3%	0.5%	0.8%	0.0%	0.7%	0.8%	0.9%	1.1%	1.0%	0.8%	0.5%	0.8%	0.9%

NETWORK COMPOSITION - New Feeders	1	2	3	4	5	6	7	8	9	10	11	12	13	14
URBAN	**ENW**	**NPG - 15**	**NPG - 23**	**EPN**	**LPN**	**SPN**	**West Midlands**	**WPD - Wales**	**WPD - South West**	**WPD - EMEB**	**SPD**	**SPM**	**SHEPD**	**SEPD**
Central business district (H)	3.7%	3.5%	3.5%	2.5%	2.8%	2.4%	3.1%	2.4%	1.3%	3.4%	2.5%	3.5%	2.5%	2.1%
Dense urban (apartments etc) (H)	4.0%	3.7%	3.5%	6.2%	16.9%	5.8%	3.8%	10.0%	4.9%	3.5%	10.6%	5.3%	10.6%	4.2%
Town centre (H)	3.9%	3.6%	3.6%	2.7%	3.4%	2.7%	3.3%	2.9%	1.5%	3.6%	2.8%	3.7%	2.8%	2.3%
Business park (M)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Retail park (M)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Suburban street (3/4b detached / semis) (M)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
New build housing estate (M)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Terraced Street (H)	11.6%	6.1%	6.2%	7.1%	16.9%	6.1%	9.7%	42.7%	7.8%	5.0%	16.3%	18.3%	16.3%	5.3%
Rural village (overhead)(L)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Rural village (underground) (L)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Rural farmstead / small holdings (VL)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
SUBURBAN														
Central business district (H)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Dense urban (apartments etc) (H)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Town centre (H)	1.2%	1.2%	1.2%	1.6%	1.5%	1.6%	1.4%	1.6%	2.0%	1.3%	1.6%	1.3%	1.6%	1.7%
Business park (M)	1.2%	1.2%	1.2%	1.6%	1.5%	1.6%	1.4%	1.6%	2.0%	1.3%	1.6%	1.3%	1.6%	1.7%
Retail park (M)	1.2%	1.2%	1.2%	1.6%	1.5%	1.6%	1.4%	1.6%	2.0%	1.3%	1.6%	1.3%	1.6%	1.7%
Suburban street (3/4b detached / semis) (M)	21.5%	27.6%	25.0%	13.6%	5.7%	15.7%	21.4%	8.4%	15.8%	22.2%	12.0%	18.9%	12.0%	16.8%
New build housing estate (M)	23.6%	26.7%	23.7%	21.2%	21.2%	22.3%	23.5%	8.2%	20.6%	21.1%	12.7%	20.5%	12.7%	21.9%
Terraced Street (H)	13.0%	13.1%	11.0%	16.4%	22.3%	16.3%	12.7%	4.2%	13.7%	9.6%	6.4%	11.2%	6.4%	15.0%
Rural village (overhead)(L)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Rural village (underground) (L)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Rural farmstead / small holdings (VL)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RURAL														
Central business district (H)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Dense urban (apartments etc) (H)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Town centre (H)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Business park (M)	3.4%	2.1%	2.1%	6.1%	5.3%	6.2%	5.1%	6.4%	10.6%	2.6%	6.9%	4.0%	6.9%	7.3%
Retail park (M)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Suburban street (3/4b detached / semis) (M)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
New build housing estate (M)	5.4%	4.6%	8.0%	8.8%	0.4%	8.1%	6.1%	4.6%	8.2%	11.5%	11.6%	5.1%	11.6%	9.1%
Terraced Street (H)	1.4%	0.6%	2.0%	3.3%	0.2%	3.7%	1.4%	0.8%	2.5%	1.9%	3.5%	1.2%	3.5%	3.8%
Rural village (overhead)(L)	2.2%	2.4%	3.8%	3.6%	0.2%	3.0%	2.6%	2.2%	3.4%	5.9%	4.8%	2.1%	4.8%	3.5%
Rural village (underground) (L)	2.0%	2.0%	3.2%	3.0%	0.1%	2.5%	2.3%	1.8%	2.9%	4.9%	4.0%	1.9%	4.0%	2.9%
Rural farmstead / small holdings (VL)	0.5%	0.5%	0.7%	0.7%	0.0%	0.6%	0.6%	0.5%	0.9%	1.1%	1.0%	0.5%	1.0%	0.7%

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Addendum – Modifications to the WS3 Phase 2 methodology and assumptions

The intention in disaggregating the LV model inputs from the original five regions to the licence area level has been to conserve the broad trends in terms of uptake of low carbon technologies. Certainly the overall numbers of LCTs as defined by the DECC scenarios are unchanged by the disaggregation of the LV feeder model to the fourteen licence areas.

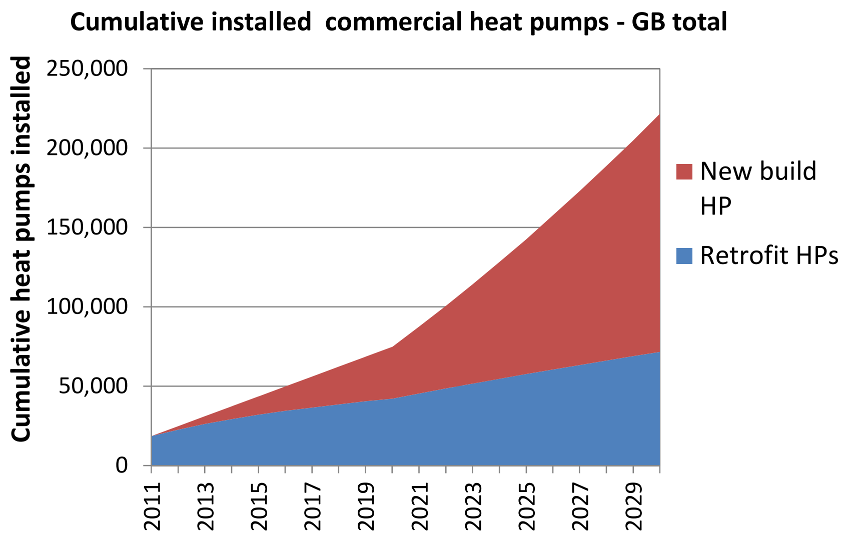
However, while the over-arching methodology applied to disaggregate the GB-level uptake into smaller geographic areas has been retained, a number of changes to the detail of the methodology and to certain assumptions have driven more subtle changes in the LCT uptake projections. These changes concern the split of uptake between new build and existing feeders and the split between domestic and commercial buildings. A summary of these changes and their impact is given below.

Heat pumps

The commercial heat pump uptake in the Phase 2 model was weighted to favour uptake in the new build sector. This was to reflect the inertia associated with a change of main heating technology.

Two factors combined to increase the uptake of commercial heat pumps in new buildings relative to retrofit installations. It was assumed that a typical heating technology replacement cycle in the existing stock is 15 years, such that one fifteenth of the existing commercial buildings make an investment in a heating technology each year. All new buildings were assumed to make an investment in a heating technology. The likelihood that an investment would result in an installation of a heat pump was then weighted to be twice as likely in a new building compared to an existing building.

The combined impact of these assumptions was to strongly favour the uptake of heat pumps in the new build sector. This is shown in the charts below, which plot the GB total heat pump stock split between new build and existing feeders and the associated percentage uptake of heat pumps in the existing compared to the new build stock. Each plot is based on the Central scenario.



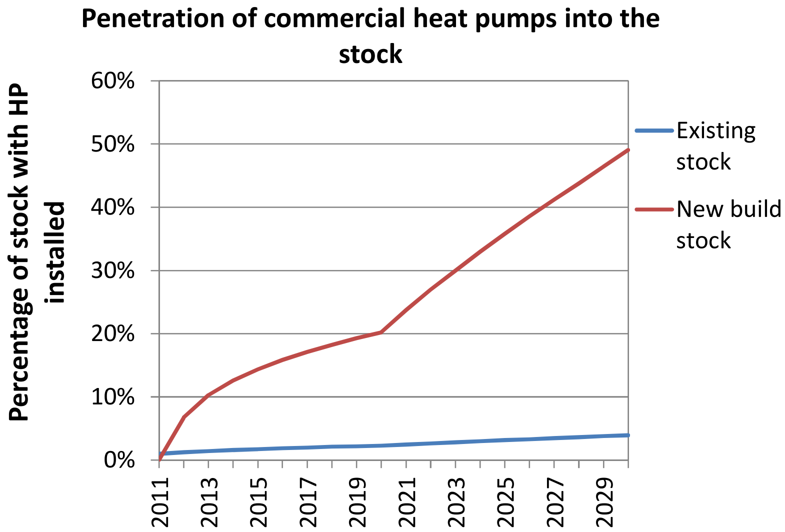
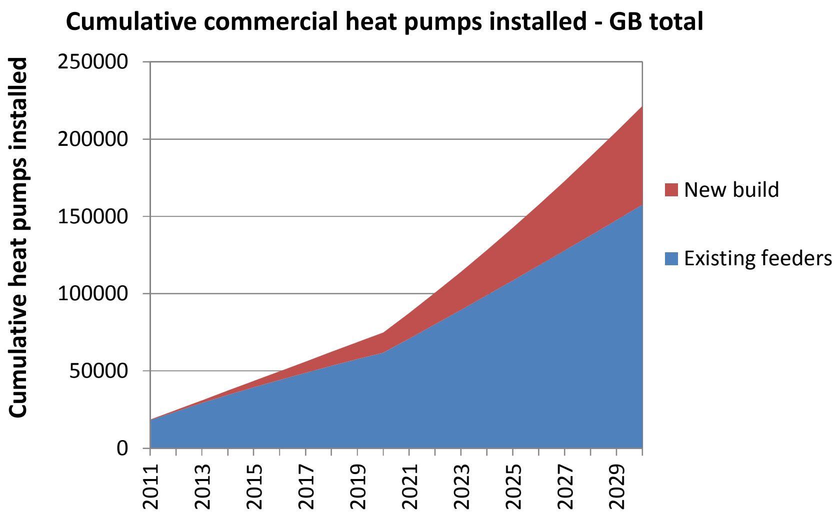


Figure 1, Commercial heat pump uptake in the Phase 2 model (DECC Central scenario). The overall commercial heat pump uptake split between existing and new build feeders is shown in the top chart. The penetration of heat pumps into the new build and existing stock is shown in the bottom chart.

While we believe that heat pump uptake is likely to be stronger in the new build sector, the weighting of uptake toward new buildings generated by the original modelling assumptions has amplified this effect excessively.

In the revised model we have applied a simplified and more transparent approach, which prorates annual uptake of commercial heat pumps between the existing and new build stock. A weighting factor of two is still applied to the new build sector, but no difference in decision-making frequency has been applied. The result is that heat pump uptake is still favoured in the new build stock, but is not as polarised as in the Phase 2 version of the model. The revised split between new build and existing feeders is shown in the plots below. The overall GB results in the Central scenario are shown.



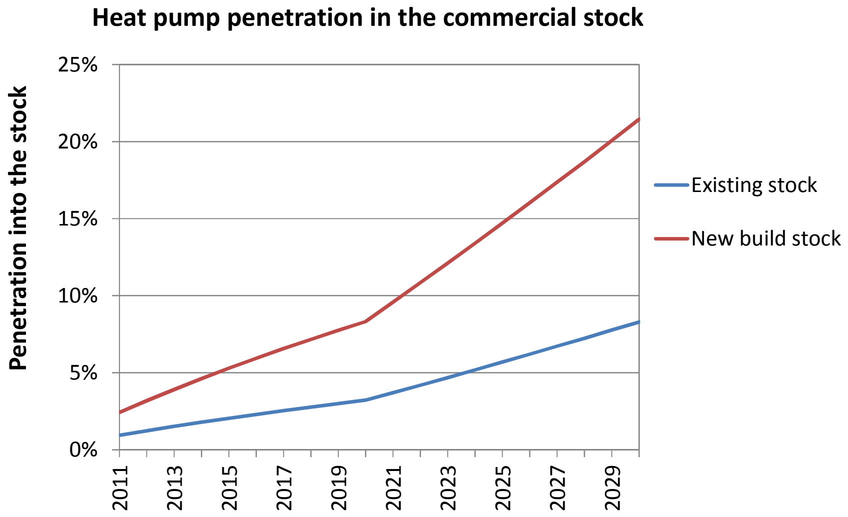


Figure 2, Commercial heat pump penetration in the licence area model (Phase 3). The overall commercial heat pump uptake split between existing and new build feeders is shown in the top chart. The penetration of heat pumps into the new build and existing stock is shown in the bottom chart.

Photovoltaics

As described in Section 2.3 Work Stream 3 Phase 3.2 report, the propensity to take up PV in different regions and building types (domestic, commercial, retrofit and new build) has been calculated using the Element Energy Feed-in Tariff model (the FIT model). In order for the overall uptake forecasts to match the DECC scenarios, the uptake predicted by the FIT model has been calibrated to the DECC overall uptake rate. In the Phase 2 version of the model, this was achieved by simply multiplying the cumulative uptake in each year predicted by the FIT model by a set of annual factors, such that the total uptake across all regions and building types matched the DECC scenarios.

In revising the modelling to produce the licence area level split, we noticed that this simple means of calibrating to the DECC scenarios could result in some improbable cumulative uptake curves for the residential sector. An example is shown in the chart below.

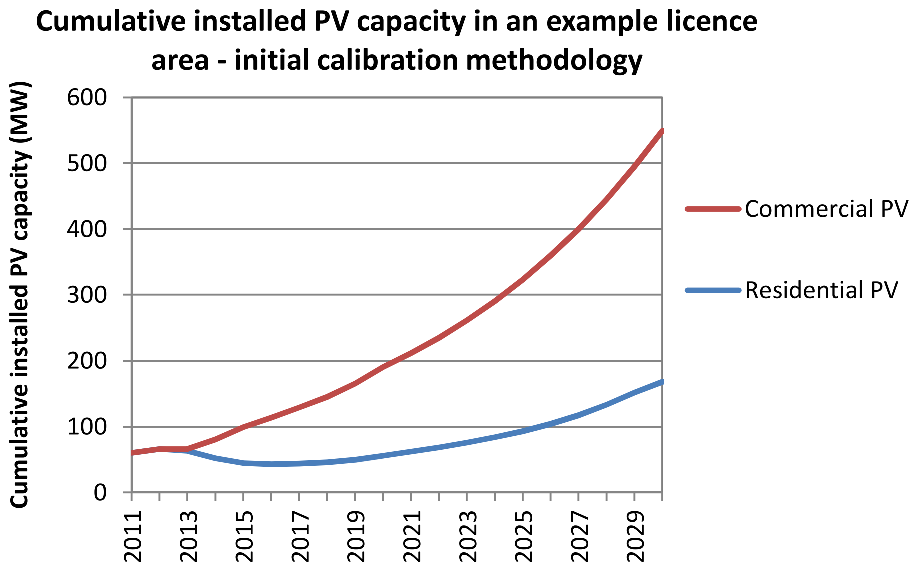


Figure 3, Cumulative installed PV capacity forecast in a sample licence area. The split between residential and commercial buildings has been derived by simply prorating the cumulative uptake in each year (DECC Central scenario) between building types in the proportions predicted by the Element Energy FIT model.

The modelling following this approach produced a drop in the cumulative installed capacity in the domestic sector over the earlier years of the forecast. The reason for this was that the FIT model predicts a rate of increase in the uptake of PV in the commercial sector that outstrips the overall rate of increase forecast in the DECC scenario. To match the DECC scenario, the simple prorating technique effectively shifts capacity from residential to commercial, resulting in a drop in the residential installed capacity in the early years.

The methodology of calibrating to the DECC scenarios has been altered to correct for this. In the revised approach, rather than simply prorating the cumulative uptake by each year between the building types, the annual new installed capacity in each year has been distributed among the building types in the same proportions that annual new uptake is spread across the building types in the FIT model. Cumulative uptake curves have then been generated for each feeder type by summation of the annual new installations figures. An example of the resulting cumulative uptake curves is given below.

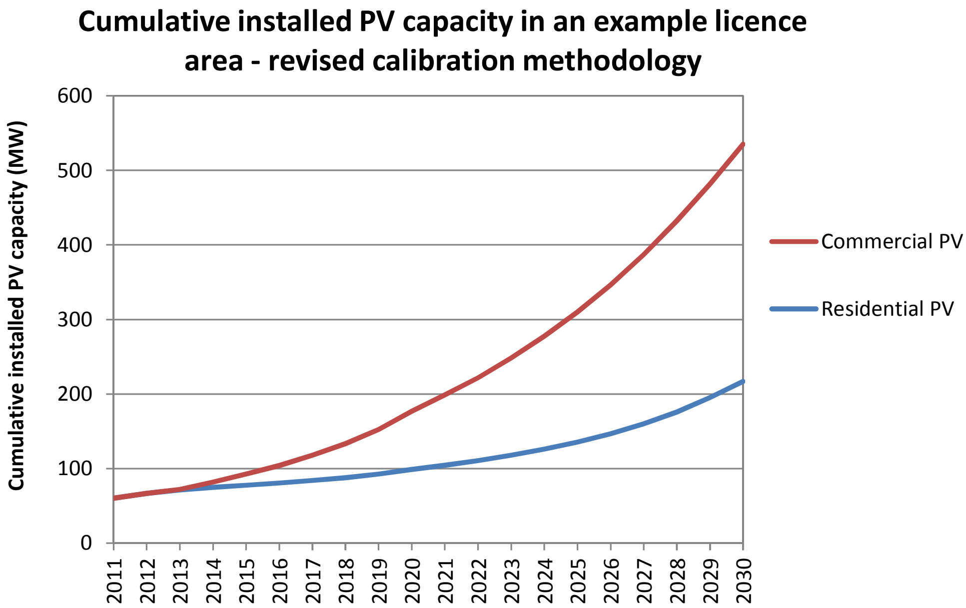


Figure 4, Cumulative installed PV capacity in a sample licence area. To derive the split of cumulative uptake between residential and commercial sectors, the annual installed capacity in each year is first split on the basis of the Element Energy FIT model, the annual uptakes in each sector are then summed to give a cumulative uptake curve.

As shown in the chart above, the revised methodology has generated a smoother uptake curve in both the residential and commercial sectors. The revised approach has also resulted in a change in the split of PV capacity between residential and commercial sectors. The overall installed PV capacity is unchanged and matches the DECC scenarios in each year (to 2030).

Electric Vehicles

There have been no changes to the methodology or assumptions determining the disaggregation of EV uptake. Small differences in the split of EV connections between existing and new build feeders may result from the introduction of more granular new build rates (i.e. for each GOR, rather than aggregated to the five regions in the Phase 2 model).