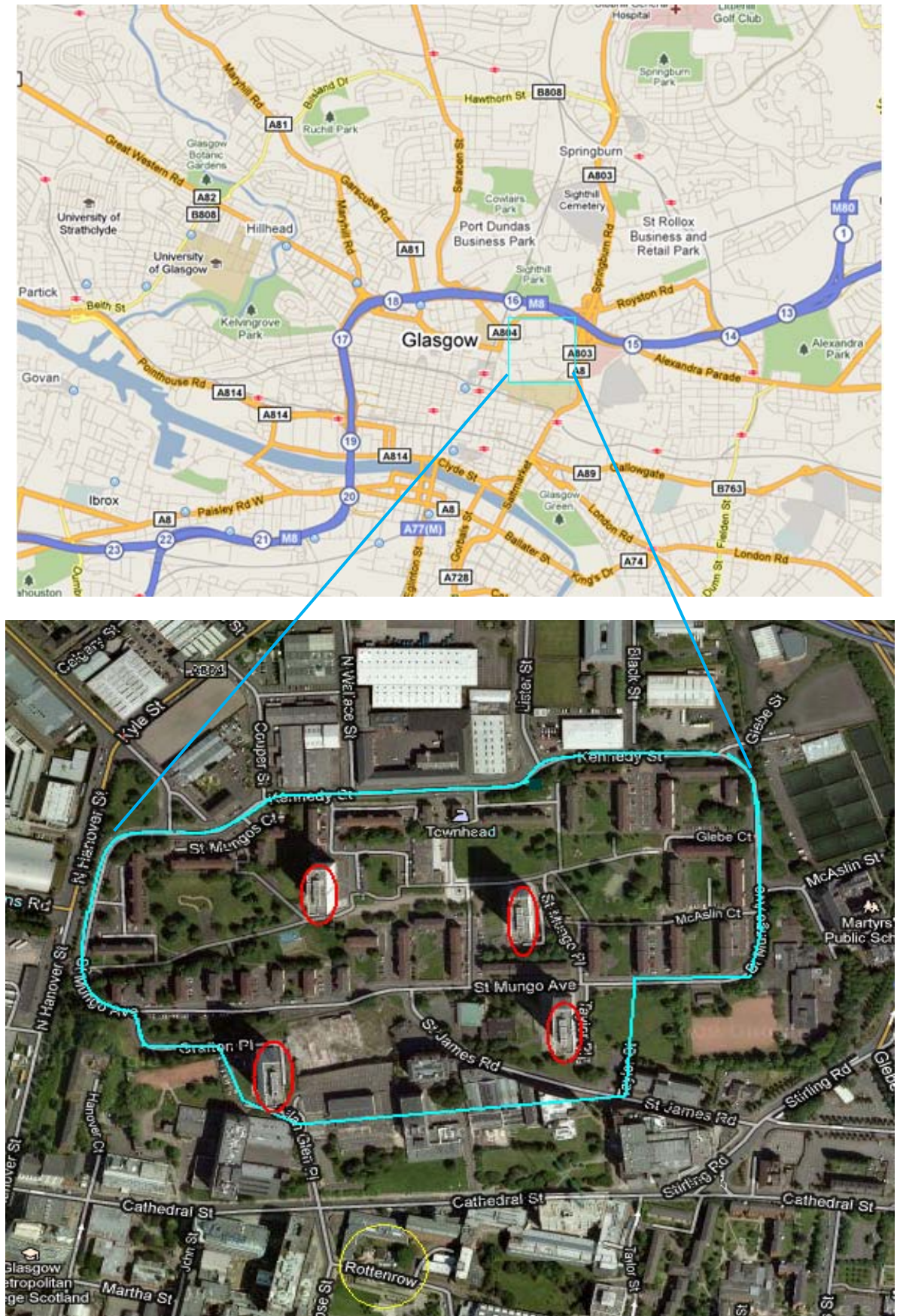


Appendix B

Figure 1

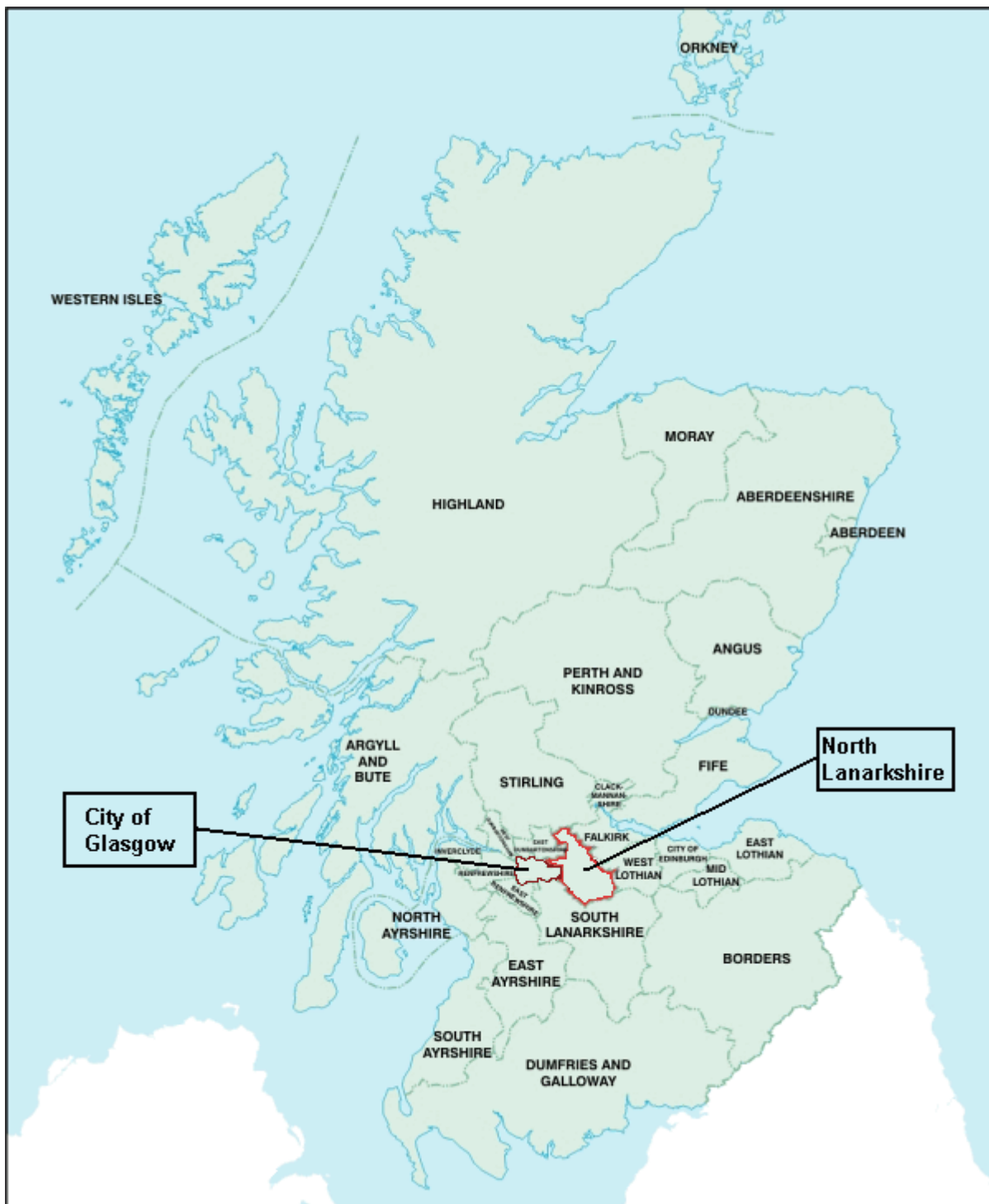
Appendix B Figure 1: Map of the Townhead Area in Glasgow showing High and Low Rise Premises proposed for the Trial



Appendix B

Figure 2

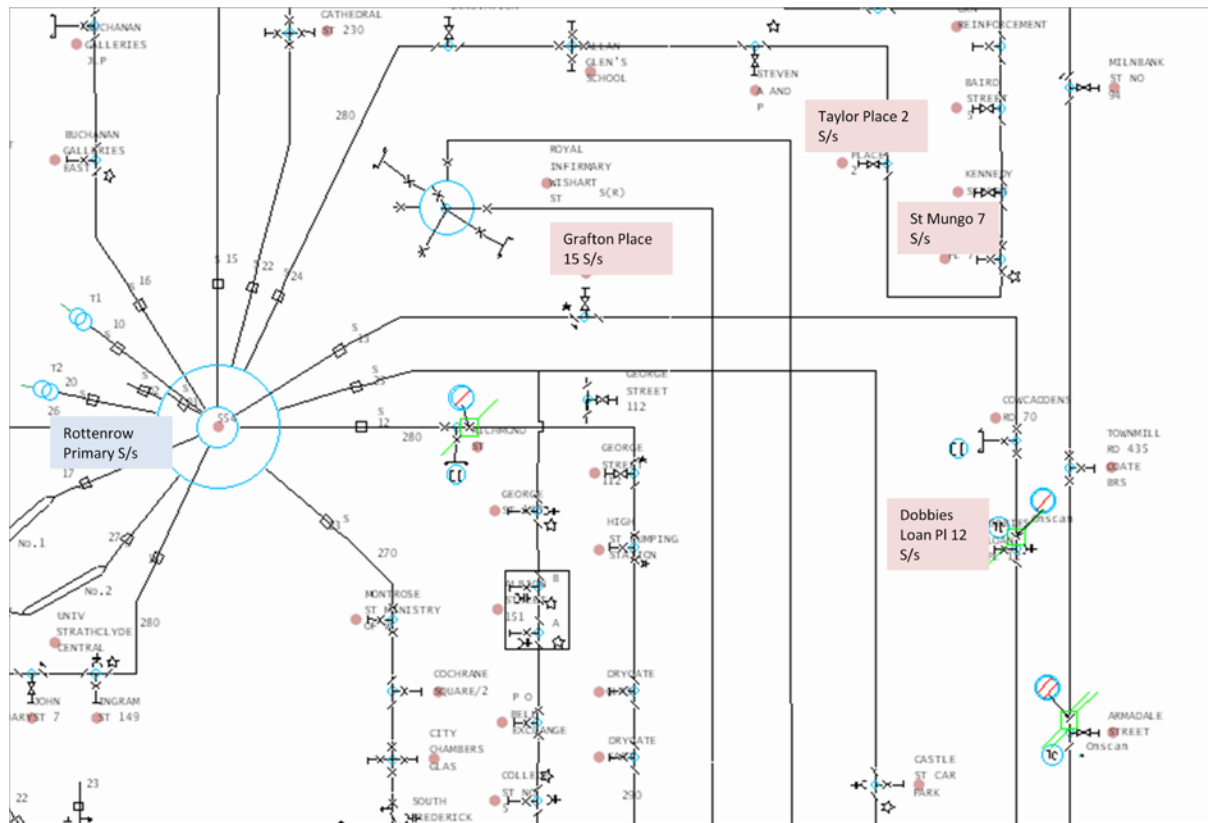
Appendix B, Figure 2 Map of Council Areas



Appendix B

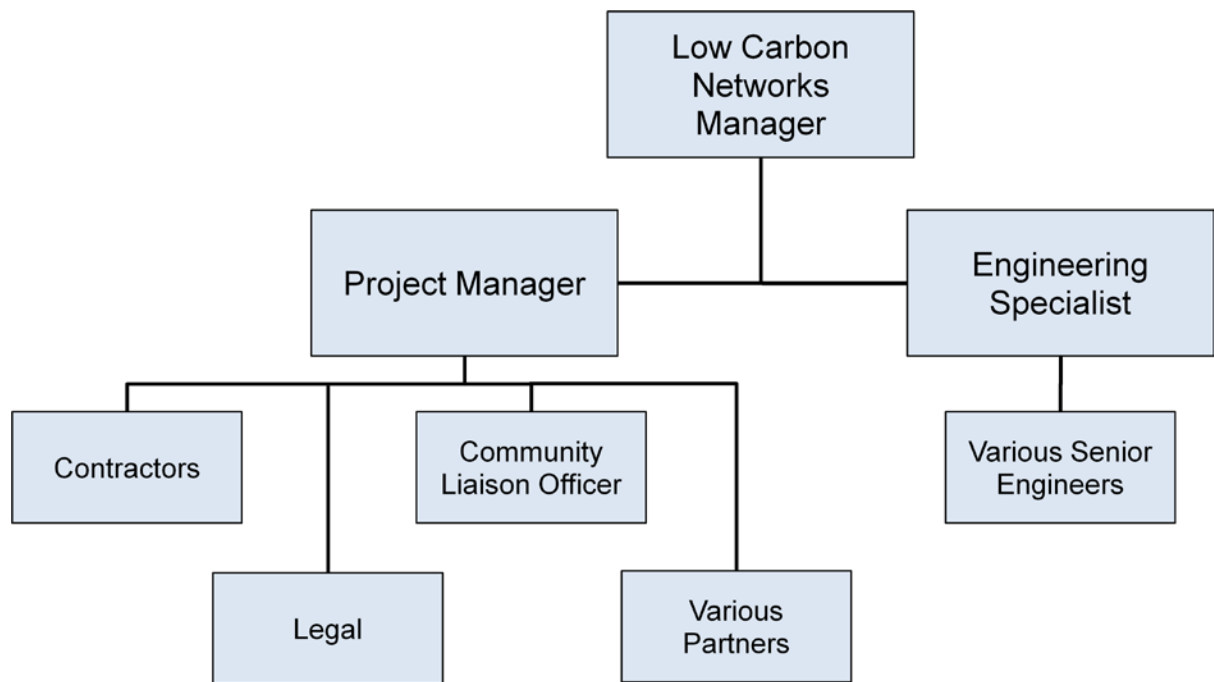
Figure 3

Single Line Diagram of 11kV Network showing substations within project area



Appendix C

Organogram



Appendix D

Project Plan

Demand Side Management of Electric Storage Heating

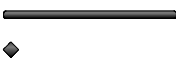


Project: SP Overview Programme.mpp
Date: Fri 03/09/10

Task
Split



Progress
Milestone



Summary
Project Summary



External Tasks
External Milestone



Deadline



Appendix E

Calculation of Benefits

Calculation of Carbon Benefits

For the purposes of quantifying the carbon benefits derived from the nationwide roll-out of the demand side management (DSM) initiative as demonstrated in the Project Solution, a number of key assumptions have been made:

- In the years 2015 to 2019, the uptake of DSM is projected to increase by 1% per annum from starting at 0.2% in 2015.
- 5% of UK demand is capable of being shifted on an annual basis for the period 2020 to 2050.
- The 5% uptake of DSM from 2020 onwards is based on the assumption that every UK home has a smart meter capable of the functionality being demonstrated as part of this project.
- UK Electricity projected demand is based on the Alpha scenario of the Pathways analysis undertaken by DECC (2010). A linear interpolation of the values between years where no values are provided has been made.

The carbon saving made by DSM has been estimated on the basis that peak demand has been moved to an alternative time of day. For this reason, the load which has been shifted will be fed from plant with average carbon intensity opposed to a marginal carbon intensity (typically associated with peak plant).

The average carbon intensity values are taken from the Alpha scenario of the Pathways analysis by DECC (2010). Marginal Plant Carbon Intensity values are based on numbers published by DECC in the *Valuation of Energy Use and Green House Gases (GHG) Emissions for Appraisal and Evaluation* Publication. This document by DECC assumes a marginal plant carbon intensity of 0.3939kgCO₂/kWh until 2020. By 2040, it is assumed that marginal plant and average plant will have the same carbon intensity. In the period 2020 to 2040 it is assumed that the carbon intensity reduces in a linear manner until it reaches the average plant carbon intensity in 2040 as stated in the Alpha scenario of the Pathways document.

The table below details the calculation and process followed to derive the carbon saving.

Net Benefits

Using the principals detailed in the Ofgem (2010) Paper of Demand Side Response, the three main areas of benefit to Great Britain from the nationwide deployment of this technology relate to:

- Reduction in Networks Reinforcement through reducing peak demand by 5%
- Reduction in capital investment of generation plant due to a smoothing of the demand profile

- Daily Wholesale cost savings through demand side response opposed to generation side response.

These savings have been quantified using the following assumptions:

Networks Reinforcement: Based on the average annual reinforcement cost in DPCR5, the annual reinforcement cost is assumed to increase proportionally to the increase in electricity demand outlined in Alpha scenario of the DECC Pathways Analysis (as per the Carbon benefit assumptions). Demand side response would facilitate 5% of the annual demand to be shifted which would result in a corresponding reduction in network reinforcement required, i.e. a 5% reduction per annum.

Capital investment: Savings in capital investment are assumed to be in line with the savings reported by Ofgem in the Demand side response analysis. These have been taken as the worst case scenario from the analysis. These savings are assumed to be realised every year until 2050.

Wholesale cost savings: Savings in wholesale costs are assumed to be in line with the savings reported by Ofgem in the Demand side response analysis. These have been taken as the worst case scenario from the analysis. These savings are assumed to be realised every year until 2050, the increasing cost of carbon may in fact increase the potential saving but this has not been considered.

Direct Benefits

No direct benefits have been assumed to be realised from this project as it focuses on a relatively small group of customers to prove the functionality of the equipment and obtain the operational experience of deploying such technology.

Costs Associated with Deployment of the Project Solution

It is assumed that the smart meter roll out will include most of the functionality that is being trialled in this project. For this reason, the costs associated with rolling out smart meters has not been considered as this is a cost which will be undertaken regardless of the success of this project.

The only additional cost assumed to be incurred to deploy this technology nationwide, is the additional cost of a the control system for the DSM. It has been assumed that this will be approximately at a cost of £10m per DNO group for it to control the majority of customers within their respective areas. The assumption being that these are deployed before the smart meter roll out is complete on the following basis:

- 2015/16 – one DNO group installs system
- 2016/17 – second DNO group installs system
- 2017/18 – third DNO group installs system
- 2018/19 – fourth and fifth DNO groups install system
- 2019/20 – sixth and seventh DNO groups install system.

An ongoing opex cost of £100k per DNO group is also assumed until 2050.

Carbon Benefit/Net Benefits/Box 14 & 15 References:

DECC. (July 20th 2009) UK Low Carbon Transition Plan, National Strategy for climate and energy.

IHS Global Insight. (July 2009) Demand Side Market Participation Report for DECC.

Ofgem. (15th July 2010) Demand Side Response, A Discussion Paper.

DECC (2010) 2050 Pathways Analysis:

http://www.decc.gov.uk/en/content/cms/what_we_do/lc_uk/2050/2050.aspx

Glasgow Electric Storage Heating

Carbon Savings through DSM

		2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	2031/32	2032/33	2033/34	2034/35	2035/36
% of discretionary load capable of being shifted by DSM	'a'	-	-	-	-	-	0.2%	1%	2%	3%	4%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Average Generation Carbon Intensity(kgCO2/kWhe)	'b'	-	-	-	-	-	0.33	0.33	0.33	0.33	0.33	0.33	0.31	0.29	0.27	0.26	0.24	0.22	0.20	0.18	0.17	0.15	0.14	0.14	0.13	0.12	0.12	0.11
Marginal Generation carbon Intensity (kgCO2/kWhe)	'c'	-	-	-	-	-	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.39	0.37	0.35	0.33	0.31	0.29	0.27	0.25	0.23	0.21	0.19
Carbon intensity reduction by shifting from marginal to average plant (kgCO2/kWhe)	'd'=c-b	-	-	-	-	-	0.07	0.07	0.07	0.07	0.07	0.07	0.08	0.10	0.12	0.14	0.16	0.17	0.17	0.17	0.17	0.16	0.15	0.13	0.12	0.10	0.09	0.08
Total Electricity Demand (TWh)	'e'	382.9	385.5	388.0	390.6	393.1	395.7	404.2	412.7	421.2	429.8	438.3	451.1	464.0	476.8	489.7	502.5	514.6	526.6	538.7	550.7	562.8	572.8	582.8	592.9	602.9	612.9	625.3
Total demand capable of being shifted (TWh)	'f'= a x e	-	-	-	-	-	0.79	4.04	8.25	12.64	17.19	21.91	22.56	23.20	23.84	24.48	25.13	25.73	26.33	26.93	27.54	28.14	28.64	29.14	29.64	30.14	30.65	31.27
Carbon Saving (Tonnes CO2)	'g'= f x d	-	-	-	-	-	52,150	266,366	543,964	832,795	1,132,859	1,444,156	1,892,489	2,363,939	2,858,505	3,376,188	3,916,988	4,474,099	4,539,629	4,568,354	4,593,711	4,615,699	4,274,180	3,917,838	3,546,674	3,160,686	2,759,876	2,353,350
Carbon Cost (£)	'h'	-	-	-	-	-	£23	£24	£24	£24	£25	£25	£30	£34	£39	£43	£38	£52	£57	£61	£66	£70	£77	£83	£90	£96	£103	£109
Equivalent Financial Cost saving (£)	=h x g	-	-	-	-	-	£1,199,446	£6,392,773	£13,055,134	£19,987,083	£28,321,479	£36,103,900	£56,774,671	£80,373,915	£111,481,694	£145,176,080	£148,845,525	£232,653,158	£258,758,851	£278,669,612	£303,184,917	£323,098,907	£329,111,857	£325,180,582	£319,200,641	£303,425,887	£284,267,221	£256,515,132

Continued		2030/31	2031/32	2032/33	2033/34	2034/35	2035/36	2036/37	2037/38	2038/39	2039/40	2040/41	2041/42	2042/43	2043/44	2044/45	2045/46	2046/47	2047/48	2048/49	2049/50	
% of discretionary load capable of being shifted by DSM	'a'	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%	5% Worst case scenario from OFGEM DSR paper
Average Generation Carbon Intensity(kgCO2/kWhe)	'b'	0.14	0.14	0.13	0.12	0.12	0.11	0.11	0.10	0.09	0.09	0.08	0.08	0.07	0.06	0.06	0.05	0.05	0.04	0.03	0.03	0.03 Alpha Scenario assumed from DECC Pathways Document
Marginal Generation carbon Intensity (kgCO2/kWhe)	'c'	0.29	0.27	0.25	0.23	0.21	0.19	0.17	0.15	0.12	0.10	0.08	0.08	0.07	0.06	0.06	0.05	0.05	0.04	0.03	0.03	0.03 Valuation of Energy Use and Green House Gases Emissions for Appraisal & Evaluation
Carbon intensity reduction by shifting from marginal to average plant (kgCO2/kWhe)	'd'=c-b	0.15	0.13	0.12	0.10	0.09	0.08	0.06	0.05	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Electricity Demand (TWh)	'e'	572.8	582.8	592.9	602.9	612.9	625.3	637.8	650.2	662.7	675.1	689.2	703.3	717.4	731.5	745.6	767.1	788.6	810.0	831.5	853.0	853.0 Alpha Scenario assumed from DECC Pathways Document
Total demand capable of being shifted (TWh)	'f'= a x e	28.64	29.14	29.64	30.14	30.65	31.27	31.89	32.51	33.13	33.76	34.46	35.17	35.87	36.58	37.28	38.35	39.43	40.50	41.58	42.65	
Carbon Saving (Tonnes CO2)	'g'= f x d	4,274,180	3,917,838	3,546,674	3,160,686	2,759,876	2,353,350	1,928,421	1,485,089	1,023,354	543,216	-	-	-	-	-	-	-	-	-	-	-
Carbon Cost (£)	'h'	£77	£83	£90	£96	£103	£109	£116	£122	£129	£135	£142	£148	£155	£161	£168	£174	£181	£187	£194	£200	
Equivalent Financial Cost saving (£)	=h x g	£329,111,857	£325,180,582	£319,200,641	£303,425,887	£284,267,221	£256,515,132	£223,696,817	£181,180,850	£132,012,682	£73,334,214	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0	£0

Net Benefits through DSM

Assume reinforcement is proportionally related to the increase in electricity demand

DPCR 5 Reinforcement cost (£m) (2007/08 prices) £275

DPCR 5 Reinforcement cost (£m) (2010/11 prices-based on 2.5% inflation) £296

Approximate annual cost of Reinforcement (£m) £59.2

		2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26	2026/27	2027/28	2028/29	2029/30	2030/31	2031/32	2032/33	2033/34	2034/35	2035/36
Total Electricity Demand (TWh)	'e'	382.9	385.5	388.0	390.6	393.1	395.7	404.2	412.7	421.2	429.8	438.3	451.1	464.0	476.8	489.7	502.5	514.6	526.6	538.7	550.7	562.8	572.8	582.8	592.9	602.9	612.9	625.3
Increase in Electricity demand y-o-y after DPCR5 (%)	'j'	-	-	-	-	-	-	2.2%	2.1%	2.1%	2.0%	2.0%	2.9%	2.8%	2.8%	2.7%	2.6%	2.4%	2.3%	2.3%	2.2%	2.2%	1.8%	1.7%	1.7%	1.7%	2.0%	
Projected Annual reinforcement cost (£m)	'k'= e + j	£0.00	£59.2	£59.2	£59.2	£59.2	£59.2	£60.5	£61.8	£63.0	£64.3	£65.6	£67.5	£69.4	£71.3	£73.3	£75.2	£77.0	£78.8	£80.6	£82.4	£84.2	£85.7	£87.2	£88.7	£90.2	£91.7	£93.6
Annual saving through deferring 'a' % of load (£m)	= a x k	£0.00	£0.0	£0.0	£0.0	£0.0	£0.1	£0.6	£1.2	£1.9	£2.6	£3.3	£3.4	£3.5	£3.6	£3.7	£3.8	£3.8	£3.9	£4.0	£4.1	£4.2	£4.3	£4.4	£4.4	£4.5	£4.6	£4.7
Annual capital cost saving from OFGEM DSR report (£m)		-	-	-	-	-	-	-	-	-	-	-	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0
Annualised daily wholesale cost savings from Ofgem DSR report (£m)		-	-	-	-	-	-	-	-	-	-	-	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0

Continued		2030/31	2031/32	2032/33	2033/34	2034/35	2035/36	2036/37	2037/38	2038/39	2039/40	2040/41	2041/42	2042/43	2043/44	2044/45	2045/46	2046/47	2047/48	2048/49	2049/50	
Total Electricity Demand (TWh)	'e'	572.8	582.8	592.9	602.9	612.9	625.3	637.8	650.2	662.7	675.1	689.2	703.3	717.4	731.5	745.6	767.1	788.6	810.0	831.5	853.0	Alpha Scenario assumed from DECC Pathways Document
Increase in Electricity demand y-o-y after DPCR5 (%)	'j'	1.8%	1.7%	1.7%	1.7%	1.7%	2.0%	2.0%	2.0%	1.9%	1.9%	2.1%	2.0%	2.0%	2.0%	1.9%	2.9%	2.8%	2.7%	2.7%	2.6%	
Projected Annual reinforcement cost (£m)	'k'= e + j	£85.7	£87.2	£88.7	£90.2	£91.7	£93.6	£95.4	£97.3	£99.1	£101.0	£103.1	£105.2	£107.3	£109.4	£111.6	£114.8	£118.0	£121.2	£124.4	£127.6	
Annual saving through deferring 'a' % of load (£m)	= a x k	£4.3	£4.4	£4.4	£4.5	£4.6	£4.7	£4.8	£4.9	£5.0	£5.1	£5.2	£5.3	£5.4	£5.5	£5.6	£5.7	£5.9	£6.1	£6.2	£6.4	
Annual capital cost saving from OFGEM DSR report (£m)		£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	£129.0	Worst case scenario from OFGEM DSR paper
Annualised daily wholesale cost savings from Ofgem DSR report (£m)		£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	£146.0	Worst case scenario from OFGEM DSR paper