Gas Network Innovation Competition Full Submission

Supplementary Answer Form

Project: H21

Tick if this answer has been provided verbally: ☐

Project code	NGNGN05	Question Number	5
Question date	22nd August 2019	Answer date	27th Aug 2019
Submission section question relates to	Appendix B		
Topic	Conversion Costs		
Question	Can you provide some explanation between the difference in cost per customer provided within the KPMG estimates in table 9 and the assumptions made in table 10. Additionally, can you also provide explanation as to what is driving the differences in costs for each location?		
Notes on question			
Answer	Table 9 is based on the table given in the Executive Summary on page 7 of the KPMG "2050 Energy Scenarios" report (pasted below) and the total costs given there are given in the report in Sections 5.4.1 for the Gas Option and 8.4.1 for the Electric Option. The per customer costs within the report are derived from KPMGs build up for the total costs for the various energy supply options as summarised in the table on page 7 of the report given below.		

	Evolution of Gas	Prosumer	Diversified energy	Electric Future
Practical obstacles	Low/Medium	Very high	Medium/High	High
Incremental cost	£104-122bn	£251-289bn	£156-188bn	£274-318bn
Incremental cost per consumer up to 2050	£4,500-5,000	£11,000-12,500	£6,800-8,000	£12,000-14,000

The total incremental costs in the above table are derived from values given in section 5.4.1 (for the natural gas to hydrogen conversion option) and 8.4.1 for the all-electric option.

5.4.1 Costs

Cost Range: £104bn-£122bn

- This scenario is a relatively low capital cost given that it uses the existing gas network assets, assets that have already been paid for by customers.
- As this scenario continues to use gas there is a relatively small difference in commodity costs, mostly driven by the energy requirements of the steam methane reformer process.
- The building of steam methane reformers is a large gas network investment.
- There is relatively low amount of investment needed for household conversion. Although this is still substantial.

Table 5.2: Cost Breakdown

	Costs (£ billion)	
	Low	High
Incremental commodities cost [27]	21	21
Electricity networks	-	-
Gas networks	43	52
Household adaption	40	49
Total	104	122

8.4.1 How Much investment is required?

Cost Range: £274bn- £318bn

- High commodity costs in this scenario due to high electricity prices as electricity generation is decarbonised
- High network costs as electricity system has to take on the full peak demand that the gas system used to supply. Significant additional flexible electricity generation is required to back up intermittent renewables.
- Largest cost is household conversion as every property fitted with heat pump or electric boiler.

Table 8.2: Cost Breakdown

	Costs (£ billion)	
	Low	High
Incremental commodities cost [36]	115	115
Electricity networks	26	43
Gas networks	7.2[37]	8.8
Household adaption	126	152
Total	274	318

Re Section 5.4.1 - Primarily the gas incremental costs per customer are lower because we are re-purposing an existing asset with the major costs being those relating to new infrastructure required on the gas network (SMR hydrogen production facility with associated CCS). The KPMG report gives costs for these of between £43 and 52 billion with the other large cost being assigned to household adaptation at between £40 to 49 billion. There is a smaller cost assigned to the potential increase in the future cost of natural gas which will be the source fuel for the SMR.

Re Section 8.4.1. The major cost assigned in the report for the all-electric option is the cost to convert customers from gas to electric appliances at between £126 and 152 billion. This cost is greater than the total cost of the hydrogen conversion option. There are then additional costs assigned to the electricity grid (£26 to 43 billion) and for incremental commodities costs (£115 billion).

Table 10 as presented has a column missing which makes the information contained hard to interpret. An update of this table will be made in the resubmitted NIC bid document but the updated table is given below for information – the missing column is highlighted in green.

An additional table is given here which may give more perspective and sense of the conversion process. This table is based on analysis of UK conversion costs from the H21 North of England report. The cost per customer has been presented broken down by cost contribution of the various component factors (network conversion, hydrogen production infrastructure etc.).

The network and appliance conversion costs per customers are formulated to decrease as the conversion proceeds due to a couple of factors. Once the UK conversion from natural gas to hydrogen becomes policy the assumption is that newly installed or replacement appliances will increasingly be dual-fuel greatly simplifying the conversion process and thus reducing the cost. In addition, lessons learned from the on-going conversion process (including the increasing number of trained operatives) will steadily reduce the per customer cost of conversion.

The Hydrogen Transmission System (HTS) costs assigned per city are "lumpy" due to the fact that the first city in an area to be converted will require the construction of a significant length of HTS which will then be able to supply adjacent cities hence their zero cost for this field – the total average cost for the UK HTS is the relevant one to consider.

The hydrogen production facilities will largely be constructed in line with the incremental increase in demand and therefore the costs are constant for each city.

The hydrogen storage per customer costs drop as the conversion proceeds as the increasing length of the HTS provides greater line-pack and the greater number of customers gives greater diversity for the demand smoothing out production and storage requirements.

City	Population guestimate (In area to convert in millions)	Proportional variation from Leeds	Number of connections (customers)	Timeline		Cost per City Hydrogen conversion (£Ms)	Cost per City Electric heating (based on KPMG report) (£Ms)	Cumulative savings (£Ms)
				Year start	Year Finish			
leeds	0.66	1.00	265,000	2026	2029	1,896	£5,189	£3,293
Teesside	0.56	0.85	225,250	2029	2032	1,369	£3,748	£5,671
Kingston Upon Hull	0.26	0.39	103,350	2029	2032	604	£1,653	£6,720
Newcastle	1.12	1.69	447,850	2032	2035	2,778	£7,602	£11,545
Manchester	2.41	3.65	967,250	2032	2035	5,533	£15,144	£21,155
Sheffield	0.56	0.85	225,250	2035	2038	1,273	£3,484	£23,366
Liverpool	1.71	2.59	686,350	2035	2038	3,781	£10,349	£29,933
Edinburgh	0.49	0.75	198,750	2036	2039	1,386	£3,793	£32,340
Glasgow	1.14	1.73	458,450	2039	2042	2,579	£7,059	£36,820
Birmingham	2.81	4.25	1,126,250	2039	2042	6,012	£16,454	£47,263
Bristol	0.44	0.67	177,550	2042	2045	1,184	£3,241	£49,320
Cardiff	0.35	0.54	143,100	2042	2045	834	£2,282	£50,768
Aberdeen	0.23	0.35	92,750	2042	2045	849	£2,322	£52,242
Leicester	0.34	0.51	135,150	2045	2048	795	£2,177	£53,623
Luton	0.21	0.32	84,800	2045	2048	630	£1,724	£54,717
Oxford	0.16	0.24	63,600	2045	2048	515	£1,410	£55,612
London	8.54	12.91	3,421,150	2045	2052	17,007	£46,545	£85,150
TOTALS	22.00	N/A	8,821,850	N/A	N/A	£49,026	£134,175	£85,150

		Average cost per domestic meter / £				
City	Approximate number of domestic meters	Network and appliance conversion	HTS	H2 production	H2 storage	Total
Leeds (city)	265,000	2,358	1,075	2,679	1,042	7,155
Teesside (Greater Area)	225,250	2,358	0	2,679	1,042	6,079
Kingston Upon Hull (City)	103,350	2,123	0	2,679	1,042	5,843
Newcastle (Greater Area)	447,850	2,123	359	2,679	1,042	6,202
Manchester (Greater Area)	967,250	1,910	142	2,679	989	5,721
Sheffield (City)	225,250	1,719	264	2,679	989	5,652
Liverpool (Greater Area)	686,350	1,719	121	2,679	989	5,509
Edinburgh (City)	198,750	1,719	1,585	2,679	989	6,973
Glasgow (Greater Area)	458,450	1,719	238	2,679	989	5,626
Birmingham (greater Area)	1,126,250	1,547	174	2,679	937	5,338
Bristol (City)	177,550	1,547	1,507	2,679	937	6,671
Cardiff (City)	143,100	1,547	664	2,679	937	5,828
Aberdeen (City)	92,750	1,547	4,036	2,679	885	9,148
Leicester (City)	135,150	1,547	773	2,679	885	5,885
Luton (City)	84,800	1,547	2,314	2,679	885	7,426
Oxford (City)	63,600	1,547	2,987	2,679	885	8,099
London (Greater Area)	3,421,150	1,393	14	2,679	885	4,971
Totals	8,821,850	1,639	297	2,679	942	5,557

Attachments	