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2018 Future Energy Scenarios
Costing webinar

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Introduction

Below are the speaker notes to accompany the FES 2018 costing webinar slides. The webinar took place on the 26th March 2019.

Content

Slide 1: TITLE

Slide 2: WELCOME

Good morning and welcome to the 2018 Future Energy Scenarios costing webinar.

Today we shall see the results of our FES costing project. Here with me is Neil Rowley and Shibo Liu who are the team behind the work. Neil shall be taking you through the results shortly.

First I thought it would be useful to provide some context. The purpose of this costing project is to add depth and colour to the scenarios, to help understand the relative merits of each scenario. It is not forecasting future energy bills. These are modelled costs using a whole energy system tool that Neil will explain.

It is costing the FES scenarios that are built which are bottom up. The scenarios are credible and plausible pathways based on the research, stakeholder engagement and analysis we undertake each year. They are not extreme, but plausible envelopes for the future of energy system. Whilst each scenario is consistent and meets security of supply for example, none are designed to be stand-alone, they are designed to be used as a set to understand future uncertainty. They are also unrestrained by network capability as this is dealt with in other NGSO publications.

Neil will now take you through the approach, the results and our key conclusions.

We will then take time for Q&A.

Slide 3: AGENDA

Hello every one. I am delighted to talking about FES 18 Costing today

I will be taking you through the rest of this pack - we have 11 slides to present to you today

And we will be covering:

- The project background
- Key conclusions
- How the Scenarios compare at the Total System Cost. Then a breakdown of:
- Power Supply
- Road Transport,
- Domestic heating &
- I & C costs

This will take around 20 minutes, at which point we will open the webinar up for Questions & Answers

Slide 4: COSTING FES 2018 SCENARIOS

We stated in FES 18 publication our intention to costs the four Future Energy scenarios. This links strongly to the new framework introduced last year, where we updated the main influencers on the scenarios: Speed of Decarbonisation & Level of Decentralisation

This gives us the opportunity to explore the differences between pathways that are compliant with the Climate Change Act and those that are not compliant. As well as exploring themes around central vs decentralised energy. Just to remind people this is defined as where energy system solutions are physically located, moving from large scale central to smaller scale local solutions.

While the axis defines the direction for the scenarios, they are not developed as extremes cases but rather they aim to explore the credible envelope range. For instance, our most decentralised scenario, CR has 65% of generation capacity from decentralised sources, thereby still having significant capacity connected to the Transmission system.

Similarly, our scenarios do not focus entirely on one particular energy solution, such as Electrification or H2 - they emphasise such technologies, as related to the narrative of each scenarios

So why have we done this? Well it serves to further enhance our understanding of the FES scenarios, how they relate to each other, where are the common and the scenario specific challenges? In essence it helps to provide additional insights to the scenario development process.

Just moving back to the slide, you can also see the key Marco Assumptions are listed. These are useful to understand as they underpin the scenarios:

- Population rises to 70.5m in 2050 - consistent in all scenarios
- Likewise Houses rise to 31.5m in all scenarios
- Economy growth, denoted through Gross Domestic Product ranges from 0.9-2% yearly average, split by left to right hand side of the axis, i.e. TD & CR 2% GDP

Slide 5: MODELLING APPROACH

A recap how we do FES as this is part of the process:

We start at a relative high level, defining the 2050 compliant scenarios through the use of a whole energy system optimiser, and by defining the key technologies and approaches of those world's as inputs.

We use the UK times model for this process. UKTM for short.

Once that is complete, we then do a deep dive into the individual energy sectors to refine the technology developments and uses in each scenario. Of course, for the non-2050 compliant scenarios we only focus on this bottom analysis.

FES is developed in an unconstrained manner, I.e. any distinct challenges such as operability are considered at a high level but analysed in detail post the FES process. Normally this step is where the scenarios become complete and FES finishes. However, this year for the costing work we have create a closed loop by inserting the FES scenarios back into the uktm model.

This is something that hadn't been done before, so we worked closely with a team from University Colleague London (UCL), to help us replicate FES 18 into the model.

The challenge of this work was to turn the data that is derived from numerous specialist models into one model and ensure we had a good representation of each scenario at the end of the process.

We achieved this, although it is important to remember that as a result these are representations and not exact.

So why have we taken this approach? Well, this allows us to take advantage of the technical & economic data of the UKTM database whilst basing the modelling on the FES 18 scenarios to create rich and full worlds. The diagram at the bottom of the slide illustrate this approach. The scope for this work includes all costs associated with the upstream production, midstream transportation and downstream appliances for the Electricity, transport, heat and industry sectors.

It is worth noting that we have used simplified network modelling for the midstream costs. Couple of points on the form of the costs:

a) these are in undiscounted form

b) assets are annuitized over expect asset life, so for new nuclear generator this is based on 60 years' life expectancy.

Slide 6: **KEY CONCLUSIONS**

This slide highlights our key conclusions from this analysis, which you will see in more detail as we look at the results section.

1. We have found there to be a small costs difference between the scenarios in 2050. This is driven by the improving economics of renewable & low carbon energy systems. It ultimately means that costs are less of a barrier to decarbonising the UK than we may have thought, although it is still more expensive.

2. Looking at the 2050 compliance scenarios of TD & CR, it can be seen that there is a very small difference between them. Taking potential error margin into account it can be considered that there is no clear distinction to define the way we should develop our energy system based purely on costs.

3. Within the power supply sector, costs relate strongly to the amount of capacity built in each world. Higher capacity, as required to support electrification of demands and security of supply, equals higher costs.

4. Road transport costs are similar in all scenarios. This reflects the consistency of our EV growth across the scenarios. Some of the differences are due to the challenge of cost effectively decarbonising the commercial vehicle fleet, this impacts TD & CR.

5. Heating costs are higher in 2050 compliant scenarios as the cost to improve insulation and change heating appliances away from gas boilers increase costs

Our key takeaway from all this is that the similarity across the scenarios mean we can plausibility compared them and consider them credible.

Slide 7: TOTAL SYSTEM COST IN 2050

Moving on to our first charts, and starting with the whole system costs. First let me describe the chart format to you:

- We have cost on the Y-axis & each scenario in 2050 on the x-axis
- We included a breakdown of the key energy sectors in the bar charts
- This excludes sectors such as Agriculture, Aviation & Shipping which are of less interest to Electricity & Gas sectors
- At the bottom, you will see carbon equivalent emission levels for each scenario. The first line represents the sector included in the cost stack whereas the second line is for the total system emissions
- You can see that total costs range from £316bn to £343bn with an order of scale going from: Transport, residential, power generation, Industrial & Commercial, then Networks costs (Including Balancing service costs)
- The key principle of showing the costs here is to show the relative difference between the scenarios. The absolute number should only be considered as a guide based on the functions of UKTM

So what does it tell us?

- The 8% difference between the highest and lowest cost scenarios illustrates the recent reductions in low carbon technology costs
- Just to reinforce a point here - as we have costed the scenarios there is no strict counterfactual based on today's world. The scenarios serve as the comparisons, but it must be remembered that these are of course there own unique, rich world's distinct from each in many ways and in many ways similar.
- Comparing TD & CR with each other there is a 2% difference between them. It is helpful to understand that to model this, assumptions on the cost maturity of technologies is taking into account. However, this is highly uncertain area and can clearly have a significant impact on the results. To appreciate this, you only need to consider how fast solar and wind generation have reduced in cost and the challenge of predicting this.

Slide 8: POWER SUPPLY SECTOR

Moving on to the power supply sector

In this slide, you will see we have a cost chart on the left, same format as described in the previous chart and a FES chart on the right. All the remaining sector slides follow this format.

The main groups of technology here are: low carbon (nuclear and Ccs) wind, solar, other renewables, storage and interconnectors and thermal (gas plant). As mentioned in the key conclusions, costs in the Power Supply sector are related to the build capacities.

CE & SP have the smallest capacities at just under 200GW which can be seen on the chart to the right. This directly related to lower Electricity demands and low carbon generation levels than TD & CR. These capacity levels translate to modelled cost of £41/40Bn in 2050. Wind and low carbon generation such as nuclear take a significant portion of costs. However, the diversity of generation sources can be seen on the cost stack on the left.

Turning back to chat on the right, TD & CR can be seen to have larger capacities. The key point here is that while TD has 44GW less capacity than CR, they come out with a very similar cost. So in essence this means that TD is more expensive on a £/MW metric. However, TD on the other hand benefits from a deeper emission reduction, as shown at the bottom of the cost chart. This could be important as the UK starts to explore the implications from a potential Net Zero carbon requirement.

So what is happening in the scenarios? TD is influenced by having CCS plant in the mix and more nuclear plant than CR. This plant has a high capital cost. CR on the other hand has more modular, renewable generation in the form of onshore wind and solar which has experienced the recent cost reductions. However, without CCS in the mix there is a need to use some unbated gas for balancing purposes resulting in the slightly higher emissions. Just to note, Offshore wind is a major component of both scenarios.

Slide 9: ROAD TRANSPORT SECTOR

In this slide, along with the cost chart we have the FES 18 EV Growth out to 2050. This chart highlights the radical changes portrayed in FES 18 over the next 30 years in road transport. It also serves to highlight the close convergence in our EV growth ranges by the time we reach 2050.

Just some 2m EV difference between the scenarios. This is influenced by the continuing maturity of EV technology and the forecast cost parity with Internal Combustion Engines in the 2020s, for cars. Thus making EV attractive to end consumers. In addition, the clearly stated aspirations from government to achieve low carbon road transport by 2040 signals the intention to ensure the transition happens.

This similarity in EV numbers strong influences the overall transport costs in 2050 and helps to ensure that all scenarios are broadly similar. The yellow bar in the stack chart shows the significance of cars, which are mostly Evs

So, what is influencing the slight cost differences? Well there are some difference between the scenarios when it comes to how cars are used - sharing, and automation levels for example.

Of equal importance is the cost of decarbonising the energy intense commercial vehicle sector (HGVs). Here, the challenge of decarbonising comes with an increased cost. This can be seen as £41bn is spent in TD & CR as opposed to £32bn in CE & SP which largely retain diesel in this category. So, while it is clear that good progress in affordable decarbonised cars is being made, it is less clear how this will happen in the commercial energy intense sector

Slide 10: DOMESTIC HEATING SECTOR

In this slide to go along with the cost chart we have the heating appliance numbers in 2050 for each scenario. Unlikely transport, it is fair to say that there is no clear direction as to how we will decarbonise our home heating sector. This results in FES 18 highlighting a variety of approaches.

Starting with CE & SP, the chart on the right highlights that gas boilers make up the lion share of the appliances (some 20m). This means we retain higher emissions in home heating. As a consequence, gas boilers and the fuel costs make up the majority of the costs. To achieve an average thermal efficiency of 10.5MWh/yr we spend £6bn on insulation measures.

CR reverses our current heating position today - Electrification sources make up the majority of the heating appliances in 2050 with some support from gas sources including Biomethane to retain some boilers. Here HP costs together with fuel costs make up the majority of the cost. TD largely continues like today with gas sources meeting most people's needs, be it H2, natural gas or biogas.

This pathway has a reduced capex cost due to the high number of gas boilers (inc.H2). However, fuel costs are highest here as natural gas is used to create the H2.

Both TD & CR spend around £13bn on home insulation measures to bring the average thermal demand down to 8.5MWh/yr. Ultimately TD approach comes out slightly more expensive overall, however, again it is worth reiterating that modelling error is a factor to be aware of here and hence it is prudent to not draw too strong a conclusion from this.

As we move forward and the industry continues to explore how to decarbonise heat, it may well be that other non-cost factor become of equal importance:

- Supply vs demand solution and public acceptability
- Regional vs national initiative
- Public engagement and levels of consumer choice to names some issues

Slide 11: INDUSTRIAL & COMMERCIAL SECTOR

The last section is Industrial & Commercial

This sector is characterised by relatively few assets when considered against homes but they are energy intense. The chart on the right - Electricity demand highlights a range of between 170THw & 187THw. There are strong similarly between what is happening in this sector to the previous one. This is because the same drivers are present. The challenge as to whether we decarbonise or not, influences the scenarios, together with which direction: gas or electrification routes we go.

This means the costs are higher in the TD & CR where they convert away from prominently Natural Gas use in CE & SP. The capex vs opex issues between TD and CR are the same as the domestic heating sector, with TD having smaller capex but higher opex to create the H2.

There is also the balance here between our modelled result looking slightly more expensive for a TD approach (modelling error accepted) and the deeper emission reduction in TD due to the availability of CCS. Again, if we aim to achieve greater than an 80% emissions reduction then this will become important

Thank you for listening now we will now hand you over to Marcus for the Q&A session of the webinar

Slide 12: Recap – key conclusions

This slide recaps the key conclusions from this analysis that we shared at the beginning of the webinar

Slide 13: Thank you and close

Slide 14: Key assumptions across the scenarios