1IEE – Introduction to Energy Engineering

Climate Change Topic
UK Energy options for the future

The UK is currently at a crossroads in terms of energy production. Between now and 2020 all the current major electrical power generating stations which use oil will have closed, all except 3 of the UK nuclear power stations will have stopped production and, at most, 6 of the current major coal fired power stations will still be operating (DBERR 2007). At the same time the UK has committed itself to cut Carbon Dioxide (CO_2) emissions by 80% of the 1990 levels by 2050 (DECC 2013). As a result many new options for electricity generation are being considered as are many ways to reduce the seemingly ever increasing demand for electricity.

To illustrate the challenges you are provided with a spread sheet calculator of electricity production, Carbon dioxide emission and relative cost. Your task is to explore first how easy it is to balance electricity supply and demand (remember we cannot store electricity, we have to generate what we need when we need it) whilst meeting our carbon (80% reduction by 2050) and renewable energy (30% contribution by 2020) targets and not making electricity more expensive for consumers. Once you have a solution then you can research how practical that solution is for the UK to implement both technically and in terms of public opinion.

Task 1 (individual) – Use the Electricity Calculator spread sheet to consider the flowing four scenarios for 2025 and make a note of the results in each case.

- Set the input values (orange boxes) to the current production in the UK

Coal	Gas	Nuclear	Hydro	Wind	Other
137	73	60	1.8	7.1	28.6

All values are in terawatt-hours (TWh)

- Reduce fossil fuel usage to meet the carbon target, increasing nuclear to meet electricity demand whilst keeping renewable sources at around current levels.
- Reduce fossil fuel usage to meet the carbon target, increasing renewable energy to meet electricity demand and minimising nuclear use.
- Now try removing fossil fuels completely and using either nuclear or renewable sources to meet electricity demand.

Although very appealing from an environmental point of view, why might a completely "renewable" electricity supply cause problems?

Task 2 (group) – Now each team is going to look at one aspect of the Electricity Calculator spread sheet and how new technology or other practical issues will change the results it gives.

Next week your team (either all together or one/two nominated speakers) will be expected to present your findings for Task 2. You will have 5 minutes to briefly explain the aspect of the problem you have looked at and how you think it will impact on the future UK electricity supply. At the end of all the presentations we will look at how these all fit together as an illustration of what might happen by 2025.

Remember to be realistic in your recommendations. Think about how practical your proposed methods are. Is it an untried theory that needs time for development or a proven technology which is in use somewhere? How long will development take and what are the chances it will/won't work? How long will it take to build working

commercial facilities (not just experimental ones) based on the idea? Where in the UK will they go? Will there be delays in getting permission to build them? You will need to make estimates where there is no detailed information available. Remember to make upper and lower estimates to quantify the uncertainty in your recommendations.

Red Teams
Fossil fuels (Coal, Oil and Gas) are criticised because they are a non-renewable source of energy. However, they are an extremely important part of UK electricity production. Investigate how efficient coal and gas fired power-stations actually are, that is how many Watts of power are used to produce each Watt of electrical power at a typical domestic socket. Find out whether they can be made more efficient by using new technology. Quantify, estimating if necessary, the efficiency improvements that could be made by 2025 using this new technology and how much more electricity that would provide per tonne of carbon dioxide being produced. Use this to recommend how much you think fossil fuels can contribute to UK energy production in 2025 whilst meeting the CO_2 target of a 53% reduction from 1990 levels.

Team 1 – try to maximise your recommendation by investigating new technologies
Team 2 – considering the public opposition to new coal fired stations (e.g. Kingsnorth) consider what would be the minimum contribution you would recommend

Orange Teams
Fossil fuels (Coal, Oil and Gas) are criticised because their use produces a large amount of the CO_2 emitted every year in the UK. However, they are an extremely important part of UK electricity production. Recently the idea of "capturing" the CO_2 emitted when fossil fuels are burnt has been proposed (UKERC 2012). Investigate whether this technology could help to reduce CO_2 emissions before 2025. Is carbon capturing a realistic prospect or an impractical idea at present? Could it be used on existing stations or only on new stations? How much could it contribute to reducing CO_2 emissions from coal and gas fired power-stations by 2025? Use this to recommend how much you think fossil fuels can contribute to UK energy production in 2025.

Carbon Capture and Storage (CCS) can be used on the Electricity Calculator spread sheet by choosing "Yes" under "Install CCS?".

Team 1 – consider the realistic maximum contribution that fossil fuels could make if carbon capture were implemented
Team 2 – given the difficulties of implementing new technologies such as carbon capture what would be the realistic minimum you would recommend

Yellow Teams
Nuclear energy has been out of favour in the UK for some time and no new nuclear power stations have been started since 1980. However, the growing concern about carbon emissions has highlighted that nuclear power produces significantly less CO_2 than fossil fuel generated electricity and is therefore a potential way for the UK to generate sufficient energy using existing technology and meet carbon emission targets. To meet UK energy demand in 2025 using only nuclear power would mean building around 40 new stations and the public opposition to the building of new nuclear stations is considerable. In the past this has restricted new development to sites with existing nuclear stations but new technology might mean stations can produce more electricity and therefore fewer are required. With these ideas in mind investigate the number and size of new nuclear stations that it might realistically be possible to have running in the UK by 2025 (which means considering the time it might take to get permission and to build the stations as well as where they will go). Use this to

recommend what contribution they might realistically make to UK energy production in 2025.

Team 1 – consider the maximum realistic contribution that nuclear power could make in 2025 if it was strongly supported by the government
Team 2 – make a recommendation about the minimum level of nuclear power we could realistically expect to see in 2025. Can the UK go "nuclear free" like Germany?

Green Teams
Wind Energy is currently the highest profile renewable energy source with large new "wind-farms" being built. However, public opposition to new large scale facilities appears to be growing and sufficiently windy locations are becoming fewer. Investigate whether the growth in wind energy can continue and where the new wind turbines might go. Use this to recommend what contribution they might realistically make to UK energy production in 2025.

Team 1 – consider the maximum realistic contribution that wind farms could make in 2025 if they were strongly supported by the government
Team 2 – given the current economic crisis and practical difficulties of getting recent wind farms up and running what is the minimum level of wind power we could see in 2025?

Blue Teams
Renewable Energy doesn't just mean wind turbines. Unlike many mountainous areas the UK cannot supply its energy needs from traditional river based hydro-electricity but there are suggestions about wave, tidal and solar power. Some of these options have been experimented with or used in other countries. Investigate which, if any, of these technologies could realistically make a contribution to UK energy production by 2020. Use this to recommend what contribution they might realistically make to UK energy production in 2020.

Team 1 – Consider the use of solar power (both big power stations and small scale solar panels) and recommend how much it might contribute to UK electricity by 2025
Team 2 – Consider the Severn Barrage project (tidal power) and how much it might contribute to UK electricity by 2025

Violet Teams
A great deal of emphasis is placed on new "environmentally friendly" methods of producing electricity but UK demand is set to rise by over 6% before 2025. This reflects our increasing demand for new technology, changing lifestyles and changes in our wider environment. For example the recent series of hot summers is increasing the demand for air conditioning in the UK and the cold winters encourage further heating capacity to be installed. Investigate whether anything can be done to help slow this rising demand or even reduce it? Would the cost of such measures actually be less than producing more electricity? Can such measures realistically only be applied to new buildings? Use this to recommend what contribution such steps might realistically make to UK energy demand in 2025.

Team 1 – Consider how much change a big campaign of efficiency saving might be able to contribute in reducing demand for electricity in 2025
Team 2 – As people have to pay more for electricity and appliances become more efficient anyway, consider how much demand will change by 2025 without a "big campaign" for changing lifestyle

White Team

You will consider the policies and proposals which the UK government (both the previous Labour government and the current coalition government) are using to plan for future UK electricity needs in practice. In particular look at the following:

- Does the government see a future in which one fuel provides the majority of electricity in the UK (like in France) or a mixture? Why?
- What is a "feed-in tariff" and how is it meant to change electricity production?
- What is the "Renewables Obligation" and how is it meant to change electricity production?
- What is "CHP" and is it any "greener" than a traditional power station?

References

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