nationalgrid

Our energy insights

Residential air–conditioners; giving them the third degree

In our Future Energy Scenarios[1] (FES), Consumer Power indicates that there will be a substantial rise in the number of air-conditioners in our homes. Around 20 million residential units would be installed by 2050 up from 0.3 million units today.

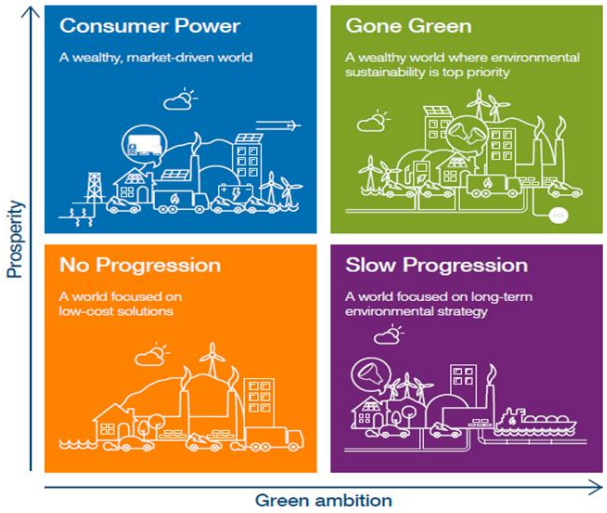
In a Consumer Power world, climate change means temperatures will have risen by nearly 3ºC, making air-conditioning much more desirable than today.

This level of deployment means that at least an extra 19 GW of electricity will be required during their peak usage times, on hot summer days, in the later afternoon. That is the equivalent power output of six Hinkley Point C power stations.

What is Consumer Power?

Our FES scenarios (see Figure 1) consider four credible and plausible energy pathways to 2050. **Consumer Power** is a world where society is enjoying the benefits of high prosperity but without too much regard for the environmental consequences of its actions. People will be looking for new and exciting products that will enhance their lifestyle and comfort.

Figure 1 National Grid's Future Energy Scenarios



One of the products we expect to increase significantly is air conditioners. They are common in offices, shops and cars, but it is still rare to have one in your home in the UK. This will change in a **Consumer Power** world. We believe that there could be a 60% adoption rate by 2050; Figure 2 illustrates our predicted take-up of residential air conditioners. We have assumed a relatively slow initial take up, which then rapidly increases towards 2050 as temperatures increase. Of course the rate at which technology is adopted is uncertain and 60% could be reached sooner if conditions are favourable.

[1] http://fes.nationalgrid.com

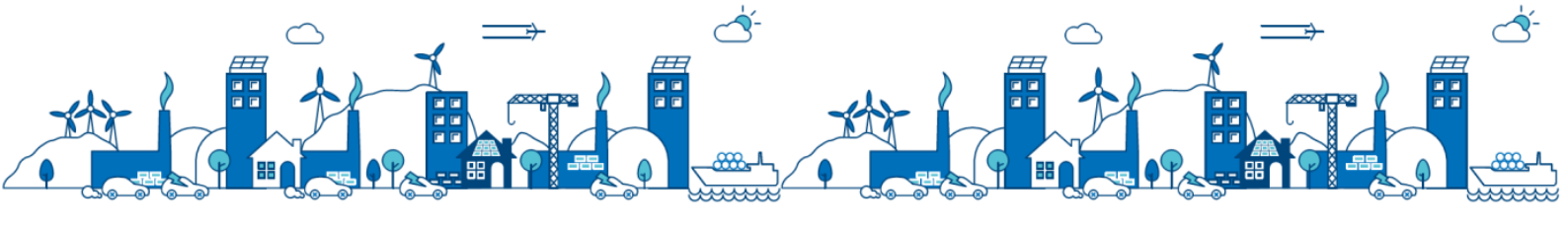
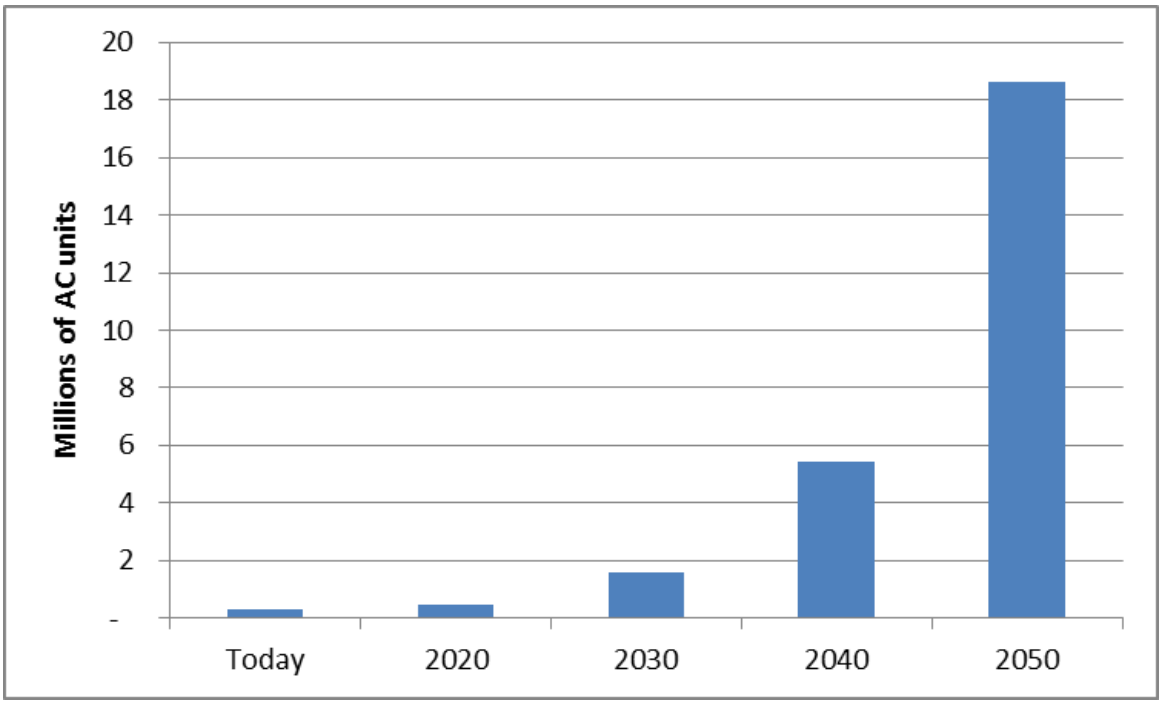


Figure 2 Number of residential air-conditioners in Consumer Power



In what way can we expect the temperature to change?

It is not that people want air conditioners just for the sake of having them – although some might. In this less environmentally conscious world it is likely that the aims of the Paris Agreement[2] on climate change will be breached. That is, we will not be able to keep a global temperature rise this century, "well below two degrees Celsius above pre-industrial levels".

The UK Climate Projections[3] model allows us to generate a potential temperature rise for the period covering the 2050s. Using the Medium High Emissions scenarios the model indicates that it is as likely as not that there will be a 2.8°C rise in temperature. Such a rise would give the UK the same average annual temperature as Turkey today. The Committee on Climate Change[4] is of a similar view and it recently stated that "heatwaves in the UK like that experienced in 2003 are expected to become the norm in summer by the 2040s".

In 2003 there were, in places, ten consecutive days where the temperature was above 30°C and some places reached 38°C[5]. More recently June 2017 was the hottest since 1976's famous heat wave, with five consecutive days of temperatures above 30°C and temperatures peaking at 34.5°C.

More air-conditioners and warmer weather; so what?

With warmer weather and a more affluent, but less environmentally conscious society the rise of air-conditioners is inevitable in a **Consumer Power** world. Today their annual demand is 0.1 TWh. We believe that the annual demand in 2050 will be 11 TWh. This will make up about 2.5% of the total annual electricity demand.

However, air-conditioners are not used all year and not even all day in hot weather. There is a sizeable increase in demand when the temperature rises above 22°C.

What are significant are the peak days and the peak time within those days. It is possible that

[2] http://unfccc.int/paris_agreement/items/9485.php
[3] http://ukclimateprojections.metoffice.gov.uk/21684
[4] https://www.theccc.org.uk/wp-content/uploads/2016/07/UK-CCRA-2017-Synthesis-Report-Committee-on-Climate-Change.pdf

[5] http://www.metoffice.gov.uk/climate/uk/interesting/aug03maxtemps.html & http://www.metoffice.gov.uk/climate/uk/interesting/hot-spell-june-2017

these peak days may account for only 20 days in a year – but the system must have the ability to cater for them.

Residential air-conditioners are used more over weekends than weekdays. So their peak days are more likely to be either Saturday, Sunday or holidays. **Error! Reference source not found.** 3 illustrates the potential range of increase that air-conditioners in 2050 could make to a current August weekend's demand profile.

The range, in the shaded red area, is caused by the number of units that we think may actually be consuming energy, as they will not all be on at once. We have assumed a lower limit of about 40% operating and an upper limit of about 75%.

In the lower case there is a maximum demand, at 5:30 PM, of 53 GW. This is likely to be caused by a build-up of heat which reaches its highest point at this time of day. This 53 GW is a sizeable increase on today's typical August profile of 19 GW. At the highest extreme, this profile could achieve 73 GW with 39 GW coming from air-conditioners. Putting these into today's context; the current end user peak day demand is 61 GW at 5:30 PM – but on a winter's day. It is, however, below the 2050 winter peak demand of 85 GW.

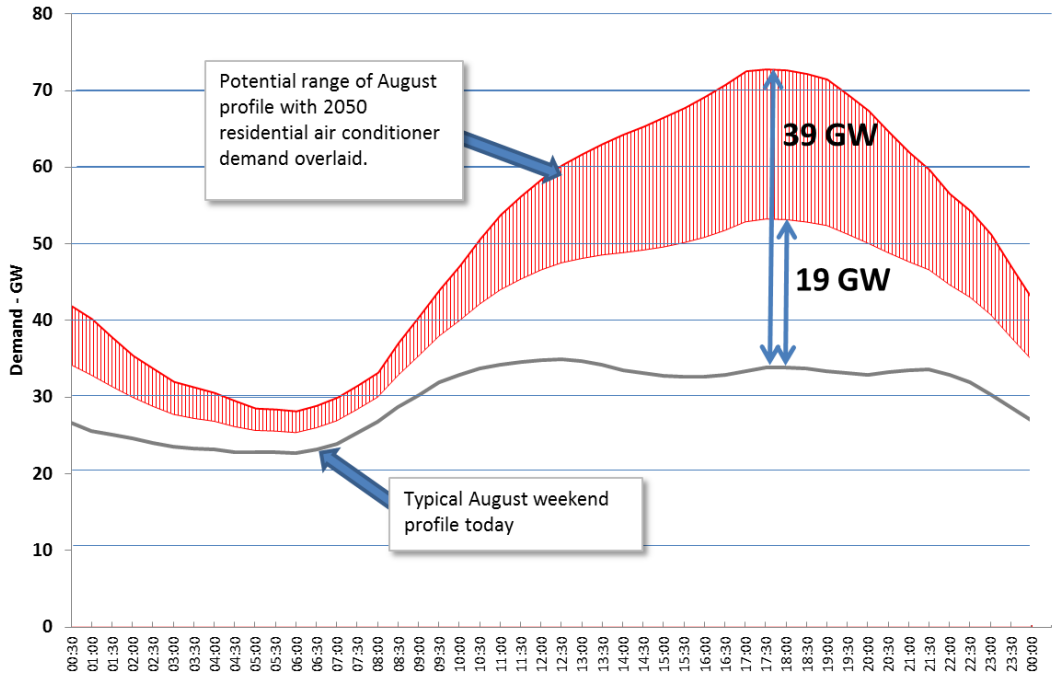
This amount of generation will be available, in a **Consumer Power** world, as it is required to meet the winter peak. As this is a summer's day there will be 15 GW of solar PV generation available. This would contribute significantly to the 19 GW required for the lower end of the range, but only partially address meeting the need for 39 GW at the upper range of the projection.

Even though 15 GW is a significant amount of generation, it is considerably less than the 44 GW of solar capacity in **Consume Power.** This is due to the different peak times of solar generation at 1 PM and air-conditioning demand at 5:30 PM. These misaligned peaks cause a 12 hour period of increasing demand from 7:00 AM to 7:00 PM, this increase is comparable to the change in demand which is managed by the System Operator toady. Of course, by 2050 the generation mix will be very different, with increased intermittent renewables making this more challenging. However, there will be large volumes of batteries in a **Consumer Power** world, which will help the intraday supply and demand balance.

Are there other implications?

Summer time is currently regarded as the low demand period and therefore more suitable for carrying out power station or network maintenance work. However, in this future scenario, summer demand is approaching that of our current winter demands. This will have an impact on the operational maintenance of the generators and the network in general. How and when it is undertaken whilst minimising the impact to the consumer may have to be reconsidered. To shift maintenance to

Figure 3 Number of residential air-conditioners in Consumer Power



other wetter, colder and windier seasons introduces challenges will not be ideal so new ways of working may be required.

Can we decrease the need for air-conditioners?

Assuming that the temperature increase is a given in this scenario, then the mass adoption of air-conditioners is not the only solution to the problem and there are some potential mitigations.

Currently, and in the recent past, substantial efforts have been placed on the building sector to increase the heat retention capabilities of the modern housing stock. This has been partly driven by housing regulations.

Consideration could be given to introducing building regulations which mitigate some of the effects of excess heat. These could include requirements for improved ventilation of buildings, solar reflective walls and rooftops, and optimising open space planning. Such changes would be particularly important in high density residential areas where the effects will be felt the most – the so called urban heat islands.

What about the rest of the weather…

Although they are not the focus of this article there are other areas where climate change may have effects on the energy system. One is the consequence of a decrease in cloud cover. Once again using the UK Climate Projection model, a cloud reduction would cause an increase in the amount of solar power generation by about 8%. The FES **Consumer Power** solar generation value of 15 GW does not include an allowance for any cloud reduction. So, at the maximum air-conditioner usage time, in August at 17:30, there would be an additional 1 GW of electricity generation.

In conclusion

A substantial rise in summer time demand is likely within our **Consumer Power** scenario where society is driven by consumerism with less regard to the environmental impact. Within this scenario we foresee that a temperature increase of almost 3^{o}C is likely. This would result in a significant uptake in domestic air-conditioners which will cause a summer demand of 53 GW to 73 GW.

This range will still be inside **Consumer Power's** annual peak demand of 85 GW - so security of supply is not at risk. The major effect is the GB electricity system moving to a "double peak" system with both a winter and summer peak. As essential routine maintenance is usually scheduled during the summer period, innovative ways of undertaking maintenance may well be needed in this world of more regular high electricity demand.

If you have any questions or comments we would like to hear from you.

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