System Operability Framework

nationalgrid

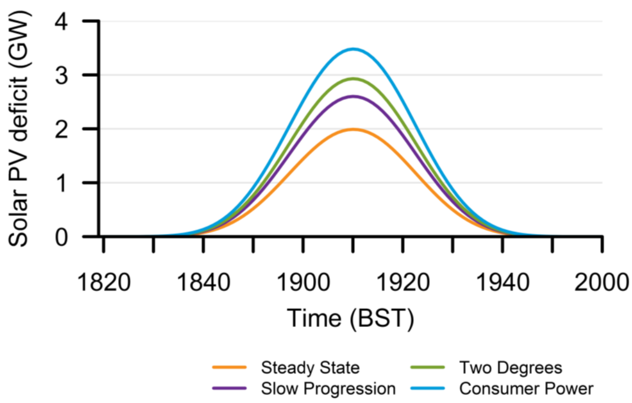
# Solar Eclipse August 2026

**The UK's next significant solar eclipse will be in August 2026. By that time, we expect installed capacity of solar photovoltaic (PV) generation will be in the range of 15 GW to 26 GW, according to the 2017 Future Energy Scenarios. Despite this huge growth, the disruption of normal demand patterns and solar PV output during the eclipse will remain manageable, with careful planning and coordination between system users and operators of interconnected systems.**

## Executive Summary

The eclipse will occur on 12 August 2026 at about 19:10 BST (18:10 GMT/UTC). Assuming a clear sky, the maximum generation deficit from solar PV could be in the range of 2-3.5 GW at the peak of the eclipse, see Figure 1. The reduction and recovery of solar PV generation would occur over about 60 minutes in total, at rates between to -230 MW/minute and +125 MW/minute, respectively.

**Figure 1:** Solar PV generation deficit during the eclipse

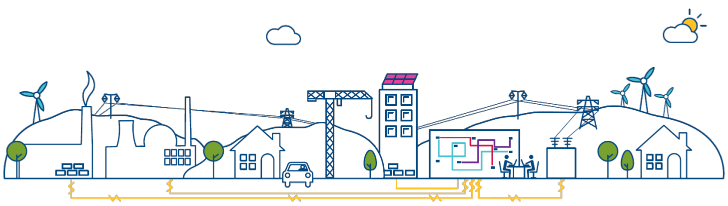


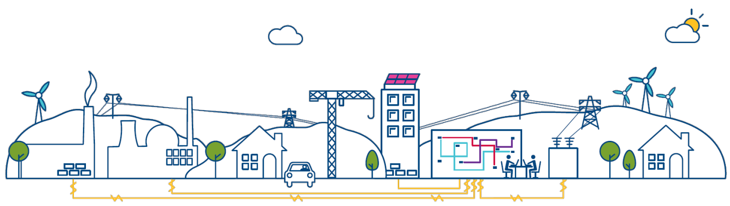

The balance between electricity supply and demand will be modified by factors other than the output of solar PV generation. These include the changes in demand that will occur up to an hour either side of the eclipse, as people modify their normal routines to observe the event. The effect of a large portion of the population doing this in unison will have a significant impact on system operation. In this assessment we use observations from a real demand 'pick-up' event and demonstrate how it will work to reduce the impact of the loss of solar PV generation.

We merge models of available solar radiation and the progression of the moon's shadow on the earth's surface with solar power output profiles and typical demand patterns. We use these models to investigate how demand on the transmission system might vary during the event. These show that with sufficient planning, including coordination with system users and the operators of interconnected power systems, this event will remain within the capability of the system operator.

We are also able to identify some questions that will need to be addressed during the operational planning that will occur closer to the event. These include:

- How will the eclipse affect the power systems in Ireland and continental Europe, to which GB will have an increased interconnection capacity?
- How will distributed storage assets behave during the event?
- What information about distributed energy resources will the system operator have access to during planning and operational timescales?

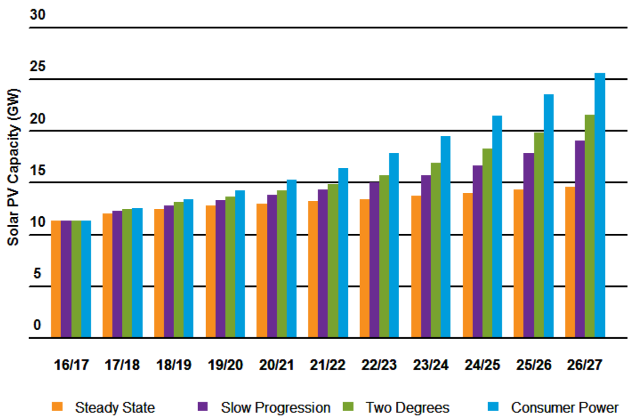




# Background

Solar PV generation capacity will continue to grow over the next ten years. The 2017 Future Energy Scenarios show that by 2026, the installed capacity could rise to between 14.6 GW and 25.6 GW, Figure 2. This is an increase from approximately 12 GW today.

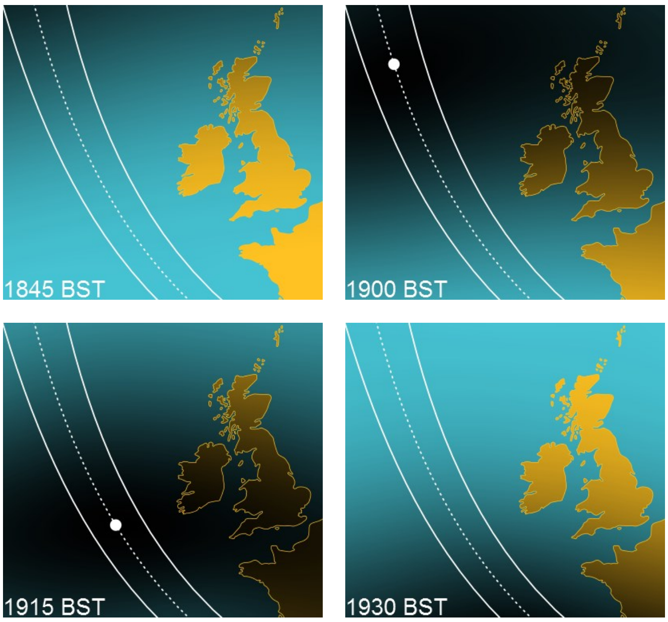
**Figure 2:** Growth in solar PV capacity




The most recent solar eclipse visible from the UK was in March 2015. It was the first to occur with a significant capacity of solar PV generation, approximately 6 GW. The sun was obscured by between 98% in north Scotland and 82% in south-east England. The effect of the eclipse was reduced by thick cloud that covered the country, which meant that it was relatively dull before the eclipse started. As a result, the deficit in generation from solar PV was minimal.

Experience from solar eclipses in March 2015 and August 1999, has shown that the effect on power demand of people simultaneously breaking their routines to observe the eclipse will be an important factor to consider.

**Figure 3:** Path of the 2026 total solar eclipse and extent of its shadow




The path of the August 2026 eclipse passes north to south, down the Atlantic coasts of the UK and Ireland. Figure 3 shows the path of the total eclipse and a projection of the eclipse shadow.

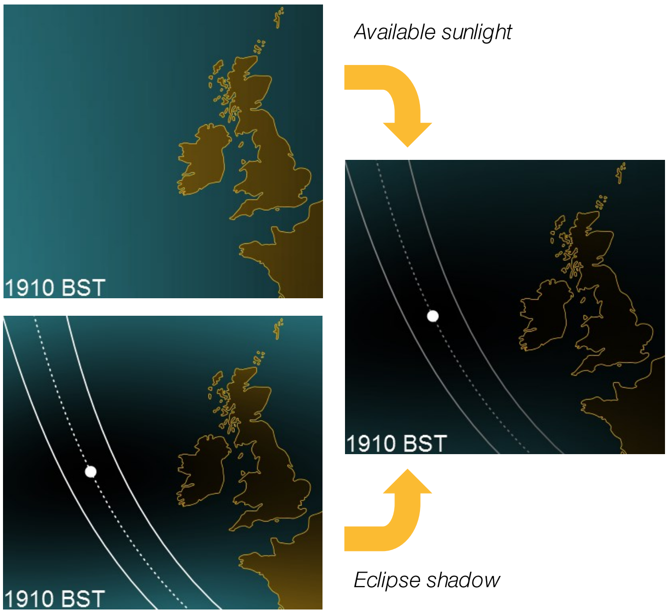
# Method

In order to analyse the effects of the eclipse on the GB power system, we use a model with three layers:

1. Available solar radiation
2. Eclipse shadow
3. Solar PV capacity

The top layer contains observed solar radiance at the top of the atmosphere for the appropriate time of year [1]. This removes variances caused by atmospheric conditions. The second contains the positions and opacity of the eclipse shadow, interpolated in time and space from calculations by NASA [2] and the UK Hydrographic Office [3]. Combining the top two layers gives the available radiation, Figure 4, for the underlying solar PV capacity in the third layer.

**Figure 4:** Combining the top two layers of the eclipse model



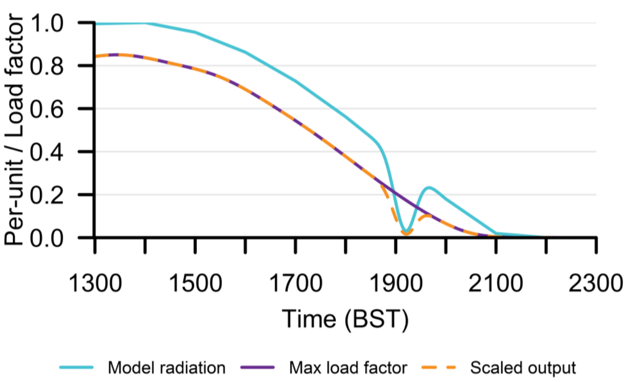

The bottom layer of the model, shown in Figure 5, contains the geographic distribution of existing solar PV generation capacity. This is derived from the public databases for subsidy schemes such as the Feed-In Tariff and Renewables Obligation [4&5]. The model assumes that the majority of new solar PV capacity, from a national perspective, will be deployed in similar areas as existing capacity. This allows the capacity in this layer to be scaled to the capacities of future years from the 2017 Future Energy Scenarios.

**Figure 5:** Geographic distribution of existing solar PV capacity

The three-layer model calculates the available solar radiation and how much of that is captured by the geographic distribution of solar panels. The output of the three-layer model is therefore transformed from a normalised profile of the radiation collected by the solar panels into a power or load factor for the whole population of solar PV capacity.

The effect of this is to limit the maximum load factor to approximately 85%, as shown in Figure 6. Note that this load factor will tend to increase in the future as it becomes more common to install greater generation capacity behind the converter and connection point to the network than their rating. This practice, which is done to maximise the utility of converter and of the site's connection capacity, has the effect of extending the duration of maximum output, as well as increasing output for the rest of the day. Its effect on visibility and control to the system operator was discussed in SOF 2016 [6].

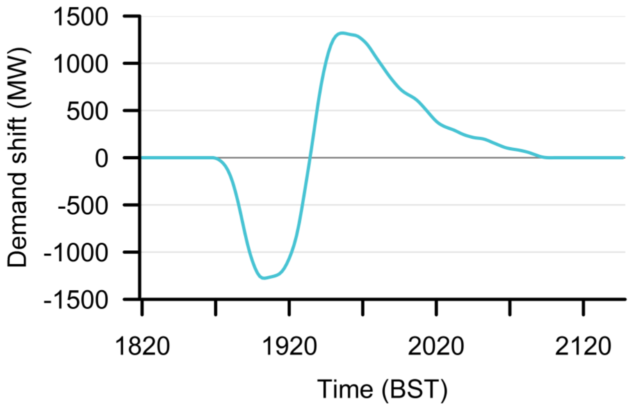
**Figure 6:** Available radiation scaled by a maximal solar PV power profile




To investigate the effect of the coordination of behaviours on power demand, we consider a large TV pick-up; specifically from the Royal Wedding in 2011.

Figure 7 shows this event shifted to align with the time of the 2026 eclipse. It shows how demand is supressed as people stop their normal routines to congregate and watch the event. As it finishes, people start to go back to what they were doing before, but a large proportion of them will also boil kettles to make tea, open fridge doors or flush toilets (causing water companies to have to pump large quantities of water). These simultaneous actions cause a large increase or 'pick-up' in demand; in this case approximately 2.6 GW over 30 minutes, at a maximum rate of 260 MW/minute.

**Figure 7:** Example demand variation before and after a 'pick-up'

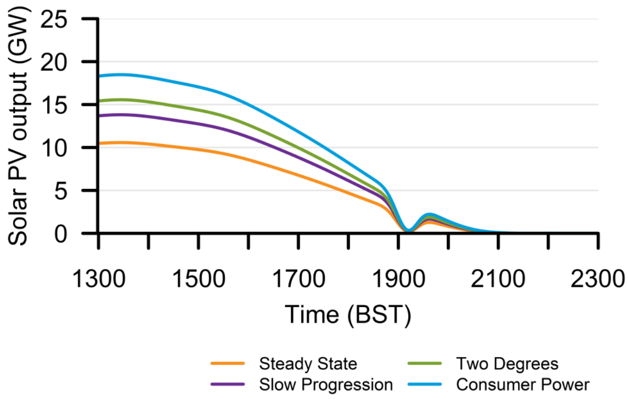



To manage such as fast increase in demand, the system operator takes a variety of actions such as ensuring that multiple gas-fired power stations are ready to increase output at short notice and holding hydro pumped storage generators on standby.

# Analysis

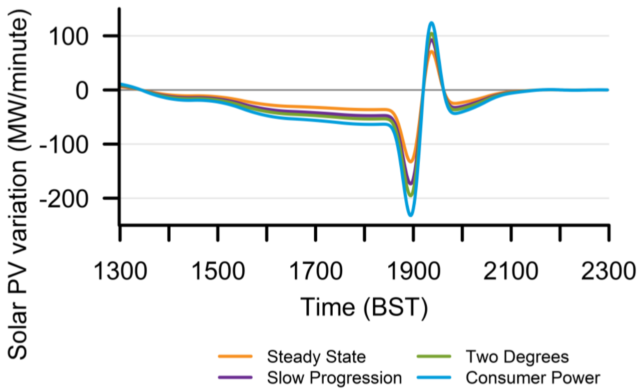
The model produces the power output from the solar PV generation capacities in each of the Future Energy Scenarios, Figure 8. The deficit during the eclipse is shown in Figure 1.

**Figure 8:** Maximum solar PV generation profile on 12 August 2026



In addition to the magnitude of the generation deficit, the speed of the variation of output is a potential risk. Figure 9, shows that in the scenario with the greatest solar PV capacity, Consumer Power, the variation rate of solar PV generation reaches extremes of -230 MW/minute before the eclipse peak and +130 MW/minute after it. While these values are greater than those experienced on a typical day, there are not greater than those during other historic events.

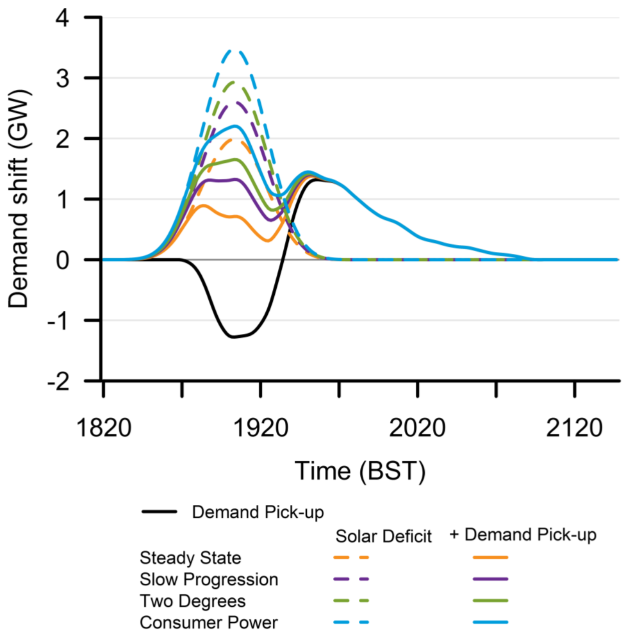
**Figure 9:** Variation of solar PV generation profile




The 2017 Future Energy Scenarios include approximately 3 GW of new non-domestic storage capacity in all scenarios, in addition to existing highly-flexible energy resources, such as pumped storage hydro and interconnectors. Storage technologies and interconnectors generally have the technical capability to vary their input or output quickly. If their dynamic capabilities are available to the system operator, through aggregators or by other means, the flexibility of the whole system can be greatly enhanced.

All solar PV generation is presently connected to the distribution networks and does not participate in the Balancing Mechanism. This will generally continue for new installations because each is small enough not to be required to do otherwise. A reduction in output from solar PV generation therefore appears to the system operator as an increase in transmission demand. Transmission demand is effectively the power transfer from the transmission network to the distribution networks. Figure 10 shows how this apparent increase in demand combines with the variation of underlying demand caused by human behaviour. The two dynamics counteract each other to reduce the magnitude and speed of demand variation throughout the eclipse.

**Figure 10:** Apparent increase in transmission demand during eclipse




# Conclusions

As the mix of generation changes over time, so will the spectrum of risks to the safe, reliable and efficient operation of the power system. The system operator has a responsibility to assess how these risks might change and will lead the industry to prepare appropriately. As the capacity of solar PV generation increases, so does the risk of disruption to the power system in the event of rare events such as a significant solar eclipse.

We have assessed the challenges that will be presented by the solar eclipse in 2026 and found that they will be within the range of historic events. With careful planning and strategic coordination, with power system users and the operators of interconnected power systems, this event will remain manageable through normal planning processes.

Over the coming years, we will monitor how similar events impact other power systems and learn from system operators around the world. The next total eclipse is due to traverse the USA on 21 August 2017. In particular, this event will include a partial eclipse over California, causing an increase in net load (transmission demand) from 17.5 GW up to 23.5 GW [7].

We will also monitor developments of distributed energy resources, particularly solar PV and storage. We will continue to work with the industry to ensure that appropriate information and control schemes are available to system operator to ensure the safe, reliable and efficient operation of the power system.

# Limitations

The intent of this preliminary study is to assess the magnitude of the impact on power supply that a solar eclipse would have when solar PV generation capacity has grown to up to 26 GW. It further tests how a large demand pick-up profile could combine with the drop in supply. Overall, this study will inform how soon more detailed planning will be necessary.

The next most significant variable, and the first not to be included in this study, is lighting demand. In 2015 there was approximately 1 GW of lighting demand, some of this is automatically controlled, such as street lighting. The demand evolved over 45 minutes in advance of the eclipse peak, but took twice as long to be turned off afterwards. In 2026 it is likely that the majority of lighting will remain on after the eclipse because it will be dusk.

During the 2015 eclipse we witnessed a small reduction (approx. 300 MW) in the output of distributed wind generation output, due to the reduction of solar energy into local weather systems. There will be a larger capacity of wind generation subject to this effect in 2026, but its relative significance could be reduced because of the time of day. This 'wind effect' is not included in this study.

Interconnector flows between GB and Ireland, and between GB and continental Europe are not included in the study. The solar PV capacity on the island of Ireland is presently forecast to be 370 MW [8], which is less than the interconnection capacity with GB (approximately 1000 MW), meaning that the effect on the GB system should be small. The impact of the eclipse on continental Europe and the potential consequences on GB interconnector flows will require further analysis.

The model neglects the complexities of atmospheric effects on the light spectrum and how the resultant spectrum is captured by solar panels. It doesn't explicitly take account of the diversity of the orientation of solar panels; their bearing and inclination. It assumes that the geographic distribution of solar PV generation in 2026 will not be significantly different to 2017.

Further modelling can address some of these limitations, but a large degree of uncertainty will remain. The largest source of uncertainty is how many people will observe the eclipse and how their power use will change as a result. Experience from the recent eclipses shows that this can be affected by everything from the intensity of media coverage to the weather conditions. After detailed planning, the remaining uncertainty will be managed by the system operator. This will include ensuring that it has access to the requisite resources to increase or decrease supply and demand in real-time.

# References

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