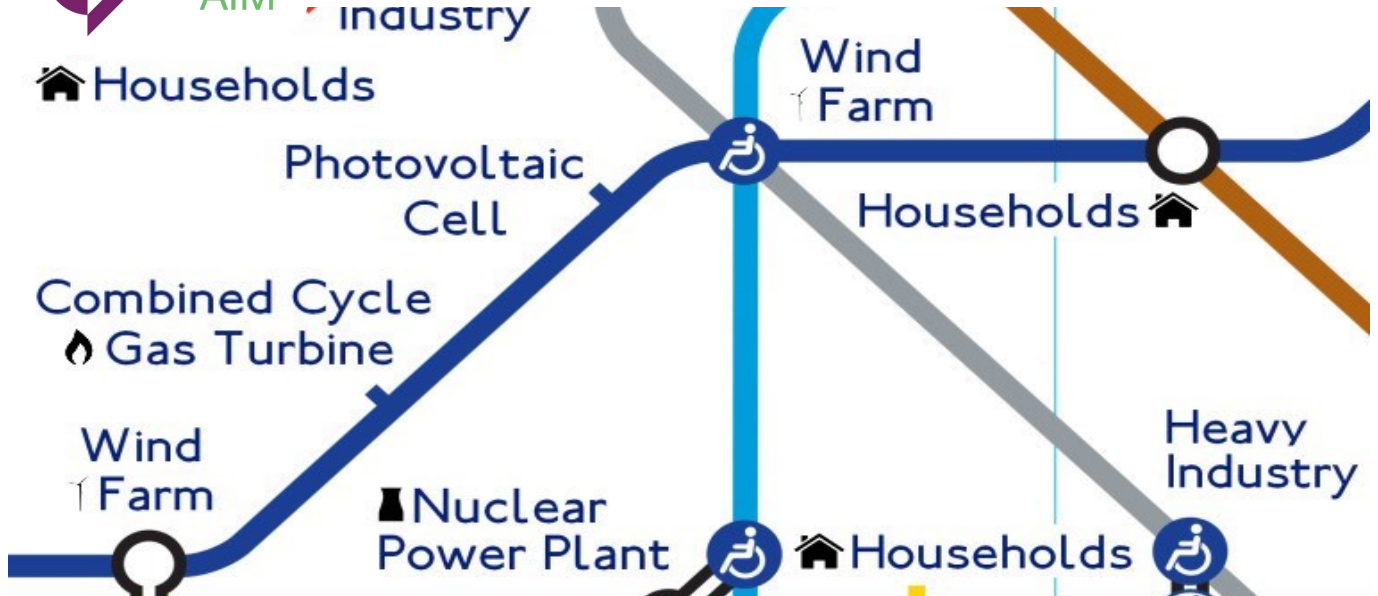




Industry

# Smith institute



## Keeping the lights on: robust design for decarbonised electricity systems

**TakeAIM Winner 2018:**  
Adriaan Hilbers

Department of Mathematics  
Imperial College London  
South Kensington  
Campus  
London SW7 2AZ

Imagine you run the electricity grid. One morning, contrary to all forecasts, the wind tails off. You frantically call up other power plants, begging them to make up the lost wind power. But a few minutes later it happens: blackouts!

Designing electricity systems robust to weather-based uncertainty is essential to avoid situations like this. With weather-dependent renewables such as wind power, this is difficult for two reasons. The first is uncertainty: we simply don't know the future wind levels. The second is that electricity systems are fiendishly complex. Think of them like the London Tube: complicated networks throughout which supply must match demand. This makes the effect of a new wind farm on the system as-a-whole difficult to estimate.

For this reason, decision-makers frequently employ computer models simulating a power system's operation given some demand and weather data. Determining which data to use is difficult; a grid with 10 wind farms requires windspeeds at 10 locations, each uncertain. My research uses probabilistic and data-reduction techniques to create "representative years" that encode all possible future weather in a concise dataset. Using this data allows models to evaluate the expected effect of a new wind farm and inform decisions in a complex and uncertain setting.

In the face of climate change, "greening up" electricity requires a complete restructuring of electricity systems from fossil fuels to renewables. Ensuring the correct decisions are made in this transition makes our energy future affordable and sustainable — while also keeping the lights on.

### Sponsors

The Smith Institute, enabled by the generous sponsorship of our leading corporate partners, ran the TakeAIM competition in 2018 to make visible the crucial role that mathematics will increasingly play in all aspects of our lives. The competition was open to undergraduate and postgraduate students working in the mathematical sciences. First prize was £1,250 of Apple vouchers, with nine runners-up each receiving £100 of Amazon vouchers.