

CASE STUDY - VRS 2018/19

RENEWABLE ENERGY STORAGE



Scott Carnie-Bronca (17 years)

Bachelor of Mathematical Sciences (Advanced) majoring in Applied Mathematics and Statistics, The University of Adelaide

Supervisor: Dr Giang Nguyen

A Markov-chain-based Investigation into Renewable Energy Storage in SA

When it is hot we put on cooling but what if we can't power it? Increasing temperatures and frequent heatwaves mean more South Australians turn on cooling, this puts pressure on the SA power grid. Energy storage is vital to maintaining a reliable renewable energy sourced power grid. During his Vacation Research Scholarship, Scott has been working on a project investigating the renewable energy generation quantity and storage required to support the South Australian power grid.

Crunching the Numbers

To model the amount of half-hourly energy transfer into or out of a battery, we first obtained data on electricity usage of South Australia and on power generation by the Broken Hill solar farm for the year of 2018, both from the Australian Energy Market Operator. The power generation was subsequently scaled up to different amounts, to investigate the amount of generation required. As both data sets have strong yearly cycles, a statistical technique called filtering was used to remove the seasonal variation from the random, short-term component.

We then fit time series models, a form of statistical model, to the short-term components of both usage and generation data. These models were used as input for a stochastic model called a Markov chain, which allowed for a simulation analysis of the random component. Together, the random short-term component and deterministic long-term trend represent the simulated net transfer into and out of a battery. Real-world effects such as battery capacity and degradation of charge were applied, to provide accurate simulations of a battery's charge throughout a year.

Quotes – Scott Carmie-Bronca

"My project, investigating a renewable energy grid for South Australia, is important for the community as energy storage is vital for maintaining an all-renewable grid due to the high variability in production."

"It has been very interesting working on a project through the VRS, as it has allowed me to experience mathematical research with other students interested in mathematics. The project also helped me decide to continue in research after university. I plan on continuing to work in the field of stochastic modelling, however probably not in the field of energy."

Quotes – Dr Giang Nguyen

"When it is hot we put on cooling but what if we can't power it? Increasing temperatures and frequent heatwaves mean more South Australians turn on cooling, this puts pressure on the SA power grid. Secure, affordable, and reliable energy is a crucial goal for Australia, and this goal requires sustained effort from many fronts. One of which is mathematical sciences, which can help provide insight into the complex problem and give supporting evidence for policymaking."

"Scott's work has used mathematics and real-life data to estimate the required amount of battery storage — much, much more than what we have right now — to achieve the ultimate goal of all-renewable energy grid."

"Energy storage is vital to maintaining a reliable renewable energy sourced power grid. During his Vacation Research Scholarship, Scott has been working on a project investigating the renewable energy generation quantity and storage required to support the South Australian power grid."