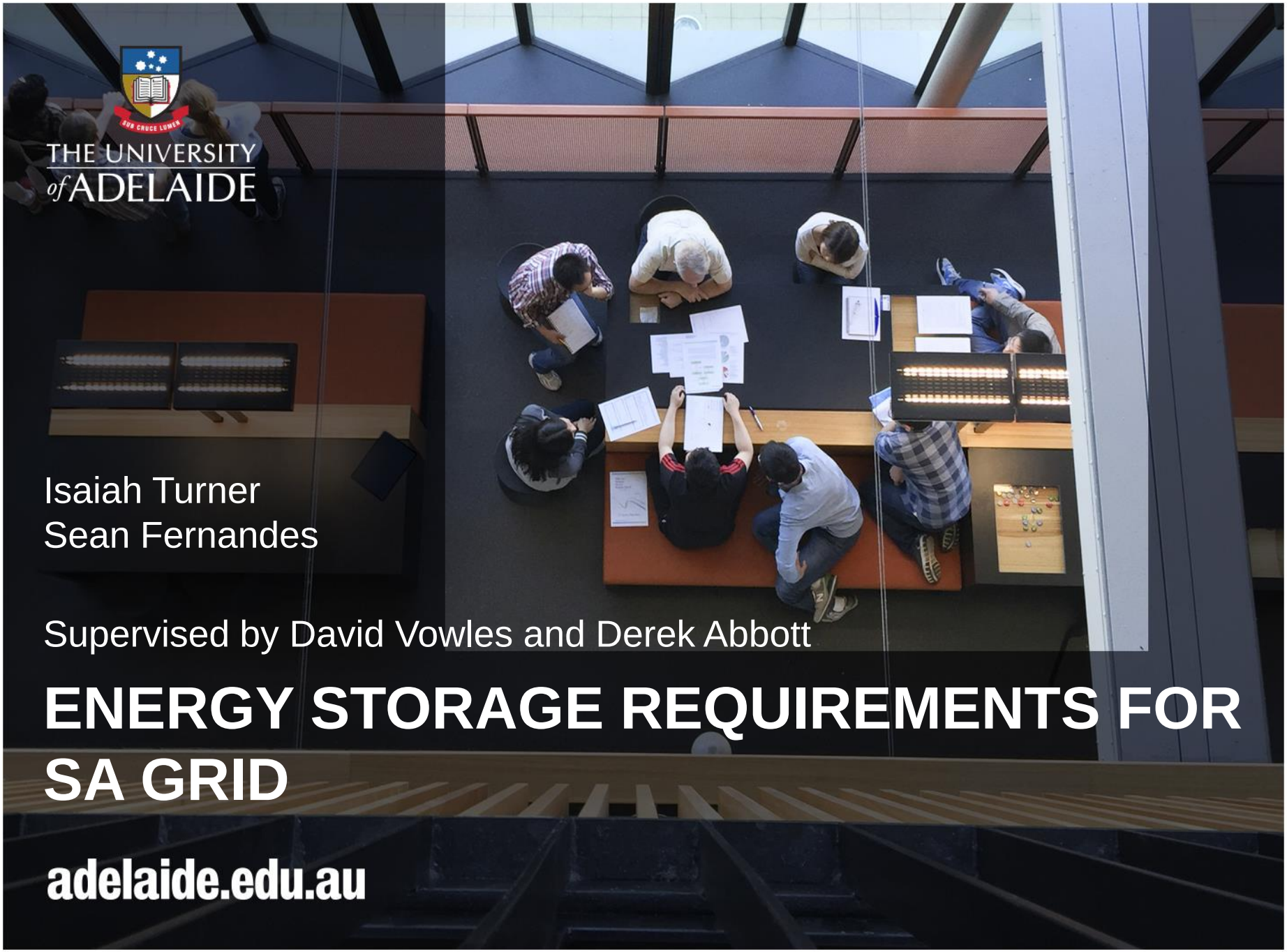

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ENERGY STORAGE REQUIREMENTS FOR SA GRID

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Outline

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- **Project Management**
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  - Milestone and Objectives
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- **References**

Introduction: Project Aim

- To investigate the energy storage requirements of the SA grid to ensure current high levels of reliability with high levels of intermittent renewable energy generation. This is achieved through an improved version of genetic algorithms.

Introduction: Background

- National Electricity Market generation fleet changing. **[1]**
  - Retiring coal fired generation for renewable energy.

- Government and community supports shift towards more renewable energy supply. **[1]**
  - Reduces environment and health problems.
  - Meet Renewable Energy Target scheme. **[2]**

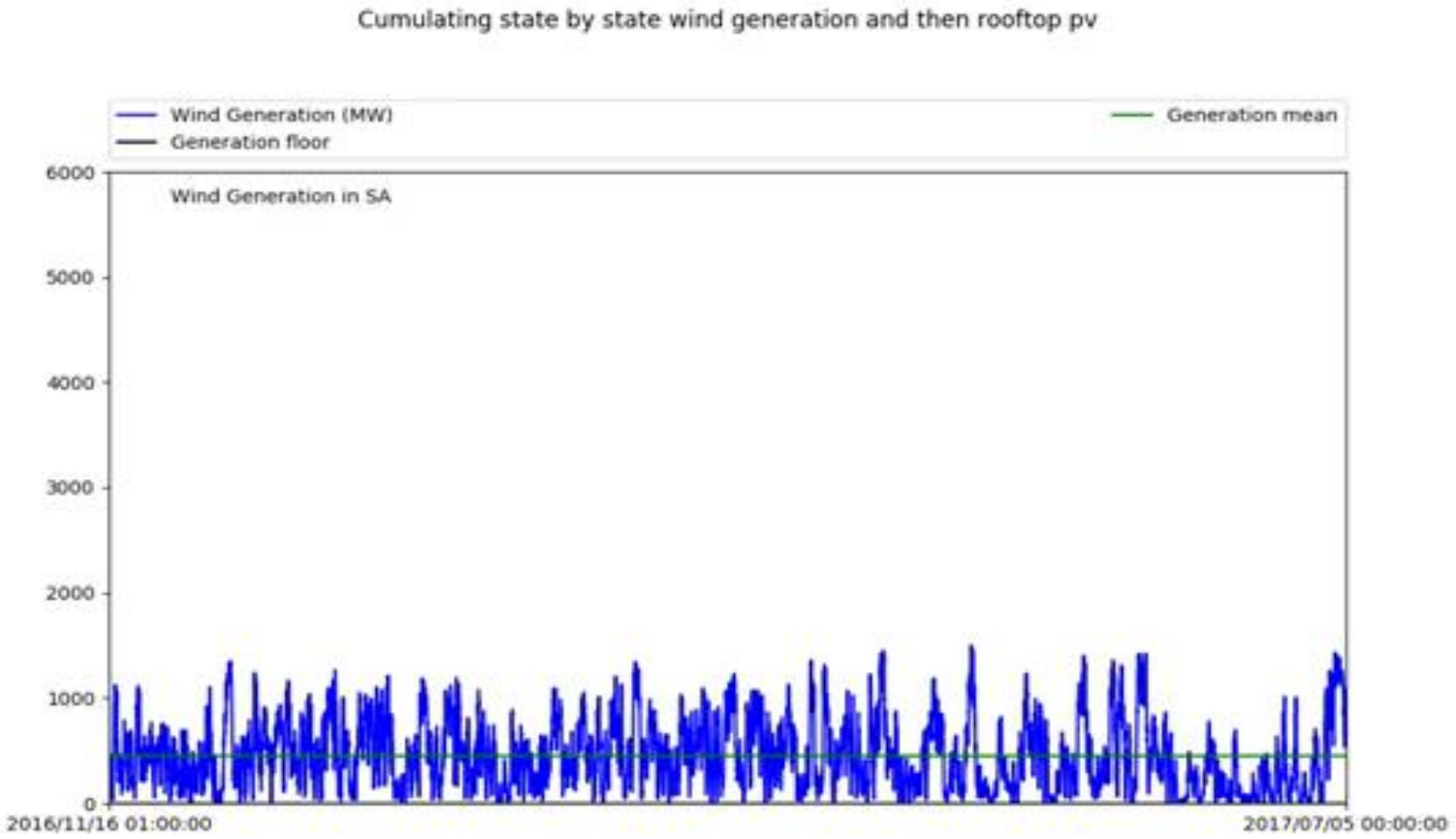
Coal generation

Renewable generation

Introduction: Motivation

- **<u>Issue:</u>** intermittent renewable power sources. **[3]**
  - Wind/Sun unavailability → No energy generation
- Dispatchability.
- Inability to control power supply.
  - Inability of supply meeting demand
  - Need storage to reduce controllable generation reliance

Australia's wind and solar generation (2017 Group) [4]

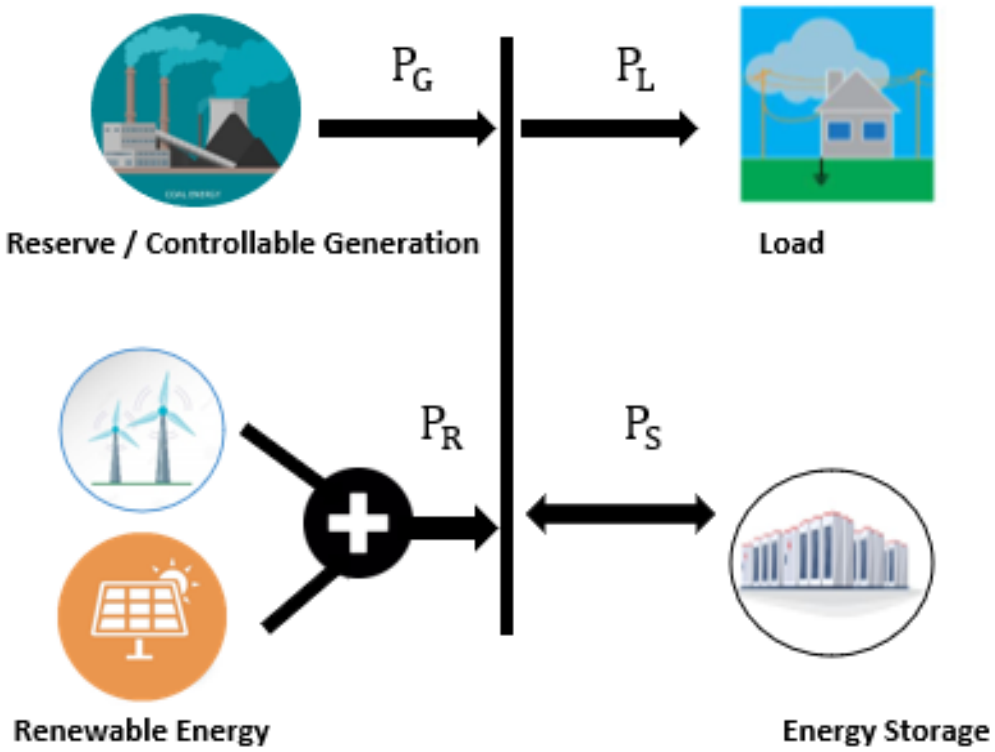


Introduction: Previous Studies 2018

- Use Batteries and Pumped Hydro to store energy.
  - Cultana Pumped Hydro Storage Project.
  - Snowy Mountain Hydro Project.

- Use Genetic algorithm to find near-optimal solution for given population to minimise controllable generation **[5]**
  - Used Tournament Selection
  - One Point Crossover
  - Mutation

Simple Model of SA Power Grid



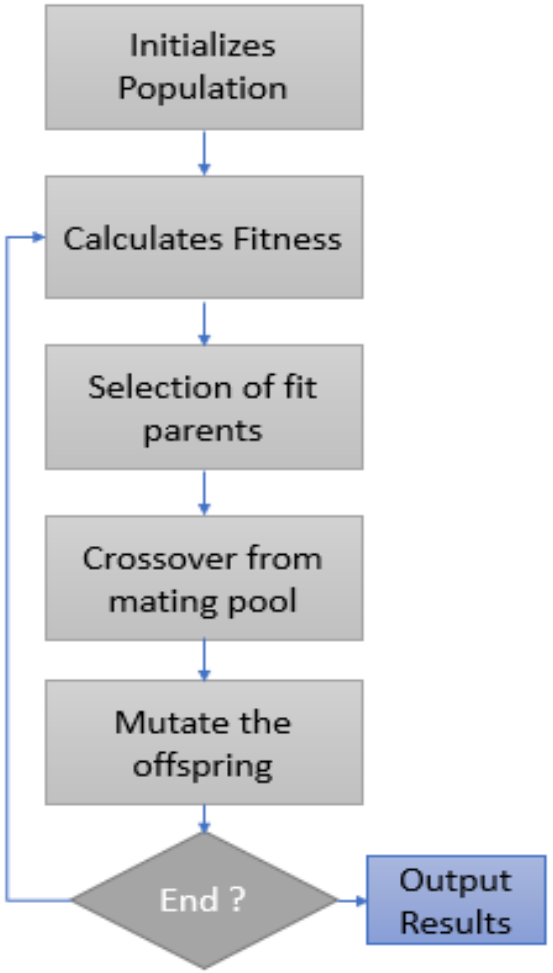
- Aim is to optimize the energy storage in order to reduce the reserve/controllable generation

$$P_G + P_R + P_S = P_L$$

Genetic Algorithms Explained

- Optimization technique based on natural selection **[6]**
  - Survival of the fittest
- Useful in dealing with intermittent renewable energy

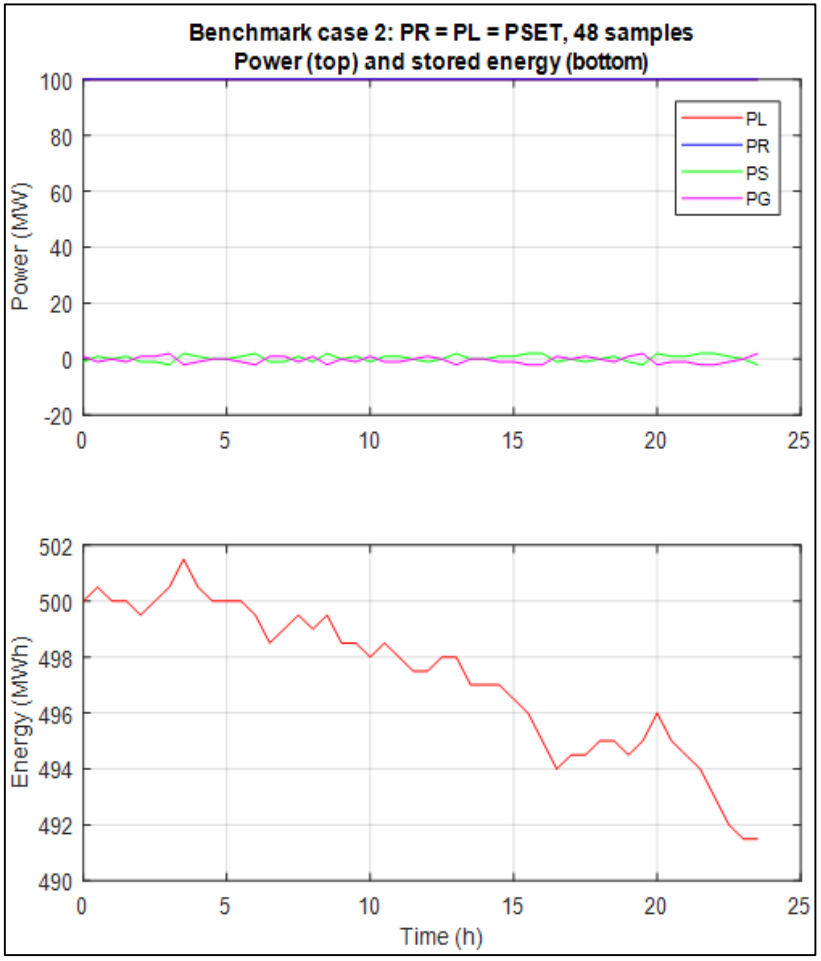
Can help to minimise reserve generation.



Short Term Objectives: Getting Benchmarks Working

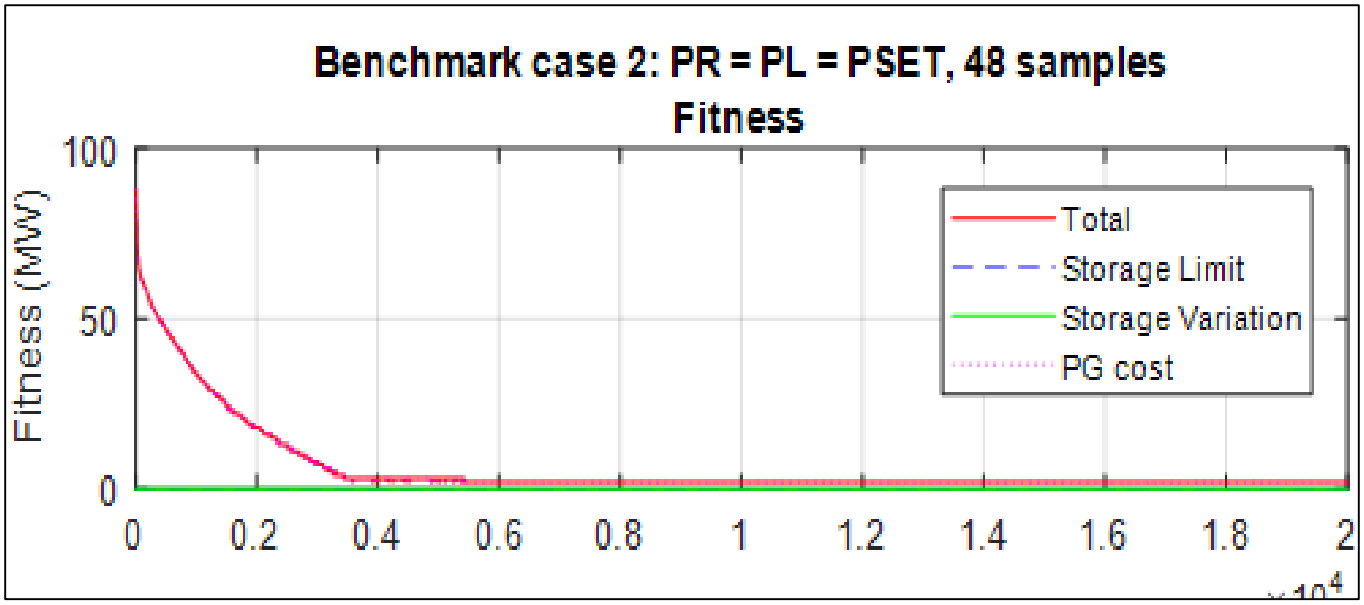
- Work on making sure model and genetic algorithm benchmarks are satisfied.
- Good Genetic Algorithm – Zero Fitness
- Bad Genetic Algorithm – Non zero Fitness and fitness reaching zero after large generations

Example (Test Case 2 2018)



- $\mathbf{P_R}$ = 100 MW
- $\mathbf{P_L}$= 100 MW
- $\mathbf{P_S}$= 0 MW
- $\mathbf{P_G}$= 0 MW
- **Bad results:**
- Small variations in $\mathbf{P_G}$ & $\mathbf{P_S}$
- Storage discharged to $\mathbf{E_S}$ = **491.5**

Example (Test Case 2 GA 2018)



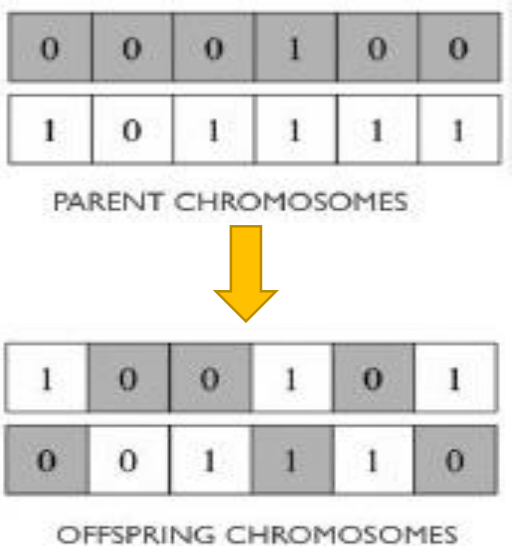
Bad results:

Minimum Fitness = 2

Doesn't reach optimal solution of zero

Short Term Objectives: Genetic Algorithms Improvements

1) Uniform Crossover



- Each variable treated equally

2) Rank Selection

Chromosome	Fitness Value	Rank
A	8.1	1
B	8.0	4
C	8.05	2
D	7.95	6
E	8.02	3
F	7.99	5

- Rank each chromosome of population by fitness

Short Term Objectives: Measuring Performance

- Add functions into the Genetic Algorithm that will help to evaluate its performance.

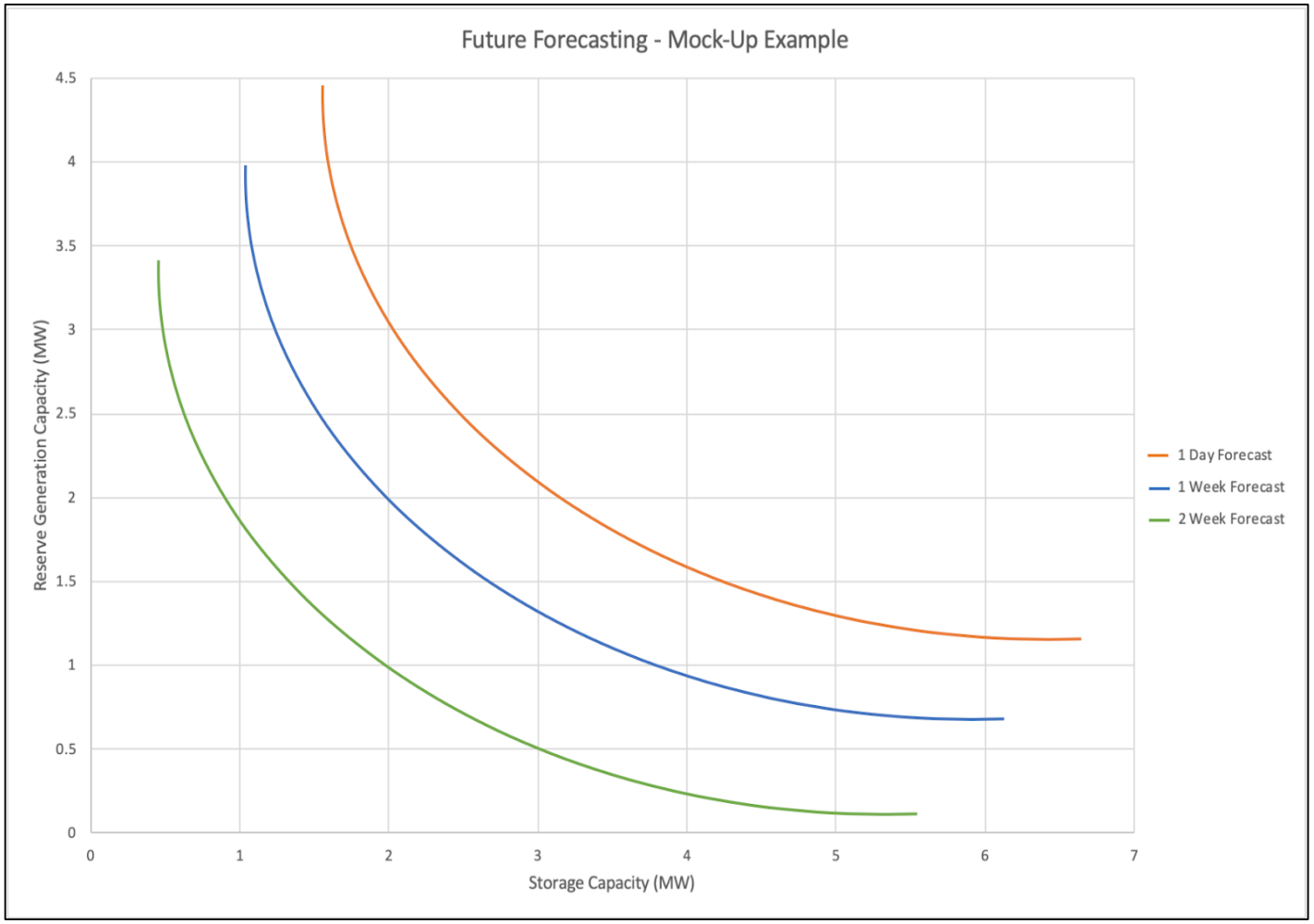
- These functions will measure the Genetic Algorithm's:
  - Speed
  - Accuracy
  - Reliability

- Will allow us to easily quantify the success of the Genetic Algorithm.

Long Term Objectives: Real Data

- To use real data from different organisations in order to produce more reliable results and test cases.

Long Term Objectives: Forecasting



Project Management: Task Allocation

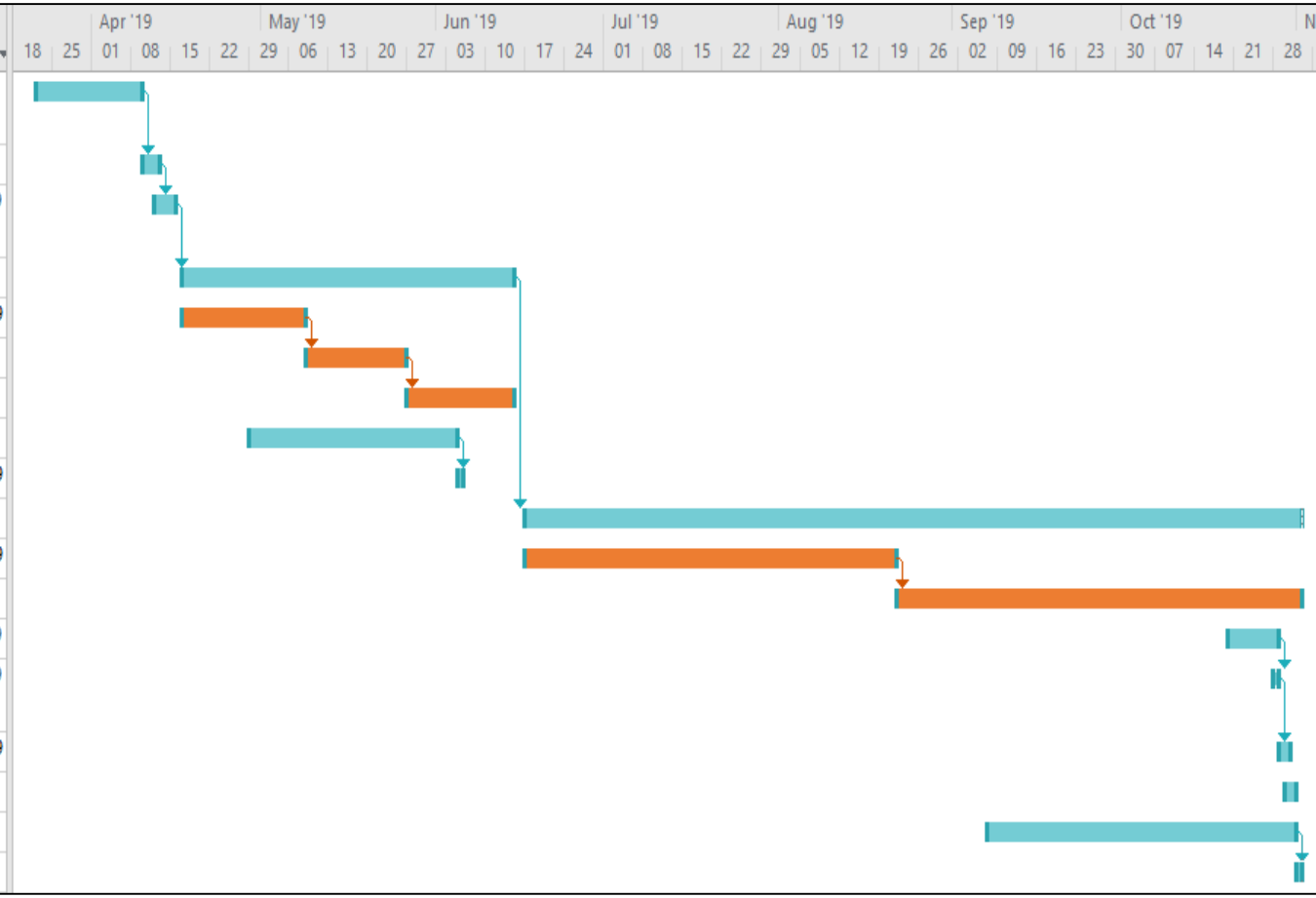
Task	Allocation
Proposal Seminar	Together
Project Management	Sean
Short Term Objectives	Together
Long Term Objectives	Together
Thesis Draft	Individual
Exhibition Poster	Together
Project Exhibition	Together
Honours Thesis	Individual
Final Seminar	Together
YouTube Video	Isaiah

Project Management: Milestone and Objective

Task	Assessment Date
Proposal Seminar	15 April - Mid Semester Break
Project Management	Ongoing
Short Term Objectives	14 June - Week 13 Semester 1
Long Term Objectives	1 November - Week 12, Semester 2
Thesis Draft	5 June - Week 12, Semester 1
Exhibition Poster	31 October - Week 12, Semester 2
Project Exhibition	31 October - Week 12, Semester 2
Honours Thesis	1 November - Week 12, Semester 2
Final Seminar	TBC
YouTube Video	31 October - Week 12, Semester 2

Project Management: Gantt Chart

Task Name	Start	Finish
Start Investigation and Literature Search	Fri 22/03/19	Tue 09/04/19
Project Wiki - Draft	Wed 10/04/19	Fri 12/04/19
Proposal Seminar Presentation and Preparation	Fri 12/04/19	Mon 15/04/19
Short Term Objectives	Wed 17/04/19	Fri 14/06/19
Getting Benchmarks working	Wed 17/04/19	Wed 08/05/19
Genetic Algorithms Improvement	Thu 09/05/19	Sun 26/05/19
Measuring Performance	Mon 27/05/19	Fri 14/06/19
Thesis Draft Write Up	Mon 29/04/19	Tue 04/06/19
Thesis Draft Due	Wed 05/06/19	Wed 05/06/19
Long Term Objectives	Mon 17/06/19	Fri 01/11/19
Real Data	Mon 17/06/19	Wed 21/08/19
Forecasting	Thu 22/08/19	Fri 01/11/19
Project Wiki - Full	Sun 20/10/19	Mon 28/10/19
Final Seminar Presentation and Preparation	Mon 28/10/19	Mon 28/10/19
Project Exhibition and Preparation	Tue 29/10/19	Wed 30/10/19
Youtube Video	Wed 30/10/19	Thu 31/10/19
Final Honours Thesis Documentation	Sat 07/09/19	Thu 31/10/19
Final Honours Thesis Due	Fri 01/11/19	Fri 01/11/19



Project Management: Resources and Budget

- Our long term objectives involve using real life data to better replicate the SA grid - a percentage of our budget may be used to obtain this data.
- AEMO data can be retrieved using tools produced in previous projects.
- BOM data may need to be purchased using given budget.
- Other programs that we will be using, such as MATLAB and Microsoft Office, are free and readily available.

Conclusion

- Electricity market is changing:
  - Utilise different storage systems to reduce impact of intermittency/reliability issues in renewable sources.
  - Minimise the amount of reserve generation.

- Improve energy storage model by:
  - Make improvements to Genetic Algorithm - crossover implementation and fitness selection.
  - Introducing real data to the model.

References

[1] AEMO, “South Australian Electricity Report 2018”. 07 November 2018. [Online] AEMO, “http://www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/SA_Advisory/2018/South-Australian-Electricity-Report.pdf,” [Accessed 29 Mar. 2019]

[2] Clean energy and the electricity market | energy.gov.au", *Energy.gov.au*, 2019. [Online]. Available: https://www.energy.gov.au/government-priorities/energy-supply/renewable-energy-and-technology. [Accessed: 05- Apr- 2019].

[3] The keys to solving renewable intermittency, *New Energy Solar*, 2019. [Online]. Available: https://www.newenergysolar.com.au/renewable-insights/renewable-energy/the-keys-to-solving-renewable-intermittency. [Accessed: 10- Apr- 2019].

[4] UniAdel. (2017, Sept. 15). Australia’s wind and solar generation[Video file]. Available: https://www.youtube.com/watch?v=FcoaTuhRy7w&feature=youtu.be

[5] J. Bullas, “Energy Storage Requirements for the South Australian Grid,” Adelaide, 2018.

[6] D. Goldberg, Genetic Algorithms in Search, Optimization & Machine Learning, Reading, Massachusetts: Addison-Wesley Publishing Company, Inc., 1989.

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Thank you for Listening

Any Questions ?