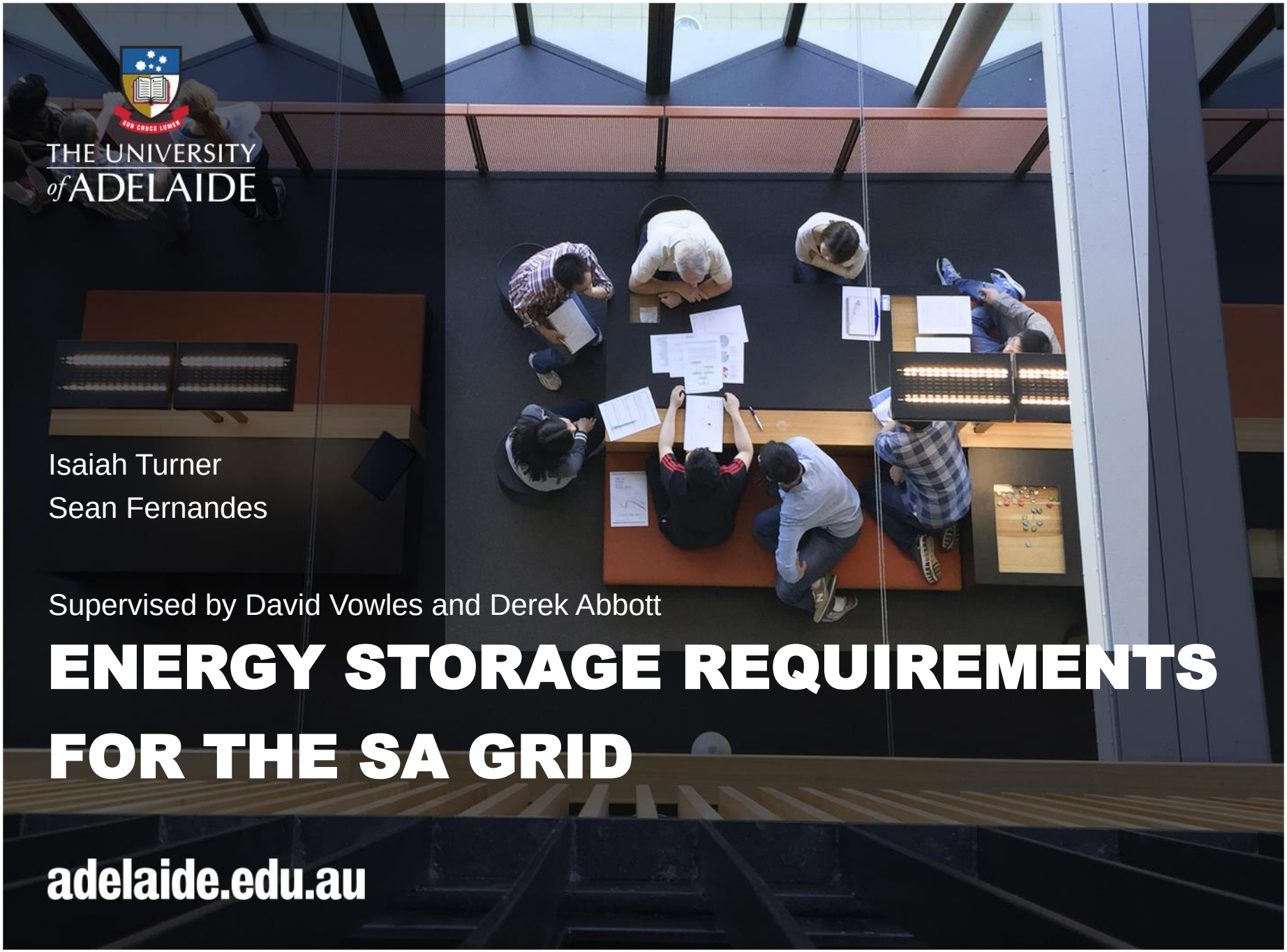

THE UNIVERSITY of ADELAIDE

Isaiah Turner
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Supervised by David Vowles and Derek Abbott

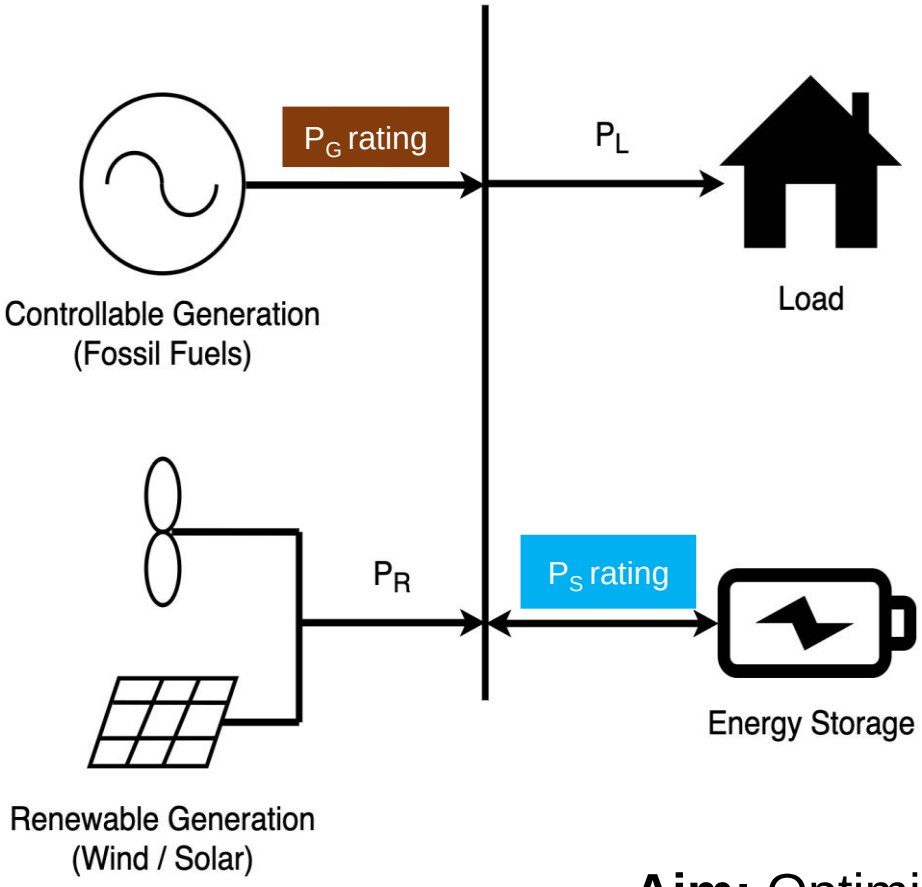
ENERGY STORAGE REQUIREMENTS FOR THE SA GRID

adelaide.edu.au

Outline

- Project Aim
- Background
- Motivation
- How to Optimise?
- Why Optimise?
- Genetic Algorithms
- Why Genetic Algorithms?
- Techniques and Results
- Accuracy Benchmark
- Future Work and Conclusion
- References

Project Aim



- P_G : Controllable Generation
- P_R : Renewable Generation
- P_S : Energy Storage
- P_L: Total Load

$$P_G + P_R + P_S = P_L$$

Aim: Optimise P_S rating to minimise P_G rating

Background

- **Energy Transition:** Fossil → Renewable
- Meet 'Renewable Energy Target' scheme
  - Reduce GHG emissions
  - Generate more electricity from renewables

Non - renewables

Renewables

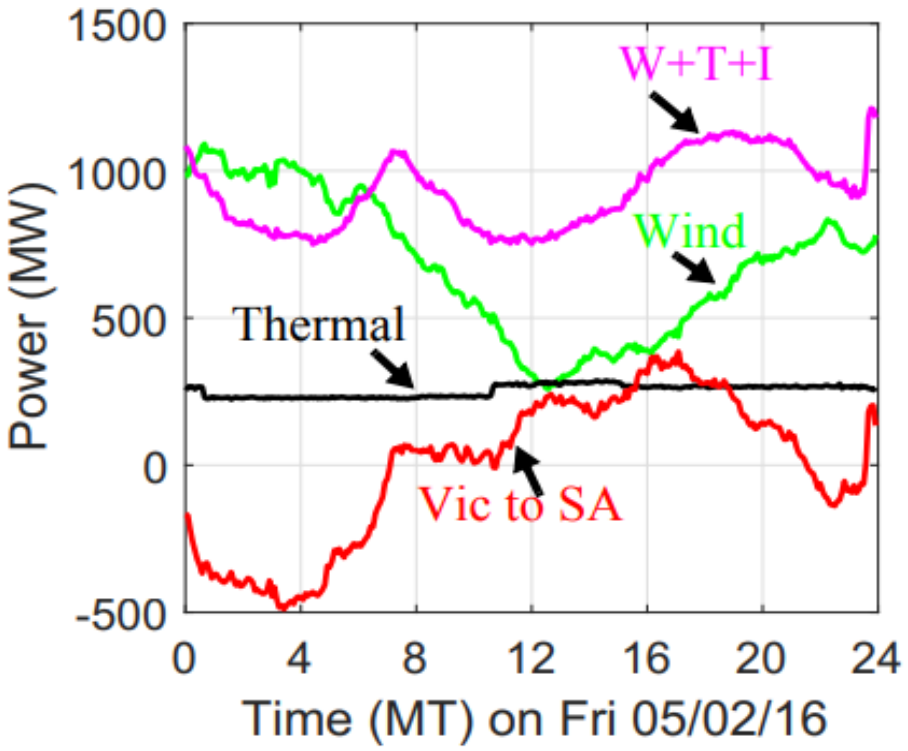
(Wind / Solar)

Storage

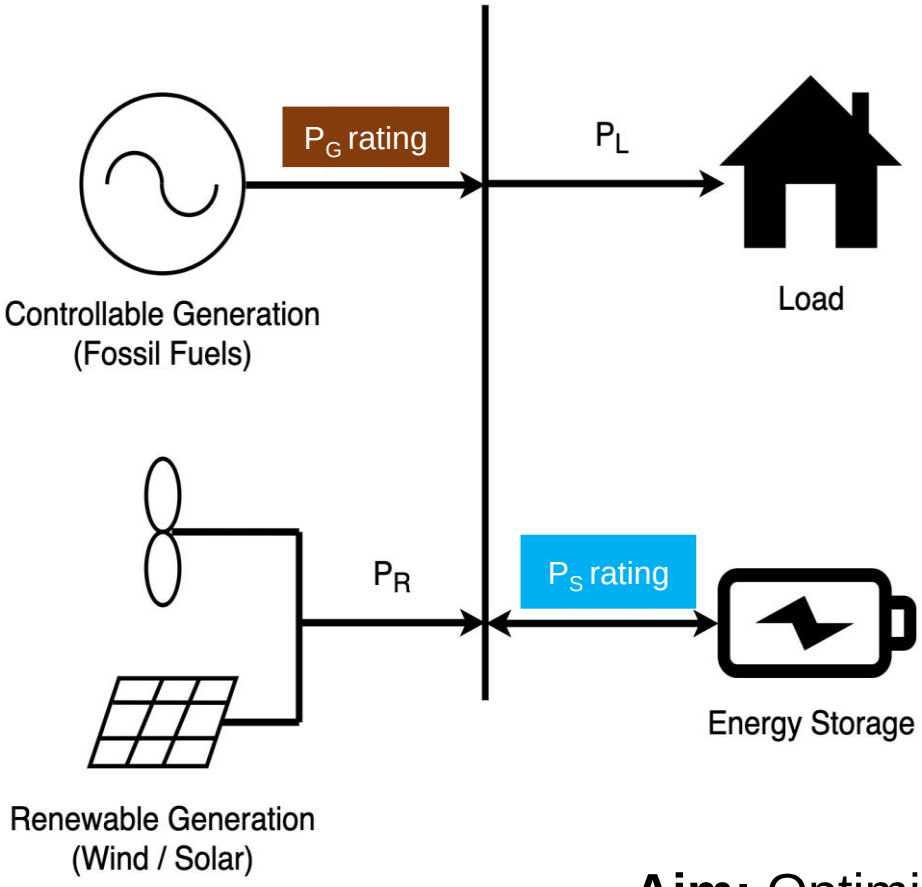
(Pumped hydro / batteries)

Motivation

- **Issue:** Intermittent Renewable Power Sources
  - Power may not be available when needed
- Leading to dispatchability issue
  - inability to control power supply
- **Solution:** Energy Storage



How to Optimise?



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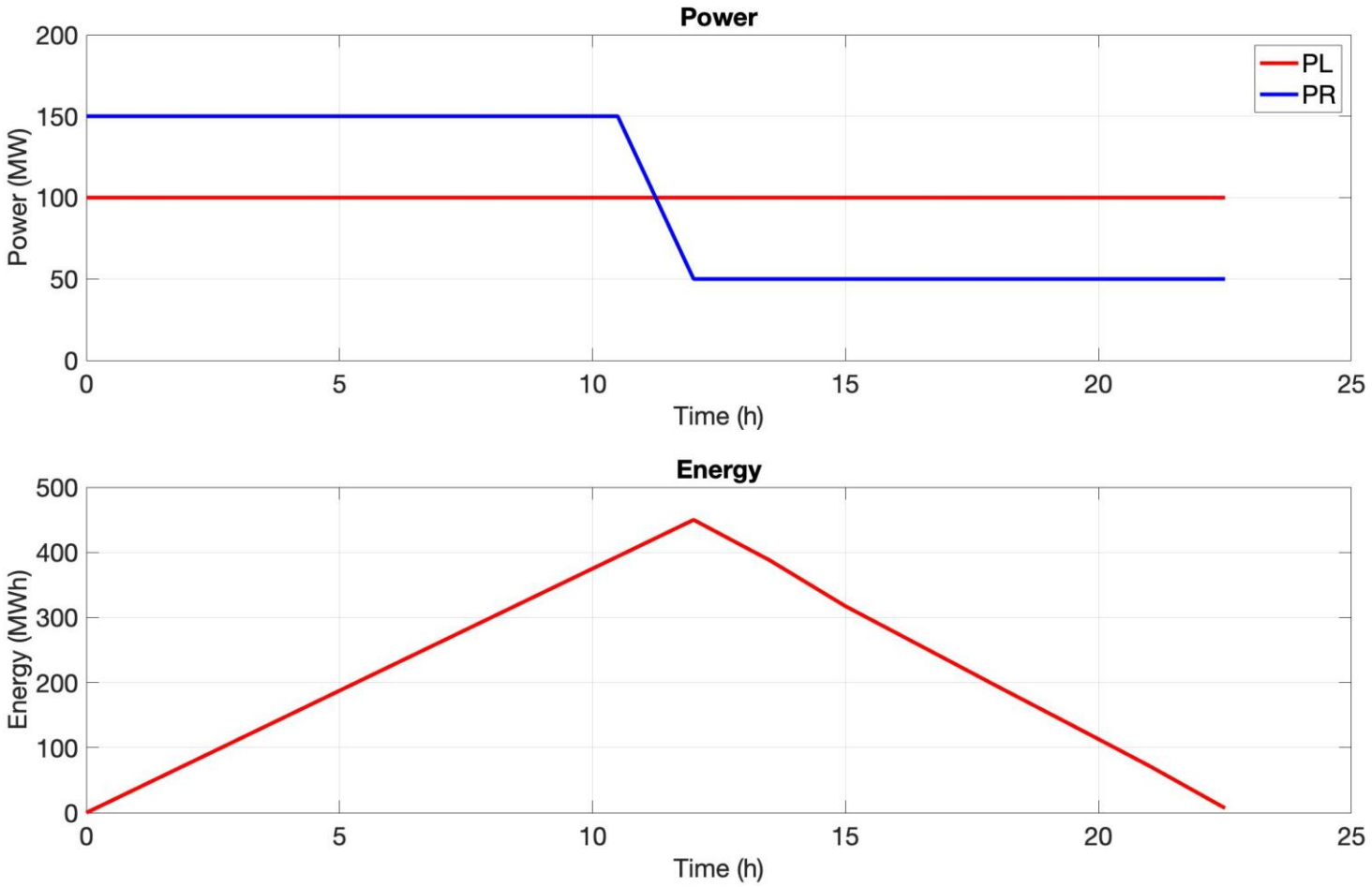
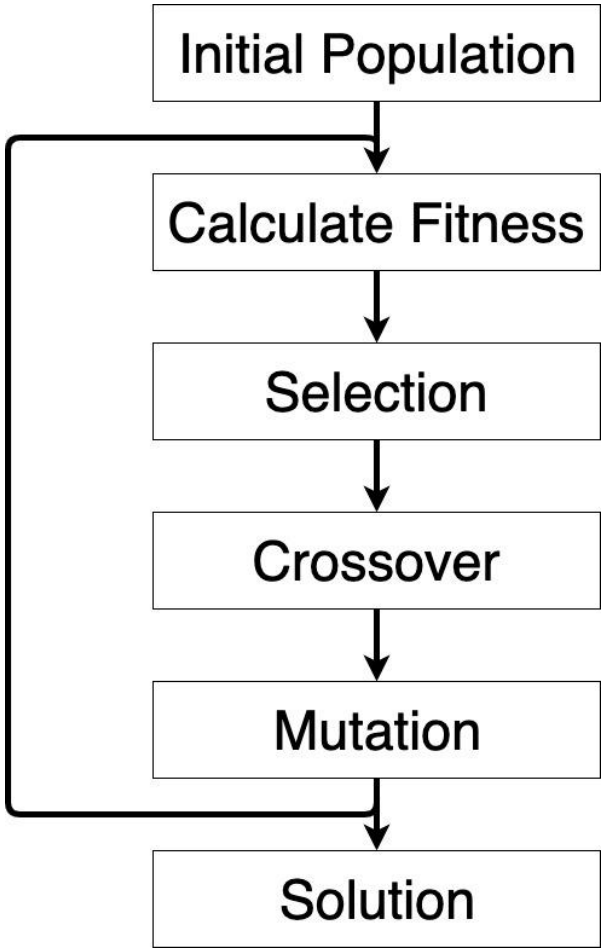
Why Optimise?



Genetic Algorithms

- Search based algorithm.
- Use the concept of “Survival of the Fittest”
- Find an optimal solution through a set of processes.
- Repeatedly modifies population of individual solutions.



Why Genetic Algorithms?

Number of time variables (t) →
(48 variables)

Number of individuals $(Npop)$ →
(100 individuals)

$v_{1,1}$	$v_{1,2}$	$\cdots$	$v_{1,t}$
$v_{2,1}$	$v_{2,2}$	$\cdots$	$v_{2,t}$
$\vdots$	$\vdots$	$\ddots$	$\vdots$
$v_{Npop,1}$	$v_{Npop,1}$	$\cdots$	$v_{Npop,t}$

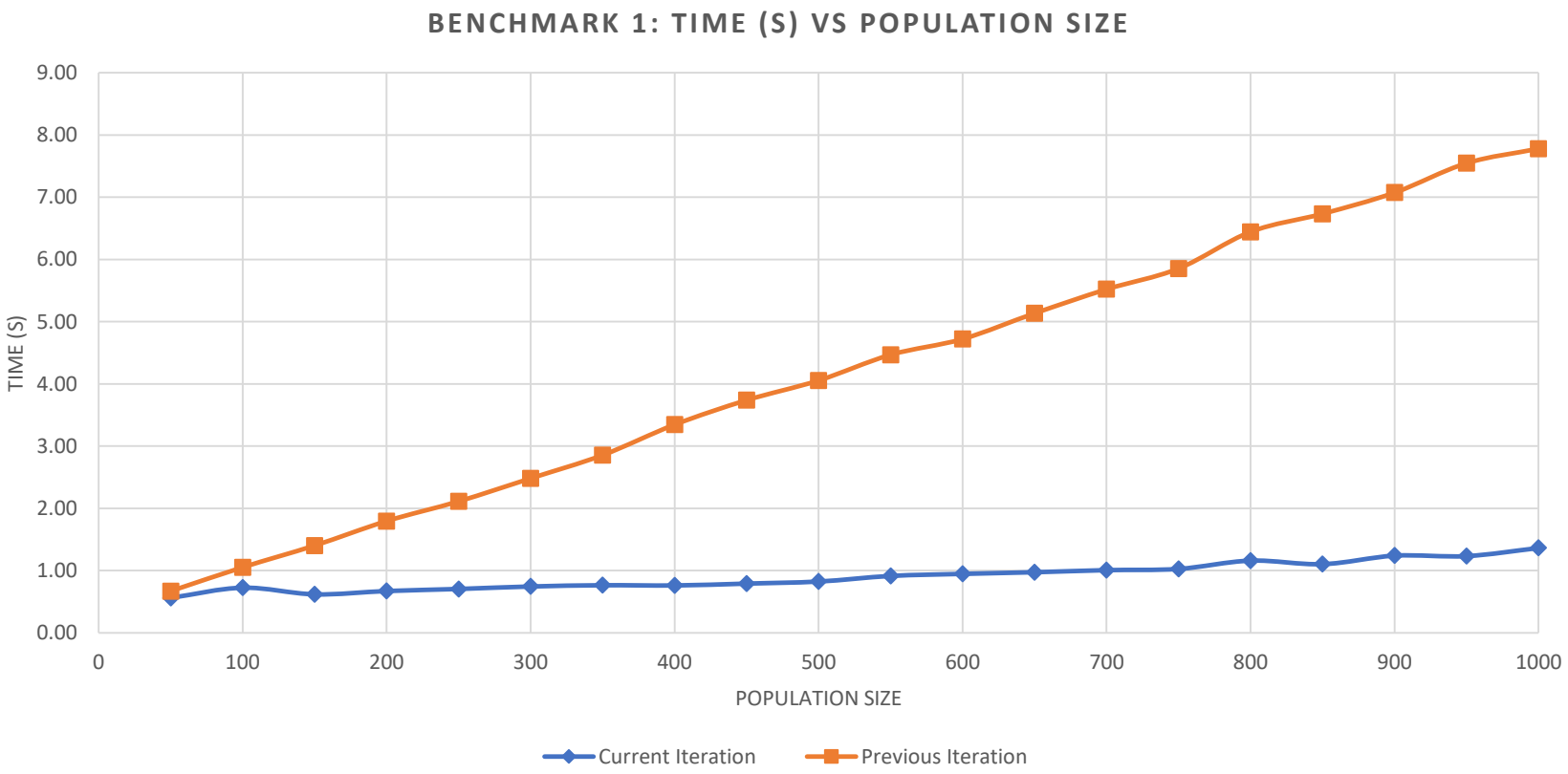
Technique 1: Code Vectorisation

- Serialised Code → Vectorised Code
  - To increase speed

Serialised Code	Vectorized Code
for i = 1:10 y(2, i) = randVal; end	y(2, all) = randVal;

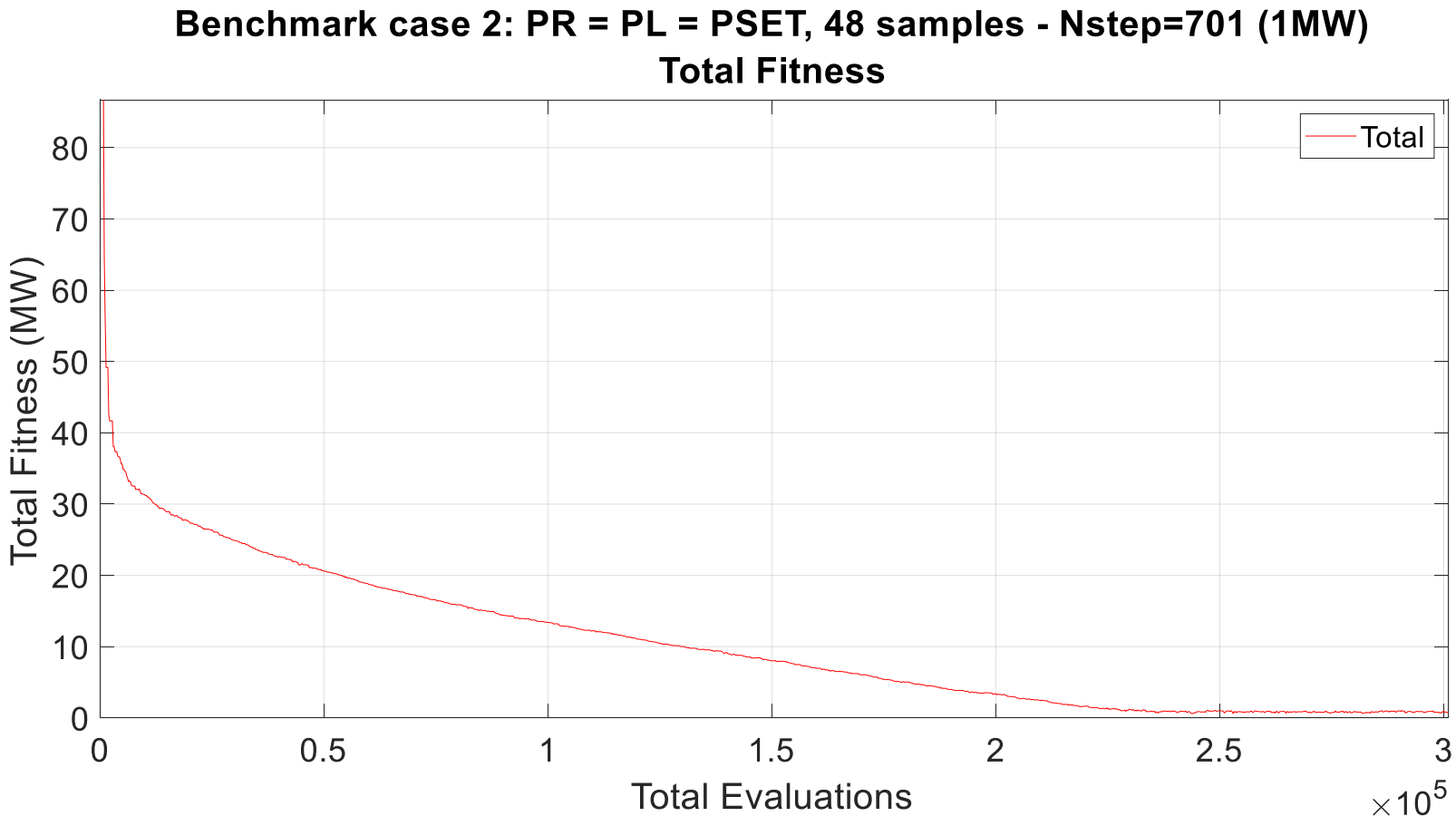
- **Serialised Code** : Low speed → Takes more time to process
- **Vectorized Code** : High speed → Takes less time to process

Results: Code Vectorisation

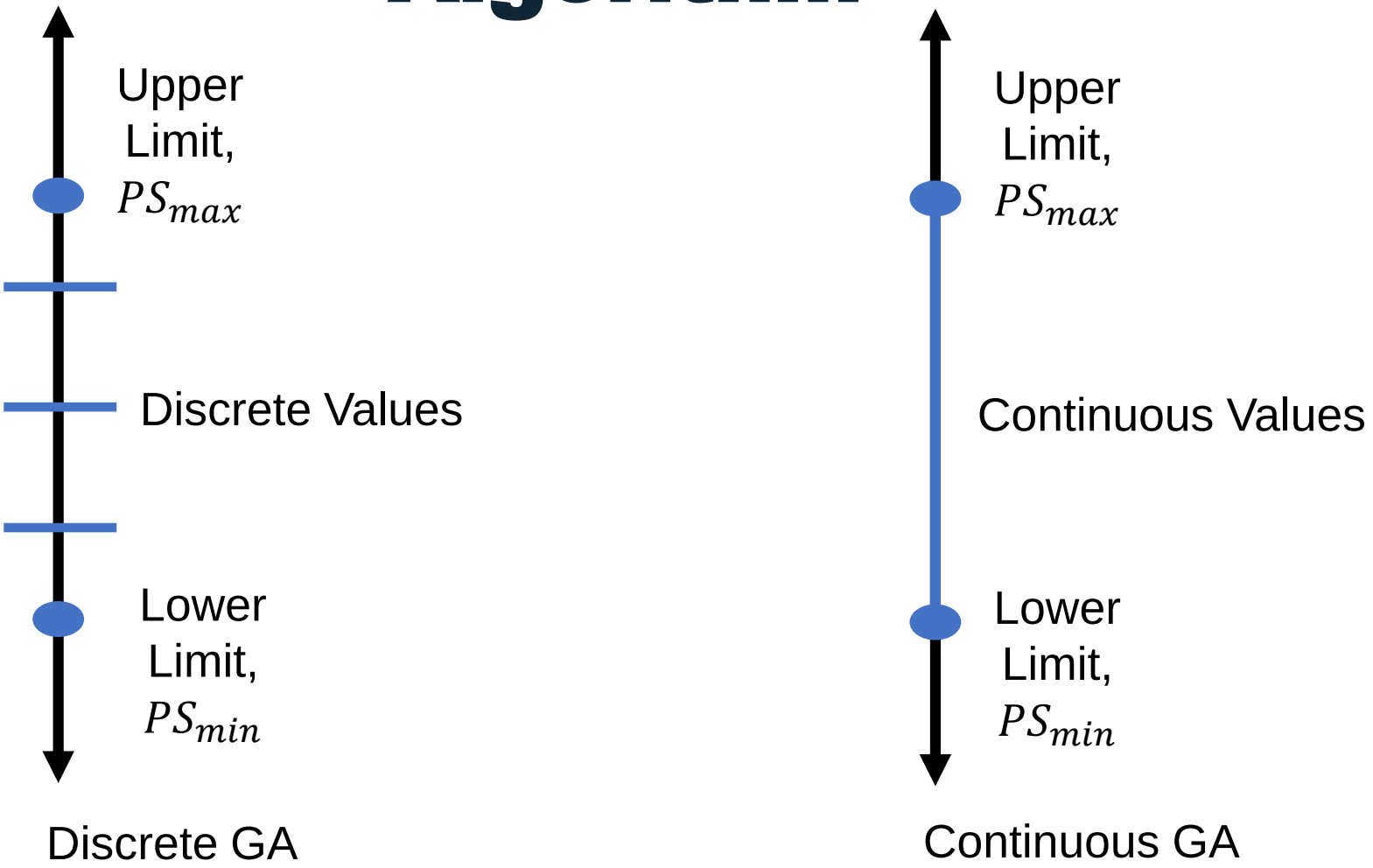


- The current iteration **(blue)** is **5 times faster** than the previous iteration **(orange)**

Technique 2: Convergence Theorem



Technique 3: Continuous Genetic Algorithm



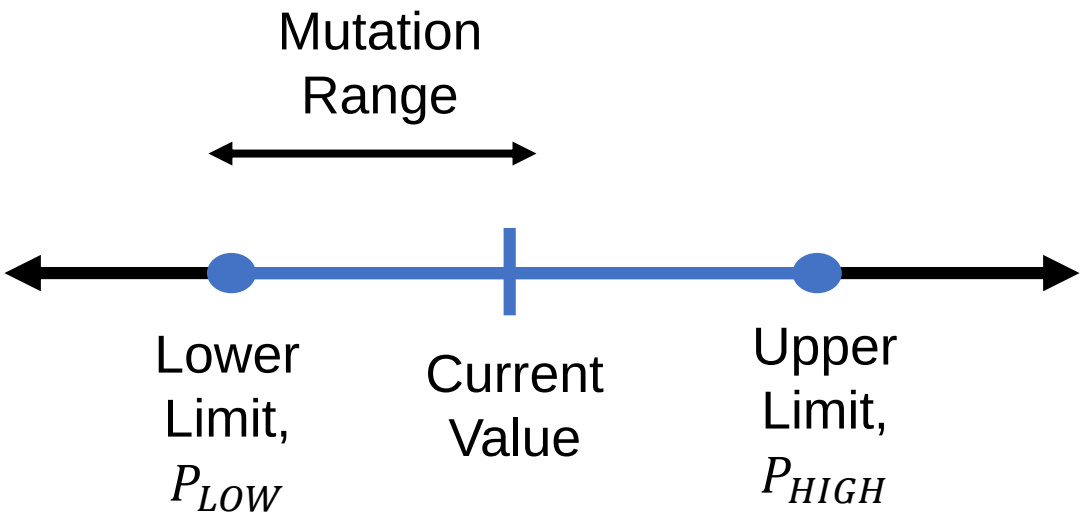
Results: Continuous Genetic Algorithm

Test Case 2	
Continuous Final Fitness (MW)	**Discrete Final Fitness (MW)**
0.458	2.000

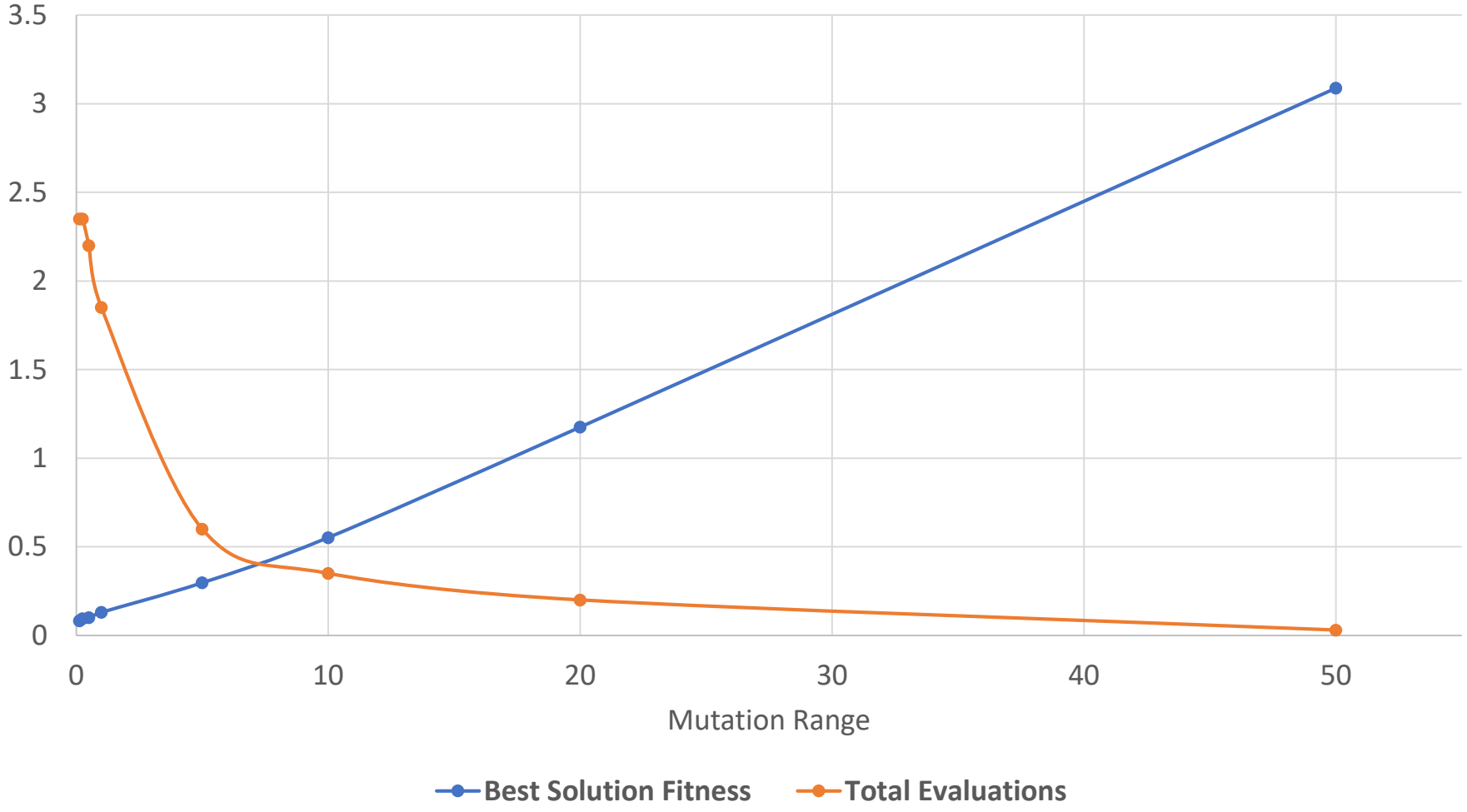
- Continuous GA is more accurate because it has a lower fitness.
- Lower fitness means less fossil fuels.

Technique 4: Mutation Range

- This only applies to Continuous GA
- The range of values that can be mutated to from an initial value
- To reduce the variability of the mutation process and increase performance

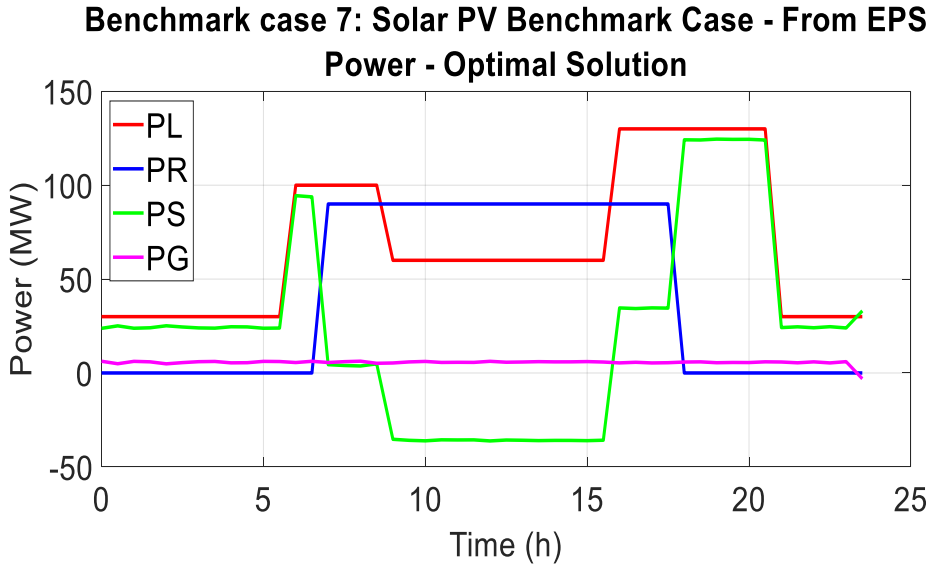


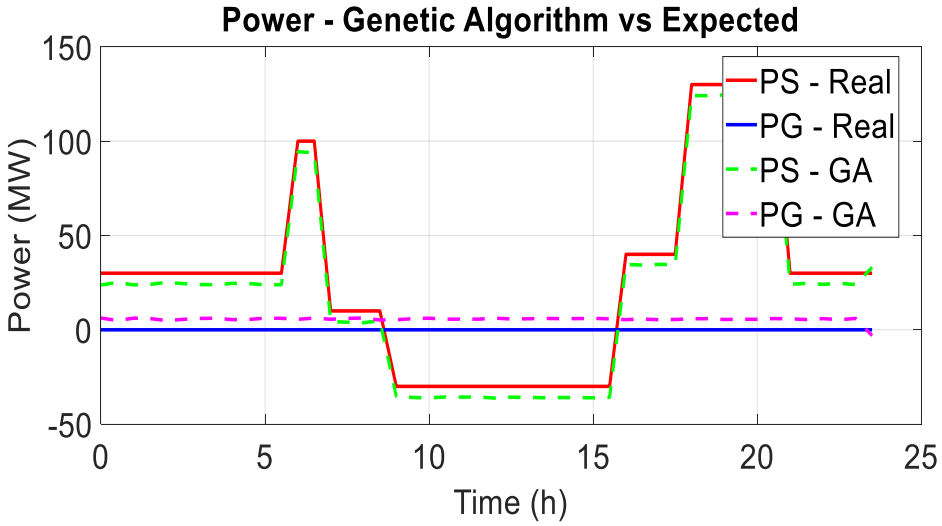
Results: Mutation Range



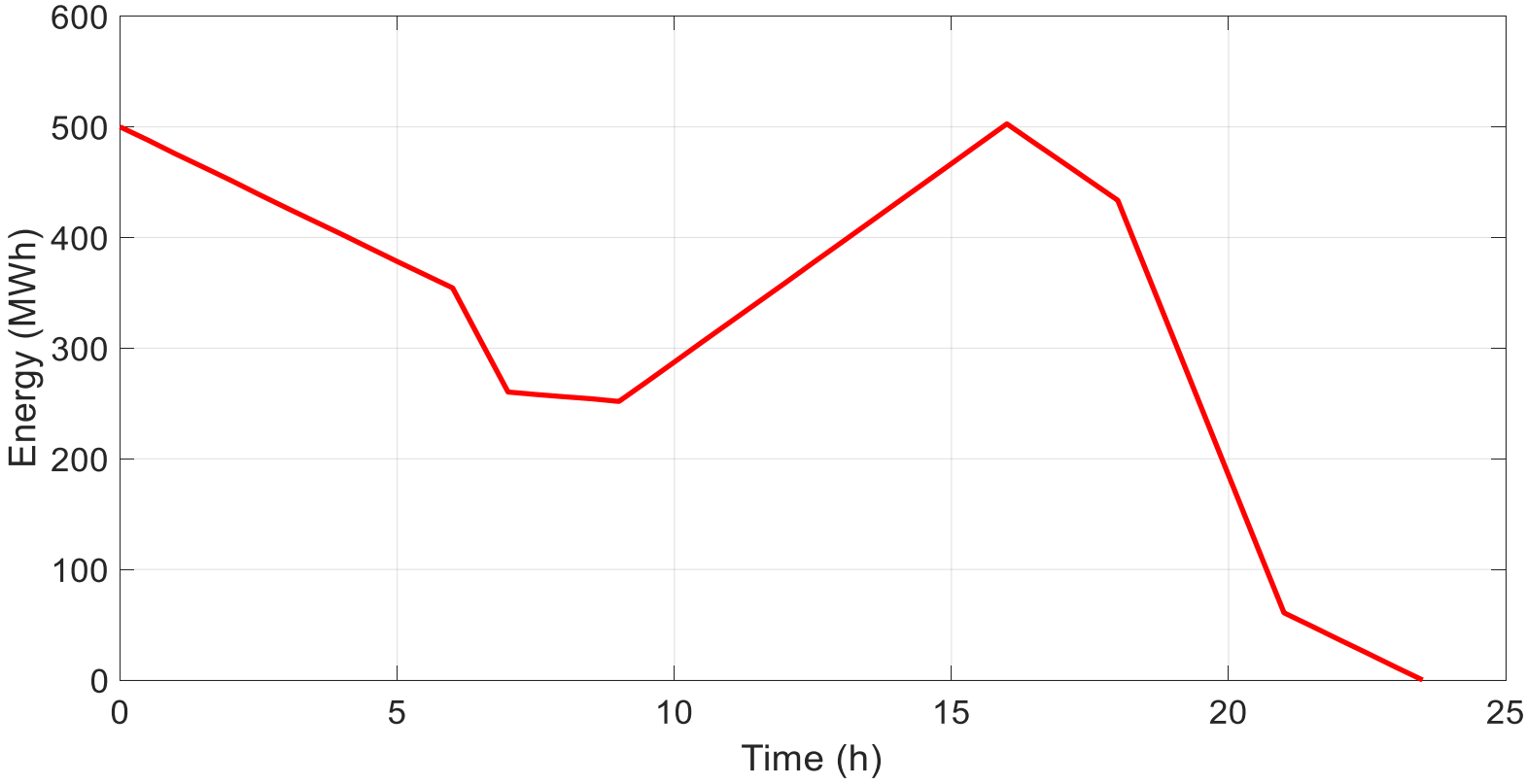
Accuracy Benchmarking

- Solar PV Benchmark
- $\mathbf{P_L}$ and $\mathbf{P_R}$ varies throughout the day.
- Power Model Results:
  - Deviation in $\mathbf{P_S}$ & $\mathbf{P_G}$ by 6 MW
  - GA is reasonably accurate here





Accuracy Benchmarks



- Shows the amount of energy within the storage device
- Shows the discharging and charging rates

Future Work and Conclusion

- Future Work
  - Use real-time data (i.e. AEMO)
  - More accurate modelling of the SA power system
  - MEX File

- Conclusion
  - Genetic Algorithm produces faster & more accurate results.
  - Provides an estimate for storage needs.

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Thank you for listening

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