50MW OCGT Plant Replacement by Hybrid Renewables with Storage

(NOVO PRO® sw Simulation)

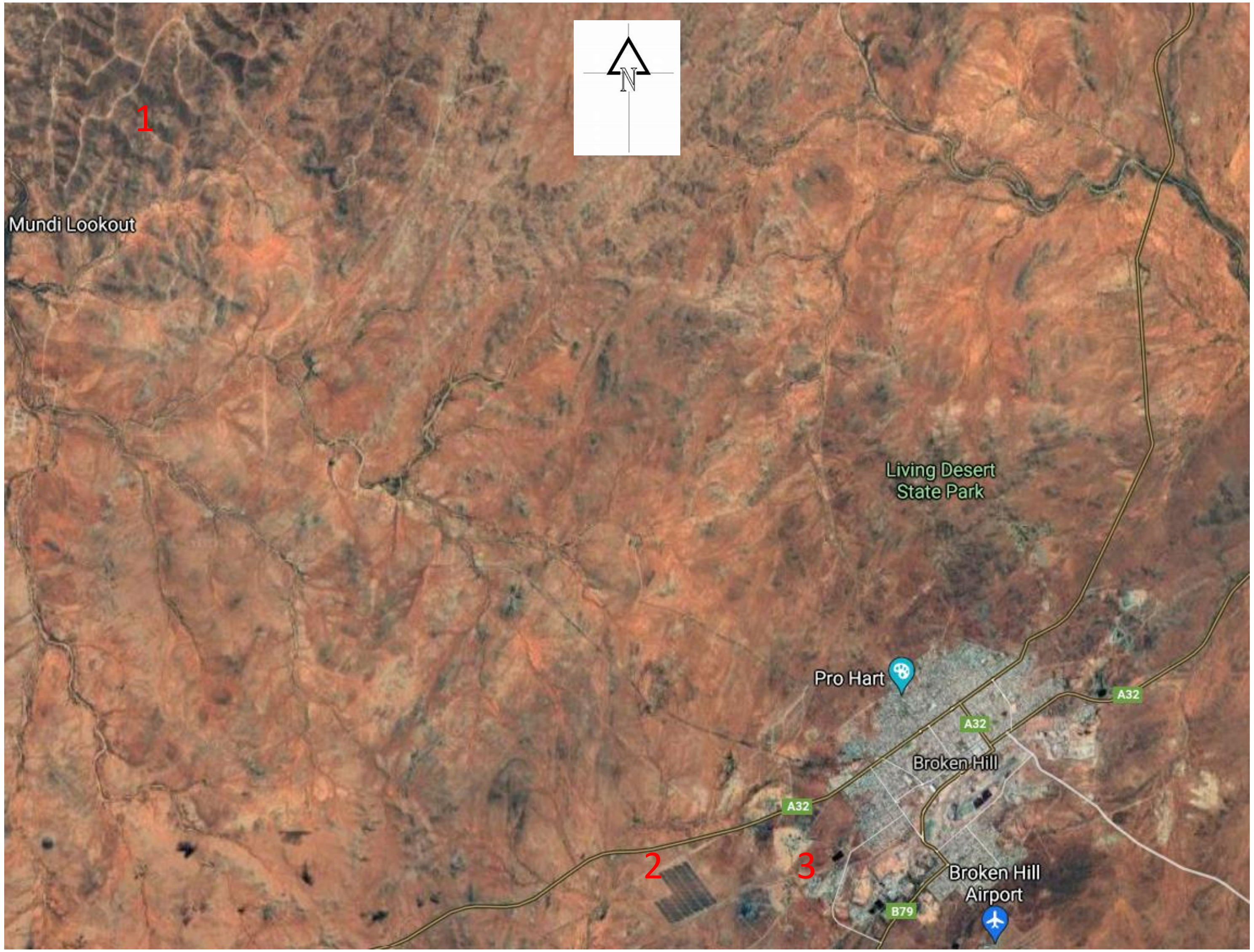
Introduction

A remote mining location (NSW, Australia) with an existing grid connection is to have its existing 50MW OCGT back-up PP replaced by an installation combining Wind and Solar PV with storage. The resulting configuration is intended to be the main power supply to the community with the grid connection acting as back up.

Two configurations of the hybrid plant are considered, differing only in the energy storage technology:
- Option 1: 53MW Solar, qty “x” wind turbines (Silverton wind farm) + 150-200 MW/1,550 MWh CAES
- Option 2: 53MW Solar, qty “y” wind turbines (Silverton wind farm) + 62.5 MW/250 MWh BESS (Li Ion type)

NOVO PRO is used to analyse the proposed configurations and to identify any potential issues arising.

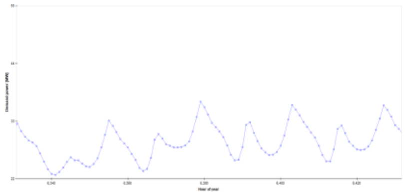
Introduction - Satellite Image of Location



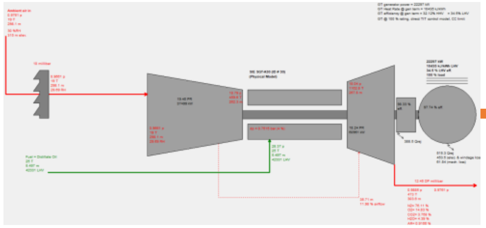
1- Silverton wind farm (58x GE 3.4-130), 32°S-141 ° E
2- 53MW solar pv plant
3- 50MW OCGT plant

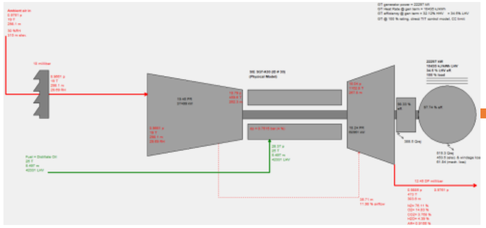
Introduction -Existing Configuration

(snapshot of performance for Sept 20th -23rd)



2x 25MW GT's in open cycle configuration





0 MW

Mining Community

250km long 220kV line

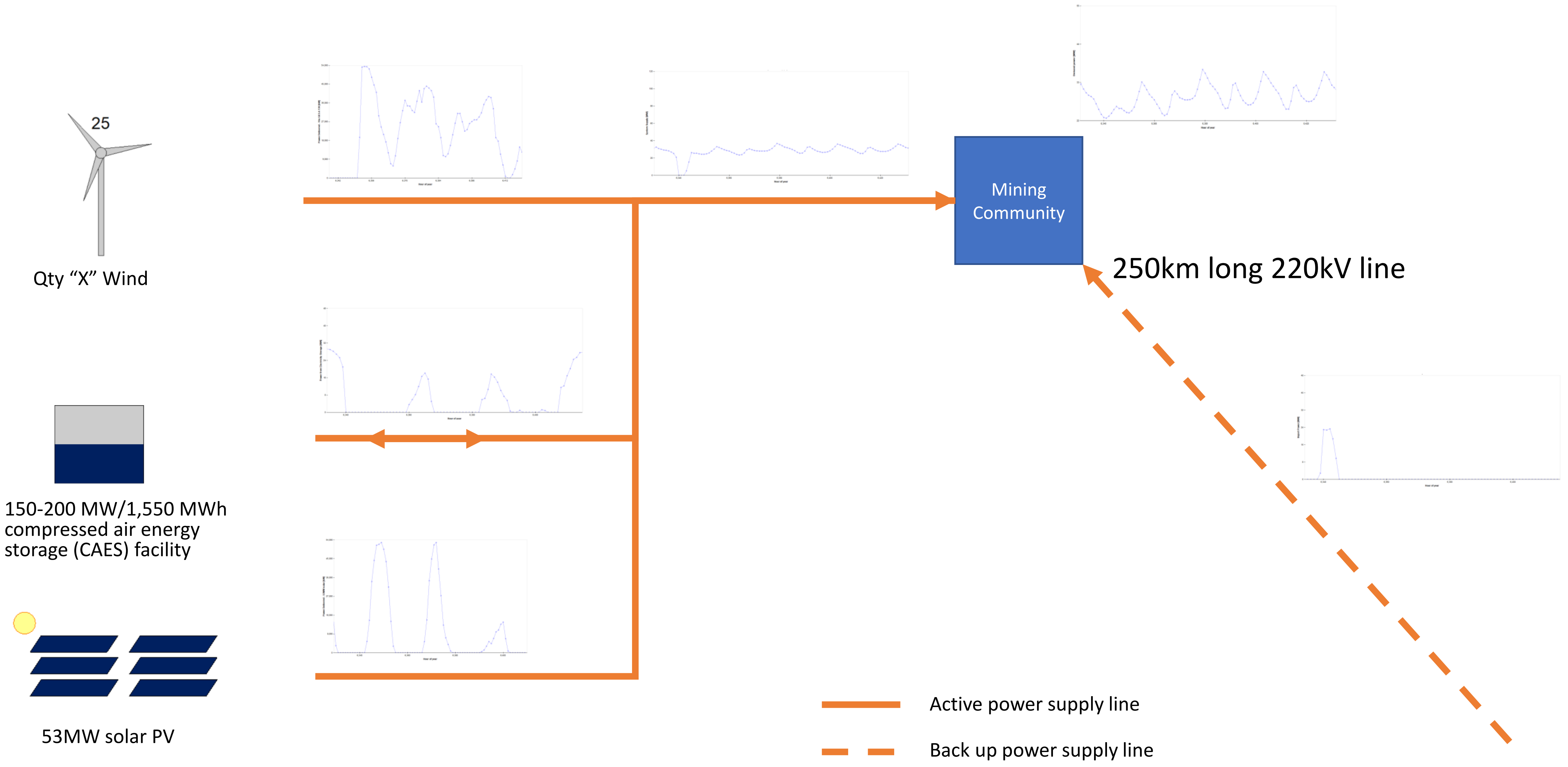
(100% of demand met from Grid)

Active power supply line

Back up power supply line

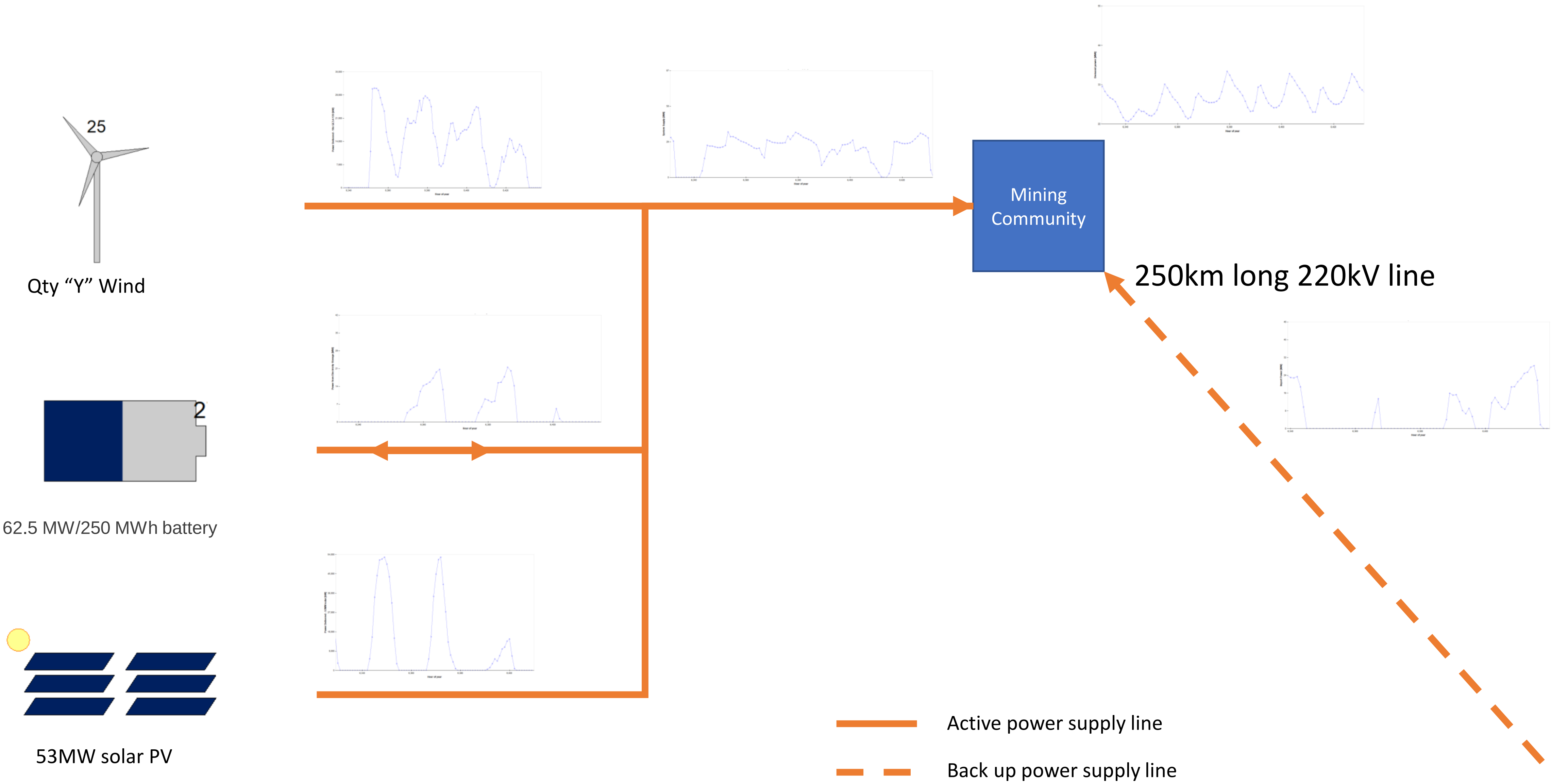
Introduction - Option 1

(snapshot of performance for Sept 20th -23rd)



Introduction - Option 2

(snapshot of performance for Sept 20th -23rd)



Thermoflow

Method & Data Sources

GT PRO® is used to establish the 50MW OCGT fuel demand model for subsequent use in NOVO PRO.

Demand power, demand power price and site data are determined.

NOVO PRO is used to model the existing case plus Options 1 & 2 including optimisation of the wind turbine count for each option.

NOVO PRO outputs are used to determine the economic viability of the proposed configurations

References:

Energy storage systems: Capital costs, maintenance costs etc: https://www.energy.gov/sites/prod/files/2019/07/f65/Storage%20Cost%20and%20Performance%20Characterization%20Report_Final.pdf

Energy prices & demand data (NSW, Australia): https://aemo.com.au/Energy-systems/Electricity/National-Electricity-Market-NEM/Data-NEM/Data-Dashboard-NEM

BOM website (Broken Hill meteorological data): http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=122&p_display_type=dailyDataFile&p_startYear=2020&p_c=-442734627&p_stn_num=047048

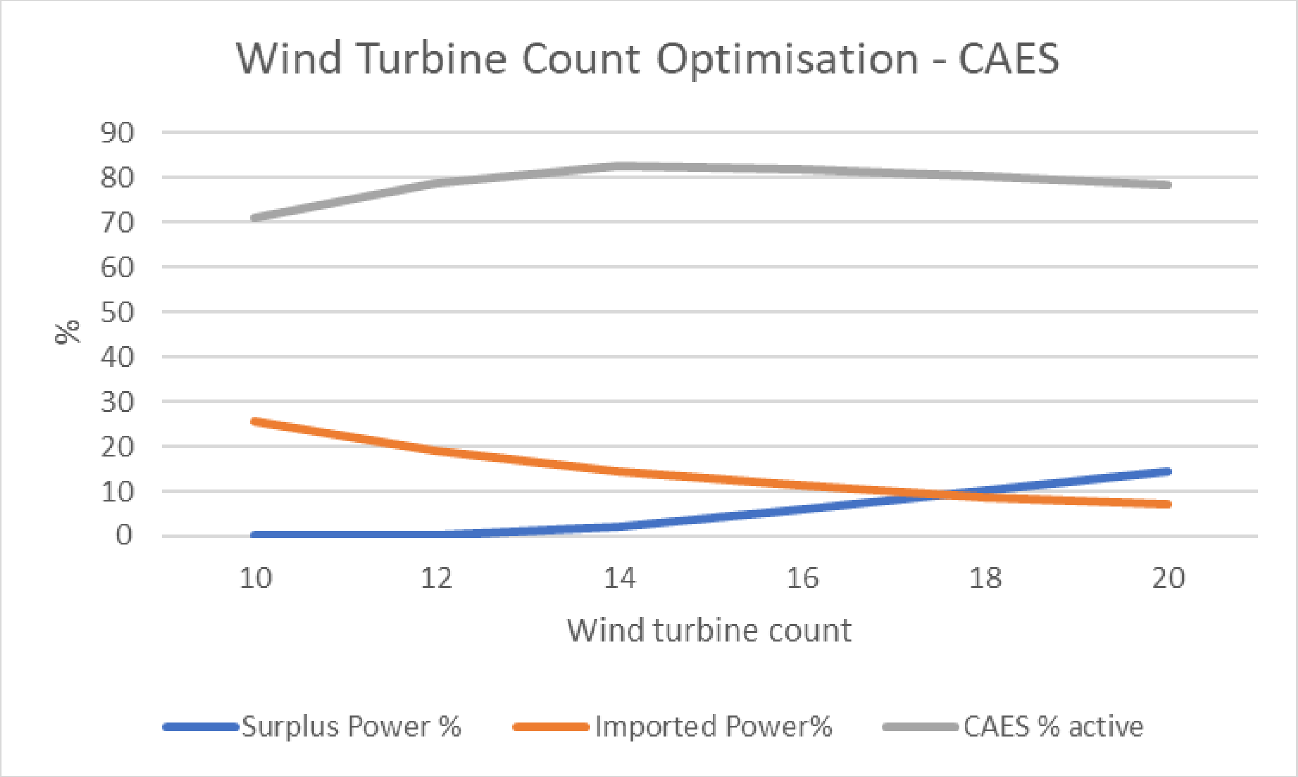
Results -Wind turbine count optimisation for CAES system (using “CAES percent active” as the criterion)

Solar PV plant size and storage capacity are a given.

Varying the WT count for the configuration suggests that there exists an optimum wind turbine count which will ensure that the CAES system activity is maximised. Put simply:

-too few wind turbines means that the CAES will never charge to capacity.

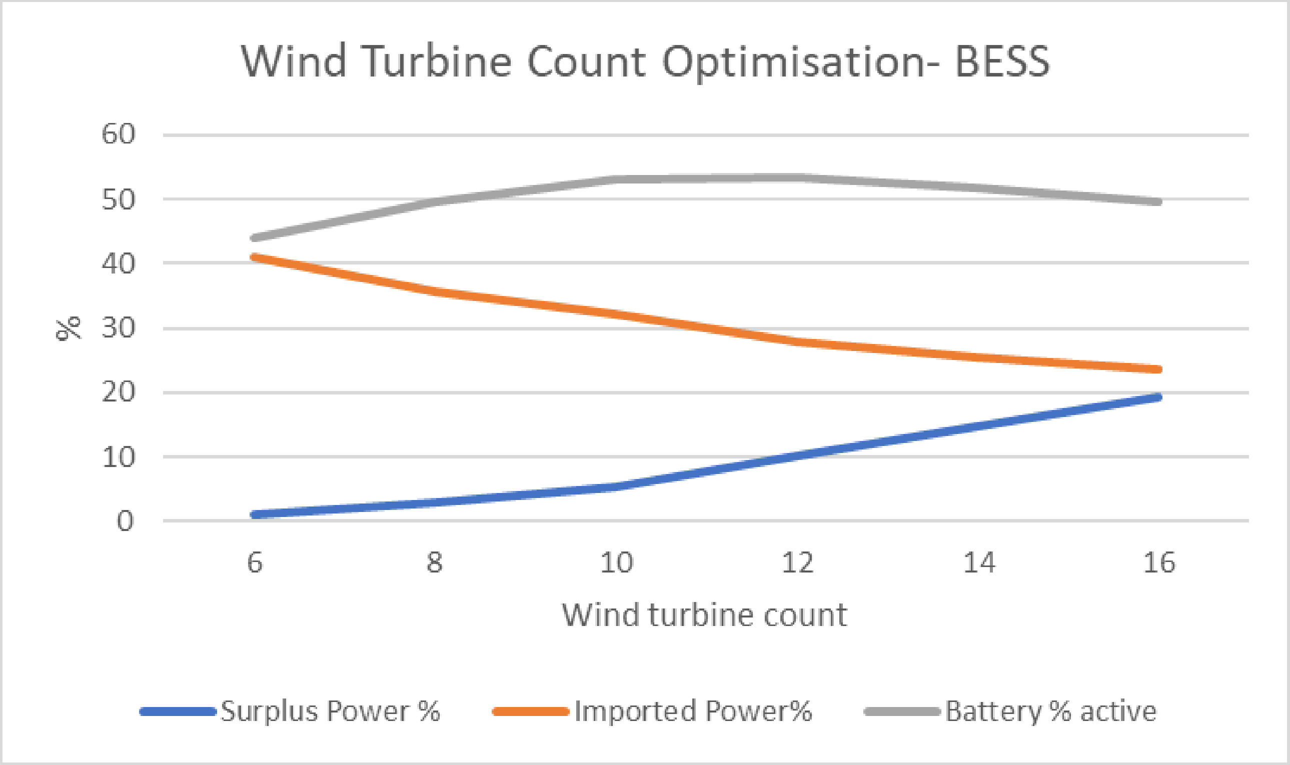
-an excess of wind turbines means that the CAES will charge to full capacity, but will seldom discharge.



Conclude that 14 wind turbines is the optimum. Note that for wind turbine counts of 10 & 12, NOVO PRO issues advisory messages that “…the storage system may be oversized”

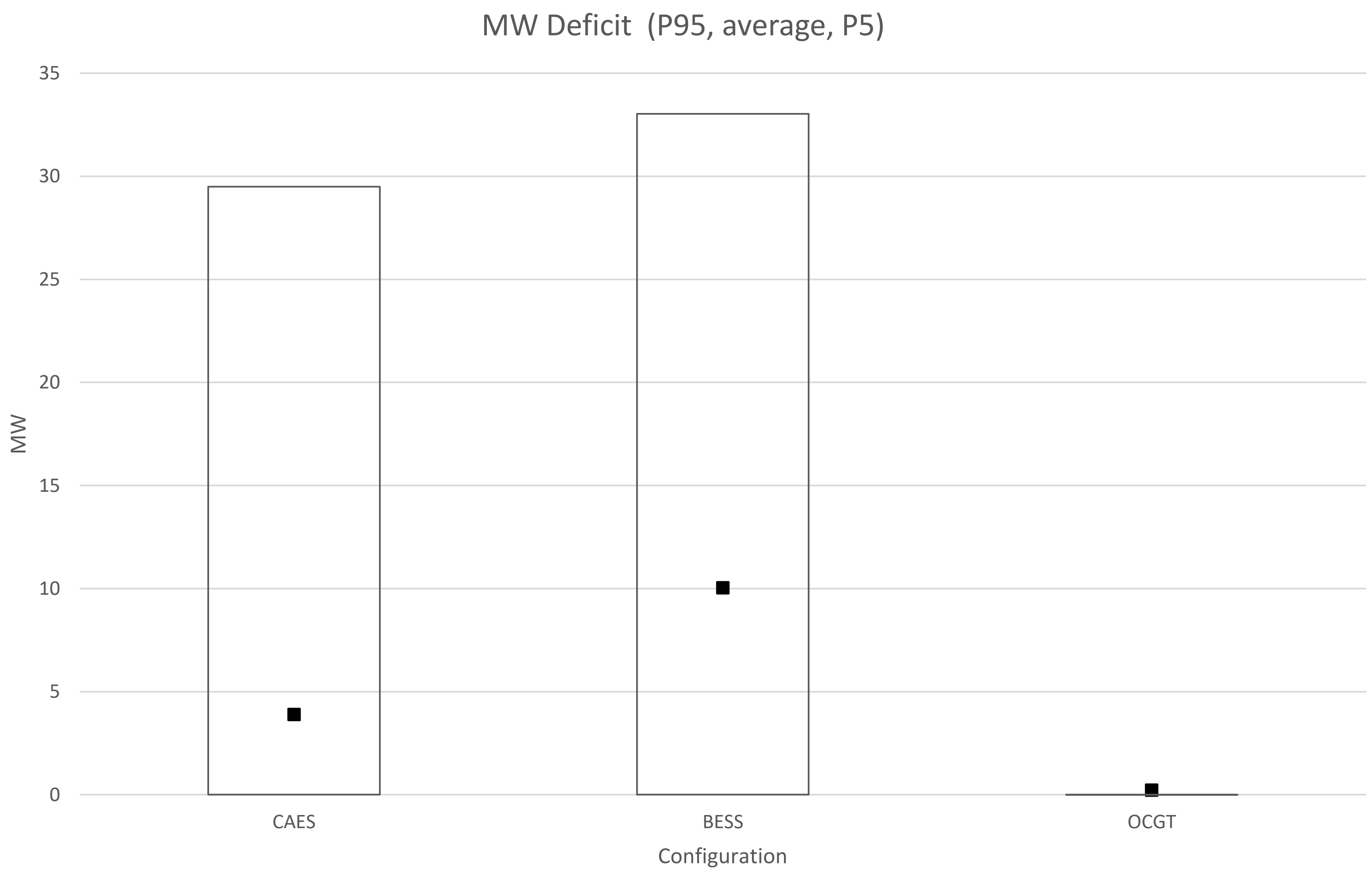
Results - Wind turbine count optimisation for BESS system (using “BESS percent active” as the criterion)

The same logic is applied to the BESS based configuration.



Conclude that 10-12 wind turbines is the optimum.

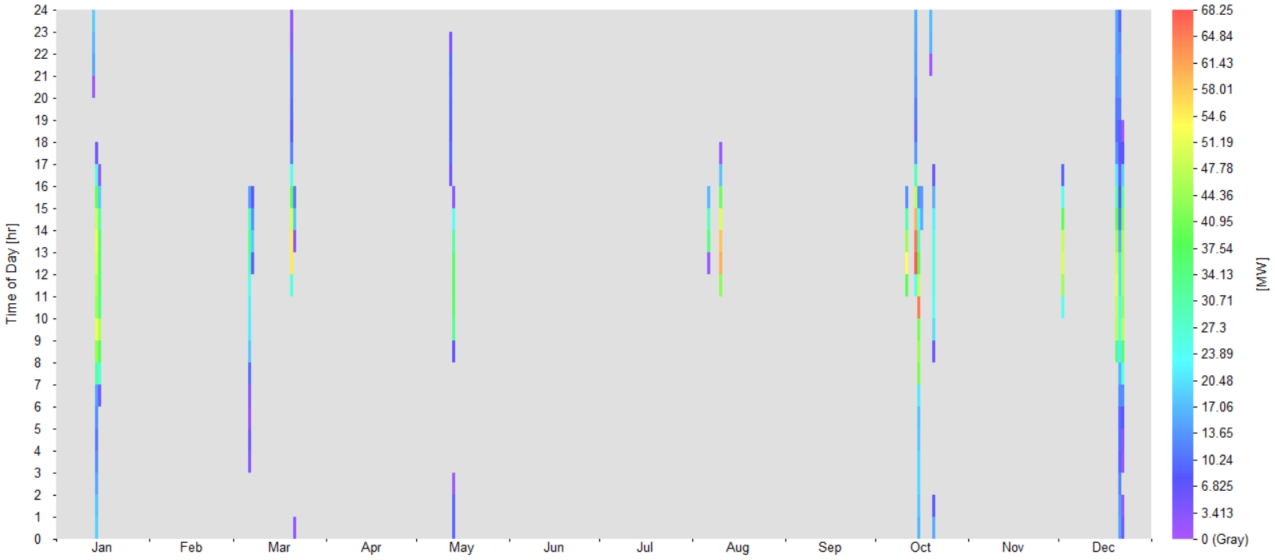
Results – Imported Power (Deficit MW Box Plot)



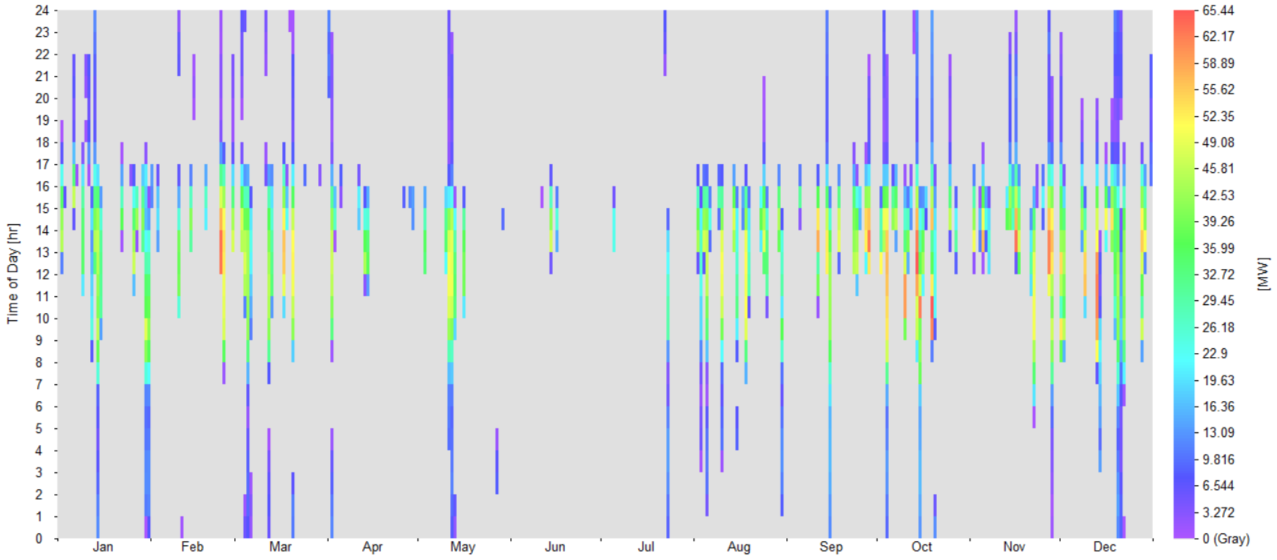
Conclude that even an optimised hybrid system still has associated with it a large deficit power spread

Results – Implications for 220kV grid connection (Surplus power)

Option 1 (CAES)

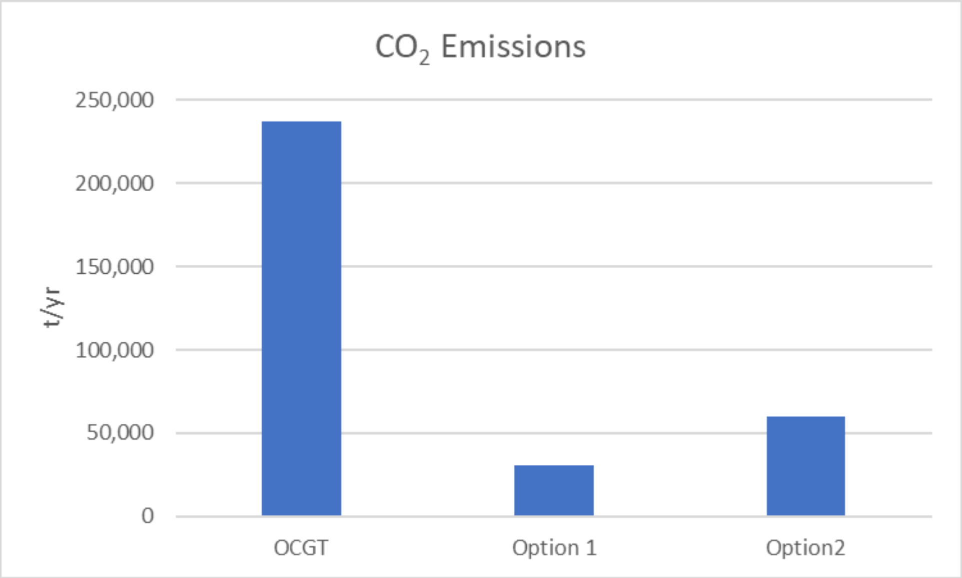


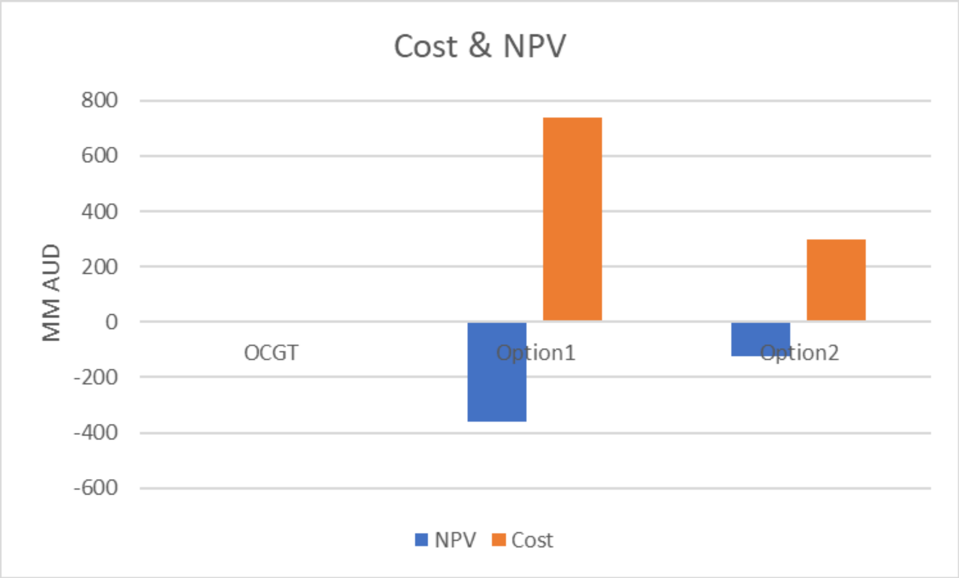
Option 2 (BESS)



Larger storage capacity of the CAES means less surplus power to grid

Results – CO_2 Emissions, Plant Cost & NPV





CO_2 emissions associated with Option 1 & 2 since majority of NSW grid is fossil fuelled

Findings & Conclusion

Option 1 is more expensive than Option 2 and consequently offers inferior financial performance. Both options have inferior performance relative to the existing OCGT in terms of expected import power requirement (up to 33MW for Options 1 & 2, practically zero MW for the OCGT plant). The advantage of Option 1 and Option 2 over the existing OCGT is the CO_2 emissions (theoretically zero for Options 1 & 2, up to 237000 t/yr for the OCGT). Retaining the OCGT plant may be justified in light of the fluctuating import power requirement and the absence of a scheme in Australia to monetise the avoided CO_2 emissions

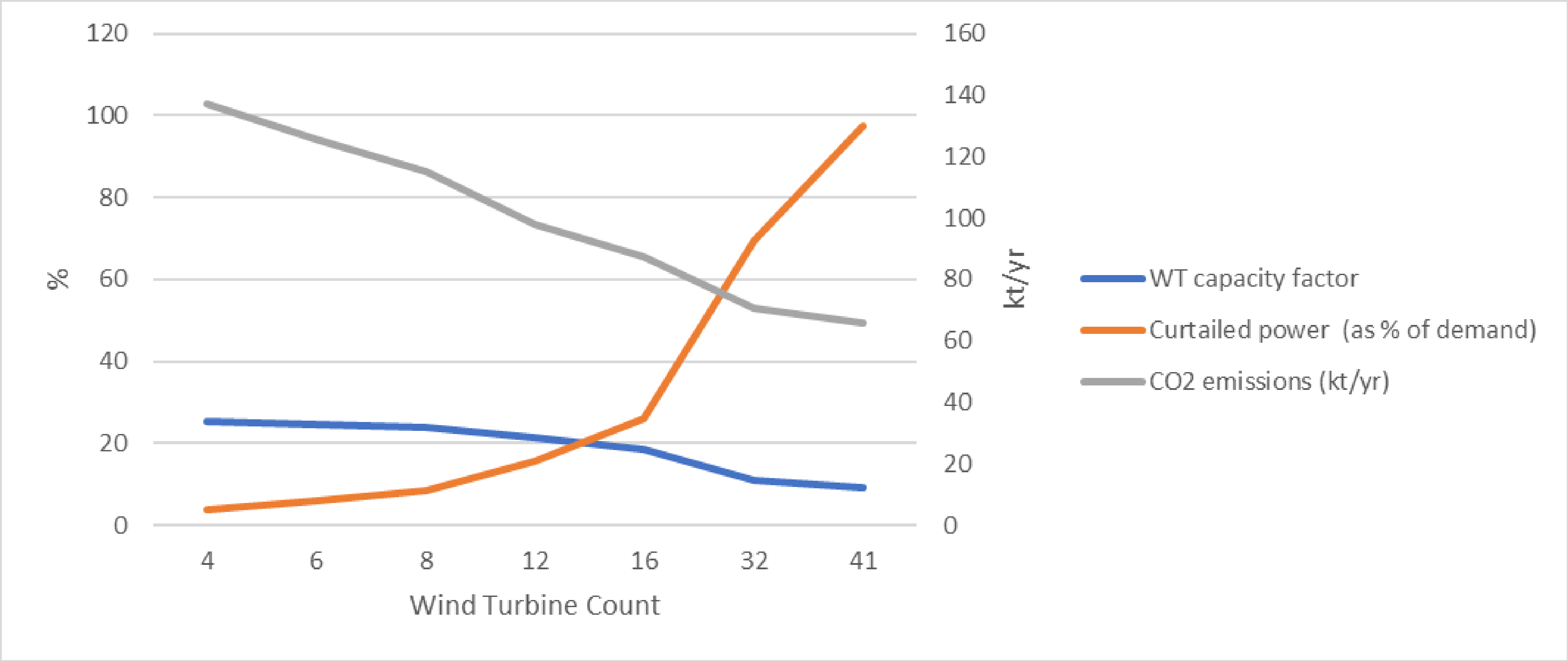
Appendix – Option 3

(no storage, OCGT retained, WT curtailment)

This option is considered since no carbon trading scheme exists at the present time in Australia, hence demonstration of reduced CO_2 emissions at Broken Hill has potentially the same merit of zero CO_2 emissions.

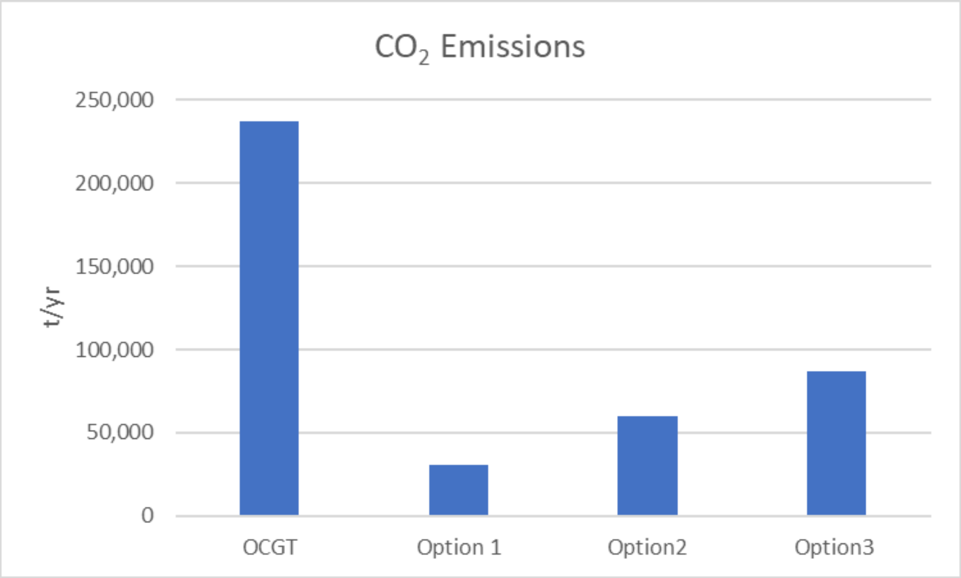
The method is similar to that used for the simulation of Options 1 & 2, except in this case wind turbine power curtailment is employed to limit the power that would otherwise need to be exported to the grid.

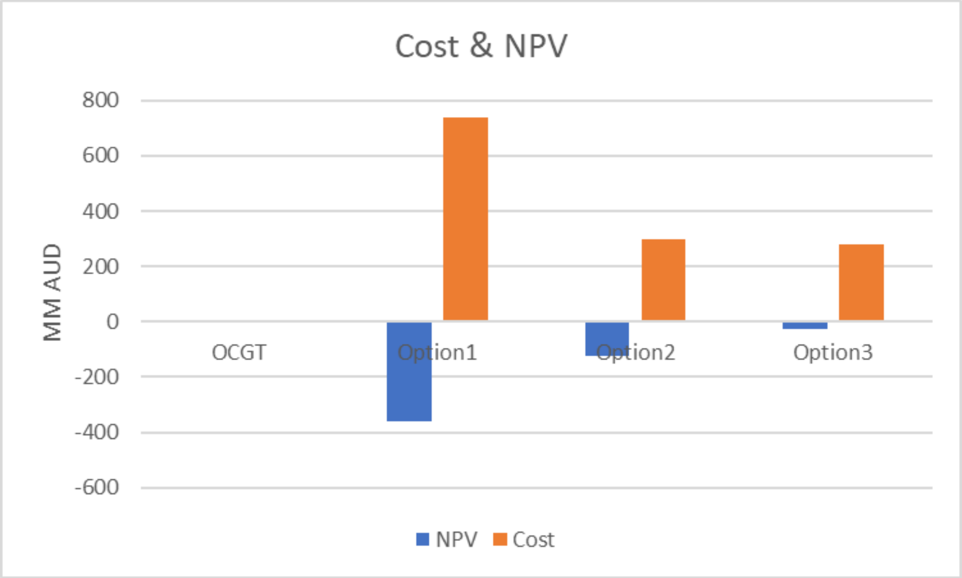
Option 3 – 53MW solar PV + Qty "n" Wind Turbines + Existing OCGT



Conclude that around 16 wind turbines will provide a reasonable reduction of CO_2 emissions for the overall plant while ensuring that the wind turbine capacity factor remains at around 18%. There is no point having more than 41 wind turbines in the plant since curtailed energy will be greater than the demand energy beyond this point.

Results – CO_2 Emissions, Plant Cost & NPV

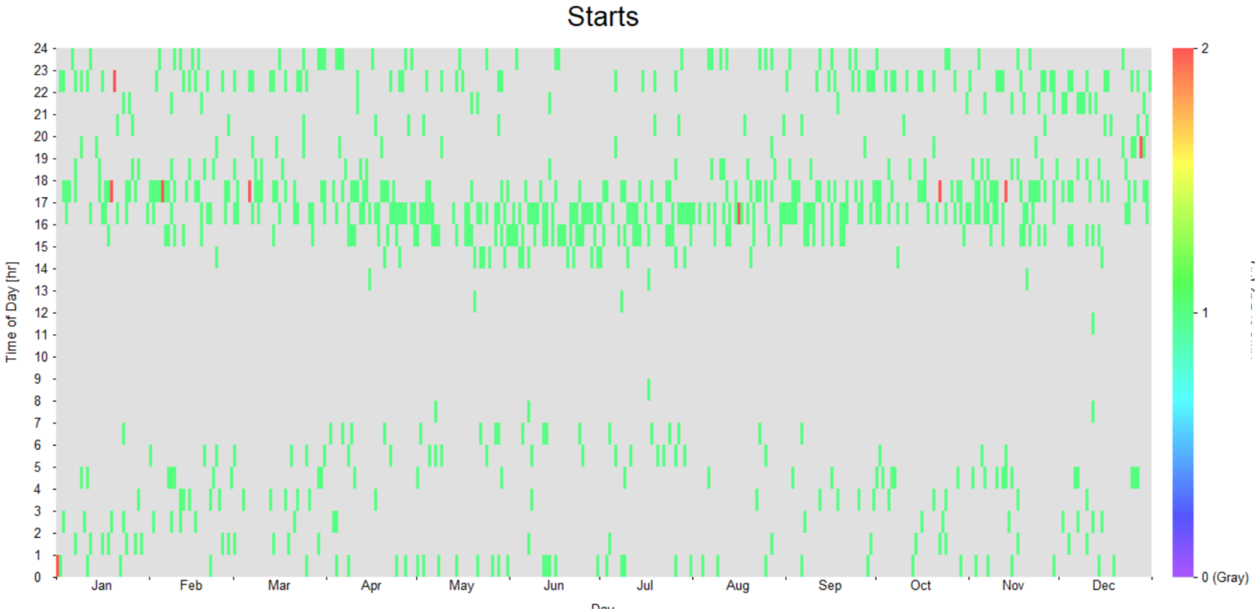


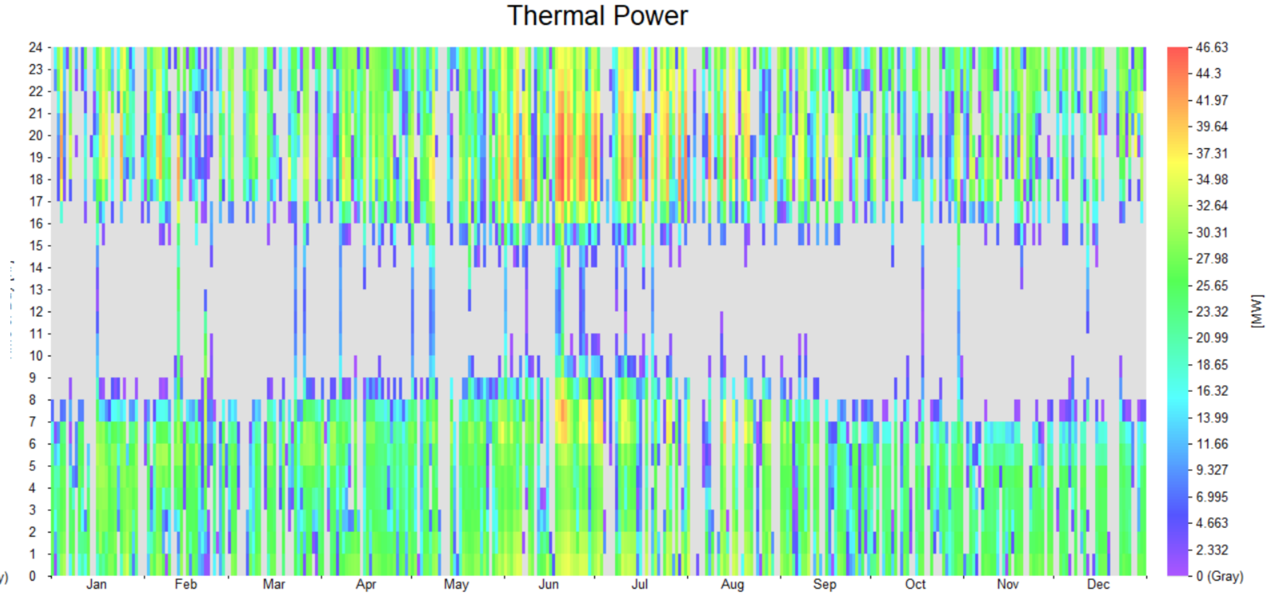


Option 3 may be a reasonable compromise in terms of CO_2 emissions and project cost/NPV

Option 3 – Implications for Existing OCGT in terms of plant starts

NOVO PRO predicts a very dynamic demand for the OCGT plant in terms of the plant starts - further investigation would be required to determine the suitability of the existing thermal plant for the anticipated duty.





Thank you!

Questions? Email us: info@thermoflow.com