AUSTRALIAN EARTH SCIENCE EDUCATION

Implementing Alternative Energy Student Worksheet

The conventional electricity grid

Providing electricity when and where it is needed is a complex task requiring more than 850 000 km of distribution grid in Australia. The National Electricity Market (Qld, NSW, ACT, Vic, SA, Tas) is one of the longest interconnected markets in the world. Maintaining grids is expensive and accounts for nearly half of every electricity bill.

Interconnected electricity lines allow power to be sourced from a variety of generation locations and types. The grid was not originally designed to store excess electricity. However, this is changing with the installation of the Hornsdale Power Reserve (using Tesla's Powerpack) in South Australia, construction of Snowy Hydro 2.0 and the increasing prevalence of small-scale household batteries.

Table 1: Electricity generation in Australia

Source	Availability in Australia	Response time	2020 energy mix
Coal	Large reserves (1000+ times annual consumption)	Slow – many hours	62%
Wind	Potential varies with region	Opportunistic – must be stored	9.9%
Solar	Generally high availability	Opportunistic – must be stored	9.9%
Gas	Moderate reserves (20+ times annual consumption)	Medium – tens of minutes	9.9%
Hydro	Limited large scale; affected by drought	Fast – tens of seconds	6.5%
Liquid fuels	Limited reserves (3 times annual consumption)	Medium – tens of minutes	0.1%

The remaining power generation is from biofuels and waste coal mine gas.

Case study: Agnew Microgrid

Gold Fields' Agnew Gold Mine in WA is on the edge of a privately owned power grid and 130 km from the nearest public town. The existing power grid is aging and could not fulfill all of the mines power needs.

The gold mine uses large amounts of electricity to process more than a million tonnes of ore every year. A stand-alone microgrid had the potential to provide a reliable source of power, reduce carbon emissions and achieve long-term savings in power costs by creating the mine's own power supply.

Hybrid Power Supply

The Agnew Microgrid gets power from a variety of sources:

- Five wind turbines (up to 18 MW)
- 10 000 solar panels (up to 4 MW)
- Gas fired generation (up to 18 MW)

The grid is stabilised by a 13 MW / 4 MWh battery that stores electricity and provides instant backup

if renewable power supplies suddenly drop out. Renewables provide more than 80% of electricity at the Agnew site in favourable conditions and more than 50% of overall electricity.

Cost of developing a microgrid

Electricity costs at Agnew account for approximately 15% of the cost of mining and gold production. The microgrid cost $112 million to install. The Federal Government's Australian Renewable Energy Agency contributed $13.5 million in funding.

Benefits of the microgrid

The renewable components of the microgrid reduce Agnew Mine's carbon emissions by 46 000 tonnes of CO_2 every year. This is equivalent to powering 11 500 homes or removing 12 700 cars from the road. The microgrid offers very reliable power to the mine and has attracted workers to Agnew who value working for a company that aims to mine sustainably.

Questions

1. What factors made it reasonable for Gold Fields to invest in a microgrid for Agnew Mines?

2. Explain why fossil fuels and batteries are part of the microgrid.

3. Use data from Table 1 to justify the use of gas as part of the microgrid rather than coal or diesel (liquid fuel).

4. Hydro power is rarely chosen for microgrids in Australia. Why do you think this is the case?

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5. What factors would make investment in a microgrid worthwhile? Why doesn't the Federal Government invest in neighbourhood microgrids? _____

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References:

Clean Energy Council (2021). Clean Energy Australia: Report 2021. https://assets.cleanenergycouncil.org.au/documents/resources/reports/clean-energy-australia/clean-energy-australia-report-2021.pdf

Clean Energy Council (nd). Technologies: Grid. https://www.cleanenergycouncil.org.au/resources/technologies/grid

EDL (nd). Agrew Hybrid Renewable Microgrid. https://edlenergy.com/wp-content/uploads/2021/01/EDL-Fact-Sheet-Agnew-Hybrid-Renewable-Microgrid-1.pdf

Gold Fields Ltd (2020). Renewables a natural choice for powering mining's future – the case of Agnew – Mining Australia. https://www.goldfields.com/in-the-news-article.php?articleID=9208