

Background

Households have electricity usage needs. This electricity can be purchased from an electricity provider or generated using solar panels.

Naomi has installed solar panels on the roof of her house to generate electricity from the sun. Currently the electricity generated from the solar panels is used to meet any electricity usage in the house at the time it is generated. This saves Naomi money on her electricity costs because it reduces the amount of electricity she needs to buy from her electricity provider.

Naomi currently receives no benefit or income for the electricity generated by the solar panels that exceeds her electricity usage. She is, therefore, considering purchasing and installing a battery that would store any excess electricity generated from the solar panels. The battery would then discharge its energy to satisfy Naomi's electricity usage at times when not enough solar power is being generated.

Electricity (including that generated by solar panels, stored in the battery and purchased from the electricity provider) is measured in kilowatt hours (kWh).

The battery that Naomi is considering costs \$7,000 and would be installed on 1 January 2022, with an expected working lifetime of 20 years. The battery can store a maximum amount of

12.5 kWh of electricity at any one time (and is subject to a minimum of 0 kWh). Any electricity generated from the solar panels when the battery is full will not be able to be stored. Electricity usage would first be met from current solar electricity generation, then from any stored battery energy and finally by paying for electricity from the electricity provider.

From 1 January 2022, Naomi will pay \$0.17 for each kWh of electricity purchased from her electricity provider. The electricity price increases with annual electricity price inflation on 1 January 2023, and each 1 January thereafter. A recent government report estimated electricity price inflation over the next 20 years to be 4% p.a. Naomi thinks that the global focus on climate change will cause electricity prices to rise faster than 4% p.a. and she

estimates that electricity price inflation may increase by an additional 0.25% p.a. year on year (i.e. an increase of 4.0% p.a. at 1 January 2023, 4.25% p.a. at 1 January 2024, 4.50% at 1 January 2025, etc.).

To help Naomi analyze whether installing a battery would be cost effective, she has installed a measuring device and provided you with data showing her solar electricity generation and electricity usage for 2020 in hourly increments. (Data has not been provided for 29 February. This date can be ignored.) Naomi has asked you to analyze the potential savings in her electricity costs from purchasing a battery. She has asked you to consider the data on an hourly basis.

QUESTIONS;

- (i) Carry out checks on the data provided to confirm that the data is complete and fit for use. This should include:
- creating a graph showing the average solar electricity generation and average electricity usage for each hour in a day, i.e. the average over all amounts for 1 am, and each subsequent hour within a 24-hour period.
 - investigating any significant outliers.
 - making any corrections that are needed.
- (ii) Calculate, for each hour in 2020, the amount of electricity that needed to be bought from the electricity provider (measured in kWh and subject to a minimum of zero).
- (iii) Calculate, for each hour in 2020, the excess solar electricity generated over electricity used (measured in kWh and subject to a minimum of zero).
- (iv) Model the cumulative battery charge level (measured in kWh) for each hour over 2020, assuming a battery had already been installed.
- The battery charge level should:
- begin at zero at 1 January 2020 00:00.
 - allow for the increase or decrease in charge level depending on the hourly results of parts (ii) and (iii).
 - be subject to the cap on the maximum battery charge level.
- (v) Calculate the amount of electricity for each hour in 2020 that would have been bought from the electricity provider (measured in kWh and subject to a minimum of zero), assuming a battery had already been installed.

Calculate the saving over 2020 (in dollars (\$)), using 1 January 2022 electricity prices and ignoring discounting) from installing a battery compared to using the existing solar panels alone.