Battery Cost Savings Model - Formal Report

1. Purpose of the Model

This model assesses the cost-effectiveness of installing a battery storage system in a solar-powered household. It quantifies savings in grid electricity costs when excess solar power is stored and reused, comparing scenarios with and without a battery over a 20-year horizon, under two electricity price inflation assumptions.

2. Data and Checks

Data Source: Hourly electricity usage and solar generation for 2020.

Columns:

- Hour
- time_stamp
- generation_(kWh)
- usage_(kWh)

Checks performed:

- Valid timestamp format
- 8760 rows

-Outliers(both negative and positive values) were found and replaced with adjacent mean values.

- Hourly average plots confirmed expected residential patterns after correcting outliers
- No significant anomalies were found after these corrections were done; data was deemed complete and fit for analysis.

3. Assumptions Used

- Battery cost: $7,000
- Lifetime: 20 years
- Max capacity: 12.5 kWh

- Discount rate: 6% per annum
- Electricity price (2022): $0.17/kWh
- Scenario 1: 4% inflation annually (Government estimate)
- Scenario 2: Starts at 4%, increases by 0.25% yearly (Naomi's estimate)
- Usage and generation patterns remain constant
- No battery degradation or feed-in tariffs considered.

4. Methodology

Hourly Modeling:

- Calculate grid electricity needed (no battery): max(usage - generation, 0)
- Calculate excess solar: max(generation - usage, 0)
- Simulate battery storage: store excess, discharge when needed
- Cap battery charge at 12.5 kWh, minimum 0 kWh

Monthly Aggregates:

- Summarized total generation, usage, and grid electricity for each calendar month

Financial Projection (20 years):

- Base savings from 2020 scaled using forecasted electricity prices
- Calculate NPV at 6% discount rate
- Calculate IRR using root-finding techniques

Each scenario (with and without battery, and under both inflation forecasts) is modeled separately.

5. Financial Results Summary

Scenario 1 (Government estimate - 4% inflation):

- NPV: approximately $ 1,906.73
- IRR: approximately 8.74%
- Conclusion: Financially viable (NPV is more than $7,000)

Scenario 2 (Naomi estimate - increasing inflation):

- NPV: approximately $ 2,979.29
- IRR: approximately 9.80%
- Conclusion: Financially viable investment

6. Reasonableness and Validation Checks

- Battery charge correctly bounded between 0 and 12.5 kWh.
- Hourly flows and balances checked via plots.
- Monthly aggregates match hourly totals.
- IRR calculations consistent with NPV trend.

Results are consistent with expectations for a typical solar-powered household with battery storage.

7. Recommendations

- Battery installation is financially justifiable under Naomi's inflation scenario.
- Assuming energy prices rise at 4% per year or more, the battery system yields between 8.74% and 9.80% annual returns — making it a strong long-term investment.

Suggestions:

- Investigate potential feed-in tariff policies.
- Consider lower battery installation costs.
- Explore higher usage scenarios or time-of-use tariffs.

Model is reusable for other households and future projections.