Deep Decarbonisation of Energy Systems: Foresight's Diversified Approach to Portfolio Construction

October 2024

Skaftåsen Wind Farm, Sweden, part of Foresight's portfolio

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Branden Victoria Solar Farm, UK, part of Foresight's portfolio

1. Introduction

“With increasingly complex interactions between different energy components, it has never been more crucial for investors to construct diversified portfolios that manage risks, while still delivering attractive returns.”

Dan Wells
Partner
Co-Lead of Foresight Energy Infrastructure Partners

In the evolving landscape of global energy systems, the shift towards decarbonisation has entered a pivotal new phase. With increasingly complex interactions between different energy components, it has never been more crucial for investors to construct diversified portfolios that manage risks, while still delivering attractive returns. From diverse renewable energy sources to the dynamics of energy storage and grid interconnections, Foresight’s diversified portfolio approach identifies abundant opportunities across Australia, Europe, and the UK.

The energy transition is fast accelerating, reflecting the growing recognition of the climate crisis and energy security risks associated with an over-reliance on fossil fuels.[1] In 2023, global investment in the energy transition hit a record $1.8 trillion,[2] up 17% from the previous year. c.$1 trillion of investment went to power generation, storage and grid infrastructure, with the remaining going towards clean industry and electrification of heat and transport.

Yet, the scale and scope of global investments in the energy transition need to expand significantly to achieve climate and socio-economic development goals. BNEF estimates that $79 trillion[3] of supply-side investment will be required over 2024-2050 to achieve net zero. Of this spending, $21.4 trillion[4] is needed to develop grid infrastructure that can support the broader distribution of renewable capacity, accommodate increased electrification of demand, and better manage variable and intermittent supply. This equates to an average annual investment requirement of c.$7.1 trillion up until 2050, four times the record investment level in 2023.

Achieving this significantly higher level of investment will necessitate greater participation from private market institutional investors. As more capital continues to be allocated into the energy transition, there is a need to think consciously about the portfolio-level implications of investing across a more diversified opportunity set.

[1] BNEF 2H 2023 LCOE Study, page 1
[2] BNEF Investment Trends 2024
[3] BNEF New Energy Outlook 2024
[4] BNEF New Energy Outlook 2024

Construction of Skaftåsen Wind Farm, Sweden, part of Foresight’s portfolio

2. Thesis statement

Investors who construct a diversified investment portfolio comprised of uncorrelated or negatively correlated assets across the renewable energy infrastructure spectrum, including generation, storage and grid assets, could unlock highly significant diversification benefits over two timescales:

1. Short run benefits

Including complementary resource profiles in the same portfolio could provide cash flow smoothing benefits, and improve the overall resilience of a variable portfolio level return.

2. Long run benefits

Different types of energy infrastructure technologies may respond differently to market risk factors, often in opposite directions. These patterns could enable the construction and optimisation of portfolios using a systems approach, managing risk levels more efficiently over the long term.

Bannerton Solar Farm, Australia, part of Foresight's portfolio

3. Importance of portfolio construction

The global energy transition is being driven forward at pace due to institutional capital flowing into clean energy infrastructure sectors. These capital flows are readjusting due to rapid cost declines from technology development, increasing social consciousness of climate change, a focus on sustainable investing and favourable policy developments across developed and emerging markets.

The energy transition, with a successful track record of attractive returns from greenfield development and an active secondary market, is now viewed as a mature infrastructure theme. As such, investors can invest broadly across various technology sectors and risk profiles.

This growth requires considering how multiple energy infrastructure investments can integrate within deeply decarbonised energy systems, especially in challenging macro-economic conditions.

Current research in portfolio construction highlights that diversifying across complementary resource profiles with negative correlations in production and revenue, could effectively reduce[5] risk and generate superior risk-adjusted returns. Negative or neutral correlations can therefore be viewed as key indicators of portfolio diversification potential. Correlational analysis across key data trends also provides valuable insights into optimal portfolio construction strategies.

[5] Downing, 2023, Swiss Federal Institute of Technology Zurich, 2019, Timera Energy, 2020

However, these diversification benefits have not yet been explored from a temporal perspective. Similarly, diversification across the broader spectrum of energy infrastructure assets—encompassing generation, storage, and grid sectors—plays a crucial role.

As such, we believe that future energy systems will be characterised by greater complexity as the decarbonisation of power continues. Of particular importance is the increasingly interconnected and interdependent nature of energy systems which are composed of large numbers of constituent parts, from renewable energy generating plants, to energy storage, transmission and distribution assets, and EV charging infrastructure. Power pricing dynamics, for example, are driven by a range of assets which interact with each other, in particular the generation profiles of different renewable sources, the nature of available energy storage and the levels of interconnection between grids.

For investors, understanding these dynamics and partnering with specialised managers who have the relevant expertise is crucial for navigating the complexities of the energy system. The key is to construct well-diversified investment portfolios that offer balanced exposure to energy system risks, while delivering attractive risk-adjusted returns.

Kövallen Wind Project, Sweden, part of Foresight's portfolio

4. Our unique insight

Hypothesis:

Short -run

Including complementary resource profiles in the same portfolio could provide cash flow smoothing benefits, improving the overall resilience of a variable portfolio level return.

Pooling data across an international portfolio of over 430 infrastructure assets, Foresight analysed its investments across the UK, Europe and Australia within sub-portfolios of complementary generation assets across the various markets. The analysis focused on three critical streams of data: asset production profiles, portfolio performance versus budget, and revenue generation.

The primary objective was to determine whether variation across complementary resource portfolios would exhibit negative or neutral correlations, indicating the potential for reduced portfolio risk and superior risk-adjusted returns from diversification.

1. With respect to analysis of production profiles, we found a -0.72[6] correlation across hydro and solar production in Europe (Appendix 1) and a -0.42 correlation across onshore wind and solar in Australia (Appendix 2).
2. In terms of production versus budget, a slightly weaker negative correlation of -0.24 was observed across solar and hydro generation (Appendix 3).
3. Looking at total revenue generated based purely on capture prices and stripping out subsidy or contracted revenue effects, a -0.41 correlation across hydro and solar in Europe (Appendix 4) was found. A correlation of -0.50 was found across wind and solar in Australia (Appendix 5).
4. When assessing production and revenue profile variations across regions, correlation of -0.80 between solar production in Europe and Australia (Appendix 6) and a correlation of -0.51 across Australian wind and European solar revenues (Appendix 7) were observed.

Our findings reveal that weak to strong negative correlations exist between production variance, performance against budget and revenue profiles of various complementary renewable energy generation resources. The findings suggest that portfolio diversification across technology profiles and geographies could lead to risk mitigation over the short term, and that a conscious approach to portfolio construction can help investors achieve superior risk-adjusted returns.

[6] A -1.0 correlation would be perfectly negatively correlated with a 0 equaling no correlation.

FEIP

Foresight Energy Infrastructure Partners (FEIP) aims to construct a portfolio of investments that exhibit complementary production and revenue profiles, evidenced by a degree of negative correlation to each other. Diversification across complementary natural resource profiles is intended to help smooth the cash flow of the fund investments and provide more stable income.

To illustrate this concept, the accompanying analysis examined the presence of negative correlations among complementary renewable energy generation technologies within the Foresight portfolio. Spanning recent years, the consistent results across various production and revenue profiles suggest that incorporating complementary assets into the same portfolio can provide significant risk mitigation and diversification benefits in the short term.

Kövallen Wind Project, Sweden, part of Foresight’s portfolio

4. Our unique insight continued

Hypothesis:

Long-run

Various types of energy infrastructure technologies may respond differently to market trends, sometimes even in opposing directions. This variation invites a more strategic approach to portfolio construction and optimisation, allowing for better risk management over the long term through a systems-based perspective.

Different types of energy infrastructure earn their revenues in different ways: (i) renewable generation assets primarily earn revenues in payment for the power they generate; (ii) storage assets primarily earn their revenues through the spread between high and low power prices (trading or arbitrage revenues) and the provision of ancillary services to the grid operators, and (iii) grid assets primarily earn their revenues through a combination of regulated revenues, availability payments, capacity payments and ancillary service revenues from grid operators.

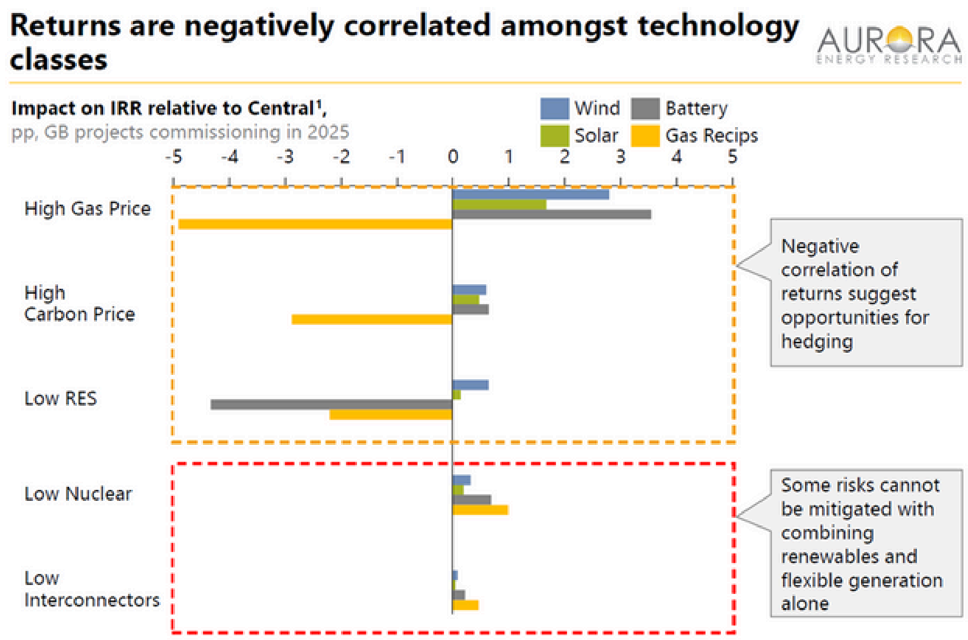
Constructing portfolios with these different types of assets (generation, storage, and grid) could be advantageous due to their varying correlation profiles, which are often negatively correlated.

By harnessing these negative correlations through the construction of diversified energy infrastructure portfolios, investors could capture significant long-term, portfolio-level benefits. In turn, these might help provide superior risk-adjusted return from energy transition investing.

To test this, Foresight worked with a UK power market consultant, Aurora Energy Research, to analyse multiple trend-based risk scenarios that may play out in the energy sector over time.

Considering trends in key risk factors such as carbon pricing, gas pricing, renewables, nuclear deployment, and interconnection, deviations from central case returns were modeled for various technology sectors, as illustrated below.

Return deviations from key market risk factors



The findings showed that different technology types exhibited opposing return deviations, highlighting the possible existence of long-term negative correlations. Such correlations suggest that portfolio-level diversification would contribute to more resilient, risk-adjusted returns. For example, an excess supply of renewable energy sources, such as wind and solar, may lead to lower capture prices for these generation assets. Conversely, this oversupply benefits storage assets, such as batteries and gas reciprocating engines, which can capitalise on increased volatility and earn more from price fluctuations.

4. Our unique insight continued...

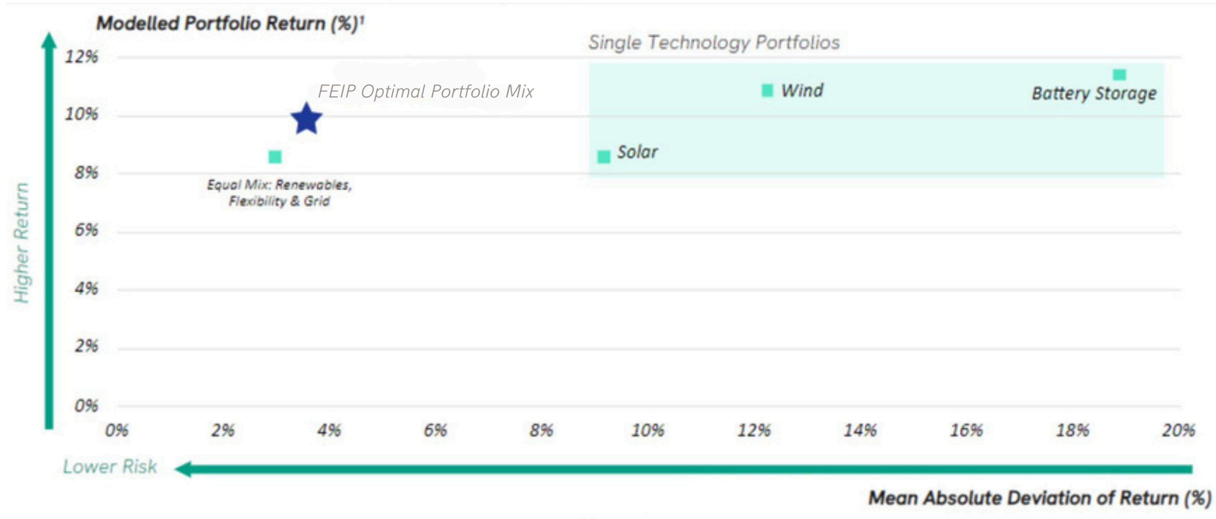
Plotting the mean absolute deviations against (central case) returns for different investment portfolios (single technology versus diversified) reveals a key finding; well diversified energy infrastructure portfolios could achieve a superior risk-adjusted return.

By integrating complementary technologies into a blended and diversified portfolio, the resulting mix can be seen to achieve an average return while significantly reducing risk. Thus enhancing the portfolio's overall risk-adjusted performance

The analysis suggests that investors who invest in a diversified portfolio of complementary renewable energy assets have the potential to unlock superior risk-adjusted returns, through risk mitigation and portfolio diversification.

Through extensive portfolio modeling, Foresight collaborated with Aurora Energy Research to determine the optimal portfolio mix. The FEIP strategy is designed to deliver the highest risk-adjusted returns to investors.

Risk and return of modeled energy infrastructure portfolios



[7] Source: Aurora Energy Research. Returns modelling was conducted based on performance of UK-based projects, reaching commissioning in 2025

Foresight Energy Infrastructure Partners

FEIP aims to combine complementary investments with long-term negative correlations to reduce portfolio risk and enhance risk-adjusted returns. For example, while renewable energy build-out rates may negatively impact solar and wind generation revenues, they positively affect energy storage and interconnectors due to increased volatility in wholesale power prices.

The graph above illustrates the risk and return of three technology-specific portfolios compared to the optimal portfolio mix, which represents FEIP’s target portfolio. The analysis revealed that although the target portfolio returns were in the mid-range compared to technology-specific portfolios, the overall risk—measured by the mean absolute deviation of returns—was significantly lower.

Conclusion

The analysis highlights the advantages of building a well-diversified energy infrastructure portfolio. By incorporating complementary risk and return profiles, such a portfolio offers the potential for significant diversification benefits, enhancing risk mitigation across both short-term and long-term investment horizons. Furthermore, deploying capital into storage and grid assets alongside renewable energy generation can be seen as essential for maintaining system flexibility and reliability, especially as the penetration of renewables increases.

Looking ahead, investors should analyse their capital deployment programs holistically, ensuring exposure to different asset types and technologies, as well as geographies. This strategic approach allows for more effective risk mitigation and attractive returns, particularly in the face of evolving market dynamics and power market fluctuations.

Bald Hills Wind Farm, Australia, part of Foresight's portfolio

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Appendices

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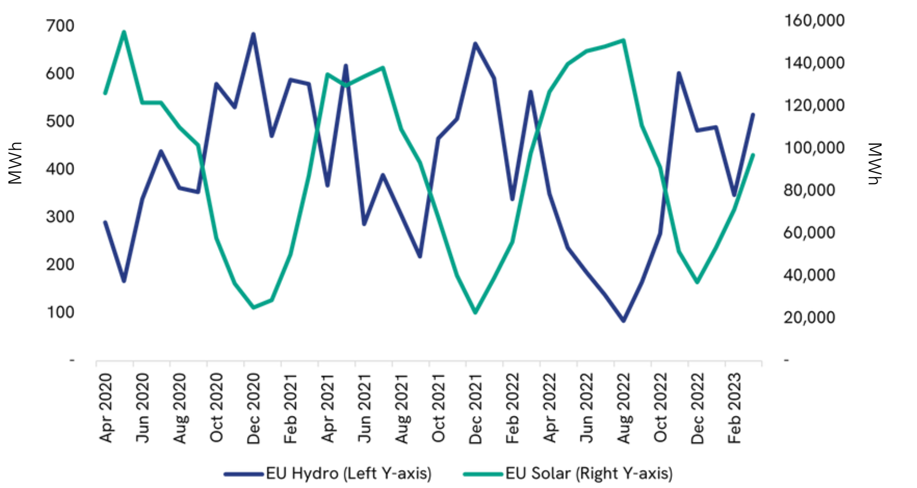
Porttfolios of assets with the prefix (“EU”) include assets in the UK and across Europe, with revenues denominated in GBP.

Portfolios of assets with the prefix ("AU") include assets in Australia, with revenues tracked in AUD.

Appendix 1

Hydro and solar production profiles across Europe

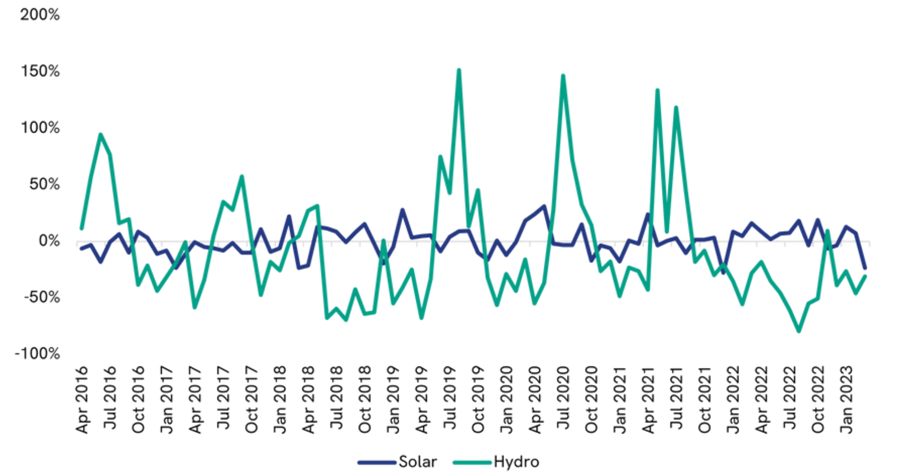
Correlation of -0.72



Appendix 3

Hydro and solar production deviation versus budget profiles

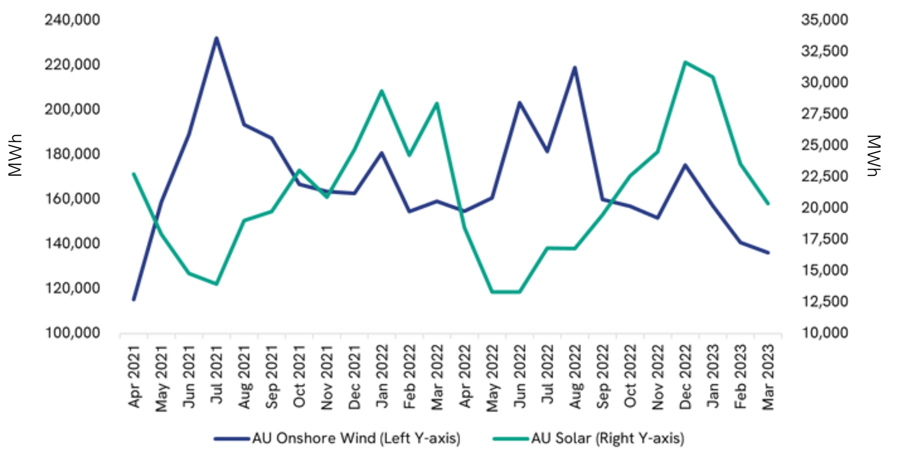
Correlation of -0.24



Appendix 2

Wind and solar production profiles across Australia

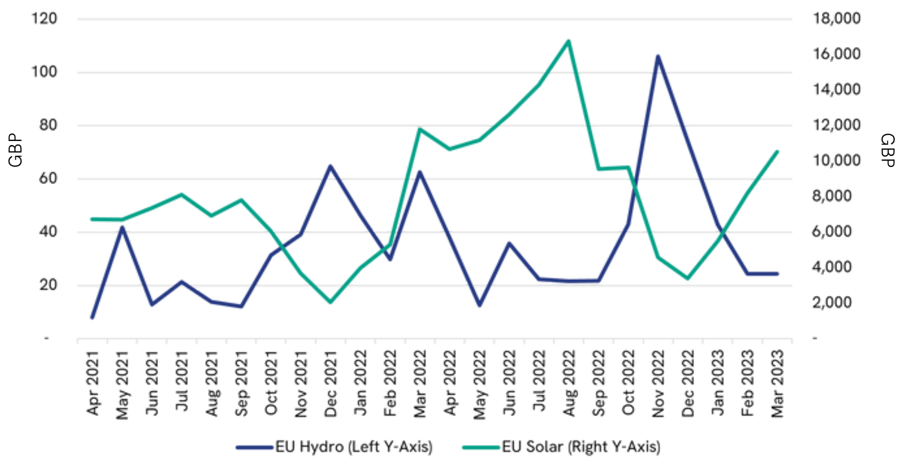
Correlation of -0.42



Appendix 4

Hydro and solar revenue profiles across Europe

Correlation of -0.41

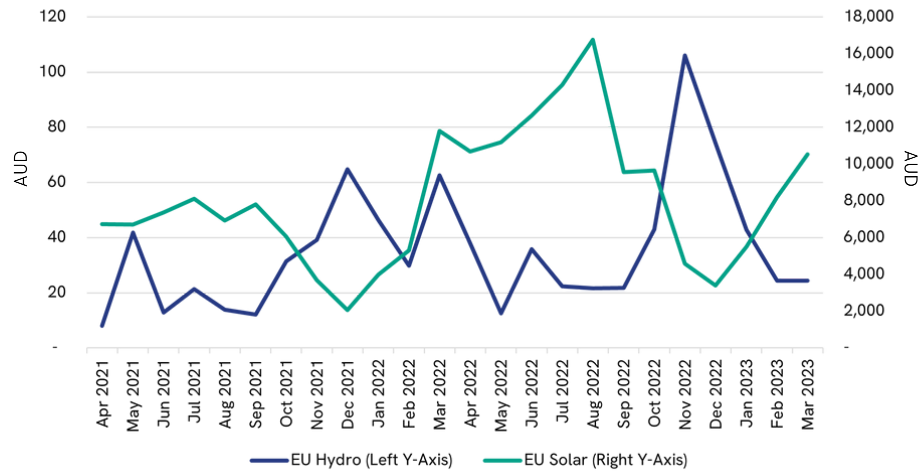


Appendices

Appendix 5

Wind and solar revenue profiles across Australia

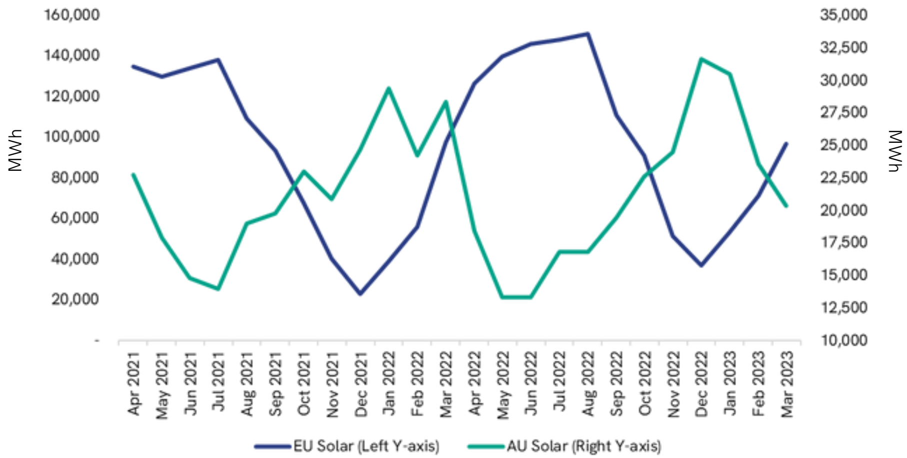
Correlation of -0.50



Appendix 6

Solar production profiles across Europe and Australia

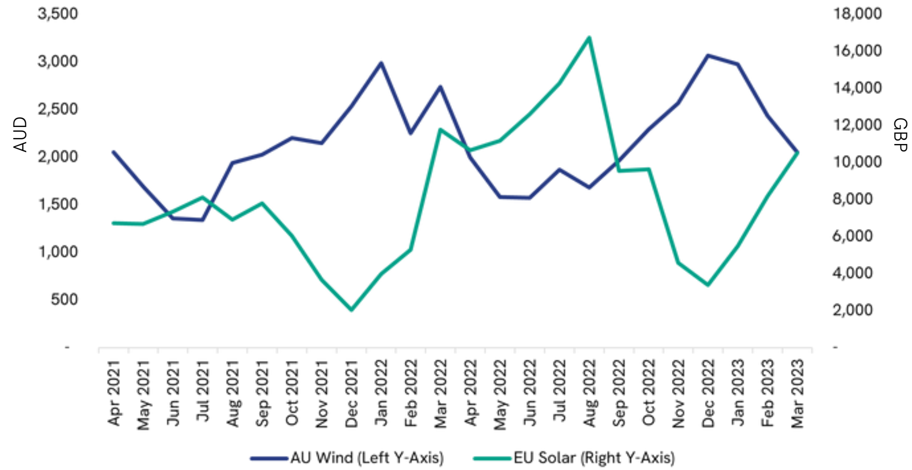
Correlation of -0.80



Appendix 7

Wind and solar revenue profiles across Australia and Europe

Correlation of -0.51



Note: Although these sub-portfolios have different capacity sizes, their variation in terms of production and revenue profiles are comparable for correlation analysis.

There are a few ways in which this analysis could be extended in the future. These include:

- *Reinforcing the validity of data from existing operational assets over longer time periods and a wider geographic catchment.*
- *Expanding analysis of long-run portfolio diversification benefits, through modeling a greater range of risk scenarios.*
- *Examining the influence of including a wider range of energy transition technologies, such as green hydrogen, pumped hydro storage or grid interconnectors.*

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