Hitting the target with portfolio engineering

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According to the International Energy Agency's latest world outlook report, reaching the critical but formidable goal of net zero emissions by 2050 will require major efforts from across society, though it will also offer major advantages in terms of human health and economic development. Certainly, the inherent intermittency of renewable energy sources and the effect that has on stable grid operations will become more pronounced, putting obstacles in the way of the energy transition.

Successful portfolio building can decrease that variance and enhance the ability to fund the extensive pipeline of projects required for the aims of the energy transition to be achieved. In the context of a renewable energy-powered world, this must be done in a precisely targeted way to better manage the inherently stochastic nature of renewable energy. This will directly contribute to freeing up the path to financing the unprecedented volumes of new renewable energy infrastructure that is required for the energy transition to achieve its goals quickly and sustainably.

Portfolio creation in electricity generation is not a new art, however in practice it is sometimes less mature than an established science.

The assortment of power-producing assets that vary in technology, feedstock fuel, or geographic location is a key component of every modern energy system, and is designed to minimize disruptions and optimize economic operation. With renewables-dominated energy systems, which are progressively the case as we move towards zero emissions, the aim remains the same, but the tools to achieve that will have to differ. Renewable energy output is intermittent, as the renewable input resource itself is stochastic and non-controllable. We can aim to manage this inherent volatility better and create portfolios that are fit-for-purpose for the energy transition by encompassing targeted diversification over the resource itself, namely wind or solar irradiation.

The journey so far

To date, portfolio creation has typically involved tiering layers of baseload technologies, like nuclear and previously coal-fired power plants, followed by layers of more versatile, dispatchable-on-demand technologies, for example gas-fired or hydroelectric assets that can ramp production up or down at will and at short response times. This is needed to compensate for the top-tier being occupied by the more stochastic production of renewable energy sources.

When there is high production from renewables, these systems can compensate by dampening production at the middle tier or, where possible, by reversing hydroelectric capacity to store the excess. Both are safer and more economic solutions than ramping down baseload capacity. When there is low wind, causing low renewable energy injections to a grid, the middle tier can swiftly ramp up production to fill in the gaps. This can be further augmented by storage systems, most commonly hydroelectric dams, battery storage or power-to-hydrogen and hydrogen-to-power assets, which are able to further store and release energy to balance grids.

In energy mixes that are dominated at ever-growing levels by renewable energy, due to the transition of the electricity sector, the first two tiers are compressed and, eventually, certain technologies like coal are being phased out. These baseload technologies will no longer be intended to carry the system load by design, which will be accomplished by renewable energy instead.

Illustrating the speed at which this change is happening, Germany's energy mix has transitioned to a state where production by renewables increased by 50% in the period between 2015 and 2020. Simultaneously, coal and nuclear electricity generation decreased by 40%. Balancing was possible by an increased participation of gas generation to the energy mix.

Redesigning the process

The big question is how do we bridge the opposing forces of the need for more green energy and the adverse effect that has on stable grid operations? The solution contemplated here is that this may be addressed efficiently by taking a fresh look at how to optimally arrange generating assets for a better portfolio build-up, beyond and above the necessary augmentation of these systems with built-to-scale storage technologies.

Diversification over the renewable input resource, be it windiness or solar irradiation, has so far been focused on creating portfolios of randomly dispersed generating assets. Provided that the dispersion is not insignificant, different locations, in some cases even locations that are a mere 100km apart, can be exposed to different weather patterns and therefore reap some degree of portfolio effect. This is common practice amongst balancing groups, where wind farms team up to bid jointly for their participation to the day-ahead planning, aiming to reduce volume risk.

Another level to this approach is the pairing of wind and solar assets to flatten seasonal variances, as solar production typically peaks in the summer months, whereas winds blow stronger, denser and for longer during winter. This is part of the goal-seeking that shapes national energy mix strategies, which favour and incentivise the deployment of all available renewable energy technologies.

In summary, portfolio-building has shown beneficial effects on risk, as it spreads and thereby reduces overall technical risks, including outages. It further lowers commercial risk, flattens variances, and thereby enhances

H1

Q1

Asset	A	B	C	D	E	Portfolio, quarter
A	1.0	0.5	0.5	0.1	0.2	0.5
B	0.5	1.0	0.7	0.3	0.2	0.5
C	0.5	0.7	1.0	0.3	0.1	0.5
D	0.1	0.3	0.3	1.0	0.9	0.5
E	0.2	0.2	0.1	0.9	1.0	0.5
Portfolio, quarter	0.5	0.5	0.4	0.4	0.4	1.0

Q2

Asset	A	B	C	D	E	Portfolio, quarter	Portfolio, half-year
A	1.0	0.8	0.1	-0.2	-0.4	0.2	0.4
B	0.8	1.0	-0.1	-0.3	-0.4	0.2	0.4
C	0.1	-0.1	1.0	-0.4	-0.2	0.1	0.3
D	-0.2	-0.3	-0.4	1.0	0.6	0.1	0.3
E	-0.4	-0.4	-0.2	0.6	1.0	0.1	0.3
Portfolio, quarter	0.4	0.3	0.3	0.1	0.1	1.0	1.0

H2

Q4

Asset	A	B	C	D	E	Portfolio, quarter
A	1.0	0.7	0.3	0.1	0.2	0.5
B	0.7	1.0	0.1	0.2	0.1	0.4
C	0.3	0.1	1.0	0.2	0.0	0.3
D	0.1	0.2	0.2	1.0	0.5	0.4
E	0.2	0.1	0.0	0.5	1.0	0.4
Portfolio, quarter	0.5	0.4	0.3	0.4	0.4	1.0
Portfolio, season	0.5	0.4	0.3	0.4	0.4	1.0

Q3

Asset	A	B	C	D	E	Portfolio, quarter	Portfolio, half-year	Portfolio, annual
A	1.0	0.6	0.5	0.0	-0.5	0.3	0.4	0.4
B	0.6	1.0	0.0	-0.3	-0.4	0.2	0.3	0.3
C	0.5	0.0	1.0	-0.4	-0.4	0.2	0.2	0.3
D	0.0	-0.3	-0.4	1.0	0.6	0.2	0.3	0.3
E	-0.5	-0.4	-0.4	0.6	1.0	0.1	0.2	0.3
Portfolio, quarter	0.3	0.2	0.2	0.2	0.1	1.0	1.0	1.0
Portfolio, season	0.3	0.2	0.2	0.2	0.1	1.0		

Scale: 1.0, 0.9, 0.8, 0.7, 0.6, 0.5, 0.4, 0.3, 0.2, 0.1, 0.0, -0.1, -0.2, -0.3, -0.4, -0.5, -0.6, -0.7, -0.8, -0.9, -1.0

the financeability and bankability of a cluster over that of its constituents.

This can now be driven forward to the next level with appropriate, targeted portfolio engineering, following a quantified deterministic approach.

The first step is to statistically measure the intensity, profile and variance of the input resource across a wide geographic area, for instance across the European continent. Weather patterns must be identified with descriptive statistics over relevant time frames, which can span from hourly through to seasonal and even annual. Climate change scenarios are then utilised to predict the evolution of these patterns over a time frame matching the useful life of these generating assets, spanning up to three decades.

Next, each new asset under consideration for inclusion in a portfolio is analysed in an iterative process in terms of its correlation to the group, after adjusting for installed capacity and captured market prices. A positive addition to the group will be expected to contribute a negative correlation to the aggregate assets of the group over the appropriate periodicity. These appropriate time intervals are different depending on the desired goal: when it comes to enhancing security of supply, correlation on an hourly basis is more relevant.

Augmented by sufficient storage capacity, which is a key enabler of the energy transition, the significance of hourly mismatches becomes less relevant and the right time span becomes rather days or weeks. Seen from a different perspective, when it comes to enhancing asset financeability and bankability, decreasing EBITDA variance, or lowering insurance risks, the more appropriate time frame is semi-annual or annual in length.

As a final step, climate change scenarios are overlaid and the same analysis is repeated in a depth of time of up to three decades, as explained above, aiming to establish whether the reverse correlation pattern detected can be relied upon for the useful life of these investments.

The result is the refinement of the selective process for the creation of electricity generating portfolios. These can feature a significantly lower aggregate variation coefficient by up to 10%, according to independent estimates. That is often enough to bridge the P90 to P50 production gap of wind farms and stabilize portfolios at or near the P50 levels.

This is overwhelmingly beneficial to all stakeholders: the higher output predictability is certainly welcome at the grid level, where it enables a more economic and stable operation, and very importantly also a dispersed production across zones or interconnected markets, reducing grid losses.

In competitive interconnected markets, these benefits will be passed through directly to end-consumers. Individual producers within any given portfolio benefit from a decreased risk of mismatches with their day-ahead bids, as their pooled productions are aggregated before they are included in the day-ahead planning. Off-takers experience less input volatility, allowing them to have to work less hard, and take less risks, to match to their supply contracts.

The result is that equity investors may enjoy an enhanced investment attractiveness at portfolio level, which in turn enhances the ability to fund the extensive pipeline of projects required for the aims of the energy transition to be achieved. Similarly, lenders are able to take significantly lower risk at portfolio level, thereby finding it markedly easier to extend credit to such pooled projects, possibly even without the need for long-term offtake arrangements.

In conclusion, portfolio building in a renewable energy-powered world can -and quite likely must- be done in a precisely targeted way to better manage the inherently stochastic nature of renewable energy. This will directly contribute to freeing up the path to financing the unprecedented volumes of new renewable energy infrastructure that is required for the energy transition to achieve its goals quickly and sustainably.

Biography

Christos Kosmas is a finance executive specializing in asset management and structured finance in the energy infrastructure sector.