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ENERGY RESEARCH

AEMO SERVICES

# LTESA contract modelling: Analytical comparison of fixed-shape fixed-volume vs generation following contracts

Public Report

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# Details and disclaimer

**Key contacts**
**For further queries, please contact:**

**Weijie Mak**
**Head of Commissioned Projects, APAC**
**(weijie.mak@auroraer.com)**

**George Prassas**
**Project Leader**
**(George.Prassas@auroraer.com)**

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# Agenda

# Context and report summary

**Context**

In December 2020, the Electricity Infrastructure Investment Act was formally enacted, detailing the NSW Government's plans to transform the electricity system into one that is cheap, clean and reliable. Crucial to the delivery of its ambitious plan is the buildout of 12 – 14 GW of new build renewables capacity (and long-duration storage), which would be supported by Long Term Energy Service Agreements (LTESAs), by 2030.

Under this context, Aurora Energy Research (Aurora) was commissioned by AEMO Services to undertake an extensive NEM-wide power market modelling exercise to analyse the costs and risks associated with Fixed-Shape-Fixed-Volume (FSFV) and Generation-Following (GF) contracts. Four market scenarios were modelled for the purpose of this exercise:

1. **Equilibrium LTESA Scenario** - An equilibrium scenario to build a baseline for assessing outcomes/potential risks of contractual structures for project developers, the Scheme Financial Vehicle (SFV) and consumers. The scenario is modelled closely after the Aurora 2021 Q1 Central
2. **Non-equilibrium scenarios** – Three non-equilibrium scenarios were modelled to "stress-test" and quantify risks to consumers, project developers and the SFV. These scenarios include: (i) *Low wholesale price/high renewables output* scenario which depresses wholesale prices; (ii) *Extreme high prices* scenario which result in significant price volatility; and (iii) *Low renewables output/weather year scenario* which reduces renewables output while increasing wholesale prices

This report contains the key assumptions, analysis, and findings derived from our modelling of the FSFV and GF contractual structures. The report has been designed alongside extensive discussions/consultation with AEMO Services. It is not aimed at providing any recommendations and should not be interpreted as a reflection of Aurora's views and/or support for either contract structure.

**Report summary**

The analysis presented in this report shows that FSFV and GF LTESA contracts can reduce the cost-of-capital to potential LTESA projects, in turn reducing the cost to consumers. The Generation-Following contract comes at a higher risk to the SFV as project output risk sits with them. Under the FSFV contract, the developer wears the delivery risk, and if they were required by either economic incentives or financing to mitigate these risks it would erode the value of the contract and result in a higher cost to the consumer.

This document presents the key findings that emerged from Aurora's extensive power market modelling exercise of contractual structures with the following sections:

A. **Project overview and executive summary –** An overview of the context for the project and the purpose of this report. Key takeaways and snapshots of key results are also included here

B. **NEM wholesale market modelling approach and key inputs assumptions –** A summary of Aurora's modelling approach for this project, alongside detailed explanation for all scenarios modelled and key input assumptions used for NSW and other NEM states

C. **NEM wholesale market key outputs for LTESA scenario –** Key results for NSW power market outcomes, including wholesale time-weighted average prices, renewables dispatch-weighted average prices , capacity and generation mix, and marginal loss factors assumed for the project

D. **Contract modelling approach and key assumptions –** A summary of contract taxonomy and key assumptions, and a detailed overview of the modelling approach for both FSFV and GF contracts

E. **Analytical outcomes of FSFV vs GF under Equilibrium LTESA Scenario analysis –** Key insights on the impact of FSFV and GF contracts on the cost of financing assets (both WACCs/LCOEs), including the cost of firming FSFV assets. Full deep-dives of the key analytical outputs are explored throughout this section of the report

F. **Analytical outcomes of FSFV vs Generation-Following contracts under non-equilibrium scenario analysis** – Key insights on the impact of alternative power market outturns on the cost of financing and firming for FSFV and GF contractual structures. This section provides a deep-dive on the additional firming requirements, cash flows considerations and wholesale prices across the "stress-test" scenarios

All prices in this report are shown in real 2021 values (as of 30th June 2021).

Source: Aurora Energy Research

# Key takeaways

| | Key takeaway | Details/insights | Section |
|---|---|---|---|
| 1 | LTESA contracts could result in a significant reduction in WACCs of 3.6 – 4.8 p.p. for GF contracts, but reductions under FSFV contracts are far more limited to as little as 2.2 p.p. due to the cost of firming | ▪ By providing assets with a predictable/guaranteed price option, LTESA-contracts would reduce the cost of financing assets over the course of the 20-year LTESA contract (even if the option is not exercised)<br>▪ However, the gains are limited under FSFV-contracts due to the additional firming costs/risks. In a case where the asset was required to perfectly firm itself for every MWh of production, gains from the LTESA-contract could be almost entirely eroded by additional costs of firming<br>▪ Under GF-contracts, WACCS reduce by 3.6 – 4.8 p.p., but reductions under FSFV contracts are limited to 2.2 p.p. – 4.8p.p.<br>▪ While GF-contracts see a reduction in LCOEs[1] of 20-25%, FSFV contracts are not expected to see notable decreases in LCOEs due to the cost of firming | Section V.1 |
| 2 | The costs of firming FSFV-contracts will not only be borne by developers, but also consumers and project financiers as additional physical firming capacity will need to be developed | ▪ Firming fixed shape fixed volume contracts will necessitate an additional 1 - 4 GW of firm dispatchable capacity relative to generation-following contracts (for a total of 14 GW). With coal retirements, existing assets will only be able to make up 5.7 GW of this.<br>▪ Firming FSFV will therefore entail notable costs/risks to: (i) consumers who will have to pay for 1 – 4 GW of additional firming capacity due to the contractual structure of FSFV; (ii) developers who would have to build firming capacity due to uncertainty over future availability of firming capacity; and (iii) project financiers who are unlikely to finance FSFV projects due to uncertainty of firming capabilities | Section V.4 |
| 3 | Firming LTESA-contracts will be complex and will require a range of technologies with differing capacities and duration. This is best managed on a portfolio basis either by larger gen-tailers/developers, or the Scheme Financial Vehicle (under GF) | • Firming LTESA contracts will require a range of technologies that differs by capacity and duration – renewable assets could be short of their contractual positions for several consecutive days which limits the role of short-duration batteries<br>• Firming assets by individual developers could therefore be prohibitively costly and challenging – developers might have to build extremely long-duration storage to cater for occasions where production is persistently short<br>• These risks are better managed by larger developers/gen-tailers who would be able to firm their portfolio across different assets (both renewables and dispatchable firming technologies)<br>• Under GF contracts, these risks are pooled across assets and reduced in aggregate for the Scheme Financial Vehicle | Section V.4 |
| 4 | Risks of under-production/firming result in lower exercising/contracting under FSFV contracts relative to GF contract; onshore wind sees higher risks than solar | ▪ Due to inherent risks in FSFV-contracts when assets are short their contracted positions, assets are: (i) more likely to under contract their expected production profiles/volumes compared to a GF contract; and (ii) less likely to exercise their options<br>▪ The risks of FSFV-contracts are more prominent for onshore wind assets than it is for solar due to the variability of wind production across the day/weather-years<br>▪ For example, an optimised onshore wind asset is expected to contract to a lower POE 65 shape, while solar contracts to POE 85. In terms of exercising the LTESA contract, onshore wind is only expected to exercise the LTESA for 10 years (out of a 20-year LTESA), as compared to Solar which exercises this for 14 years | Section V.2, V.3 |

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[1] Levelized Cost of Energy.

Sources: Aurora Energy Research

# Key takeaways

| | Key takeaway | Details/insights | Section |
|---|---|---|---|
| 5 | Risks to FSFV contracts are further highlighted under non-equilibrium stress test scenarios where WACCS could increase by up to 1.5 – 2 p.p. | ▪ Three non-equilibrium scenarios were modelled to “stress-test” the modelled LTESA scenario. These alternate scenarios are expected to reflect the key (but not exhaustive) considerations faced by developers/project financiers when undergoing an assessment of their contract:<br>▪ **Low wholesale prices/ high renewables buildout** – Higher renewables buildout reduces wholesale power prices. This encourages the asset to more frequently exercise the contract.<br>▪ **Extreme high prices**– Modelled after a “Callide-style” event where wholesale prices were significantly higher, increasing the liability when asset is short.<br>▪ **Low renewable output/weather year** – Extended low renewable output results in (i) greater need for firming; (ii) higher wholesale prices when asset is caught short<br>▪ Relative to an equilibrium scenario, GF contracts see little changes to WACCs in the non-equilibrium outcomes while FSFV contracts could see an increase in WACCS of up to 1.5 – 2 p.p<br>▪ LTESA projects contracting 100% of their generation under the LTESA GF contract are able to avoid market downside by exercising the contract and benefit from merchant exposure by selecting to not exercise the contract for the two-year swap period where volatility is anticipated (however, this volatility is difficult to anticipate)<br>▪ While downside risks are higher, FSFV could also see potential upside benefits – being less contracted, the asset is more likely to be long than it is short of its contracted position. Therefore, FSFV-contract holders could see higher merchant revenues in periods where prices are higher (e.g. during price spikes) . | Section VI.1 |
| 6 | FSFV assets could have sufficient financial coverage to firm themselves for a week of $1000/MWh prices and prolonged wind drought, even under non-equilibrium scenarios. Nonetheless, holding cash reserves adds additional financial costs to projects | ▪ FSFV assets are expected to under-contract their expected production due to the risks of being short its contract position<br>▪ Under an optimal-sized outcome, assets are therefore more likely to be, both financially and physically, long of its contracted positions than short over the asset life-time<br>▪ While there are inherent risks in an FSFV-contract, asset is expected to be able to accumulate a reasonable cash reserve to tide over prolong periods of high price spikes and low renewables production<br>▪ However, this could still be challenging for project financiers as conditions/covenants might have to be put in place to ensure that accumulated net cash-flows are set aside for working capital/liquidity reserves to prevent insolvency, which ultimately translates into additional financing costs to these projects | Section VI.2 |

Sources: Aurora Energy Research

# Aurora has constructed an "LTESA Scenario"[1] based on Aurora's Q1 2022 Central outlook to analyse the implications of LTESA contract structures

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| | | Aurora Central | LTESA scenario[1]<br>(Used for analysing LTESA contract structures) |
|---|---|---|---|
| **Policy** | **Federal emissions policy** | ▪ Retention of the LRET in its current form and no specific $CO_2$ emissions target for the NEM | • As per Aurora Central |
| | **State schemes** | ▪ NSW: EIR partially met: ~10GW renewables by 2030 (out of a target of 12 GW), and 1GW pumped hydro by 2035 assumed<br>▪ QRET, SRET, VRET and TRET not met | ▪ NSW: EIR[1] partially met: ~10 GW of new renewables by 2030 (out of a target of 12 GW), and full buildout of long-duration storage under roadmap (i.e. +3 GW pumped hydro by 2036)<br>▪ QRET, SRET, VRET met, and ~90% renewable penetration by 2040 in all states |
| **Demand** | **Underlying demand** | ▪ Aurora in-house modelling, refer to Market Modelling Inputs | ▪ As per Aurora Central |
| | **DER** | ▪ Aurora in-house modelling, refer to Market Modelling Inputs | ▪ As per Aurora Central |
| **Commodity prices** | **Gas prices** | ▪ Aurora in-house global commodity price modelling - LNG netback prices, refer to Market Modelling Inputs | ▪ As per Aurora Central |
| | **Coal prices** | ▪ Aurora in-house global commodity price modelling – coal export price for uncontracted, non-mine-linked coal plants, refer to Market Modelling Inputs | ▪ As per Aurora Central |
| **Supply** | **Coal closures** | ▪ AEMO's latest (February 2022) announced closure timeline with the exception of a few assets (see slide 14) | ▪ AEMO's expected closure timeline + updated with latest with latest asset specific news (e.g. Eraring).<br>▪ See slide below |
| | **Technology costs** | ▪ Aurora in-house modelling, refer to Market Modelling Inputs | ▪ As per Aurora Central |
| | **New Hydro** | ▪ Kidston from 2025, Snowy 2.0 included from 2027 and 1GW of pumped hydro in NSW via the Electricity Infrastructure Roadmap | ▪ Kidston from 2025, Snowy 2.0 included from 2027 and +3GW of pumped hydro in NSW via the Electricity Infrastructure Roadmap |
| **Network augmentation** | **Inter-regional** | ▪ AEMO 2022 ISP Step Change Optimal Development Pathway unless otherwise stated: EnergyConnect, QNI & VNI upgrades, QNI Connect, VNI West and Marinus Link (Stage 2 not included) | ▪ As per Aurora Central |
| | **Intra-regional** | ▪ AEMO 2022 ISP Step Change Optimal Development Pathway and their effect on the network capacity of each REZ (refer to Market Modelling inputs) | ▪ As per Aurora Central |
| **Marginal Loss Factors** | **Endogeneity** | ▪ Aurora methodology that factors in grid limits and robustness of MLFs into build decisions and asset specific MLFs incorporated into short-run marginal costs and therefore bidding behaviour | ▪ As per Aurora Central |
| **Bidding behaviour** | **Scarcity pricing / Uplift** | ▪ Purpose-built uplift function - capturing the deltas between price and the short-run marginal cost of the marginal generator, based on historical behaviour | ▪ As per Aurora Central |

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1) Scenario has been designed following consultation with AEMO Services.

Source: Aurora Energy Research

# Comparison of the Fixed Shape Fixed Volume and the Generation Following contract structures

| Contract taxonomy | Fixed Shape Fixed Volume | Generation Following |
|---|---|---|
| Shape | ✓<br>The LTESA Operator and the SFV agree on an intraday and seasonal generation shape to financially settle against. The LTESA Operator can be physically long or short the contracted level of generation across contracted dispatch intervals | ✗<br>There is no intraday or seasonal generation requirement |
| Volume | ✓<br>There is a contractual minimum generation requirement. When the LTESA Operator has been short the contracted generation position within the financial settlement period, they must be able to meet (and exceed) the contractual position in other dispatch intervals to be net-positive the financial settlement position with the SFV | ✓ ✓ ✓<br>There is a contractual minimum generation requirement. The SFV is obligated to pay the LTESA Operator for generation as sent out<br>Volume risk arising from variability in renewable production is managed by the SFV across a portfolio, rather than by the individual LTESA Operators |
| Contract Price | ✓<br>SFV pays a flat Contract Price to the LTESA Operator for the contracted shape | ✓<br>SFV pays a flat Contract Price to the LTESA Operator for a fixed proportion of production |
| Floating Price | ✓<br>LTESA Operator and SFV settle the contract against the Floating Price, which equates to the wholesale market price. Except when the wholesale price is below $0/MWh, then the Floating Price floor is $0/MWh and the economic incentive for the LTESA Operator is to curtail | ✓<br>LTESA Operator and SFV settle the contract against the Floating Price, which equates to the wholesale market price. Except when the wholesale price is below $0/MWh, then the Floating Price floor is $0/MWh and the economic incentive for the LTESA Operator is to generate down to the negative value of the Contract Price |
| Optionality | ✓<br>The LTESA Operator exercises the contract over a 2-year[1] swap period giving at least 6-months notice before the start of the next Financial Year when the swap is activated | ✓ ✓ ✓<br>The LTESA Operator exercises the contract over a 2-year[1] swap period giving at least 6-months notice before the start of the next Financial Year when the swap is activated<br>Additional value to the LTESA Operator as an insurance product as there is less merchant exposure – potential incentive to exercise more often |

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[1] If the LTESA Operator exercises the swap in the last year of the 20-year contract, it is allowed to be a 1-year swap period instead

Source: Aurora Energy Research

# LTESA contracts reduces the cost of capital for asset owners; benefits for FSFV contracts are lower and varies significantly under stress test scenarios

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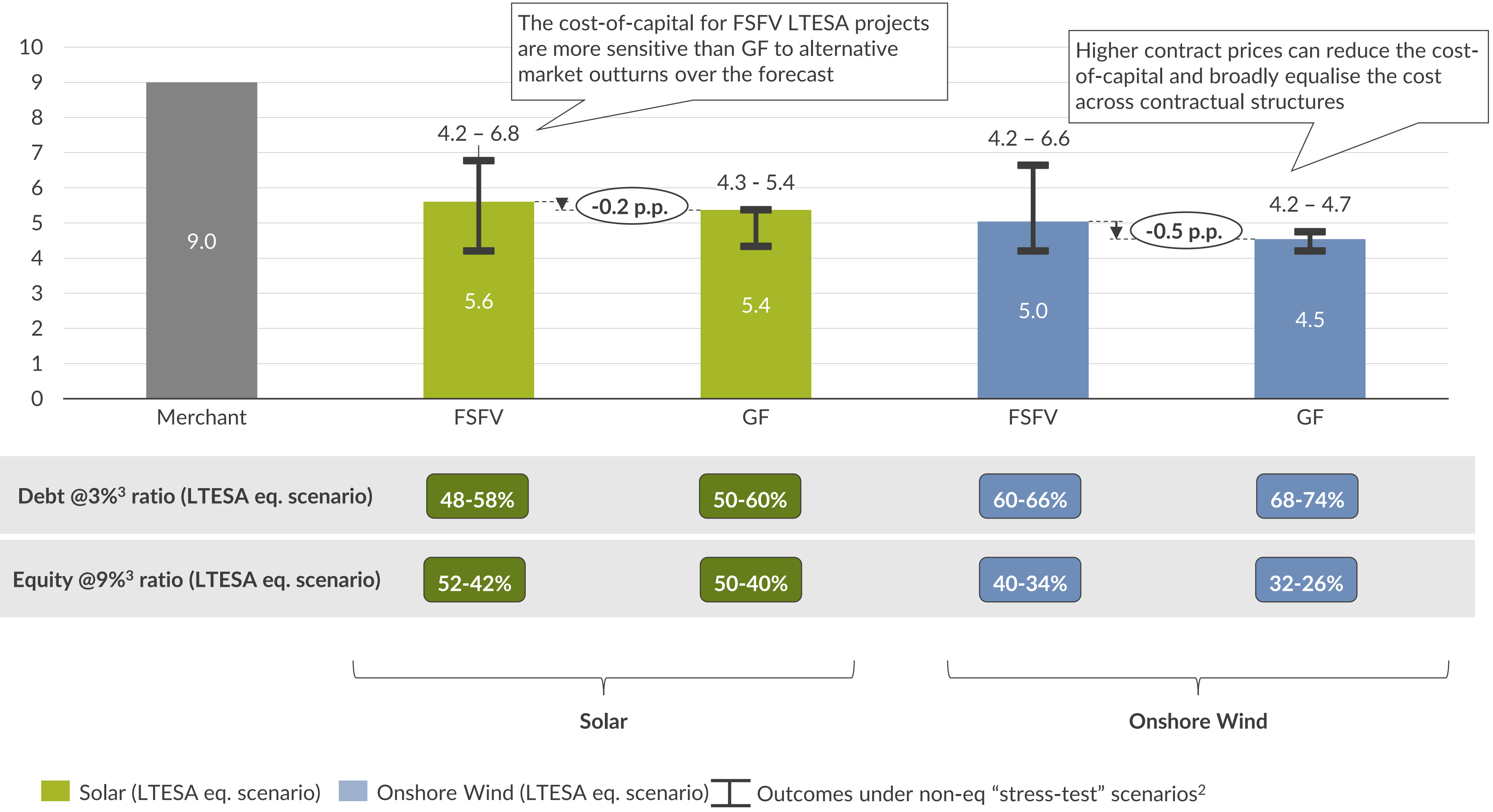
**WACC of optimised LTESA-contracted asset vs merchant asset (over a 20-year LTESA period) under eq. and non-eq senarios[2]**

Normalised, Merchant LCOE = 100



The cost-of-capital for FSFV LTESA projects are more sensitive than GF to alternative market outturns over the forecast

Higher contract prices can reduce the cost-of-capital and broadly equalise the cost across contractual structures

| | | | | |
|---|---|---|---|---|
| **Debt @3%[3] ratio (LTESA eq. scenario)** | 48-58% | 50-60% | 60-66% | 68-74% |
| **Equity @9%[3] ratio (LTESA eq. scenario)** | 52-42% | 50-40% | 40-34% | 32-26% |

## Cost-benefit of LTESA on asset WACC

- LTESA contracts are expected to reduce the WACCs of assets by providing bankable revenue streams which support debt financing
- The benefits are higher for GF contract relative to FSFV contracts under the modelled equilibrium scenario at equivalent contractual strike prices - GF contracts see 0.2 – 0.5 p.p. lower WACCs across solar and onshore wind in equilibrium
- FSFV WACCs are more sensitive to the “stress-test” scenarios due to the merchant exposure to alternative wholesale price outcomes from under-contracting and the additional firming requirements to defend the contractual shape, particularly when stress-testing low renewable output
- GF WACCs are more resilient to the “stress-test” scenarios as the asset can firm revenues by exercising the contract, practically avoiding the impact of alternative market outturns and volatility
- Onshore wind has some downside risk from the GF contract because the intraday ”duck-curve” of wholesale price means that wind has greater potential upside from merchant exposure to higher shoulder prices
- Crucially this analysis assumes FSFV and GF contracts face the same cost of equity assumption of 9%. In practice, the risk of FSFV contract could also increase the cost of equity due to increased merchant exposure and less firm revenues, which in-turn further increases the cost-of-capital limits the benefit of the FSFV contract relative to GF

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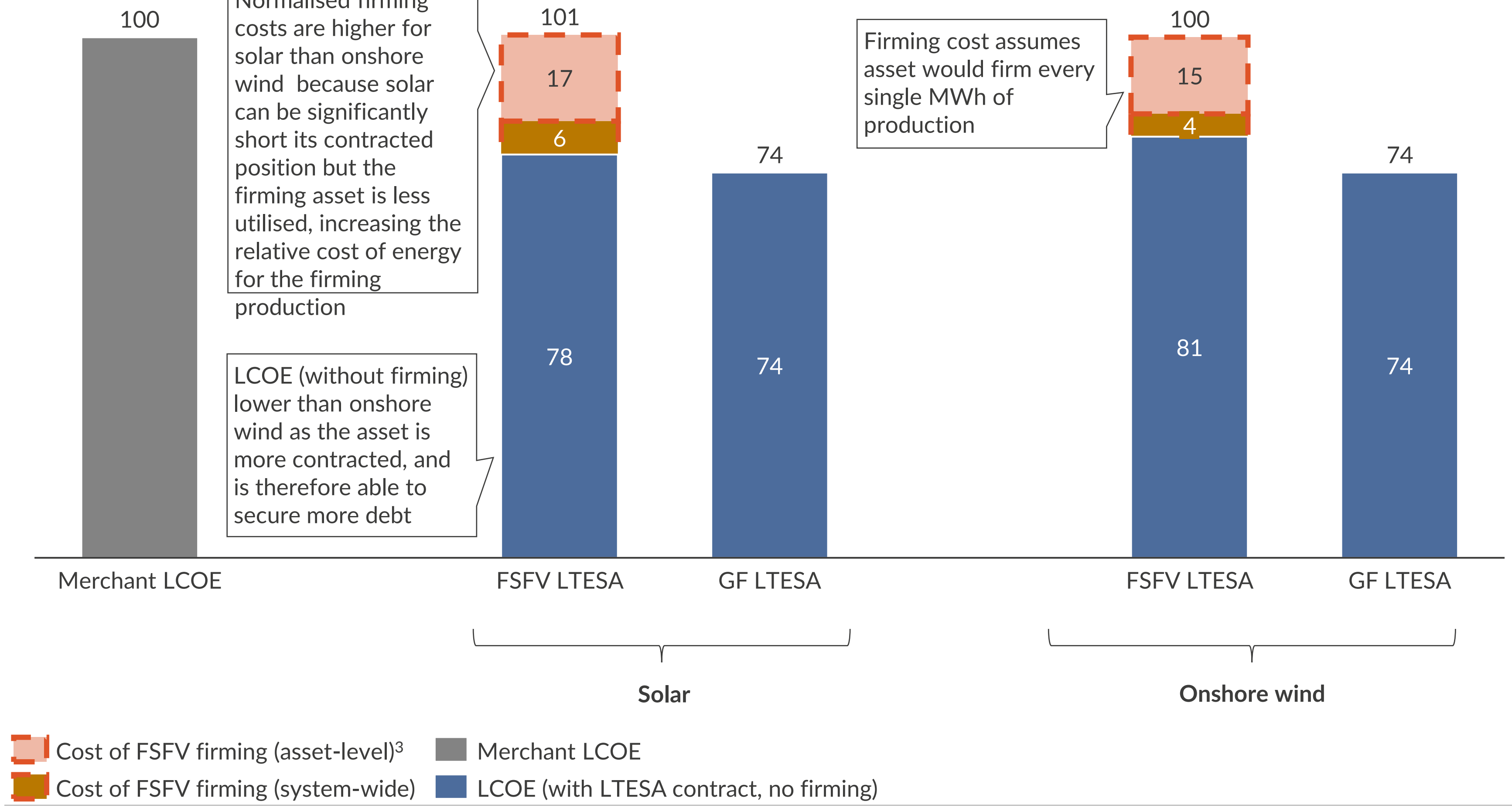
1) Without the limit, assets could seek to increase debt ~100% under these contracts. 2) The three market sensitivities explored were: high renewable build out resulting in lower wholesale market prices; major market event resulting in extreme high prices experienced for one month in every three years; low renewable outputs for one in every three years. 3) Assumptions provided by AEMO Services

Source: Aurora Energy Research

# FSFV has a similar potential as GF contracts to reduce LCOEs by 20 – 25%, but benefits could be eroded with the need to firm production

**LCOE[1] of optimised LTESA-contracted asset vs merchant asset (over a 20-year LTESA period) under equilibrium LTESA Scenario[2]**

Normalised, Merchant LCOE = 100



Normalised firming costs are higher for solar than onshore wind because solar can be significantly short its contracted position but the firming asset is less utilised, increasing the relative cost of energy for the firming production

LCOE (without firming) lower than onshore wind as the asset is more contracted, and is therefore able to secure more debt

Firming cost assumes asset would firm every single MWh of production

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1) Levelised Cost of Energy. 2) Analysis is based on LCOE-contract prices, assuming asset contractual shape has been fully optimised. We have not considered potential merchant revenues post the 20-years (e.g. if an asset lifetime is 25 – 30 years). 3) Cost incurred if FSFV-asset is required to physically firm itself by constructing and operating an additional asset to firm the LTESA project individually

Source: Aurora Energy Research

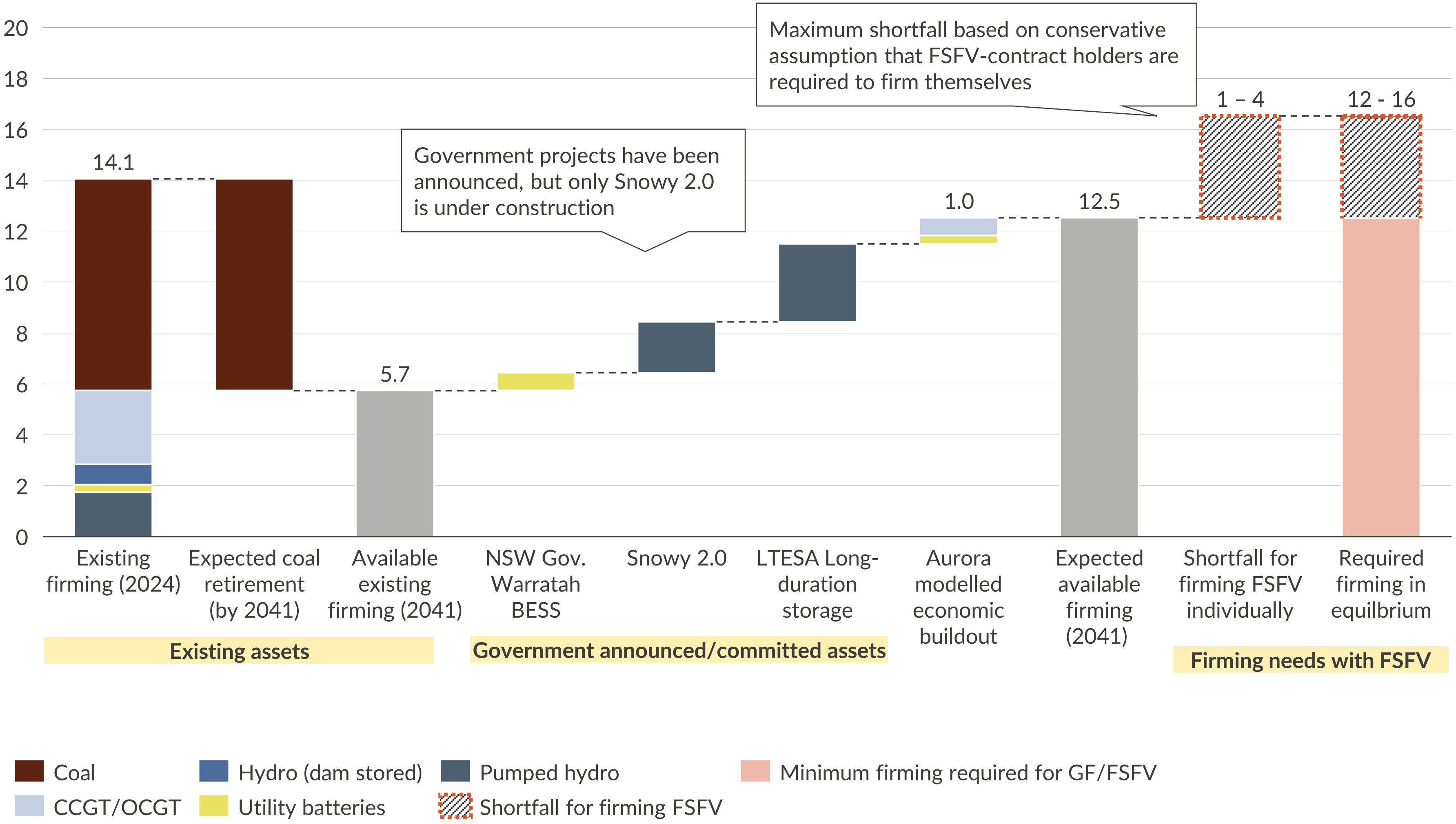
## Cost-benefit of LTESA on asset LCOE in equilibrium LTESA Scenario

- Securing an LTESA contract will help with reducing LCOEs for both GF-contracts and FSFV-contracts (if firming is not required)
- A holder of an LTESA contract could enjoy the benefit even if the option is not exercised:
  - **Non-exercise period**: In periods where the asset does not exercise the LTESA, the assets benefit from being able to secure debt (@3%) at 1.5 DSCR, simply by holding onto an LTESA option
  - **Exercise-period** – When LTESA is exercised, it has been assumed that debt (@3%) for the contracted proportion of the asset's generation, can be secured at 1.1 DSCR. This is a risk transfer from the developer to the SFV and consumers
- As onshore wind has a significantly more varied generation profile that carries higher risk, the reduction in LCOEs under a FSFV (without firming) would be lower than that of Solar (19% reduction for onshore wind vs 22% for solar). This is due to onshore wind contracting less than solar under FSFV-LTESA
- However, the gains from LTESA-contracts are expected to be largely eroded by the need to firm the contract (especially if the asset has to firm itself)
- Firming-costs are likely to be lower for larger developers/gen-tailers if they are able to pool firming resources across assets
- Under GF-contracts, assets are not required to firm themselves.

# FSFV-contracts increase firming needs of the system by up to 4GW, adding costs and uncertainty to developers, consumers, and project financiers

**Required firming capacity for LTESA contracts vs available firming capacity in NSW – under equilibrium LTESA Scenario**

GW



Government projects have been announced, but only Snowy 2.0 is under construction

Maximum shortfall based on conservative assumption that FSFV-contract holders are required to firm themselves

## Firming requirements needed for LTESA fleet (GF/FSFV)

- ~12.5 GW of dispatchable capacity will be required to firm the NSW renewables fleet in the 2040s under the modelled LTESA equilibrium scenario
- However, by requiring FSFV LTESA projects to firm themselves individually, Aurora estimates that an additional 1 – 4 GW of firming capacity would be required, bringing the total requirement to 12 – 16 GW[3]
- This poses significant risks to LTESA projects – even if assets could financially firm themselves, only 5.7 GW of existing assets are expected to be on the system following coal retirement. Assets will need to rely significantly on the proposed pipeline of Government announced projects, in addition to developing their own firming capacities
- This could result in additional costs to consumers as the last 1 – 4 GW of firming assets are needed solely to firm FSFV-contract positions and are anticipated to have a low utilisation on a day-to-day basis
- Firming needs could be higher if:
  - Government announced or committed assets fail to materialise
  - Varying weather outcomes lead to significantly lower renewables output
  - The system mitigates the risks in dispatchable resource availability (e.g. drought, battery outages/state-of-charge) by further gold-plating reliability of firming
- Generation following contracts do not face these risks as they are not required to firm themselves

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1) Including known commissioning assets. 2024 was chosen to coincide with first year of LTESA contract. 2) Currently modelled and assumed as pumped hydro. 3) The FSFV-contract structure will require LTESA holders to firm their own production (either by procuring from the market or building their own capacities). At present, our understanding is that this has yet to be finalised.

Source: Aurora Energy Research

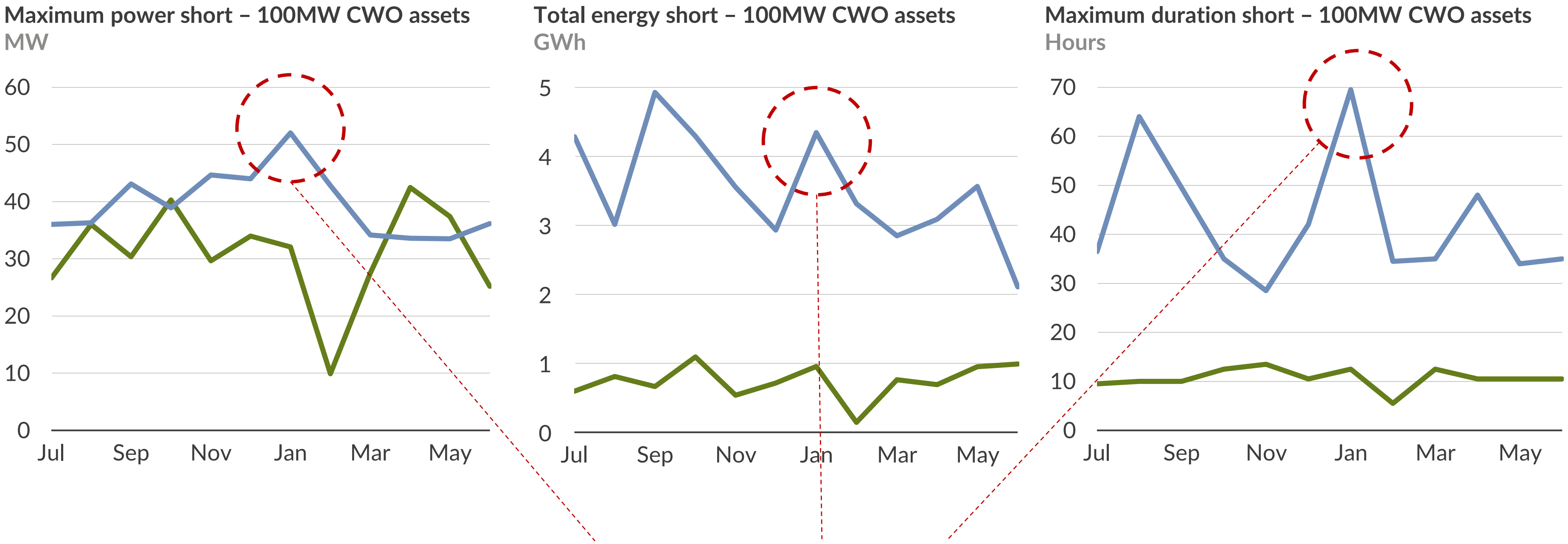
# The firming solution will be complex for FSFV contracts, which creates significant challenges for individual asset owners and debt financing

**Illustration of different firming requirements for CWO asset in FY 2030[1]**

**Maximum power required to firm FSFV contractual short position**

**Total energy required to firm FSFV contractual short position**

**Maximum duration of energy required to firm FSFV contractual short position**



In January 2030, to physically firm and defend an LTESA contract a representative CWO wind asset requires:

- **>50MW of dispatchable capacity** (over half the size of the asset)
- **>4GWh of firming production** (~5.5MW constantly running at 100% capacity factor)
- **~70 hours of consecutive firming production** (~3 days of constant dispatchable capacity)
- **Requirements could increase significantly in a low weather year/renewables output[2]**

🟩 Solar 🟦 Onshore Wind

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1) Analysis was conducted under the equilibrium LTESA scenario, under a median representative weather year (2016). 2) Explored under non-equilibrium analysis in Section VI.

Source : Aurora Energy Research

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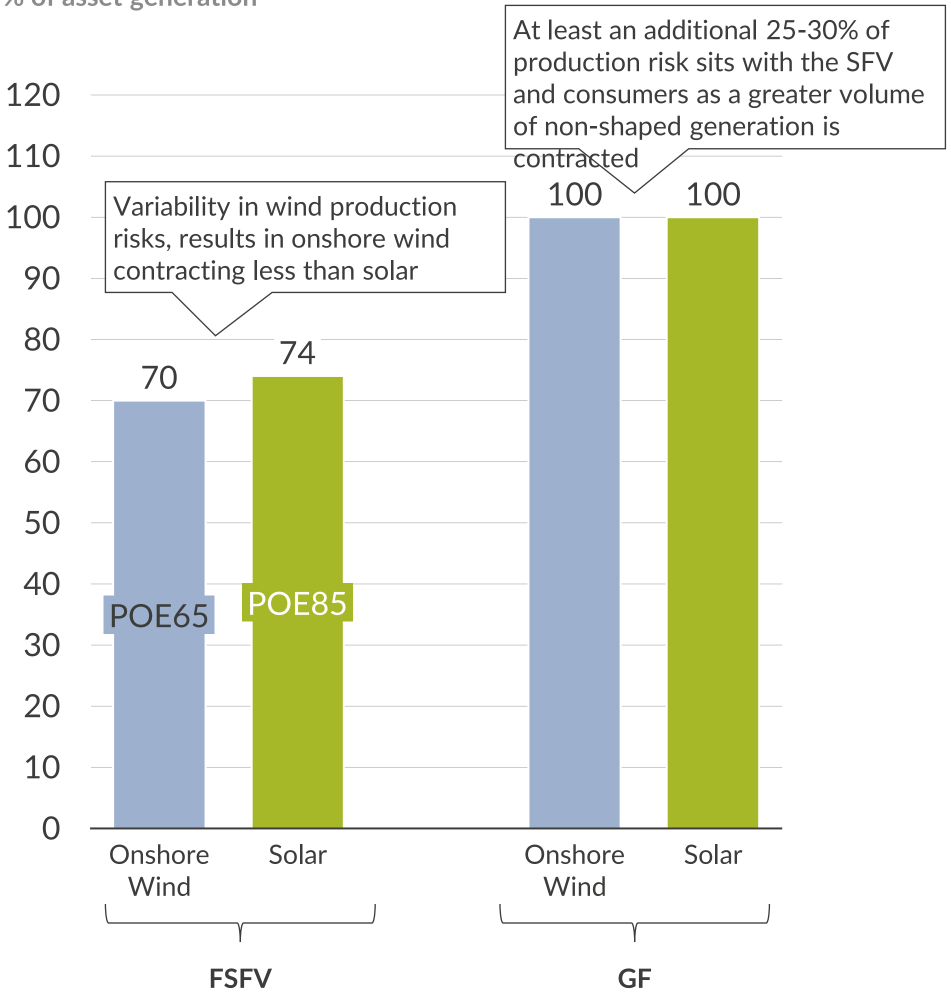
### Different firming needs for representative CWO assets

- Firming FSFV-contracts will be complex due to the:
  - **Significant size of firming capacity required -** could be up to 50% of installed renewable capacity for onshore wind
  - **Extended duration of firming capacity required** – 3 days of continuous dispatchable generation will be required
- For smaller, individual asset developers, this will likely imply that:
  - Significant firming capacity must be developed, which will be associated with high cost to developers and the system
  - Storage is unlikely to be the full solution – Li-ion storage is duration-limited, while longer duration storage (e.g. pump hydro) is extremely costly and technically challenging. Gas peakers could provide an alternative but gas pipelines are limited, costs are sensitive to global commodity markets and the technology could be against ESG goals of many developers
  - Assets are only able to contract a relatively small proportion of its capacity to reduce risk, which in-turn limits the benefits of LTESA contracts
- Bankability could also be an issue – even if equity providers are willing to undertake some risks of failing to meet the contractual position (for short periods of time), debt providers will likely require assets to have the optionality to firm themselves or require oversight on exercise behaviour
- Pooling across a portfolio of assets can help to mitigate firming risks. For larger gen-tailers they could lower risks of FSFV contracts by pooling across assets. Under GF-contracts, this production risk can also be partially mitigated by the consumer-trustee pooling across the portfolio of assets contracted

# FSFV leads to lower contracting and exercising of LTESA options than GF; onshore wind faces greater risks due to variability in production profiles

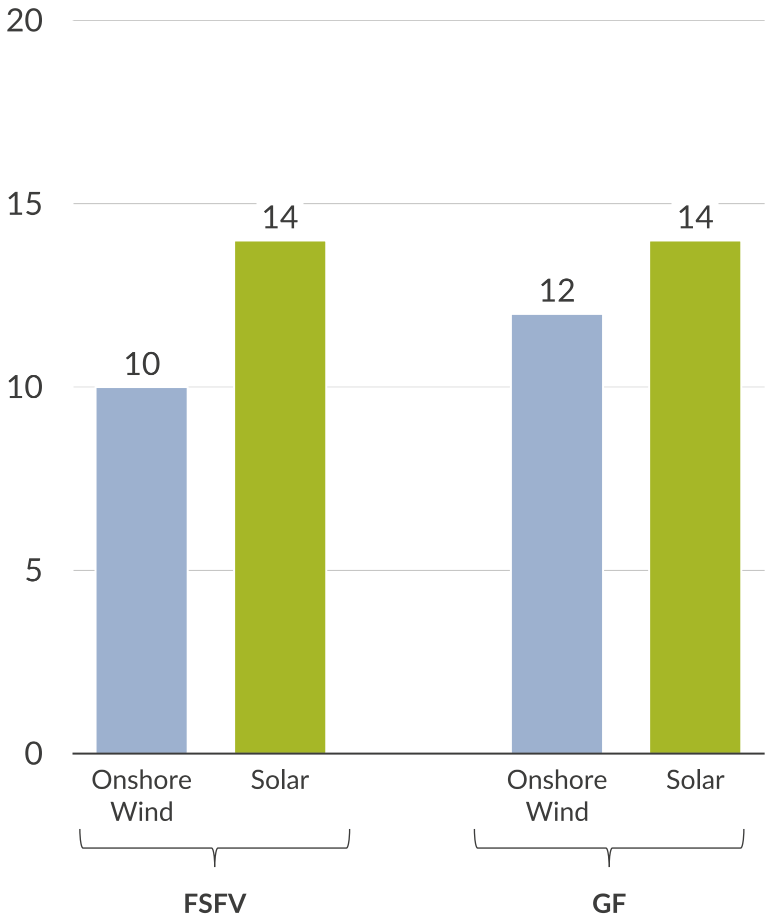
**Optimal Contractual Shape/Size under LCOE contract price**[1]
% of asset generation



Variability in wind production risks, results in onshore wind contracting less than solar

At least an additional 25-30% of production risk sits with the SFV and consumers as a greater volume of non-shaped generation is contracted

**Number of years LTESA contract is exercised under LCOE**[1] **contract price**
Years (Maximum = 20-years)



### Optimal contract sizing and exercisability of LTESA contracts

- Due to inherent risks of being short of the contractual positions under FSFV-contracts, assets are likely to:
  - Under-contract its expected output/generation profiles
  - Less frequently exercise their options
- Under-contracting to reduce firming needs is already seen in the market today – e.g. a 10 MW PPA-firmed onshore wind asset might required 30 MW of available capacities
- However, under-contracting would come with its associated costs to capital, including reducing the ability of assets' to secure debt
- The oversizing risks of FSFV-contracts are more prominent for onshore wind assets than for solar due to the variability of wind production across the day, weather-years and intra-year seasonality
- For example, an optimised onshore wind asset is expected to contract to a lower ~70% of production, while solar contracts to ~75% of production. In terms of exercising the FSFV LTESA contract, onshore wind is only expected to exercise the LTESA for 10 years (out of a 20-year LTESA), as compared to Solar which exercises this for 14 years
- The GF contractual arrangement encourages onshore wind to exercise more frequently, driven in part by mitigating merchant exposure risk experienced in the FSFV contract
- Prolonged exercise and a higher level of contracting under GF contracts will increase the production risk to the SFV by at least 25-30% compared to FSFV contracts

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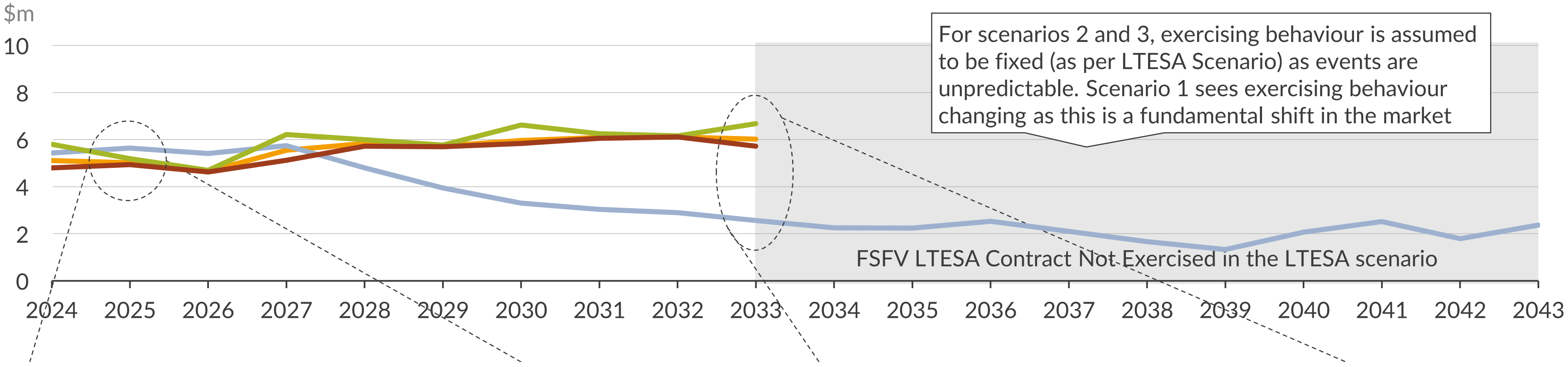
[1] Assumes contract is struck at LCOE-pricing (lower bound on contract pricing). Aurora has also conducted analysis based on risk-neutral strike price (upper bound).

Source: Aurora Energy Research

# FSFV assets would have sufficient financial coverage to firm themselves for a week of $1000/MWh prices and prolonged wind drought

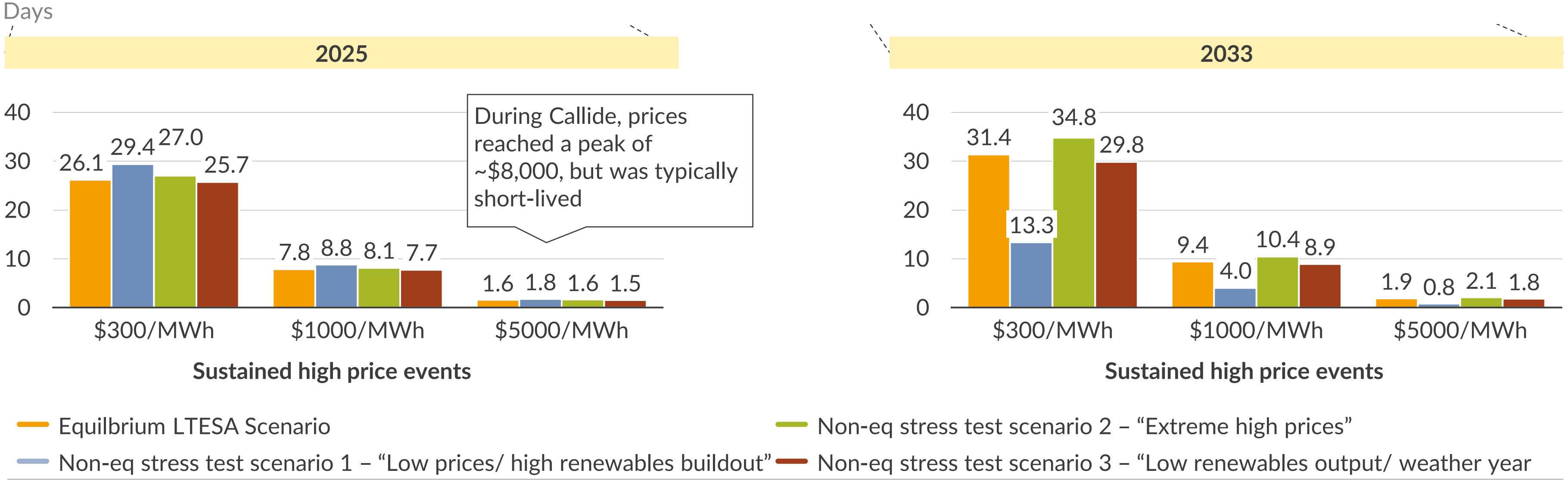
**Cash flow analysis for FSFV-contracted asset[1] (assuming LCOE-contract price) – 100 MW CWO onshore wind**

**Project's yearly reserve from "net" long-short[2] cash flow positions[3]**



For scenarios 2 and 3, exercising behaviour is assumed to be fixed (as per LTESA Scenario) as events are unpredictable. Scenario 1 sees exercising behaviour changing as this is a fundamental shift in the market

**Number of consecutive days an onshore wind project could experience a wind drought during high-prices before depleting the project reserve**



During Callide, prices reached a peak of ~$8,000, but was typically short-lived

---

1) Assumes optimised asset under LCOE contract pricing. 2) At low wholesale prices the LTESA onshore wind project is anticipated to always exercise the FSFV contract. 3) Project reserve is assumed to keep 25% of the previous year's reserve as well as cashflows for the current year. 4) "Optimal-sized" contract for this analysis was taken as the contractual shape that maximised the minimum cash flows available for debt servicing (CFADS)

Source: Aurora Energy Research

### Cash flow analysis for FSFV contracted onshore wind

- While there are inherent risks in an FSFV-contract, an optimally sized contract is expected to be able to accumulate a reasonable cash reserve to tide over prolong periods of high price spikes and low renewables production – even under non-equilibrium scenarios
- In an extreme "wind-drought" scenario, where wind output entirely stops, the cumulated cash reserve should be able tide over:
  - 25 – 30 days of $300/MWh prices
  - 7 – 8 days of $1000/MWh prices
  - 1 – 2 days of $5,000/MWh prices
- Prolonged prices of $5,000/MWh (alongside 0 wind production) is extremely rare – prices during Callide exceeded $8,000/MWh but was typically short-lived and focus in evening peaks
- Nonetheless,, this could still be challenging for project financiers as conditions/covenants might have to be put in place to ensure that accumulated net cash-flows are set aside for working capital/liquidity reserves to prevent insolvency

# Agenda

# Aurora has constructed an "LTESA Scenario"[1] based on Aurora's Q1 2022 Central outlook to analyse the implications of LTESA contract structures

| | | Aurora Central | LTESA scenario[1] (Used for analysing LTESA contract structures) |
|---|---|---|---|
| **Policy** | **Federal emissions policy** | ▪ Retention of the LRET in its current form and no specific $CO_2$ emissions target for the NEM | • As per Aurora Central |
| | **State schemes** | ▪ NSW: EIR partially met: ~10GW renewables by 2030 (out of a target of 12 GW), and 1GW pumped hydro by 2035 assumed<br>▪ QRET, SRET, VRET and TRET not met | ▪ NSW: EIR[1] partially met: ~10 GW of new renewables by 2030 (out of a target of 12 GW), and full buildout of long-duration storage under roadmap (i.e. +3 GW pumped hydro by 2036)<br>▪ QRET, SRET, VRET met, and ~90% renewable penetration by 2040 in all states |
| **Demand** | **Underlying demand** | ▪ Aurora in-house modelling, refer to Market Modelling Inputs | ▪ As per Aurora Central |
| | **DER** | ▪ Aurora in-house modelling, refer to Market Modelling Inputs | ▪ As per Aurora Central |
| **Commodity prices** | **Gas prices** | ▪ Aurora in-house global commodity price modelling - LNG netback prices, refer to Market Modelling Inputs | ▪ As per Aurora Central |
| | **Coal prices** | ▪ Aurora in-house global commodity price modelling – coal export price for uncontracted, non-mine-linked coal plants, refer to Market Modelling Inputs | ▪ As per Aurora Central |
| **Supply** | **Coal closures** | ▪ AEMO's latest (February 2022) announced closure timeline with the exception of a few assets (see slide 14) | ▪ AEMO's expected closure timeline + updated with latest with latest asset specific news (e.g. Eraring).<br>▪ See slide below |
| | **Technology costs** | ▪ Aurora in-house modelling, refer to Market Modelling Inputs | ▪ As per Aurora Central |
| | **New Hydro** | ▪ Kidston from 2025, Snowy 2.0 included from 2027 and 1GW of pumped hydro in NSW via the Electricity Infrastructure Roadmap | ▪ Kidston from 2025, Snowy 2.0 included from 2027 and +3GW of pumped hydro in NSW via the Electricity Infrastructure Roadmap |
| **Network augmentation** | **Inter-regional** | ▪ AEMO 2022 ISP Step Change Optimal Development Pathway unless otherwise stated: EnergyConnect, QNI & VNI upgrades, QNI Connect, VNI West and Marinus Link (Stage 2 not included) | ▪ As per Aurora Central |
| | **Intra-regional** | ▪ AEMO 2022 ISP Step Change Optimal Development Pathway and their effect on the network capacity of each REZ (refer to Market Modelling inputs) | ▪ As per Aurora Central |
| **Marginal Loss Factors** | **Endogeneity** | ▪ Aurora methodology that factors in grid limits and robustness of MLFs into build decisions and asset specific MLFs incorporated into short-run marginal costs and therefore bidding behaviour | ▪ As per Aurora Central |
| **Bidding behaviour** | **Scarcity pricing / Uplift** | ▪ Purpose-built uplift function - capturing the deltas between price and the short-run marginal cost of the marginal generator, based on historical behaviour | ▪ As per Aurora Central |

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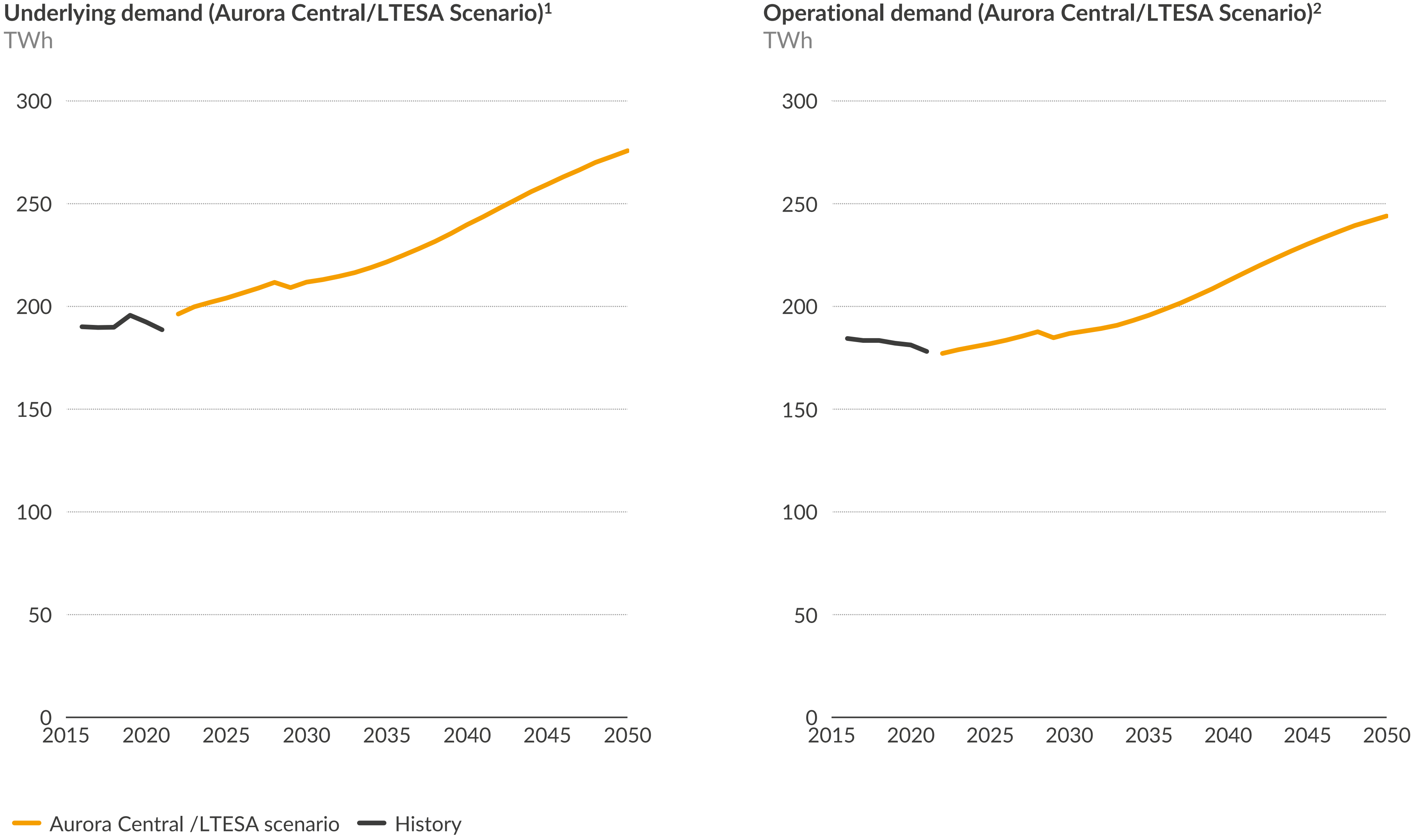
1) Scenario has been designed following consultation with AEMO Services.

Source: Aurora Energy Research

# Underlying and operational demand forecast rises steadily over the forecast horizon to reach 275 TWh and 243 TWh by 2050



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1) Underlying demand includes commercial and residential demand and EV demand; 2) Operational demand is underlying demand net of rooftop solar and BTM battery generation

Sources: Aurora Energy Research, AEMO

**Aurora's demand forecast**

- Demand forecast is an input into Aurora's power market forecast model
- Based on the fundamentals of GDP, population and energy efficiency outlook, Aurora's in-house demand modelling forecasts growth in underlying demand, driven predominately from the commercial sector in early years and EVs in later years
- The closure of Portland in FY2029 in the Aurora Central scenario can be seen by a ~5.3TWh reduction in underlying and operation demand
- Growth in operational demand is slowed with the rapid uptake of rooftop solar, which Aurora forecasts will continue over the first half of the century

# LTESA Scenario assumes coal closures in line with AEMO’s timelines (February) unless a media announcement has been made more recently

| Coal Plants | State | Capacity GW | Aurora Central 22Q1 closure timeline | AEMO’s expected closure timeline | AEMO’s 2022 ISP Step Change closure timeline | AEMO Services LTESA scenario |
|---|---|---|---|---|---|---|
| **Bayswater** | NSW | 2685 | 2034 | 2036 | 2034 | 2034 |
| **Eraring** | NSW | 2880 | 2026 | 2033 | 2028 | 2026 |
| **Liddell** | NSW | 1800 | 2024 | 2024 | 2024 | 2024 |
| **Vales Point B** | NSW | 1320 | 2028 | 2030 | 2027 | 2030 |
| **Mt Piper** | NSW | 1320 | 2041 | 2041 | 2040 | 2041 |
| **Callide B** | QLD | 700 | 2027 | 2029 | 2026 | 2029 |
| **Callide C** | QLD | 840 | 2050 | - | 2040 | - |
| **Gladstone** | QLD | 1680 | 2036 | 2036 | 2031 | 2036 |
| **Kogan Creek** | QLD | 744 | 2043 | 2043 | 2029 | 2043 |
| **Millmerran** | QLD | 852 | 2050 | 2052 | 2043 | 2052 |
| **Stanwell** | QLD | 1460 | 2047 | 2047 | 2034 | 2047 |
| **Tarong** | QLD | 1400 | 2038 | 2038 | 2028 | 2038 |
| **Tarong North** | QLD | 450 | 2038 | 2038 | 2029 | 2038 |
| **Loy Yang A** | VIC | 2210 | 2040 | 2049 | 2033 | 2040 |
| **Loy Yang B** | VIC | 1140 | 2048 | 2048 | 2030 | 2048 |
| **Yallourn** | VIC | 1450 | 2029 | 2029 | 2027 | 2029 |

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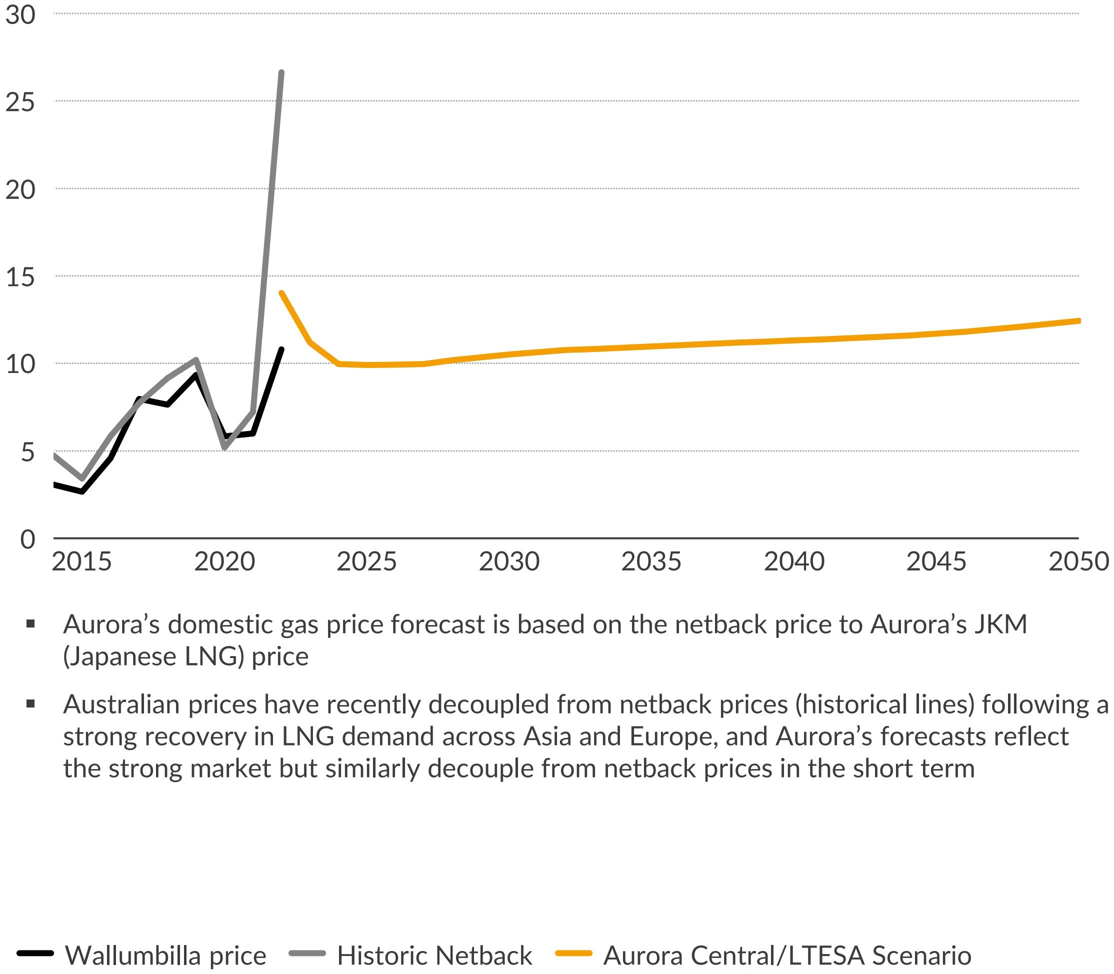
1) Expected to add another 75MW capacity by 2023 (additional 25MW each year from Jul 2021); 2) Expected to add another 30MW capacity by Jan 2021; 3) Expected to add another 15MW capacity by Sep 2021; 4) First financial year without generating capacity; 5) Close one unit each year until the closure time; 6) Closes two units each year until the closure time; 7) All units close in the same year; 8) Timeline extracted from AEMO’s *Generating unit expected closure year – January 2022*

Sources: Aurora Energy Research, AEMO

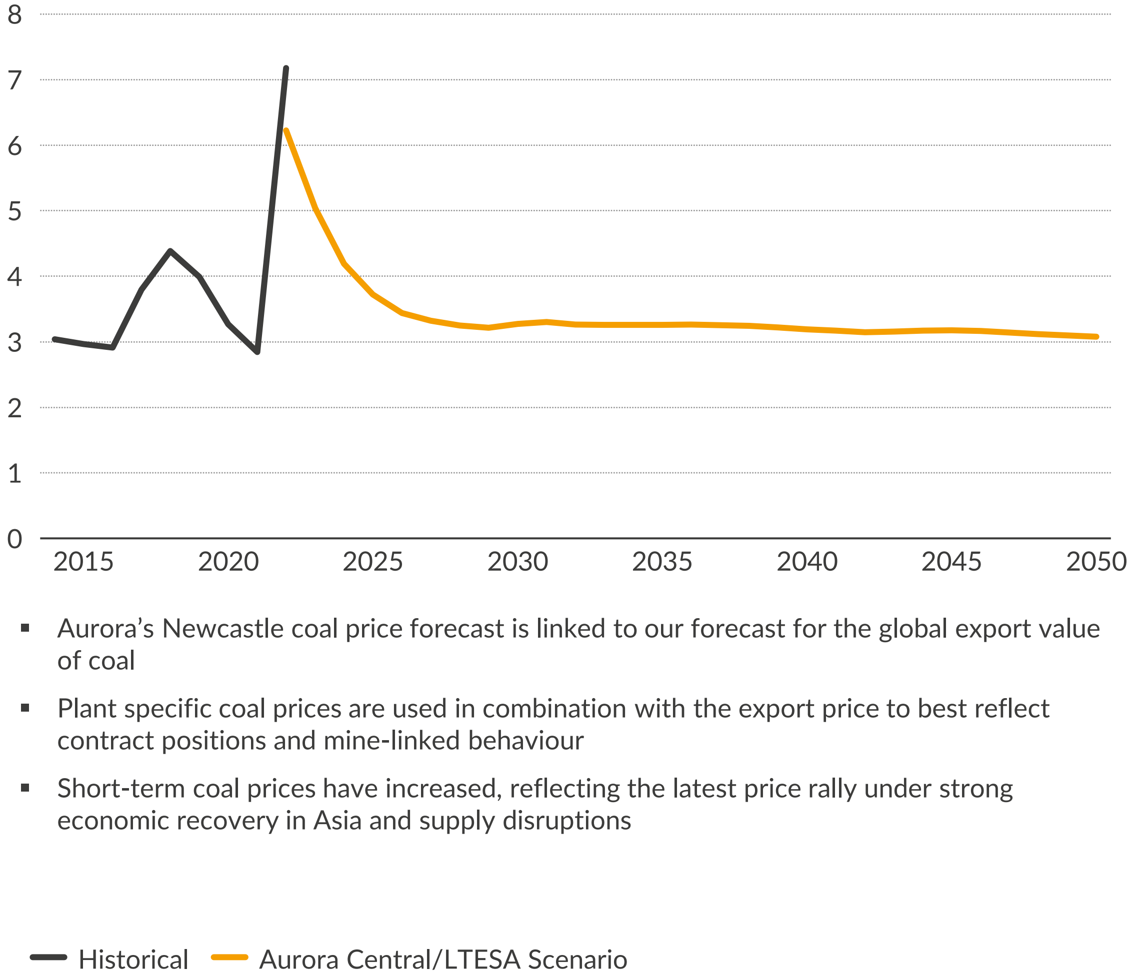
# Gas prices are expected to average $10-12/GJ in the long-term, while coal prices average $3/GJ

**Gas price forecast**[1]
$A/GJ, real 2021



- Aurora's domestic gas price forecast is based on the netback price to Aurora's JKM (Japanese LNG) price
- Australian prices have recently decoupled from netback prices (historical lines) following a strong recovery in LNG demand across Asia and Europe, and Aurora's forecasts reflect the strong market but similarly decouple from netback prices in the short term

**Coal price forecast**[2]
$A/GJ, real 2021



- Aurora's Newcastle coal price forecast is linked to our forecast for the global export value of coal
- Plant specific coal prices are used in combination with the export price to best reflect contract positions and mine-linked behaviour
- Short-term coal prices have increased, reflecting the latest price rally under strong economic recovery in Asia and supply disruptions

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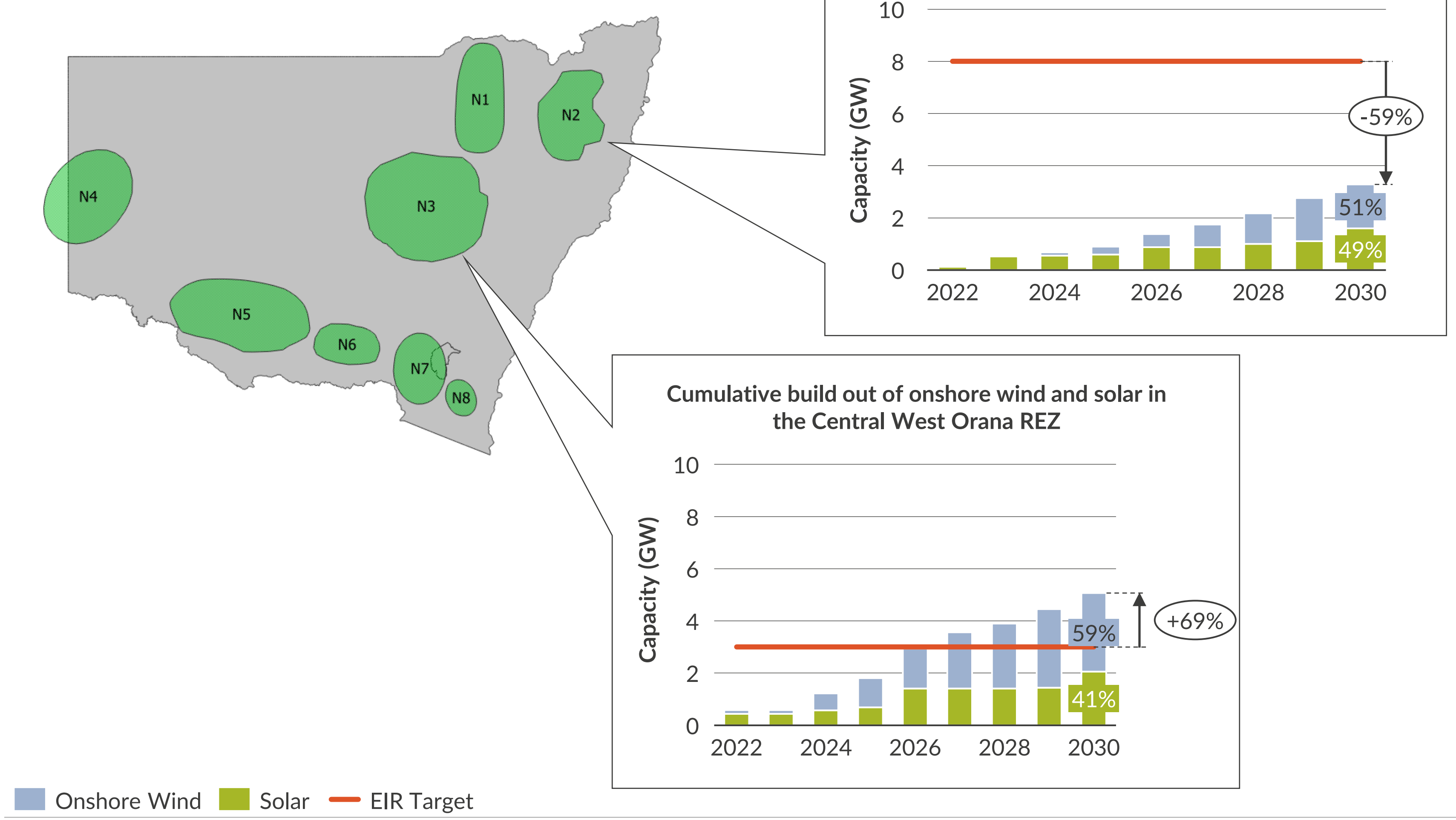
1) The LNG netback price has average ~$27/GJ between July 2021 to February 2022. The market is anticipated to correct as commodity shortage issues are resolved and the market responds to the rapid rise in Asian demand, while the Australian gas price has been somewhat decoupled from the prices observed in Asia. 2) Australian thermal coal prices have averaged ~$7/GJ between July to December 2021. 3) AEMO prices shown are for their CCGTs in Queensland

Sources: Aurora Energy Research, Australian Energy Regulator, AEMO, ACCC, Department of Industry, Science, Energy and Resources

# NSW renewables buildout occurs in both Central West Orana and New England through to 2030, with a preference for wind in both REZs

**NSW additional renewable deployment by REZ**

**Map of NSW REZs**



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1) The anticipated buildout is 8 GW in New England, 3 GW in Central-West Orana and 1 GW elsewhere. 2) 5% project WACC was assumed as a representative WACC for subsidised asset. This was only assumed in NSW. All other solar and wind assets in other states continue to build based on merchant WACCs of 9%. Scaling was required as total buildout under the 5% WACC assumption did not reach 10 GW.

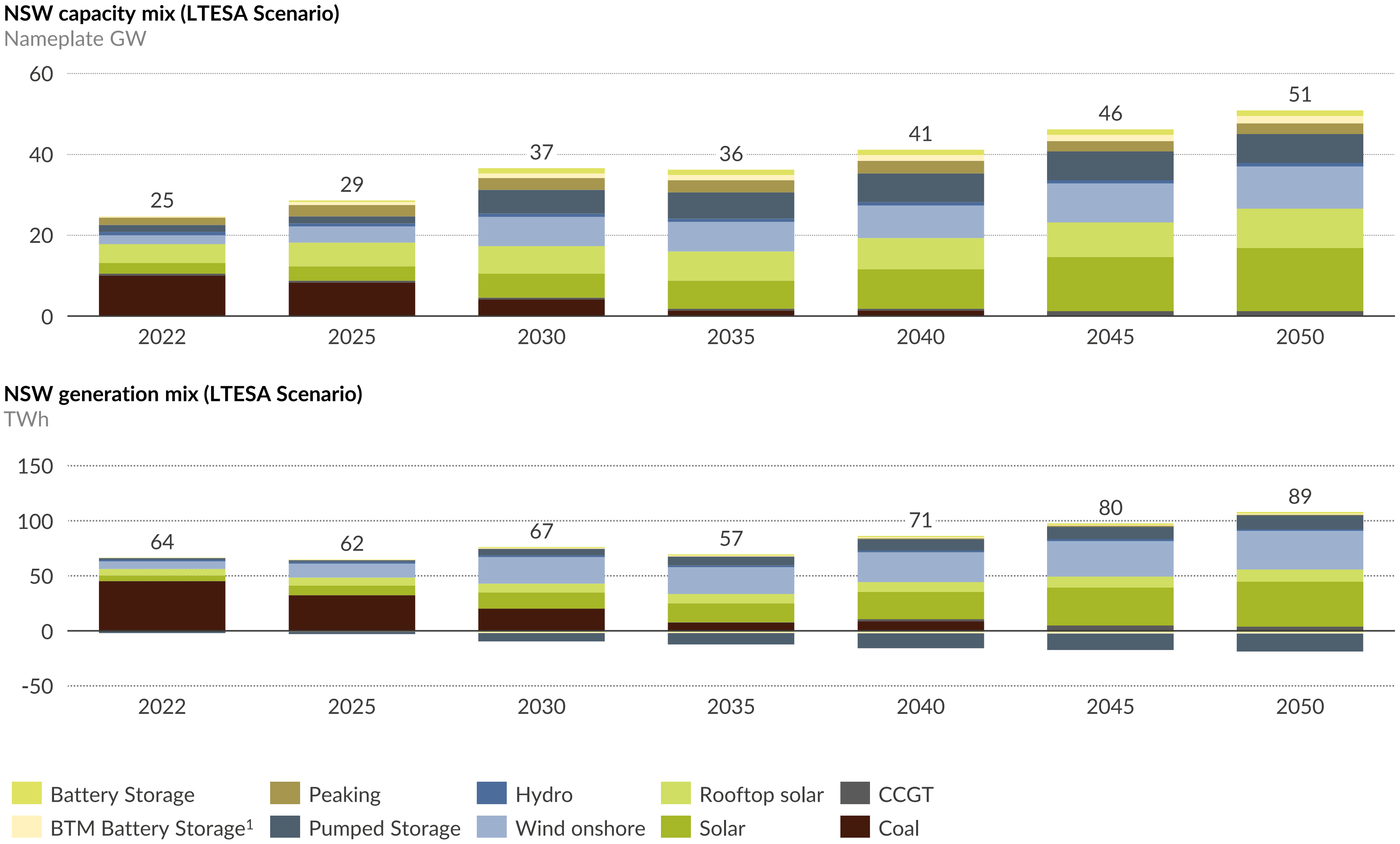
Source: Aurora Energy Research

**Aurora's approach to modelling renewables build out in NSW:**

- Until 2030:
  - Aurora's modelling assumes, exogenously, a total of 10 GW of new build renewables in NSW from 2022 - 2030
  - This is shy of the 12 GW[1] of new developments announced in planning documentation released by the NSW Government
  - The lower assumed buildout is expected from potential grid planning + supply chain delays, and was derived based on further discussions with AEMO Services
  - To determine the location of the 10 GW of new technologies, Aurora has: (i) assumed a flat 5% WACC for all new build technologies in NSW[2]; (ii) allowed the model to endogenously build capacities in different REZs based on the lower WACC assumption; and (iii) scaled the resulting buildout to achieve a total of 10 GW of renewables by 2030[3]
- Post 2030:
  - Buildout of renewables are assumed to be endogenous based on merchant economics in all States (including NSW), beyond any explicit targets that has been assumed

# Agenda

# NSW sees a rapid expansion in renewables capacities in the 2020s, with 10 GW of new grid-connected renewables building by 2030



1) Behind-the-meter batteries linked to rooftop solar.

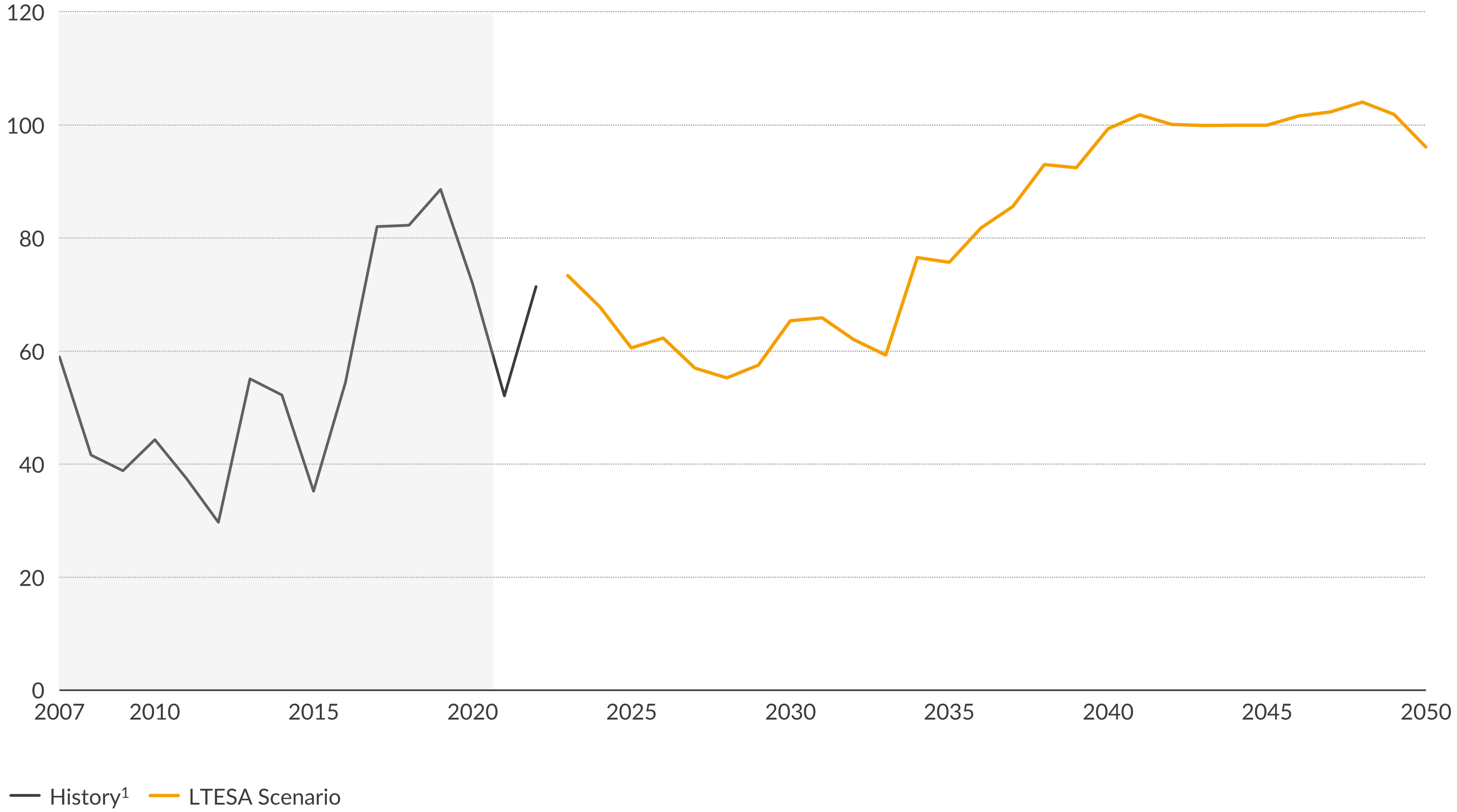
Source: Aurora Energy Research

**NSW-wide capacity and generation forecast (LTESA Scenario)**

- Aurora models ~7 GW of onshore wind and ~6 GW of utility-scale solar PV in NSW by 2030, this increases to ~11GW of onshore wind and ~16GW of utility-scale solar by 2050
- Until 2030, buildout of renewables are assumed exogenously, in order to meet pre-determined targets (~ 10 GW of new build from now till 2030 through EIR)
- Beyond 2030, renewables build based on merchant economics, with an assumed WACC of 9%
- Renewable capacity in NSW doubles between FY2022 and FY2030, driven by the objectives of the NSW Electricity Infrastructure Roadmap
- The closure of coal assets in the 2030s and 40s precipitates accelerated build out toward the back of the forecast

# LTESA Scenario sees long-term average wholesale prices rising to an annual average of $76/MWh in the 2030s and $101/MWh in the 2040s

**NSW TWA prices (LTESA Scenario)**
$A/MWh, real 2021



1) Historic values are in nominal dollars

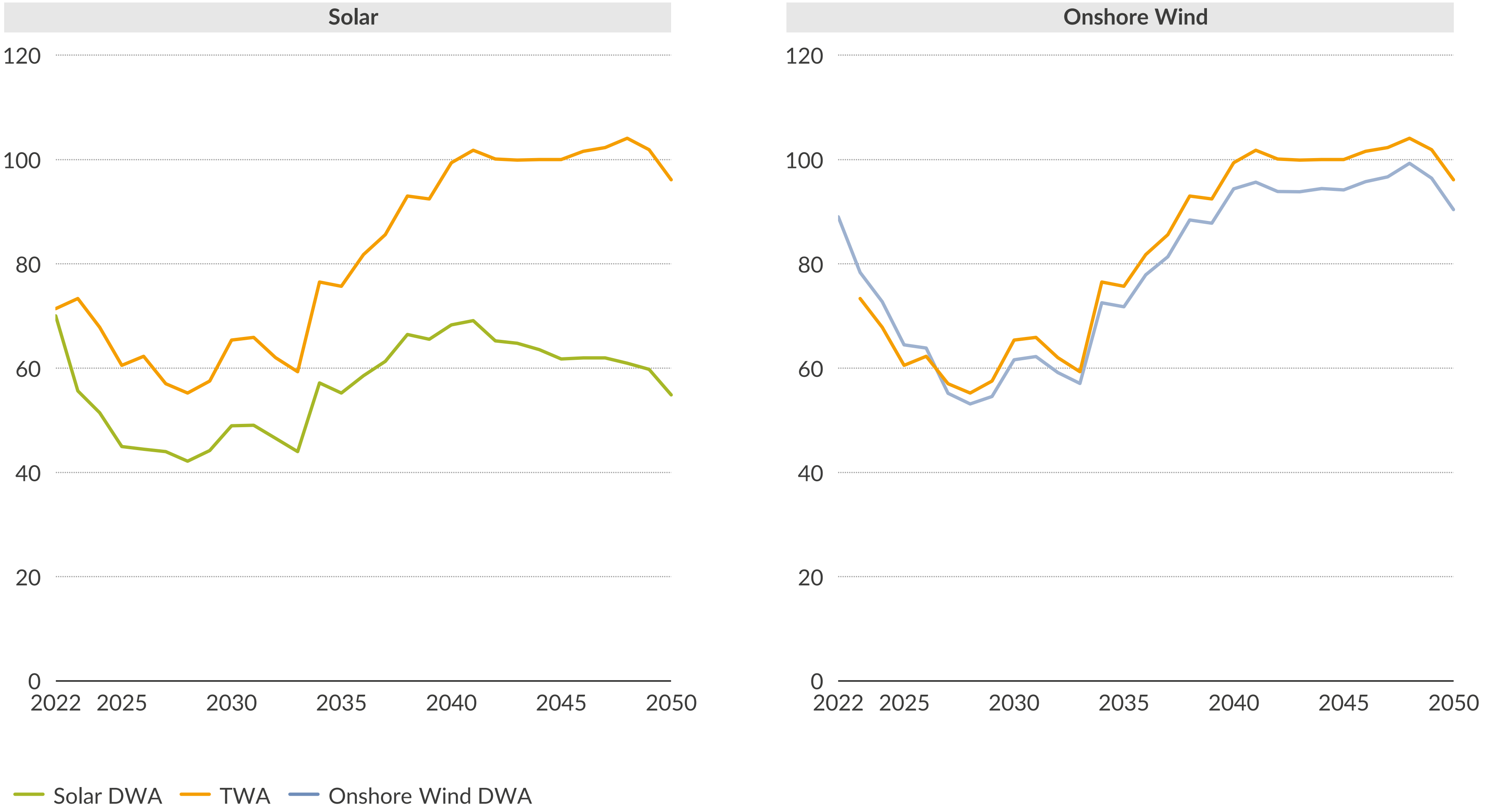
Source: Aurora Energy Research

**NSW TWA price forecast (LTESA Scenario)**

- Over the first 5-years of the forecast the wholesale prices are expected to trend down from current high levels as recent surge in thermal commodity prices are expected to move down to long-term trends
- Prices remain in the $55-65/MWh through the late 2020s and early 2030s as renewable penetration backed by state renewable energy schemes offsets the exit of coal generators
- Price increases from the mid-2030s as the exit of the last few coal generators in NSW (most notably Bayswater in 2034) drives higher prices as flexible technology more frequently set the margin to firm renewables
- By the early 2040s deep renewable penetration coupled with no coal generators and more affordable firming technology results in more stable price outcomes around $100/MWh

# Solar Wind DWAs average $55/MWh, while onshore wind DWAs average $70/MWh across the forecast horizon

**CWO TWA and DWA prices[1] (LTESA Scenario)**
$A/MWh, real 2021



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1) DWAs presented are post-curtailment (at $0/MWh) and pre MLF

Source: Aurora Energy Research

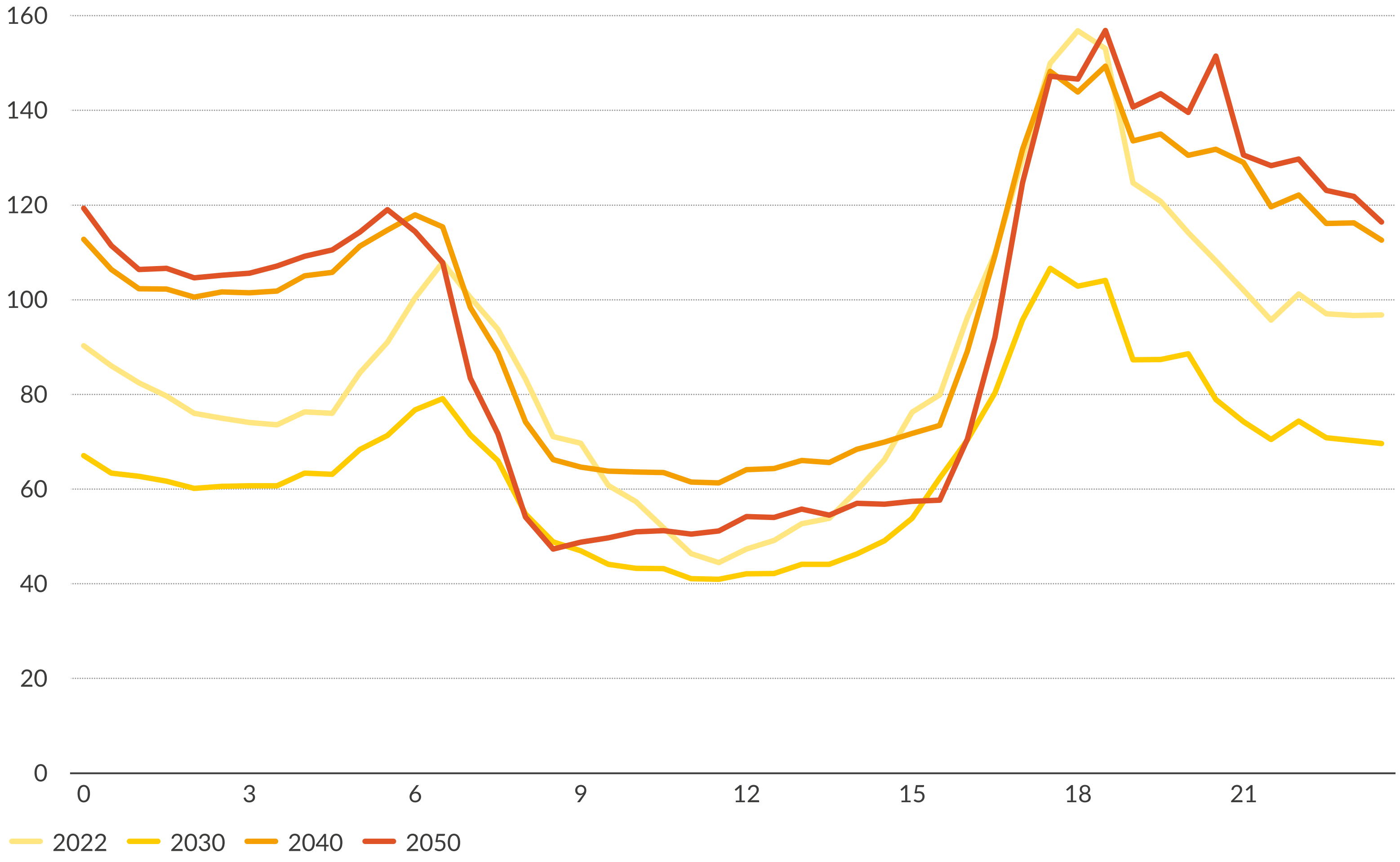
**Onshore wind and solar DWA prices (LTESA Scenario):**

- Solar DWA prices are at a significant discount to TWA prices in NSW due to the saturation of solar production
- The highly correlated production profile of solar assets both within NSW and in interconnected regions results in solar frequently setting the margin (at ~$0/MWh) throughout the middle of the day
- Conversely, wind is at a premium to the TWA in the short term, and then only at a small discount to the TWA price over the longer term forecast
- Wind DWA prices are at a premium in the short term as high thermal commodity prices drive up morning and evening peak prices that the generic CWO wind profile captures
- As commodity prices settle to long-term trends the generic CWO wind profile is less favourably exposed to high prices, capturing some of the low middle of the day prices observed by wind projects

# The "duck curve" will become steeper by 2030 as solar production dominates in the middle of the day, but coal retirements could improve this

**Time-Weighted Intraday Average Price (LTESA Scenario)**

A$/MWh



**Onshore wind and solar DWA intraday prices (LTESA Scenario):**

- The "duck curve" is expected to become deeper over the short-medium term in the mainland states as rooftop and grid scale solar meets more of demand
- From 2030 to 2040, NSW will see the whole intraday price curve shift upwards as coal retirements pull sizeable chunks of baseload generation out of the supply mix
- As renewables build post 2040, we see the duck curve shift back down as renewables set the margin more frequently at lower prices with suitable technologies replacing baseload generation in the supply mix
- As more storage assets and EV's enter the market, the drop in price between ~09:00-15:00 flattens out as demand increases for cheap midday power - driven by pumped hydro, batteries and smart[1] vehicles.

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[1] Aurora assumes vehicles will look to charge during the day, but not fully adapt to the cheapest prices. This in-turn sees midday prices rise due to the volume of EV's charging at the same time.

Source: Aurora Energy Research

# Agenda

AURORA

**I. Project overview and executive summary**

**II. NEM wholesale market modelling approach and key inputs assumptions**

1. "AEMO Services LTESA Scenario" summary
2. Demand input assumptions
3. Commodity price input assumptions
4. Supply-mix and renewables input assumptions

**III. NEM wholesale market key outputs for LTESA scenario**

1. Capacity and generation mix
2. TWA prices
3. Solar and Wind DWA prices
4. Marginal loss factors

**IV. Contracts modelling approach and key assumptions**

1. Contract Taxonomy
2. Modelling overview of Fixed Shape Fixed Volume (FSFV) contracts
3. Modelling overview of Generation-Following (GF) contracts

**V. Analytical outcomes of FSFV vs Generation Following under Equilibrium-market analysis**

1. Overall financial (WACCs/LCOEs) implications for developers/consumers
2. Deep-dive on Generation Following (GF) contracts)
3. Deep-dive on Fixed Shape Fixed Volume contracts
4. Deep-dive on firming requirements for FSFV contracts
    - i. Firming requirements at a system level
    - ii. Firming requirements at an asset-level (physical firming)

**VI. Analytical outcomes of FSFV vs Generation-following contracts under non-equilibrium market analysis**

1. Overall financial (WACCs/LCOEs) implications for developers/consumers
2. Deep-dive on "stress-test" scenarios
    - i. Low wholesale prices/high renewables build out
    - ii. Extreme High Prices
    - iii. Low renewables output/weather year

**VII. Appendix**

# The following key assumptions are used when deriving contractual analysis for key analytical deliverables

| Assumption | Explanation |
|---|---|
| **Financial Settlement** | ▪ The granularity at which the project and the offtaker financially settle cash-flows<br>▪ Monthly financial settlement in LTESA exercised periods |
| **Debt Service Coverage Ratios (DCSRs)** | ▪ Merchant cashflows (involved in both exercise and non-exercise periods) are evaluated with a DSCR[1] of 1.5 can be accessed by an LTESA asset to simulate the ability to secure another contract (e.g. a power purchase agreement) in non-exercise periods<br>▪ Contracted cashflows are evaluated with a DSCR[1] of 1.1 |
| **Cost of Debt/ Equity** | ▪ Cost of debt for the project is set at 3% and cost of equity for the project is set at 9%[2] |
| **Floating Price** | ▪ The contractual Floating Price is the price at which the project and offtaker financially settle against<br>▪ The Floating Price is generally the wholesale price, however, there are some important deviations from this rule (e.g. Floating Price is $0/MWh when wholesale prices are <$0/MWh) |
| **Fixed Price** | ▪ The flat strike price contracted between the project and the offtaker<br>▪ The delta between the Fixed Price and Floating Price indicates the directionality of cashflows between the project and offtaker for a two-way Fixed Price (i.e. Fixed Price does not represent a price ceiling or floor)<br>▪ Aurora has modelled the majority of this analysis by using the project LCOE under a 5% WACC for the fixed-price |
| **Negative Price Curtailment** | ▪ In both generation following (GF) and fixed-shape-fixed-volume (FSFV) contracts, assets are assumed to curtail at negative wholesale prices. In the case of the FSFV contract, the developer will still receive the fixed price if its notional quantity is still applicable in these intervals |
| **Optionality** | ▪ Degree of optionality in contract - for the buyer or seller<br>▪ Options for the developer to exercise in the LTESA contract are assumed to be in 2-year periods with 6 months notice which commence at the beginning of the financial year. The exercise period may be a single year if it coincides with the last year of the LTESA contract.<br>▪ In both contracts, assets are assumed to exercise the option in any two-year period where the two-yearly cash flows available for debt service (CFADS) is greater than the equivalent CFADS that would be obtained if the option were not exercised |
| **Contract Optimising Position** | ▪ In both contracts, assets are assumed to seek the contractual position that maximises their minimum monthly cash flows available for debt service (CFADS) in order to get sufficient debt into their project |
| **Tenor** | ▪ Length of time remaining before a contract expires – 20 years for the LTESA contract. |

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1) DSCRs provided for the analysis by AEMO Services. 2) Cost of Equity and Debt provided by AEMO Services

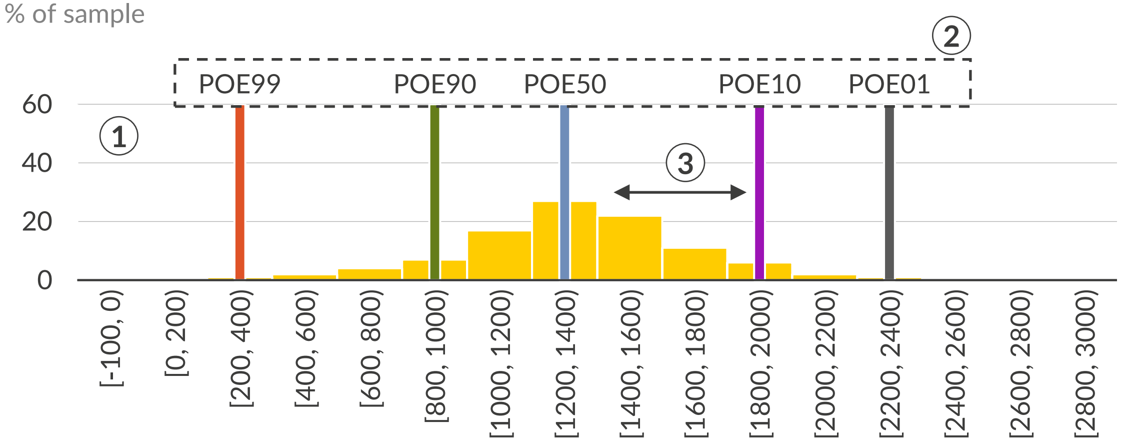
Source: Aurora Energy Research

# The following statistical and finance concepts will be used throughout this analysis

AURORA

## Statistical concepts used in this analysis

**Example distribution of half hourly load in a year**
% of sample



### ① Distribution

- Function giving the probability of occurrence of different outcomes in a sample

### ② POE

- Probability of exceedance
- A POE99 value indicates that 99% of values in a distribution are above this value,
- The POE99 value is taken from the 1st percentile of the distribution

### ③ Standard Deviation

- Measure of the spread of a distribution
- The smaller the standard deviation, the less volatile/wide the distribution

## Financial concepts used in this analysis

### Debt sizing concepts

| | | | |
|---|---|---|---|
| **CFADS** | **Cash flow available for debt service** | In Aurora's analysis, we consider earnings before interest, taxation, depreciation and amortisation (EBITDA) | |
| **DSCR** | **"Debt service coverage ratio"** | $\frac{CFADS}{Total\ Debt}$ | In Aurora's analysis, we make standard DSCR assumptions in order to size debt for projects |

### NPV & IRR

| | | | |
|---|---|---|---|
| **NPV** | **Net Present Value** | Current discounted value, with some rate of return $r$ of future cash flows for a project | $NPV = \sum_{n=0}^{N} \frac{C_n}{(1+r)^n}$ |
| **IRR** | **Internal Rate of Return** | Implied single annual rate of return for a project that makes NPV equal to 0 | $\sum_{n=0}^{N} \frac{C_n}{(1+IRR)^n} = 0$ |

Source: Aurora Energy Research

# Agenda

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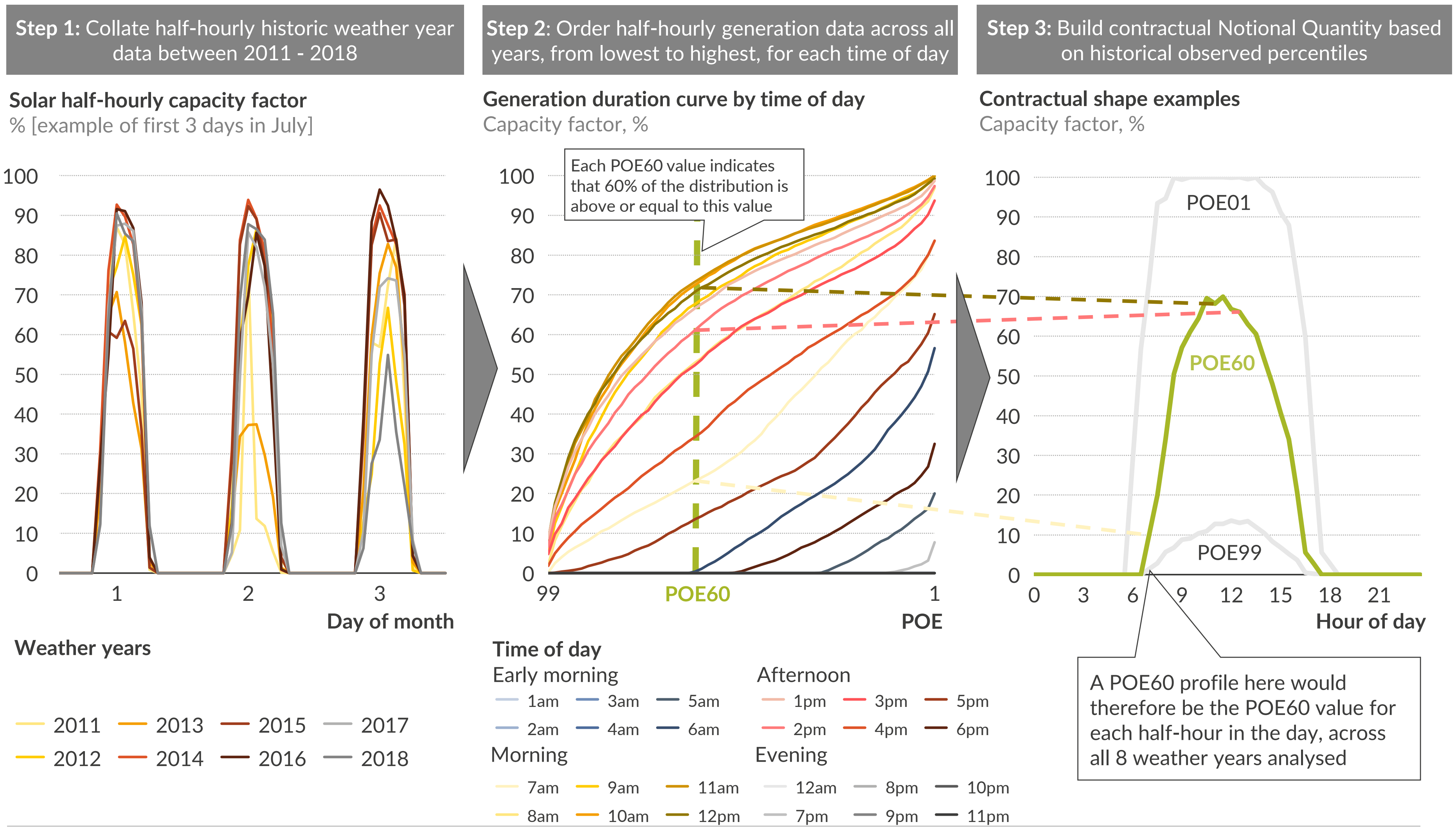
Illustrative Example

# Solar FSFV shape – A three step approach was taken to derive POE shapes from half-hourly generation data across 8 historic weather years

**Aurora's three step approach to derive half-hourly sculpted Notional Quantity for FSFV contracts – Example of Solar in CWO**



**Step 1:** Collate half-hourly historic weather year data between 2011 - 2018

**Solar half-hourly capacity factor**
% [example of first 3 days in July]

**Step 2:** Order half-hourly generation data across all years, from lowest to highest, for each time of day

**Generation duration curve by time of day**
Capacity factor, %

Each POE60 value indicates that 60% of the distribution is above or equal to this value

**Step 3:** Build contractual Notional Quantity based on historical observed percentiles

**Contractual shape examples**
Capacity factor, %

A POE60 profile here would therefore be the POE60 value for each half-hour in the day, across all 8 weather years analysed

Source: Aurora Energy Research

**Deriving POE shapes for FSFV contracts – Solar**

- In order to analyse the contractual risks associated with FSFV contracts, Aurora has undertaken a three-step methodology to derive representative POE shapes
- The process is conducted for each and every month, such that we have POE intraday contractual shape at a monthly level (as advised by AEMO Services that monthly settlement is likely to be preferred option within FSFV contractual agreement)
- For solar, we observe that production is significantly more varied in the morning and evening shoulders as the solar asset is ramping before/ after 6am/6pm. At these times, overall production levels are typically lower.
- Throughout the morning - middle of the day (8am – 2 pm), production is less varied and typically higher
- Expectingly, POE60 for solar is highest in the middle of the day and tails off before/after 6am/6pm

Illustrative Example

# Onshore Wind FSFV shape - A three step approach was taken to derive POE shapes from half-hourly generation data across 8 historic weather years

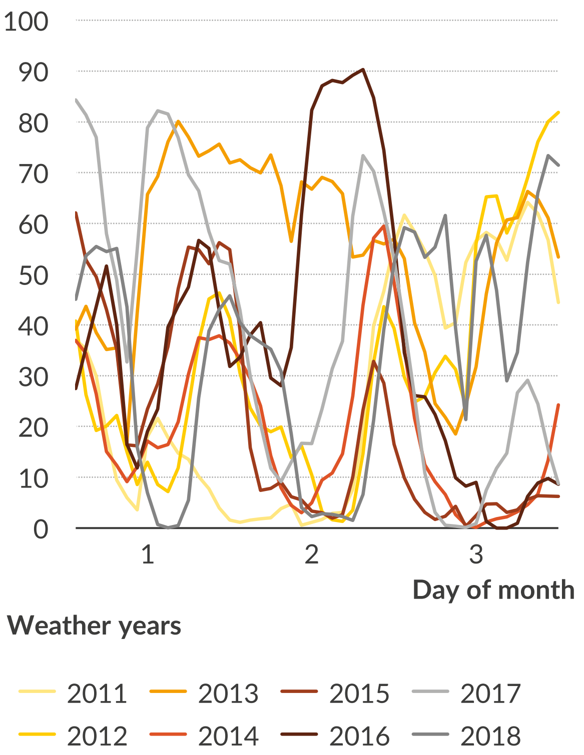
**Aurora's three step approach to developing half-hourly sculpted Notional Quantity for FSFV contracts – Example of Onshore Wind in CWO**

**Step 1:** Collate half-hourly historic weather year data between 2011 - 2018

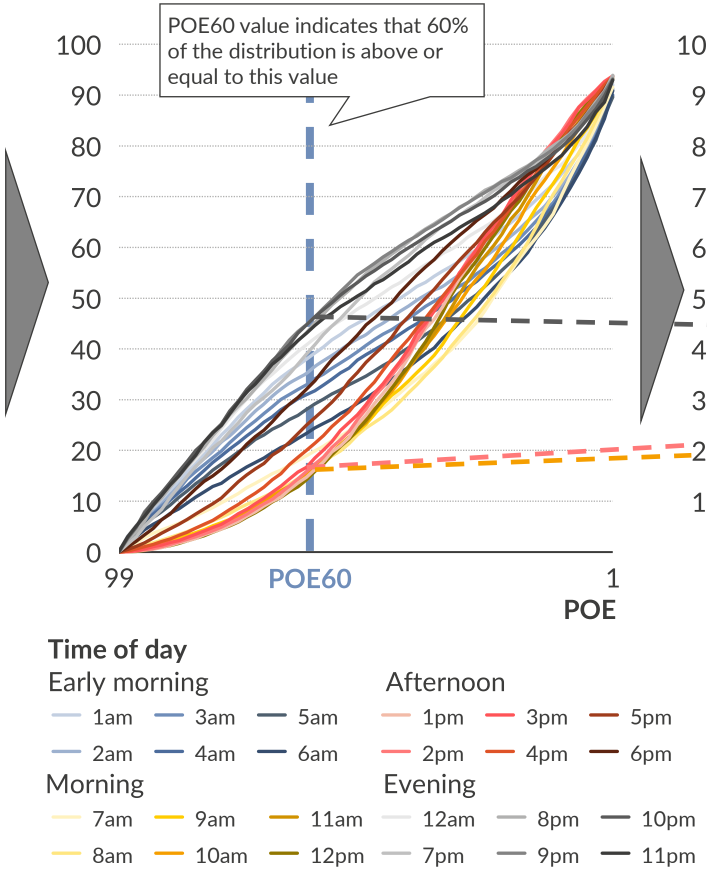
**Step 2**: Order half-hourly generation data across all years, from lowest to highest, for each time of day

**Step 3:** Build contractual Notional Quantity based on historical observed percentiles

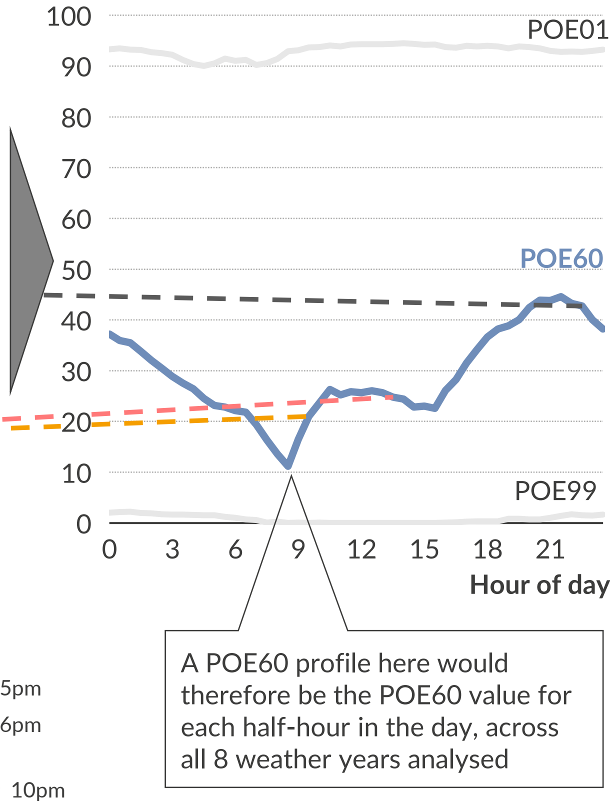
**Onshore Wind half-hourly capacity factor**
% [example of first 3 days in July]



**Generation duration curve by time of day**
Capacity factor, %


POE60 value indicates that 60% of the distribution is above or equal to this value

**Contractual shape examples**
Capacity factor, %



A POE60 profile here would therefore be the POE60 value for each half-hour in the day, across all 8 weather years analysed

**Deriving POE shapes for FSFV contracts – Onshore Wind**

- In order to analyse the contractual risks associated with Fixed Shape Fixed Volume (FSFV) contracts, Aurora has undertaken a three-step methodology to derive representative POE shapes must first be derived
- The process is conducted for each and every month, such that we have POE intraday contractual shape at a monthly level (as advised by AEMO Services that monthly settlement is likely to be preferred option within FSFV contractual agreement)
- Unlike Solar, we see that onshore wind profiles can varying significantly within the day/across days for different weather years
- For the POE60 of a representative onshore wind asset in CWO, we see lowest production in the middle of the day and highest output in the evening/night

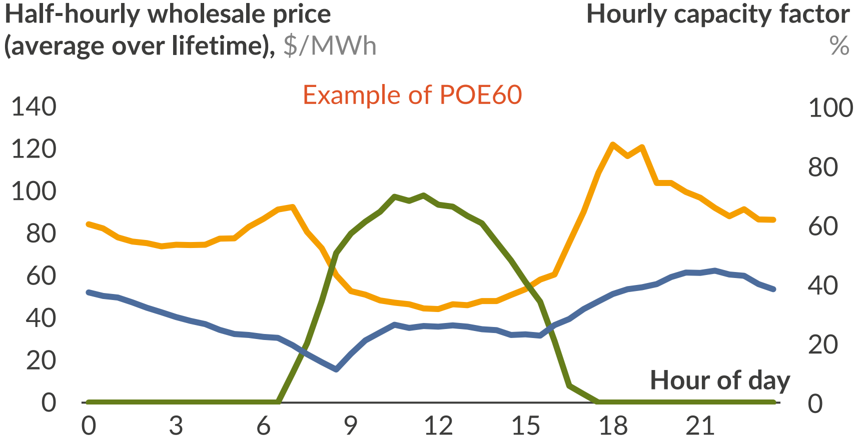
Source: Aurora Energy Research

Illustrative Example

# FSFV Contract Price (Upper Bound) – Risk-neutral POE contract prices serve as an upper bound, and are mapped for each asset and each POE shape

Aurora's approach for upper bound on FSFV contract prices – POE risk-neutral price for Solar and Onshore Wind in CWO, COD 2024

**Step 1:** We calculate a FSFV Risk-Neutral Contract Price based on the dispatch-weighted average price of the contractual shape over the contract term (i.e. 20 years)



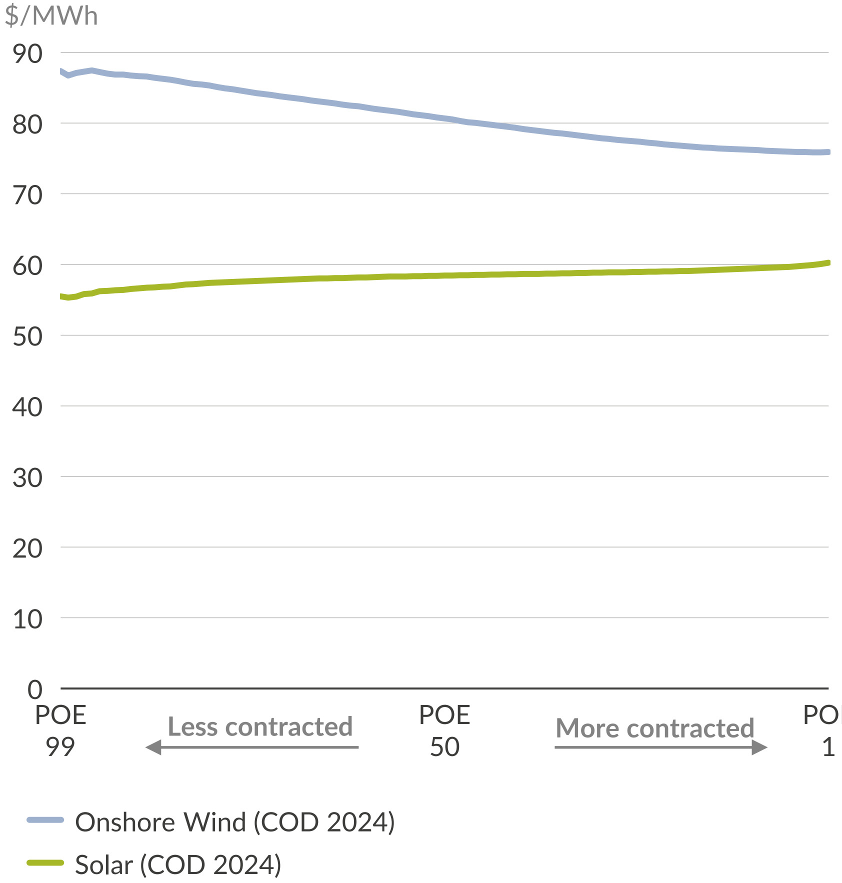
FSFV Risk-Neutral[1] $\text{Price}_{POEXX} = \frac{\Sigma(\text{Contractual shape}_t \times \text{Floating Price}_t)}{\Sigma(\text{Contractual shape}_t)}$

Solar FSFV Risk-Neutral $\text{Price}_{POE60} = \frac{\Sigma(\text{POE60}_t \times \text{Floating Price}_t)}{\Sigma(\text{POE60}_t)}$

Wind FSFV Risk-Neutral $\text{Price}_{POE60} = \frac{\Sigma(\text{POE60}_t \times \text{Floating Price}_t)}{\Sigma(\text{POE60}_t)}$

**Step 2:** We map up a FSFV Risk-Neutral Contract Price for both wind and solar, for each and every POE level, over the 20 year contract periods modelled

FSFV contract risk-neutral price for each POE – assumes COD in 2024



**Deriving upper bound on FSFV contract prices – POE risk-neutral prices**

- POE risk-neutral prices serve as an upper bound on FSFV contract prices
- To derive a risk-neutral price, we take the average wholesale price that a merchant asset is expected to receive (for each POE shape) over the 20-year contract lifetime (i.e. 2024 – 2043 for a COD 2024 asset)
- Under this risk-neutral price, an asset is indifferent between (i) participating in the merchant market; or (ii) being contracted under LTESA
- This risk-neutral price is therefore equivalent to the dispatch weighted average price for the 20 year period, for each specified POE production shape
- This example shows a COD 2024 asset, but the analysis can be conducted for multiple COD Years

---

1) Subscript POEXX represents the probability of exceedance half-hourly shape, where XX is a placeholder for a probability of exceedance percentile. Subscript t represents a half-hourly time interval.

Source: Aurora Enerrgy Research

Illustrative Example

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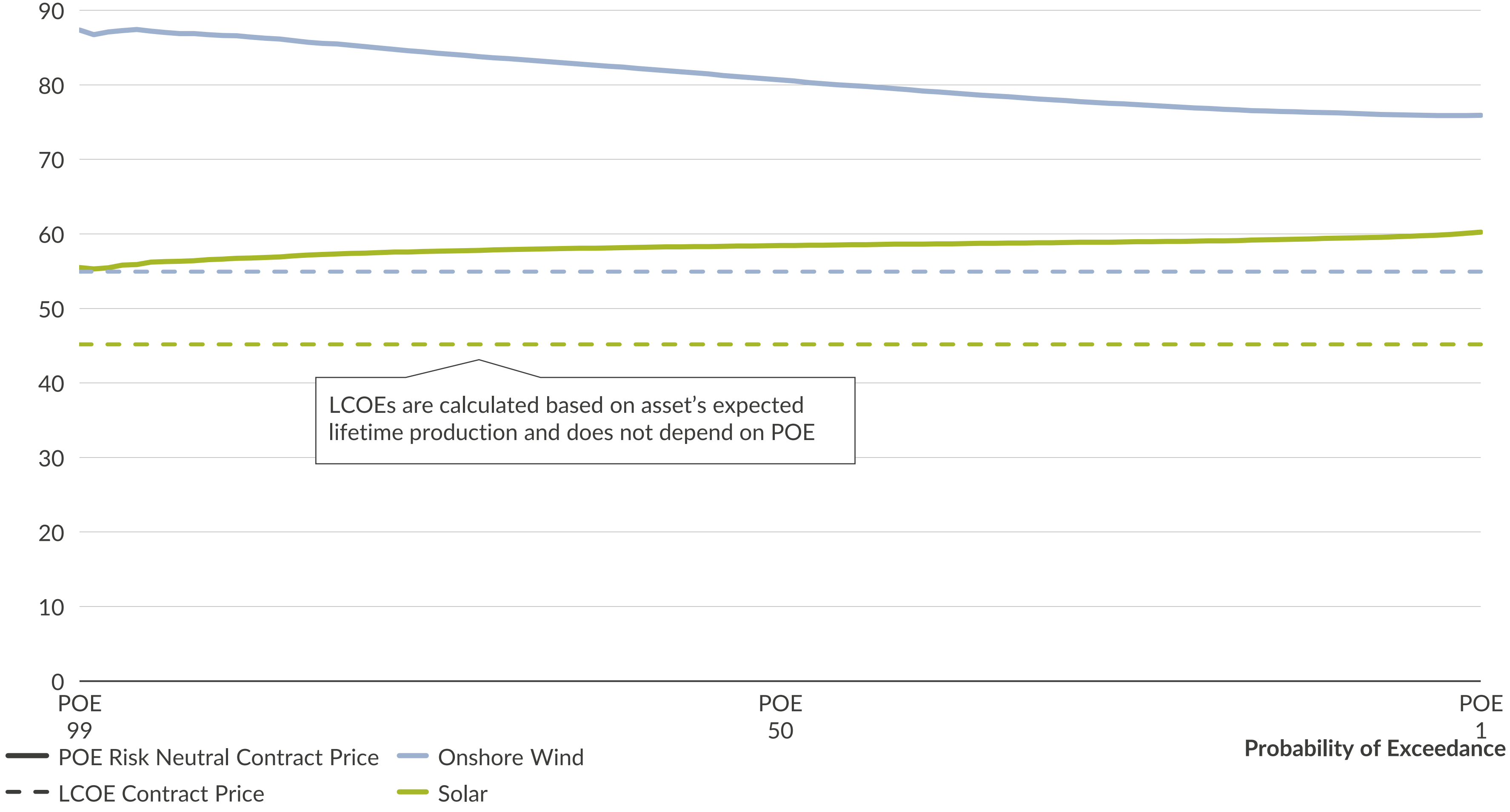
# FSFV Contract Prices – Upper bounds are determined by POE risk neutral prices; LCOEs of new wind/solar assets serve as a potential lower bound

**Upper/Lower bounds on FSFV contract prices – Solar and Onshore Wind in CWO, COD 2024**

**FSFV Contract Price – POE Risk-Neutral Contract Price [Upper Bound] versus LCOE Strike Price [Lower Bound]**
$/MWh



LCOEs are calculated based on asset's expected lifetime production and does not depend on POE

---

1) A 5% WACC is assumed for a subsidised asset, based on consultation with Aurora's Client and alignment with AEMO Services.

Source: Aurora Energy Research

**Upper/Lower Bound of FSFV contract prices**

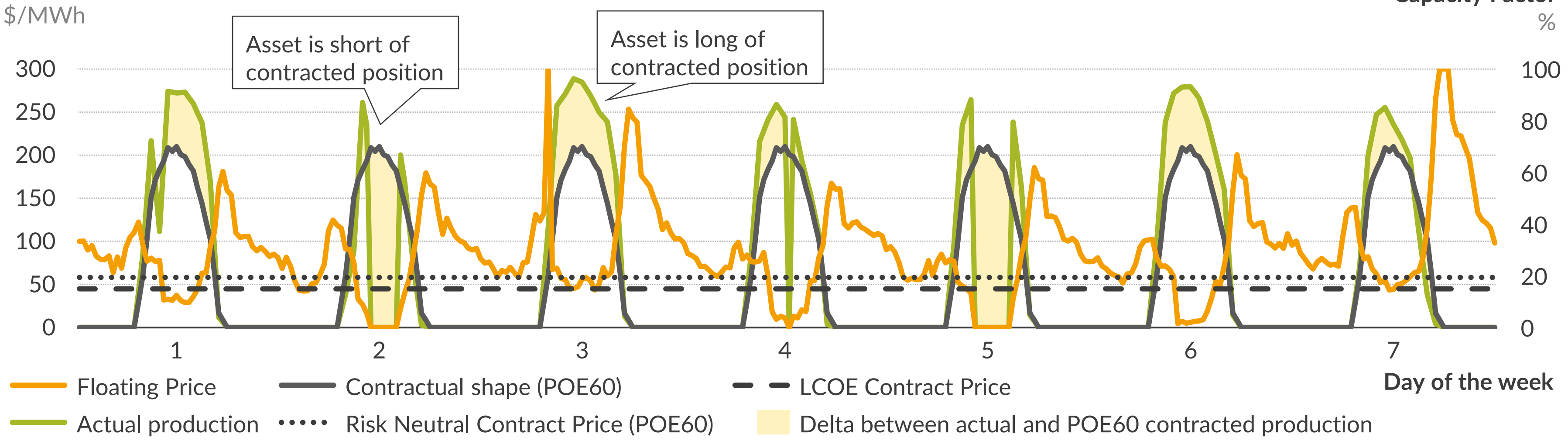
- While POE risk-neutral prices serve as an upper bound on contract prices (discussed on previous slide), LCOEs are assumed to set a lower bound on FSFV contracts
- LCOEs for new onshore wind/solar assets are derived based on Aurora's renewables cost estimates (see slide 22 and 23), and an assumed WACC of 5%[1]
- LCOEs are calculated based on the expected production of the asset across it's lifetime and therefore, does not depend on Probability of Exceedance
- The LCOE Strike Price for a solar asset built in FY2024 sits $10-15/MWh below the Risk-Neutral Contract Price
- The delta is larger for onshore wind, where the difference between the LCOE Strike Price and the Risk-Neutral Contract Price is $20-30/MWh

Illustrative Example

# Solar FSFV Cash Flows – Contracted asset sees more stable returns on average, but face notable risks in periods where wholesale prices are high

**Comparison of cashflows for FSFV contracted (LCOE + risk neutral prices) vs merchant asset – example week for Solar in CWO**

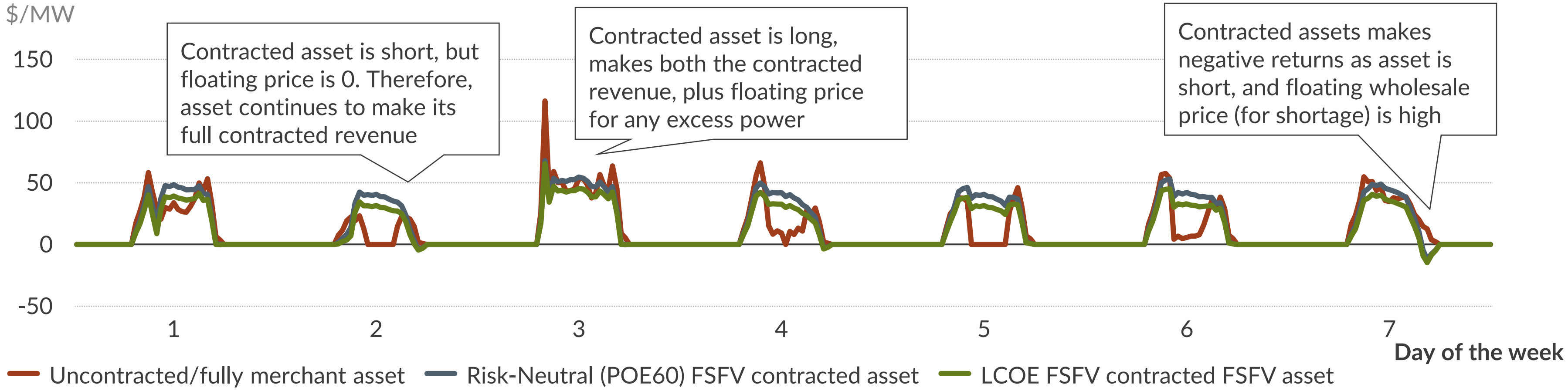
**NSW half-hourly wholesale price and FSFV solar contract prices (example of POE60)[1,3]**



Asset is short of contracted position

Asset is long of contracted position

**Comparison of half-hourly revenues for uncontracted vs FSFV contracted asset over the sample week[2,3]**



Contracted asset is short, but floating price is 0. Therefore, asset continues to make its full contracted revenue

Contracted asset is long, makes both the contracted revenue, plus floating price for any excess power

Contracted assets makes negative returns as asset is short, and floating wholesale price (for shortage) is high

---

1) Project cash flows settle at the Floating Price when production is short/long the contractual position. 2) For the contracted asset, the revenues stem from contract payments + any additional revenues/costs incurred for excess/deficit at prevailing wholesale prices. 3) Assume Floating Price floor at $0/MWh and asset economically curtails at the Floating Price floor.

Source: Aurora Energy Research

**Solar cash flows for FSFV contracted and uncontracted asset for a sample week**

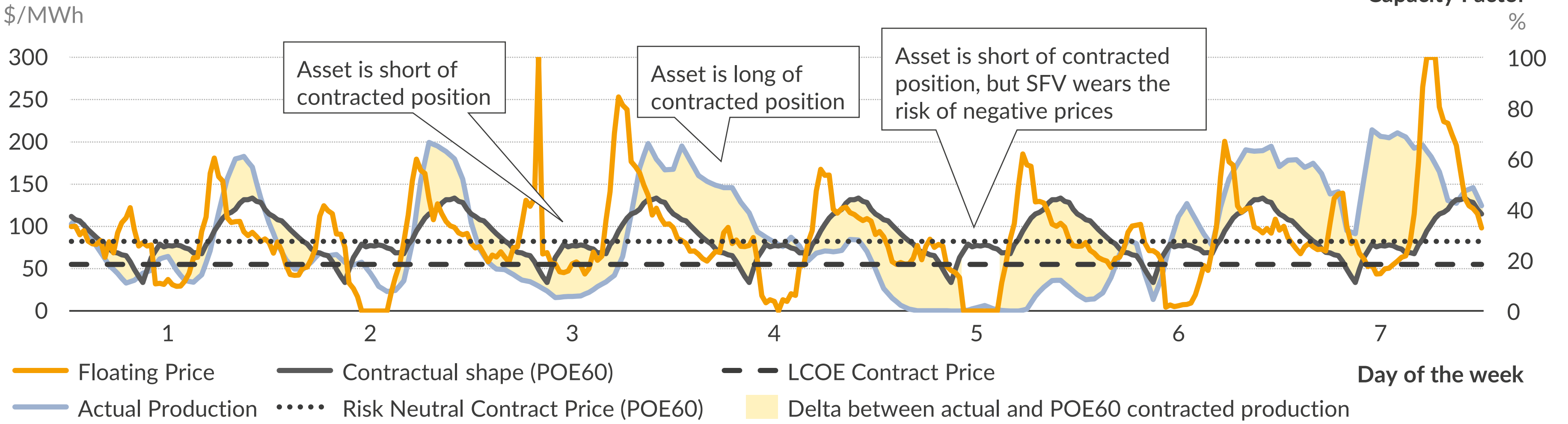
- Participating in a FSFV contract could provide more stable returns to a solar asset on an average day, but could see significant risks when wholesale prices are high and the asset is short of its contracted Notional Quantity
- An uncontracted asset is assumed to face the prevailing wholesale price (termed floating price) at any given half-hour interval
- A contracted asset, on the other hand, is assumed to face both the contracted price, and the floating price (when it's short/long its contractual position) at any given half-hour interval
- In particular, contracted assets could face negative cash flows if it's short of its Notional Quantity while floating prices are extremely high as the asset would have to make up for the short-fall through paying the spot wholesale rate
- For a solar asset, these instances are likely to happen in the morning/evening shoulders, where the asset's production is most varied and wholesale prices are high
- Although cash flows are monitored at the half-hourly Time Interval level, we model Financial Settlement at monthly intervals

Illustrative Example

# Onshore Wind FSFV Cash Flows – asset cash flows are significantly more varied than Solar due to variation/fluctuations in wind production profiles

**Comparison of cashflows for FSFV contracted (LCOE + risk neutral prices) vs merchant asset – example week for Onshore Wind in CWO**

**NSW half-hourly wholesale price and FSFV onshore wind contract prices (example of POE60)[1,3]**

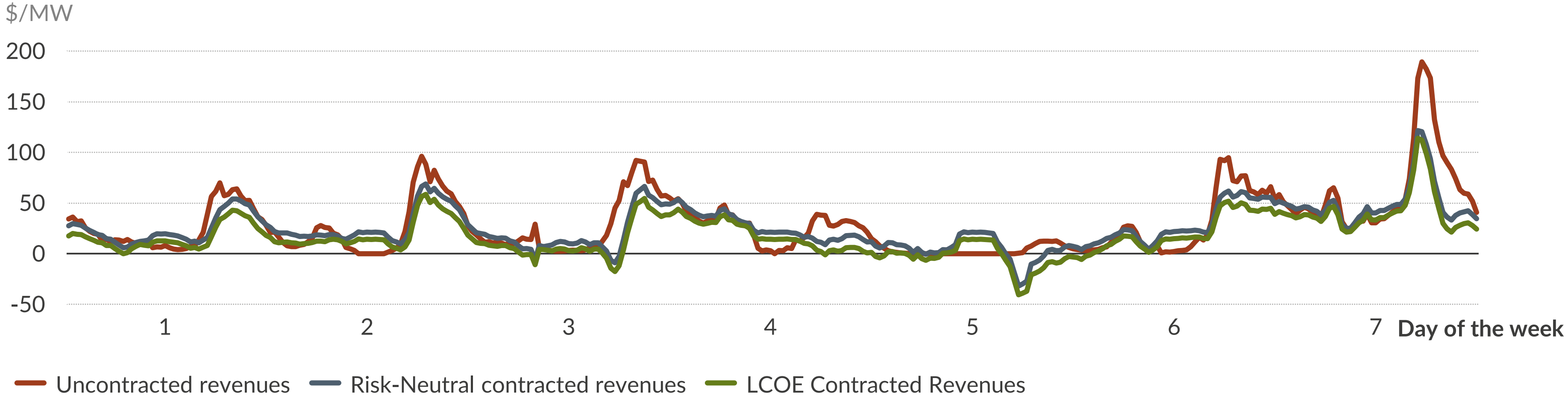


Asset is short of contracted position

Asset is long of contracted position

Asset is short of contracted position, but SFV wears the risk of negative prices

**Comparison of half-hourly revenues for uncontracted vs FSFV contracted asset over the sample week[2,3]**



**Onshore Wind cash flows for FSFV contracted and uncontracted asset for a sample week**

- Under a FSFV contract, onshore wind is likely to face higher volatility/uncertainty in cash flows than a solar asset
- An uncontracted asset is assumed to face the prevailing wholesale price (termed floating price) at any given half-hour interval
- A contracted asset, on the other hand, is assumed to face both the contracted price, and the floating price (when it's short/long its contractual position) at any given half-hour interval
- As wind asset production is less predictable on both an intraday and intra-year basis, the asset could face multiple periods where it's cash flows are negative, posing a potential risk to repayments under the scheme

---

1) Project cash flows settle at the Floating Price when production is short/long the contractual position. 2) For the contracted asset, the revenues stem from contract payments + any additional revenues/costs incurred for excess/deficit at prevailing wholesale prices. 3) Assume Floating Price floor at $0/MWh and asset economically curtails at the Floating Price floor.

Source: Aurora Energy Research

# Agenda

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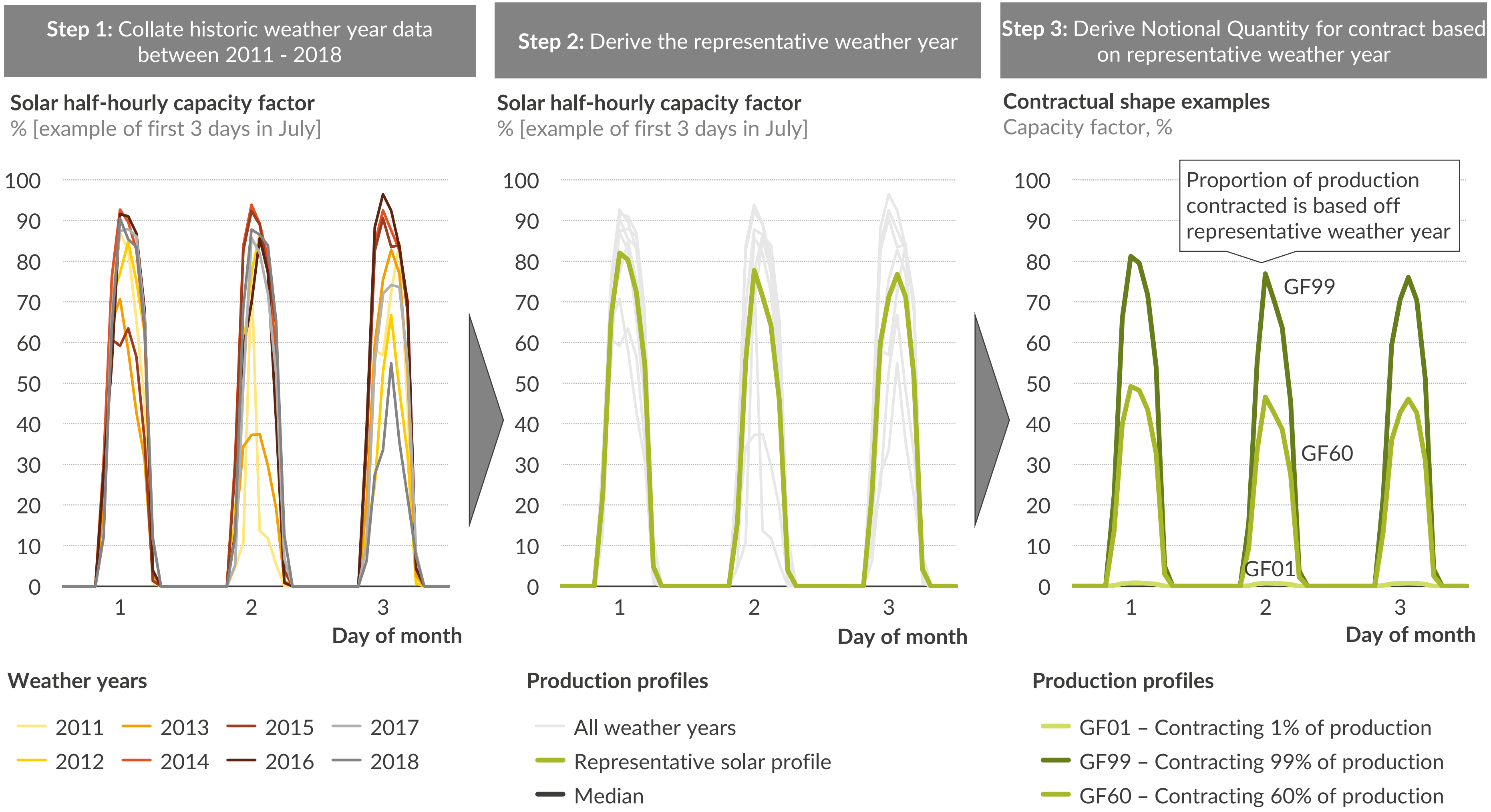
Illustrative Example

# Solar GF shape - A three step approach was taken to derive GF shapes from half-hourly generation data across 8 historic weather years

**Aurora's three step approach to developing half-hourly dispatch shape for generation following contracts – Example of Solar in CWO**


**Step 1:** Collate historic weather year data between 2011 - 2018

**Solar half-hourly capacity factor**
% [example of first 3 days in July]

**Step 2:** Derive the representative weather year

**Solar half-hourly capacity factor**
% [example of first 3 days in July]

**Step 3:** Derive Notional Quantity for contract based on representative weather year

**Contractual shape examples**
Capacity factor, %

Proportion of production contracted is based off representative weather year

## Deriving GF shapes for generation-following contracts – Solar

- By analysing half-hour production data over an eight year period (2011 – 2018), we took the median across each half hour, for each day to form a single representative weather year to dispatch against
- We then formed each generation following shape by taking the percentage of dispatched generation that will be contracted under the LTESA contractual arrangement
- Unlike FSFV contracts, this shape is not fixed – as the intraday and seasonal shape of contracted varies with the output of the asset
- For solar this means contracting more production during the high irradiance summer months, and less during winter

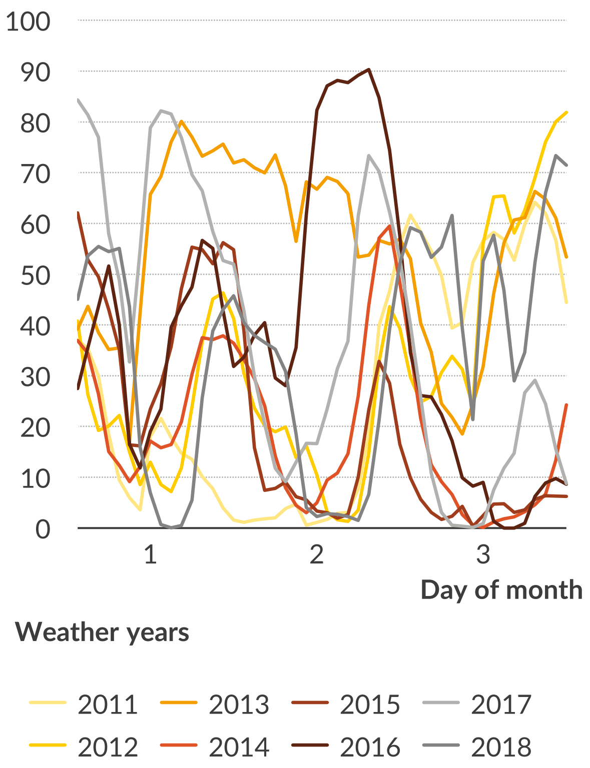
Illustrative Example

# Onshore Wind GF shape - A three step approach was taken to derive GF shapes from half-hourly generation data across 8 historic weather years

**Aurora's three step approach to developing half-hourly dispatch shape for generation following contracts – Example of Onshore Wind in CWO**

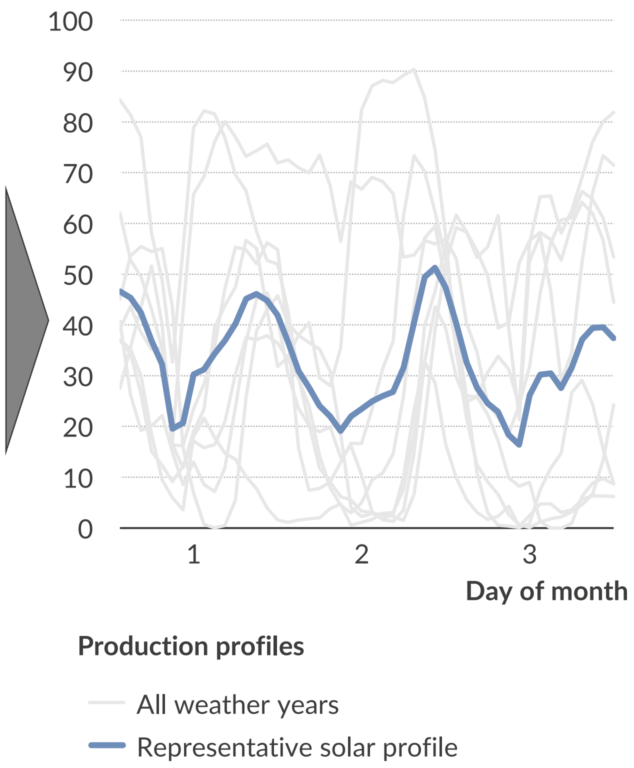
**Step 1:** Collate historic weather year data between 2011 - 2018

**Onshore Wind half-hourly capacity factor**
% [example of first 3 days in July]



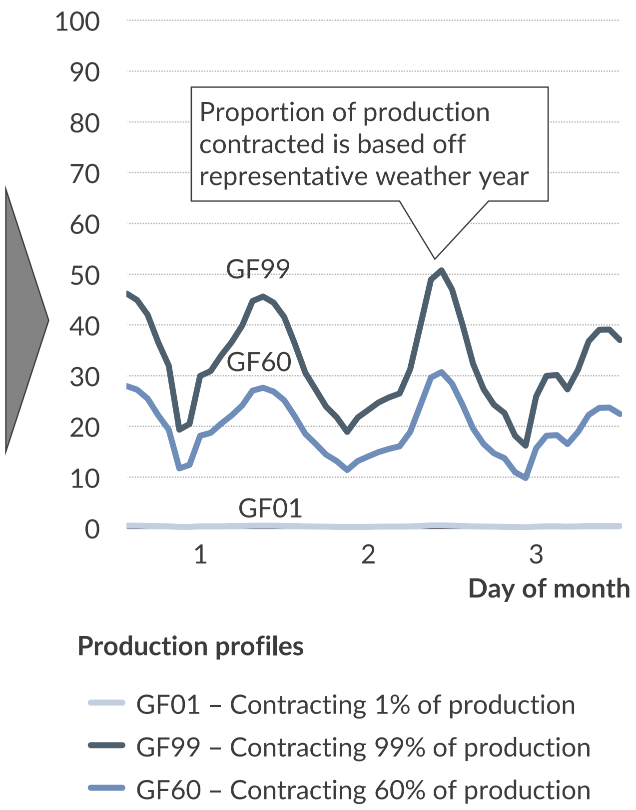
**Step 2:** Derive the representative weather year

**Onshore Wind half-hourly capacity factor**
% [example of first 3 days in July]



**Step 3:** Derive Notional Quantity for contract based on representative weather year

**Contractual shape examples**
Capacity factor, %



Source: Aurora Energy Research

**Deriving GF shapes for generation-following contracts – Onshore Wind**

- By analysing half-hour production data over an eight year period (2011 – 2018), we took the median across each half hour, for each day to form a single representative weather year to dispatch against
- We then formed each generation following shape by taking the percentage of dispatched generation that will be contracted under the LTESA contractual arrangement
- Unlike FSFV contracts, this shape is not fixed – as the intraday and seasonal shape of generation contracted varies with the output of the asset
- Wind production is also extremely varied – as seen on the first chart on the left, production could be significantly different for the over the same period of 3 days in different weather years
- For wind this means that the SFV is exposed to the intraday and intra-year variability in wind production

Illustrative Example

AURORA

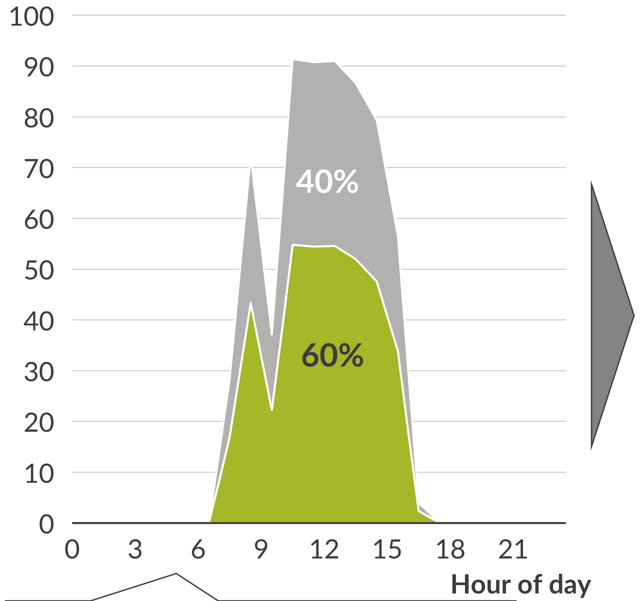
# GF Contract Price – Upper bounds are determined by Risk-Neutral prices; LCOEs of new wind/solar assets serve as a potential lower bound

**Aurora's approach for deriving Generation Following Contract Price (risk-neutral [upper bound] and LCOE [lower bound])**

Sample day of merchant and contracted capacity for a solar asset (e.g 60% contracted)

**Sample date of solar asset dispatch**

Capacity factor, %



In the 9:00-9:30am interval, the solar generator reached 55% capacity. In this contractual structure, 60% of this production will be contracted to the SFV when the contract is exercised

▨ Uncontracted (40%) 🟩 Contracted (60%)

Mathematical calculation for the risk-neutral price for an asset that has contracted a proportion $\boldsymbol{p}$ of their generation[1]

$$contractual\ shape_t = p \times generation_t$$

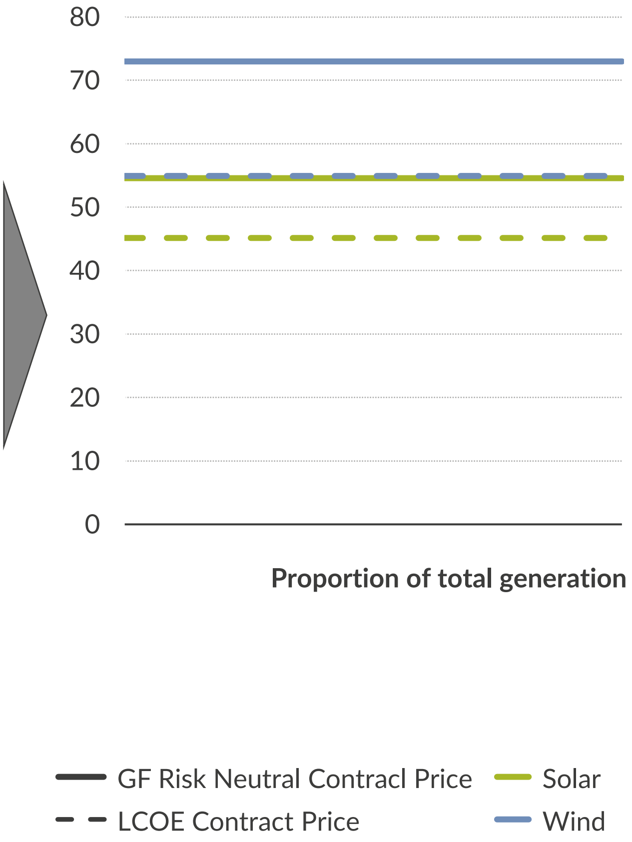
$$\begin{aligned} &GF\ Risk\ Neutral\ Contract\ Price \\ &= \frac{\sum(contractual\ shape_t \times floating\ price_t)}{\sum(contractual\ shape_t)} \\ &= \frac{\sum(p \times generation_t \times floating\ price_t)}{\sum(p \times generation_t)} \\ &= \frac{\sum(generation_t \times floating\ price_t)}{\sum(generation_t)} \\ &= Fully\ Merchant\ DWAP_{20\ year\ period} \end{aligned}$$

Regardless of the generation proportion, $p$, that is contracted, it will cancel out in the risk-neutral price calculation.

Generation Following Risk-Neutral Contract Price

**Contract price – GF Risk-Neutral vs LCOE Strike**

$/MWh



**Upper/Lower Bound of GF contract prices**

- In the Generation Following contractual structure the project developer can bid any proportion of the asset's production (in each Time Interval) to the LTESA arrangement
- The proportion must be the same for all Time Intervals (e.g. if the asset wants to bid 10% of its production at 12 – 1pm, it must do so for the entire day as well)
- As such, the Risk-Neutral Contract Price for the Generation Following contractual arrangement is the same at each and every proportion of total generation contracted
- The Risk-Neutral Contract Price is equal to the expected dispatch-weighted price of the project, such that developer is indifferent between a fully contracted or a fully merchant position from a total cash flows perspective
- The LCOE Strike Price is ~$10/MWh and $20/MWh below the Risk-Neutral Contract Price for solar and wind projects respectively

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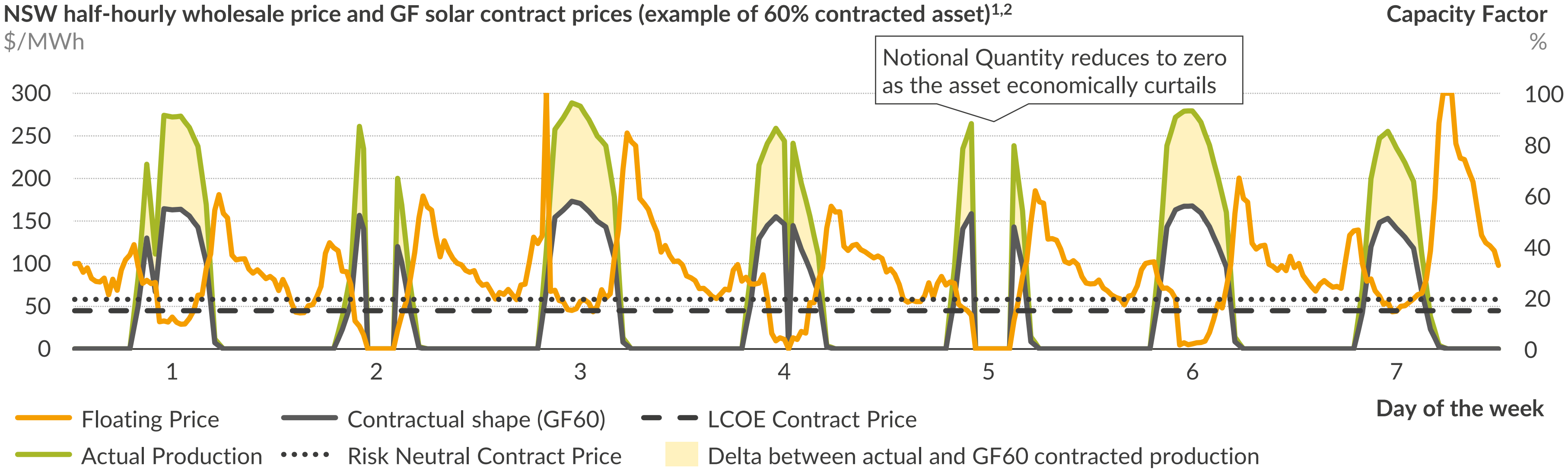
[1] Post-curtailment at $0/MWh and post-MLF

Source: Aurora Energy Research

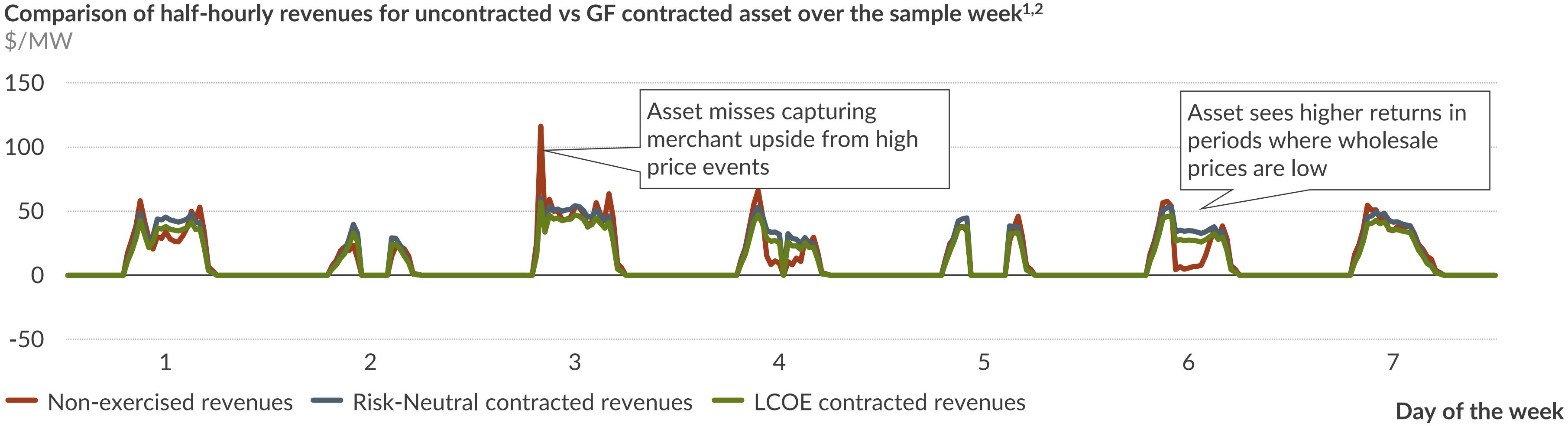
# Solar GF Cash Flows – Contract assets see more stable returns and is not at risk of negative cash flows, although upside is limited

**Comparison of cashflows for 60% GF-contracted asset vs merchant asset – example week for Solar in CWO**

**NSW half-hourly wholesale price and GF solar contract prices (example of 60% contracted asset)[1,2]**



**Comparison of half-hourly revenues for uncontracted vs GF contracted asset over the sample week[1,2]**



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1) Project cash flows settle at the Floating Price for any production in excess of the contracted capacity. In this case, 60% of asset production is contracted, and settled at the contract price while the remaining 40% is settled at the floating price.2) Assume Floating Price floor at $0/MWh and asset economically curtails at the Floating Price floor.

Source: Aurora Energy Research

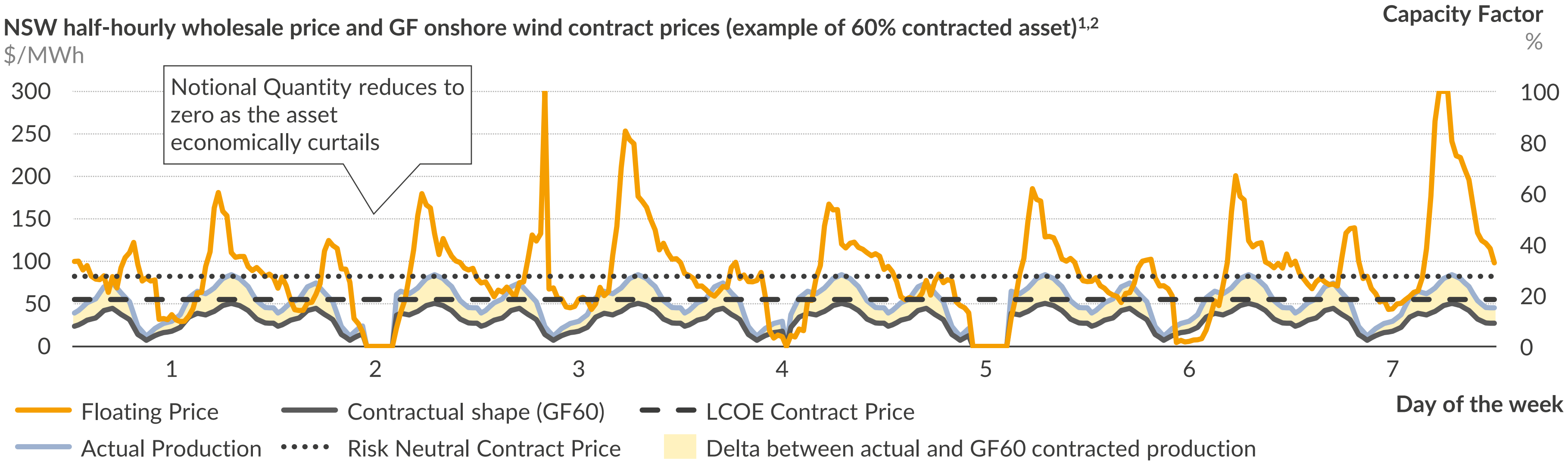
**Solar cash flows for GF contracted and uncontracted asset for a sample week**

- Similar to the approach with FSFV contracts, the financial position of the uncontracted and contracted asset is calculated at the half-hourly level with monthly Financial Settlement
- Relative to a fully merchant solar asset, a GF-contracted asset will see more stable returns – it receives higher returns typically in the middle day when floating wholesale prices are low, at the expense of forgoing potentially lucrative high prices in the morning and evening shoulder periods
- Crucially, unlike the FSFV contract, a GF asset cannot be short of its contracted position. Therefore it is not exposed to any risk of negative cash flows (the asset curtails at a floating price floor of $0/MWh)

# Onshore Wind GF Cash Flows – Contracted assets sees limited upside, although risk of negative cash flows is entirely mitigated relative to FSFV

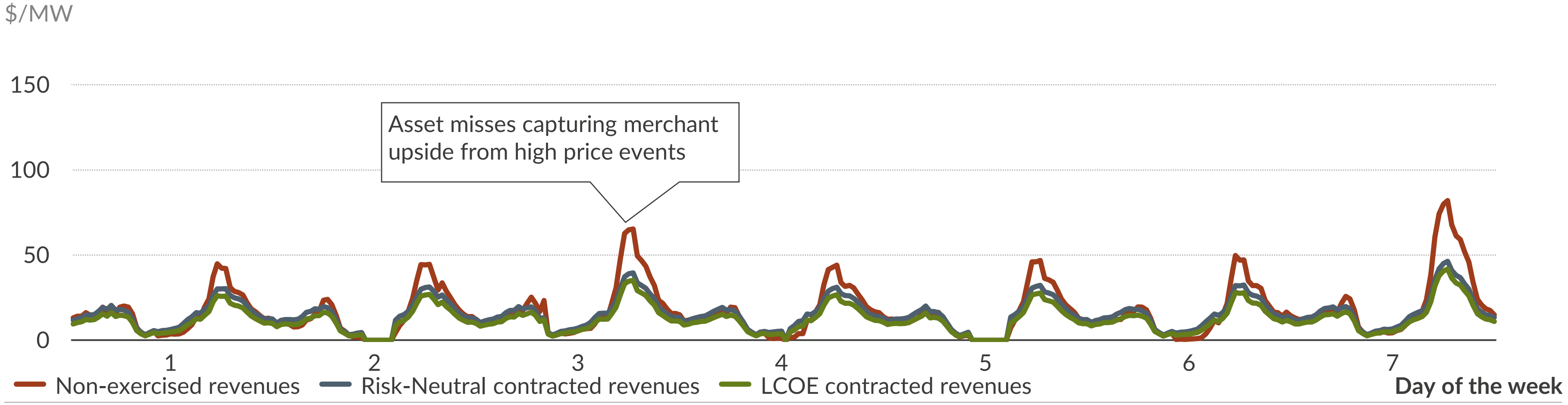
**Comparison of cashflows for 60% GF-contracted asset vs merchant asset – example week for onshore wind in CWO**

**NSW half-hourly wholesale price and GF onshore wind contract prices (example of 60% contracted asset)[1,2]**



Notional Quantity reduces to zero as the asset economically curtails

**Comparison of half-hourly revenues for uncontracted vs GF contracted asset over the sample week[1,2]**



Asset misses capturing merchant upside from high price events

**Onshore wind cash flows for GF contracted and uncontracted asset for a sample week**

- Similar to the approach with FSFV contracts, the financial position of the uncontracted and contracted asset is calculated at the half-hourly level with monthly Financial Settlement
- Relative to a fully merchant solar asset, a GF-contracted asset will see more stable returns – it receives higher returns typically in the middle day when floating wholesale prices are low, at the expense of forgoing potentially lucrative high prices in the morning and evening shoulder periods
- Crucially, unlike the FSFV contract, a GF asset cannot be short of its contracted position. Therefore it is not exposed to any risk of negative cash flows (the asset curtails at a floating price floor of $0/MWh). This is most prominent for onshore wind, where an FSFV asset saw multiple periods of negative cash flows occurring

---

1) Project cash flows settle at the Floating Price for any production in excess of the contracted capacity. In this case, 60% of asset production is contracted, and settled at the contract price while the remaining 40% is settled at the floating price.2) Assume Floating Price floor at $0/MWh and asset economically curtails at the Floating Price floor.

Source: Aurora Energy Research

# Agenda

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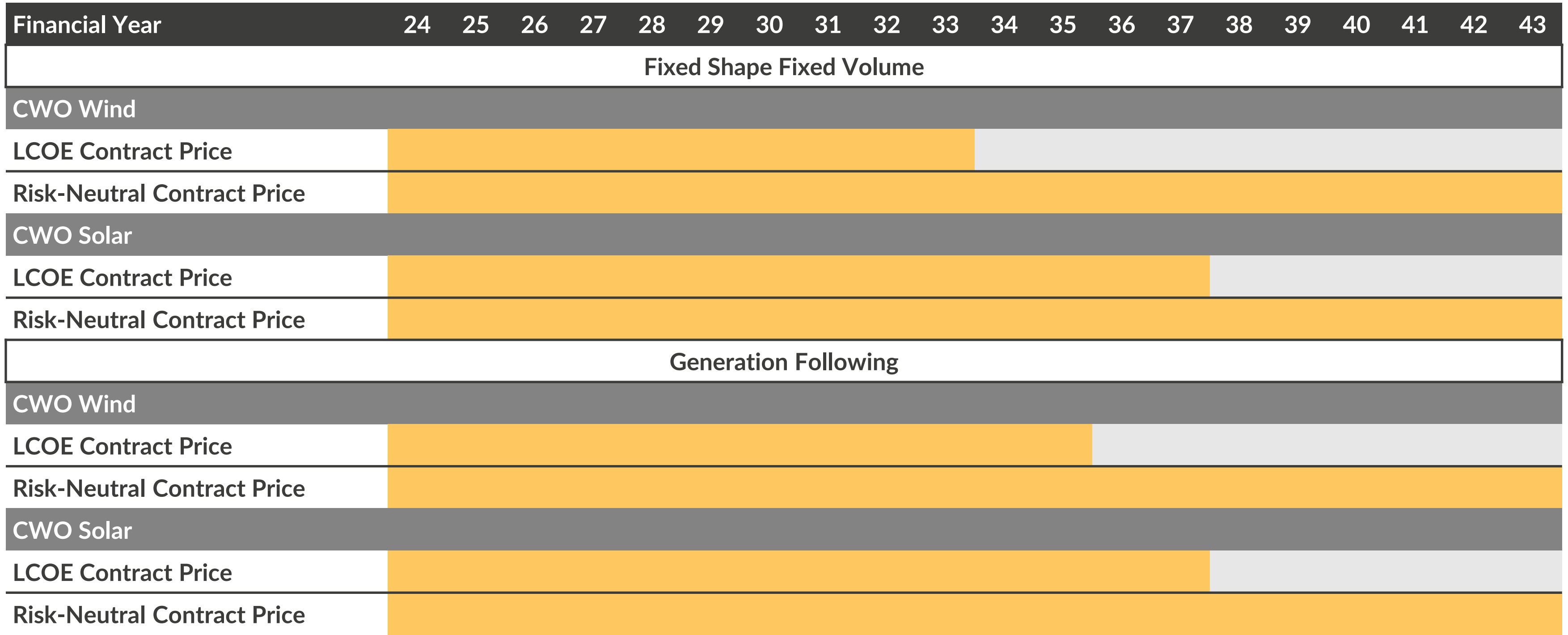
# Based on the modelled scenario, LTESA holders are expected to exercise the option frequently, particularly under Risk-Neutral Contract prices

AURORA

## Exercising behaviour of the LTESA contract holder



| Financial Year | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | 42 | 43 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Fixed Shape Fixed Volume** | | | | | | | | | | | | | | | | | | | | |
| **CWO Wind** | | | | | | | | | | | | | | | | | | | | |
| LCOE Contract Price | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ |
| Risk-Neutral Contract Price | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 |
| **CWO Solar** | | | | | | | | | | | | | | | | | | | | |
| LCOE Contract Price | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ |
| Risk-Neutral Contract Price | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 |
| **Generation Following** | | | | | | | | | | | | | | | | | | | | |
| **CWO Wind** | | | | | | | | | | | | | | | | | | | | |
| LCOE Contract Price | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ |
| Risk-Neutral Contract Price | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 |
| **CWO Solar** | | | | | | | | | | | | | | | | | | | | |
| LCOE Contract Price | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ |
| Risk-Neutral Contract Price | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 | 🟧 |

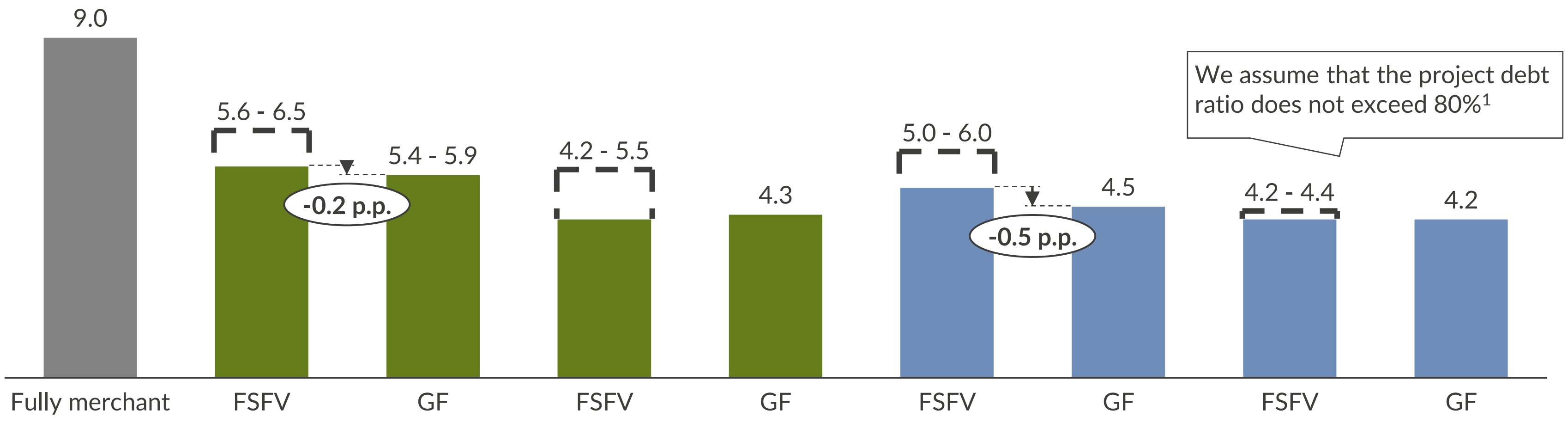
🟧 Exercise the contract ▒ Do not exercise the contract

**Expected option-exercise behaviour for solar and wind assets:**

- Solar and wind assets are both expected to frequently exercise the GF/FSFV contracts under the market scenario and contractual prices modelled
- At the higher Risk-Neutral Contract Prices we find that assets will choose to always exercise the contractual arrangement
- At LCOE Contract Prices, the exercising behaviour of solar assets is unchanged, exercising up to 2038
- For wind assets we see a difference in exercise behaviour at the LCOE Contract Price for the FSFV and GF contracts – where the wind asset chooses to exercise more under the GF contract
- Note that exercisability in this exercise has been based purely on comparing the contract prices and expected wholesale outcomes – it does not consider any other contractual obligations of the asset (e.g. covenants from debt providers which might require the options to be exercised)

# Generation-following contracts reduces WACCs relative to FSFV contracts, with the biggest improvement seen by onshore wind under LCOE prices

**Weighted Average Cost of Capital (WACC)**
%



We assume that the project debt ratio does not exceed 80%[1]

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Debt ratio** | 48-58% | 50-60% | 68-80% | 66-78% | 60-66% | 68-74% | >80% | >80% |
| **Equity ratio** | 52-42% | 50-40% | 32-20% | 34-22% | 40-34% | 32-26% | <20% | <20% |

**LCOE Contract Price** | **Risk-Neutral Contract Price** | **LCOE Contract Price** | **Risk-Neutral Contract Price**

**Solar** | **Onshore Wind**

🟩 Solar 🟦 Onshore Wind ⌐¬ Additional cost for asset-level firming

**Weighted Average Cost of Capital for solar and wind (LTESA Scenario):**

- At Risk-Neutral Contract Prices the costs of capital is similar across the GF and FSFV contractual structures
- However, at the lower LCOE Contract Price the cost of capital is higher under FSFV compared to GF
- The lower WACC for GF at lower contract prices is because the GF asset contracts a higher proportion of its production and, for wind, the GF contract is exercised more frequently
- In the LTESA Scenario we find that the reduction in the WACC from the GF contract (before adjusting for asset-level firming costs) for:
    - Solar is 0.2 p.p, and
    - Wind is 0.5 p.p.
- Asset-level firming ~0.9 p.p. to the cost of capital for both LTESA wind and solar projects

---

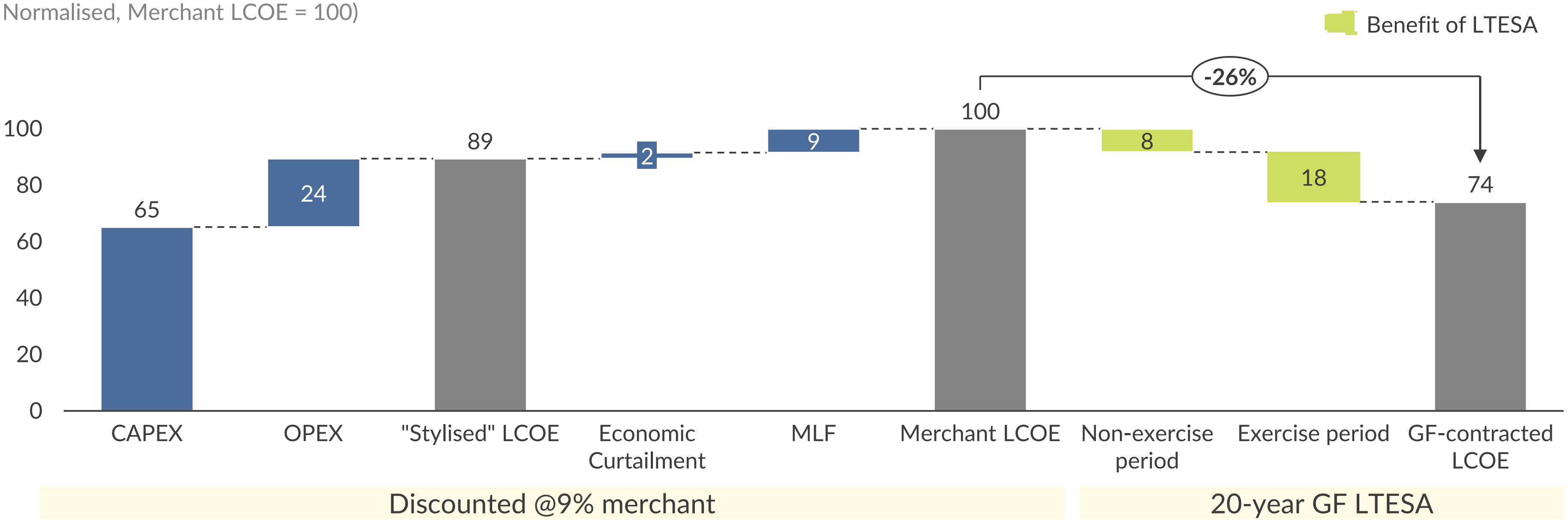
1) Without the limit, assets could seek to increase debt ~100% under these contracts.

Source: Aurora Energy Research

# GF onshore wind – LTESA contract reduces LCOE by up to 26%, across both the exercise and non-exercise periods

**Breakdown of impact of LTESA-contract on the LCOE[1] for a CWO wind project (over the 20-year LTESA period)[2]**

Normalised, Merchant LCOE = 100)



### Definition of key terms

| Key terms | Definition |
|---|---|
| Economic curtailment | The asset curtails generation at wholesale prices below $0/MWh |
| Marginal Loss Factor (MLF) | Marginal network losses at the transmission network connection points at which the generators are located |
| Merchant LCOE | The levelized cost of energy of generating energy over the 20-year lifetime of a LTESA asset[2] accounting for grid and economic constraints |
| Non-exercise period | Benefit in a reduction in the WACC of the asset, by holding LTESA option that allows more asset to secure debt at 1.5 DSCR |
| Exercise period | Benefit in a reduction in the WACC of the asset, which is enabled by holding and exercising the LTESA option which allows assets to secure debt at an assumed 1.1 DSCR |

### Impact on asset LCOE from Onshore Wind GF LTESA

- The "Merchant LCOE" of an asset takes into account its CAPEX and OPEX, but also potential losses from economic curtailment and MLF, and has been normalised to 100%
- By securing a GF-contract, we see a reduction in the LCOE from two key components:
  - **Non-exercise period**: In periods where the asset does not exercise the LTESA, the assets benefit from being able to secure debt (@3%) at 1.5 DSCR, simply by holding onto an LTESA option (for example, by being able to achieve a PPA).
  - **Exercise-period** – When LTESA is exercised, it has been assumed that debt (@3%) for the contracted proportion of the asset's generation, can be secured at 1.1 DSCR. This is a risk transfer from the developer to the SFV and consumers (which the SFV can manage through pooling across contracts)
- Note that this does not necessary imply a (higher) subsidy to assets. This added risk to the SFV would only materialise into higher subsidy payments should the asset be "out-of-money" from its contract price (but this is managed by the SFV through pooling across contracts)
- This analysis is meant to assess the risks to both developers/FSV from engaging in an LTESA contract. It is not meant to inform the precise bidding decision, the contractual prices, or equivalent subsidies for each asset.

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1) Levelised Cost of Energy. 2) Assumes LCOE-contract prices. Analysis is done over the 20-year LTESA period. We have not considered potential merchant revenues post the 20-years (e.g. if an asset lifetime is 25 – 30 years). 3) Scheme Financial Vehicle

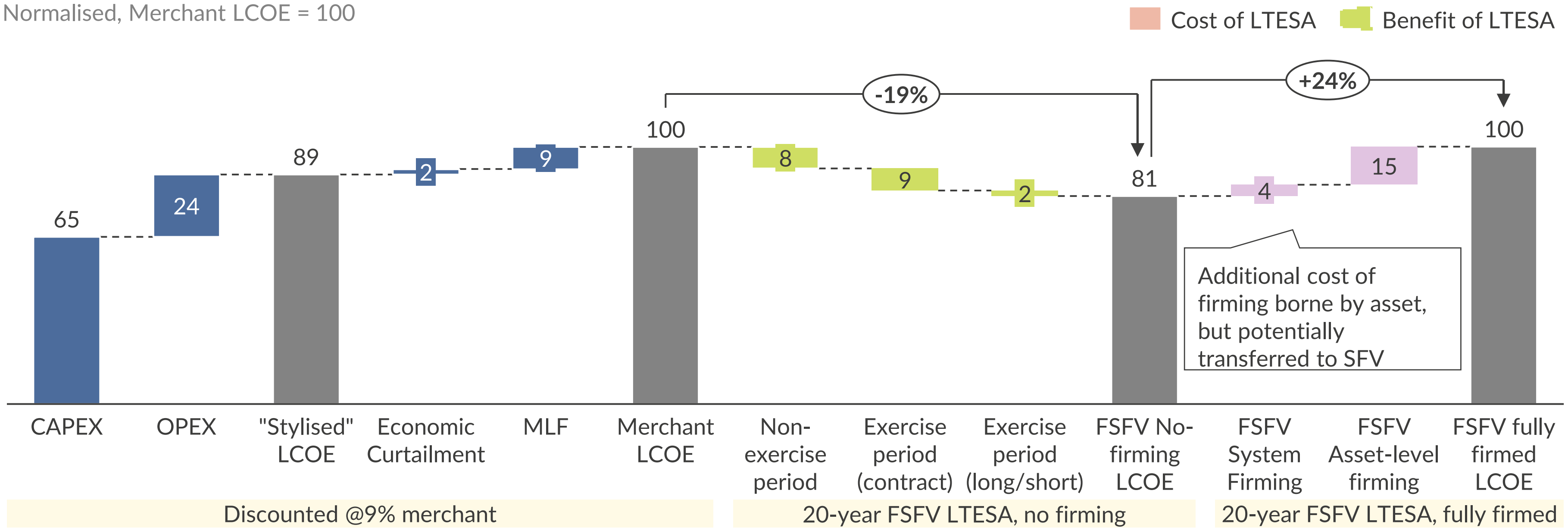
Source: Aurora Energy Research

# FSFV onshore wind – FSV contract could reduce LCOEs by up to 19%, but gains could be quickly eroded if assets are required to firm themselves

AURORA

**Breakdown of impact of FSFV on LCOE[1] of CWO onshore wind project (over the 20-year LTESA period)[2]**

Normalised, Merchant LCOE = 100



Additional cost of firming borne by asset, but potentially transferred to SFV

### Definition of key terms

| Key terms | Definition |
|---|---|
| **Economic curtailment** | The asset curtails generation at wholesale prices below $0/MWh |
| **Marginal Loss Factor (MLF)** | Marginal network losses at the transmission network connection points at which the generators are located |
| **Non-exercise period** | Benefit in a reduction in the WACC of the asset, by holding LTESA option that allows more asset to secure debt at 1.5 DSCR |
| **Exercise period (contract)** | Benefit in a reduction in the WACC of the asset, which is enabled by holding and exercising the LTESA option which allows assets to secure debt at an assumed 1.1 DSCR |
| **Exercise period (long/short)** | Potential risks/benefits in revenues from being long/short the FSFV POE shape during the exercise period |
| **FSFV System firming** | Cost incurred to the project from constructing additional firming capacity to ensure that both the system and the FSFV LTESA fleet can be covered |
| **FSFV Asset-level firming** | Cost incurred if FSFV-asset is required to physically firm itself by constructing and operate an additional asset to firm the LTESA project individually (Aurora assumed this to be an OCGT – fuel cost included)[4] |

### Impact on asset LCOE from Onshore Wind FSFV LTESA

- Similar to GF contracts, an asset could benefit from a reduction LCOE by securing a FSFV contract. The benefit stems from:
  - **Non-exercise period**: In periods where the asset does not exercise the LTESA, the assets benefit from being able to secure debt (@3%) at 1.5 DSCR, simply by holding onto an LTESA option
  - **Exercise-period** – When LTESA is exercised, it has been assumed that debt (@3%) for the contracted proportion of the asset's generation, can be secured at 1.1 DSCR. This is a risk transfer from the developer to the SFV and consumers (which the SFV can manage through pooling across contracts)
- However, the gains from securing a FSFV contract could be quickly eroded if the asset was required to firm itself. The degree of the increase in cost would depend on whether the asset is required to physically firm itself
- Furthermore, consumers could be facing higher risks/costs as assets are likely to increase their LTESA contract bid in order to recover the cost of building the firming asset individually
- This analysis is meant to assess the risks to both developers/FSV from engaging in an LTESA contract. It is not meant to inform the precise bidding decision, the contractual prices, or equivalent subsidies for each asset

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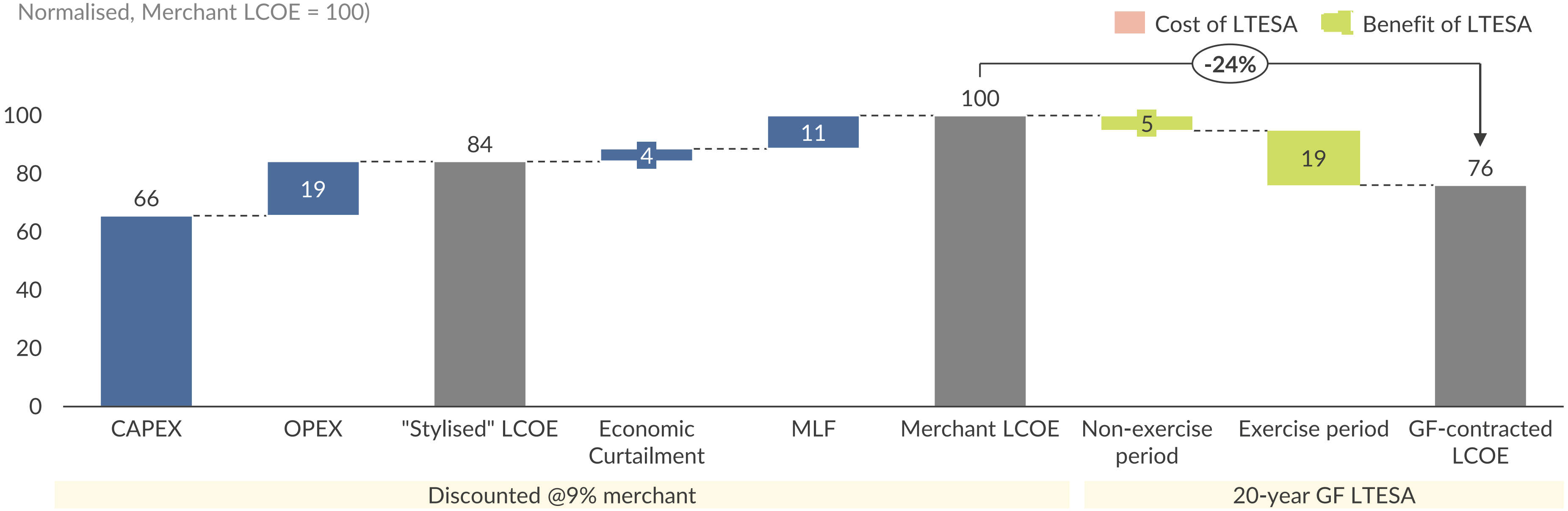
1) Levelised Cost of Energy. 2) Assumes LCOE-contract prices. Analysis is done over the 20-year LTESA period. We have not considered potential merchant revenues post the 20-years (e.g. if an asset lifetime is 25 – 30 years). 3) Scheme Financial Vehicle. 4) OCGT need not be the cheapest, but it is the chosen technology due to uncertainty in duration of firming required at any point

Source: Aurora Energy Research

# GF Solar – LTESA contract reduces LCOE by up to 24%, across both the exercise and non-exercise periods

**Breakdown of impact of LTESA-contract on the LCOE[1] for a CWO solar project (over the 20-year LTESA period)[2]**

Normalised, Merchant LCOE = 100)



### Definition of key terms

| Key terms | Definition |
|---|---|
| **Economic curtailment** | The asset curtails generation at wholesale prices below $0/MWh |
| **Marginal Loss Factor (MLF)** | Marginal network losses at the transmission network connection points at which the generators are located |
| **Merchant LCOE** | The levelized cost of energy of generating energy over the 20-year lifetime of a LTESA asset[2] accounting for grid and economic constraints |
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### Impact on asset LCOE from Solar GF LTESA

- The "Merchant LCOE" of an asset takes into account its CAPEX and OPEX, but also potential losses from economic curtailment and MLF, and has been normalised to 100%
- By securing a GF-contract, we see a reduction in the LCOE from two key components:
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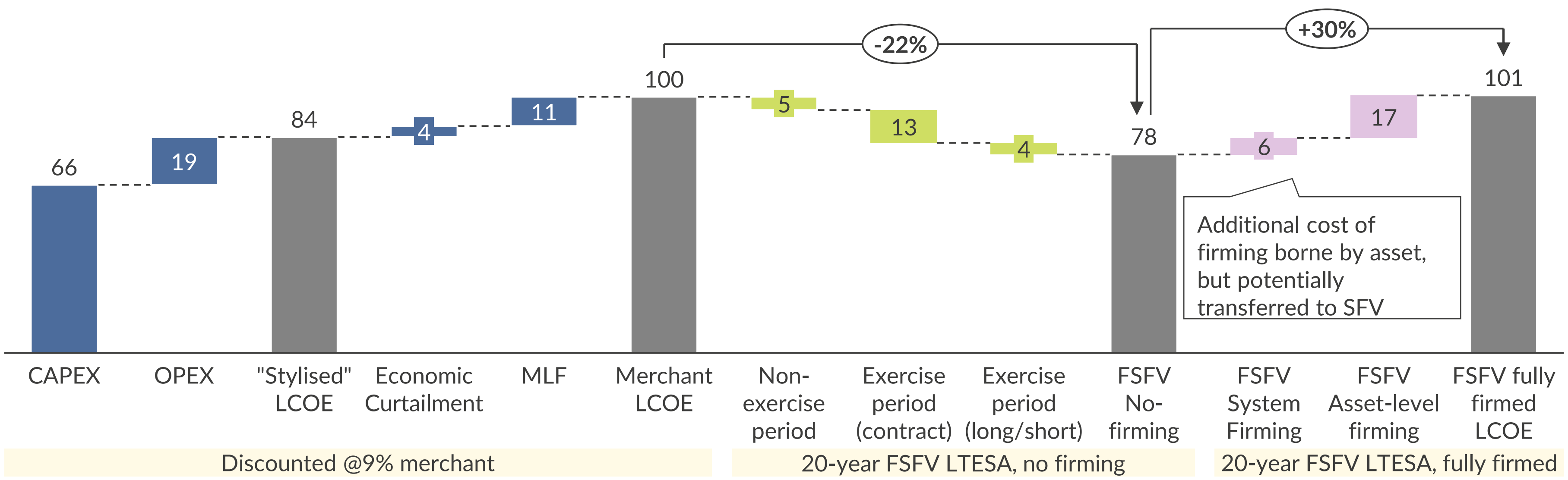
1) Levelised Cost of Energy. 2) Assumes LCOE-contract prices. Analysis is done over the 20-year LTESA period. We have not considered potential merchant revenues post the 20-years (e.g. if an asset lifetime is 25 – 30 years). 3) Scheme Financial Vehicle

Source: Aurora Energy Research

# FSFV solar– FSV contract could reduce LCOEs by up to 22%, but gains will be eroded if assets are required to firm themselves

**Breakdown of impact of FSFV on LCOE[1] of CWO solar project (over the 20-year LTESA period)[2]**

Normalised, Merchant LCOE = 100



Additional cost of firming borne by asset, but potentially transferred to SFV

## Definition of key terms

| Key terms | Definition |
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| **Economic curtailment** | The asset curtails generation at wholesale prices below $0/MWh |
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1) Levelised Cost of Energy. 2) Assumes LCOE-contract prices. Analysis is done over the 20-year LTESA period. We have not considered potential merchant revenues post the 20-years (e.g. if an asset lifetime is 25 – 30 years). 3) Scheme Financial Vehicle. 4) OCGT need not be the cheapest, but it is the chosen technology due to uncertainty in duration of firming required at any point

Source: Aurora Energy Research

### Impact on asset LCOE from Solar FSFV LTESA

- Similar to GF contracts, an asset could benefit from a reduction LCOE by securing a FSFV contract. The benefit stems from:
  - **Non-exercise period**: In periods where the asset does not exercise the LTESA, the assets benefit from being able to secure debt (@3%) at 1.5 DSCR, simply by holding onto an LTESA option
  - **Exercise-period** – When LTESA is exercised, it has been assumed that debt (@3%) for the contracted proportion of the asset's generation, can be secured at 1.1 DSCR. This is a risk transfer from the developer to the SFV and consumers (which the SFV can manage through pooling across contracts)
- However, the gains from securing a FSFV contract could be quickly eroded if the asset was required to firm itself. The degree of the increase in cost would depend on whether the asset is required to physically firm itself
- Furthermore, consumers could be facing higher risks/costs as assets are likely to increase their LTESA contract bid in order to recover the cost of building the firming asset individually
- This analysis is meant to assess the risks to both developers/FSV from engaging in an LTESA contract. It is not meant to inform the precise bidding decision, the contractual prices, or equivalent subsidies for each asset

# Agenda

# Assets with a higher contracted position will see trade-off between lower volatility/risks at the expense of lower expected cash flows…

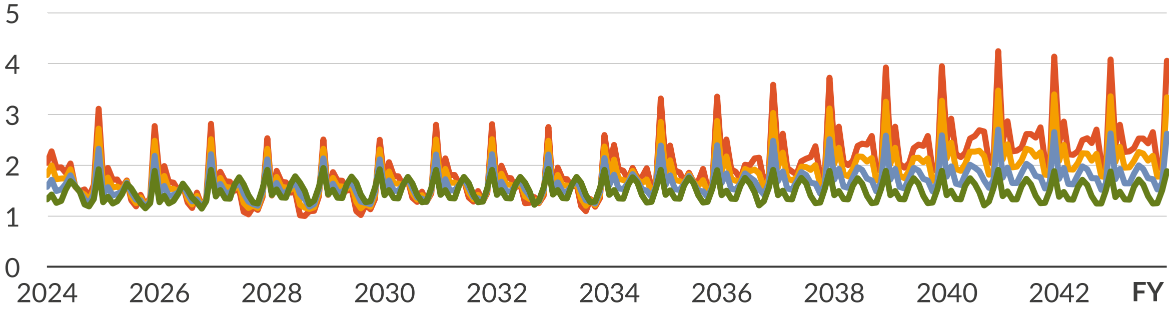
AURORA

**Representative cashflows for GF (LCOE) contracted and merchant asset – 100 MW Onshore Wind in CWO**

The total monthly cash flows of a generation following asset…

**Total Monthly Cash Flows – Central-West Orana Wind (100MW)[1]**

$m

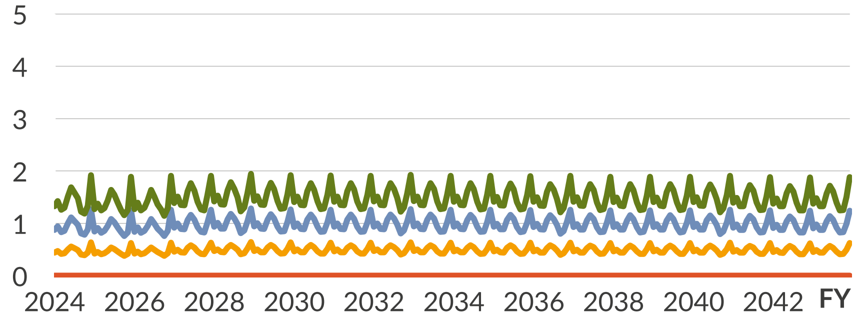


| Summary Statistics | Average ($millions) | Std. Dev. ($millions) |
|---|---|---|
| Fully Merchant | 1.97 | 0.61 |
| GF33 | 1.81 | 0.44 |
| GF 66 | 1.65 | 0.29 |
| GF 100 | 1.49 | 0.19 |

Is the sum of its contracted cash flows…

**Contracted Monthly Cash Flows[1]**

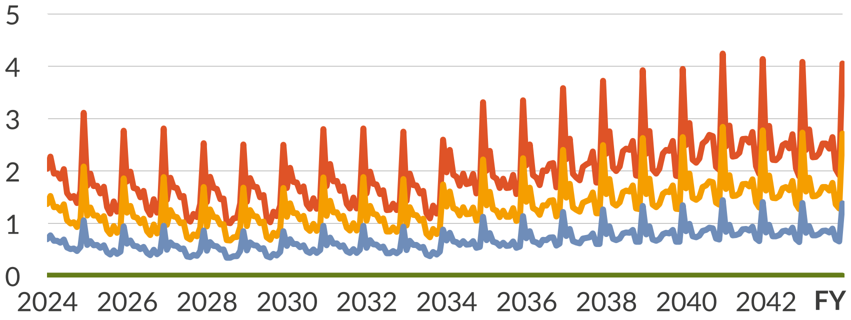
$m



… and merchant cash flows[2] for any uncontracted portions

**Merchant Monthly Cash Flows – Central-West Orana wind (100MW)**

$m



**Cash Flows at example GF Contractual Proportion**

- Fully merchant/Uncontracted
- 33% contract (GF33)
- 66% contracted (GF66)
- 100% contracted (GF100)

---

1) Assumes contract is for LCOE price. 2) Merchant cash flow is based on prevailing floating price

Source: Aurora Energy Research

**Monthly cash flows for GF contracted assets – example of onshore wind**

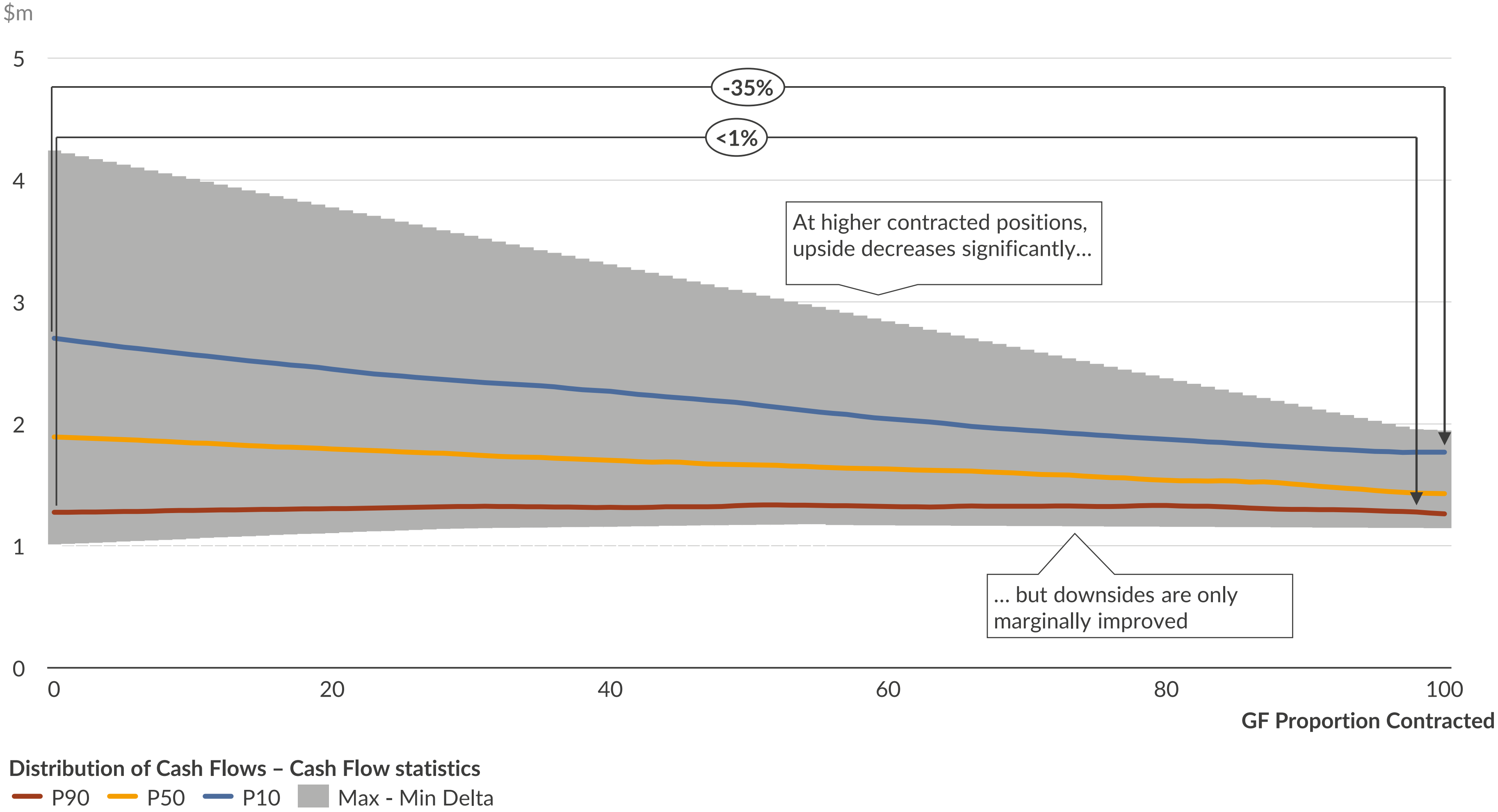
- A GF contracted asset will derive value from both the GF Contract (for proportion of generation contracted) and the floating wholesale price (for non-contracted generation)
- There risk-reward trade-off is evident – a more heavily contracted asset will see lower average returns, but also lower risks
- For example, relative to an asset which is fully contracted (GF100), an asset which has a third of it's revenue contracted (GF33) will see:
  - Higher average monthly returns of $1.81m vs $1.49m, but
  - Higher risks, with a standard deviation of 0.44m vs 0.19m
- The example on this slide looks at a selected number of contracted percentages and at a LCOE contract price for Onshore Wind, but Aurora has conducted the analysis for all percentages (0 – 100%), for both LCOE and Risk-Neutral contract prices, and also for Solar

# … The value of forgone upside in cash flows could significantly outweigh the limited improvements to downsides with increasing contracted positions…

AURORA

**Distribution of cashflows for GF (LCOE) contracted and merchant asset – 100 MW Onshore Wind in CWO**

**Distribution of monthly Cash Flows over assets lifetime (2024 – 2043)– Central-West Orana Wind (100MW)**



At higher contracted positions, upside decreases significantly…

… but downsides are only marginally improved

Source: Aurora Energy Research

**Monthly cash flows for GF contracted assets – example of onshore wind**

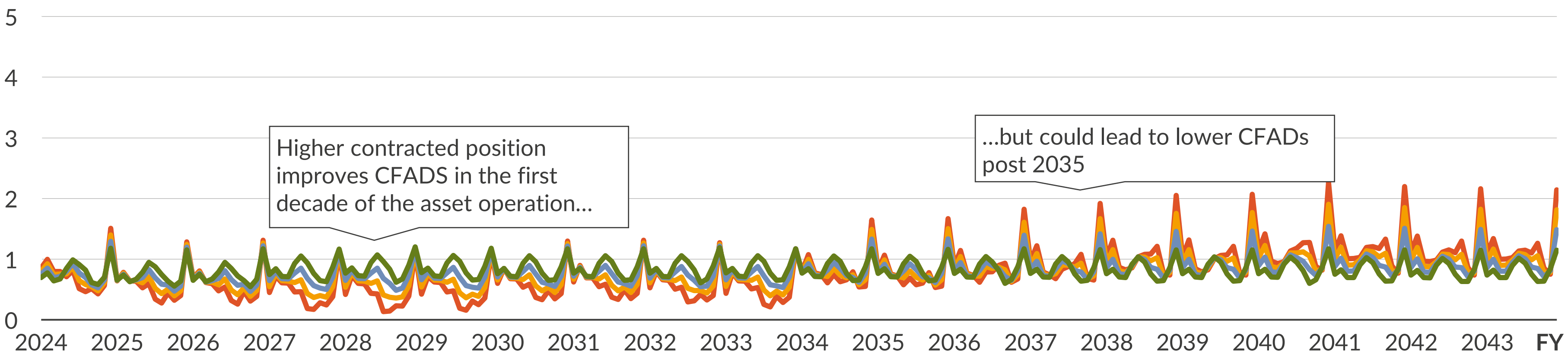
- The reduction in volatility/risks from a higher contracted position under a GF-contract stems predominantly from a reduction in upsides, while the improvements in downside revenues are minimal
- Moving from a fully uncontracted/merchant (0% GF) asset to a fully contracted (100% GF) asset sees a reduction in P10 cash flows of ~35%, but only an improvement in P90 cash flows of <1%
- The example on this at a LCOE contract price for onshore wind, but Aurora has conducted the analysis for both LCOE and Risk-Neutral contract prices, and also for solar

# … however, higher contracted positions leads to significant improvements in CFADs (for at least the first decade) which is crucial for debt servicing

**Monthly CFADS[1] for GF (LCOE) contracted and merchant asset – 100 MW Onshore Wind in CWO**

**Monthly CFADS – Central-West Orana Onshore Wind (100MW)**

$m



Higher contracted position improves CFADS in the first decade of the asset operation…

…but could lead to lower CFADs post 2035

$$\textit{Cash Flows Avaiable for Debt Servicing } (CFADS) = \frac{\textit{Merchant Cash Flows}}{DSCR_{Merchant}} + \frac{\textit{Exercised Cash Flows}}{DSCR_{Contract}} - \frac{\textit{Operating expenses}}{DSCR_{Contract}}$$

**Cash Flows at example GF Contractual Proportion**

— Uncontracted — 33% contract (GF33) — 66% contracted (GF66) — 100% contracted (GF100)

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[1] Cash Flow Available for Debt Service.

Source: Aurora Energy Research

**Monthly CFADs for CWO onshore wind**

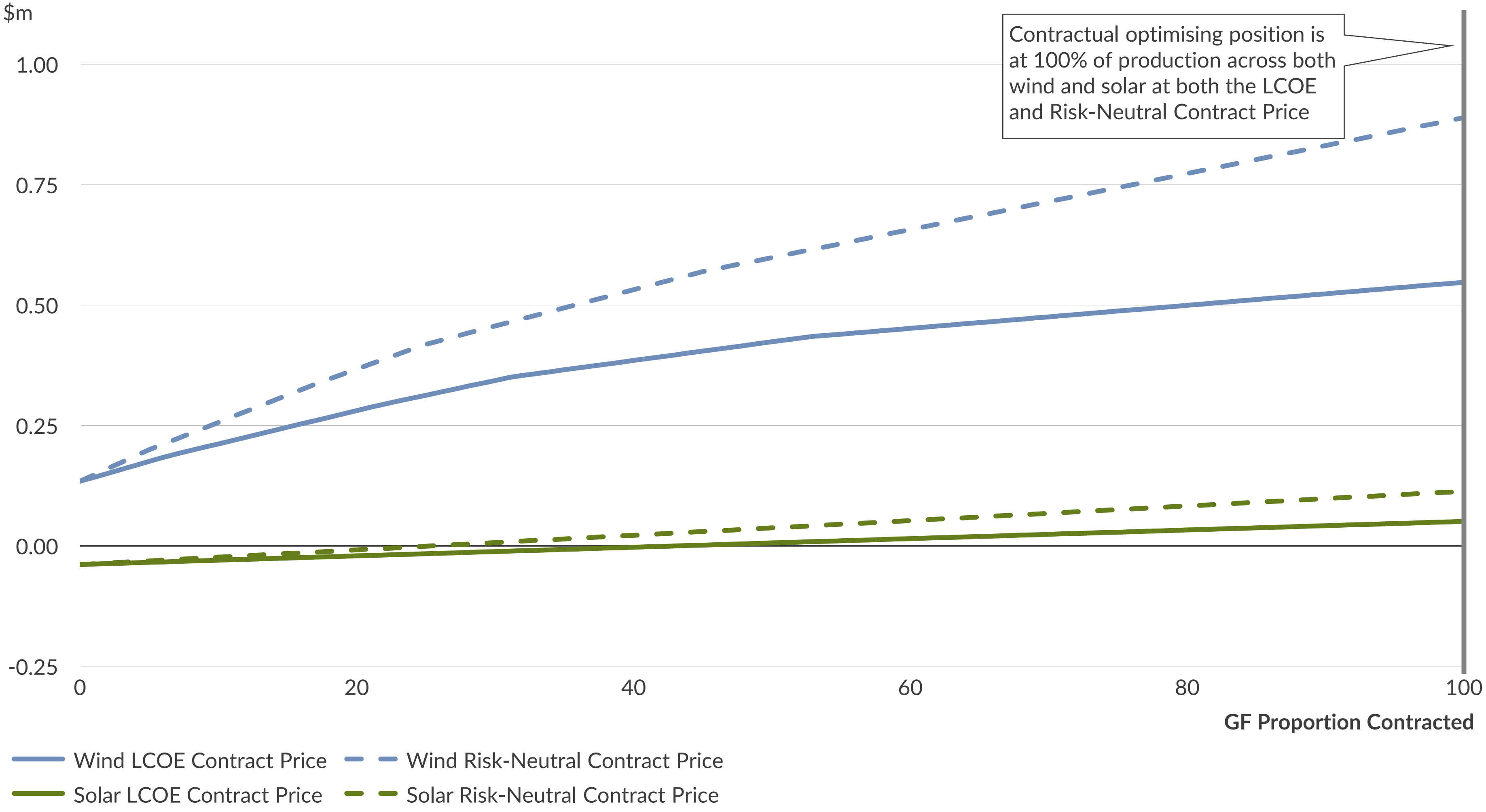
- Cash Flow Available for Debt Service (CFADS) become more stable over the forecast with higher GF-contracted positions
- At a 100% contracted position there is no merchant exposure, and the CFADS are directly determined by seasonality in asset production on a month-to-month basis
- At lower contracted positions, the asset is exposed to wholesale market prices, and as such CFADS move with wholesale price volatility
- In particular, we see higher wholesale prices over the back of the forecast as coal retires, increasing the CFADS accumulated by LTESA projects
- Therefore, while a higher GF-contracted position limits the upside (and expected returns) of an asset, the improvement in stability of CFADS could provide significant benefits for asset developers to secure debt-financing

# Projects are modelled to maximise minimum monthly CFADS; this happens when 100% of production are contracted

AURORA

**Optimisation decision based on minimum monthly CFADS – 100 MW Onshore Wind and Solar in CWO**

**Minimum Monthly CFADS (100MW) across asset's lifetime (2024 – 2043)**
$m



Contractual optimising position is at 100% of production across both wind and solar at both the LCOE and Risk-Neutral Contract Price

Source: Aurora Energy Research

**Minimum monthly CFADS by GF contracted position – example of CWO Solar and Onshore Wind**

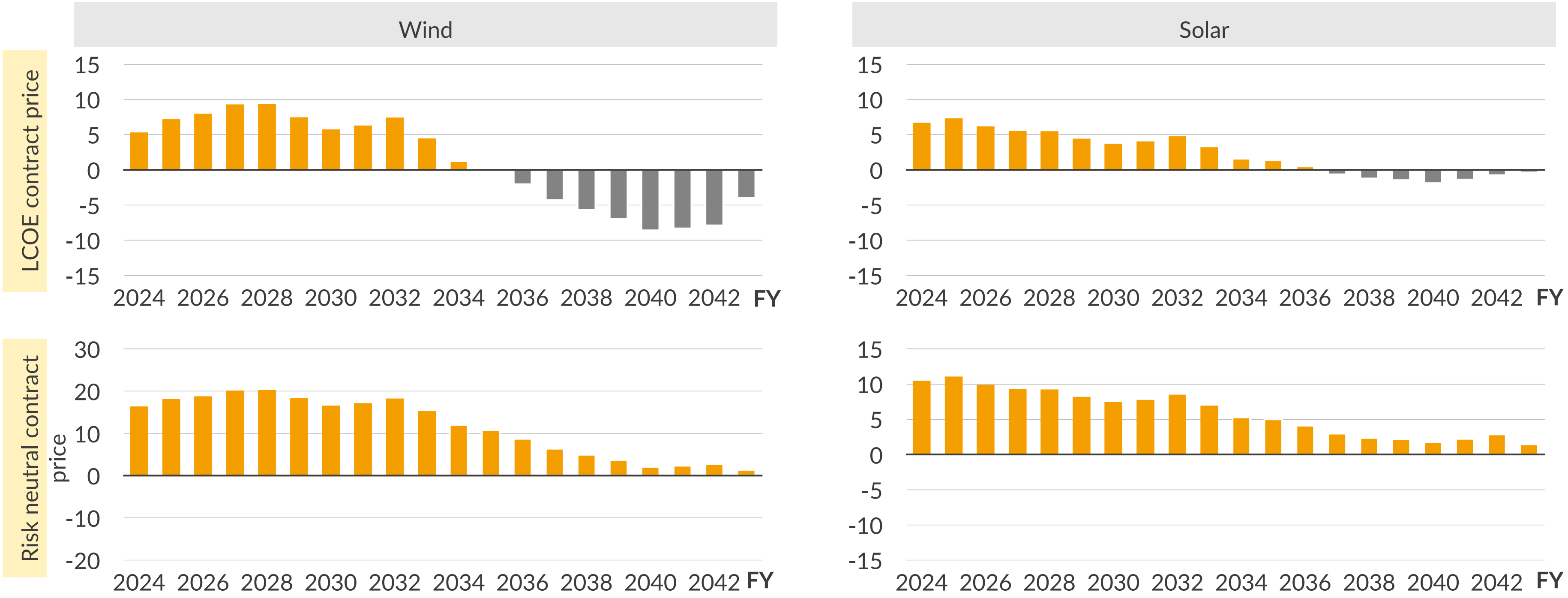
- Following discussions with AEMO Services, Aurora's modelling assumes that assets are optimising to maximise the minimum monthly CFADS received (in order to increase/maximise leverage)
- With higher levels of GF contracting, an asset sees greater stability in monthly return, and a reduction in potential downside
- Therefore, under a GF-contract, both onshore wind and solar assets are assumed to have a preference for contracting 100% of total volumes (under both LCOE and Risk-Neutral contract prices) in order to maximise their minimum monthly CFADS

# Exercising behaviour has been modelled for both LCOE and Risk Neutral contract prices based on CFADS maximisation

**Exercise condition for Generation-Following LTESA contract holders**

**Difference in Two-Yearly CFADS**

$m



$$\left(\frac{\boldsymbol{Merchant\ Cash\ Flows}}{\boldsymbol{DSCR_{Merchant}}} + \frac{\boldsymbol{Contracted\ Cash\ Flows}}{\boldsymbol{DSCR_{Contract}}}\right) - \frac{\boldsymbol{Non-exercised\ Cash\ Flows}}{\boldsymbol{DSCR_{Merchant}}} > \boldsymbol{0}$$

***Excercise Condition***:

🟧 Exercise the contract ⬛ Do not exercise the contract

Source: Aurora Energy Research

**Exercise condition of LTESA contracts**

- To examine/simulate the exercise behaviour of GF LTESA contracts we have modelled the potential CFADS from exercising and non-exercising in parallel
- Merchant and non-exercised cash flows have been weighted by the merchant DSCR of 1.5 and contracted cash flows weighted at the contracted DSCR of 1.1
- The exercise decision then becomes a maximisation of weighted cash flows for exercise vs non-exercise
- At Risk-Neutral Contract Prices the we find that both wind and solar will choose to exercise over the 20-year contract tenor, however, the decision becomes more marginal at the back of the forecast
- At LCOE Contract Prices the LTESA projects will choose to exercise less
- Interestingly the choice not to exercise is more clear/pronounced for wind compared to solar, where wind has clear incentive to maximise merchant exposure over the back of the forecast (under the weighting assumptions used in the analysis)

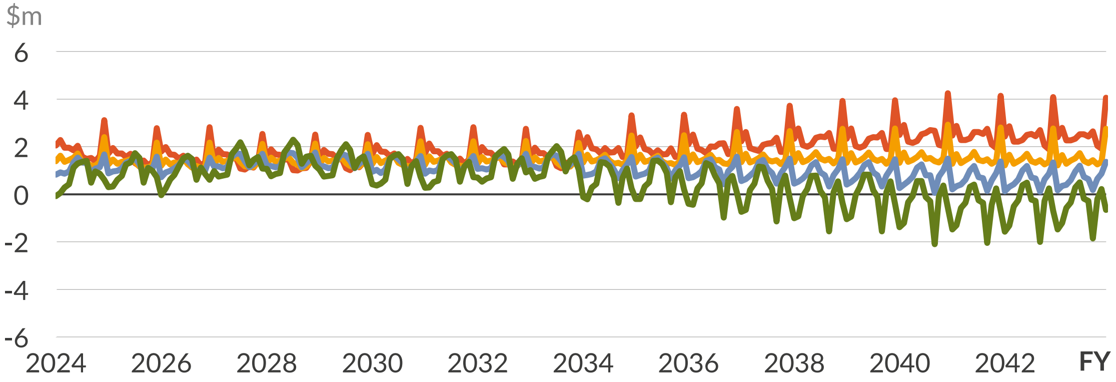
# Agenda

# FSFV-contracted onshore wind assets could face both higher risks and lower expected returns at increasingly higher levels of contracted positions

## Representative cashflows for FSFV (LCOE) contracted and merchant asset – 100 MW Onshore Wind in CWO

The total monthly cash flows of a FSFV contracted asset...

**Total Monthly Cash Flows – Central-West Orana Wind (100MW)**

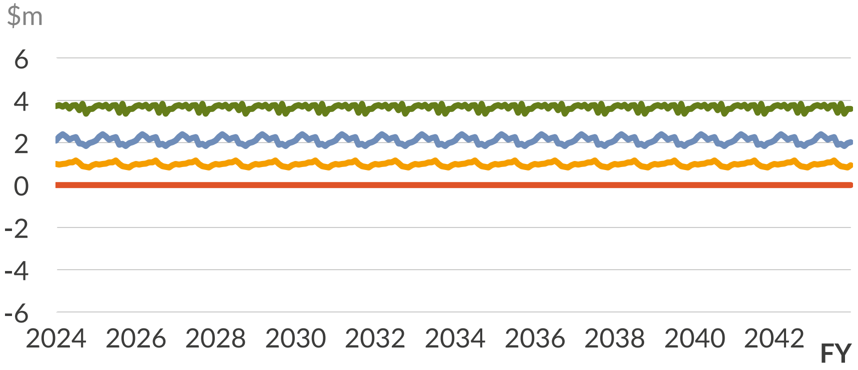


| Summary Statistics | | |
|---|---|---|
| | Average ($millions) | Std. Dev. ($millions) |
| Fully Merchant | 1.97 | 0.61 |
| POE 67 | 1.48 | 0.33 |
| POE 34 | 1.07 | 0.38 |
| POE 01 | 0.53 | 0.89 |

=

Is the sum of its contracted cash flows...

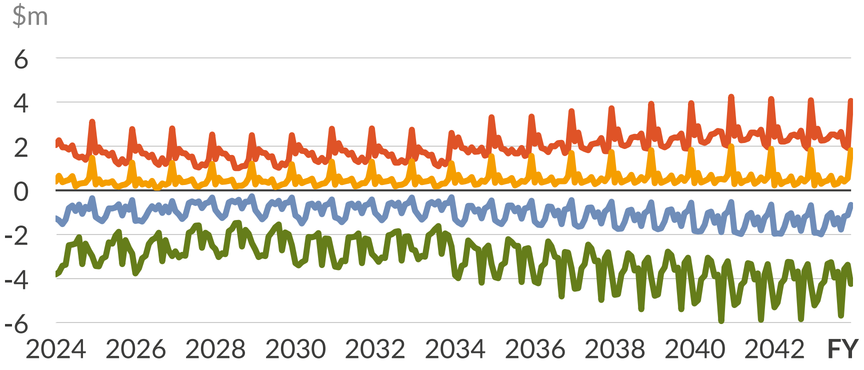
**Contracted Monthly Cash Flows – Central-West Orana Wind (100MW)**



+

... and merchant cash flows[2] for any uncontracted portions and long/shorts of contracted position

**Merchant Monthly Cash Flows – Central-West Orana Wind (100MW)**



**Cash Flows at example POE Contractual Shape**

▬ Uncontracted ▬ POE67 ▬ POE34 ▬ POE01

Source: Aurora Energy Research

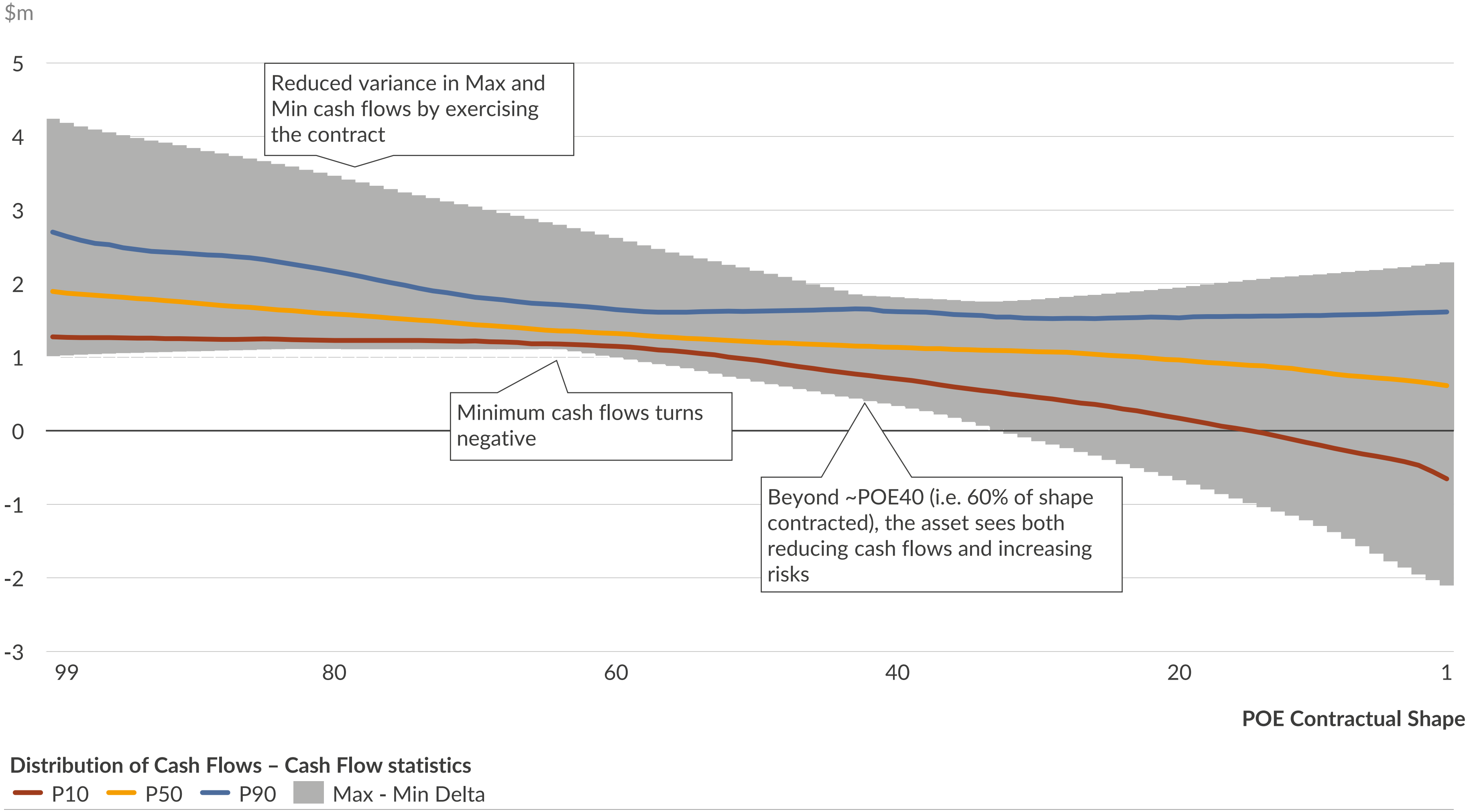
### Monthly cash flows for FSFV contracted assets – example of onshore wind

- An FSFV-contracted asset monthly cash flows is composed of both the contracted revenues, plus the floating/merchant wholesale price for any shorts/long in contracted positions and non-contracted positions
- Onshore wind could benefit from lower risks at the expense of lower expected returns at smaller FSFV contracted positions, but the benefit quickly erodes once the asset contracted positions increase
- For example:
    - Moving from a fully uncontracted asset to an asset which has contracted for a third of its production (POE67) would see a reduction in expected revenues of $0.49m (or 25%) alongside a reduction in standard deviation of $0.28m (or ~45%)
    - However, moving from a POE 67 to POE 01 shape leads to both a reduction in expected revenues of $0.95m (~65%) and an increase in risk of standard deviation of $0.56m (or 170%)
- The example on this slide looks at a selected number of contracted percentages and at a LCOE contract price for Onshore Wind, but Aurora has conducted the analysis for all POE (0 – 100%), for both LCOE and Risk-Neutral contract prices, and also for Solar (more overleaf)

# FSFV wind asset could reduce risks in cash flows by contracting up to POE 40 (60% of its shape); going beyond this reduces returns and increases risks

## Distribution of cashflows for FSFV (LCOE) contracted asset – 100 MW Onshore Wind in CWO

**Distribution of monthly Cash Flows over assets lifetime (2024 – 2043)– Central-West Orana Wind (100MW)**



Reduced variance in Max and Min cash flows by exercising the contract

Minimum cash flows turns negative

Beyond ~POE40 (i.e. 60% of shape contracted), the asset sees both reducing cash flows and increasing risks

Source: Aurora Energy Research

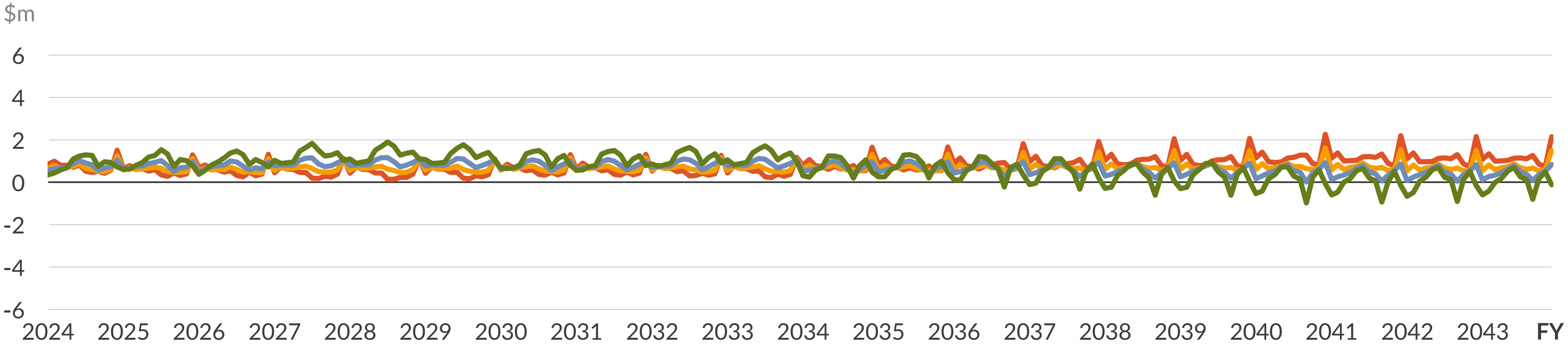
**Monthly cash flows for FSFV contracted assets – example of onshore wind**

- Onshore wind assets could benefit from reducing risks/volatility in cash flows by contracting a low proportion of its shape under FSFV contracts – our analysis suggests that for a representative CWO asset, overall volatility in cash flows could be reduced up to ~POE40 contractual position. Do note that the decrease in volatility mainly stems from a reduction in upside with limited improvements in downside
- However, beyond a POE40 contractual position, assets would see increasing risks alongside a reduction in expected (P50) cash flows
- Crucially, minimum cash flows (<P10) turn negative beyond a POE60 position, entailing significant risks for debt repayment

# LCOE Contract Price FSFV Monthly CFADS – CFADS are the metric used to evaluate the risk associated with different contractual terms

Monthly CFADS[1] for FSFV (LCOE) contracted and merchant asset – 100 MW Onshore Wind and Solar in CWO

**Monthly CFADS – Central-West Orana Wind (100MW)**



$$Cash\ Flows\ Avaiable\ for\ Debt\ Servicing\ (CFADS)$$

$$= \frac{Merchant\ Cash\ Flows}{DSCR_{Merchant}} + \frac{Exercised\ Cash\ Flows}{DSCR_{Contract}} - \frac{Operating\ expenses}{DSCR_{Contract}}$$

**CFADS at example POE Contractual Shape**

— Uncontracted — POE67 — POE34 — POE01

Source: Aurora Energy Research

**Monthly CFADs for FSFV-contracted CWO onshore wind**

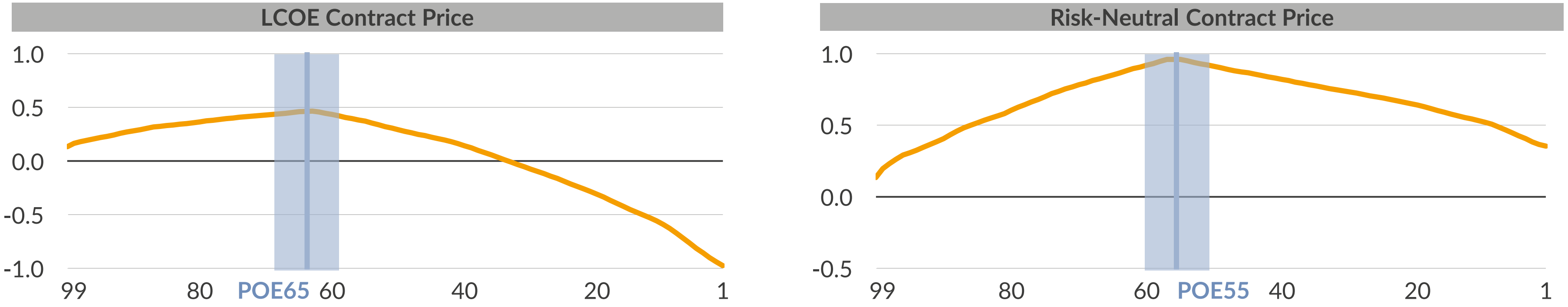
- At the start of the forecast, where wholesale prices are lower and less volatile, we find that wind assets benefit from being in a highly contracted position
- However, over the forecast higher wholesale prices and volatility increase the risk associated with being merchant exposed and short the contracted position
- This is of particular concern for wind, where the LTESA project could experience "droughts" of prolonged low production where the asset is short it's contractual position
- When low production correlates with high price outcomes (where low renewable output can be a key determinant of higher price outcomes as dispatchable coal capacity exits the system) then the asset can experience months of negative CFADS from being over-contracted

# To maximise minimum CFADS, onshore wind is expected to bid a shape of POE 65 – 55, while solar would bid a shape between POE 80 – 75

**Comparison of minimum monthly CFADs by FSFV contractual positions and contract type (LCOE/Risk-neutral) – 100 MW Onshore Wind & Solar, CWO**

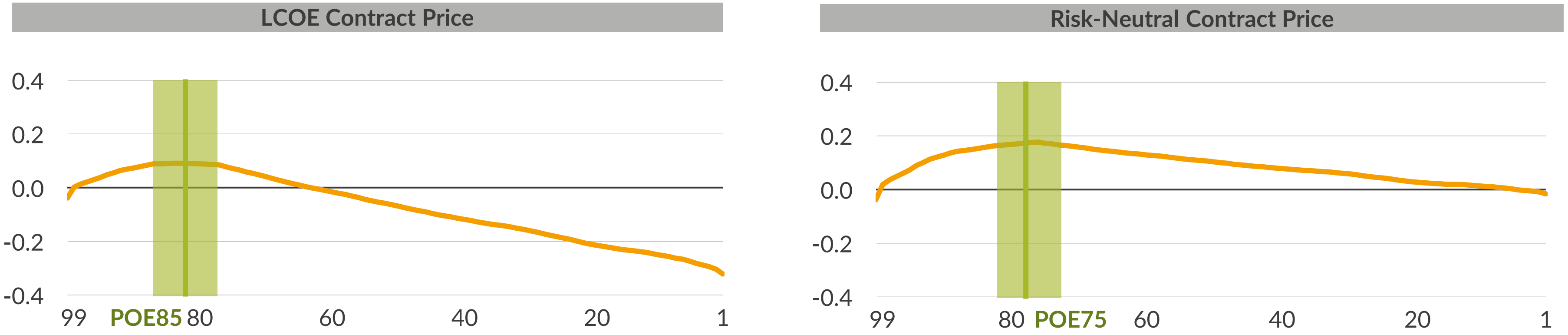
**Minimum Monthly CFADS over the lifetime of the asset (2024 – 2043)**
$m

**Onshore Wind**


LCOE Contract Price

Risk-Neutral Contract Price

**Solar**


LCOE Contract Price

Risk-Neutral Contract Price

Source: Aurora Energy Research

**Minimum monthly CFADS by FSFV position - example of CWO Solar and Onshore Wind**

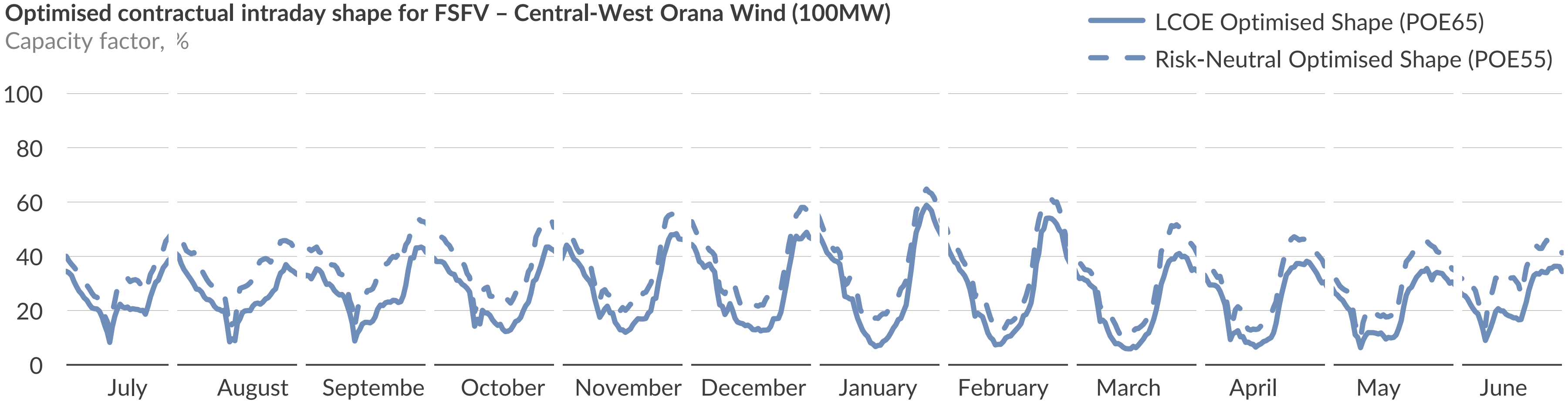
- Following discussions with AEMO Services, Aurora's modelling assumes that assets are optimising to maximise the minimum monthly CFADS received (in order to increase/maximise leverage and minimise risk)
- For onshore wind, minimum monthly CFADS are maximised at ~POE 65 under a LCOE contract price, and POE 55 under a Risk-Neutral contract price
- For solar, minimum monthly CFADS are maximised at POE 80 under a LCOE contract price, and POE 75 under a risk-neutral contract price
- Although higher from a POE perspective, onshore wind assets are expected contract a lower proportion of their production to the LTESA contracts. Solar has high capacity factors for middle of the day production at low POE levels (see pages 47 and 48 for clarification)
- Assets are likely/willing to secure higher levels of contracted positions under Risk-Neutral contracts than LCOE contracts as the contract prices are higher for Risk-Neutral contracts
- The monthly optimised shapes can be seen in the next slide

# Based on the optimised POE shapes, the following generation profiles were used for modelling contractual outcomes (which takes into seasonal profiles)

**Representative POE shapes for optimised solar and onshore wind assets in CWO**

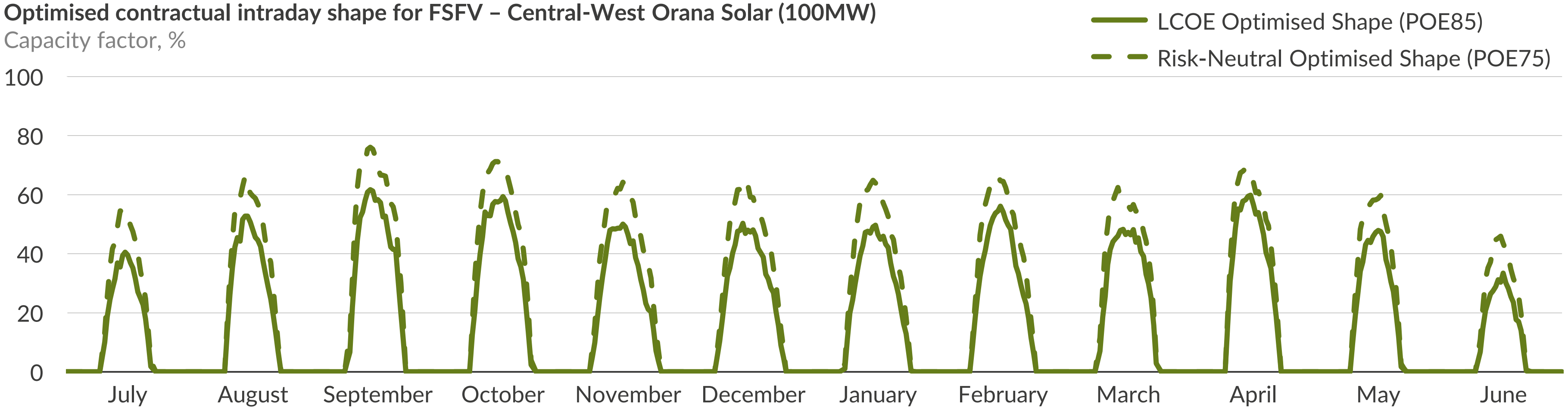
**Optimised contractual intraday shape for FSFV – Central-West Orana Wind (100MW)**

Capacity factor, %



**Optimised contractual intraday shape for FSFV – Central-West Orana Solar (100MW)**

Capacity factor, %



**Optimised POE shapes**

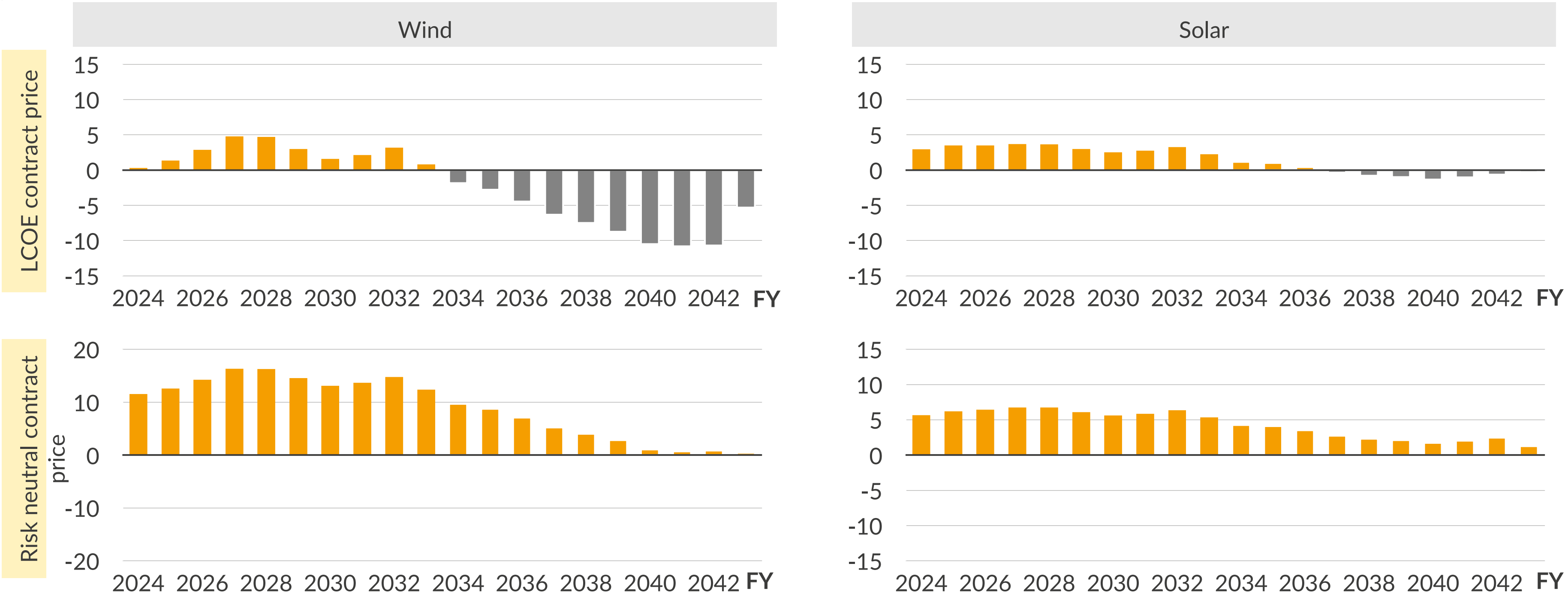
- Based on the optimised POEs derived in the previous slide, the graphs show the representative shapes used for modelling contractual outcomes
- These take into account seasonal variations at the monthly level across the historic weather years used in this analysis

# FSFV-contract assets' exercising behaviour has been modelled for both LCOE and Risk Neutral contract prices based on asset CFADS

**Exercise condition for Generation-Following LTESA contract holders**

**Difference in Two-Yearly CFADS**

$m



**Excercise Condition:**

$$\left(\frac{Merchant\ Cash\ Flows}{DSCR_{Merchant}} + \frac{Exercised\ Cash\ Flows}{DSCR_{Contract}}\right) - \frac{Non{-}exercised\ Cash\ Flows}{DSCR_{Merchant}} > 0$$

🟧 Exercise the contract ⬛ Do not exercise the contract

Source: Aurora Energy Research

**Exercise condition of LTESA contracts**

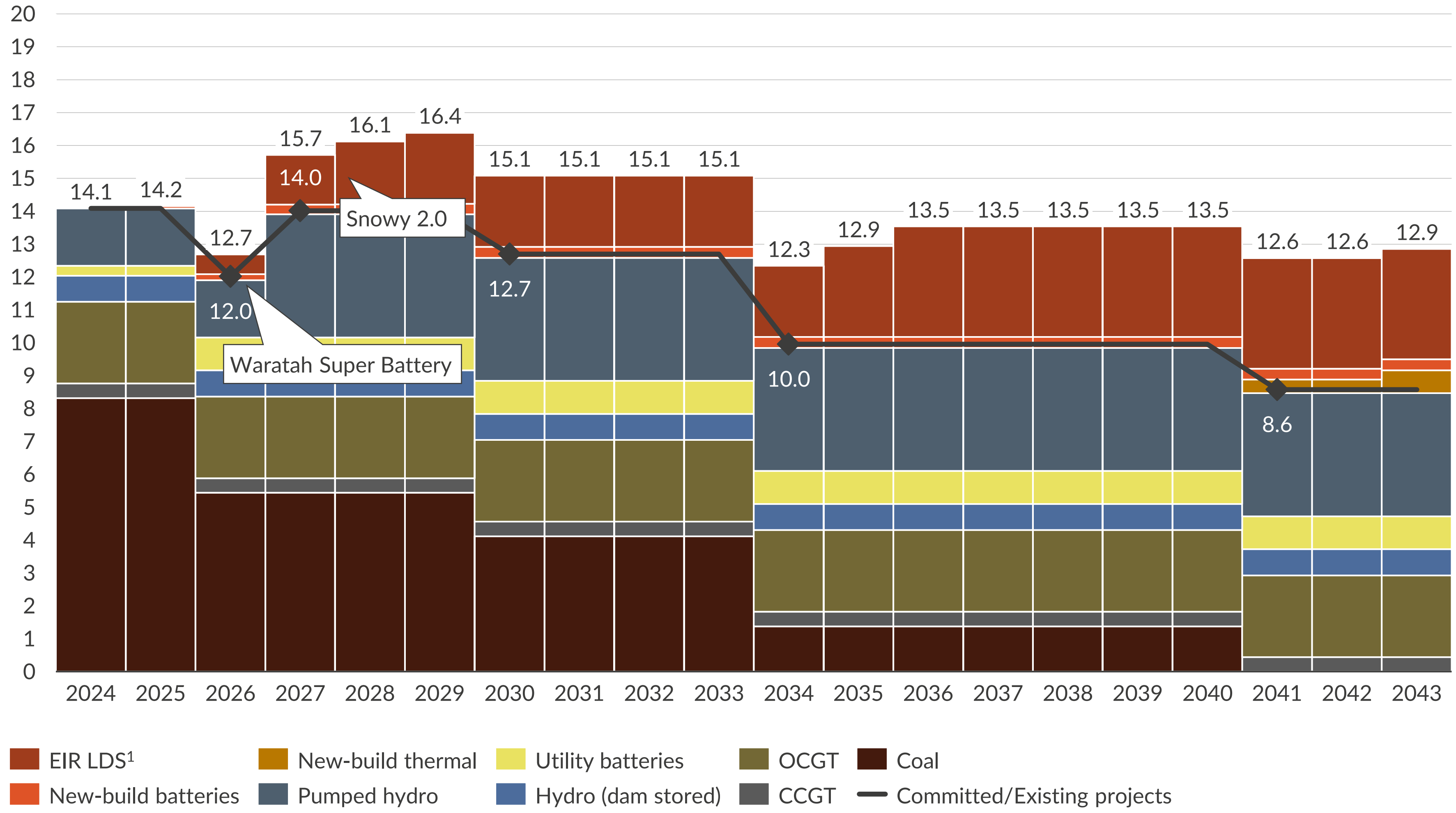
- Same as in the GF contract, solar and wind assets are both expected to frequently exercise the GF/FSFV contracts under the market scenario and contractual prices modelled
- At the higher Risk-Neutral Contract Prices assets will choose to always exercise the contractual arrangement
- At LCOE Contract Prices, the exercising behaviour of solar assets is the same relative to the GF contractual arrangement, exercising up to 2038
- For wind assets we see a difference in exercise behaviour at the LCOE Contract Price for the FSFV and GF contracts – where the wind asset chooses to exercise for 2 additional year under the GF contract

# Agenda

AURORA

# Under the modelled LTESA scenario, Aurora expects 12.5 – 13 GW of firming capacity to be available across NSW post-2040…

**Installed NSW dispatchable capacity – existing and new build**
GW



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1) Long Duration Storage including pumped hydro

Source: Aurora Energy Research

**Available dispatchable capacity to firm NSW renewables**

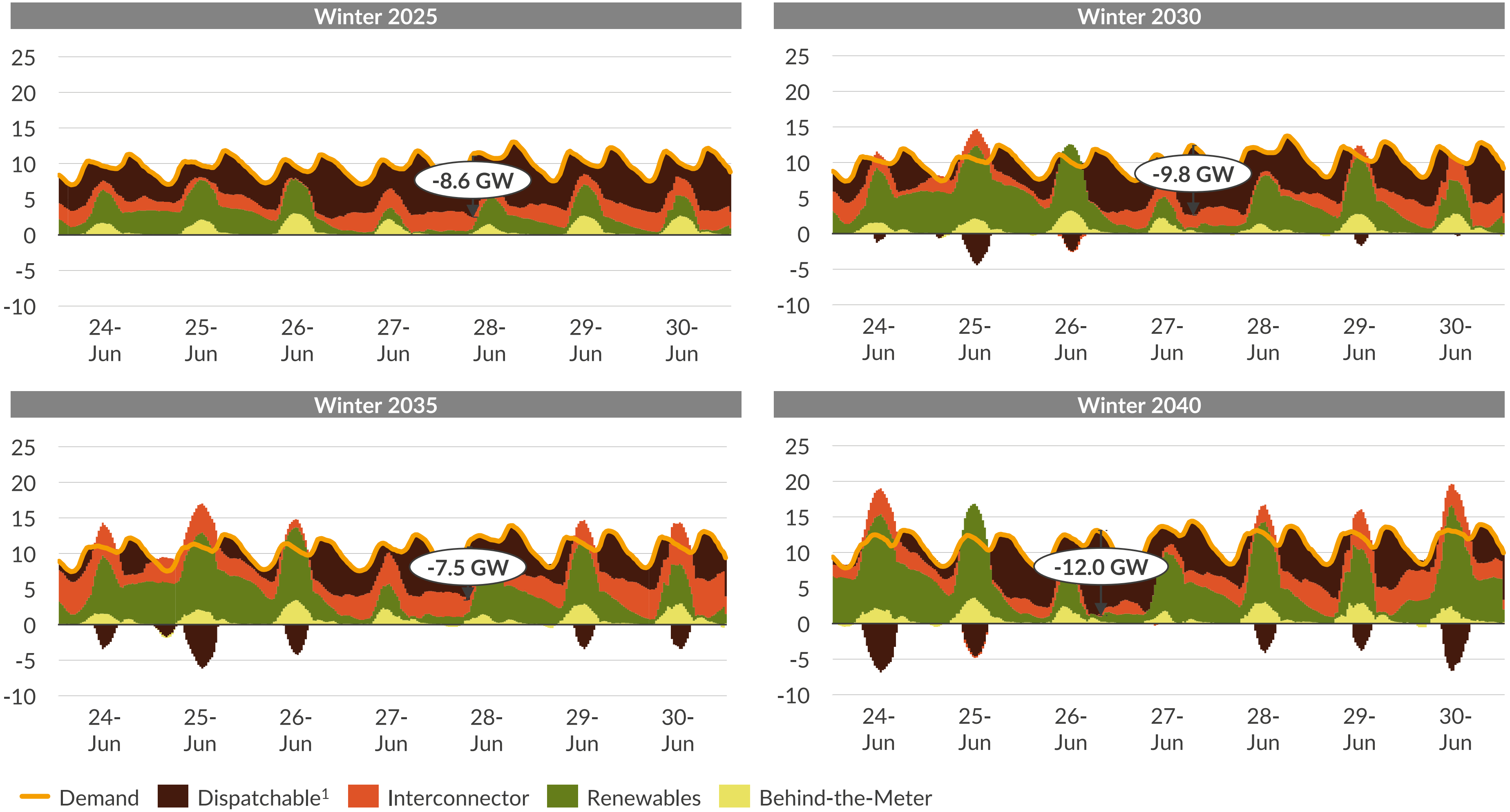
- At a system level, total installed dispatchable capacity are expected to range between ~12.5 GW – 13 GW post 2040
- A general decrease is expected across the horizon with the retirement of coal assets
- In addition to the buildout of batteries and gas assets, long-duration storage coming through the EIR (EIR LDS) will be required to provide for a significant proportion of new firming capacity coming online in NSW
- These assets will be available to firm the NSW renewables generation fleet when renewables production is low/unpredictable

# The modelled LTESA Scenario finds that NSW would require at least 12 GW of firm dispatchable energy for system security…

**Snapshots of generation profiles in NSW**

**Energy of demand and production in NSW**

GW



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[1] Dispatchable generation includes predominantly coal, gas and batteries

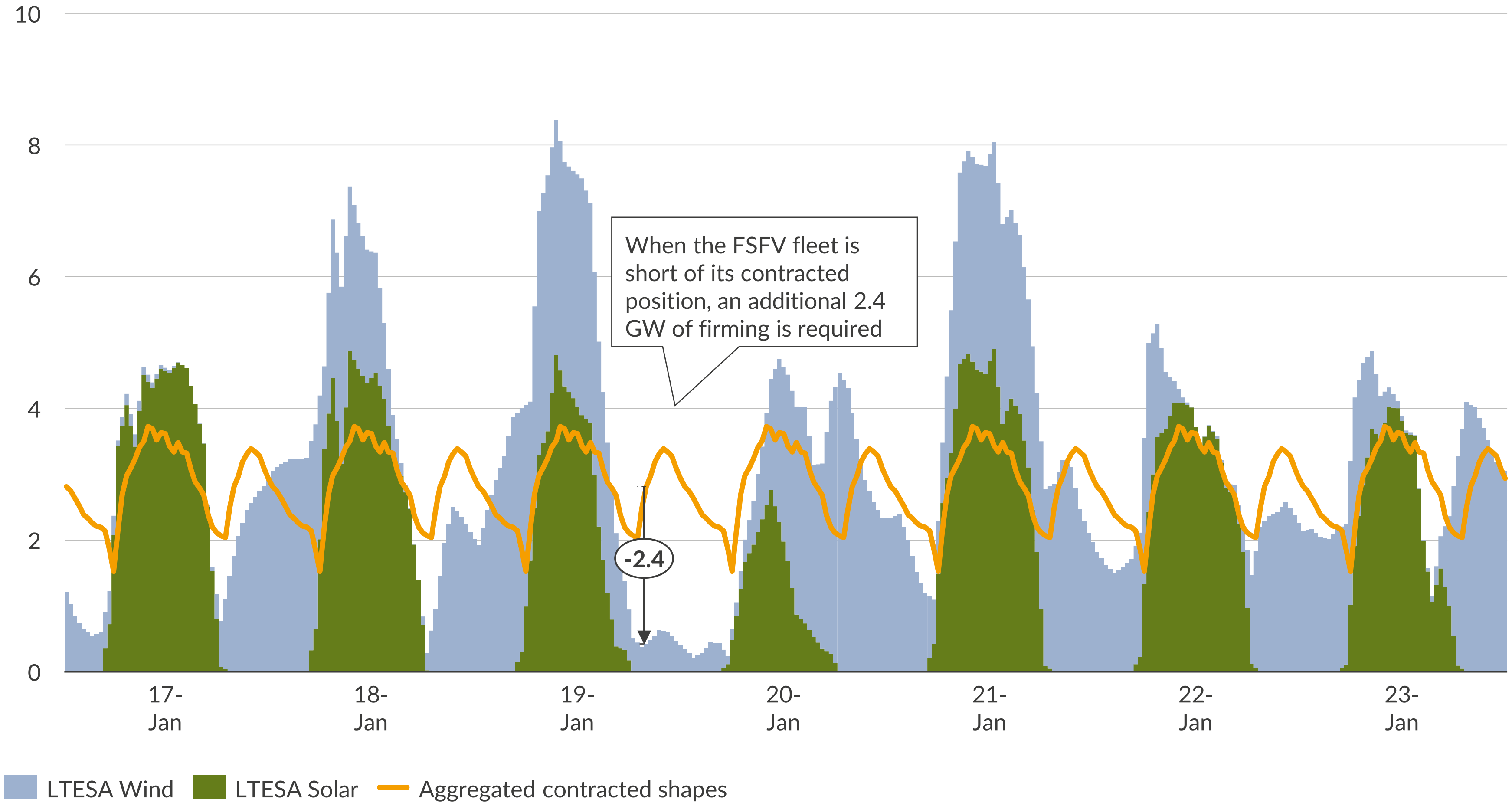
Source: Aurora Energy Research

**Required system firming needs for NSW (without any contracts)**

- In the equilibrium scenario modelled for the LTESA Scenario, system firming requirements are expected to increase throughout the horizon
- This is due to a growing reliance on renewables production alongside rising demand – when renewables production is (unexpectedly) low, a higher level dispatchable capacity would be required to meet the shortfall
- The maximum required need for dispatchable capacity increases from 8.6 GW in Winter 2025 to 12 GW in Winter 2040
- With 12 – 13 GW of firming dispatchable capacity expected in the system, renewables production (without any contracts) should be sufficiently firmed. This outcome would be the same under a GF-contract structure.
- However, FSFV-contracts will change the firming requirements (more on next slide)

# … However, requiring FSFV-contracted assets to physically defend their FSFV shape will further increase the needs for firming

**LTESA fleet-wide half-hourly FSFV contractual positions**[1]
GW, for sample week in 2042



When the FSFV fleet is short of its contracted position, an additional 2.4 GW of firming is required

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[1] Assumes LCOE-contract, at optimal contract positions.

Source: Aurora Energy Research

**Additional LTESA firming needs to defend FSFV contract position**

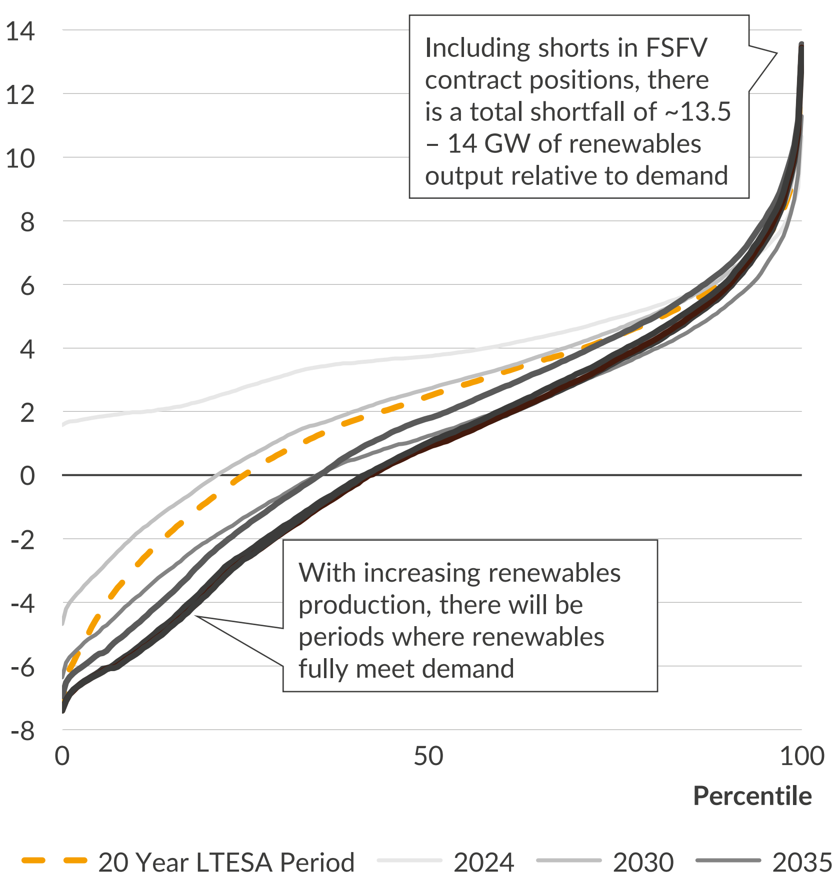
- The need for FSFV-contracted LTESA assets to firm-up their generation would lead to additional firming requirements, when their production is short of their contracted position
- For a sample week in summer 2042, the need to meet FSFV contracted positions could add an additional 2.4 GW of firming requirements above and beyond the 12 GW of firming requirements shown in the previous slide
- This would therefore be an additional cost to consumers if FSFV-contracted assets pass on the higher cost of firming through higher LTESA-contract prices

# With FSFV-contracts, NSW will see requirements for >13 GW of firming capacity; a maximum of 12.5 GW will be available in the system post 2040…

**Residual demand "duration" curve[1]**

**Residual demand (with FSFV-contract positions) in NSW**

GW



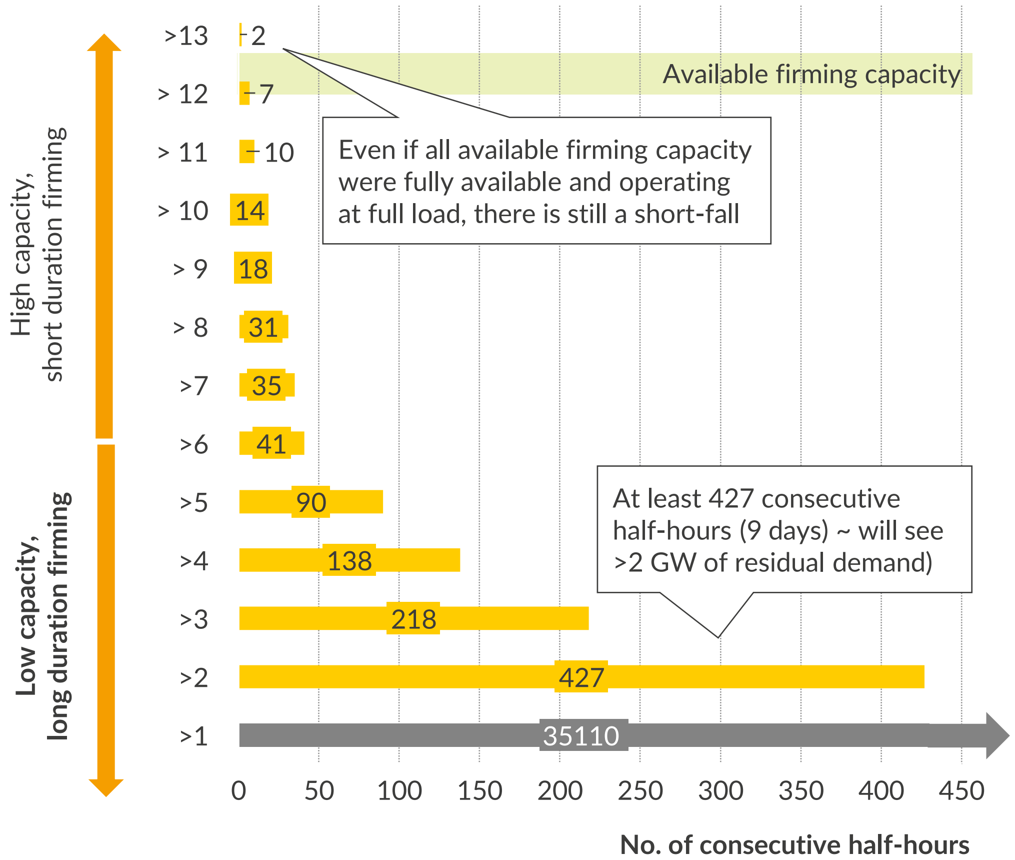
Including shorts in FSFV contract positions, there is a total shortfall of ~13.5 – 14 GW of renewables output relative to demand

With increasing renewables production, there will be periods where renewables fully meet demand

**Residual demand by consecutive half-hour**

**Residual demand in NSW over the LTESA Period**

GW



Even if all available firming capacity were fully available and operating at full load, there is still a short-fall

At least 427 consecutive half-hours (9 days) ~ will see >2 GW of residual demand)

---

1) Residual demand is defined as operational demand not met by renewables or flows from external sources, i.e., interconnectors. 2) Interconnector flows are also included. 3) 12.3GW is the minimum dispatchable capacity modelled over the 20 year LTESA period starting 2024, occurring in 2034 (refer to page 71 for additional detail on dispatchable capacity in NSW)

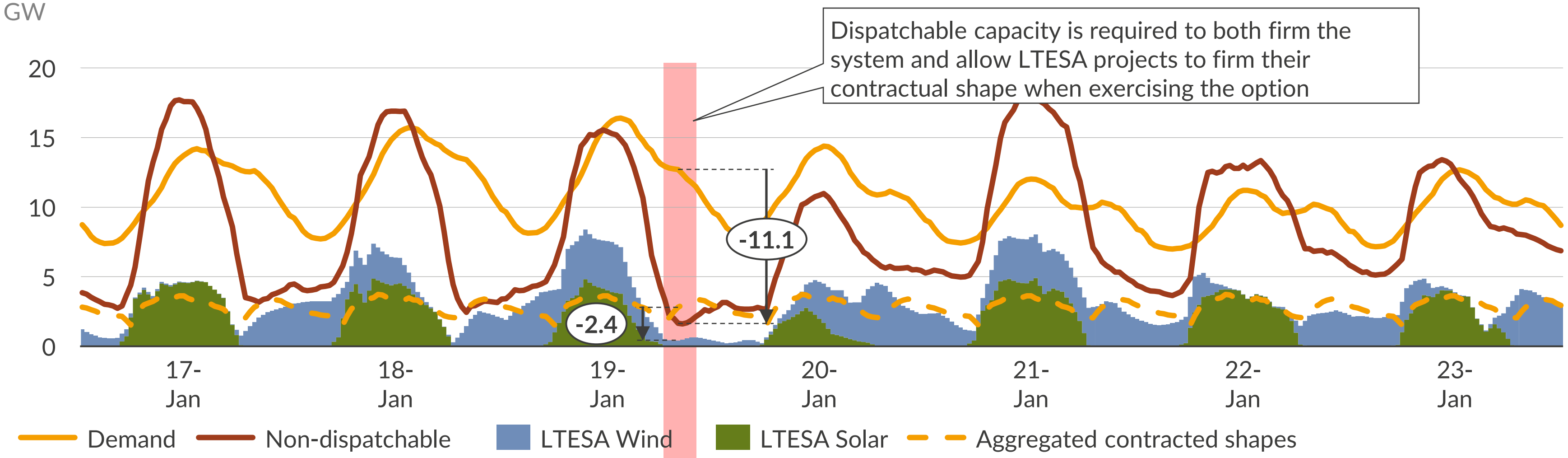
Source: Aurora Energy Research

**Total NSW-wide firming requirements under FSFV LTESA contracts**

- Despite a significant buildout of renewables under the EIR, NSW is still expected to see many periods where renewables do not suffice in meeting total demand
- This is likely to increase with FSFV contracts as shortfalls will also include shorts in FSFV-contract position
- Crucially, at a maximum, greater than 13 GW of firm capacity will be required to ensure system security + firm contracts.
- With only ~12.5 GW of firm capacities available (assume all are available to operate), the system will still be short – this would not have been the case without FSFV contracts
- Ensuring system security will require a mix of technologies:
  - Shorter-duration batteries could be well-suited to meet system needs where a residual demand is large, but only for short-durations
  - Longer-duration storage/ gas peakers will also be required to cater for prolonged lulls in renewables output relative to demand
- This will have implications if physical firming is required at an asset level – assets will unlikely be able to procure long-duration storage (e.g. pumped hydro) individually

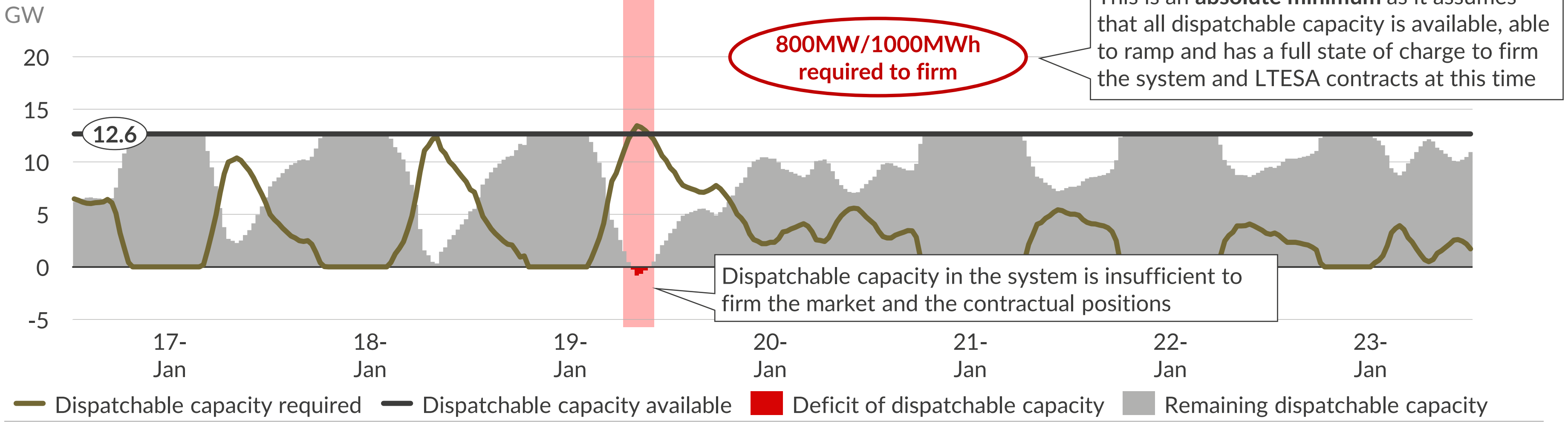
# … therefore, at least 800MW/1000MWh of additional new-build dispatchable capacity is needed to firm both system and contract positions

**Energy demand/production in NSW and contractual position of LTESA projects – Summer 2042**



Dispatchable capacity is required to both firm the system and allow LTESA projects to firm their contractual shape when exercising the option

**Dispatchable capacity required to firm system and LTESA positions – Summer 2042**



This is an **absolute minimum** as it assumes that all dispatchable capacity is available, able to ramp and has a full state of charge to firm the system and LTESA contracts at this time

Dispatchable capacity in the system is insufficient to firm the market and the contractual positions

Source: Aurora Energy Research

**Additional firming required for FSFV contracts**

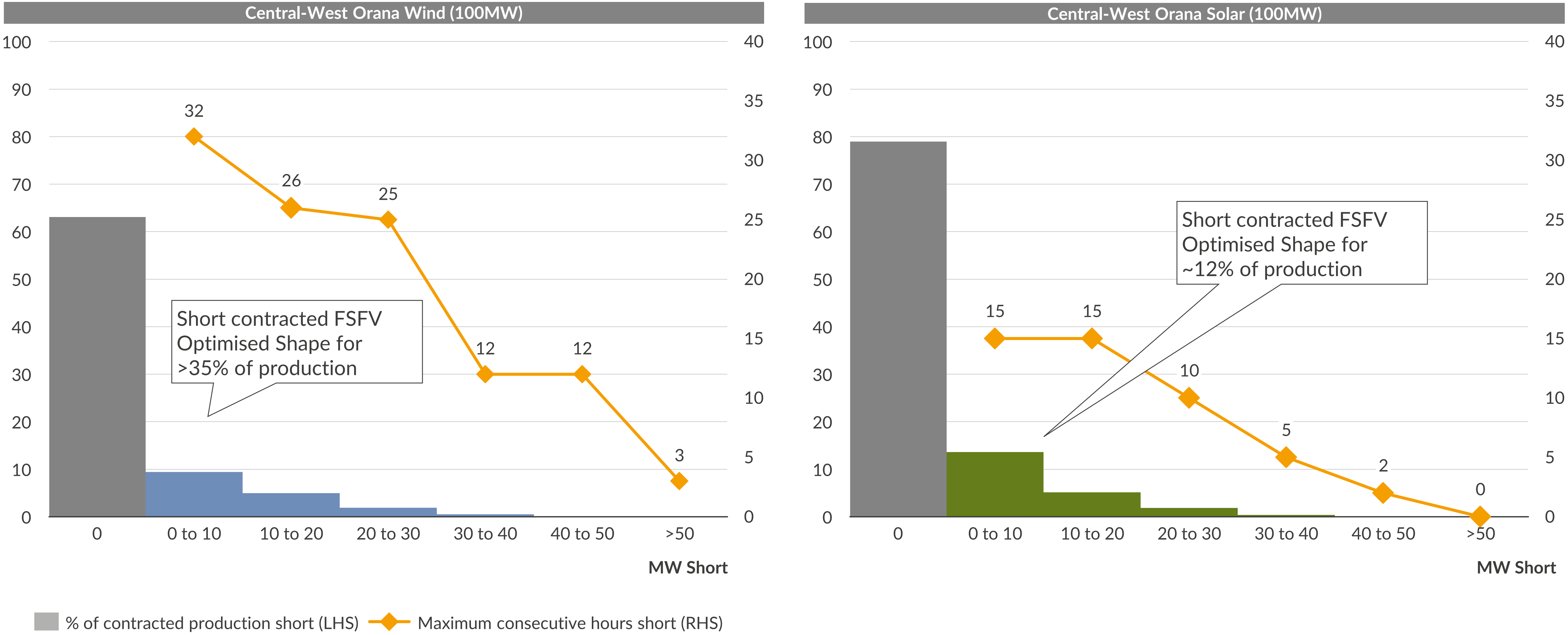
- In periods where renewables output are low, and FSFV-contracts are short, significantly dispatchable capacity is required to firm both the system and the LTESA-contract positions
- In an equilibrium scenario, Aurora estimates that at least 800 MW/1000MWh of additional new-build dispatchable capacity will be required, above and beyond the buildout assumed in the modelling exercise
- This is the absolute minimum of required capacity – it assumes that all dispatchable capacity are available for firming, able to ramp up to provide for the sudden shortfall, and able to stay on for a prolonged period of time to cover the entire duration of the short-fall
- In practice, a system that is significantly reliant on duration-limited storage for firming could be met with a situation where storage assets are (i) not sufficiently charged to provide for immediate firming needs; and (ii) not able to provide prolonged firming requirements
- Coal/gas assets could also have significant ramping times

# Agenda

# At the optimal monthly shape, LTESA projects are anticipated to be significantly short the contractual position, especially wind projects

**Distribution of energy short the FSFV contracted position at the Optimised Monthly Shape**

LHS: % of contracted production; RHS: Consecutive hours short the contract position within the MW short range



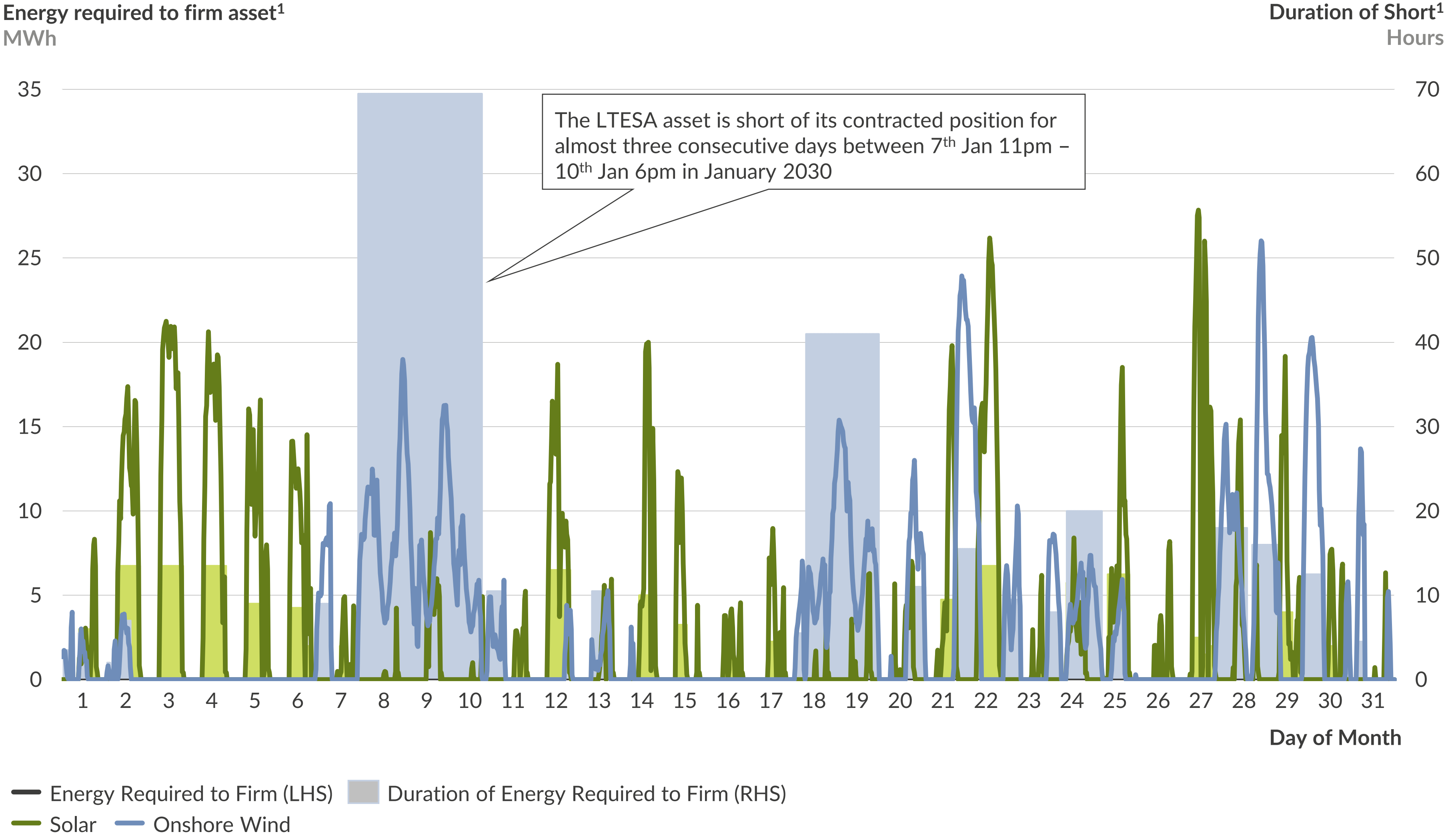
Short contracted FSFV Optimised Shape for >35% of production

Short contracted FSFV Optimised Shape for ~12% of production

Source: Aurora Energy Research

# For the representative weather year modelled, a wind asset could require 3 consecutive days of firming to physically defend the contract

**LTESA fleet-wide duration and depth of shortage for FSFV-contract – example week in 2030**



The LTESA asset is short of its contracted position for almost three consecutive days between 7th Jan 11pm – 10th Jan 6pm in January 2030

---

1) Based on optimal contract positions.

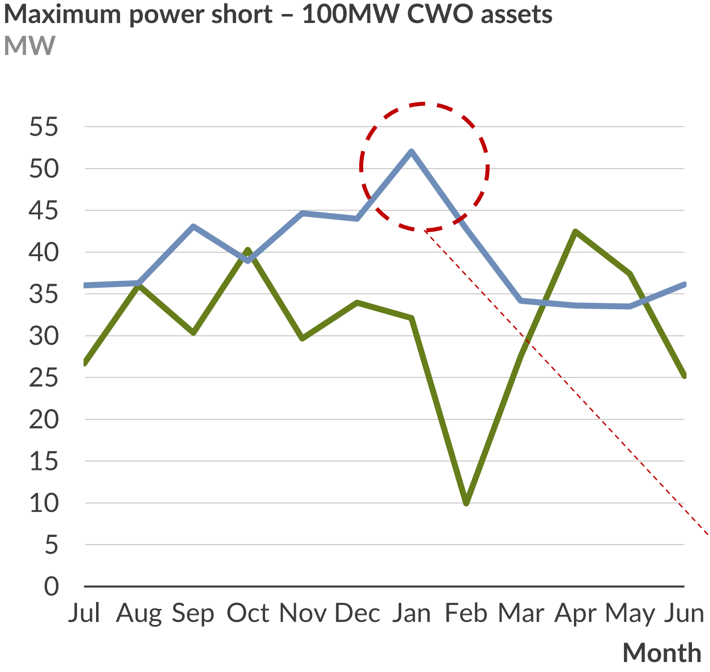
Source: Aurora Energy Research

**Required firming needs for LTESA fleet (duration and total output)**

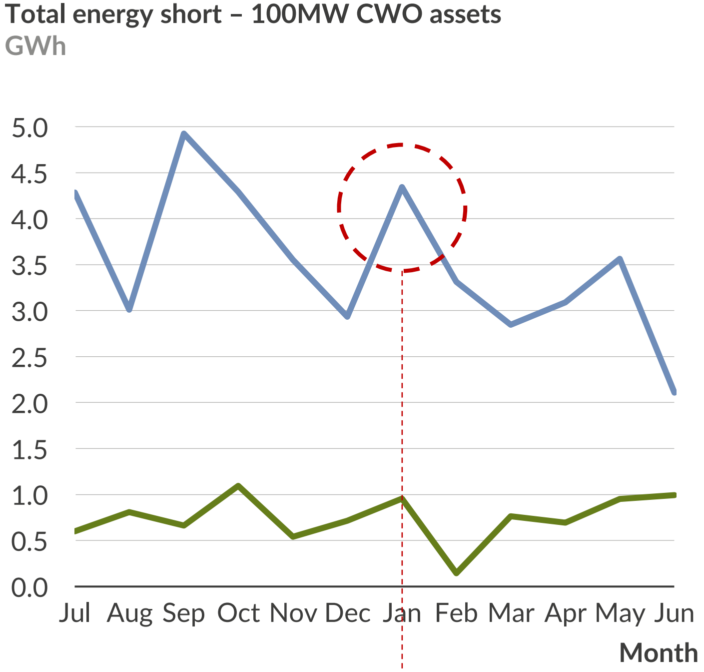
- Under a FSFV contract, the LTESA renewables fleet will face multiple periods where it would be short of its contracted position. Often, this would also be for prolonged periods of time
- For example, in an example week in 2030, the LTESA wind fleet is short of its contracted position for almost 3 consecutive days
- In other periods, the asset could be significantly shorter (in terms of MWh) but only for a small number of hours
- This poses a significant issue if assets are required to firm themselves physically – each asset will have to procure (i) significant capacities of firming technologies; (ii) varied duration of firming technologies.
- Often, these assets would be sitting idle until a firming event occurs, translating into greater costs for the developer (or consumers if this is passed on through higher LTESA contract prices)

# To physically defend the contractual position, individual projects would therefore require a mix of long duration firming and large peaking capacity

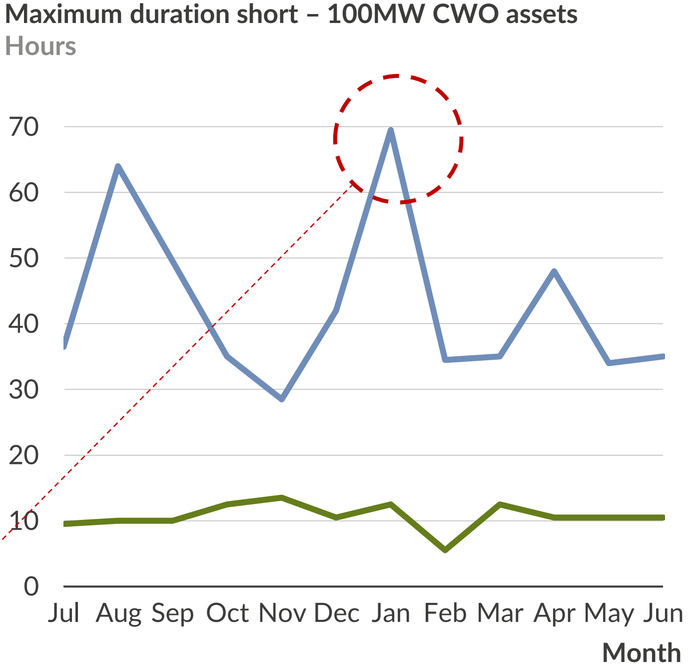
**Maximum power required to firm FSFV contractual short position in 2030**



**Total energy required to firm FSFV contractual short position in 2030**



**Maximum duration of energy required to firm FSFV contractual short position in 2030**



In January 2030, to physically firm and defend an LTESA contract a representative CWO wind asset requires:

- **>50MW of dispatchable capacity** (over half the size of the asset)
- **>4GWh of firming production** (~5.5MW constantly running at 100% capacity factor)
- **~70 hours of consecutive firming production** (~3 days of constant dispatchable capacity)

▬ Solar ▬ Wind

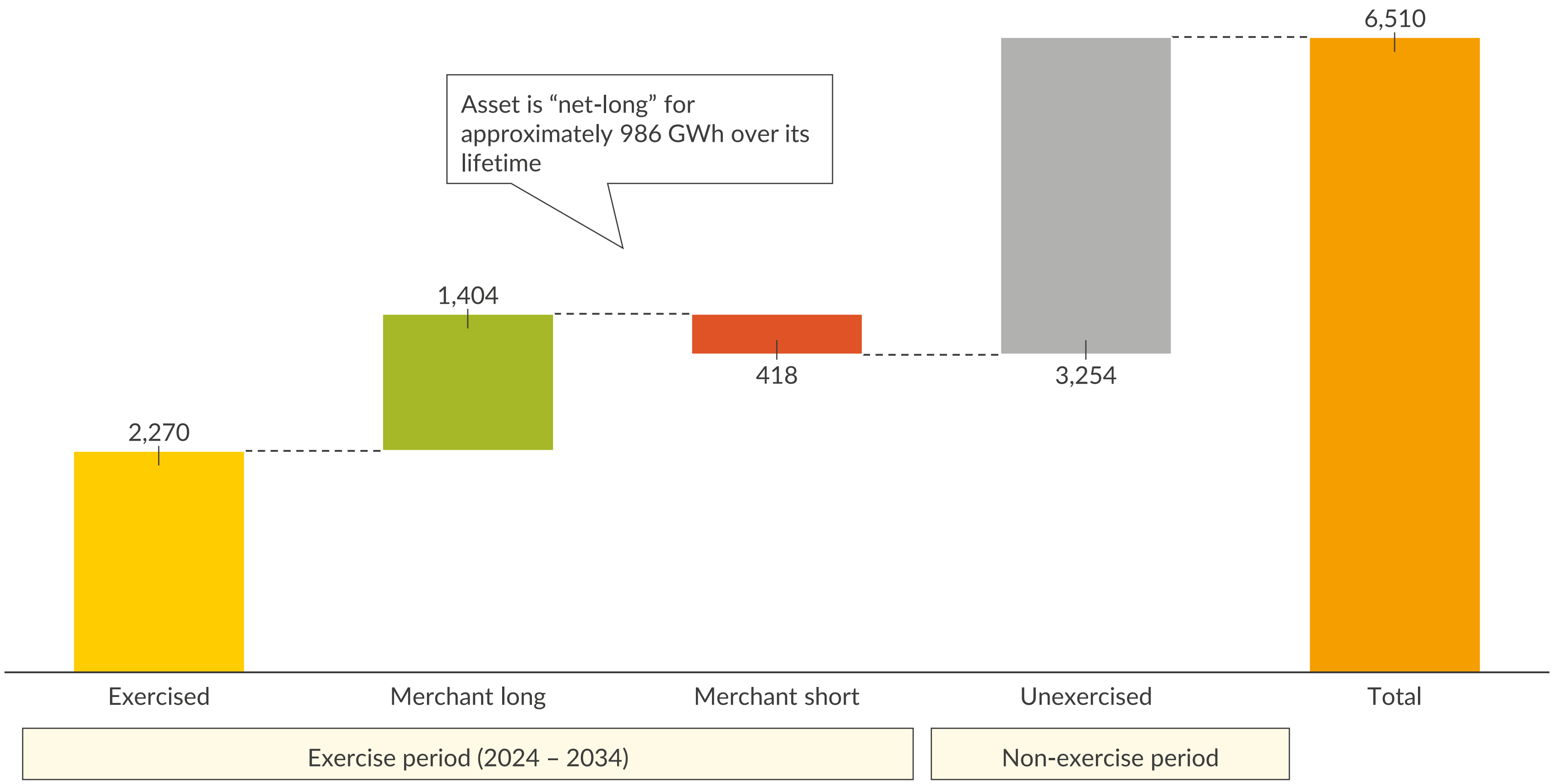
Source : Aurora Energy Research

Illustrative Example

# While assets are often short of its contracted position, a CWO onshore wind asset is expected to be thrice as long its merchant position relative to short…

**Total energy production (including shorts and longs) for a 100 MW FSFV contracted CWO onshore wind asset**

**Total production over lifetime (2024 – 2043)[1]**
GWh



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1) Generation is post-curtailment at $0/MWh and post-MLF for a 100MW Wind Asset

Source: Aurora Energy Research

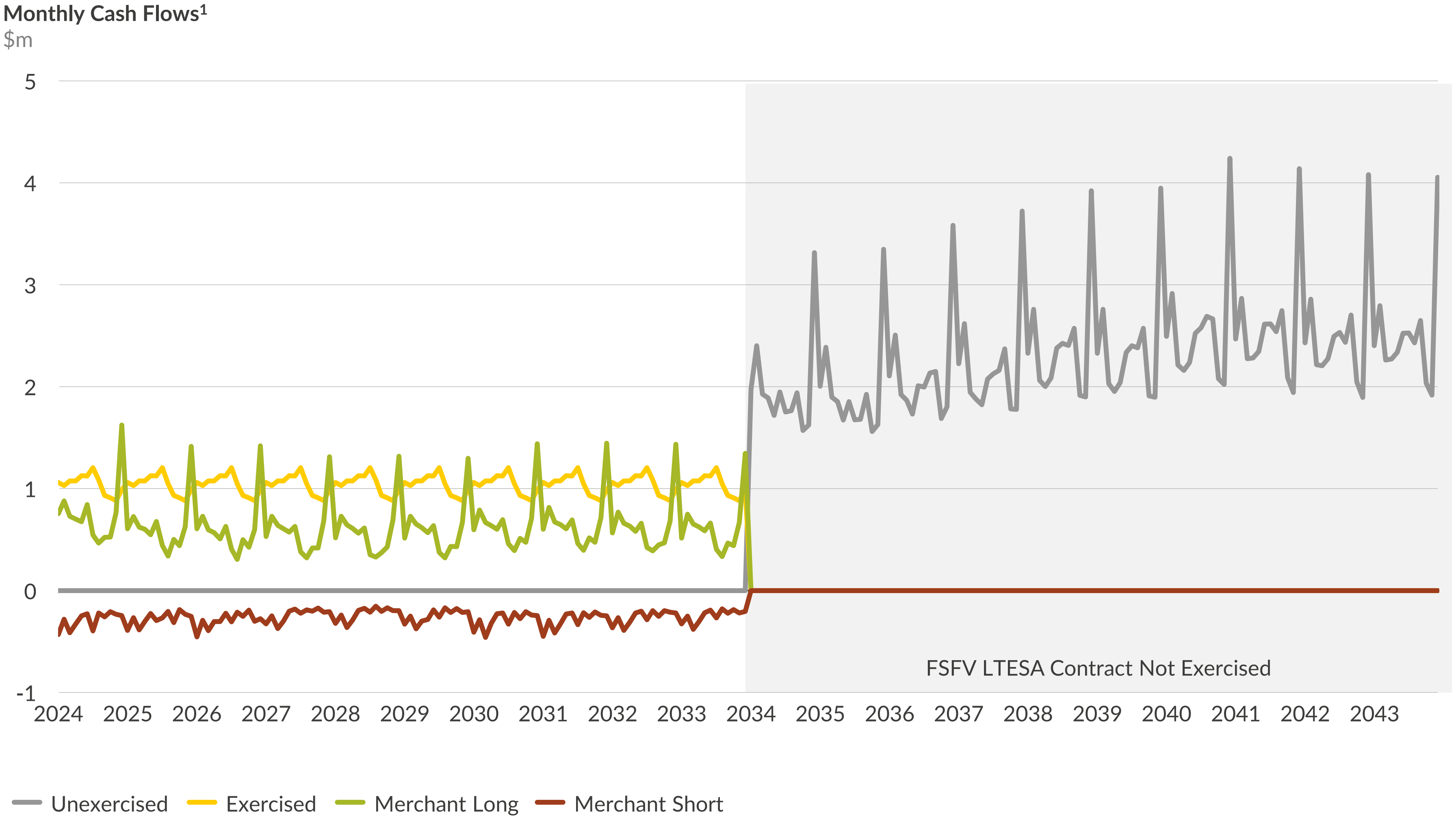
**Lifetime energy production for CWO onshore wind under FSFV contract**

- Our analysis of a representative 100MW CWO wind asset shows that the project will be ~400GWh short the FSFV LTESA contract when optimally sizing and exercising the contract
- However, the asset is actually net long its contracted position – the asset is merchant long for 1404 GWh relative to short of 418 GWh over the expected exercise period of 2024 – 2034
- This is particularly the case for assets which have a lower POE-contracted position – by committing a lower POE profile to minimise risk/maximise minimum CFADs, assets will inherently be more likely to be long of its contracted position than short
- This implies that there will be opportunities for the asset to financially firm its short positions with its long position (more on next slide)
- This result is conducted under an equilibrium analysis for an average weather year – significant deviations in weather/renewable production outturn or market outturns could vary results (discussed in non-equilibrium section)

Illustrative Example

# … moreover, the asset's cash flows on a monthly basis stemming from long positions typically exceed the losses incurred from short positions…

Monthly cash flow for FSFV-contracted asset (assuming LCOE-contract price) – 100 MW CWO onshore wind



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[1] Assumes optimised asset under LCOE contract pricing.

Source: Aurora Energy Research

**Monthly cash flows breakdown**

- Even though the asset could see multiple periods where it is physically short of its contracted position, the asset's monthly cash flows indicates that the revenues stemming from merchant-long positions are likely to outweigh the losses incurred when the asset is short of its contracted position
    - Merchant long – cash flows resulting from generation exceeding the Notional Quantity and settled at wholesale prices
    - Merchant short – cash flows resulting from generation below the Notional Quantity and the project is liable to procure the difference from the wholesale market
- The asset could, therefore, financially firm its short positions even though it might difficult to physically firm its positions in all periods
- This result is conducted under an equilibrium analysis for an average weather year – significant deviations in weather/renewable production outturn or market outturns could vary results (discussed in non-equilibrium section)

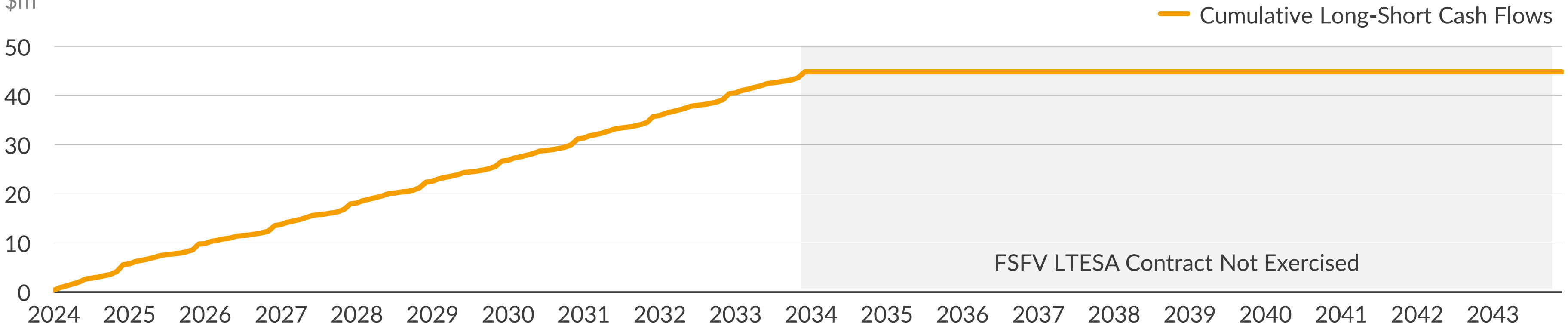
Illustrative Example

# … assets could therefore be able to financially firm their short positions over the course of its LTESA contract

**Monthly cash flow analysis for FSFV-contracted asset (assuming LCOE-contract price) – 100 MW CWO onshore wind**

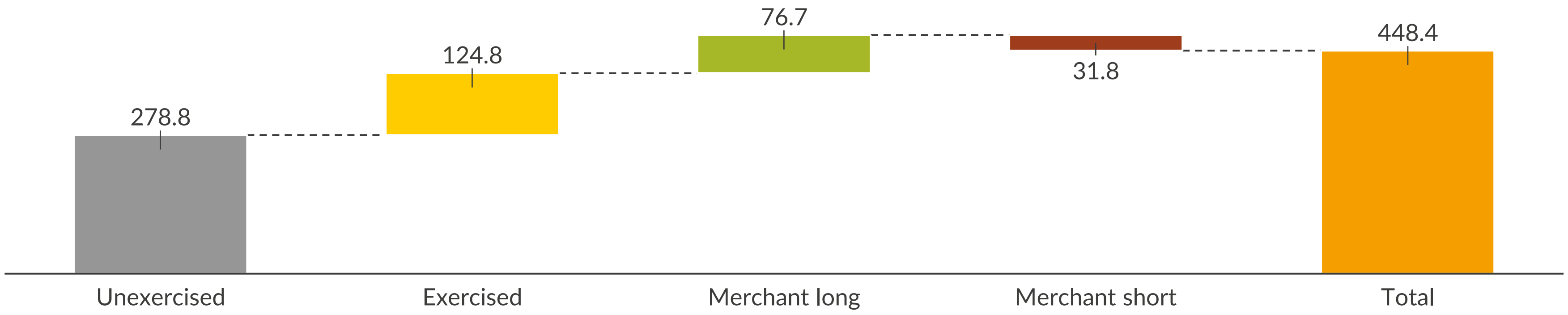
**Cumulative “net” long-short cash flow positions**[1]

$m



**Total Cash Flows over lifetime (2024 – 2043)**[1]

$m



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[1] Assumes optimised asset under LCOE contract pricing.

Source: Aurora Energy Research

**Lifetime cash flow analysis for FSFV contracted onshore wind**

- As the asset is merchant-long positions (both production and cash flows) outweigh that of the shorts, the asset is not only able to typically cover its shorts in a given month but is also capable of building up a sizeable “reserve” of extra cash flows over the course of the LTESA
- In this particular example, we see that lifetime merchant long positions ($76.7m) are more than twice as much as “merchant shorts”
- The “reserve” of cash flows could, theoretically, allow assets to protect itself from the unexpected risks of significant downside events - e.g. grey swan events such a high price period (Callide style event) coinciding lower renewables production
- While this may be theoretically helpful in providing additional security in repayment of debts, executing this in practice could be significantly more challenging as it would require contractual agreements etc. to ensure that the excess cashflows put into reserve and not disbursed to equity (or equally, used to repay the principal on debt ahead of schedule)

# Agenda

# In addition to the equilibrium LTESA scenario, Aurora has modelled three non-equilibrium scenarios to stress-test the analysis

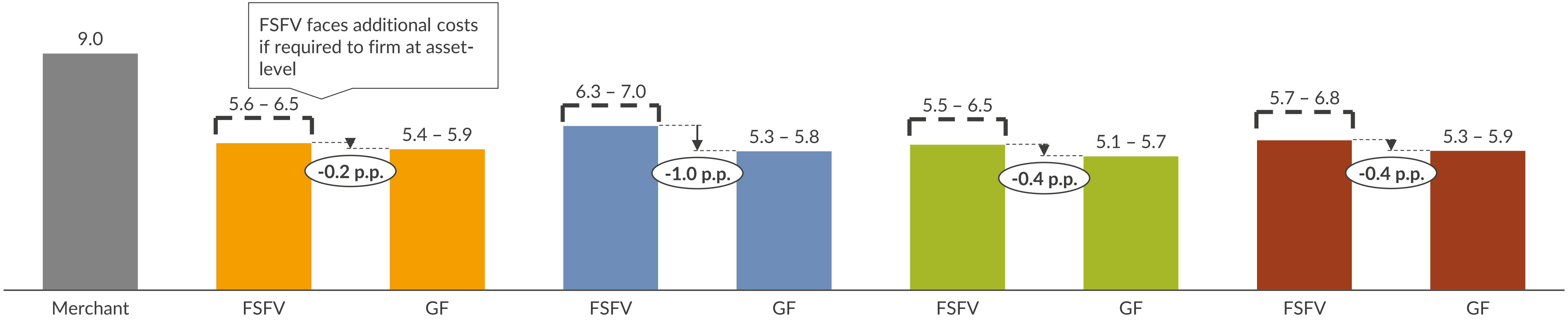
**List of non-equilibrium “stress-test” scenarios modelled**

| Model scenario | Description | Modified inputs | Frequency of non-equilibrium “deviation” | Exercise behaviour |
|---|---|---|---|---|
| 1 Low wholesale prices/ high renewables buildout | Sustained lower prices in NSW from an increased in renewables buildout | Increase build out of renewable projects, assuming that proportional of demand met by renewables is the same as ISP 2022 Step Change | Sustained over whole horizon | Assumed to change/re-optimised as non-equilibrium deviation is sustained |
| 2 Extreme high prices | Sustained period of extreme high price volatility, which poses a risk to assets if they were short their contract position | Assumed “Callide-style” price volatility in NSW, with all other inputs held constant | One month, once in 3 years | No change, same as eq. LTESA Scenario |
| 3 Low renewables output/ weather year | Temporary reduction in renewables buildout, which results both in (i) higher likelihood that the asset is short of its contractual position; and (ii) higher wholesale prices due to lower renewables production | Change in median weather year profile in eq. LTESA Scenario to one with low renewables production (across both wind and solar) | One year, once in 3 years | No change, same as eq. LTESA Scenario |

Source: Aurora Energy Research

# LTESA Solar projects – Generation-following contracts reduces WACCs relative to FSFV contracts across all of the “stress-test” scenarios

**Weighted Average Cost of Capital (WACC)**
%



FSFV faces additional costs if required to firm at asset-level

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Debt ratio** | 48-58% | 50-60% | 45-55% | 52-62% | 48-58% | 55-65% | 45-55% | 52-62% |
| **Equity ratio** | 52-42% | 50-40% | 55-45% | 48-38% | 52-42% | 45-35% | 55-45% | 48-38% |

**LCOE Contract Price**

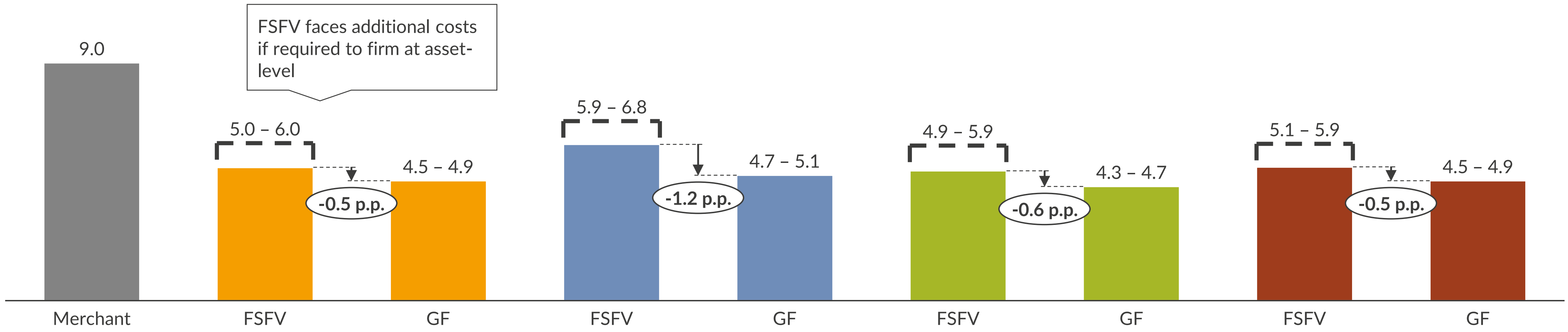
**LTESA scenario** **Scenario 1** **Scenario 2** **Scenario 3**

🟧 Equilibrium LTESA Scenario
🟦 Non-eq stress test scenario 1 – “Low prices/ high renewables buildout”
🟩 Non-eq stress test scenario 2 – “Extreme high prices”
🟥 Non-eq stress test scenario 3 - "Low renewables output/weather years"
⌐ Additional cost for asset-level firming

Source: Aurora Energy Research

# LTESA Onshore wind projects – Generation-following contracts reduces WACCs relative to FSFV contracts across all of the “stress-test” scenarios

**Weighted Average Cost of Capital (WACC)**
%



FSFV faces additional costs if required to firm at asset-level

| | Merchant | FSFV | GF | FSFV | GF | FSFV | GF | FSFV | GF |
|---|---|---|---|---|---|---|---|---|---|
| **Debt ratio** | | 60-66% | 68-74% | 46-52% | 65-71% | 62-68% | 72-78% | 60-66% | 68-74% |
| **Equity ratio** | | 40-34% | 32-26% | 54-48% | 35-29% | 38-32% | 28-22% | 40-34% | 32-26% |

**LCOE Contract Price**

**LTESA scenario** | **Scenario 1** | **Scenario 2** | **Scenario 3**

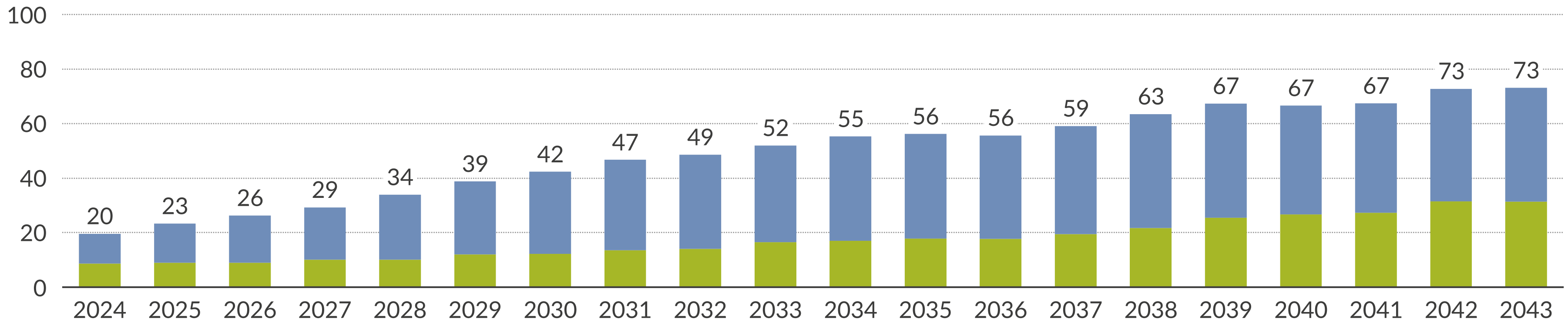
🟧 Equilibrium LTESA Scenario
🟦 Non-eq stress test scenario 1 – “Low prices/ high renewables buildout”
🟩 Non-eq stress test scenario 2 – “Extreme high prices”
🟥 Non-eq stress test scenario 3 - "Low renewables output/weather years"
[ ] Additional cost for asset-level firming

Source: Aurora Energy Research

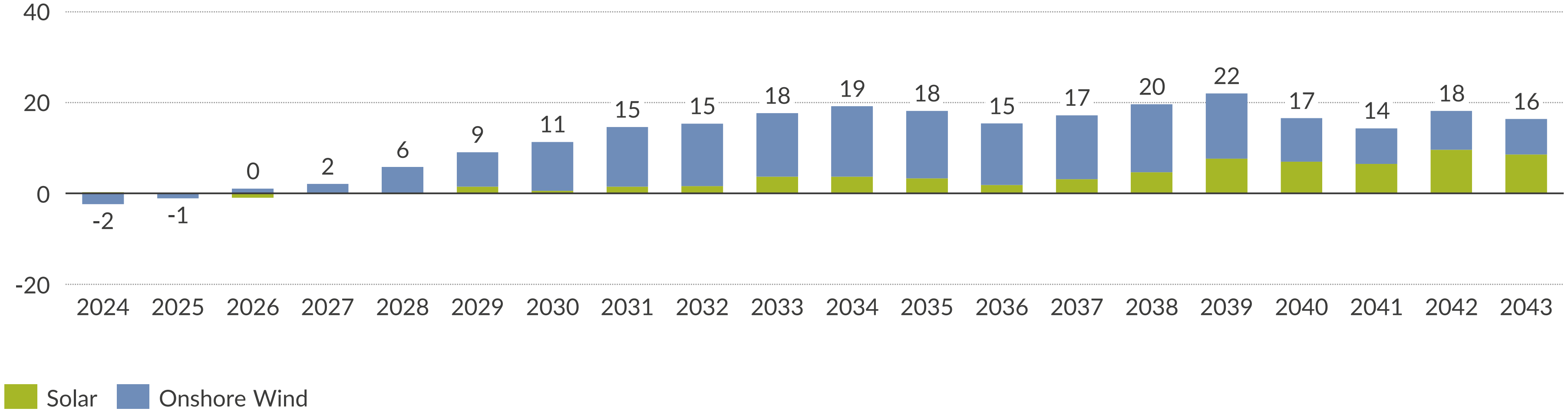
# Agenda

# High renewables scenario sees NEM-wide renewables capacity reaching 73 GW by 2040s, or 16 GW higher than the eq. LTESA scenario

**NEM-wide capacity mix – "Low wholesale prices/ high renewables buildout" scenario**
Nameplate GW



**NEM-wide capacity delta between high renewables sensitivity and the LTESA scenario**
Nameplate GW



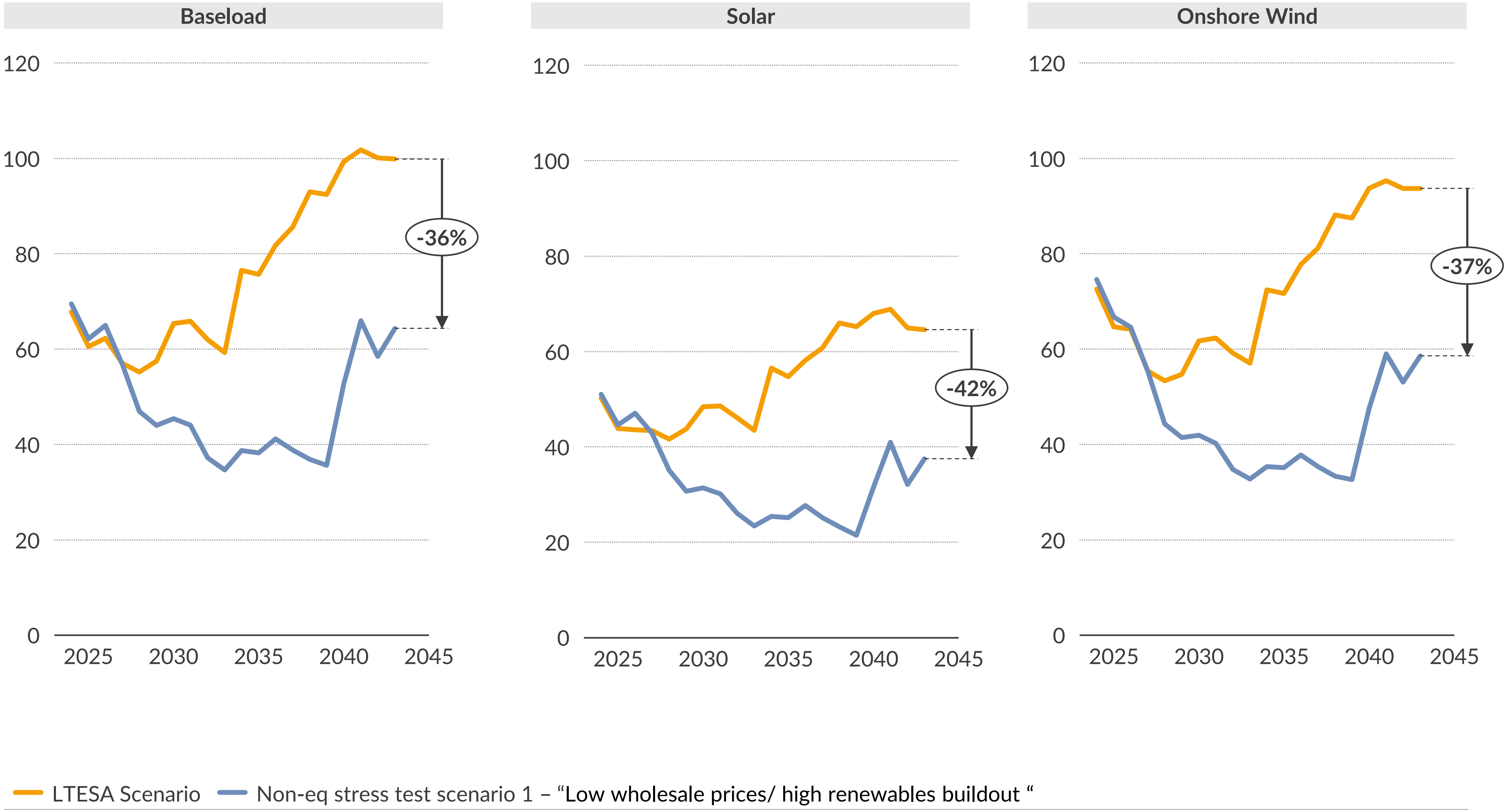
Source: Aurora Energy Research

**Installed capacity in "Low wholesale prices/ high renewables buildout" scenario**

- The modelled "Low wholesale prices/ high renewables buildout " scenario assumes that the proportion of demand fulfilled by renewables generation is similar to the 2022 ISP Step Change (Draft) scenario
- Across the NEM, total onshore wind and solar buildout reaches 73 GW by the early 2040s, or 16 GW higher than the equilibrium LTESA Scenario modelled

# Greater renewable buildout will result in wholesale prices decreasing by 35 – 40% across the forecast horizon

**TWA, DWA prices in NSW**
$/MWh



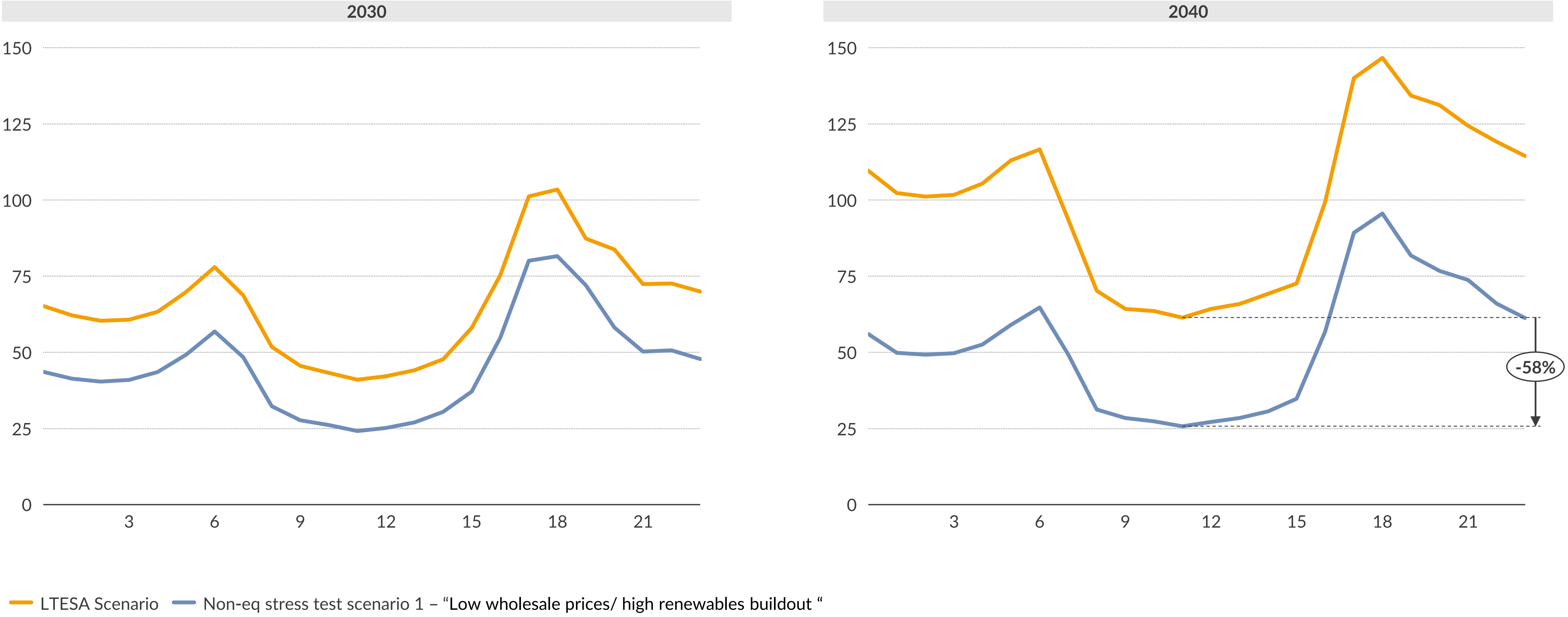
Source: Aurora Energy Research

**Wholesale prices in "Low wholesale prices/ high renewables buildout " scenario**

- Greater buildout of low marginal cost renewables pushes out relatively more expensive coal/gas generation and results in wholesale prices being supressed
- Relative to the equilibrium LTESA Scenario, the non-equilibrium "Low wholesale prices/ high renewables buildout " scenario sees:
  - Baseload prices decreasing by an annual average of 35% (or $27/MWh)
  - Solar DWA prices decreasing by an annual average of 40% (or $21/MWh)
  - Onshore Wind DWA prices decreasing by an annual average of 37% (or $27/MWh)

# The depression in wholesale prices are most prominent in the middle of day, when solar output is high

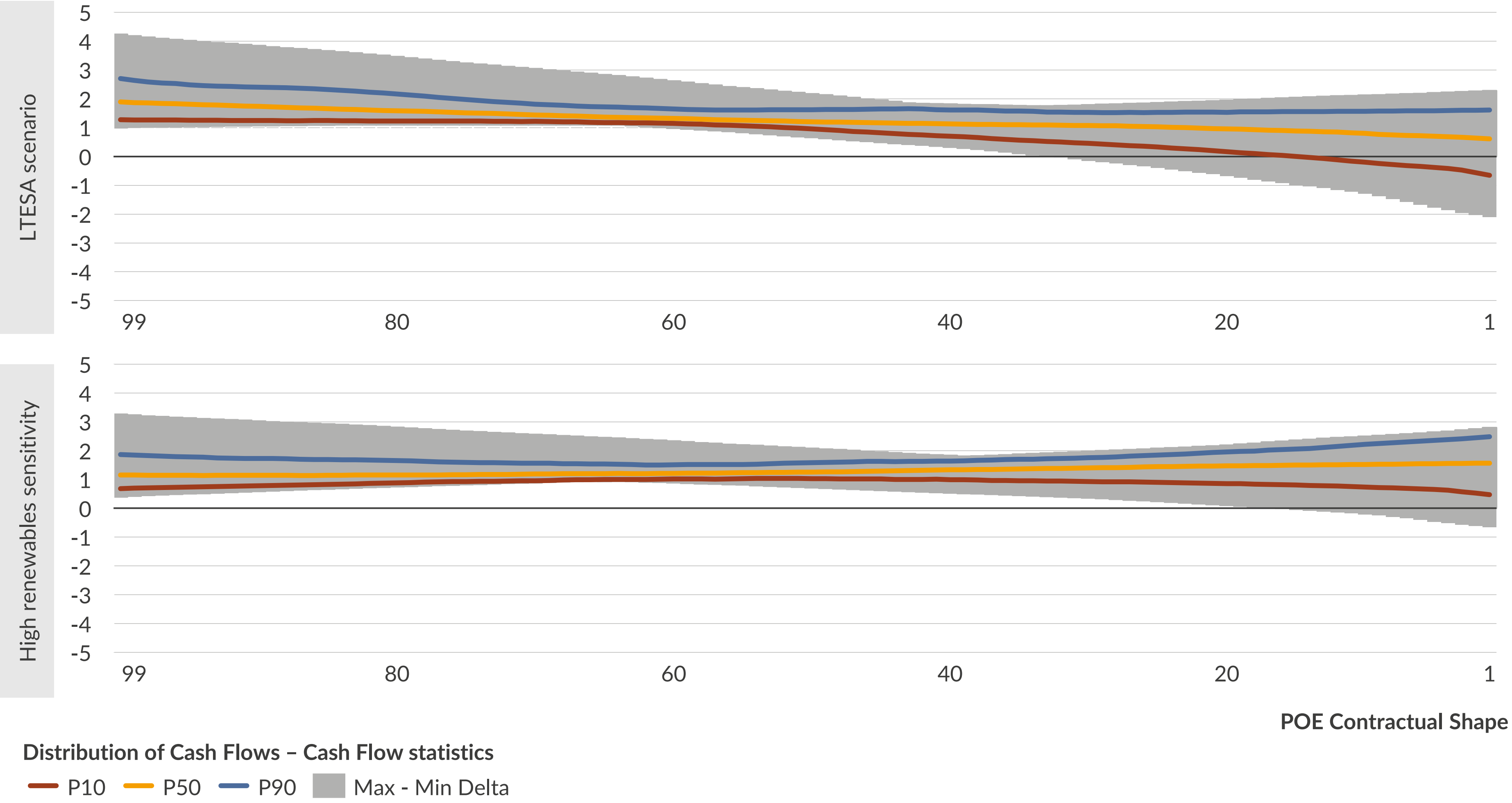
**Average intraday wholesale prices**
$/MWh



Source: Aurora Energy Research

# Analysis of cash flows at potential contractual positions shows the increased risk of oversizing the FSFV contract

**Distribution of Cash Flows – Central-West Orana Wind (100MW)**
$m



Source: Aurora Energy Research

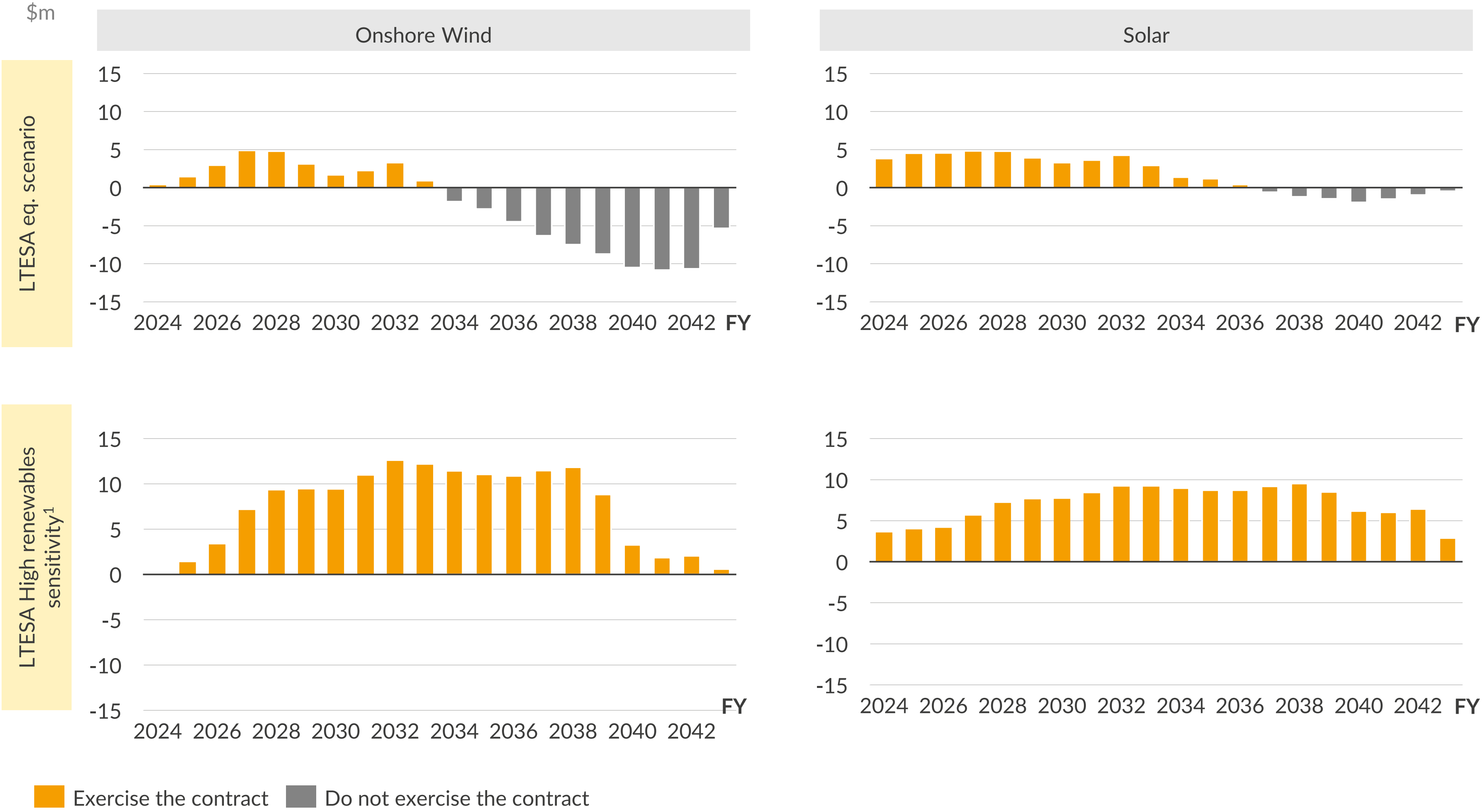
**Monthly cash flows for FSFV contracted assets – example of onshore wind**

- In the LTESA Scenario we find a contract size inflection point, beyond which the project materially increases it's downside cash flow risk without a compensate upside return
- In the "Low wholesale prices/ high renewables buildout " stress-test scenario we similarly observe this inflection point, however it is observed at a more contracted position and the magnitude of the downside risk is less severe
- The reason for this is because at lower wholesale prices when more renewables build out, the asset is more likely to be settling at a Floating Price that is close to or below the Contract Price
- As such, the project faces less oversizing risk from being long/short the contracted position

# With a prolonged depression wholesale prices, the asset is expected to exercise the FSFV-contract for all 20-years of the LTESA

**Exercise condition for FSFV LTESA contract holders – under LCOE contract prices**

**Difference in Two-Yearly CFADS**



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1) Low wholesale prices/ high renewables buildout

Source: Aurora Energy Research

**Exercise condition of LTESA contracts under "Low wholesale prices/ high renewable buildout" Scenario**

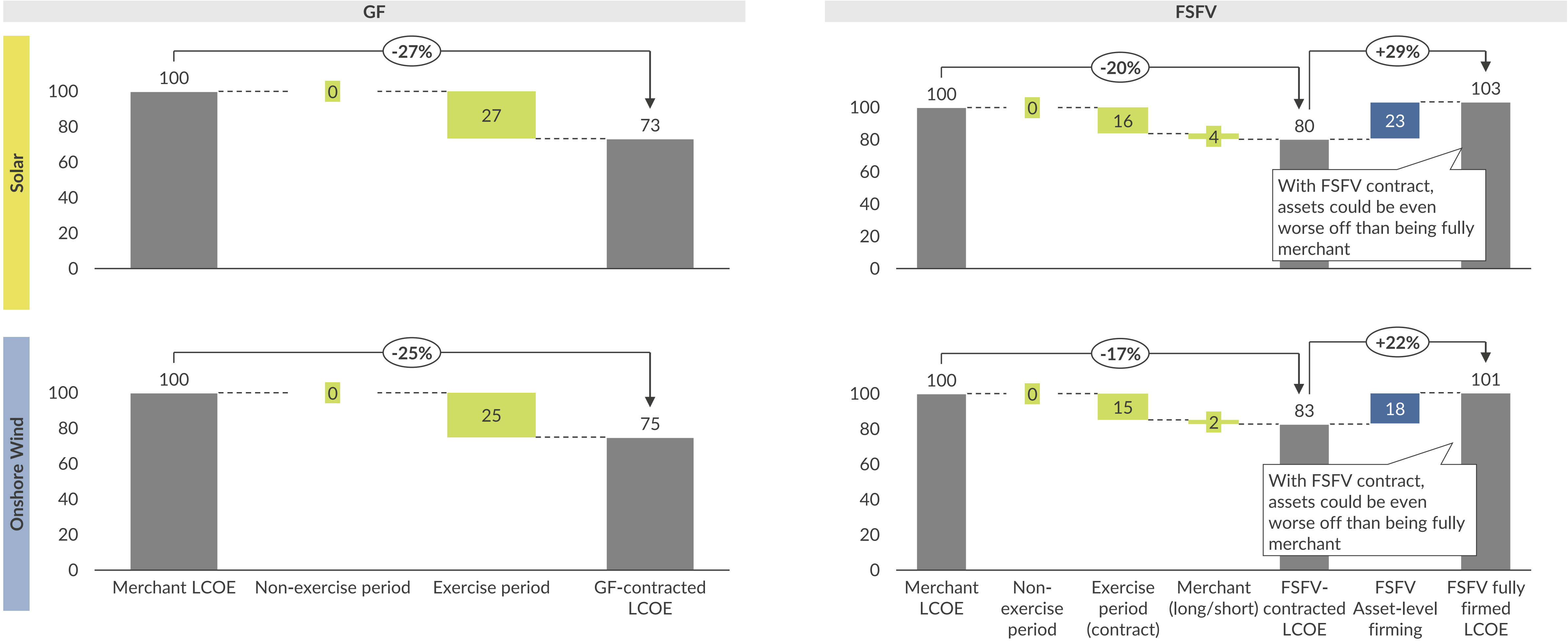
- Due to the depression in wholesale prices under the non-equilibrium High Renewables sensitivity, assets are expected to exercise their LTESA contract throughout all 20-years of the contract duration
- This is in contrast to the equilibrium LTESA scenario where onshore wind assets were expected to only exercise for the first 10 years, and solar for the first 12 years

# Under the High Renewables scenario, FSFV-contracted asset could see LCOEs higher than a fully merchant asset

AURORA

**Breakdown of impact of LTESA-contract on the LCOE[1] for a CWO onshore wind project (over the 20-year LTESA period)[2]**

Normalised, Merchant LCOE = 100)



With FSFV contract, assets could be even worse off than being fully merchant

With FSFV contract, assets could be even worse off than being fully merchant

Source: Aurora Energy

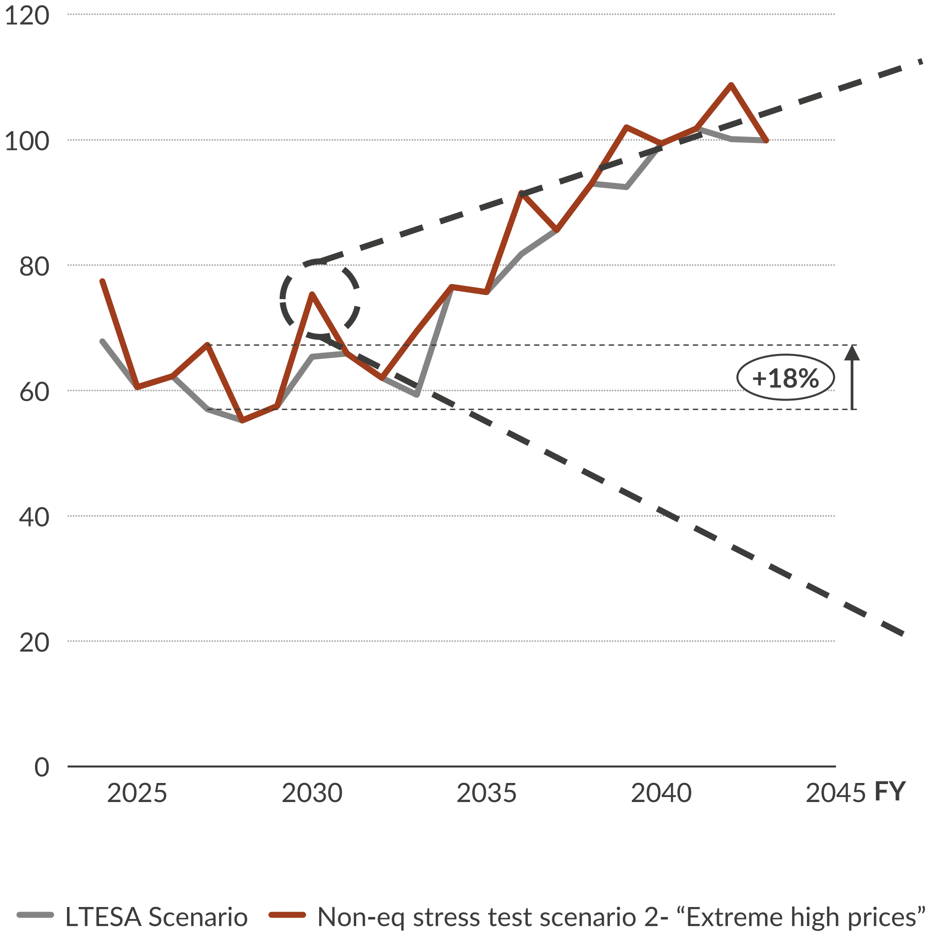
# Agenda

# The non-equilibrium “Extreme High Prices” scenario is modelled by replicating price volatility experienced during Callide explosion for NSW

## LTESA scenario with a major market event

**NSW TWA prices under Extreme High Prices scenario**[1]

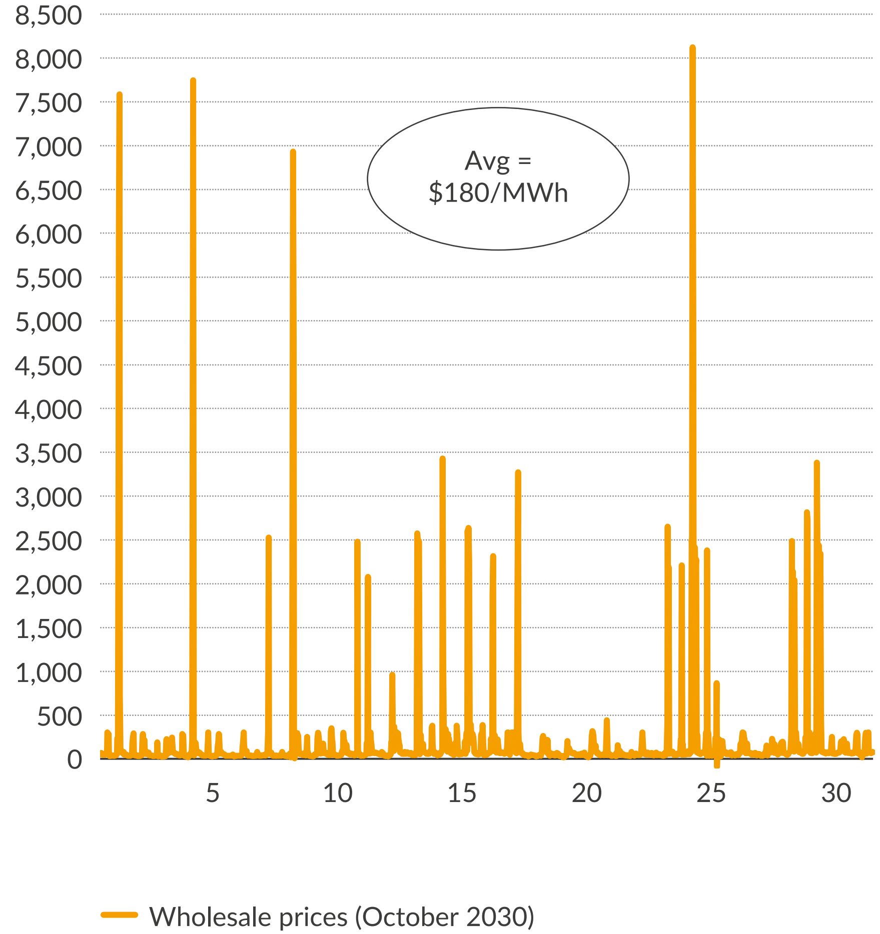
$/MWh, real 2021



## E.g. of extreme prices modelled in October 2030

**Wholesale price in a sample month with extreme prices**

$/MWh, real 2021



**Extreme high price scenario model**

- Aurora has modelled an extreme high price event scenario by assuming that Callide-style events happen in NSW for a month, once every 3 years
- We have assumed that the volatility experienced in QLD during Callide explosion is directly transposed onto that of NSW prices
- This results in a spike in LTESA wholesale prices once every 3 years, by an annual average of 20%
- The impact is most significant in the month where the volatility is highest (October), where frequent price spikes exceed $1000/MWh were observed
- We assume that these events are unpredictable – therefore the asset exercise position on LTESA contract is exactly similar to that of the LTESA equilibrium scenario (i.e. it cannot change it’s exercise position in accordance with high prices)

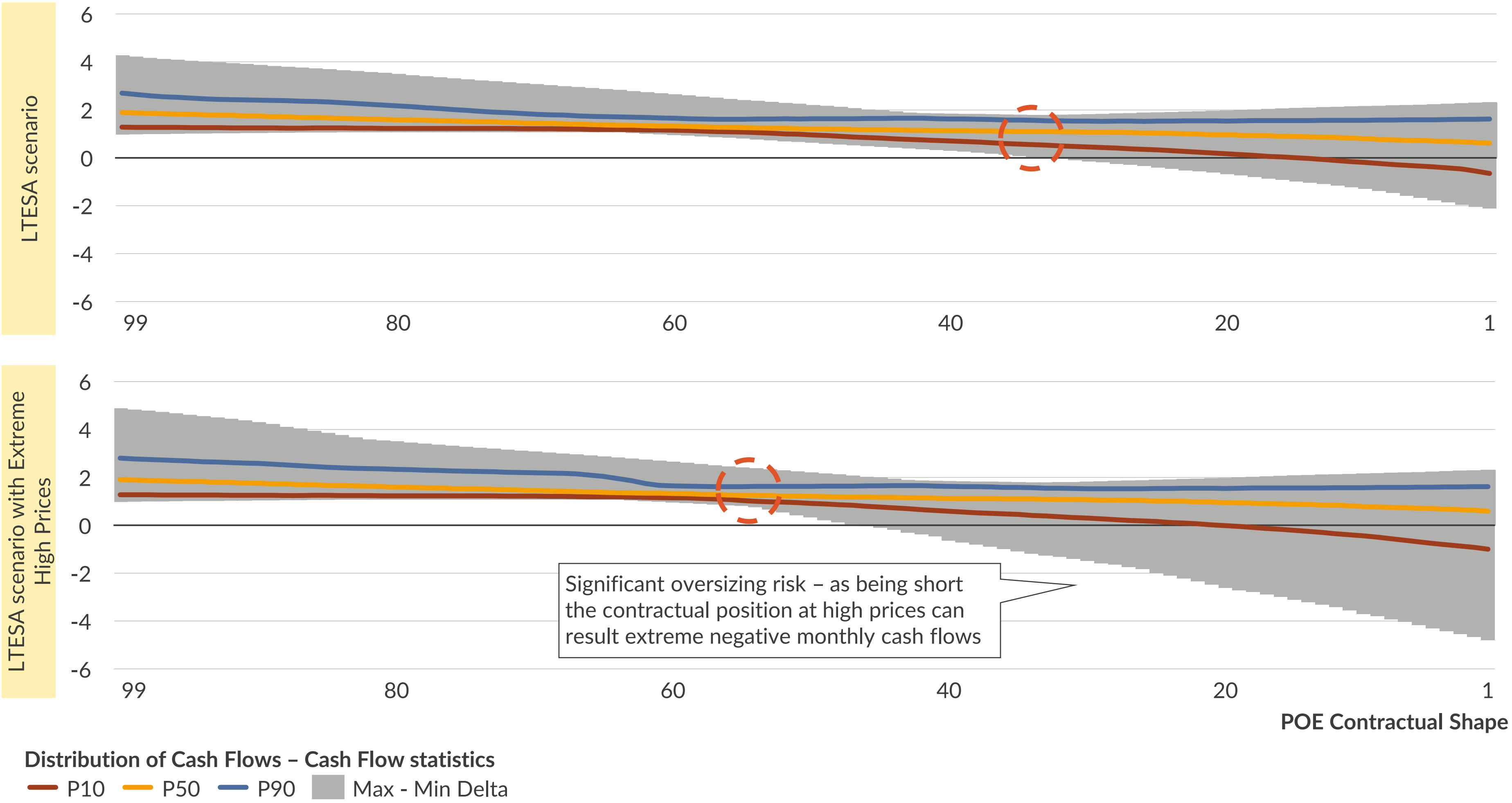
---

1) Modelled assuming **Callide-style volatility for a month once every three years**

Source: Aurora Energy Research

# High price events amplifies the risks of over-sizing; FSFV onshore wind cashflows now turn negative at POE55 instead of POE35 in the eq. scenario

**Distribution of Cash Flows for FSFV-contracted  Central-West Orana Wind (100MW) under LCOE contract prices**
$m



Significant oversizing risk – as being short the contractual position at high prices can result extreme negative monthly cash flows

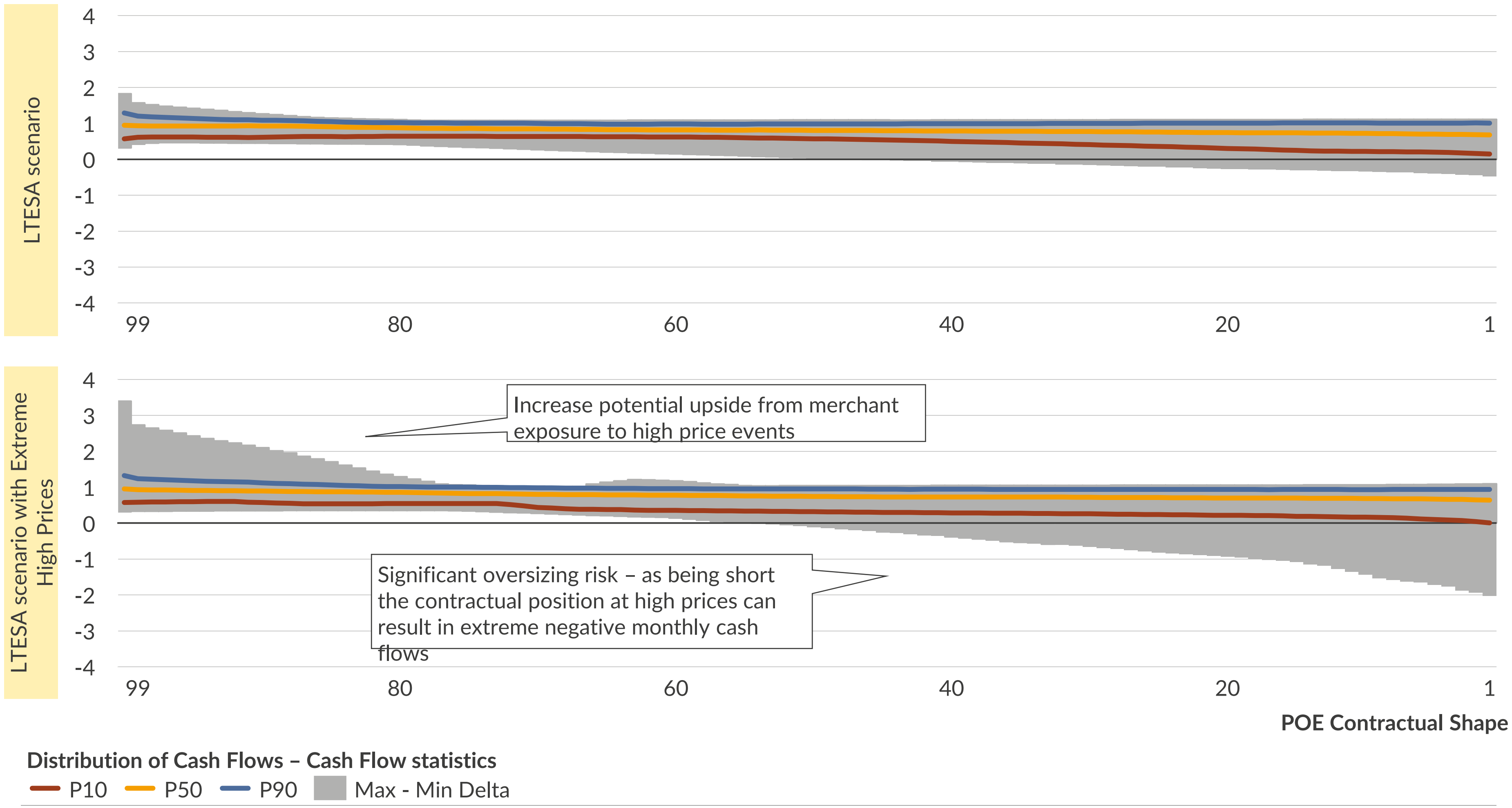
**Risk of over-sizing due to High Price events**

- High price event amplifies the risks of over-sizing POE-contract shape for FSFV assets
- First, the asset could face a negative cash flow position under lower contracted positions relative to the eq. LTESA Scenario (POE 55 vs POE 35)
- Second, negative cash flows are also amplified, where losses are significantly higher in the Extreme High Prices scenario relative to the equilibrium LTESA Scenario

# However, FSFV-assets which secured a contractual shape would be able to benefit from merchant-upside during high price events

AURORA

**Distribution of Cash Flows for FSFV-contracted Central-West Orana Solar (100MW) under LCOE contract prices**
$m



Increase potential upside from merchant exposure to high price events

Significant oversizing risk – as being short the contractual position at high prices can result in extreme negative monthly cash flows

**Benefit of FSFV contract during High Price events if asset is less contracted**

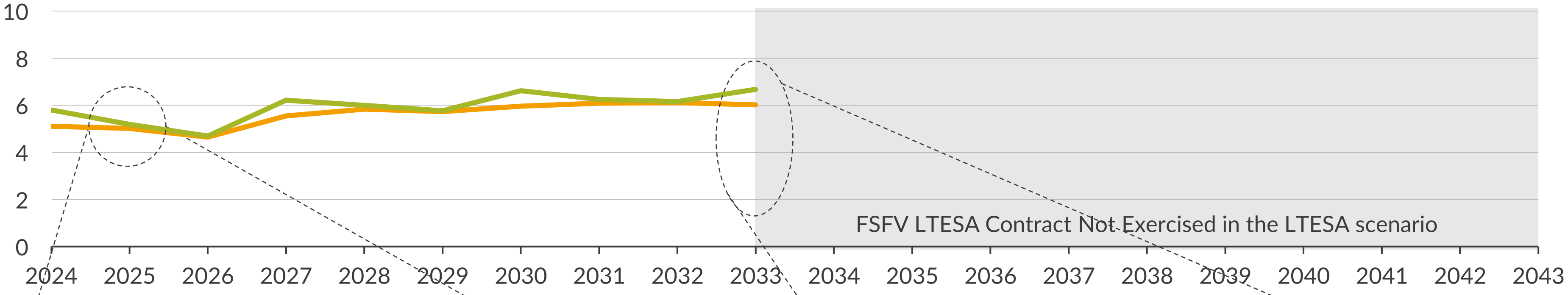
- By under-sizing/taking a lower contractual shape, assets under a FSFV-contract could asset see higher returns from periods of prolonged high prices
- The benefit stems from merchant revenues received from being long its contractual position
- This assumes that periods of high prices are independent of renewables production – if assets were short of its contractual position, the asset could face significant risk
- Furthermore, project financiers are unlikely to consider potential upsides – only the downside risks will be considered for debt

# A well-optimised/sized asset should have sufficient cash flows to tide itself over periods of prolonged high prices (if asset is not short)…

**Cash flow analysis for FSFV-contracted asset[1] (assuming LCOE-contract price) – 100 MW CWO onshore wind**

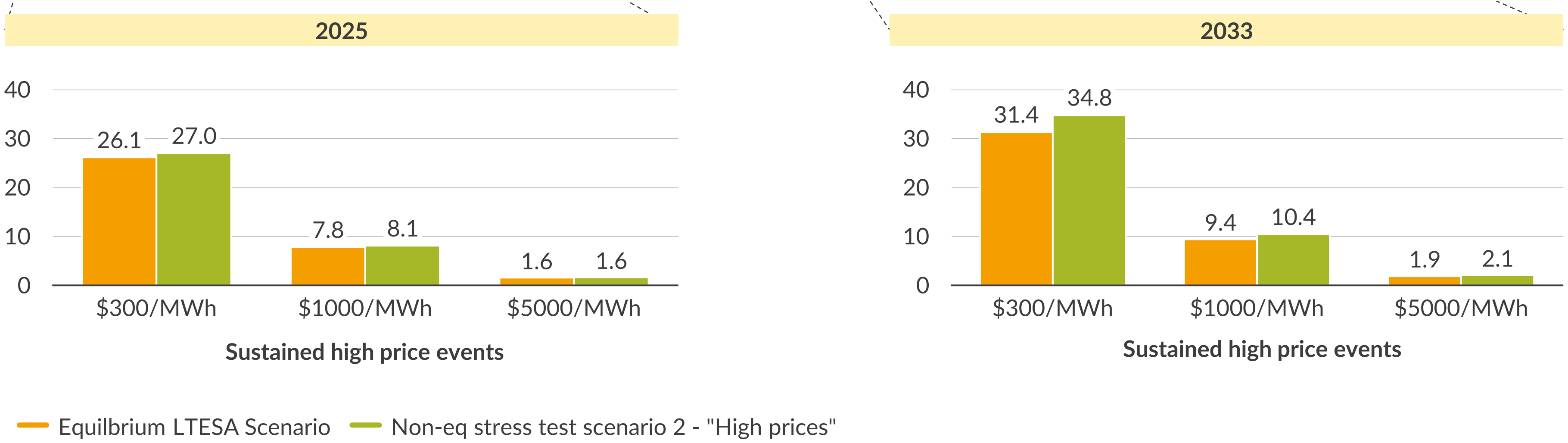
**Project's yearly reserve from "net" long-short[2] cash flow positions[3]**

$m



**Number of consecutive days an onshore wind project could experience a wind drought during high-prices before depleting the project reserve**

Days



**Cash flow analysis for FSFV contracted onshore wind in Extreme High Prices**

- While there are inherent risks in an FSFV-contract, an optimally sized contract is expected to be able to accumulate a reasonable cash reserve to tide over prolong periods of high price spikes and low renewables production – even under non-equilibrium scenarios
- In an extreme "wind-drought" scenario, where wind output entirely stops, the cumulated cash reserve should be able tide over:
  - 25 – 30 days of $300/MWh prices
  - 7 – 8 days of $1000/MWh price
  - 1 – 2 days of $5,000/MWh prices
- Prolonged prices of $5,000/MWh (alongside 0 wind production) is extremely rare – prices during Callide exceeded $8,000/MWh but was typically short-lived and focus in evening peaks
- Nonetheless,, this could still be challenging for project financiers as conditions/covenants might have to be put in place to ensure that accumulated net cash-flows are set aside for working capital/liquidity reserves to prevent insolvency

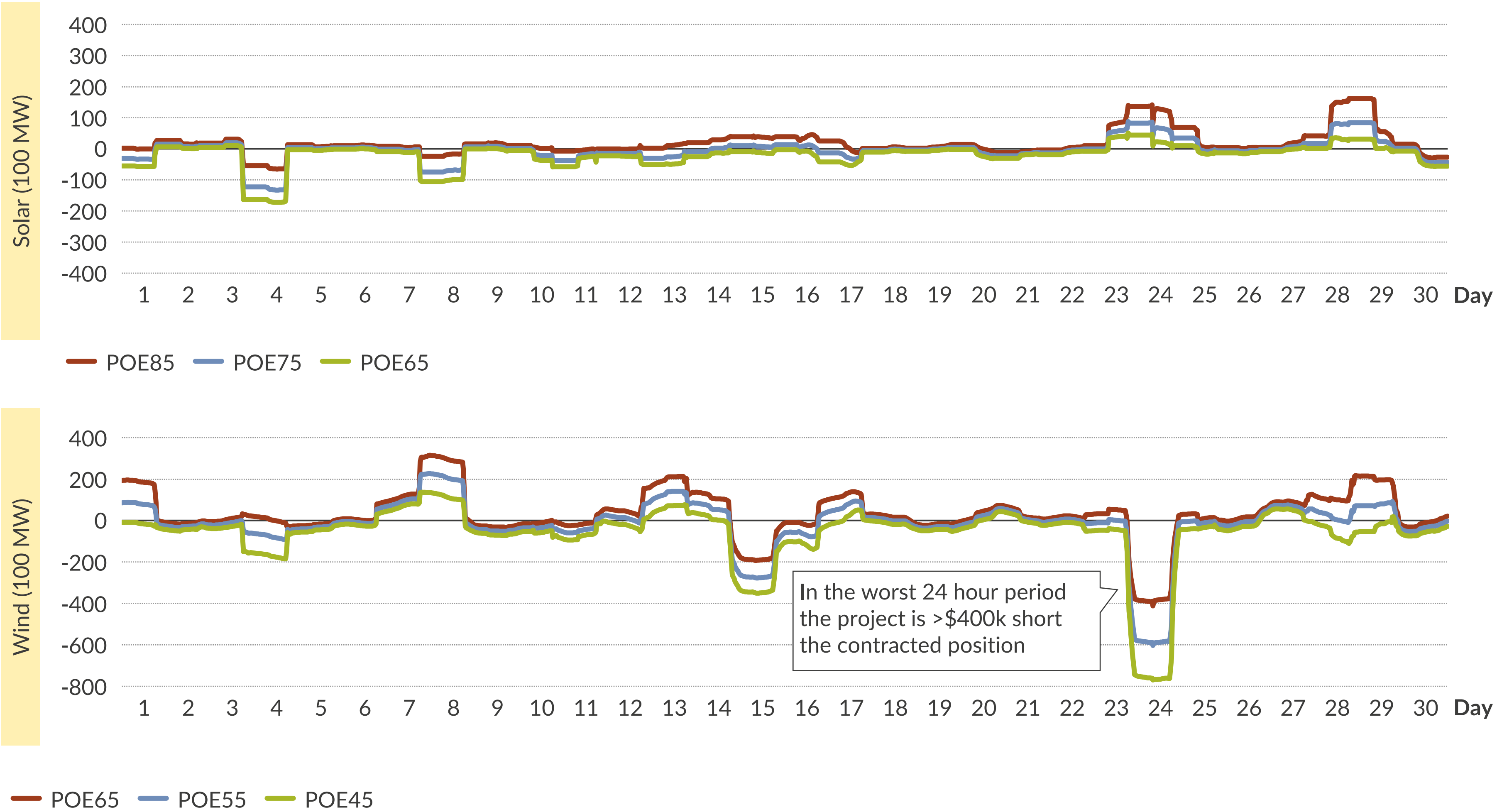
---

1) Assumes optimised asset under LCOE contract pricing. 2) At low wholesale prices the LTESA onshore wind project is anticipated to always exercise the FSFV contract. 3) Project reserve is assumed to keep 25% of the previous year's reserve as well as cashflows for the current year. 4) "Optimal-sized" contract for this analysis was taken as the contractual shape that maximised the minimum cash flows available for debt servicing (CFADS)

Source: Aurora Energy Research

# …However, working capital within-month/short periods of time could still see significantly fluctuations

**Rolling 24 hour merchant cash flow position during October 2030 (exercising FSFV LTESA contract)**
$000s



In the worst 24 hour period the project is >$400k short the contracted position

Source: Aurora Energy Research

### Impact on working capital of Extreme High Prices

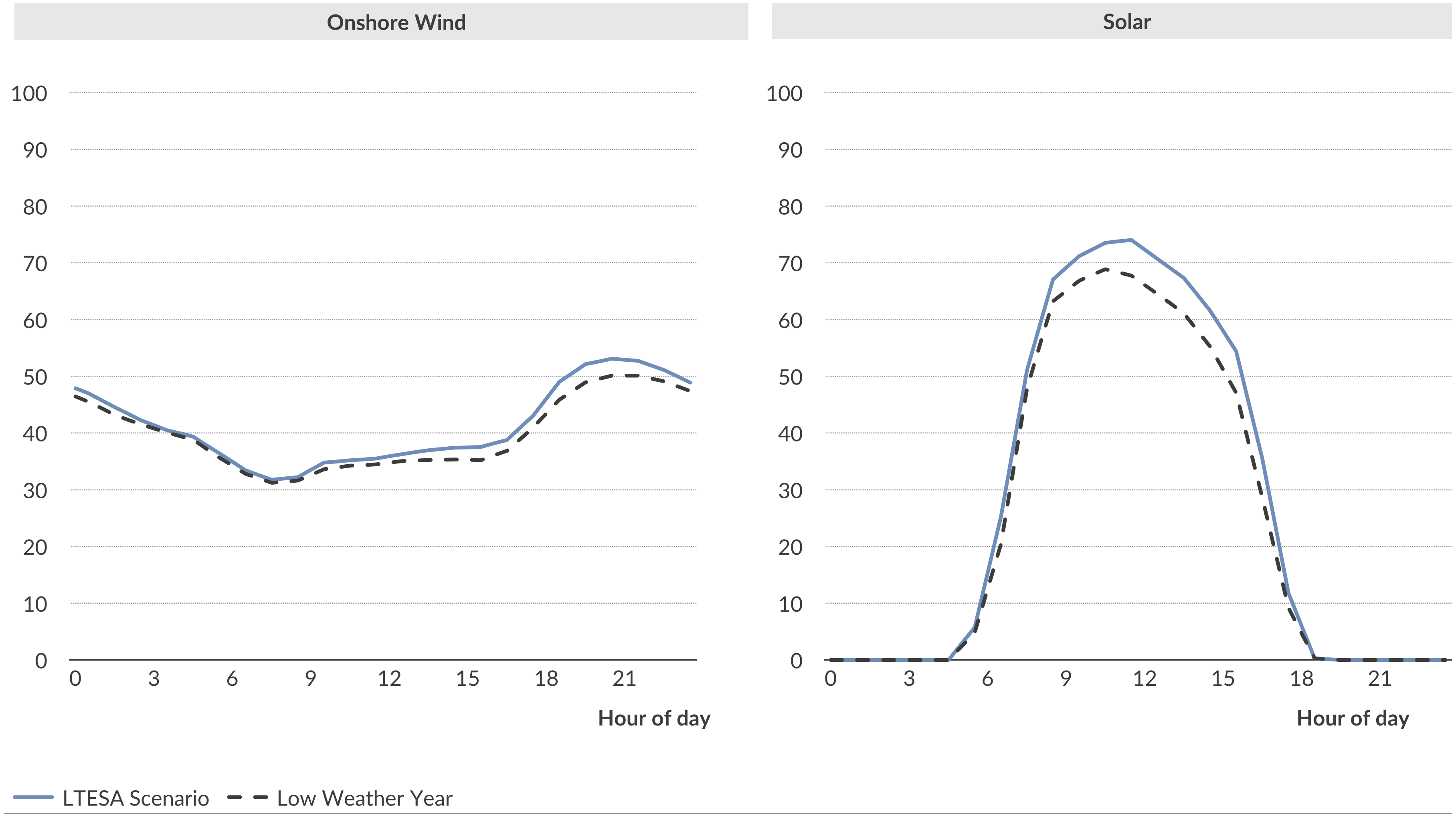
- While asset would likely have sufficient cash reserves over a long-period of time, short-term (within month) working capital could be significantly affected by Extreme High Price events
- In a day of extreme high prices (modelled after Callide), the asset could be up to $400k short of it's contracted position
- This could be a concern for project financiers which may be concerned about working capital over a short period of time (e.g. day-to-day) and not just over the month

# Agenda

# Aurora has modelled a low renewables output/weather year scenario where wind and solar see lower production throughout the day…

**Intra-day onshore wind and solar capacity factor for the representative and low weather year (once every three years) in Central West Orana**

%



Source: Aurora Energy Research

**Renewable generation profile and capacity factor in Low renewables output/weather year scenario**

- Aurora has modelled a low renewables output/weather year based on assessment of historic weather profiles over the last 10 years
- In this exercise, we assume that a low renewable output year will materialise once every 3 years
- During the low renewable output year, production profiles are depressed throughout the day, and average annual capacity factors for:
  - Onshore Wind – falls from 41% to 39%
  - Solar – falls from 27% to 25%

# Low renewables production/weather year leads to higher prices, particularly when the asset is short of its contractual position

**TWA, DWA prices in NSW**

$/MWh

Source: Aurora Energy Research

**Wholesale prices in Low Renewables Output/Weather Year**

- In a low renewables output/weather year, the asset is likely to be short of it's contractual position while also facing higher prices
- The increase in prices are most prominent towards the back of the horizon, as coal retires from the system and gas assets are increasingly at the margin
- In the 2040s, solar could see a increase in DWA prices of ~8%, while wind could see an increase in DWA prices of ~5%

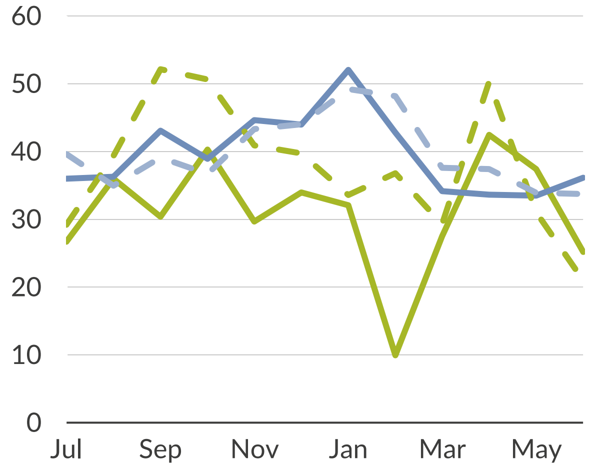
# Low Renewables Output/Weather Year increases the complexity of firming as up to 100 consecutive hours of firming will be required

AURORA

**Illustration of different firming requirements for CWO asset in FY 2030[1]**

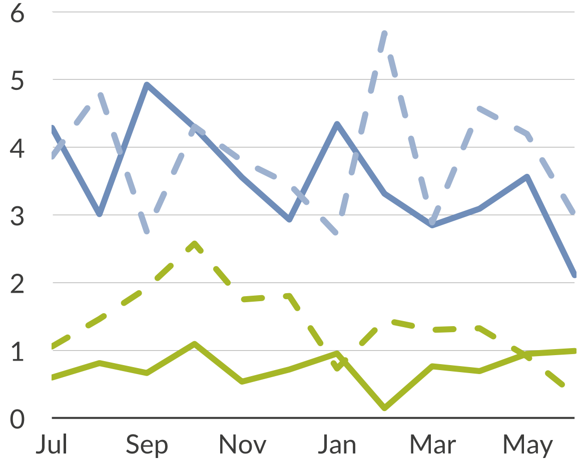
**Maximum power required to firm FSFV contractual short position**

**Maximum power short – 100MW CWO assets**
MW



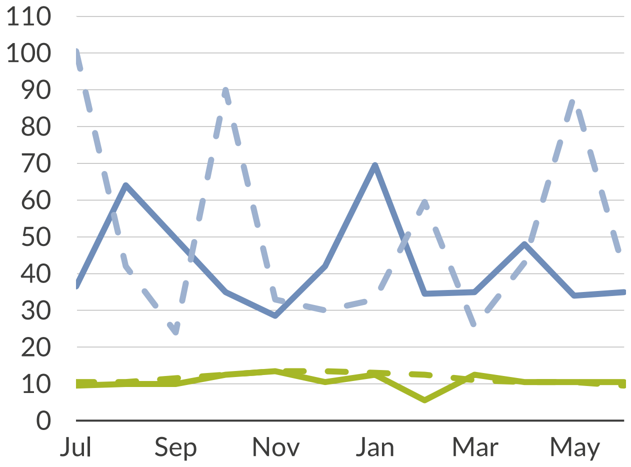
**Total energy required to firm FSFV contractual short position**

**Total energy short – 100MW CWO assets**
GWh



**Maximum duration of energy required to firm FSFV contractual short position**

**Maximum duration short – 100MW CWO assets**
Hours



| | | | | | | |
|---|---|---|---|---|---|---|
| **Equilibrium Scenario** | 52 MW | 42 MW | 4.9 GWh | 1.1 GWh | 70 hours | 14 hours |
| **Non-Equilibrium Scenario** | 50 MW | 52 MW | 5.7 GWh | 2.6 GWh | 100 hours | 14 hours |

▬ Solar - eq. LTESA Scenario
▬ Onshore Wind - eq. LTESA Scenario
╌ Solar – non-eq stress test scenario 3 – "Low renewables output/ weather year"
╌ Onshore Wind – non-eq stress test scenario 3 – "Low renewables output/ weather year"

Source : Aurora Energy Research

**Firming requirements under Low Renewables Output/Weather Year scenario**

- Firming requirements will be significantly higher and more challenging under Low Renewables Output/Weather Year Scenario
- For Solar assets, significantly higher capacities could be required – maximum power short increases from 42 MW to 52 MW
- For Onshore wind assets, the challenge lies in the duration of shortfall, where the maximum duration increases from 70 hours to 100 hours
- This poses a significant risk and cost to developers – risk of under producing its contracted position in an adverse year could result in developers significantly over-sizing their asset
- In practice, assets are unlikely to size to the worst possible renewables output year, although more firming than an average renewable year would still be required

# Agenda

# Comparison of the Fixed Shape Fixed Volume and the Generation Following contract structures

| Contract taxonomy | Fixed Shape Fixed Volume | Generation Following |
|---|---|---|
| Shape | ✓<br>The LTESA Operator and the SFV agree on an intraday and seasonal generation shape to financially settle against. The LTESA Operator can be physically long or short the contracted level of generation across contracted dispatch intervals | ✗<br>There is no intraday or seasonal generation requirement |
| Volume | ✓<br>There is a contractual minimum generation requirement. When the LTESA Operator has been short the contracted generation position within the financial settlement period, they must be able to meet (and exceed) the contractual position in other dispatch intervals to be net-positive the financial settlement position with the SFV | ✓ ✓ ✓<br>There is a contractual minimum generation requirement. The SFV is obligated to pay the LTESA Operator for generation as sent out<br>Volume risk arising from variability in renewable production is managed by the SFV across a portfolio, rather than by the individual LTESA Operators |
| Contract Price | ✓<br>SFV pays a flat Contract Price to the LTESA Operator for the contracted shape | ✓<br>SFV pays a flat Contract Price to the LTESA Operator for a fixed proportion of production |
| Floating Price | ✓<br>LTESA Operator and SFV settle the contract against the Floating Price, which equates to the wholesale market price. Except when the wholesale price is below \$0/MWh, then the Floating Price floor is \$0/MWh and the economic incentive for the LTESA Operator is to curtail | ✓<br>LTESA Operator and SFV settle the contract against the Floating Price, which equates to the wholesale market price. Except when the wholesale price is below \$0/MWh, then the Floating Price floor is \$0/MWh and the economic incentive for the LTESA Operator is to generate down to the negative value of the Contract Price |
| Optionality | ✓<br>The LTESA Operator exercises the contract over a 2-year[1] swap period giving at least 6-months notice before the start of the next Financial Year when the swap is activated | ✓ ✓ ✓<br>The LTESA Operator exercises the contract over a 2-year[1] swap period giving at least 6-months notice before the start of the next Financial Year when the swap is activated<br>Additional value to the LTESA Operator as an insurance product as there is less merchant exposure – potential incentive to exercise more often |

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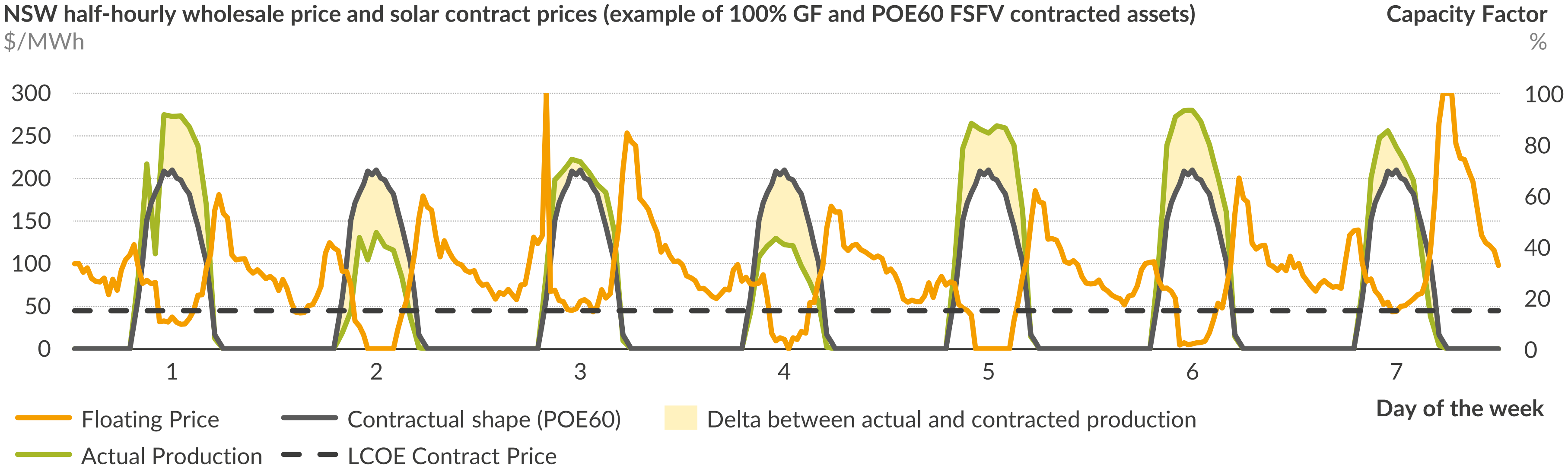
[1] If the LTESA Operator exercises the swap in the last year of the 20-year contract, it is allowed to be a 1-year swap period instead

Source: Aurora Energy Research

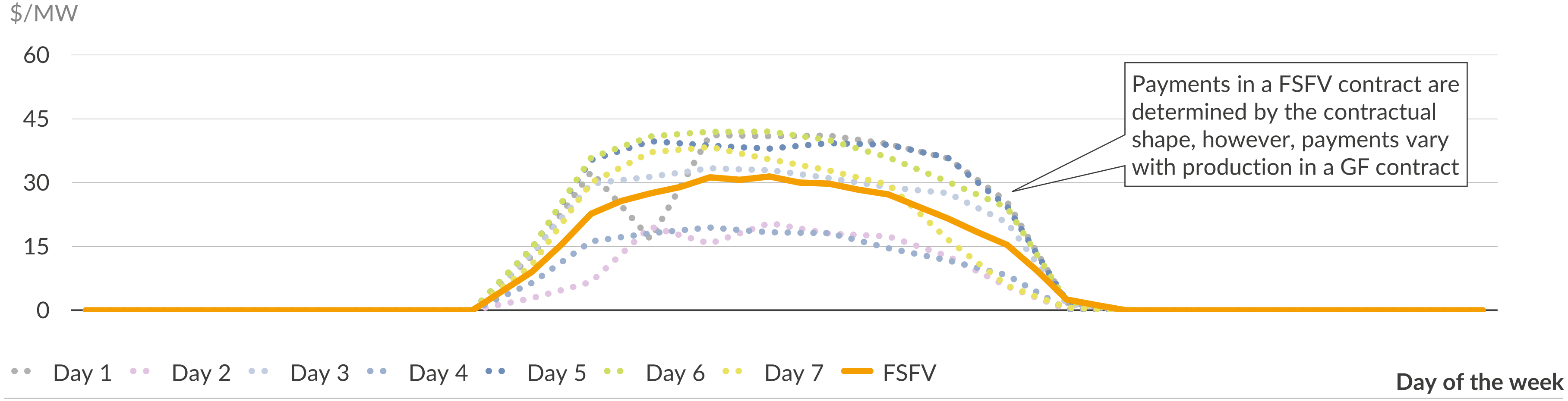
# The payments from the SFV to the LTESA Operators are known under a FSFV contractual arrangement

Comparison of costs for 100% GF-contracted asset vs FSFV (POE60) asset – example week for Solar in CWO

**NSW half-hourly wholesale price and solar contract prices (example of 100% GF and POE60 FSFV contracted assets)**



**Comparison of half-hourly costs for FSFV vs GF contracted asset over the sample week[1,2]**



Payments in a FSFV contract are determined by the contractual shape, however, payments vary with production in a GF contract

Source: Aurora Energy Research

**Payments from the SFC to the LTESA Operator over a sample week:**

- On an intraday basis the value of the payments from the SFV varies under a Generation Following contract
- However, the pre-defined contractual shape under the FSFV contract determine the payments from the SFV to LTESA Projects

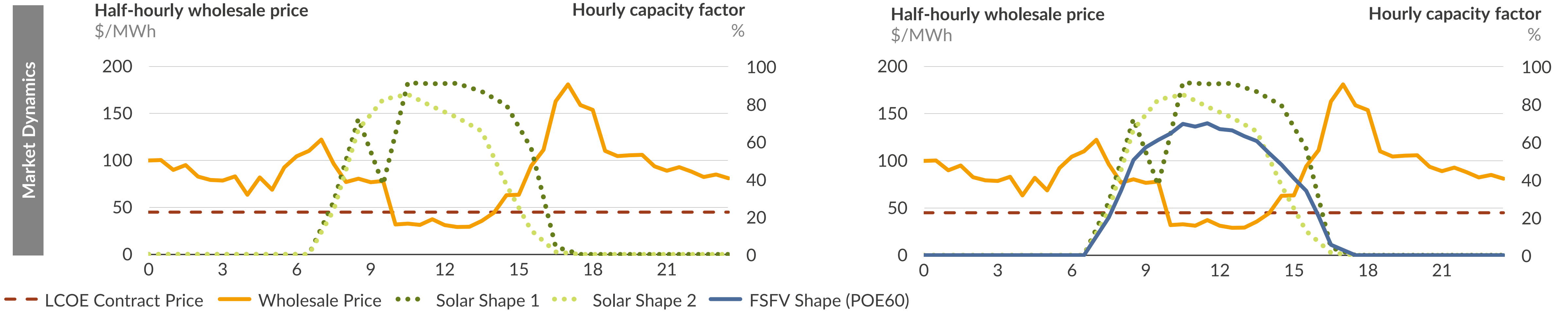
# The payments from the SFV to the LTESA Operators will fluctuate with variability in renewable output under Generation Following contracts…

AURORA

**Generation Following**

**Fixed Shape Fixed Volume**

**Market Dynamics**



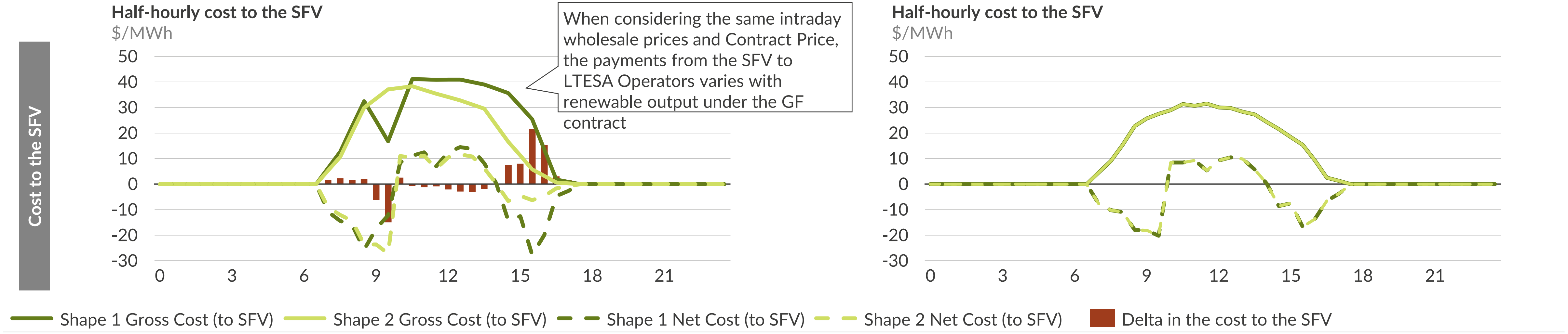
**Half-hourly wholesale price**
$/MWh

**Hourly capacity factor**
%

**Half-hourly wholesale price**
$/MWh

**Hourly capacity factor**
%

**Cost to the SFV**



**Half-hourly cost to the SFV**
$/MWh

**Half-hourly cost to the SFV**
$/MWh

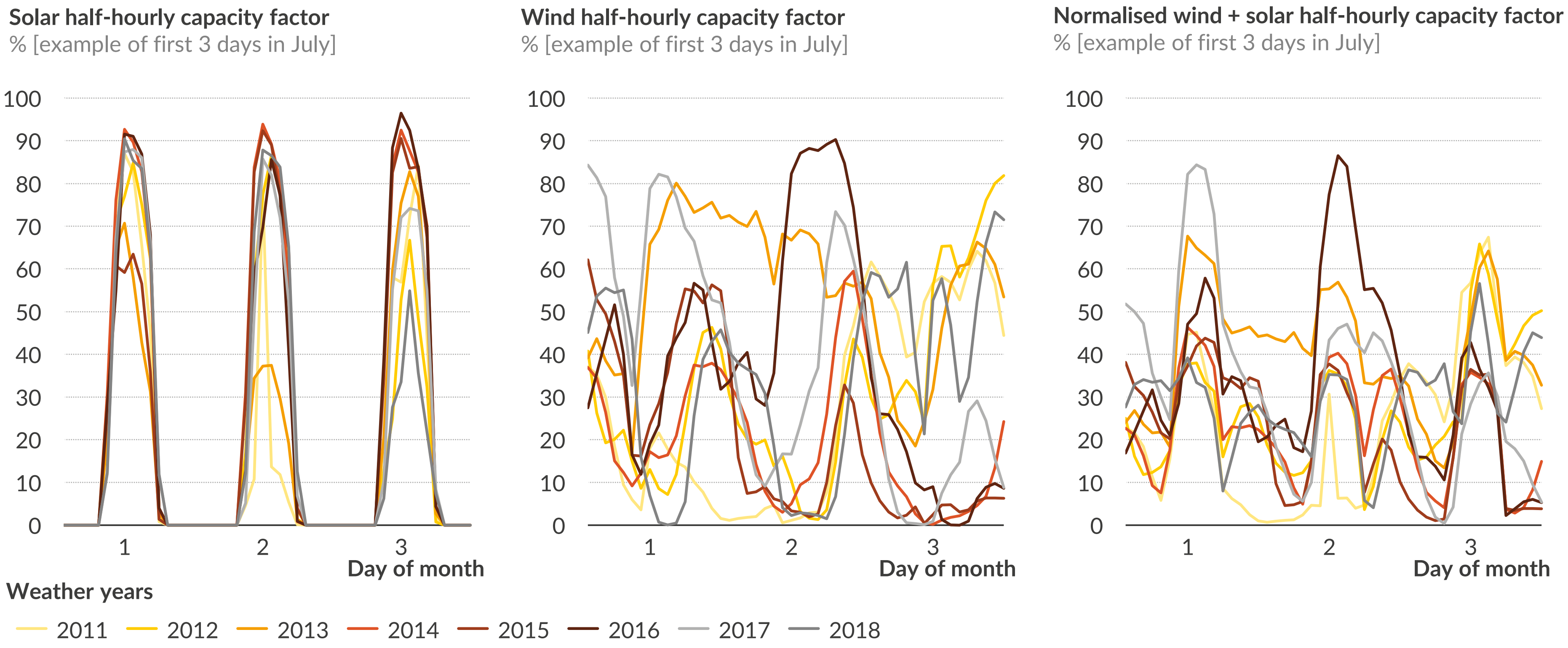
When considering the same intraday wholesale prices and Contract Price, the payments from the SFV to LTESA Operators varies with renewable output under the GF contract

Illustrative Example

AURORA

# … however, the SFV is better suited to minimise output risk from intermittency of renewable production across the portfolio

**Exploration of risk-mitigation benefits from contracting a portfolio – Example of solar and wind in CWO**



**Solar half-hourly capacity factor**
% [example of first 3 days in July]

**Wind half-hourly capacity factor**
% [example of first 3 days in July]

**Normalised wind + solar half-hourly capacity factor**
% [example of first 3 days in July]

**VAR(Solar) = 0.107**

**VAR(Wind) = 0.060**

**VAR(Optimised portfolio[1]) = 0.029**

**VAR(Solar) > VAR(Wind) > VAR(Optimised portfolio)**

**Deriving GF shapes from a portfolio of generation-following contracts**

- The variance in the production of a representative solar and wind asset across 2011-18 in CWO is considered for analysis
- We optimise for a portfolio of wind and solar assets by minimising the variance in the normalised production profile over the sample period considered
- We found that the variance of the optimised portfolio is less than that observed for the standalone solar or wind projects
- This is a simplified, illustrative example based on representative solar and wind assets without any additional consideration of market impact, variability across sites and minimum procurement requirements
  - This example should not be used to inform procurement of different capacities under the EIR

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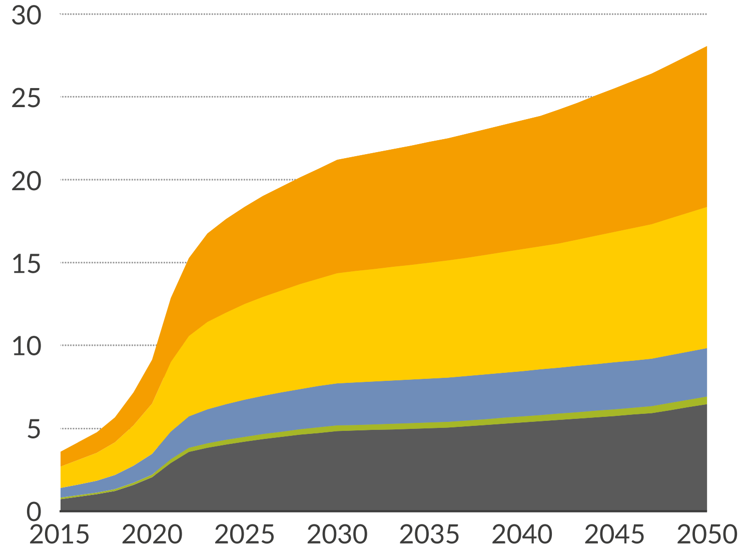
1) "Optimised" in this example only considers variance minimisation, and not the various other considerations that may apply. We roughly calculate an optimised portfolio mix of 0.39 weighted solar and 0.61 weighted wind. As such, the variance of the portfolio is calculated as: VAR(Portfolio) = $0.39^2$x VAR(Solar) + $0.61^2$ x VAR(Wind) + 2 x 0.39 x 0.61 x COV(Solar,Wind) ~ 0.029

Source: Aurora Energy Research

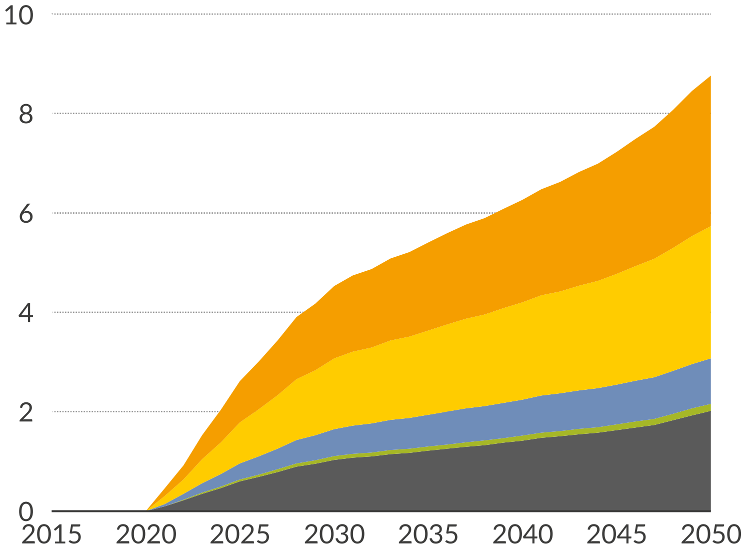
# Strong uptake in rooftop solar, behind-the-meter batteries and electric vehicles is assumed

**Rooftop solar (Aurora Central/LTESA Scenario)**
Nameplate GW



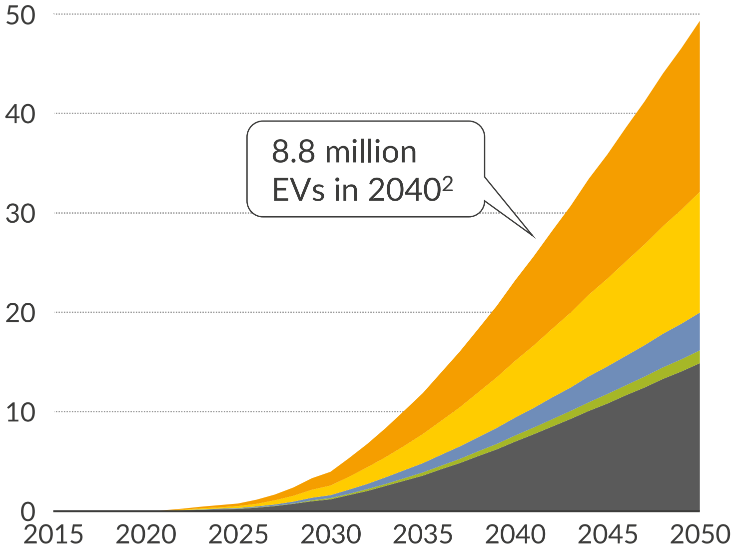
- Aurora's rooftop solar forecast is now lower than AEMO's 2022 ISP, due to the anticipated challenges of recovering network costs as rooftop solar penetration increases
- Aurora assumes network costs are shared from 2022 onwards[1]

**Behind-the-meter batteries (Aurora Central/LTESA Scenario)**
GW



- BTM battery uptake is dampened in the short term due to anticipated rule changes regarding pass-through of network costs to residential and commercial consumers
- Battery cost reductions, coupled with battery rebate programs, drive growth from mid-2020's

**Electric vehicles (Aurora Central/LTESA Scenario)** [3]
Energy required, TWh



8.8 million EVs in 2040[2]

- Aurora is bullish on electric vehicle growth based on cost reductions and uptake rates in Europe, USA and changing Chinese regulation
- Aurora assumes ~35% of EVs are smart charging by 2030, but they do not provide vehicle to grid services

🟧 NSW 🟨 QLD 🟦 SA 🟩 TAS ⬛ VIC

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1) This equates to reduced savings available to prospective residential and commercial rooftop solar installations; 2) This represents 44% of AEMO's expected total car fleet; 3) EV uptake forecasts include passenger vehicles (passenger cars and SUVs) and commercial sectors (Light vans and trucks, buses, rigid vehicles), but excludes articulated trucks. Within this, BEVs and PHEVs are included, and HEVs are excluded as they do not charge from the grid

Source: Aurora Energy Research

# Equilibrium LTESA Scenario modelled assumes the full delivery of QRET, VRET and SRET by 2030, but misses the NSW EIR + TRET target

- A range of policies have been announced by Federal and State governments over the last 18-24 months
- The AEMO Services LTESA scenario models the successful implementation of the QRET, VRET and SRET targets by 2030
- Further, the market scenario models ~90% renewable production as a proportion of underlying demand by 2040 across all states
- The market scenario does not meet the NSW Electricity Infrastructure Roadmap (explored overleaf) or the TRET due to anticipated infrastructure hurdles

## Federal policies

- Current Renewable Energy Target (RET) is 33.6TWh of renewable generation by 2030
- The LRET with accompanying Large-scale Generation Certificate renewable generation subsided are modelled to 2030
- $CO_2$ emissions for the NEM are an output of our modelling but no scheme has been imposed to ensure the Federal emissions target is met

## State renewable generation in 2030,

Percent of underlying demand

---

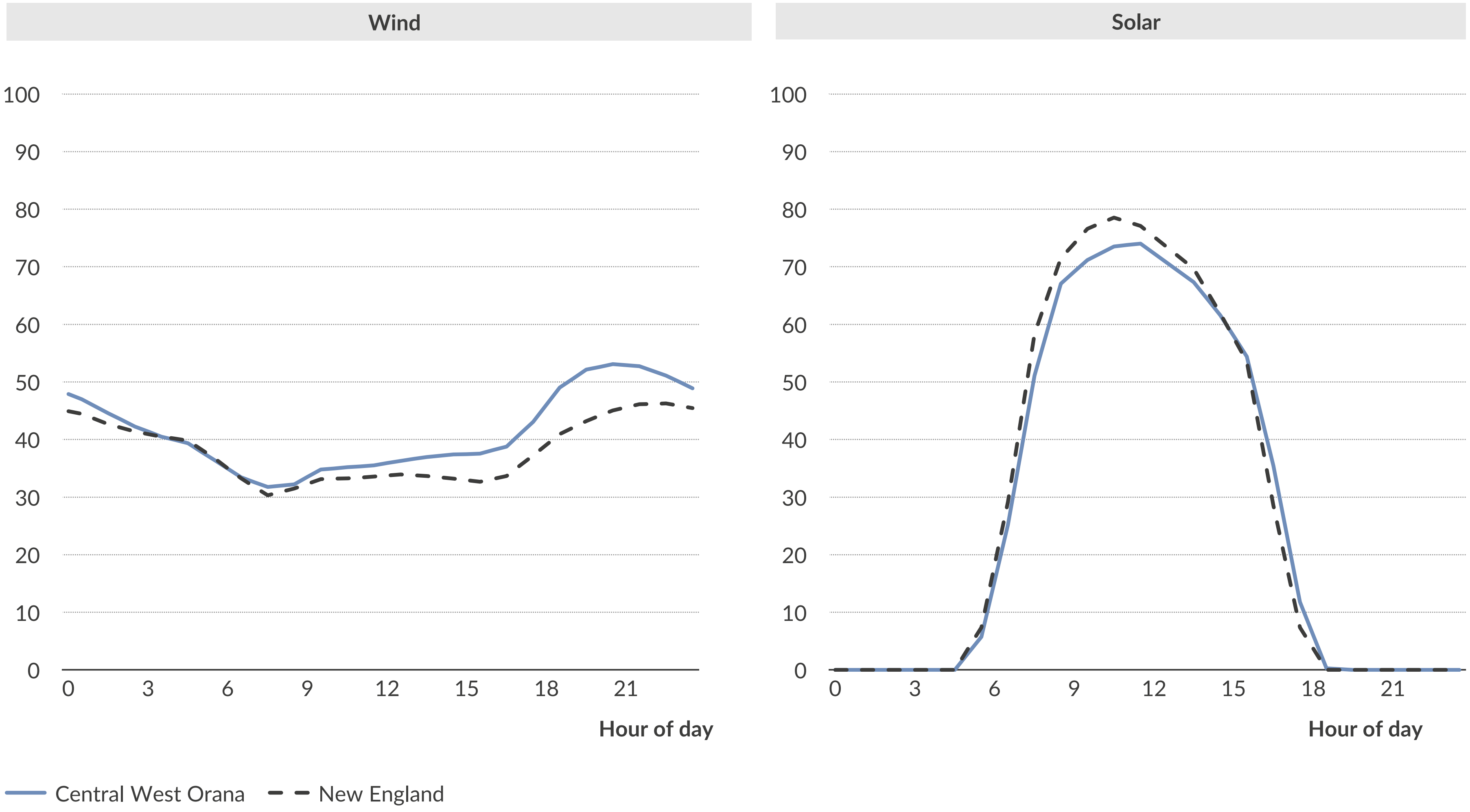
1) The VRET target of 50% of total generation from renewable resources by 2030 is met

Source: Aurora Energy Research

# While modelling CWO and New England REZ renewable assets, the following renewable generation profiles were assumed

**Intra-day wind and solar capacity factor in Central West Orana and New England REZ**

%



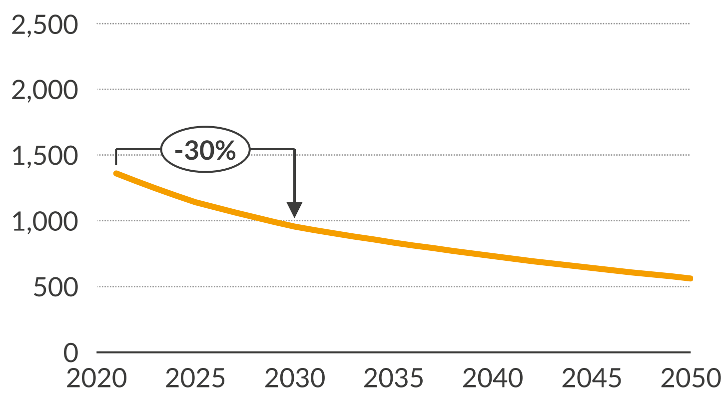
Source: Aurora Energy Research

**Aurora's production profile input assumptions:**

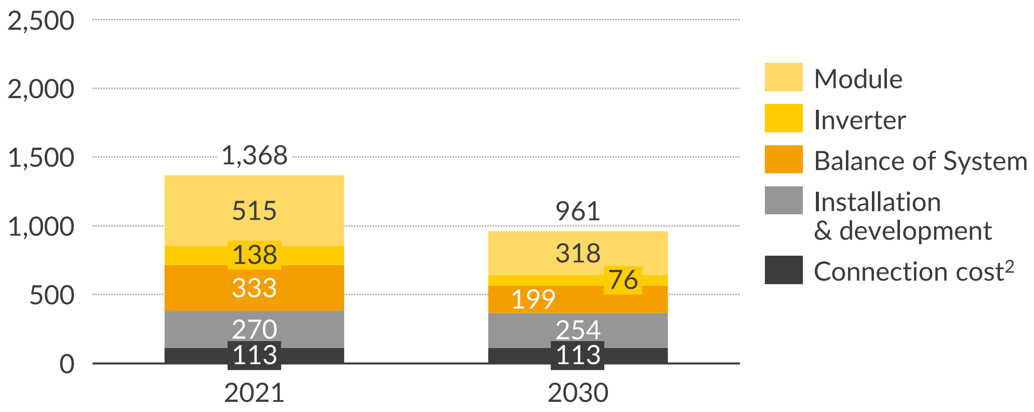
- The charts to the left illustrate representative intraday production profiles for wind and solar in the Central-West Orana and New England REZs
- These production profiles are used for power market modelling in Aurora's capacity expansion and price determination modelling
- Further, these profiles have been used for Aurora's modelling of FSFV and GF contract structures

# Utility scale solar PV is expected to see a decline in CAPEX of ~30% over the next decade while onshore wind sees a decline of 10%

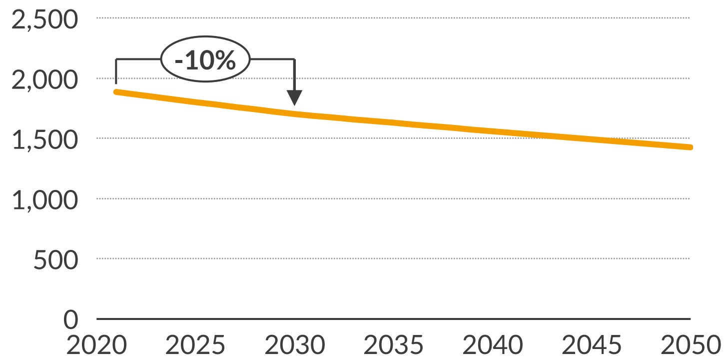
**Solar capex outlook**
A$/kW, real 2021



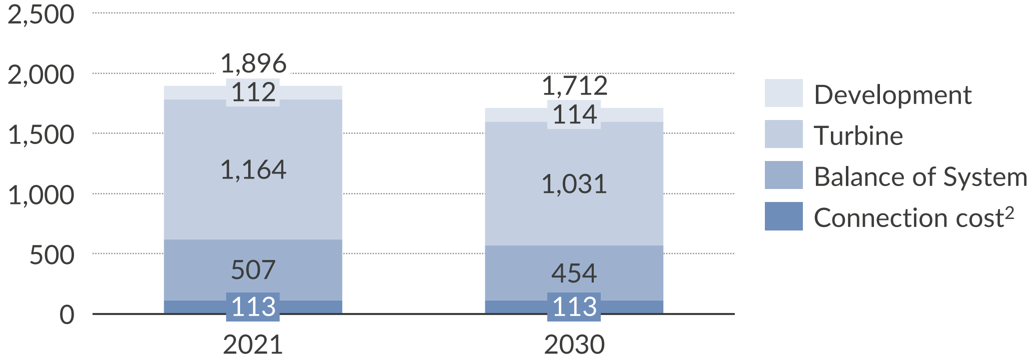
**Solar capex breakdown**
A$/kW, real 2021



**Wind capex comparison**
A$/kW, real 2021



**Wind capex breakdown**
A$/kW, real 2021



Aurora Central/ LTESA Scenario

**Solar and wind capex forecast:**

**Solar**

- Future cost reductions are expected to be achieved through the increase in module efficiency, which is likely to reach 30% by 2050
- This impacts CAPEX and OPEX through:
  - Less land area required
  - Fewer modules to install
  - Less weight to transport

**Wind**

- Cost reductions are achieved from:
  - CAPEX: improved rotor design, standardisation and reduced project contingencies
  - Fixed OPEX: improvements from holistic approach to asset management and improved component manufacturing

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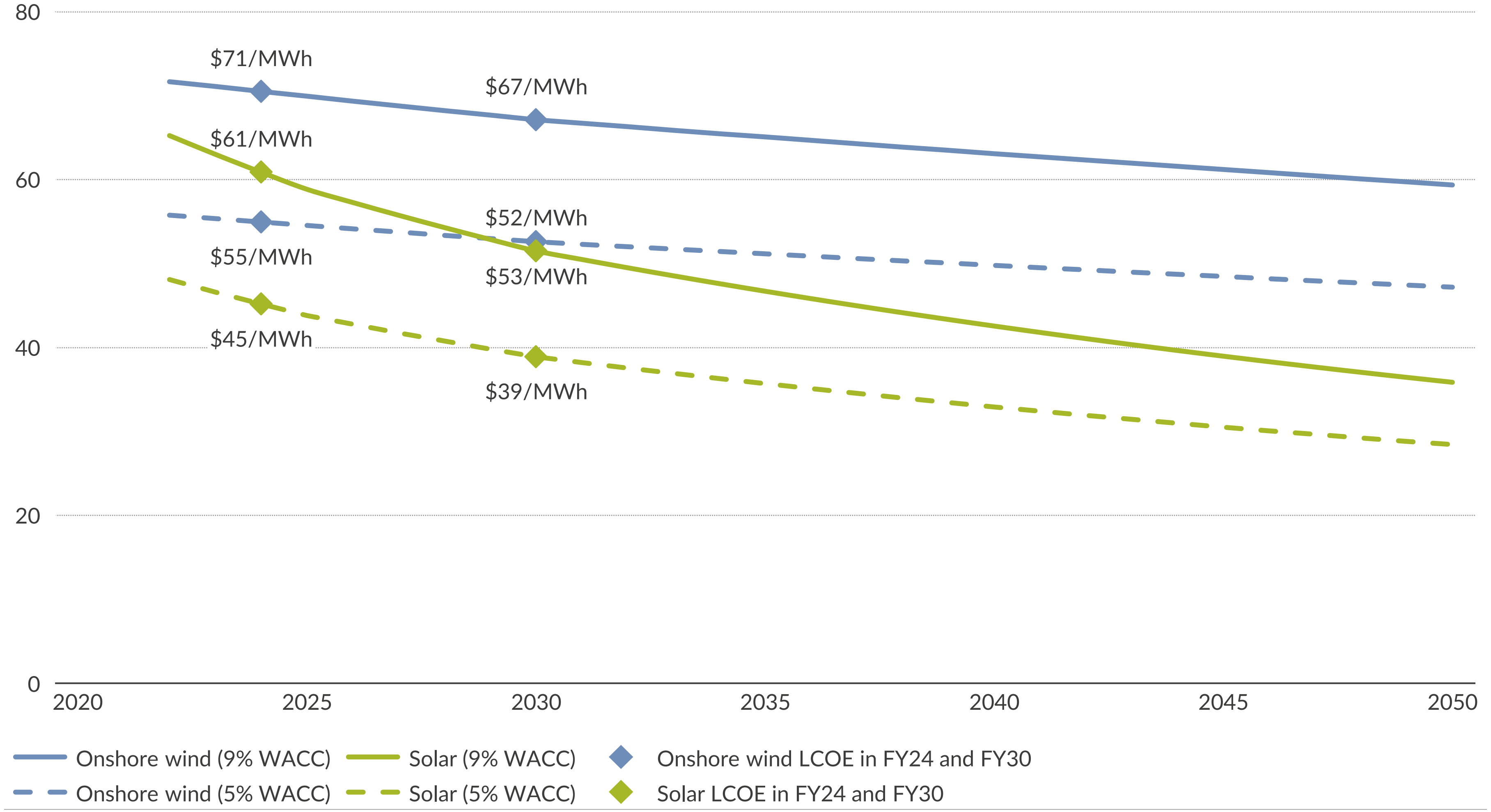
1) Cost to construct new generation, not including connection costs; 2) Highest connection cost based on AEMO 2020 ISP input assumption

Source: Aurora Energy Research

# Aurora forecasts continued cost declines in renewable LCOEs to reach $53 – 67/MWh for onshore wind and $39 – 52/MWh for Solar

**Solar and onshore wind LCOE**[1]

A$/MWh, nominal / real 2021[2]



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1) Based on Aurora cost assumptions including 9% discount rate, and assumes 30% load factor for solar PV and 40% load factor for onshore wind 2) historical project data in nominal values, forecast LCOEs in real 2021 dollars.

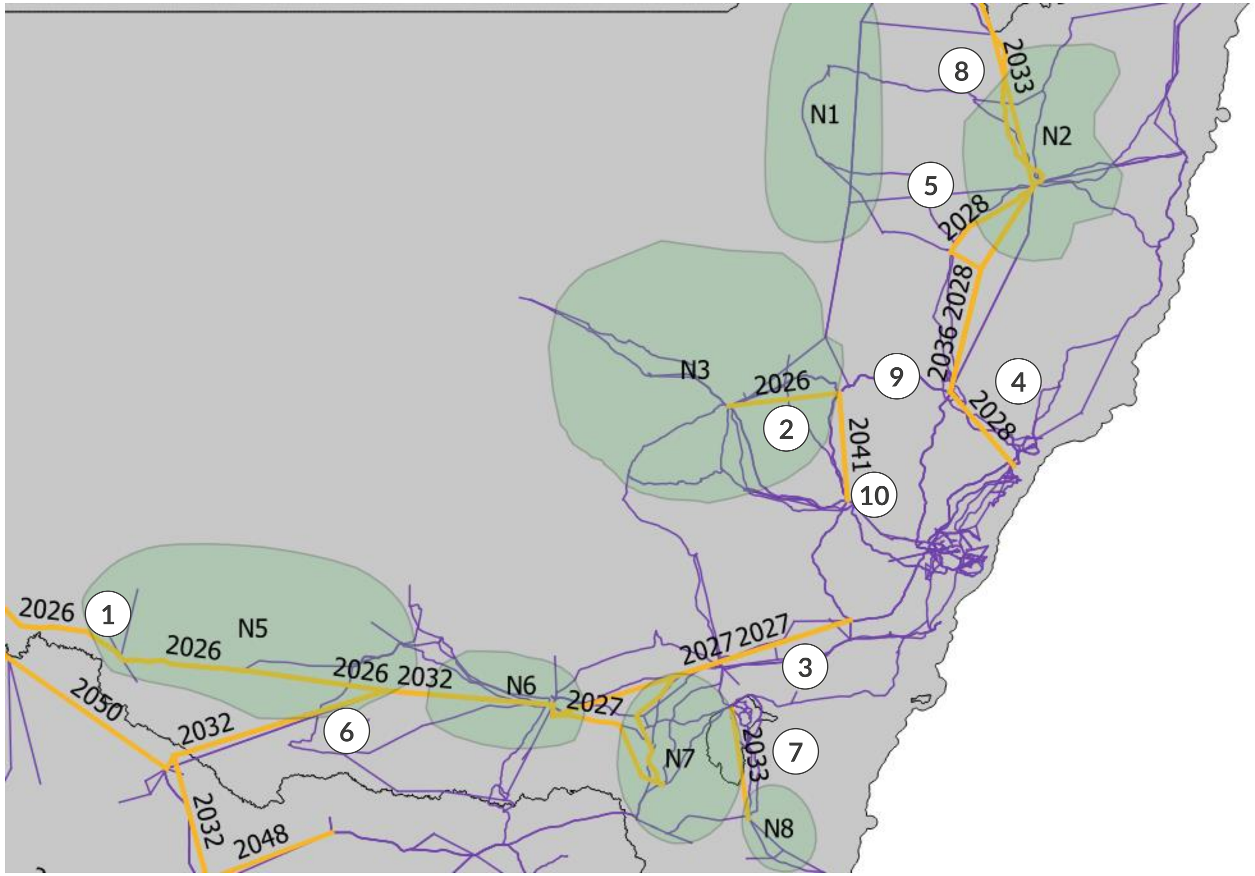
Source: Aurora Energy Research

**Levelised cost of energy for solar and onshore wind technologies:**

- Aurora cost assumptions are based on our internal global database of the various components. This is further informed by the data seen in our transaction work
- Solar continues to generate rapid cost declines, largely based on global learning rates. Grid connection costs increases slightly
- Onshore wind technology costs decline, but at a less rapid rate
- It is worth noting that the long-term DWA price for wind and solar will remain at a premium to their respective long-run LCOEs
- This is driven by a number of factors, such as; curtailment (both grid and economic), MLFs, optimal location saturation etc. which all lead to the “actual” LCOE being higher than what is seen here
- For all merchant renewables which build endogenously within Aurora’s model, a WACC of 9% is assumed

# Grid upgrades and augmentations in NSW align with the 2022 ISP Optimal Development Pathway

**NSW Transmission line upgrades modelled**



| | Project Name | Assumed commissioning date |
|---|---|---|
| 1 | Project EnergyConnect | 2026 |
| 2 | Central-West Orana REZ Transmission Link | 2026 |
| 3 | HumeLink | 2027 |
| 4 | Sydney Ring - Option 1 | 2028 |
| 5 | New England REZ Transmission Link | 2028 |
| 6 | VNI West | 2032 |
| 7 | Cooma – Monaro – Option 2 | 2033 |
| 8 | QNI Connect | 2033 |
| 9 | New England REZ Extension | 2036 |
| 10 | Central-West Orana Extension – Option 1 | 2041 |

Sources: Aurora Energy Research, AEMO

# Aurora's interconnector assumptions align with AEMO 2022 ISP Optimal Development Pathway (except Marinus Link Stage 2)

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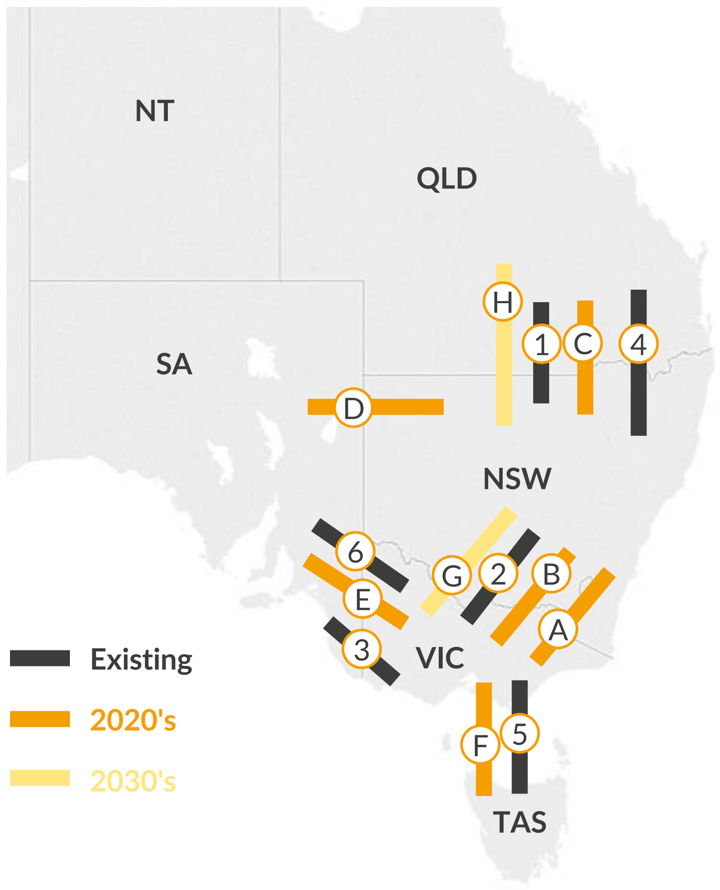
**Interconnector assumptions (Aurora Central/LTESA Scenario)**[1]
MW



| | | Interconnectors | Capacity, MW, Forward/reverse | Scenario |
|---|---|---|---|---|
| Existing | 1 | QLD to NSW | 1078/310[2] | Aurora Central/LTESA Scenario |
| | 2 | VIC to NSW | 1350/1250[3] | Aurora Central/LTESA Scenario |
| | 3 | Heywood | 600/500[4] | Aurora Central/LTESA Scenario |
| | 4 | Terranora | 180/50[5] | Aurora Central/LTESA Scenario |
| | 5 | Basslink | 594/478[6] | Aurora Central/LTESA Scenario |
| | 6 | Murraylink | 220/200[7] | Aurora Central/LTESA Scenario |
| | | **Total Existing** | **4022/2788** | |
| Proposed | A | VNI SIPS | -/250 | Aurora Central/LTESA Scenario |
| | B | VNI Minor | 170/- | Aurora Central/LTESA Scenario |
| | C | QNI Minor | 150/245 | Aurora Central/LTESA Scenario |
| | D | EnergyConnect | 800/800 | Aurora Central/LTESA Scenario |
| | E | EnergyConnect | 100/100 | Aurora Central/LTESA Scenario |
| | F | MarinusLink | 750/750 | Aurora Central/LTESA Scenario |
| | G | VNI West | 1800/1930 | Aurora Central/LTESA Scenario |
| | H | QNI Connect | 910/1080 | Aurora Central/LTESA Scenario |
| | | **Total Proposed** | **4680/5155** | |

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1) Inclusion of each interconnector in the Aurora Central scenario is indicated in the scenario column; 2) The NSW-QLD export capacity is dependent on the status of Kogan Creek and other large Queensland generators; 3) The nominal capacity of this interconnector is highly dependent on the output of Murray generators (NSW to VIC) and Lower/Upper Tumut (VIC to NSW). There is also an additional 250MW of capacity from NSW to VIC due to the capability of the new Neoen SIPS battery, as stated in The Victorian Big Battery: Fact sheet; 4) Forward direction is VIC to SA; 5) Forward direction is QLD to NSW; 6) Forward direction is TAS to VIC; 7) Forward direction is VIC to SA;

Sources: Aurora Energy Research, AEMO 2020 ISP

# Interconnector assumptions follow the 2022 ISP Optimal Development Pathway, except for the exclusion of Marinus Link Stage 2

| Interconnector[1,2] | | States | Capacity (MW) Forward/reverse | Year[4] | Included in Aurora Central/LTESA Scenario |
|---|---|---|---|---|---|
| VNI SIPS[3] | | VIC/NSW | -/250 | 2022 | ✓ |
| VNI Minor | | VIC/NSW | 170/- | 2023 | ✓ |
| QNI Minor | | QLD/NSW | 150/245[5] | 2022 | ✓ |
| Project EnergyConnect | | NSW/SA | 800/800 | 2026 | ✓ |
| | | SA/VIC | 100/100 | 2026 | ✓ |
| VNI West[4] | | NSW/VIC | 1800/1930 | 2032 | ✓ |
| QNI Connect | | QLD/NSW | 910/1080 | 2033 | ✓ |
| Marinus Link | Stage 1 | VIC/TAS | 750/750 | 2029 | ✓ |
| | Stage 2 | VIC/TAS | 750/750 | 2031 | |
| Hume Link | | NSW | 1100 | 2027 | ✓ |

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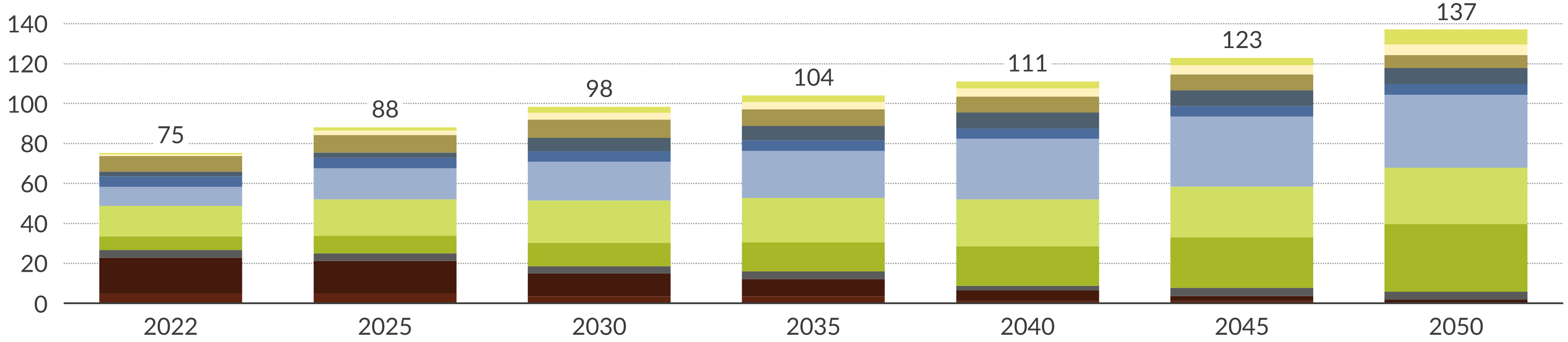
1) Based on AEMO Draft 2022 ISP Report Table 1 and Appendix 5; 2) The data extracted aligns with the 2022 ISP Optimal Development Pathway under the Step Change scenario; 3) Victoria to NSW System Integrity Protection Scheme; 4) Based on timings in Table 1 or under Step Change scenario in Appendix 5; 5) The forward capacity is in a range of 145 MW and 245 MW

Sources: Aurora Energy Research, AEMO 2018 ISP, AEMO 2020 ISP

# The NEM is expected to become increasingly dominated by renewable and flexible technologies

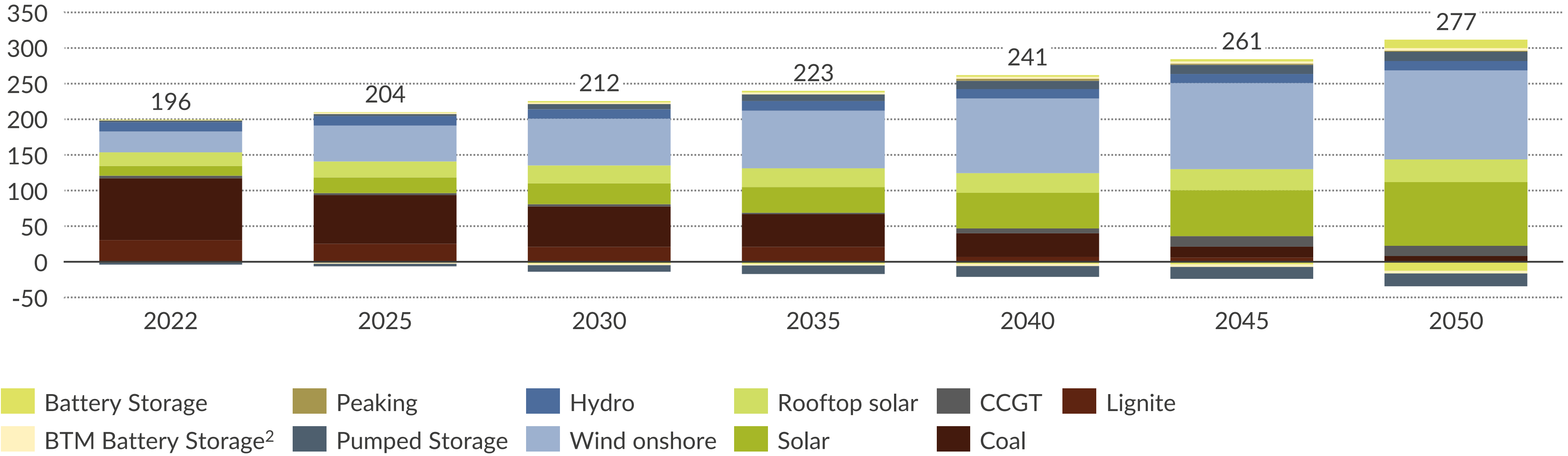
**NEM-wide capacity mix (LTESA Scenario[1])**

Nameplate GW



**NEM-wide generation mix (LTESA Scenario[1])**

TWh



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1) Scenario has been designed following consultation with AEMO Services 2) Behind-the-meter batteries linked to rooftop solar.

Source: Aurora Energy Research

**NEM-wide capacity and generation forecast (LTESA Scenario)**

- State backed renewable projects help drive renewable buildout in the early 2020's, with a doubling of wind and solar capacity between 2020 and 2025.
- Growth in renewables continues again in the 2030's as current connection constraints are solved and prices increase as further coal capacity retires
- Coal capacity retirements accelerate from the late 2020's as costs increase with end-of life issues
- The build-out of grid-scale batteries accelerates in the 2040's as costs continue to fall and revenue is improved as daily spreads progressively widen due to renewable buildout

# Aurora's approach to the LTESA contractual analysis integrates marginal loss factors

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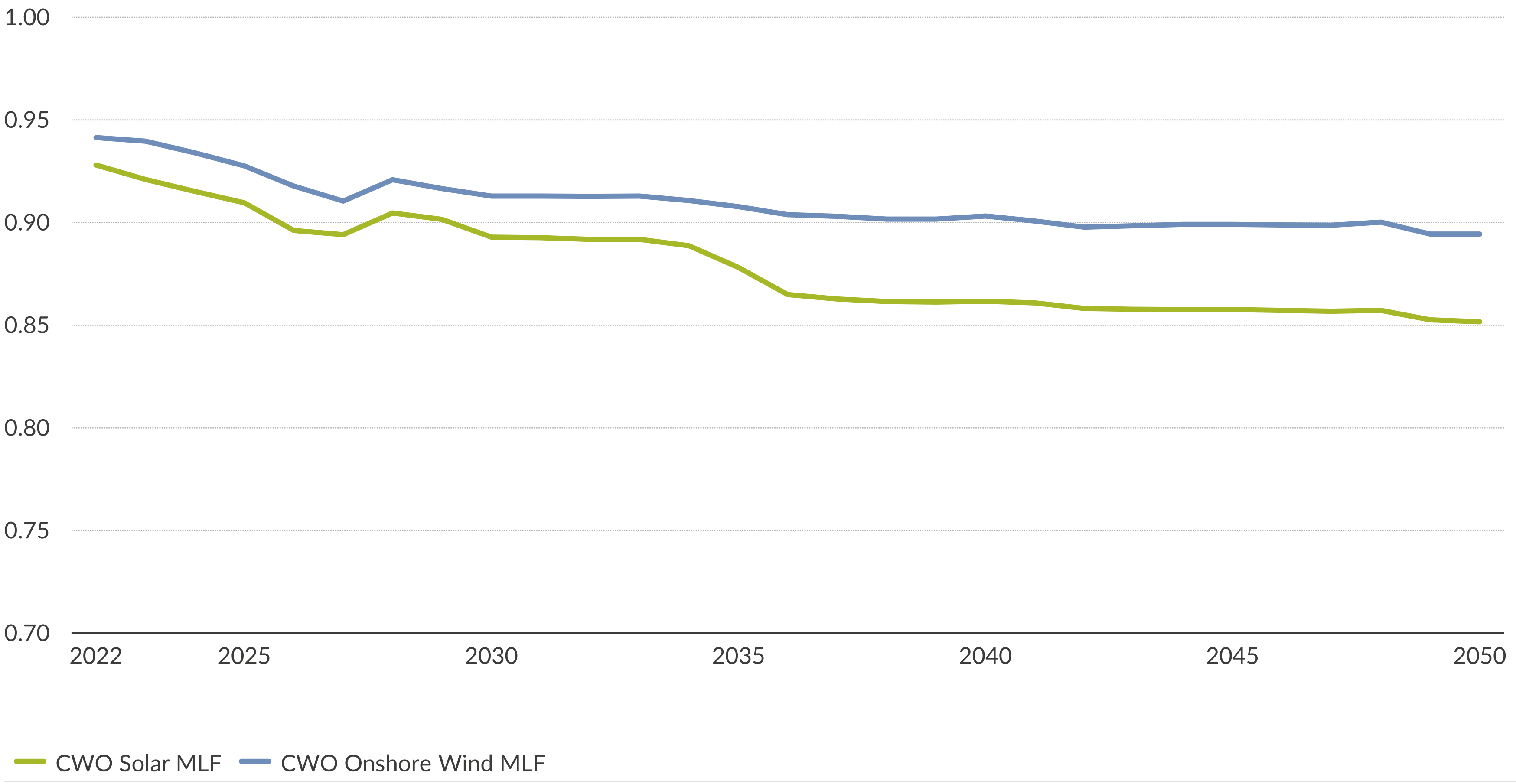
**Representative Marginal Loss Factors for Central-West Orana solar and onshore wind assets**

**Marginal Loss Factors (LTESA Scenario)**
Index



Source: Aurora Energy Research

**Marginal Loss Factors for contractual analysis (LTESA Scenario):**

- Representative MLF estimates were developed for solar and wind assets in the Central-West Orana REZ for contract modelling
- The representative MLF is calculated from the average MLF of existing CWO solar and wind assets
- Asset-level MLF forecasts are derived from Aurora's dynamic power flow modelling
- The MLF estimates are responsive to renewable build out in the region, which is precipitated by the EIR and improved merchant economics with the closure of coal generators

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