HABITAT
ENERGY

The Investment Case for Merchant Storage

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Habitat Energy provides optimisation of grid scale battery storage

Battery asset

- The battery asset is typically lithium ion, 50MW+ of capacity, 1-2 hour duration
- Front of meter, transmission or distribution connected
- Co-located with solar or stand alone

Asset Optimiser

Energy

Revenue

HABITAT ENERGY

Habitat Energy provides three main services

1. **Optimisation:** making minute-by-minute trading decisions about when to buy and sell power
2. **Route to market:** having access to trade in the relevant markets on behalf of our clients
3. **Planning and analysis:** advising on optimal system design, warranty, trading strategies, bidding for ancillary service contracts etc

Energy markets

In the UK:

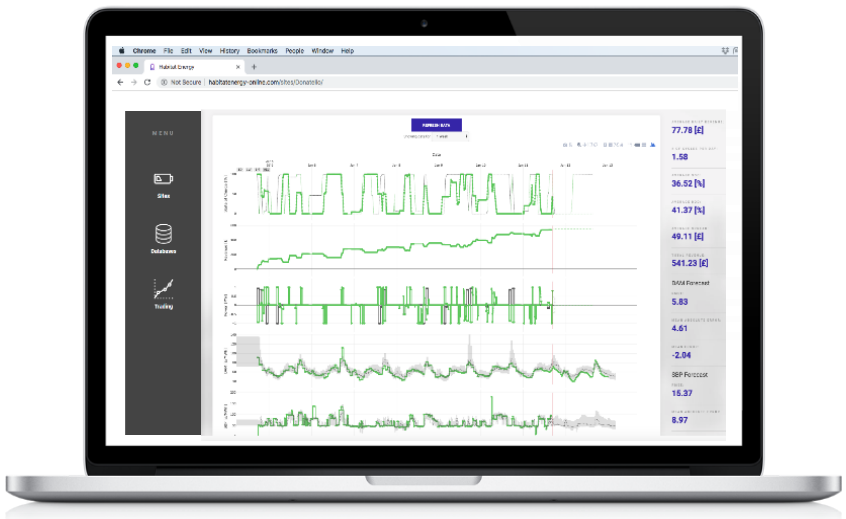
- **Wholesale markets** (day ahead, intraday)
- **Balancing Mechanism / Imbalance**
- **Frequency response** and other ancillary services

In Australia:

- **Spot market**
- **FCAS**

Our trading platform “PowerIQ” is live

PowerIQ by HABITAT ENERGY

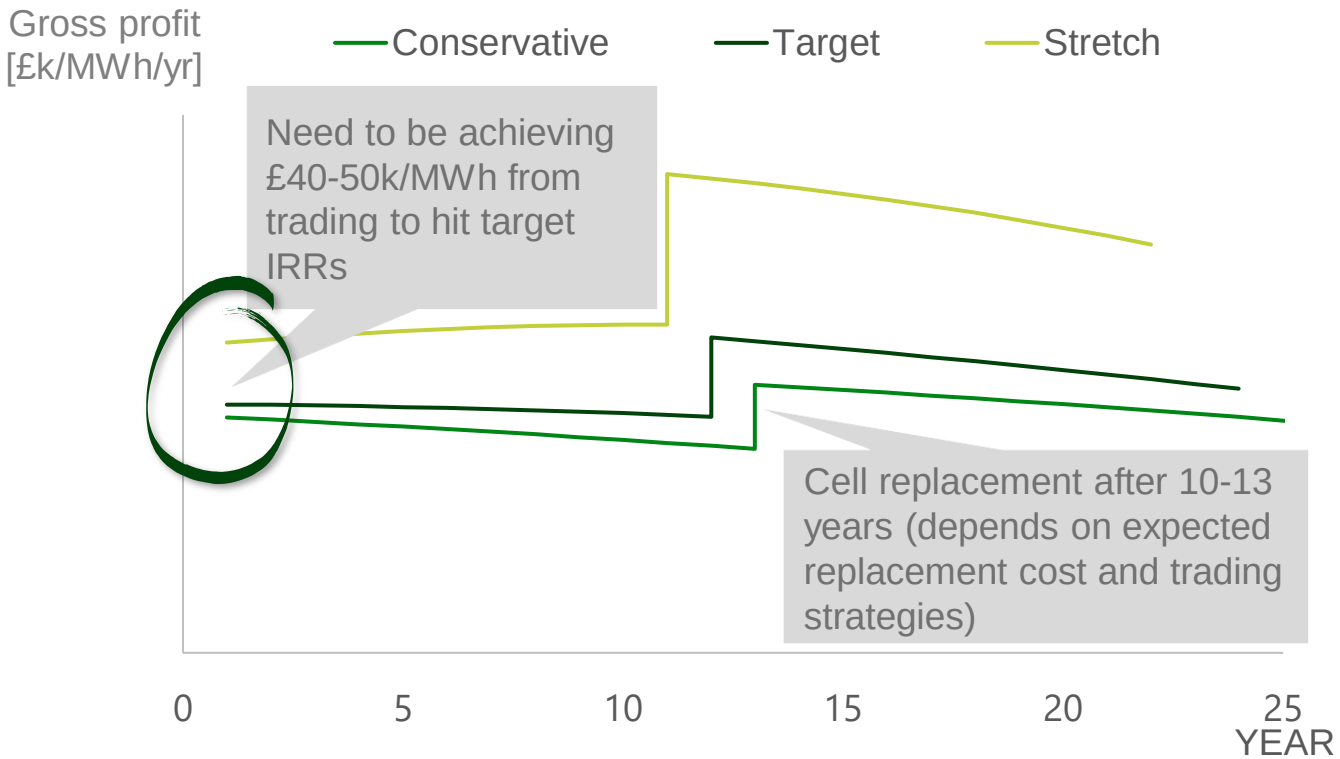


- Fully algorithmic dispatch optimisation with 24/7 human oversight
- Incorporates stochastic forecasting with machine learning, dynamic degradation management, cloud hosted
- Rapidly growing UK portfolio including
  - Gresham House (100MWh, live)
  - Arlington Energy (50MWh, onboarding)
  - Pivot Power/EDF (57MWh, due Sept 2020)
- Also now active in Australia

The investment case for merchant storage

1. **Merchant battery storage: an investment opportunity come of age**
2. **Making the investment case work**
    a. Design considerations: duration, warranties, oversizing
    b. Financial modelling: lifetime, revenue saturation, finance
3. **Co-location with solar**

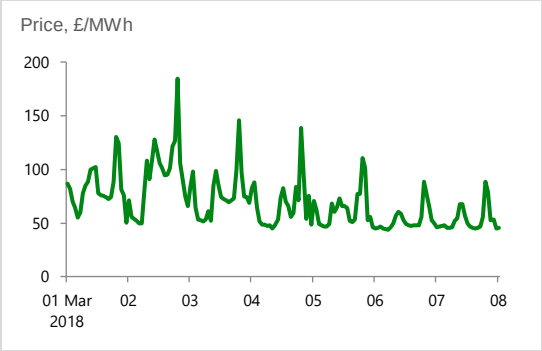
Merchant storage needs to offer 10-12% IRR (unlevered) to be investable



- In the UK, these revenues are available today and being delivered consistently on operational assets
- In Australia, significantly more revenue potential on offer but also more risk
- Investment case helped by continued improvements in capex, scale, finance, warranty performance, co-location potential

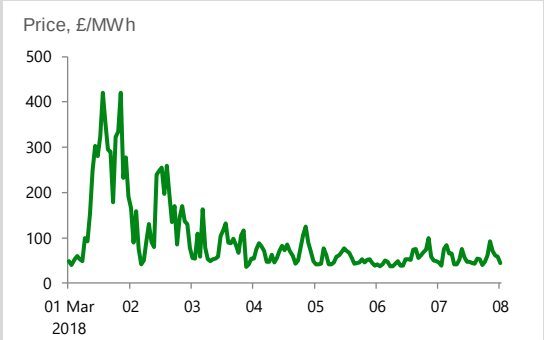
The balancing mechanism is key to UK merchant storage

Day-Ahead (N2EX)



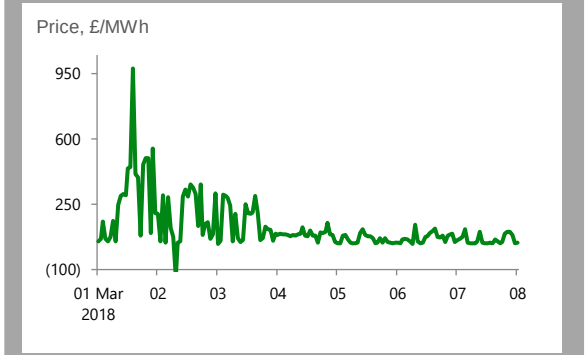
- Daily auctions for hourly and half hourly blocks
- Deep, liquid
- Not very volatile but easy to forecast

Intra-day Market (APX)



- Bilateral, continuous market, opportunity to unwind/re-optimize
- Traded up to 1 hour after gate closure
- Patchy liquidity (but improving)

Balancing Mechanism / Imbalance



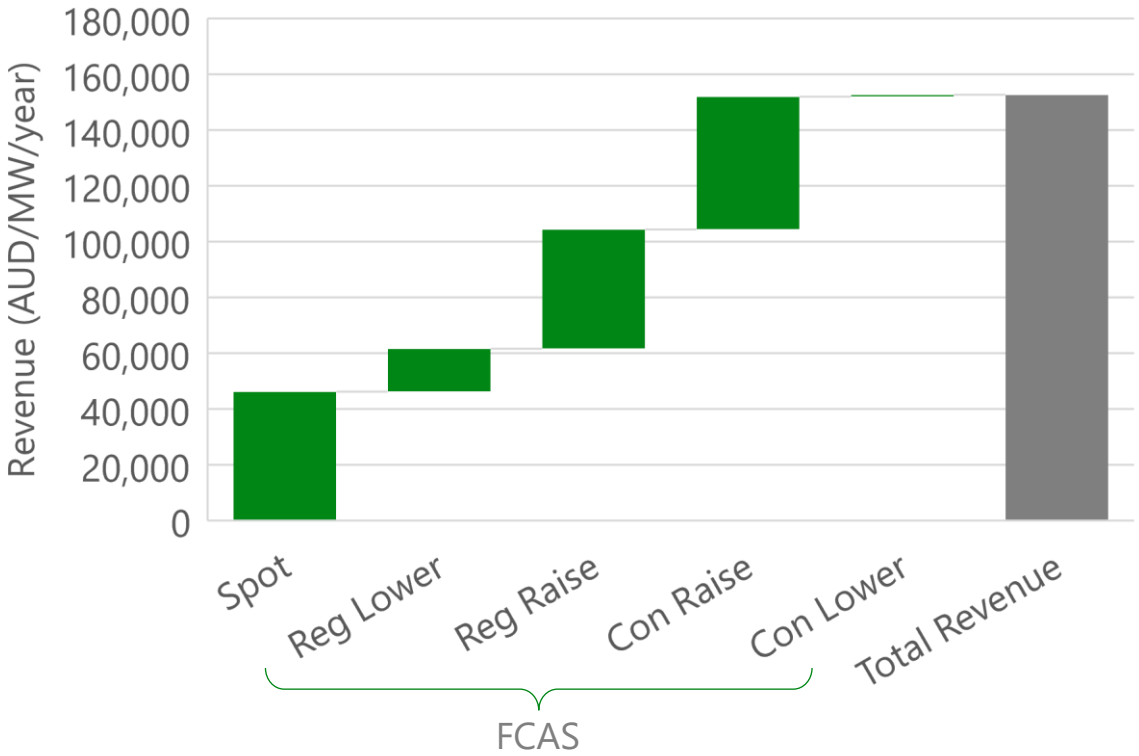
- Highest volatility and value, but also the most complexity
- Access via bid-offer pairs (pay as bid) or 'NIV chasing' (pay as cleared)

Ancillary service contracts

- FFR, reactive power and other emerging products being developed by National Grid can provide additional upside
- We believe these should be taken opportunistically and not factored into the new build investment decision given saturation risk

In Australia, substantial revenue of offer from spot and FCAS

Illustrative example (New South Wales)



- No short-dated forward markets in Australia. But spot market attractive due to 5 min settlement and in future, 5 minute pricing
- Substantial additional revenue from ancillary services (FCAS), often paying for availability with no utilization, but local markets thin and prone to saturation
- Difficult regulatory environment but renewables and storage will get built at scale without subsidy

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Frequently asked questions – design considerations

1. What battery duration should I choose?	*We recommend 1.5-2 hour systems (but 1 hour systems will still give sufficient IRR)*
2. Will manufacturer warranties cover the aggressive cycling required for arbitrage?	*Yes, but typically not without careful negotiation. Watch out for hidden constraints.*
3. Should I oversize cells to avoid capacity fade?	*No – calendar aging and time-value of money work against this*
4. Should I "top up" my cells regularly to reverse capacity fade?	*No – we typically don't see this as economic (and is a nightmare for degradation management)*

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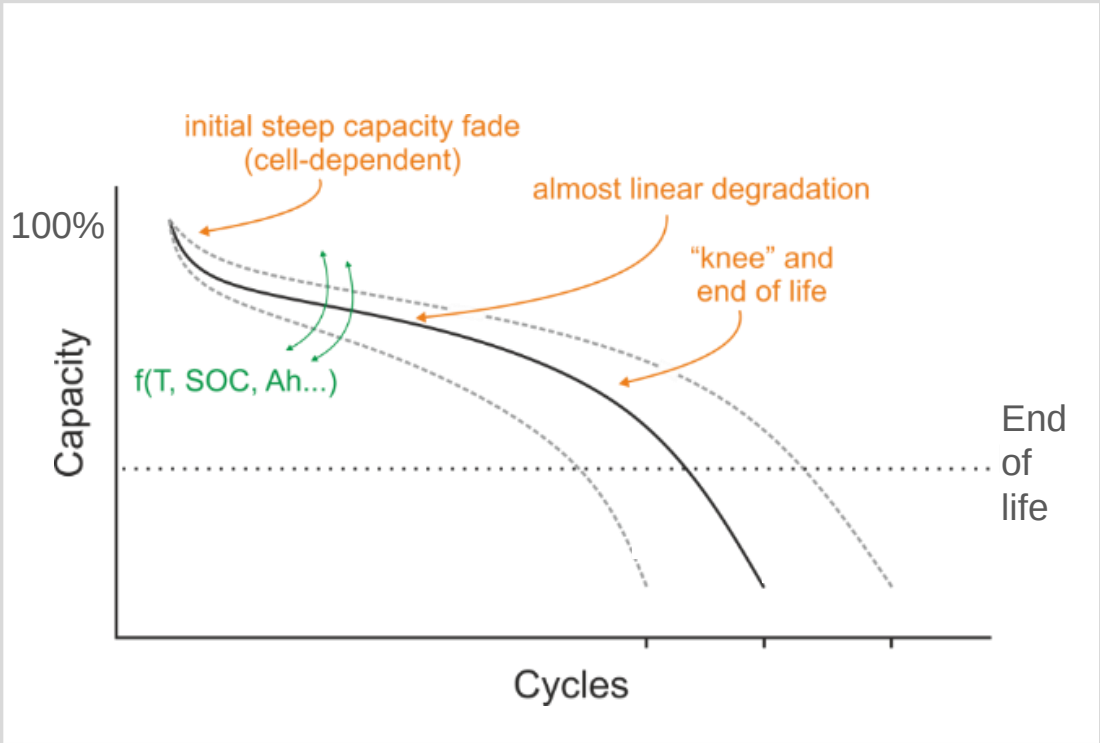
Frequently asked questions – financial modelling

1. How long will cells last?	*Warranties should offer 7-10 years, but further life beyond warranty is likely if degradation is actively managed*
2. Will merchant revenues saturate over time?	*We expect it will take many GWs of storage to materially impact revenue. Renewables growth counteracts this.*
3. Can I get debt into merchant projects?	*Yes – up to 45% asset finance is possible even without a revenue floor*

Degradation can be slowed with active management



- Capacity fade driven by calendar aging ("use it or lose it") and cyclic aging
- OEM will typically design warranty to end at 70% or 60% of nameplate capacity, but additional life is likely
- Steepness of capacity fade is heavily affected by operational behaviour, with end of life anywhere between 5,000 and 10,000 cycles
- Cost of degradation per full equivalent cycle is £15-20/MWh *on average*, but could be half or triple this *for a given cycle* depending on temperature, SOC, DOD etc

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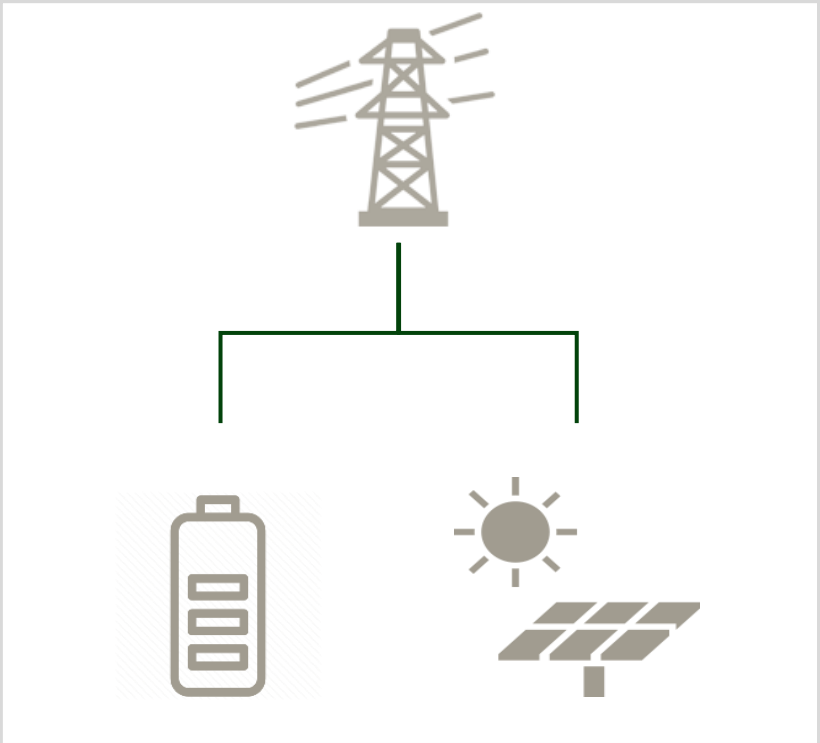
Co-located solar + storage can improve IRRs but adds complexity

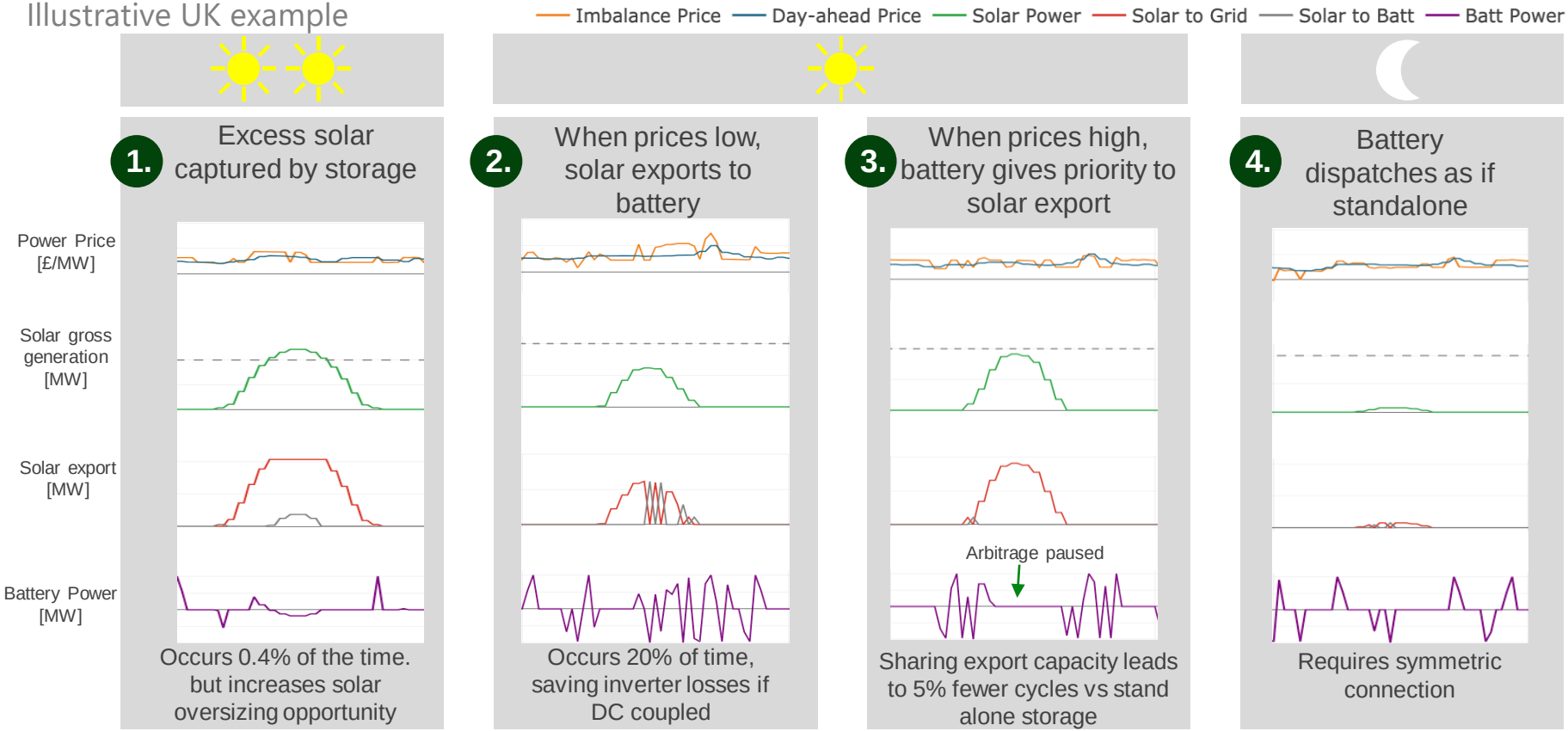


Key questions

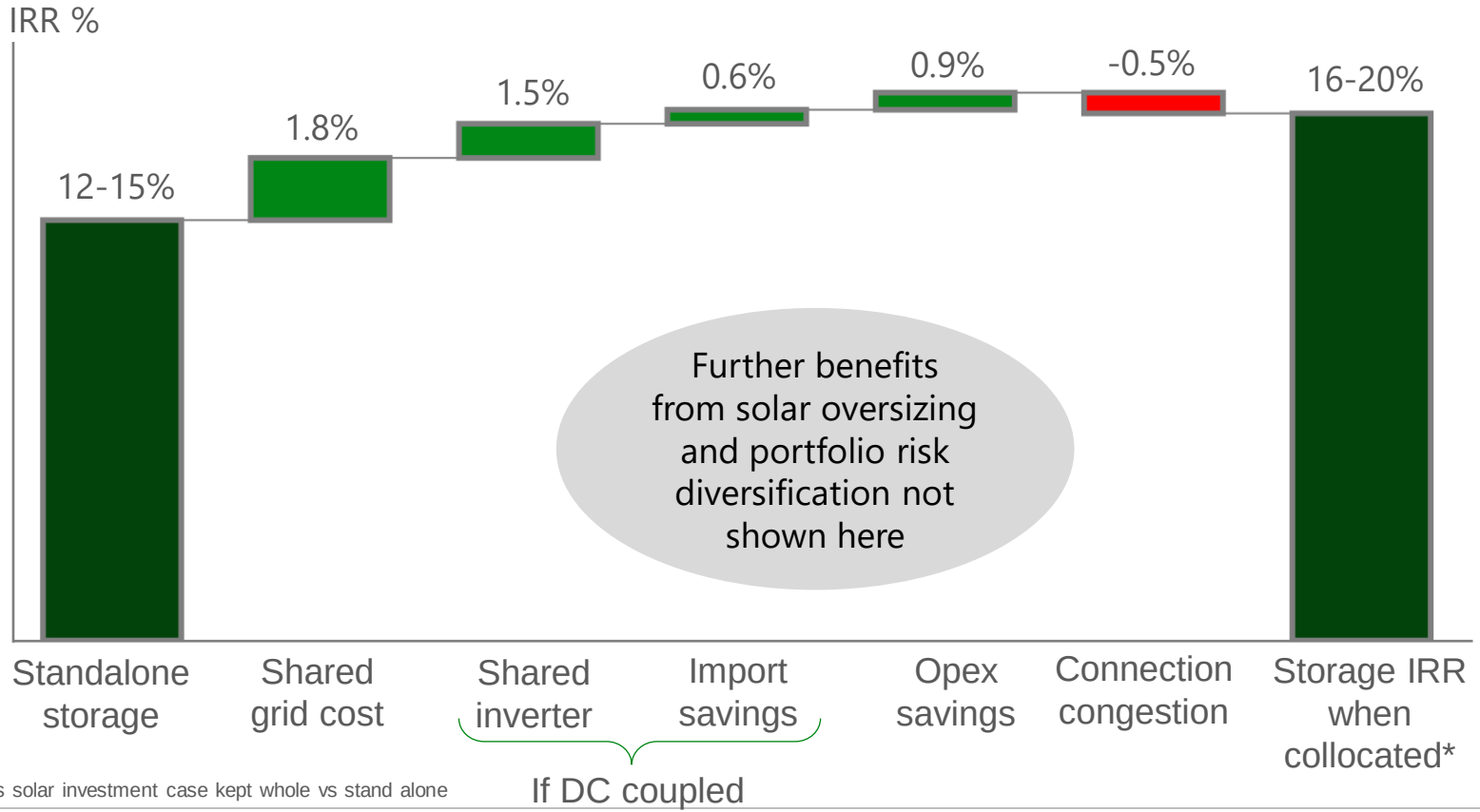
- **How should the battery be optimised around the solar?**
- **Design considerations:** How much solar and storage should be installed per unit of grid capacity? AC or DC coupled? Symmetric connection?
- **What is the investment case?**

Solar and storage can work together in various “modes”

Illustrative UK example



We estimate co-location can add up to 4-5% to the IRR of UK storage



* Assumes solar investment case kept whole vs stand alone

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