UK power

Capacity mix transition driving flexible asset value

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Contents

UK market transition & flex asset value
5 key takeaways

Takeaway	Description
1. Capacity mix transition	Structural transition in UK supply stack continues apace. Renewables (low SRMC) and engines/batteries (high SRMC) are replacing coal & CCGTs (mid-range SRMC).
2. Price shape & volatility	Stack changes increase price shape & volatility, pushing asset value into prompt. Changing load patterns & long duration batteries should dampen impact over time.
3. Flex investment battle	Engines, CCGTs, batteries & DSR competing at margin to provide capacity. There is no clear winner. Cost of capital, value management & market access are key.
4. Value management	Flex asset value is being realised in prompt horizon & BM. This means higher risk and more complex hedging & optimisation. Value extraction requires scale & sophistication.
5. Market access	Key asset owner decision: 'in-house' or 'out-source' market access. Outsourcing can provide scale & sophistication. But contract structure must be water-tight.

Competitive T-4 auction

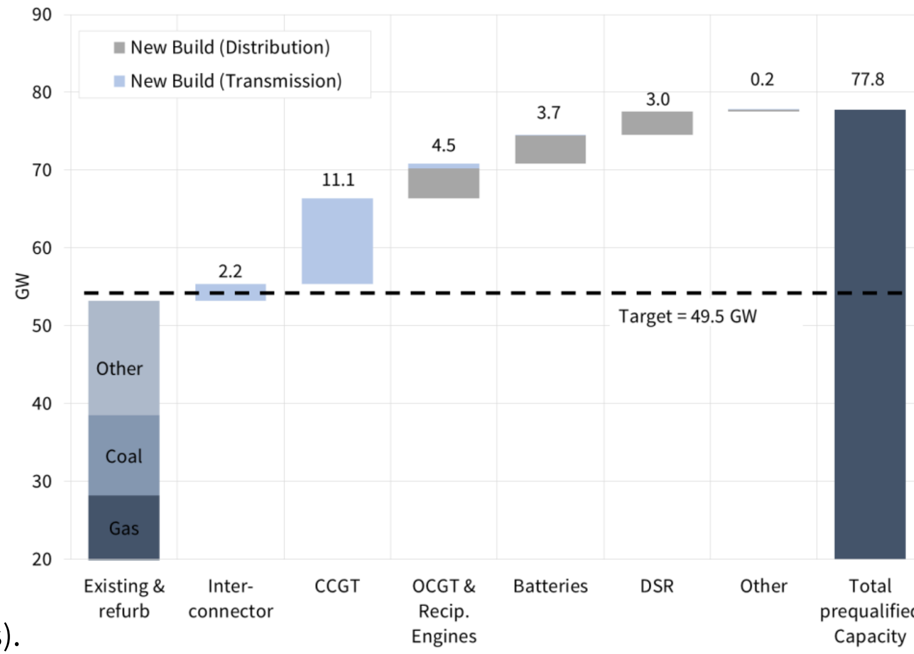
Auction balance

- 49.5 GW demand target vs 78 GW of prequalified supply.
- Falling cost of capital is driving down bids.
- Clearing price may surprise to downside (e.g. 20-25 £/kW).

Key drivers of auction outcome

1. *Exit prices of 36% coal & 1990's CCGTs*
2. *Volume of new gas engines & DSR < 25 £/kW*
3. *Competitiveness of new CCGT bids*
4. *Derating factor impact on battery bids*

- A combination of engines, CCGTs, DSR & batteries likely to deliver new capacity. No standout winner.
- Some engine & battery developers look to be under-pricing wholesale/BM & FFR revenue risks (reducing bids).
- New CCGTs benefiting from higher efficiency (56% HHV) & lower cost of capital. May bid under 25 £/kW.



2021/22 T-4 auction balance

Source: Timera Energy, EMR Delivery Body

Based on Prequalified & Conditionally Prequalified data released in Dec 17, demand target and rejected capacity (due to Credit) updates .

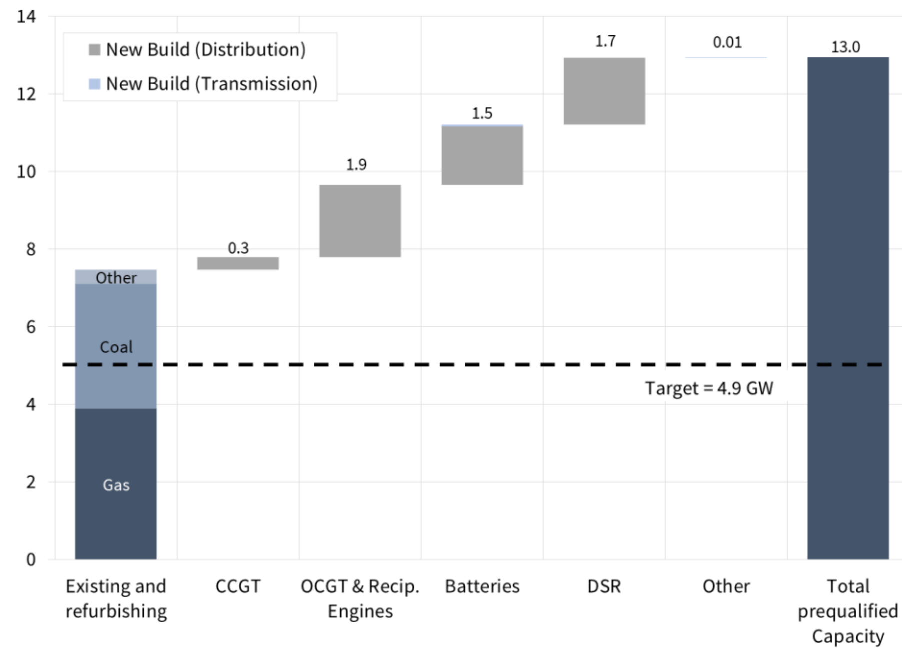
Even more competitive T-1 auction

Auction balance

- 4.9 GW demand target vs 13 GW of Prequalified supply.
- Again risk of downside surprise for clearing price (e.g. 0-5 £/kW).

Key drivers of auction outcome

- Auction fought out at the margin between thermal units that missed out in 18/19 T-4 auction.
    1. Older CCGTs (e.g. Peterborough & Corby)
    2. 36% efficient coal units (e.g. Fiddler's Ferry, West Burton).
- Other key factor is volume of 'early delivery' gas engines, DSR & batteries. These may bid zero given they are chasing other 18/19 revenue streams (e.g. triads, WS/BM volatility, FFR).
- But derating factors and supply stack dynamics mean an oversupplied capacity market does not necessarily imply an oversupplied energy market.



2018/19 T-1 auction balance

Source: Timera Energy, EMR Delivery Body

Based on Prequalified & Conditionally Prequalified data released in Dec 17, demand target and rejected capacity (due to Credit) updates .

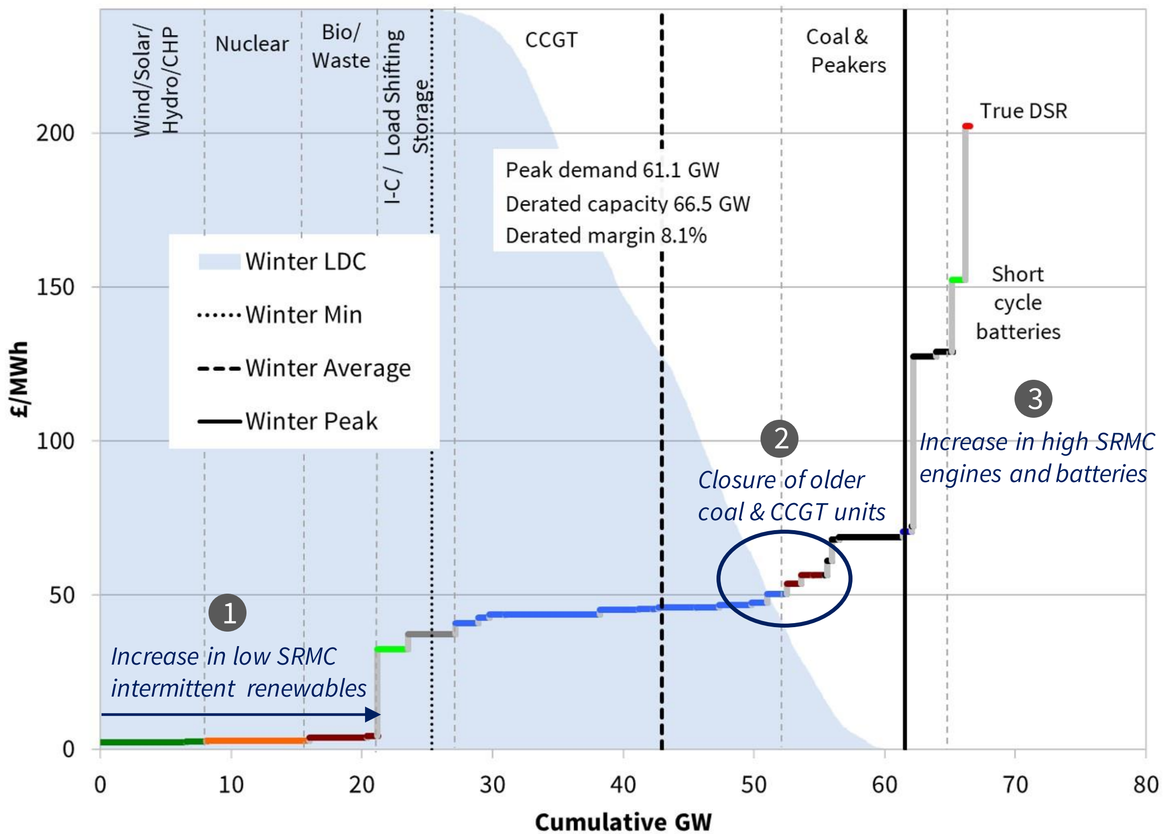
Supply stack evolution: next 5 years

3 key evolving stack drivers

1 Renewables with low SRMC pushing into bottom left of the stack. Offshore wind key. Driving up system intermittency.

2 Thermal closures removing flex capacity from mid/right stack. Closure of 11GW of coal key. As is closure of older CCGTs, or conversion to run as GTs.

3 Gas engines & batteries have dominated new flex capacity to date. Units have high SRMC (70-90 £/MWh) i.e. pushed into the top right hand of stack. This is acting to drag up the top 10-15% of prices.



Simplified de-rated Jan 2022 supply stack

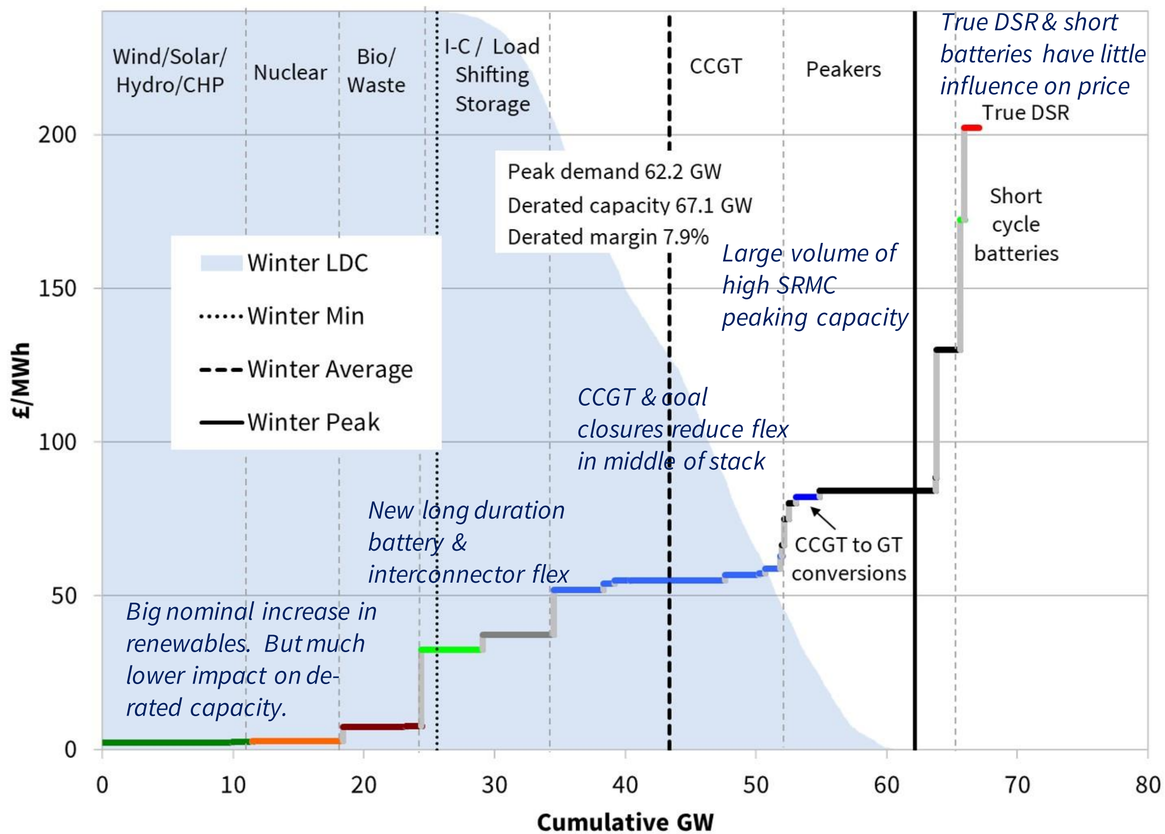
Source: Timera Energy

Supply stack evolution: next decade

Likely changes across 2020s

- 13-18GW new wind (nominal).
- 11GW of coal closures. 8-14 GW of CCGT closures.
- 5-10 GW of new gas engines.
- 3-6 new CCGT plants.
- 4-6 GW new interconnectors.
- Existing nuke life extension likely to bridge to nuke new build.
- Transition from short duration to long duration batteries (2-4GW).
- Practical limits on ‘True’ price responsive DSR (1-3GW).
- Other DSR will dampen load shape.
- EV’s will increase annual demand.

Capacity ranges provided are indicative and demand on market evolution scenario.



Simplified de-rated Jan 2031 supply stack

Source: Timera Energy

Price behavior is changing - pushing value into prompt

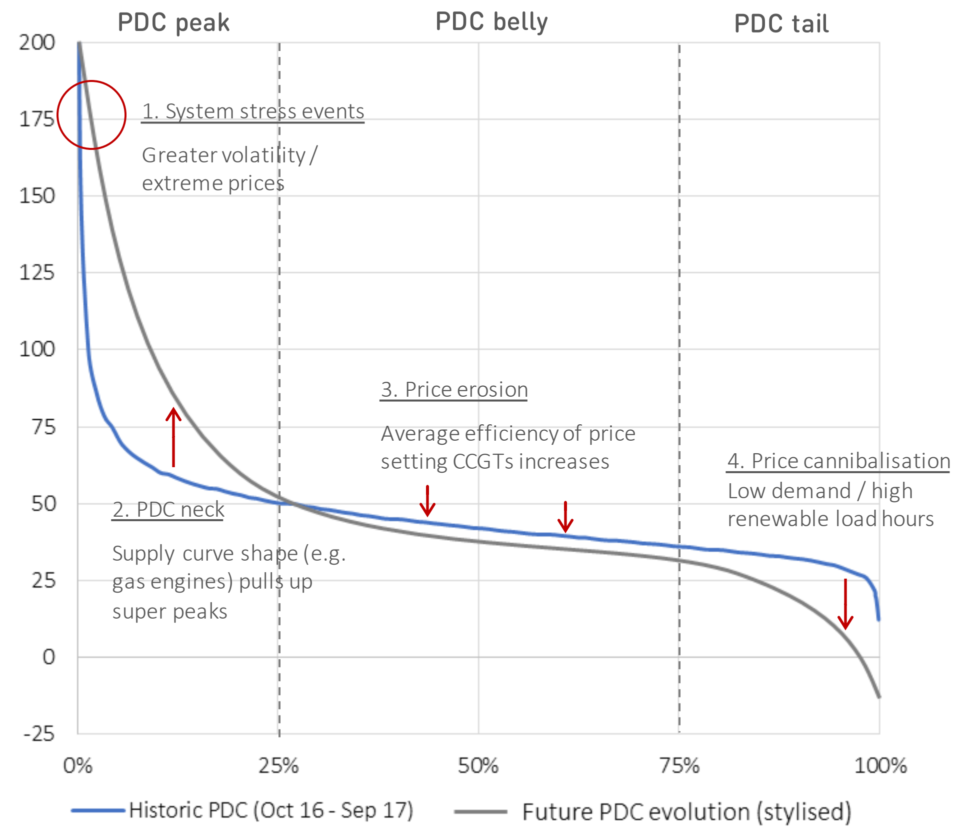
Price shape

- High variable cost engines & GTs lift peak prices. Impact increases as coal/CCGTs retire.
- This supports CCGT margin rents in peak periods.
- Rising wind/solar output pulls down tail of Price Duration Curve (PDC) → lower/negative prices.
- DSR (e.g. via smart appliances/software) acts to dampen intra-day load shape.

Price volatility

- Rising intermittency = rising volatility. This is exacerbated by higher SRMC peakers (greater shape in supply stack).
- Short duration batteries have little impact on WS pricing (balancing service focus). Long duration batteries will dampen price vol, but note capacity mismatch (e.g. 3GW batteries vs 30GW wind).

Evolution of peak price shape & volatility is pushing flex asset value into the prompt horizon & BM.



Price Duration Curve (PDC) evolution *Source: Timera Energy*

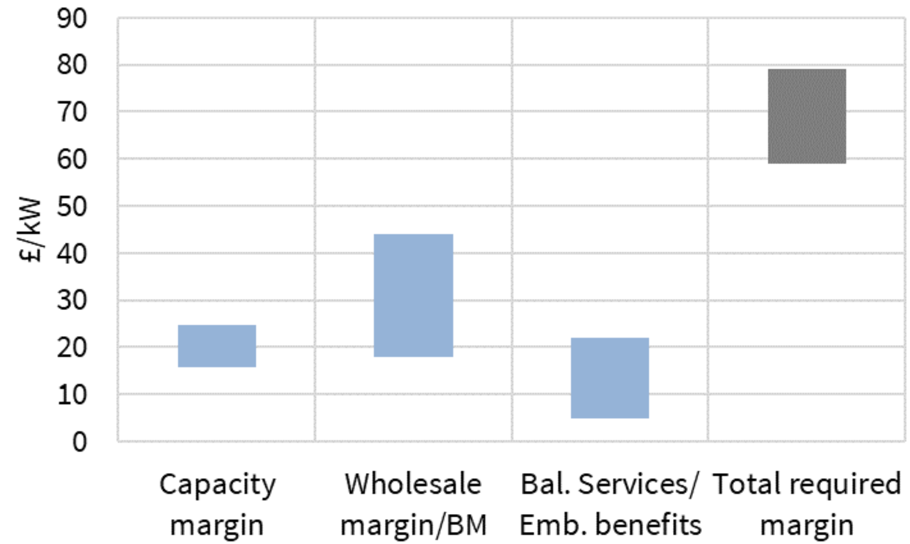
Investment economics: Gas engines

Key value drivers

- Capex 350-450 £/kW. Efficiency 35-40%.
- High flex. Low start costs.
- Embedded benefit revenue advantages (although levels lowered by recent policy changes).
- Falling cost of capital (strong Infra/PE fund interest).

Key challenges

- Shift in business model focus:
  1. From Triads (pseudo regulated*)
  2. To Wholesale & BM returns (merchant risk).
- WS & BM margin capture is driven by the complex evolution of prompt price shape & volatility.
- Investors need to properly price the risk of engines/batteries/DSR eroding this value.
- Sophisticated market access & asset optimisation capability is key to engine value capture.



Gas recip. engine annual margin ranges (1st 5 yrs)

Margin ranges depend on system capacity mix, unit efficiency, BM risk appetite, monetisation strategy (e.g. WS/BM vs STOR).

** Value of Triads based on regulated TNUoS tariff.*

Source: Timera Energy

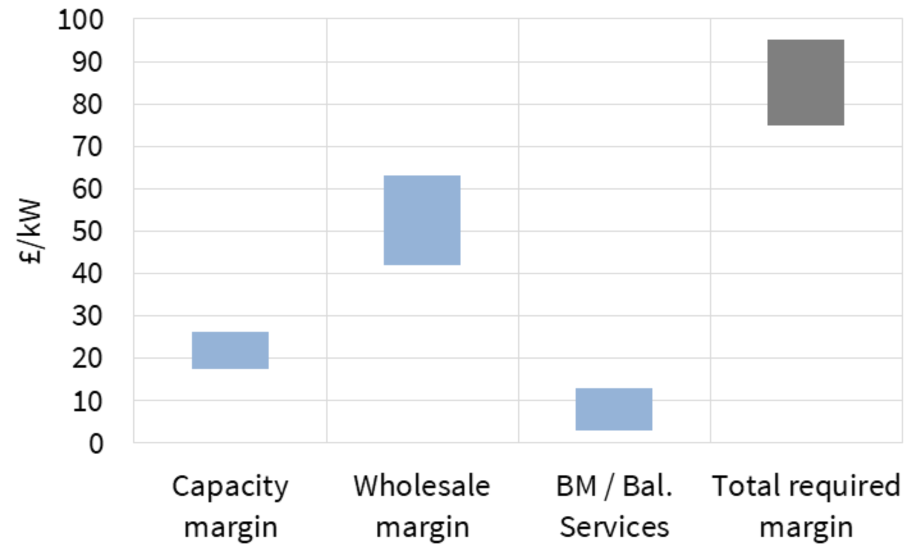
Investment economics: CCGTs

Key value drivers

- Capex 500-600 £/kW. Efficiency 56% (HHV).
- Ramping, MSG and start cost constraints.
- Longer development & payback timelines.
- Falling cost of capital (e.g. financing innovation).

Key challenges

- High renewables, CCGT overbuild, new interconnectors & long duration batteries are biggest margin threats.
- Engines & short duration batteries support peak CCGT margins given high variable cost.
- Return over first 5-10 years key to reducing project risk.
- Turbine manufacturers currently very supportive.
- Cost/availability of equity capital willing to bear market risk & innovative financing structures are reducing project costs.



New CCGT annual margin ranges (1st 5 yrs)

Margin ranges depend on system capacity mix, unit efficiency, location & SRMC structure.

Source: Timera Energy

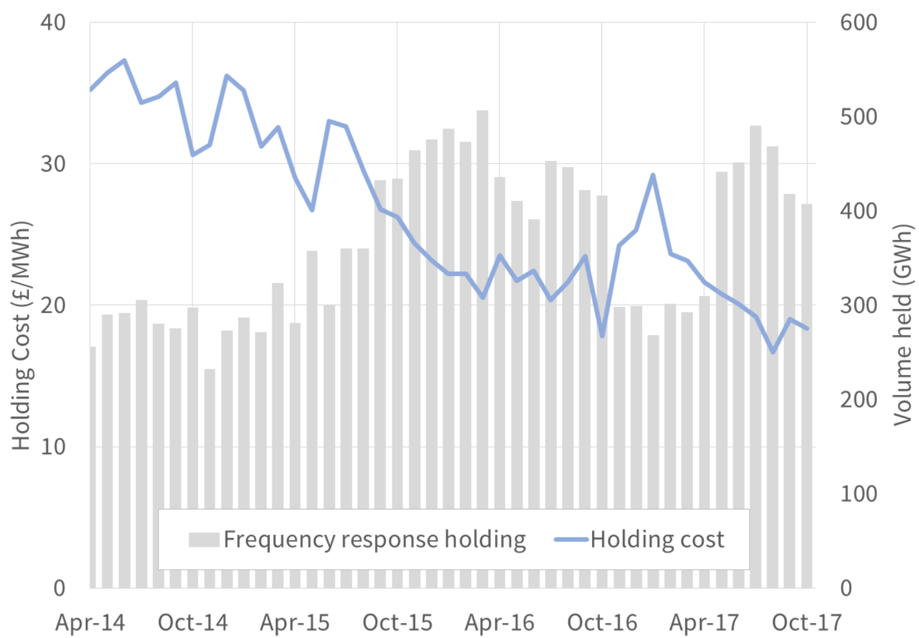
Investment economics: Batteries

Key value drivers

- Capex 350-450 £/kWh (Li-ion). Efficiency 75-85%.
- Battery costs (~50% of capex) rapidly declining.
- Frequency response (e.g. FFR) key revenue driver.
- Capacity revenue strongly linked to duration.

Key challenges

- Battery valuation, hedging & optimisation across stacked revenue streams is a complex problem.
- Dispatch decisions need to reflect variable cycling costs, accounting for own use/losses & degradation.
- Key risk of rapidly falling frequency response revenues (on top of derating factor reductions).
- Longer duration batteries set to dominate as costs decline. These may displace short duration batteries.
- Properly valuing complex optionality of storage price arbitrage & economic/operational impact of battery degradation is key to successful investment.



Commercial Frequency Response value decline (2014-17)

Source: Timera Energy, National Grid

Investment economics: Older coal/CCGT assets

Decarbonisation policy & renewable penetration are bringing 'end of life' investment decisions into focus for older coal/CCGT owners. 5 considerations:

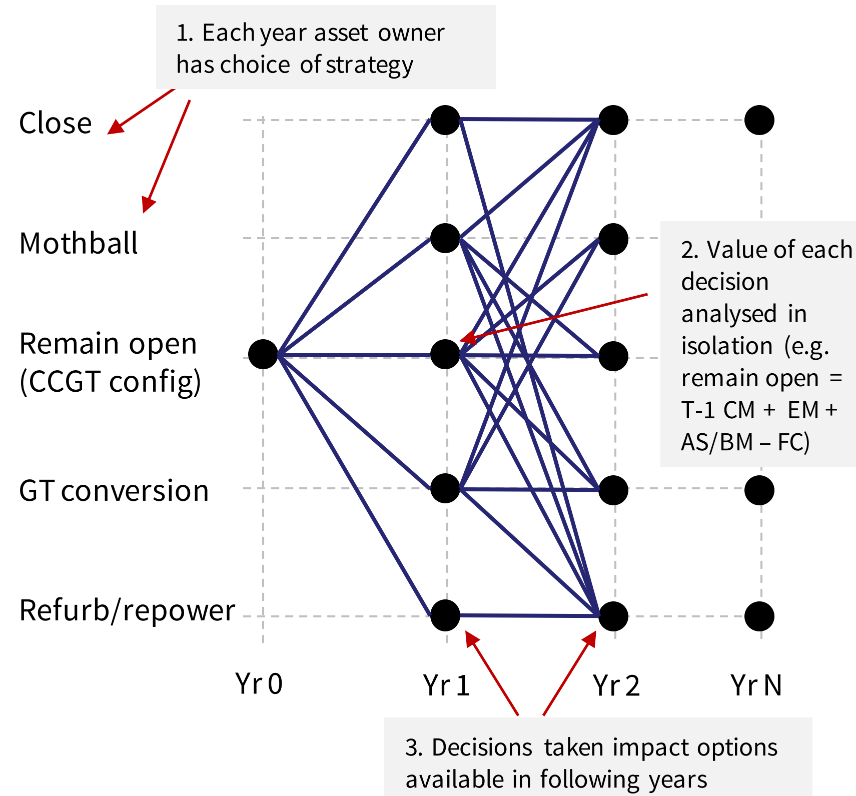
1. Adding value: Investing in enhanced asset flex (e.g. lower MSG) can unlock value via alleviating constraints in capturing price shape & volatility.

2. Conversion: Owners of older CCGTs are reducing running costs and extending asset lives via GT conversion (ST bypass).

3. Decommissioning: Site value and re-use of infrastructure are important. Deferral of closure capex can also have a big NPV impact, particularly for coal plants.

4. Capacity prices: End of life economics are often structured around capacity bids as the balancing item i.e. bid what is required to remain open.

5. Optionality: Key to maximising value is cleanly defining and valuing optionality with different interdependent exercise decisions (e.g. flex upgrade, convert, mothball, close).



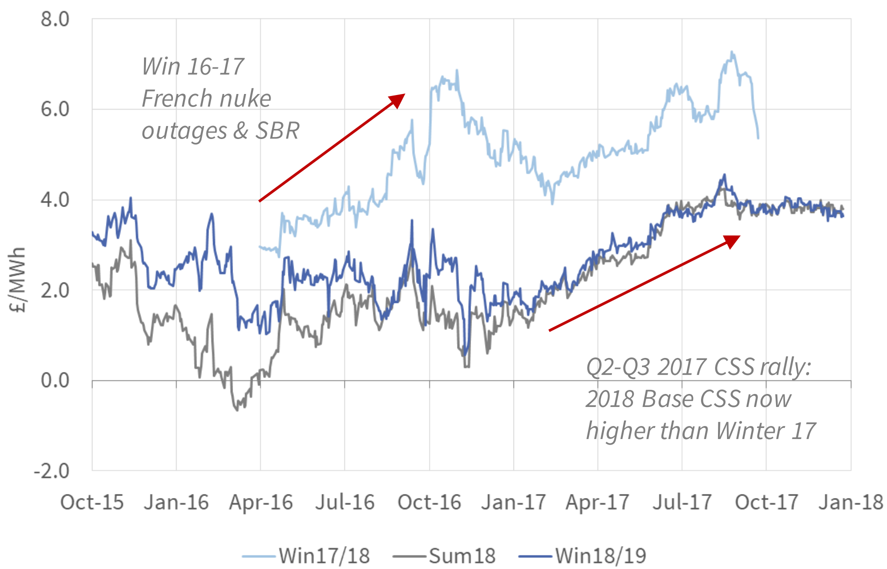
Illustrative CCGT investment optionality

Source: Timera Energy

Evolution of gas-fired generator margins

CCGT forward margins have recovered over last 2 years

Higher variable cost coal units & gas engines are dragging up peak prices and supporting CCGT generation margins.



Baseload forward CSS by season (49% efficient CCGT)

Gas engines have no intrinsic forward margin

Gas engines have no significant hedgeable margin in forward market. Value capture focus on day-ahead, within-day & BM.

Source: Timera Energy

Peakload forward CSS by season (35% efficient gas engine)

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Managing gas-fired asset value

Value pushed into prompt

- Flex asset value being pushed into Day-Ahead, Within-Day & Balancing Mechanism (BM).
- Forward hedging of price shape restricted by limited liquidity in sub-tradable peak products and no active options market.
- Evolving supplier demand for flex products to hedge retail risk (IPPs may become more active marketers).

5 key challenges in managing value

1. Defining effective forward hedging strategy (for CCGTs).
2. Understanding & hedging price shape exposure.
3. Optimizing asset flex against prompt price signals.
4. Effective BM strategy (properly accounting for risks).
5. Dynamically tracking asset risk/return performance.

CCGT

Energy margin

Forward mkts [~60%]	Prompt [~30%]	Bal Mech [<10%]
Some forward intrinsic value (e.g. winter, pks)	D-A auction drives optimised schedule	Focus on bid/offer acceptances in BM
Hedging strategy influenced by mkt conditions, costs	Additional extrinsic value capture from price volatility	Strategy influenced by gate-closure position (typically lower value)

Balancing Services / Embedded benefits

Balancing. Services revenues typically limited. No embedded benefits.

Gas engine

Energy margin

Forward mkts [0%]	Prompt [e.g. 30-50%]	Bal Mech [e.g. 50-70%]
No forward intrinsic value	Lock in positive margin in D-A auction	Focus on capturing cash out price value
Energy margin capture focused on prompt, increasing margin risk	Dispatch & hedges can be adjusted within day (lower value)	Risk from cashout forecast error and value erosion

Balancing services / Embedded benefits

Optimise energy margin vs STOR revenues. Residual EB dispatch influence.

Value management: issues & challenges for gas generators

Source: Timera Energy

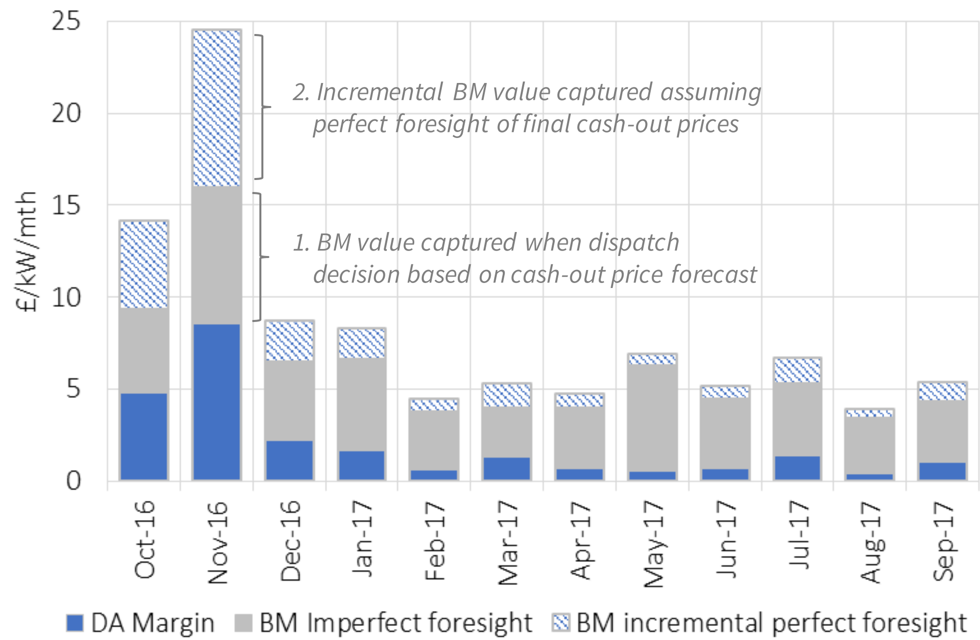
BM & cashout value capture

Price evolution

- Ofgem regulatory reforms are supporting sharper cashout price signals.
- This should drive liquidity into the within-day wholesale market as participants have a higher incentive to balance (& improve forecast accuracy).

Flex asset value capture

- CCGTs dominate BM bid-offer acceptances.
- New gas engines are focusing business model on chasing cashout price returns e.g. via 'spill & turn down' strategy.
- But developer optimism on revenues is in some cases not accounting for
  1. Risk associated with forecasting cashout prices i.e. getting it wrong costs money.
  2. Impact of large volumes of new gas engines and batteries in dampening the impact of rising cash out price volatility.



Historical 'theoretical' vs 'practical' gas engine value capture

Chart shows estimated historical DA and BM margin (based on "spill and turn-down" strategy) for a 35% efficient gas engine. BM margin is shown for perfect foresight and a simple dispatch rule based on cashout price forecasts (analysis suggests cashout price forecasts allows 60-80% of perfect foresight value capture)

Source: Timera Energy

Market access: contract structuring is key

In house market access requires scale and sophistication. Tough to gain competitive advantage vs larger incumbents.

Outsourcing market access can allow access to competitive advantage. But negotiating a water-tight structure is challenging. 5 key success factors in table below:

Success factor	Summary description	Pitfalls
1. **Governance**	Defining and enforcing guidelines for the management of asset value and risk.	Asset risk profile not aligned to owner risk appetite. Excessive rigidity constraining trader value creation.
2. **Fee structure**	Fair capture of a fixed fee covering overheads and variable fees covering trade execution costs.	Excess charging for incremental overheads. Excess variable fees incurred due to 'volume churn'.
3. **Incentivisation**	Defining a clean mechanism and value baseline from which trading desk 'value added' can be rewarded.	Alignment of party interests across value, risk & asset performance. Transparency & oversight where this isn't possible.
4. **Exposure transfer**	Clean definition of which party has responsibility for managing asset exposures at any point in time.	Prompt exposure handover. Information asymmetry in defining value base line. Transfer of 'monkey value'.
5. **Asset representation**	Capturing actual physical asset characteristics in a way that can practically be written in the contract.	'Grey areas' of exposure and value responsibility for each party from over-simplified asset representation.

Timera Energy offers expertise on value & risk in energy markets

Specialist energy consultancy
Focus on LNG and European gas & power assets

Extensive industry expertise
Practical knowledge from senior industry roles

Pragmatic commercial focus
Investment, valuation, contracting & mkt analysis

Strong client base
leading energy companies (producers, utilities, funds)

Leading industry blog
15,000+ regular readers, publications, conferences

Our clients include

Relevant recent UK power credentials

Project	Client	Summary
Peaker acquisition	**Fund**	*Market analysis, asset valuation & due diligence to support bid for UK peaker portfolio.*
Peaker investment	**Utility**	*Analysis of relative economics of gas engines vs OCGT vs battery investment options.*
CCGT investment	**PE Fund**	*Valuation & investment advice to support acquisition of portfolio of UK gas assets.*
CCGT monetisation	**Generator**	*Advice on margin evolution, hedging & risk management for portfolio of CCGTs.*
Value management	**Generator**	*Support for development of hedging & risk management strategy for CCGT portfolio.*
Margin strategy	**IPP**	*Advice on gas plant margin strategy, including impact of contracting on risk/return*
Market access	**Generator**	*Advising UK portfolio generator on R2M contract structure & counterparty selection.*
Peaker economics	**Supplier**	*Forecast of gas engine margins (wholesale, BM, Bal Services & embedded benefits).*
Market analysis	**Fund**	*Analysis of UK power market evolution & impact of peaker & battery roll out.*

Timera Energy power team members

Our team members have extensive senior industry experience and practical commercial knowledge.

Olly Spinks

20 years energy industry experience
Expert in commercial and risk analysis
Ran BP's LNG, gas & power commercial analytics function

David Stokes

20 years energy/commodity market experience
Expert in value/risk management of flexible assets
Industry roles with Origin, Williams, JP Morgan

Phil Robinson

15+ years gas industry experience (E.ON, EDF, Calon)
Expert in value & risk management of power assets
Former commercial head of Calon Energy

Nick Perry

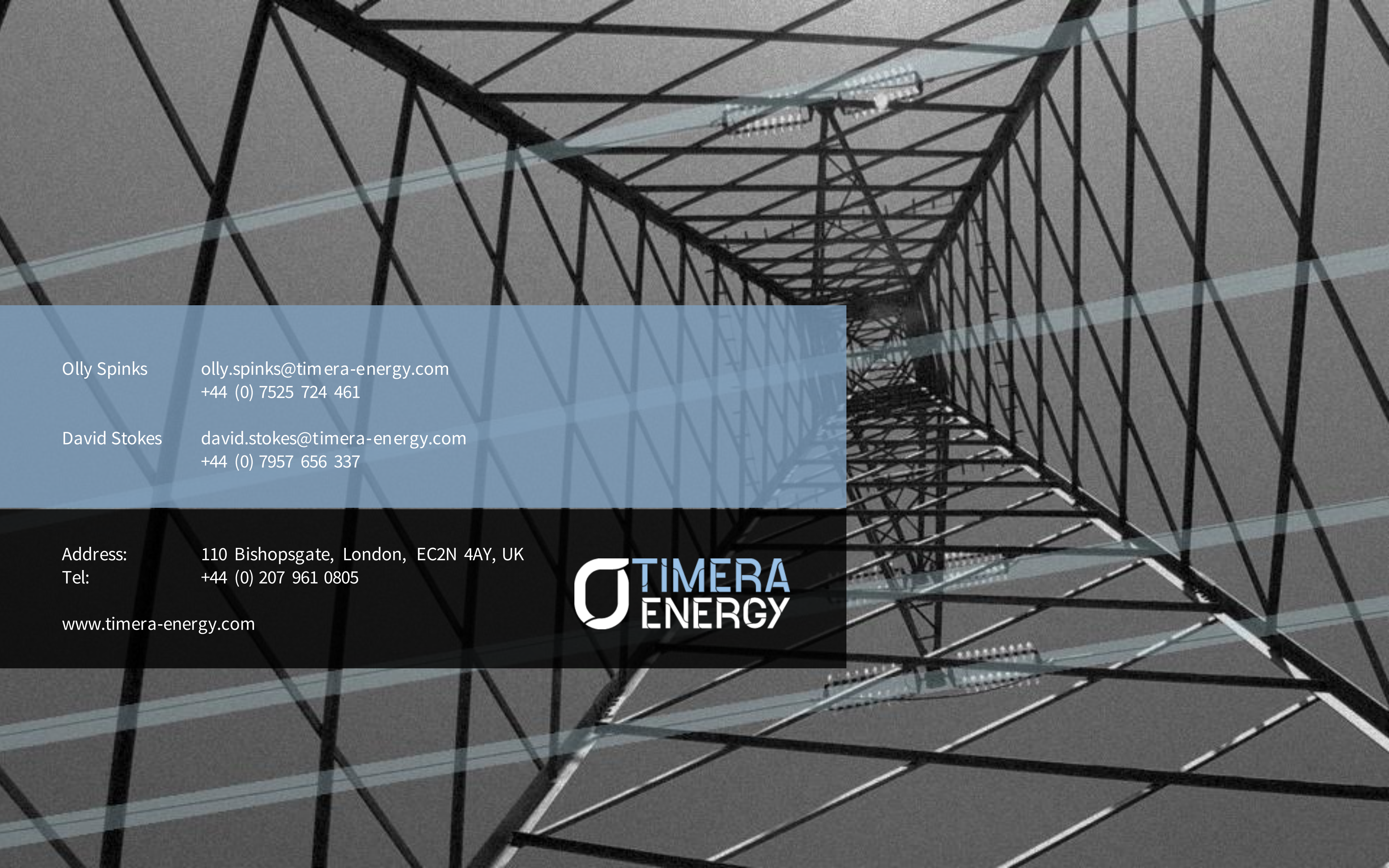
30+ years industry experience (Amoco, Exxon, Enron)
Expert in commercial & risk management strategy
Board level experience (Enron Europe, Teesside Power)

Emilio Viudez-Ruido

15 years experience in European gas & power markets
Strong expertise in market modelling & margin analysis
Expert in deconstruction & analysis of asset exposures

Henry Crawford

7 years experience in energy & capital markets
Strong commercial & market analytics experience
Industry trading & analytics background (Nova Energy)



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