System Services - An Investors Perspective

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Kelwin Power Plant

An enhanced wind farm that offers more (and better) ancillary services than equivalent steam/gas plant.

- 13 x 2.85MW GE Wind turbines
- 13 x 0.2MW Saft Li-Ion batteries
- 2MW of Maxwell ultra-capacitors
- 2MW of Freqcon full converter
- 2MW of Cummins diesel engines
Kelwin Power Plant

Ultracapacitors responding in <150ms
2MW of ultracapacitors
5 x 0.4MW diesel engines

Offers Fast Frequency Response
(<150ms)
Primary Operating Reserves
Secondary Operating Reserves
Tertiary Operating Reserves
Ramping
Reactive power

All for zero carbon emissions.
DC sub-metering?

Kilpaddoge
EirGrid 110kV
busbar (existing)

200m UG
110kV cable

M1

IPP 110/33
50MVA

M2

14km UG
33kV

M3

M4 Proposed 33kV sub-meter with two registers

Tullahenell Wind
Farm

Diesel Gens
5 x 400kW

Glencloosagh
Peaking Plant

G

200kW
75kWh
Li-Ion Battery

13 x 2.85 MW
Wind Turbine GE
Ultracapacitor response

<table>
<thead>
<tr>
<th>Unit ID: Kelwin Hybrid PPM</th>
<th>Event Date: 28/09/2019</th>
<th>Max Available FFR (MW): 2.00</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reg Cap (MW): 2</td>
<td>Event Start Time: 12:42:10.574</td>
<td>Max Expected FFR (MW): 0.59</td>
</tr>
<tr>
<td>Response Trigger (Hz): 49.9</td>
<td>Pre-Event Output (MW): -0.005</td>
<td>Max Achieved FFR (MW): 0.65</td>
</tr>
<tr>
<td>FFR Trajectory (Hz): 0.3</td>
<td>Contracted FFR Response time (s): 2.00</td>
<td>% Time FFR Achieved up to 10s: 91%</td>
</tr>
<tr>
<td>Frequency Nadir (Hz): 49.811</td>
<td>Achieved FFR Response time (s): N/A</td>
<td>Energy [0-10] vs [10-20]: PASS</td>
</tr>
</tbody>
</table>
DS3 Investment Choices

**Auction**
- 3 winners, 15 losers
- Need to recover 5x devex?
- Winners curse
- Revenues fixed 6 years
- But residual risks (business rates, TUoS, TLAF, Import charges, market interactions, technology, capacity revenue, reactive power revenue)

**Tariffs**
- Contract available if you build (probably)
- 2x higher revenue
- 2-3 years remaining (Apr-’23)
- Temporal Scarcity Scalar
- Sensitive to windiness
- Sensitive to EirGrid SNSP cap
- Adjust or early terminate if €235m budget risk
Are auctions really so cheap?

• Recent DS3 auctions cleared at €57k/MW/year for 6 years for a ½ hr battery. Some additional revenue from capacity, energy and reactive power. Capex c.€500k/MW.

• The CRU/EirGrid “Outcomes” note refers to tariffs for a battery yielding €318k/MW/year, nearly 6x more expensive.

• However this comparison was based on a 2025 scenario, i.e. after the end of the tariff contract period (2023), and is simply not relevant.

• Using actual 2018 data, we calculate that a battery in 2018 would have earned €118k/MW/year under tariffs.

• This is still 2x more than the auction price, but seems reasonable given that the term is half the term at <3 yrs, 12 month termination, SNSP variability, contract only after build etc. etc...

Hybrids are difficult...

<table>
<thead>
<tr>
<th>Problem</th>
<th>Solution</th>
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</thead>
<tbody>
<tr>
<td>Investors’ risk appetite</td>
<td>Separate companies</td>
</tr>
<tr>
<td>Rigid grid capacity</td>
<td>Dynamic sharing of grid</td>
</tr>
<tr>
<td>Reactive power unsplittable</td>
<td>Master controller</td>
</tr>
<tr>
<td>High impact, low prob. (e.g. €1.3m DS3)</td>
<td>Proportion caps to contract size</td>
</tr>
<tr>
<td>Allocation of risk</td>
<td>Enable agents or reallocation agreements</td>
</tr>
</tbody>
</table>
New build under tariffs

1.5yr investment certainty

Typical construction lead time 2yrs

Investment Decision

Secure DS3 Contract

Tariff End Date

18 month extension?

2019 2020 2021 2022 2023 2024 2025

Investment hiatus under tariffs

New DS3 consulted? New DS3 decided New DS3 implemented?
Impressions so far…

• DS3 is delivering new non-battery capability (demand side, fossil)
• DS3 allows a multiple services per contract. This enables hybrid sites or unusual technologies which can deliver a subset of the 14 services (c.f. UK).
• Tariffs have a higher cost of finance. Not attractive to banks.
• New build under tariffs is more difficult than it needs to be, given “levers”.
• Budget of €235m looks unlikely to be breached

<table>
<thead>
<tr>
<th>Forecast Spend 18-19</th>
<th>FFR</th>
<th>POR</th>
<th>SOR</th>
<th>TOR1</th>
<th>TOR2</th>
<th>RRD</th>
<th>RRS</th>
<th>SSRP</th>
<th>SIR</th>
<th>RM1</th>
<th>RM3</th>
<th>RM8</th>
<th>Total (€m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RCROI Spend (€m)</td>
<td>1.4</td>
<td>10.4</td>
<td>10.4</td>
<td>9.6</td>
<td>8.8</td>
<td>6.6</td>
<td>2.4</td>
<td>16.8</td>
<td>10.7</td>
<td>2.3</td>
<td>2.9</td>
<td>3.3</td>
<td>85.6</td>
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<tr>
<td>NINI Spend (€m)</td>
<td>0.1</td>
<td>5.7</td>
<td>3.7</td>
<td>2.9</td>
<td>4.0</td>
<td>2.1</td>
<td>0.6</td>
<td>2.5</td>
<td>2.3</td>
<td>0.9</td>
<td>1.4</td>
<td>1.2</td>
<td>27.5</td>
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</tbody>
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113.1
Questions?