True integration of renewables into the Utility Network

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Overview

- What is true integration?
- Current approach & constraints
- The economic considerations
- The required approach
- Future Direction
- Questions
True integration – the Definition!

- True integration:
  1) Achieving the maximum renewable generation (no constraints)
  2) Achieving the maximum CO$_2$ reduction (not shifting the location)
  3) Assist with dealing with peak energy demand (major capital $)
  4) Achieving the above at least cost / most economical

- Looking at two cases:
  1) Small Scale
  2) Large scale
Small Scale – Embedded Renewables
Statistics EE

- 98,675 Connected Premises
  - 2 Hydro – 4.2kW in total
  - 71 Wind – 573kW in total
  - 98,602 Solar – PV 364MW
- Semi Scheduled and Non Scheduled
  - Bagasse 68MW
  - Diesel 50MW
  - Landfill Gas 5MW
  - Natural Gas 10MW
  - Wind 144MW
  - Solar 265MW
  - Hydro 165MW
- Total 706MW

Indication of embedded generation in EE

(Reference: Essential Energy – Embedded Generation Presentation)
Drake Landing
100% Solar Community

Residential Solar PV
(Reference: Essential Energy – VARMO Presentation)
Residential Solar – 100% PV – No Compensation/Limiting
(Reference: Essential Energy – VARMO Presentation)
Residential Solar PV – with Compensation

(Reference: Essential Energy – VARMO Presentation)
Residential Solar PV vs Storage

(Reference: Professor Tony Vasallo – Batteries and PV’s Presentation)
Residential Solar PV vs Storage

(Reference: Professor Tony Vasallo – Batteries and PV’s Presentation)
Landfill Gas – Eastern Creek (>5MW)
Large Scale – Embedded Renewables
Large Scale Solar – Nyngan Solar Farm – 102MW
(Reference - Essential Energy – Nyngan Solar Farm Presentation)
> 250 Ha (1.0 km x 2.5 km)
> 1.35 Million Cells
> 152 inverters rated 0.67 MW each
> Connected in pairs to 1.5 MVA step up transformer
> 4 x 33 kV strings
> 120 MVA 132/33 kV transformer

Large Scale Solar – Nyngan Solar Farm
(Reference - Essential Energy – Nyngan Solar Farm Presentation)
Large Scale Wind – Capital Hill - 140MW
(View over Lake George)
Large Scale Wind – Gullen Range, Goulburn - 165MW
Open Cycle Gas Generation – Colongra
(Munmorah region – 660MW = 4x165MW)
Combined Cycle Gas Generation – Darling Downs

(630MW = 3x120MW + 270MW)
Coal Fired Generation – Vales Point
(1320 MW = 2 x 660MW)
Modeled Large Scale Wind Constant Load – Dancing Partner

70% of 0.65 Tonnes CO₂/MWH OCG= 0.45 Tonnes CO₂/MWH

Compare with 0.4 Tonnes CO₂/MWH for CCG

Reference: Dr Robert Barr – EESA National President
CO₂ Emissions

Wind + OCG > CCG

Reference: Dr Robert Barr – EESA National President
## Current Approach – Energy Blend / Portfolio
(Courtesy Dr Robert Barr – EESA National President)

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Tonnes of CO₂/MWh</th>
<th>$ Capital Construction Cost/MW</th>
<th>Dispatch Capable</th>
<th>Ability to Rapidly Change Output</th>
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</thead>
<tbody>
<tr>
<td>Brown Coal</td>
<td>1.4</td>
<td>High</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Black Coal</td>
<td>0.9</td>
<td>High</td>
<td>Yes</td>
<td>No</td>
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<tr>
<td>Natural Gas Open Cycle Gas Turbine</td>
<td>0.65</td>
<td>Low</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Natural Gas Combined Cycle Gas Turbine</td>
<td>0.4</td>
<td>Medium</td>
<td>Yes</td>
<td>Moderate</td>
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<tr>
<td>Hydro</td>
<td>0</td>
<td>Extremely high</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Wind</td>
<td>0</td>
<td>High</td>
<td>No</td>
<td>Nil</td>
</tr>
<tr>
<td>Solar PV</td>
<td>0</td>
<td>Very high</td>
<td>No</td>
<td>Nil</td>
</tr>
</tbody>
</table>
The Required Approach for True Integration

- **Small Scale**
  1. Economic Battery Storage (targeting under $400 / kWh), or
  2. Economic small scale ‘Statcom’ (compensation) for voltage control

- **Large Scale**
  1. Large Scale Economic Storage
  2. More economic Statcom technology (compensation)
  3. Alternative Clean Energy solutions that are:
     a) Despatchable (generation when required to match load)
     b) Low CO$_2$ per MWh
     c) Low Capital Cost (to have competitive energy globally)
     d) Can be geographically located where required
Questions?