Getting a Grid Connection to Export Power

Energy in Agriculture 2017
22th August 2017
Mullan Grid Consulting

• Electrical engineering consultancy specialising in grid connections for renewable generator installations

• Ongoing projects in Ireland & Northern Ireland

• Technical Advisor for approx 1500 MW of wind generation projects and multiple Solar, biomass, marine and hydro projects

• Experience of Gate 1, 2 & 3 and Non-GPA

• Represented on IWEA Council, IWEA, ISEA & NIRIG Grid Committees & Gate 3 liaison group

• PPA Solutions established in 2012 to advise on PPAs
The Electricity System and its Operation

Transmission

400 kV

220 kV

110 kV

Distribution

38 kV

20/10 kV (Medium Voltage/MV)

400/230 V (Low Voltage/LV)
Distribution Network – 20/10 kV
High Voltage Network
### Non-GPA Connection Offer Process - CER/09/099

<table>
<thead>
<tr>
<th>Renewable - Wind</th>
<th>Renewable – Non Wind*</th>
<th>Conventional Projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>All processed through GPA Process.</td>
<td>Processed through non GPA Process – must fulfil public interest criteria.</td>
<td>Processed through non GPA Process</td>
</tr>
<tr>
<td><strong>Exception:</strong> new build wind projects with MEC less than or equal to 0.5 MW</td>
<td></td>
<td>&lt;= 5 MW</td>
</tr>
<tr>
<td></td>
<td>Connection offers made without performing interaction** studies</td>
<td>Interaction studies are performed. If no interactions then connect If interactions exist then CER look at on a case-by-case basis If interactions exist then look at public interest benefits (e.g. Security of Supply) and the impacts of interaction on other applicant in the queue If CER approves then connect and if not approve then option to buy out interaction or remain in the GPA queue</td>
</tr>
</tbody>
</table>

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<sup>* Non Wind Renewable project is defined here as a renewable project that has a fuel source other than wind power. It is intended to be a short hand term to define those renewable projects other than wind renewable projects that are discussed in the document. Includes, biomass, hydro, high efficiency CHP, Autoproducers (renewable including wind)</sup>
Connection Offer Process - Export

- Application form – NC5 and associated documents to be submitted to ESBN along with ESB Networks Fee
- Connection Offer Processed - Non GPA applications are processed one node at a time based on deemed complete date order. Estimated timelines for processing a connection offer by ESB Networks is currently estimated at 6-9 months.
- Execute offer – 3 months
- Connection works begin

### Table 1.1 Application Fee (excluding VAT)

<table>
<thead>
<tr>
<th>MEC</th>
<th>Shallow works required</th>
<th>No shallow works required</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 ≤ 11kW</td>
<td>€0</td>
<td>€0</td>
</tr>
<tr>
<td>&gt; 11kW ≤ 50kW</td>
<td>€773</td>
<td>€773</td>
</tr>
<tr>
<td>&gt; 50 kW ≤ 500kW</td>
<td>€1,578</td>
<td>€1,578</td>
</tr>
<tr>
<td>&gt; 500kW ≤ 4MW</td>
<td>€8,956</td>
<td>€8,624</td>
</tr>
<tr>
<td>&gt; 4MW ≤ 10MW</td>
<td>€27,630</td>
<td>€23,155</td>
</tr>
<tr>
<td>&gt; 10MW ≤ 30MW</td>
<td>€53,516</td>
<td>€33,062</td>
</tr>
<tr>
<td>&gt; 30MW ≤ 50MW</td>
<td>€62,364</td>
<td>€37,066</td>
</tr>
<tr>
<td>&gt; 50MW ≤ 100MW</td>
<td>€74,794</td>
<td>€39,966</td>
</tr>
<tr>
<td>&gt; 100MW</td>
<td>€87,547</td>
<td>€43,434</td>
</tr>
</tbody>
</table>
Review of Connection Offer Process

- Large number of solar applications being currently processed through the non-GPA process; non-GPA no longer considered fit-for-purpose
- CER to consult on new connection offer process in Q3 2017
- Appears that new process will include batch processing of large wind and solar projects; planning permission of generator likely to be required to be included in batch
- Unclear what new offer process will replace non-GPA for small scale generators wanting export capacity
- Critical for small scale generation to have a voice in the up-coming consultation
Connection Offer Process - Micro Generation

- Micro-generation is classed as the connection of a generator with an MEC of less than 6kW (Single phase) or 11kW (three phase)
- Examples of micro-generator technology include Wind Turbines, Solar PV, Hydro and CHP
- There is currently no charge to apply or connect a micro-generator to the ESB network provided it is compliant.
- Complete Micro-Generation Application form – NC6 and return to ESB Networks. The applicant must confirm if an import/export meter is required on the application. ESB Networks will provide a quote for the installation of a meter if required, the cost of the meter is approx. €350.
- Proceed with installation of the Micro-Generator by a registered electrical contractor - The generator must comply with ESB Standards EN50438 and a compliance certification must be provided to ESB Networks. Do not proceed if notified by ESB Networks to not do so.
- ESB Networks will install the meters once the Micro-Generator has been installed, the relevant electrical certificates have been provided and payment for the meters has been received.
- The Micro-Generator can contact an electricity supplier to arrange purchasing/supplying of electricity once a meter has been installed.
Connection Offer Process - Parallel Generation

- Generators with no export capacity are generally referred to as Paralleled Generators.

- Apply to ESB Networks using the NC5 application, an OS Map and a detailed Site Plan. There is currently no charge to apply to connect a zero export generator to the ESB network, ESB Networks have suggested this may change in the future.

- A quote and connection agreement should be issued by ESB Networks within 30 days.

- ESB Networks will liaise with the customer to ensure protection requirements are met and a connection agreement will be issued including the Maximum Import Capacity (MIC) and Maximum Export Capacity (MEC) of the site (this will be zero).

- The installation must comply with ESB Network protection requires, the testing of this connection must be witnessed by ESB Networks.
For Export, The connection method will depend on....

1. Proposed maximum export capacity (MEC)
2. Distance from local 38/MV substations
3. Distance from local 10kV or 20kV network
4. Existing and planned generation on the network
5. Existing infrastructure i.e. size of existing conductors, and transformers
6. Existing transformer capacity
7. Location i.e. urban or rural area

110kV substation with limited or no transformer capacity (pre solar)
Case Study 1 - 500kW Generator

Connection Method

• A connection onto the existing MV Network, suitable for a 500kW Generator.

Connection Timeline

• It is estimated that it will take ESB Networks approx. 6-9 months to process a connection offer. Delays may occur due to other Non GPA applications in the area.

• Estimated timelines to construct this connection method are 9-12 months from execution of a connection agreement assuming that no upgrades are required on the existing MV Network.
Case Study 1 - 500kW Generator

Potential Connection Option 1: 0.5km of New build MV Overhead Line from the proposed Wind Turbine to the existing MV Network

Legend
- Site Location
- New MV Overhead Line
- Existing MV Overhead Line
- Existing 38kV Overhead Line
- 38kV Substations
## Case Study 1 - 500kW Generator

**Estimated Connection Costs**

<table>
<thead>
<tr>
<th>Connection Assets</th>
<th>Unit</th>
<th>Cost/Unit</th>
<th>Source</th>
<th>% Share</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Quality Metering</td>
<td>1</td>
<td>€ 5,766</td>
<td>Recent ESB Connection Offer</td>
<td>100%</td>
<td>€ 5,766</td>
</tr>
<tr>
<td>Meter LV CT Over 500kVA + Signals</td>
<td>1</td>
<td>€ 1,006</td>
<td>Recent ESB Connection Offer</td>
<td>100%</td>
<td>€ 1,006</td>
</tr>
<tr>
<td>Metering Major Test</td>
<td>1</td>
<td>€ 141</td>
<td>Recent ESB Connection Offer</td>
<td>100%</td>
<td>€ 141</td>
</tr>
<tr>
<td>630kVA MV/LV indoor substation</td>
<td>1</td>
<td>€ 34,614</td>
<td>Recent ESB Connection Offer</td>
<td>100%</td>
<td>€ 34,614</td>
</tr>
<tr>
<td>MVL 3P 50SCA OHL</td>
<td>0.5</td>
<td>€ 17,003</td>
<td>Recent ESB Connection Offer</td>
<td>100%</td>
<td>€ 8,502</td>
</tr>
<tr>
<td>MV OHL wayleaves</td>
<td>0.5</td>
<td>€ 6,000</td>
<td>MullanGrid Estimate</td>
<td>100%</td>
<td>€ 3,000</td>
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<tr>
<td>MV Compound civils</td>
<td>1</td>
<td>€ 75,000</td>
<td>MullanGrid Estimate</td>
<td>100%</td>
<td>€ 75,000</td>
</tr>
</tbody>
</table>

**Total Cost**

<p>| | | | | | |</p>
<table>
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<tr>
<th></th>
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<th></th>
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<tbody>
<tr>
<td>sub total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>€ 128,029</td>
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<tr>
<td>Contingency (10%)</td>
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<td></td>
<td></td>
<td></td>
<td>€ 12,803</td>
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<tr>
<td><strong>Total Cost</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>€ 140,832</strong></td>
</tr>
</tbody>
</table>

**Assumptions**

Assumes 0.5km of MV Overhead Line required from site to the existing MV Network

**Excludes**

On-site Electrical Works

Any MV Network upgrades that maybe required- site dependent

Estimated Connection cost for Case Study 1 is €140,832
Case Study 2 - 500kW Generator

Connection Method

- A dedicated MV connection to the local 38kV/MV Substation.

Connection Timeline

- It is estimated that it will take ESB Networks approx. 6-9 months to process a connection offer. Delays may occur due to other Non GPA applications in the area.
- Estimated timelines to construct this connection method are 18-24 months from execution of a connection agreement.
- Higher risk connection compared to Cast Study 1 due to longer distance of new build MV OHL required.
Case Study 2 - 500kW Generator

Potential Connection Option 2:
A dedicated MV Connection to an existing 38kV Substation. This example allows for 2km of dedicated new build MV Overhead Line.

Legend
- Site Location
- New MV Overhead Line
- Existing MV Overhead Line
- Existing 38kV Overhead Line
- 38kV Substations
## Case Study 2 - 500kW Generator

### Estimated Connection Costs

<table>
<thead>
<tr>
<th>Connection Assets</th>
<th>Unit</th>
<th>Cost/Unit</th>
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<th>% Share</th>
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<td>€ 5,766</td>
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<td>€ 5,766</td>
</tr>
<tr>
<td>Meter LV CT Over 500kVA + Signals</td>
<td>1</td>
<td>€ 1,006</td>
<td>Recent ESB Connection Offer</td>
<td>100%</td>
<td>€ 1,006</td>
</tr>
<tr>
<td>Metering Major Test</td>
<td>1</td>
<td>€ 141</td>
<td>Recent ESB Connection Offer</td>
<td>100%</td>
<td>€ 141</td>
</tr>
<tr>
<td>630kVA MV/LV indoor substation</td>
<td>1</td>
<td>€ 34,614</td>
<td>Recent ESB Connection Offer</td>
<td>100%</td>
<td>€ 34,614</td>
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<tr>
<td>MVL 3P 50SCA OHL</td>
<td>2</td>
<td>€ 17,003</td>
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<td>MV OHL wayleaves</td>
<td>2</td>
<td>€ 6,000</td>
<td>MullanGrid Estimate</td>
<td>100%</td>
<td>€ 12,000</td>
</tr>
<tr>
<td>MV Compound civils</td>
<td>1</td>
<td>€ 75,000</td>
<td>MullanGrid Estimate</td>
<td>100%</td>
<td>€ 75,000</td>
</tr>
<tr>
<td>MV/38kV protection</td>
<td>1</td>
<td>€ 40,000</td>
<td>MullanGrid estimate</td>
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<tr>
<td>MV Cubicle</td>
<td>1</td>
<td>€ 58,030</td>
<td>ESB Standard Prices 2016</td>
<td>100%</td>
<td>€ 58,030</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>sub total</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total Cost</td>
</tr>
</tbody>
</table>

**Assumptions**
- Assumes 2km of MV Overhead Line required from site to the existing 38kV Substation
- Assumes approx. €40k of protection required at the 38kV Substation. Amount dependent on 38kV Substation

**Excludes**
- On-site Electrical Works

- Estimated Connection cost for Case Study 2 is €286,620
- Potential to increase the amount of MW’s to reduce the cost per MW price
System Upgrade Costs

- As existing and planned generation uses up spare capacity, upgrading overhead line, underground cable or transformers could be required.
- Generators are allocated the full cost of distribution deep reinforcements.
- However these reinforcements will not be required for all connections.
- These reinforcements only identified when ESBN complete power system studies.

<table>
<thead>
<tr>
<th>Connection Asset</th>
<th>ESBN Standard Prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uprate MV overhead line per km</td>
<td>€52,260*</td>
</tr>
<tr>
<td>Uprate 38kV overhead line per km</td>
<td>€88,070-€110,310*</td>
</tr>
<tr>
<td>New 10MVA 38/MV transformer</td>
<td>€455,910*</td>
</tr>
<tr>
<td>Uprate 2 * 110/38kV 31.5MVA transformer to 2 * 110/38kV 63MVA</td>
<td>€2,903,070*</td>
</tr>
</tbody>
</table>

*ESB Standard Prices for Generators 2015
Summary

• Grid connection viability depends on many factors including proximity to grid and local available grid capacity

• Recommend to get grid applications submitted early

• ESB Networks needs to become more innovative on connection design for small renewables

• Small renewables needs a strong voice in development of connection policy
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Mob: 00353 87 3287213