Management of Distributed Generation
Using DGHost™ in NZ

Energy Networks

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Outline

• Background

• DGHost™ Method and Tool

• DG Connection Guide

• Where to from here...
PV Uptake in NZ

74 MW
30 April 2018

- 100x less PV than Australia
- No PV subsidies
Impact of DG on Distribution Networks

• Congestion
  – Network voltage limits exceeded
  – Equipment current ratings are exceeded
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DGHost™ Evolution

Clustering work
Rural, urban, city and industrial clusters

(2014)

Full Power-flow Modelling LV Networks
Requires complete network data

(2015)

DGHost
Approximate Method
Simple inputs, large representative database of modelled LV networks

(2016)

DGHost™
Online tool
NZ based LV networks database

(2018)

Timeline
DGHost™ Approximation Method

- Hosting Capacity – maximum export power per DG
- Estimate hosting capacity (HC) of each LV network using the reference data set
  - 20 million HC results
- Optimization of predictor variables
  - As independent as possible
  - Easily determined by Distribution Network Operators
- $k$-Nearest Neighbour Regression
DGH\textsuperscript{TM} Host Inputs

Per LV Network

- Transformer Rating
- Number of ICPs
- Max feeder impedance
- Penetration
  - 4 levels
- Network type
  - Single Phase
  - Reduced Neutral
DGHost™ Results

- DG hosting capacity for each LV network provided in an Excel spreadsheet
  - hosting capacities corresponding to each *DG penetration*,
  - Conservative (P25) and Median (P50) hosting capacity per penetration level

<table>
<thead>
<tr>
<th>Network ID</th>
<th>Penetration Level [%]</th>
<th>P25 [W]</th>
<th>P50 [W]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example 1</td>
<td>25</td>
<td>5800</td>
<td>6200</td>
</tr>
<tr>
<td>Example 2</td>
<td>28</td>
<td>2000</td>
<td>2300</td>
</tr>
<tr>
<td>Example 3</td>
<td>25</td>
<td>4400</td>
<td>4700</td>
</tr>
<tr>
<td>Example 4</td>
<td>50</td>
<td>7000</td>
<td>7100</td>
</tr>
</tbody>
</table>

- Models the impact of inverters set with voltage response mode
  (Volt-var settings of 0%, 30%, 60% reactive power)
Impact of Voltage Response Modes

- Inverters with grid supporting features
  - AS/NZ 4777.2:2015
- Voltage response modes
  - Volt-Var: voltages ↑ absorbs reactive power
  - Volt-Watt: voltages ↑ curtailing export

Example Volt-VAr Response (DG Connection Guideline)
DGHHost
Online Tool

www.dghost.nz

Publications on our website
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DG Connection Guide

• Provide a consistent approach to DG applications across all DNOs

• Avoid each DNO reinventing the wheel
  – Ensure the important information for each DG application captured

• Streamline the application process by providing an auto-assessment criteria to identify cases which should not adversely affect the network

• Ensure inverter settings were appropriate for the NZ

https://www.eea.co.nz/Site/publications/drafts-for-comment/drafts-for-comment-archive/amg-guideline-connection-of-small-scale-.aspx
Example LV Network

DG Penetration: 50%  11DG / 22 ICPs

- Number of ICPs (N): 22
- Transformer Size (kVA): 100
- Max Impedance (Ω): 0.18

H1: DG export power threshold, above which mitigation measures are necessary
- 3.6 kW

H2: DG export power threshold, above which mitigation via inverter volt-var response is insufficient
- 9.6 kW

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GREEN Grid
Traffic Light Implementation for DG Applications

Application for Export Power
P < $H_1$ (ie < 3.6 kW)

Application for Export Power $H_1 < P < H_2$ (ie between 3.6 and 9.6 kW)

Application for Export Power
P > $H_2$ (ie > 9.6 kW)
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DGHHost™ Applicability to Other Territories

- Reassess voltage levels, tolerances, network assumptions
- Build up database of representative networks