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ARC Project
PV Modelling & Monitoring
PV Modelling & Monitoring

Project Summary

• Duration: Oct 2013 / Oct 2016
  Funding: £8.4 million LCNF
  Partners: CES, SGS, University of Strathclyde

• Key Objectives
  Accelerate connections of renewable generation to the distribution network.
  Accelerate the time to connect new generation projects.

• Customer Benefits
  Assist communities in the development of methods of using locally produced energy, allowing generators to produce more and helping all parties benefit from reduced costs.
PV Modelling & Monitoring

Presentation Focus

The presentation focusses on modelling and monitoring of the Low Voltage (LV) network in order to analyse the impact of the integration of domestic photovoltaics (PVs).

Highlight:

• Modelling of distribution substations and their associated LV feeder circuits.
• Methodology used for the analysis.
BHA properties with proposed PV installations at Primary level

- Hoprig Road
- Deanhead
- DulceCraig
- Gunsgreenhill
- Dovecote
- Buss Craig
- Ayton Lawfield
- Grantshouse
- West End Chirnside
- Castle Street
- Briery Baulk
- Hawthorn Bank Duns
- Leitholm Village
- Churchill
- Swinton Duns

Total: 749 panels
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Swinton Duns
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**Methodology for real and assumed data**

1. Set the voltage at the Primary to measured data or start from 11.2kV

2. Equally distribute measured / assumed LV load along feeders

3. Set 11kV loads at other Secondary Substations (S/S)

4. Connect a PV (start from the electrically closest one to S/S)

5. Run a load flow

6. Check if voltage and thermal limits at all locations and all phases are satisfied

7. Mark the PV as acceptable, add the next electrically closest PV and go to 4

8. Stop when all PVs are checked / decrease Primary voltage for 0.05 and go to 2 until all PVs are connected

7. Set the PV out of operation, add the next electrically closest PV and go to 4
## Swinton Duns Results

### Recorded Winter load (19 proposed PVs)

<table>
<thead>
<tr>
<th>Primary V, date</th>
<th>PV 100%</th>
<th></th>
<th>PV 85%</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase L1</td>
<td>19/3</td>
<td>14/3</td>
<td>2/3</td>
<td>19/3</td>
</tr>
<tr>
<td>Phase L2</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Phase L3</td>
<td>8</td>
<td>5</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Phase L3</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>19</strong></td>
<td><strong>14</strong></td>
<td><strong>19</strong></td>
<td><strong>19</strong></td>
</tr>
</tbody>
</table>

*Total number of PVs that can be connected for recorded conditions.*
## Swinton Duns Results

### Assumed Summer load, **PV 100%** (19 proposed PVs)

<table>
<thead>
<tr>
<th>Winter load date</th>
<th>50% winter load</th>
<th>60% winter load</th>
<th>40% winter load</th>
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<tr>
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<td>14/3</td>
<td>2/3</td>
</tr>
<tr>
<td><strong>Primary V target</strong>*</td>
<td>11</td>
<td>11.05</td>
<td>11</td>
</tr>
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### Assumed Summer load, **PV 85%** (19 proposed PVs)

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<td>11</td>
<td>11.05</td>
<td>11</td>
</tr>
</tbody>
</table>

*The voltage at the Primary that allows the connections of all proposed PVs.

### Recorded Summer load (14 proposed PVs)

<table>
<thead>
<tr>
<th>PV 100%</th>
<th>PV 90%</th>
<th>PV 85%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary V, date</strong></td>
<td>11.11,8/7</td>
<td>11.12,31/7</td>
</tr>
<tr>
<td>Phase L1</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Phase L2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
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<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong>*</td>
<td>11</td>
<td>13</td>
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</tbody>
</table>

*Total number of PVs that can be connected for recorded conditions.*
Summary of Key Points:

- 15 sites have been modelled.
- More PVs can be connected at the beginning of the feeder.
- PV power output is 90% of installed capacity.
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Closing Summary

What is happening next / likelihood of Business as usual adoption:

- 749 PVs have been released, following BHA increasing the total number of potential sites to 1200.
- Remodelling with different cable types in order to see how much that will affect power flows and voltages.
- Trialling voltage control options at Primary and Secondary substations.
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Closing Summary

Customer Benefits:
- Customers are able to use locally produced energy and benefit from reduced costs.

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