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**Dispersed Generators Interfaced with Distribution Systems: Dynamic Responce to Faults and Perturbations**

### AIM OF THE WORK

- Analysis of the impact of distributed generators connected to distribution networks either directly (rotating generators) or by means of power electronic interfaces (static generators).
- Assessing the adequacy of the power system protections.

### DISTRIBUTED GENERATORS AND NETWORK INTERFACE MODEL

- **Microturbine unit model**
- **Fuel cell unit model**
- **Photovoltaic system model**
- **Active and reactive power controller**

### RESPONSE TO FAULTS AND PERTURBATIONS OF DISTRIBUTION NETWORKS INCLUDING DG

#### MEDIUM VOLTAGE NETWORK

Examined system configurations:
- i) two diesel units (rotating generators);
- ii) two sets of 10 microturbines (static generators);
- iii) without DG units.

**Three-phase short circuit at the common medium voltage bus**

<table>
<thead>
<tr>
<th>Short circuit location</th>
<th>Fault current with rotating generators [A]</th>
<th>Fault current with static generators [A]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pcc</td>
<td>Pcc</td>
</tr>
<tr>
<td>Three-phase short</td>
<td>Increase of the maximum current value in the faulted phase at locations 1 and 2.</td>
<td></td>
</tr>
<tr>
<td>DG contribution to fault current and transformer stress reduced by about seven times!</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Three-phase short circuit at different fault locations**

**Low voltage network**

with five small powerful DG units:
- two microturbines;
- two fuel-cells;
- one photovoltaic unit.

**Phase-neutral short circuit**

In the faulted phase at locations 1 and 2.

**Three-phase short circuit**

DG state contributions to the three-phase faults at locations 3 and 4.

<table>
<thead>
<tr>
<th>Fault location</th>
<th>DG contribution [A]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location 1</td>
<td>1.21</td>
</tr>
<tr>
<td>Location 2</td>
<td>0.31</td>
</tr>
<tr>
<td>Location 3</td>
<td>0.89</td>
</tr>
<tr>
<td>Location 4</td>
<td>0.31</td>
</tr>
</tbody>
</table>

**REMARKS**

- Negligible contribution to fault current of P-Q controlled interfaced DGs
- Possibility for many generators to be embedded without need of re-designing the feeder protection schemes
- In case of static generators does not appear to exist the typical problems arising from the connection of rotating generators to distribution networks, namely increase of fault current levels and inappropriate protection device operation when there is a short circuit on an adjacent line
- It is more straightforward to guarantee the protection system selectivity