Undergrounding Electricity Transmission: Introduction to Gas Insulated Line (GIL) technology

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Summary of GIL technology:
- Continuous welded, lifetime sealed
- High power AC transmission capacity
- Low losses & high availability
- No reactive power compensation
- No need for maintaining gas pressure
- Low internal gas density, no annual gas replenishment
- No ageing of insulating gas mixture
- Immediate automatic reclosure
- Low external electromagnetic fields
- High safety; no fire hazard
- Deployment to date up to 1km circuits, calculated deployable up to 70+km
- Ideal for undergrounding OHL sections

GIL is environmentally friendly:
- Safe for personnel and for the public
- Silent operation
- Safe to touch
- No health impact
- No risk of fire
- No burn through of enclosure
- Low electromagnetic radiation

Lifecycle considerations:
- Engineering and installation
- Operation
- End-of-life disposal

Engineering and installation: Inside an installation tent

Engineering and installation: Automated orbital welding
Engineering and installation: Buried GIL – use of special backfill material

Requirements
- Good heat dissipation
- Perfectly flowing
- Ecologically immaculate
- Re-use of excavated soil
- Short construction period

Engineering and installation: Low-cost tunnel for dig-and-cover GIL installation

Requirements
- Particularly fast installation process,
- Economic building cost,
- Maximum automation,

Lifecycle considerations

Operation: Comparative AC transmission losses

Operation: Repair approach for buried GIL
Operation: Auto-reclosure

Scenario: - Fault detection by protection system
- Line drop-off and arc extinguishing

Auto-reclosure:
- Gas insulation is self-recovering
- Successful auto re-closure: by-products are collected in the particle trap
- Unsuccessful auto re-closure: no impact or fire outside the GIL

View inside the GIL:
Test conditions: 63 kA, 500ms

No external impact.
Due to use of non-inflammable materials there is no fire risk.

End-of-life disposal: Materials almost totally recyclable & reusable

- Engineering and installation
- Operation
- End-of-life disposal

Material value underground:
- Aluminium > 40 kg/m completely reusable
- Insulation gas completely reusable
- Cast-resin components a very small proportion

Electricity transmission: Technology selection criteria

- Basic technical requirements
- Residential impact
- Visual impact
- Environmental impact
- Special technical & safety constraints
- COST

Guidelines that we observe:
Technological choices; Environmental considerations

<table>
<thead>
<tr>
<th>Equipment</th>
<th>OHL</th>
<th>GIL</th>
<th>Cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard lines in rural area</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lines with special constrains, requiring underground solutions (e.g. close to airports, through cities or valleys, in space-restricted areas etc.)</td>
<td>X</td>
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<tr>
<td>Lines with transmission power &gt; 1,500MVA</td>
<td>X</td>
<td>(X)</td>
<td>X</td>
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<td>May need double cable system</td>
<td>X</td>
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Table is for 2,000MVA
Details are extremely dependent upon project conditions!

Approximate cost comparisons: 400kV transmission systems

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Details are extremely dependent upon project conditions!
**Land usage: Comparisons for cable & GIL**

- **Cable**
- **GIL**

Potential savings on land acquisition or lifetime right-of-way costs

**Electromagnetic radiation: Comparisons for OHL, cable & GIL**

**References:**
- Gas-Insulated Transmission Lines (Oct 2010*)

*) Overall tube length >86 km

The End