Cold energy utilization
Potential cold energy users

By where energy is going to be used

Concentrated users
Cold energy and LNG is used in the same place. Natural gas is transported by local gas network.

Distributed users
Cold energy demand is not the same place. Natural gas is transported by public gas network.
Potential cold energy users

**Refrigeration**
Technologically simple. Usually demand for cold energy and LNG is distributed.

**Brayton cycle efficiency**
Chillers for gas turbines. Is not technologically complex. LNG and cold demand is in the same place.

**Cryogenic utilization**
Not efficient and technologically complex. LNG and cold energy demand is usually distributed.

**Combined**
All or some of above combined. Not easy to consolidate gas and cold demands. High efficiency.
Costs of cold energy

Costs of cold energy depends on coolant temperature

-20 °C
1 kwhc ~ 0.182 kwhe
Cold energy price for refrigeration

-50 °C
1 kwhc ~ 0.286 kwhe
Cold energy price is being reduced on higher temperatures

-100 °C
1 kwhc ~ 0.416 kwhe
Cold energy price for cryogenic use

-160 °C
1 kwhc ~ 0.833 kwhe
Costs of natural gas liquification
<table>
<thead>
<tr>
<th>Amount of cold energy wasted</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>On one LNG truck</td>
<td></td>
</tr>
<tr>
<td>3.51 MWhe</td>
<td>-160 °C</td>
</tr>
<tr>
<td>2.36 MWhe</td>
<td>-100 °C</td>
</tr>
<tr>
<td>1.21 MWhe</td>
<td>-50 °C</td>
</tr>
<tr>
<td>0.77 MWhe</td>
<td>-20 °C</td>
</tr>
</tbody>
</table>
Exergetic Cold Energy Recovery System

Mobile cold energy recovery system, which transfers cold energy from very low temperature LNG to higher temperature coolant or fluid.
• Flexible;
• Mobile;
• Scalable;
• Low power consumption;
• Eco-friendly;
• Cascaded energy gathering.
Distributed energy consumer

Cold energy and natural gas demand is not in the same place

- Transmission and distribution
  - Broker’s margin
  - Gaspool/TTF

- Transportation
  - Gaspool/TTF
  - LNG price
    - For common industrial user

- Transmission and distribution
  - Broker’s margin
  - Gaspool/TTF

- Transportation
  - Broker’s margin
  - LNG price
    - For distributed energy user
Distributed cold energy user

Cold energy and natural gas demand is not in the same place

LNG transportation

Cold energy recovery

0.77 – 3.51 MWhe
Demands should coincide
Not only by place, but also by time

Full picture
Projects must evaluated as a whole: LNG implementation + cold energy recovery

Technology
Simple and low maintenance
Further development

- Focusing on early stage project planning involving cold energy utilization in line with LNG use.
- Installation size needs to match equipment cost.
- Ports with refrigerator warehouses and LNG infrastructure can benefit.
Thank you