Application of Renewable Energy in the Petroleum Industry

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Outline

World Oil and Gas Demand
Energy Demand of Oil and Gas Industries
Key Solar Applications in Oil and Gas Industries
Conclusion

World Energy Demand: OPEC Projections up to 2035

<table>
<thead>
<tr>
<th>Year</th>
<th>Oil</th>
<th>Gas</th>
<th>Coal</th>
<th>Nuclear</th>
<th>Renewables</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>300</td>
<td>200</td>
<td>100</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>2035</td>
<td>450</td>
<td>300</td>
<td>250</td>
<td>75</td>
<td>75</td>
</tr>
</tbody>
</table>

Energy Consumption in the Oil and Gas Industry

The oil and gas industry consumes nearly 10% of total oil and gas produced.

Energy Scene Up to 2035/2040

- By 2035/2040, total energy demand will increase by nearly 50% of the present level
- Fossil fuels (oil, gas, and coal) will remain to be the dominating primary energy sources at over 82%, and reserves will remain significant
- 10% of energy produced (oil or gas) is consumed for oil or gas production and processing
- Environmental issues are serious drivers to utilize renewables sources in oil and petroleum processing

To meet very long-term energy demand, we need to be more efficient in oil production and processing.
Characteristics of Energy Usage in the Petroleum Industry

- Main forms of energy usage:
  - Thermal energy (over 93%):
    - Direct fuel
    - Steam
  - Electricity (around 7%): machine drive

- Refineries and petrochemical plants have high energy density (kW h/m²)
- Upstream processing (i.e., gathering centers) have lower energy density (kW h/m²)

Current Solar Applications in the Upstream Industry

- Uninterruptable power systems (UPSs)
- Flow monitoring
- Navigation aids
- Telecommunication
- Tank gauging
- Oil field meters
- SCADA equipment
- Remote telemetry units (RTUs)
- Field laboratories
- Safety and emergency lighting
- Seismic monitoring
- Battery chargers
- Control valves

Solarmine PV Plant at the Chevron Midway-Sunset Oil Field – In Operation Since 2003

Flexible amorphous silicon solar PV plant, with a capacity of 490 kWAC. The plant consisted of 4,800 panels and extended over 6 acres. It was connected to the local electric distribution grid to supplement required power.

Technologies for Solar Thermal Energy Utilization

<table>
<thead>
<tr>
<th>Collector Type</th>
<th>Temperature (°C)</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentrating</td>
<td>&gt; 1000</td>
<td>Power generation, materials research, chemical engin., chemical engin.</td>
</tr>
<tr>
<td>Vacuum Tube</td>
<td>~ 400</td>
<td>Power generation</td>
</tr>
<tr>
<td>Flat plate collectors</td>
<td>~ 90 – 150</td>
<td>Domestic hot water, space heating, industrial processes, space heating, industrial processes</td>
</tr>
<tr>
<td>Advanced Flat plate</td>
<td>~ 90 – 150</td>
<td>Domestic hot water, space heating, industrial processes, space heating</td>
</tr>
<tr>
<td>CPC-, Fresnel-</td>
<td>~ 90 – 150</td>
<td>Process heat applications</td>
</tr>
<tr>
<td>Parabolic Trough</td>
<td>~ 90 – 150</td>
<td>Process heat applications</td>
</tr>
</tbody>
</table>

Collectors for process heat applications

- ~ 90 – 150 °C: Flat plate collectors, parabolic trough collectors, CPC-
- ~ 150 – 250 °C: Advanced flat plate collectors, PCP, vacuum tube collectors
Comparison of collector efficiencies

Future Applications of Solar Energy in Upstream

Concentrated Solar Energy in Enhanced Oil Recovery (EOR)

- Steam temperature requirements for enhanced oil recovery: 115-300 °C
- Natural gas is currently the predominant fuel used to generate steam, but it is rapidly becoming expensive due to short-selling supply.
- Alternative fuel sources could be used, but CO₂ emissions are an issue (CO₂ sequestration could be an additional cost).
- The use of concentrated solar energy can provide huge monetary savings, and providing significant reduction of CO₂ in oil production.
- Solar steam is competitive costing $3.00 per million BTU.

Anticipated Solar Projects for EOR

- Chevron is building a demonstration plant with a capacity of 20 MWAth. Steam is generated by lower technology.
- In GCC countries, PDO/Oman is constructing a concentrated solar thermal pilot plant integrated with the conventional steam plant with a capacity of around 220 ton.
- The GCC has the potential to be a prime market for solar steam extraction of heavy oil due to high solar radiation.

Solar Steam Generation at PDO/Oman: GlassPoint Technology

- Electroplating Steinbach & Vollmann
  - ETC, 400 m²
  - Solar preheater for electroplating (70 °C)

- Food processing - Edmund Merl GmbH
  - Hot water demand for food production = 30 m³/d, 60°C
  - 568 m² flat plate collectors

Gas Pressure Regulating Station

Conclusions

- Solar thermal technologies, especially low and medium temperature systems, are proven and excellent candidates for integration with oil and gas industries.
- Downstream oil and gas are energy intensive. However, they usually lack space for solar collections.
- Upstream poses an attractive candidate for integration with solar systems.
- Integrating solar energy with operation will reduce operating costs and reduce greenhouse gas emissions significantly.

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Thank you