Distributed Cogeneration System for Sustainable Globe

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Kawasaki Heavy Industries, Ltd.
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Contents

1. Introduction of Kawasaki H.I.
2. Energy Saving by Distributed Cogeneration System
3. Contribution of Kawasaki Green Technology
4. Summary and Conclusions
1. Introduction of Kawasaki Heavy Industries

Net Sales in FY2015

FY2015 ¥1,541 Billion

2. Energy Saving by Distributed Cogeneration System

Estimation of Primary Energy Consumption

IEA World Energy Outlook 2010 (New Policy Scenario)
2. Energy Saving by Distributed Cogeneration System

CO₂ Emissions Intensity by fuel

[Graph showing CO₂ emissions intensity by fuel type, with values for different regions and countries.]


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2. Energy Saving by Distributed Cogeneration System

Primary energy consumption by fuel in each country

[Table showing primary energy consumption by fuel type in different countries, with percentages for each fuel source.]

Ref: BP Statistical Review of World Energy June 2016

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2. Energy Saving by Distributed Cogeneration System

Image of Distributed Energy System

- Metropolis
- Local Cities
- Industrial Estate

Central Power Station
- Long Distance
- Waste Heat

Distributed Energy System
- Gas Engine
- Gas Turbine

Solution for issues
- Fragile Grid

Merit of Distributed Energy System

Central Power System
- Power Demand vs. Time
- Central Power Generation
- Investment with too much margin
- Tough grid is required
- Partial operation reduce efficiency

Distributed Energy System
- Power Demand vs. Time
- Distributed Power Generation
- Optimum investment to meet demand
- Impact to grid is minimum
- Improved efficiency at partial load
2. Energy Saving by Distributed Cogeneration System

Energy Saving by Cogeneration System

Conventional system
Fuel: 80 (Natural gas) (GRID)

Cogeneration system
Fuel: 100 (Natural gas) (COGEN)

Improvement of Energy Efficiency
(compared with conventional system)
26%

Reduction of CO₂ Emission

Conventional system
CO₂: 99 (Natural gas) (GRID)

Cogeneration system
CO₂: 100 (Natural gas) (COGEN)

Reduction Rate in CO₂ Emissions
(per year, compared with conventional system)
35%
3. Contribution of Kawasaki Green Technology

Kawasaki Green Gas Turbine cogeneration

◆ Kawasaki Original Technology

- State-of-the-Art design
- High efficiency & low emission output
- High reliability & availability
  - Delivery over 8,600 units (11,500 machines)
  - Development & production experience over 40 years
### 3. Contribution of Kawasaki Green Technology

#### Track Record of Gas Turbine

<table>
<thead>
<tr>
<th>Region</th>
<th>Worldwide</th>
<th>Japan</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>728</td>
<td>7,922</td>
<td>8,650</td>
</tr>
<tr>
<td>Base Load</td>
<td>339</td>
<td>372</td>
<td>711</td>
</tr>
<tr>
<td>Stand-by</td>
<td>389</td>
<td>7,550</td>
<td>7,939</td>
</tr>
</tbody>
</table>

#### Track Record in Europe

- **Japan**: 7,922 units
- **Global**: 8,650 units

- **Europe**: 711 units
  - **Base Load**: 372 units
  - **Stand-by**: 339 units

- **North America**: 711 units
  - **Base Load**: 189 units
  - **Stand-by**: 522 units

- **Middle East**: 74 units
  - **Base Load**: 71 units
  - **Stand-by**: 3 units

- **Far East & Southeast Asia**: 267 units
  - **Base Load**: 6 units
  - **Stand-by**: 261 units

- **Australia & Pacific**: 136 units
  - **Base Load**: 21 units
  - **Stand-by**: 115 units

- **Africa**: 71 units
  - **Base Load**: 14 units
  - **Stand-by**: 57 units

- **Europe**
  - **Base Load + Stand-by**
    - **1976-2016/April**

#### Example of installation in EDP, Portugal

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3. Contribution of Kawasaki Green Technology

Advantage of Kawasaki green gas engine (High performance and environment friendly)

- Kawasaki Original Technology
- World’s highest efficiency (49.5%@LHV)
- Partial Load Performance (45% at 50% Load)
- Wide range operation (30%~100%)
- Rapid startup (Full Load after 10 min.)

World’s highest efficiency and environment friendly

- Efficiency ; 5% improved
- NOx ; Half of conventional, no de-nitration equipment

Kawasaki Green Gas Engine

Highest efficiency
Low NOx

Conventional
3. Contribution of Kawasaki
Green Technology

Track Record of Gas Engine

<table>
<thead>
<tr>
<th></th>
<th>Worldwide</th>
<th>Japan</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple Cycle</td>
<td>3</td>
<td>68</td>
<td>71</td>
</tr>
<tr>
<td>CHP</td>
<td>3</td>
<td>33</td>
<td>36</td>
</tr>
</tbody>
</table>

Japan

Far East & Southeast Asia

North America

110MW Gas Engine Power Plant

Nihon Techno Sodegaura Green Power Project

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Model</td>
<td>KG-18-V</td>
</tr>
<tr>
<td>Unit Output</td>
<td>7,800kW</td>
</tr>
<tr>
<td>No. of Unit</td>
<td>14</td>
</tr>
<tr>
<td>Total Output</td>
<td>109.2MW</td>
</tr>
<tr>
<td>Operation Start</td>
<td>August 2012</td>
</tr>
</tbody>
</table>
3. Contribution of Kawasaki Green Technology

Kawasaki can realize the best solution according to user’s needs

**Gas turbine cogeneration**
- Highest efficiency for cogeneration demand
- The smallest area

**Gas engine**
- Highest efficiency for electric demand
- Cheaper initial cost for middle demand
- Smaller area
- Easy operation

**Coal fired plant**
- Expensive initial cost but cheaper fuel
- For base demand
- Large area and infrastructures
- Highest CO₂ emission

- **Parameters**
  - Environment
  - Demand
  - Base/Peak
  - Electricity/Steam
  - Construction sequence
  - Investment
  - Fuel cost
  - Maintenance

**Best mix solution**

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3. Contribution of Kawasaki Green Technology

Global Network of Kawasaki Cogeneration System

- Kawasaki Gas Turbine Europe GmbH (Frankfurt, Germany)
- Kawasaki Heavy Industries, Ltd. (Tokyo, Japan)
- Kawasaki Machine Systems, Ltd. (Tokyo, Japan)
- Kawasaki Gas Turbines - Americas (Houston, TX, U.S.A.)
- Kawasaki Gas Turbine Asia (Kuala Lumpur, Malaysia)
- Kawasaki Machine Systems, Ltd. (Shanghai, PRC) (Seoul, Korea)
4. Summary and Conclusions

① Distributed energy system is one of the solution to optimize investment and to save energy in Central and Eastern Europe.

② Cogeneration can be employed in distributed system to save energy and to reduce CO₂ emission by effective utilization of the heat.

③ Kawasaki Green Technology assist to the preservation of global environment with the highest efficiency of gas engine and gas turbine.

④ Kawasaki can realize the best solution to combine gas turbine, gas engine and coal fired BTG according to user’s needs.

Köszönöm a figyelmet

Kawasaki, working as one for the good of the planet “Global Kawasaki”