Distributed Power Solutions

Lower Mekong Clean Energy Business Dialogue
Manila
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Imagination at work
Power & Water diverse solutions

>40,000 employees  700 locations

Wind  Solar  Water & Process Technologies  Nuclear

Renewables

Thermal  Power Gen Services  Jenbacher gas engines  Waukesha gas engines  Aeroderivative gas turbines

Distributed Power
Distributed Power

Overview

GE’s distributed power solutions provide businesses and communities the ability to generate reliable and efficient power anywhere, anytime—whether on or off the grid.

Our products cover power generation, compression and mechanical and heat recovery applications from 120 KW - 100 MW, featuring fast, flexible and reliable aeroderivative gas turbines and gas engines fueled by liquid and gaseous fuels* with efficiencies up to 95 percent.

Key Segment Served

Power Producers
• IPP’s, Utilities
• Grid stability, fast start

Commercial, Institutional and Municipal
• Hospitals, Universities, District Heating
• Combined heat and power, grid synchronization

Industrial Manufacturers
• Pulp & Paper, Chemicals, Automotive, Food & Beverage
• Cogeneration, process heat

Oil & Gas
• Exploration, Production, Midstream, Transmission
• Transient response, durable

*Natural gas, biofuels, landfill gas, coal mine gas, special gases
GE's Distributed Power Business

**Technology**
- **Aero**
  - Gas turbines
  - (18-100 MW)
- **Jenbacher**
  - Gas engines
  - (0.3-10 MW)
- **Waukesha**
  - Gas engines
  - (0.1-4 MW)
- **Clean Cycle**
  - Heat-to-power turbine
  - (125 kW)
- **Biomass Gasification**
  - Integrated gasifier system
  - (0.2 MW to 2 MW)

**Target segments**
- **✓ Power Gen**
- **✓ Mech Drive**

The broadest gas-fired portfolio ... 100 kW to 100 MW
Biomass outlook

Substantial economic growth continues ...
Developing regions growing at >5%

Energy deficit concerns ...
Multiple technologies for power generation

Diesel to power... requires fit in solution replacement
Abandoned availability of biomass ... potential segment

Global pressure to reduce carbon foot print
Force action ... including technology incentives
Biomass availability & power Demand - ASEAN

Biomass availability in the region

- Thailand: 11.1GW
- Cambodia: 1.3GW
- Malaysia: 8.2GW
- Phillipines: 2.0GW

Demand for power < 10MW in region

- Indonesia: 30.1GW
- 147MW
- 224MW
- 55MW
- 89MW
- 198MW
- 294MW
- 105MW
- 260MW
- 64MW
- 490MW
- 121MW
- 51MW

Total Biomass Avail. in the region: 52 GW

Total demand in the region: 1.8GW up to 2020
GE’s Gasification Experience

• 1961 ... First oil gasification plant
• 1978 ... First coal gasification plant
• 1984 ... First pet coke gasification plant
• 30 gas turbines operating on syngas > 1+ million operating hours
• 3 GW with GE technologies

Successfull commercial operation of worlds largest IGCC at Duke, in Indiana 618 MW net

GE’s Jenbacher gas engines is a leader in special gas applications

GE’s Jenbacher gas engines special gases experience

• 150+ MWe installed
• 2+ Million oph experience with
  – Woodgas
    50+ units sold/delivered to 10 countries
    5 units AUT, 4 units CH,
    15 units UK, 2 units Japan
  – Steelgas
  – Waste gasification
  – Coke oven gas
  – Landfill gases
Integrated Biomass Gasification Solutions

Robust, Reliable Efficient

- Integrated biomass-to-power solution that produces expected 0.2-2MW output
- Flexible to be configured for power or combined heat & power (CHP) application

Benefits
- Over 2 Million operating hours experience with special gas engines
- Reduced emissions, higher availability compared to conventional biomass to power solutions

Features
- Integrated solution with wrap guarantee
- Gasifier modules, fuel preparation, and feedstock processing
- High operating range

Ideal biomass to power solution for small to medium scale industries (>10 MW requirement)
Biomass Gasification Value Chain

Fuel Procurement
- Feedstock supply

Fuel Processing
- Briquetting
- Drying/Cutting

Gasifier + Gas Clean up
- Activated carbon, Charcoal

Gas Engine
- Refrigeration
- Heating
- Waste heat utilization

By Products
- Woodchip
- Bamboo
- Coconut Shell
- Coconut Fronds
- Rubber tree blocks
- Palm Trunks
- Napier grass
- Palm EFB
- Bagasse
- Palm Shell
- Palm Fronds
- Rice Husk
- Mustard Husk

Biomass Feedstock

Power

Waste Heat

Reliable integrated solution with performance guarantee:

<table>
<thead>
<tr>
<th>Power output</th>
<th>Specific fuel consumption</th>
<th>Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>kWhr</td>
<td>Kg/Whr</td>
<td>Gas/Liq/Solid</td>
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</table>
Case example of biomass power plant

**Typical biomass gasification project <9MW**

**Project economics (1MW solution)**

- Total installed cost: $4 millions
- Specific fuel consumption: 1 kg/Kwh
- Evaluation Period: 5 years
- Fuel cost + O&M: $0.06/Kwh
- Electricity output: 0.9 MW
- Capital cost (70% financing): $0.62 /Kwh
- Typical cost avoidance: ~$0.05+ /kWh
- Typical feed-in-tariff benefit: ~$0.025 /kWh
- ROE: 17%+

*GE estimate for example only*
Biomass in – power out as overall scope of the product, effluent treatment in GE’s scope

Two train X 900 kg/hr gasifier reference plant design ready with 2 X J420 Engine ~2 MW
Using Grass As A Greener Source of Energy

Source of Gas - Napier Grass

GE's Integrated Biomass Gasification Solution

An upgrade from the traditional gasifier technology

Every part of the grass is utilized
Gasifies the Super Napier Grass
Cooks the grass at ultra-high heat
Pure gas that fuels one of GE’s Jenbacher Reciprocating Engines, one of the world’s most efficient power generators
Processes the syngas that is produced

Fast Facts

- 60 hectares of Super Napier Grass would yield 1MW of power a day
- Power generated can be sold locally or regionally through the national grid
- By-products include bio-char and ash
  - can be used by farmers on their lands
- The end user is able to grow the feedstock needed to generate power for their own use
  - This in turn will have a positive ripple effect
    - Creating more employment
    - More investment opportunities
    - Reducing the cost of power in many areas

Fuel Pampanga’s Best Meat Factory

- Provides lower cost electricity
- This project will be able to augment people’s livelihood
- Projects like this will also help fuel the country towards the coming ASEAN Integration in 2015
- Converts waste into energy
- Burns harmful gas in its engines instead of releasing it into the atmosphere
- One of the world’s most efficient generators

Benefits of GE’s Jenbacher Reciprocating Engine
Benefits

- One unit generates 50-140kW of electricity from a heat source
- Heat is the only input; no additional fuel required or emissions generated
- Low maintenance: magnetic bearing generator, no lubricants, no overhauls
- Called an ORC because it utilizes the Organic Rankine Cycle to generate power from heat
How the Clean Cycle works

Clean Cycle™ technology is based on the Organic Rankine Cycle (ORC), which utilizes an organic working fluid with a lower boiling point than water to generate electrical power from heat.

- The cycle is closed loop – there is no combustion and no emissions.
Benefits of 100kW of fuel free power

Reliable electricity
Electrical output is grid quality, at a power factor of 1, and often at a capacity factor that exceeds 90%.

Savings or revenue
Electricity can be sold to the grid or used on-site to offset local consumption.

No added fuel
Heat is the only input required for the Clean Cycle unit to generate electricity.
- One unit avoids 196,000 liters of diesel / year*

No added emissions
The energy conversion process is closed loop and involves no combustion.
- Carbon savings from diesel offset = 143,000kg/yr

Proven performance
Requires no major overhauls, no lubricants, and produces electricity at a power factor of 1.

*Assumes diesel engine fuel efficiency of 0.25L/kWh and 8,000 operating hours
Summary

• “One GE Solution” for various configuration based on rich experienced and proven technology

• Higher engine efficiency, complete plant performance solution according to specifications, integration expertise and strong service support

• Grow fuel envelope and different scale options to continue biomass gasification technology development