Cedar Ridge CE and Technical Environmental Solutions Slovakia present Integration of a solid biomass fuelled CHP generator to wood pellet production technologies
Introduction

• Context
• Requirement / Demand
• Solutions
• Micro-turbine Biomass Generators
• Application to Pellet Production
• Industrial applications in general
• Summary
Context

- Slovak dependence on external energy:
  - Russian gas crisis in January 2009
- EU Energy Policy / SmartGrids
  - Decentralised alternative energy sources
- Slovak Act 309 of 19 June 2009
  - Promotion of renewable energy sources and high-efficiency cogeneration / URSO regulation
- ENEF 2010 results:
  - Slovak biomass can support production of 4 GW with agriculture and 4 GW with silviculture
Requirements

• Alternative energy must be carbon neutral, but also:
  – Efficient in small decentralised facilities
  – Minimise environmental impact
  – Use market-ready solutions
  – Sustainable locally through experience and expertise
  – Meet EU Standards
Requirements: EU Standards

For biomass fired generators under 300 kW, standard EN 303-5 applies for most of the member states in Europe, including Slovakia, with some exceptions:

<table>
<thead>
<tr>
<th>Substance monitored</th>
<th>Emission Limit Value up to 300 kW (mg/MJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Czech Rep.</td>
</tr>
<tr>
<td>PM</td>
<td>167,5</td>
</tr>
<tr>
<td>VOC/OGC</td>
<td>33,5</td>
</tr>
<tr>
<td>CO</td>
<td>435,5</td>
</tr>
<tr>
<td>NOx</td>
<td>435,5</td>
</tr>
<tr>
<td>SO₂</td>
<td>1675,0</td>
</tr>
</tbody>
</table>

Up to 1MW, EU standards vary, but PM +/- 50, VPC/OGC +/- 20, CO +/- 340, NOx +/- 150 (mg/MJ)
Demand

• Simple, economical and efficient biomass generation under 1MW:
  – Secure, reliable and cost-effective alternative energy
  – Remote power sources
  – Adapted to biomass sources
Solutions

• Steam technology is inefficient and expensive below 1 MWe

• Existing smaller scale biomass power generation systems are both inefficient and/or unreliable:
  – Anaerobic digestion and gas engine
  – Gasifier and gas engine

• Modular micro-turbine biomass generators are efficient and clusters are secure
BG50
Micro-turbine Biomass Generators
FUNCTIONAL SCHEME
BG Series Biomass Generators

Fuel supply
Combustion
Flue gas system
Heating
Heat-up Fresh Air
Turbine process
Power production
De-Ashing

AIR-TO-AIR HEAT EXCHANGER
AIR-TO-WATER HEAT EXCHANGER

FRESH AIR
POWER
WOODCHIPS
ASHES
Micro-turbine Biomass Generators BG250
### Micro-turbine Biomass Generators

Emissions monitoring results for BG25 and BG50 units (under 300 kW) conforms to EU standards:

<table>
<thead>
<tr>
<th>Substance monitored</th>
<th>BG25-BG50 Monitoring Result</th>
<th>Conformity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mg/m³ 11% O₂</td>
<td>mg/MJ*</td>
</tr>
<tr>
<td>PM</td>
<td>54,7 &amp; 60,4</td>
<td>38,6 (average)</td>
</tr>
<tr>
<td>VOC/OGC</td>
<td>4,39</td>
<td>2,94</td>
</tr>
<tr>
<td>CO</td>
<td>204,4</td>
<td>137,0</td>
</tr>
<tr>
<td>Formaldehyde**</td>
<td>&lt;0,6</td>
<td>&lt;0,4</td>
</tr>
<tr>
<td>NOₓ</td>
<td>Not tested</td>
<td>est. &lt;150,0</td>
</tr>
<tr>
<td>SO₂</td>
<td>Not tested</td>
<td>est. not significant</td>
</tr>
</tbody>
</table>

* Conversion from mg/m³ to mg/MJ made according to table in Swiss Federal Environment Office (OFEV) publication G412-1063 of October 19th 2007

** For fuels containing adhesives used in multi-density fibreboard (MDF) and Chipboard

And technology conforms to EU standards up to 1 MW (BG250)
Micro-turbine Biomass Generators

- Fuel requirement
  - Size

<table>
<thead>
<tr>
<th>EU G50</th>
<th>% by weight of relevant chip size (mm)</th>
<th>Extreme Values (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20% max</td>
<td>60 – 100%</td>
</tr>
<tr>
<td>&gt;31,5</td>
<td></td>
<td>31,5 – 5,6</td>
</tr>
</tbody>
</table>

- Non-polluting
- Non-corrosive
- Ash content <5%
- Preferred MC <25% (start-up), maximum 40%
Micro-turbine Biomass Generators

• Key factors in achieving energy conversion efficiency
  – High temperature combustor
  – Heat exchangers
  – Micro turbine generator
  – Computer controlled combustion
Micro-turbine Biomass Generators

- Key factors in investment cost efficiency
  - Compact design
  - Modular design
  - Integration of standard components
  - Series manufacturing

(Cost per W is foreseen to progressively approach that of large central facilities)
Micro-turbine Biomass Generators

- Key factors in operating cost efficiency
  - Installation local to energy needs, particularly direct heat utilisation
  - Flexible fuel types
  - Fully automatic computer controls
- Maintainability:
  - Designed for easy cleaning
  - Low annual cost (+/- 2% of technology investment)
- EU energy policy
Micro-turbine Biomass Generators

- **Reduction in annual carbon emissions**
  - **BG25:** 212 tonnes (8000 hours)
  - **BG50:** 375 tonnes (8000 hours)
  - **BG250:** 2650 tonnes (8500 hours)

- **Based on:**
  - 0.45kg CO2 produced per kW electricity for fossil fuel fired power station,
  - 0.19kg CO2 produced kW of heat generated by a gas-fired boiler.
Application to Pellet Production

• Dual BG50 integration to pellet production line and domestic heat:
  – Pellet production line requirement of 180 kWe
    • Direct electrical supply to pellet line
    • Supply to grid when not operating
  – Domestic building heating network uses 95 kWth according to seasonal demand
  – During warm season heat is used the dry pellet production material to improve pellet line efficiency, but no evaluation of cost savings is made
Application to Pellet Production
Application to Pellet Production
Application to Pellet Production

- Dual BG50 Investment and Operating Performance:
  - Installation cost: 1,0 €/W for total CHP energy production (within EU investment project)
  - Input: 2 x 650 tonnes wood chips at <40% m.c. (or equivalent)
  - Output: 2 x 50kWe + 95kWh (>8000 hours/year) (heat recovery foreseen to be increased to 120 kWth)
  - Operating cost:
    - Summer heat used to dry pellet material, but cost incidence is not evaluated
    - Winter heating with 50% heat usage including maintenance, depreciated over 15 years: 0,074 €/kWh
Application to Pellet Production

• BG250 Integration to pellet production lines:
  – Fuel is primarily sawdust from wood industry, but also woodchips as required
  – Each BG250 replaces existing 1 MW biomass heat production units
  – Electrical production for each BG250 is foreseen to be directly supplied to grid (250 kWe for 8500 hrs)
  – “Clean” exhaust gases at 300 C are directly used to dry pellet production material
Application to Pellet Production

Current pellet production technology

- Ambient 2,0 kg/s
- Sawdust input + Ambient 2,9 kg/s
- Biomass Heater 1 MW
- 500C 2,0 kg/s
- 215C 4,9 kg/sec
- 30 kW 4,9 kg/s

Proposed Biomass Generator Solution

- Ambient 3,5 kg/s
- Sawdust input + Ambient 1,4 kg/s
- BG250 250 kWe 950 kWth
- 300C 3,5 kg/s
- 215C 4,9 kg/sec
- 30 kW 4,9 kg/s
Application to Pellet Production

- BG250 Integration to pellet production lines:
  - Fuel is primarily sawdust from wood industry, but also woodchips as required
  - Each BG250 replaces existing 1 MW biomass heat production units
  - Electrical production for each BG250 is foreseen to be directly supplied to grid (250 kWe for 8500 hrs)
  - “Clean” exhaust gases at 300 C are directly used to dry pellet production material
  - Efficiency can exceed 95%
Industrial applications in general

- Clusters of 4 x BG250 units:
  - Secure energy supply where installation cost: <1,5 €/W
  - Input: 10 000 tonnes wood chips at <40% m.c. (or equivalent)
  - Output: 1MWe and 2 to 4 MWth (8500 hours/year)
  - Operating cost:
    - Industrial application with 100% heat usage including maintenance, depreciated over 15 years: 0,044 €/kWh
    - Winter heating with 50% heat usage including maintenance, depreciated over 15 years: 0,066 €/kWh
Summary

• Micro-turbine Biomass Generators:
  – Market ready solutions for carbon neutral alternative energy
  – Compact with minimum environmental impact
  – Simple, economical and efficient biomass generation under 1MW
  – Experience and expertise providing standard modular sustainable solution

• Slovak production of biomass generators drawing on significant industry experience