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"Engaging Citizens in Sustainable Energy to improve environment and local Economy”
ECSE Project in 2012-14.

Easy and Affordable Heating Technology on the basis of the Local Straw
By
Janush Cesljak

More about the Project:
http://www.inforse.org/europe/ECSE.htm
http://inforse.org/europe/ECSE_RU.htm

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Easy and Affordable Heating Technology on the basis of the Local Straw

Janush Cesljak – Metalreg Company
AGH-UST PhD Student
Straw

- Straw is a “mature or dried stalks of bread”
## Chemical analysis of straw in %

<table>
<thead>
<tr>
<th>Straw</th>
<th>Ash</th>
<th>Coal</th>
<th>Hydrogen</th>
<th>Oxygen</th>
<th>Nitrogen</th>
<th>Sulfur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whet</td>
<td>6,53</td>
<td>48,53</td>
<td>5,3</td>
<td>39,08</td>
<td>0,28</td>
<td>0,05</td>
</tr>
<tr>
<td>Barley</td>
<td>4,30</td>
<td>45,67</td>
<td>6,5</td>
<td>38,26</td>
<td>0,43</td>
<td>0,11</td>
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<tr>
<td>Corn</td>
<td>5,77</td>
<td>47,09</td>
<td>5,4</td>
<td>39,79</td>
<td>0,81</td>
<td>0,12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Straw</th>
<th>Dry straw Calories (MJ/kg)</th>
<th>Fresh straw Calories (MJ/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat</td>
<td>17,3</td>
<td>12-22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12,9-14,9</td>
</tr>
<tr>
<td>Barley</td>
<td>16,1</td>
<td>12-22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12,0-13,9</td>
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<tr>
<td>Corn</td>
<td>16,8</td>
<td>50-70</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3,3-7,2</td>
</tr>
</tbody>
</table>
Methods of straw incineration

- Straw should be crushed
- Straw can be burned in bales (squared or round) in so-called “cigar” system
Crushed straw

- Ljubanj, Poland

Scheme of heating system on straw

Heat supplier
Water boiler heated by the crushed straw

- Transport screw conveyor
- Channel for smoke
- Gateway
- Fire wall
- Nutrient screw conveyor
  Primary-secondary air
- Speed grill
“Cigar” incineration system
Incineration of the bale

Old technology:

- Flow-through burning
- Efficiency: 55%
- New technology:
- Flow-through burning
- Efficiency more than 80%
- Counter system for burning straw. Air which is blown in by the fan for the straw burn, is divided automatically into preliminary jet for gasification of straw, and the secondary jet for the final burn of the produced gas
Water boiler Ekopal RM
## Characteristics of boilers Ekopal RM

<table>
<thead>
<tr>
<th></th>
<th>Котел</th>
<th>RM 5</th>
<th>RM 10</th>
<th>RM 20</th>
<th>RM 30</th>
<th>RM 01</th>
<th>RM 02</th>
<th>RM 03</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Heat capacity</strong></td>
<td>kW</td>
<td>40</td>
<td>65</td>
<td>70</td>
<td>100</td>
<td>300</td>
<td>400</td>
<td>500</td>
</tr>
<tr>
<td><strong>Cubic capacity of</strong></td>
<td>м³</td>
<td>600</td>
<td>1150</td>
<td>1200</td>
<td>1700</td>
<td>5100</td>
<td>6800</td>
<td>8500</td>
</tr>
<tr>
<td>heated rooms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Efficiency</strong></td>
<td>%</td>
<td>85</td>
<td>85</td>
<td>85</td>
<td>85</td>
<td>85</td>
<td>85</td>
<td>85</td>
</tr>
<tr>
<td><strong>Water temperature</strong></td>
<td>°C</td>
<td>95</td>
<td>95</td>
<td>95</td>
<td>95</td>
<td>95</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td><strong>Water at outlet</strong></td>
<td>°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Exchange surface</strong></td>
<td>м²</td>
<td>9,0</td>
<td>11,1</td>
<td>13,0</td>
<td>16,7</td>
<td>30,8</td>
<td>34,0</td>
<td>36,0</td>
</tr>
<tr>
<td>of heat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Water volume</strong></td>
<td>м³</td>
<td>0,5</td>
<td>0,6</td>
<td>0,7</td>
<td>0,9</td>
<td>1,7</td>
<td>1,7</td>
<td>1,7</td>
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<tr>
<td><strong>Required chimney</strong></td>
<td>Пл</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>55</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>draft</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>The flow of fuel</strong></td>
<td>Кг/ч</td>
<td>12</td>
<td>19</td>
<td>21</td>
<td>30</td>
<td>90</td>
<td>120</td>
<td>150</td>
</tr>
<tr>
<td><strong>Unit load:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- round bale 80х40х40 cm</td>
<td>шт</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>6</td>
<td>ок.30</td>
<td>ок.30</td>
<td>ок.30</td>
</tr>
<tr>
<td>- Ø 125 – 170 cm</td>
<td>шт</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>The fan motor</strong></td>
<td>кВ</td>
<td>0,20</td>
<td>0,50</td>
<td>0,75</td>
<td>0,75</td>
<td>2,2</td>
<td>3,5</td>
<td>4,5</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>кг</td>
<td>1100</td>
<td>1200</td>
<td>1250</td>
<td>2200</td>
<td>5200</td>
<td>5600</td>
<td>6000</td>
</tr>
<tr>
<td><strong>Size:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- length</td>
<td>мм</td>
<td>1400</td>
<td>1350</td>
<td>1500</td>
<td>1690</td>
<td>2560</td>
<td>2635</td>
<td>2400</td>
</tr>
<tr>
<td>- width</td>
<td>мм</td>
<td>760</td>
<td>1150</td>
<td>1100</td>
<td>1210</td>
<td>2260</td>
<td>2070</td>
<td>2070</td>
</tr>
<tr>
<td>- height</td>
<td>мм</td>
<td>1820</td>
<td>2070</td>
<td>1920</td>
<td>2050</td>
<td>2700</td>
<td>2650</td>
<td>2650</td>
</tr>
</tbody>
</table>
Diagram of connected heating system
Actual view of connected heating system
Boilers are made depending on customer types in:

- Farms
- Schools
- Houses
- Plants
- Farms for pigs/birds
- Villages
Example

- Option of Ekopal RM 40 with accumulator tank- container in Scotland
Water boiler 500kW - Krasnodar
Water boiler 3x400kw, Poland
Water boiler 180 kW, school in Central Poland
Air heaters 2x1 MV
Air heater till 1000 kW
Dryer ARAJ 2,3 MV
Alignment of the temperature of the fuel oil air in air heater conducted via a pump installed in the heater air which circulates the oil from the lower side to the upper side of the air heater. Air heater is going to the customer and it must be connected to the chimney (flue system), and a drying system.

Benefits:
- The replacement of 100% of the previous expensive fuels (oil, gas, coal) dryers on the straw, wood waste, energy crops, or it seems that –
- High thermal efficiency - around 85%
- Temperature control,
- Exchange rate: 1 liter of fuel oil = 2.7 kg of straw,
- High strength and high quality,
- A stable preservation medium heat (heating oil)
- Application: for drying of different breads, especially corn, grasses, vegetables, wood and so on.
Calculations

<table>
<thead>
<tr>
<th></th>
<th>oil</th>
<th>straw</th>
</tr>
</thead>
<tbody>
<tr>
<td>thermal power</td>
<td>690kW</td>
<td>700kW</td>
</tr>
<tr>
<td>charge</td>
<td>20T</td>
<td>20T</td>
</tr>
<tr>
<td>Time for drying</td>
<td>App. 11h.</td>
<td>App. 11h.</td>
</tr>
<tr>
<td>Fuel consumption</td>
<td>750 L</td>
<td>2000 kg</td>
</tr>
</tbody>
</table>

- **Price:**
  - 1 liter: 4PLN 1 Euro
  - 1 ton of straw: 180 PLN 44 Euro
  - Oil: 750 liters x 1 Euro = 750 Euro
  - Straw: 2 tons x 44 Euro = 88 Euro
  - Condition: Farmer does not buy the straw!
  - Earnings in 11 hours 662-750 Euro!
Economy

- Equivalent:
  - 1 kg of coal = 1.5 kg of straw
  - 1 lt of fuel = 2.7 kg of straw

- Price for 1 ton of coal is 700 PLN
- Price for 1000 lt of fuel is 4000 PLN
- Price for 1 ton of straw 180 PLN
Benefits from straw boilers

- For the local authorities:
  - New work places
  - Possibility of selling your own straw - no need in use of fossil fuels
  - Less emissions
  - Use the straw instead of burning it on the fields
• For investors/ towns
• Less costs on heating
• Working places
• Fuel is bought from the local people
• Contracts with the farmers
• Boiler produces ash, which can be rich of minerals for fertilizers
Reduction of air emissions

- Modernization by changing the coal boiler RUMIA on straw boiler 500 kW RM EKOPAL

<table>
<thead>
<tr>
<th>Type of pollution</th>
<th>coal (kg/year)</th>
<th>Straw (kg/year)</th>
<th>Ecological effect (kg/year)</th>
<th>% of reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO2</td>
<td>2144</td>
<td>256</td>
<td>1888</td>
<td>88</td>
</tr>
<tr>
<td>NO2</td>
<td>300</td>
<td>205</td>
<td>95</td>
<td>32</td>
</tr>
<tr>
<td>CO</td>
<td>9000</td>
<td>1920</td>
<td>7080</td>
<td>79</td>
</tr>
<tr>
<td>dust</td>
<td>3900</td>
<td>2218</td>
<td>1682</td>
<td>43</td>
</tr>
</tbody>
</table>
Economical effects

20 kW for straw:
house 100 m²
payback 4 years

40 кВ for 3 cubic bales of straw 80x40x40 см
house 200 м²
payback period 5–6 years

Instead of buying coal, use of your own biomass
Only 8 MV thermo-station DH-Luban (West Poland)
Fuel treatment
Dryer of the exhaust gases
Offer

• Good alternative for the countries which has the same climate as in Poland

• Use biomass locally for heating in farming regions (where the straw grows) it will reduce costs for transportation, create working places and help to develop farming
The main principle of biomass strategy must be:

- Use of the biomass fuel on the local level

- In case of the excess of straw you can sell it to the neighbour
• **Strategy:**

• In short time (now): keep small and average size boilers, which are more cheaper and easy in use

• Average time: to develop local organizations (in Poland ORC) which are based on biomass for the formation of the power split