Feasibility study for production of briquettes and pellet in Kosovo using agricultural waste

Martin Englisch
The data compiled are based on personal visits, interviews and literature – real potentials and qualities may be different!

Before starting a new business: potentials, qualities and quantities shall be verified carefully!
1. Introduction – pellet market with regional differences
2. Market and prospectives in Kosovo
3. Wood pellet production Kosovo
4. Alternative raw materials
5. Summary
Pellet markets

High fuel quality, high price

- bagged, 15kg

~ 2 - 20 t

~ 20 - 1000 t

bulk

Low fuel quality, low price

~ >1000 t

Stoves
Hot air - room heating

Boiler
hot water, distribution within building

District heating/industry
hot water or steam; distribution grid

Power plants / CHP
Power with or without heat
Strategies and options

Comparison based on 2 Eastern European regions:

- **Baltics**
  - (EE, LV, LT)
  - High quality low price export
  - Highly industrial

- **Western Balkan**
  - (SI, HR, RS, BA, MN)
  - Past: low quality low price export
  - Now: regional market, low quality
  - Decentralized, many SME’s
## Area and forests

<table>
<thead>
<tr>
<th>Country</th>
<th>Population [Mio.]</th>
<th>Area [km²]</th>
<th>% Forests [%]</th>
<th>Forest Area [km²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE</td>
<td>1.3</td>
<td>45,500</td>
<td>50</td>
<td>22,750</td>
</tr>
<tr>
<td>LV</td>
<td>2</td>
<td>64,500</td>
<td>46</td>
<td>29,670</td>
</tr>
<tr>
<td>LT</td>
<td>2.9</td>
<td>65,300</td>
<td>30</td>
<td>19,590</td>
</tr>
<tr>
<td>Baltics</td>
<td>6.2</td>
<td>175,300</td>
<td>72</td>
<td>72,010</td>
</tr>
<tr>
<td>BA</td>
<td>3.8</td>
<td>51,200</td>
<td>53</td>
<td>27,136</td>
</tr>
<tr>
<td>HR</td>
<td>4.3</td>
<td>56,600</td>
<td>37</td>
<td>20,942</td>
</tr>
<tr>
<td>RS</td>
<td>7.1</td>
<td>77,500</td>
<td>31</td>
<td>24,025</td>
</tr>
<tr>
<td>MN</td>
<td>0.6</td>
<td>13,800</td>
<td>40</td>
<td>5,520</td>
</tr>
<tr>
<td>SI</td>
<td>2.1</td>
<td>20,200</td>
<td>62</td>
<td>12,524</td>
</tr>
<tr>
<td>Balkan</td>
<td>17.9</td>
<td>219,300</td>
<td>90</td>
<td>90,147</td>
</tr>
</tbody>
</table>

Sources: World Bank
Baltics

- 80 % plants certified
- 82 % production capacity used
- Average plant size 70,000 t/a
- Dynamic growth of production

<table>
<thead>
<tr>
<th></th>
<th>pellet plants</th>
<th>ENplus plants</th>
<th>capacity 2014</th>
<th>production 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>EE</td>
<td>16</td>
<td>10</td>
<td>1.280</td>
<td>995</td>
</tr>
<tr>
<td>LV</td>
<td>16</td>
<td>14</td>
<td>1.480</td>
<td>1.320</td>
</tr>
<tr>
<td>LT</td>
<td>12</td>
<td>11</td>
<td>350</td>
<td>250</td>
</tr>
<tr>
<td>Baltics</td>
<td>44</td>
<td>35</td>
<td>3.110</td>
<td>2.565</td>
</tr>
<tr>
<td>BA</td>
<td>32</td>
<td>14</td>
<td>296</td>
<td>206</td>
</tr>
<tr>
<td>HR</td>
<td>14</td>
<td>14</td>
<td>240</td>
<td>220</td>
</tr>
<tr>
<td>RS</td>
<td>37</td>
<td>8</td>
<td>450</td>
<td>250</td>
</tr>
<tr>
<td>MN</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>SI</td>
<td>4</td>
<td>3</td>
<td>120</td>
<td>100</td>
</tr>
<tr>
<td>Balkan</td>
<td>88</td>
<td>40</td>
<td>1.111</td>
<td>780</td>
</tr>
</tbody>
</table>

Sources: AEBIOM statistical report 2015; Enplus hp 01/2017

Balkan

- 45 % plants certified
- 70 % production capacity used
- Average plant size 13,000 t/a
- moderate growth of production
Baltics
- market: mainly industrial pellets (> 80%)
- Financially sound industrial producers
- Quality and Sustainability very important
- Lab equipment > € 20,000.

Balkan
- market: 100% residential
- Mainly decentralized sawmilling
- Many SME’s invested in production
- Quality and Sustainability not important
- Lab equipment < € 10,000.
ENplus® on Balkan

Certification for export (only)
- In the beginning: significant higher price for „quality pellets“ in Italy
- Now: requirement for export

Certification
- not seen as helpful tool (to improve quality)
- often more like a fee

Professional experience of management missing
- Market requirements unknown
- Quality influencing factors unknown
ENplus® in Southeast Europe

ENplus certified production in SE Europe

Source: EPC, Rakos 2016
ENplus® in Southeast Europe

Number of ENplus certified companies

- Bosnia and Herzegovina
- Bulgaria
- Croatia
- Montenegro
- Serbia
- Slovenia

Source: EPC, Rakos 2016
Quality requirements

Defined in ISO 17225-2 (basis for ENplus®, DINplus):

**A1:** Conifers and hardwood, without bark and contamination (logs, sawdust, shavings)

**A2:** Conifers and hardwood, depending on bark with or without bark, without contamination like sand, soil (logs, firewood, sawdust, shavings)

**B:** Conifers and hardwood, with bark, with some contamination like sand, soil (logs, firewood, sawdust, shavings, thinnings, branches, wood from plantation e.g. poplar)

Any agricultural residues: not accepted for quality wood pellets, however, there is ISO 17225-6: „Non-woody pellets“
Development on Balcan

- Process development improvements in HR, RS, BA: e.g. production of A1 pellets from beech-roundwood with debarking
Competitiveness in export is challenging:
- transport distance
- high production cost (raw material)
- colour and class A2

Local market may be a game changer – best example Kosovo:
- Fastest growing European market
- People are used to low quality pellets
- Low quality heating systems

=> introduction of pellets/briquettes with some drawbacks may be better accepted than in other markets (if prices are competitive)
1. Introduction – pellet market with regional differences
2. Market and prospectives in Kosovo
3. Wood pellet production Kosovo
4. Alternative raw materials
5. Summary
Kosovo, fastest growing pellet market in Europe

Pellet sales (bags only):
2014: 24,000 t
2015: 38,000 t
2016: 57,000 t

<table>
<thead>
<tr>
<th>Boiler by input</th>
<th>Share of sales 2016</th>
<th>Ratio of sales 2016/2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood/coal</td>
<td>21.2%</td>
<td>- 19.4%</td>
</tr>
<tr>
<td>Pellets</td>
<td>75.5%</td>
<td>+ 35.0%</td>
</tr>
<tr>
<td>Electricity</td>
<td>2.5%</td>
<td>- 23.8%</td>
</tr>
<tr>
<td>Oil</td>
<td>0.8%</td>
<td>- 35.6%</td>
</tr>
</tbody>
</table>

Domestic heating systems 2016:
- It is assumed that in 2016 more than 3000 pellet boilers/stoves were sold.
- Average consumption 6 t/a!

Source: study by Enver Bajçinca and Ekrem Hoxha, BNG consulting Pristina
Market in Kosovo

Demand for pellets is increasing with very high rate.

Domestic production is limited due to wood-resources.

This project aims at:

Find potential raw materials suitable for pellet/briquette production
Method applied

Field study:

- Interviews with market participants
  - 3 pellets producer
  - 3 wheat farmer
  - 1 wine producer
  - 1 wine pruning briquette producer
  - 2 raspberry producers
  - 1 fruit manufacturing company
- Personal evaluation of existing structures, technologies and potentials
- Sampling for lab analysis (total 14 samples)

Fuel parameters:

- Lab analysis
- Comparison with literature
Locations visited in field study

- Wine prunings 1-3
- Wood pellet producer 1
- Wood pellet producer 2
- Wood pellet producer 3
- Rasperry sample 1-2
- Rasperry sample 3
- Straw sample 1
- Straw sample 2
- Straw sample 3
- USAid Kosovo
- Wine prunings briquetts
Content

1. Introduction – pellet market with regional differences
2. Market and prospectives in Kosovo
3. Wood pellet production Kosovo
4. Alternative raw materials
5. Summary
For confidential reasons, data from 3 lead manufacturers from the local pellet market will not be published in this presentation.

Thank you for your understanding.
1. Introduction – pellet market with regional differences
2. Market and prospectives in Kosovo
3. Wood pellet production Kosovo
4. Alternative raw materials
5. Summary
For industrial pellets production of residential pellet, following criteria should be assessed:

- Raw material quantity available, size and volumes of individual suppliers
- Availability during year; storage options and material stability
- Harvesting, collection, logistics (incl. bulk density of raw material)
- Fuel parameters
  - Water content
  - Heating value
  - Ash content
  - Ash melting behaviour
  - Nitrogen content
  - Korrosive potential (Chlorine, Sulphur)
  - Harmful contamination (e.g. heavy metals)
Wheat straw

Quantity available, size and volumes of individual suppliers:

• Suppliers [Kosovo Green Report 2016]:
  • Farms are small, ~ 90% of farmland owned by farmers with less than 20 ha
  • Only ~ 35,000 ha is in farms > 10 ha which may be potential suppliers (total 180,000 ha)
  • ~90,000 ha wheat in total
  • ~40,000 ha maize
  • Other cereals low

• Potentials
  • average wheat yield is ~3,5 t/ha
  • According interviewed farmers, straw yield is ~ 3 t/ha (300 bales a 10 kg)
  • Most of the straw is used in farms, surplus in big farms max. 30%
  • Max. potential: 35,000 ha * 0,6wheat* 0,3surplus*3 ~ 20,000 t in whole Kosovo!

• Quantity low!
Wheat straw

Current use / competition:
  currently use: by farmers
  rest burned on fields (picking up and baling is costly)

Availability during year:
  summer-autumn on field
  traditional stores on farms whole year (small quantities)

Prices:
  • € 30 per ha if loose on field
  • € 100 - € 170 in bales depending on season
    (typically € 1.- per bale)
  • € 75 - € 80 in larger quantities

Harvesting, collection, logistics:
  bulk density low – transport is problem

Farm Kllokot, 3,5 ha
Wheat straw

- Water content may vary but usually OK for pellet production without drier
- NCV 90% of wood
- Ash content very high
- Ash melting behaviour: very low
- Nitrogen content: high
- Corrosive potential: high
- Heavy metals: low
- Potential as fuel; only for industrial systems not residential!
Straw – international use as fuel

Poland:
- Co-combustion in coal fired powerplants: straw, sunflower husks etc. due to low prices (e.g. imports from Ukraine)
- Coal compensates some of the problems with straw.

Denmark:
- Many district heating systems on straw;
- developed for this fuel;
- experienced fuel preparation and handling
- Power plants (Avedore) stopped using straw because of corrosion and slagging

Austria:
- 2 district heating systems since 20 years, others have closed
- Extensive research for small scale use including large field studies: problems with corrosion and slagging could not be solved

Germany:
- From total 44 Mio. t straw, 20% is potential for energy generation.
- Due to corrosion, slagging and emissions a combustion in small units is not possible.
- Currently there are large scale projects e.g. Emlichheim (95.000 t/a)
Wine prunings

Quantity available, size and volumes of individual suppliers:

- per grapevine 2.5 kg prunings are cut every year
- 3000 grapevines per ha resulting in 7.5 t wine prunings per ha
- Largest winary „Stone Castle“: 650 ha (~ 4.500 t)
- In same region additional: 1700 ha (~ 12.000 t)
- Total Kosovo: 3200 ha (~24.000 t)

• Quantity interesting!
Wine prunings

Current use / competition:
  used by employees as fuel
  burned on fields
  disposal required
  Interest for district heating (Jakova)

Availability during year:
  January – April
  currently free;
  offer/estimated € 40.-/t (db)

Harvesting, collection, logistics:
  cost for collection unknown;
  usually collected on collection places
  bulk density very low (110 kg/m³) – collection and transport is problem
Quality wine prunings

- different species, similar composition
- Water content may vary: 10% - 40% drying appliances necessary for pellets, heat demand small
- NCV close to wood
- Ash content between wood-logs and bark
- Ash melting behaviour: OK
- Nitrogen content: OK
- Corrosive potential: low; S/Cl good
- Good fuel properties!

<table>
<thead>
<tr>
<th>Sample 2017188</th>
<th>Standard</th>
<th>unit</th>
<th>Wine prunings Italian</th>
<th>Wine prunings Hamburg</th>
<th>Wine prunings Riesling</th>
<th>prunings briquettes</th>
</tr>
</thead>
<tbody>
<tr>
<td>moisture content</td>
<td>ISO 18134-2</td>
<td>[%]</td>
<td>12,5</td>
<td>14,6</td>
<td>15,2</td>
<td>10,7</td>
</tr>
<tr>
<td>ash content 550°C (db)</td>
<td>ISO 18122</td>
<td>[%]</td>
<td>3,7</td>
<td>4,1</td>
<td>3,5</td>
<td>4,0</td>
</tr>
<tr>
<td>net calorific value (ar)</td>
<td>ISO 18125</td>
<td>[MJ/kg]</td>
<td>15,3</td>
<td>14,9</td>
<td>14,8</td>
<td>15,8</td>
</tr>
<tr>
<td>net calorific value (ar)</td>
<td>ISO 18125</td>
<td>[kWh/kg]</td>
<td>4,2</td>
<td>4,1</td>
<td>4,1</td>
<td>4,4</td>
</tr>
<tr>
<td>net calorific value (db)</td>
<td>ISO 18125</td>
<td>[MJ/kg]</td>
<td>17,8</td>
<td>17,9</td>
<td>17,8</td>
<td>18,0</td>
</tr>
<tr>
<td>net calorific value (db)</td>
<td>ISO 18125</td>
<td>[kWh/kg]</td>
<td>4,9</td>
<td>5,0</td>
<td>5,0</td>
<td>5,0</td>
</tr>
<tr>
<td>Sulphur content (db)</td>
<td>ISO 16994</td>
<td>[%]</td>
<td>0,046</td>
<td>0,052</td>
<td>0,055</td>
<td>0,049</td>
</tr>
<tr>
<td>Chlorine content (db)</td>
<td>ISO 16994</td>
<td>[%]</td>
<td>0,0055</td>
<td>0,0044</td>
<td>0,0061</td>
<td>0,051</td>
</tr>
<tr>
<td>Carbon content (db)</td>
<td>ISO 16948</td>
<td>[%]</td>
<td>48,0</td>
<td>48,9</td>
<td>48,6</td>
<td>49,0</td>
</tr>
<tr>
<td>Hydrogen content (db)</td>
<td>ISO 16948</td>
<td>[%]</td>
<td>6,0</td>
<td>6,0</td>
<td>6,1</td>
<td>5,9</td>
</tr>
<tr>
<td>Nitrogen content (db)</td>
<td>ISO 16948</td>
<td>[%]</td>
<td>0,75</td>
<td>0,63</td>
<td>0,69</td>
<td>0,85</td>
</tr>
<tr>
<td>major ash forming elements</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminium (db)</td>
<td>ISO 16967</td>
<td>[mg/kg]</td>
<td>114</td>
<td>313</td>
<td>81</td>
<td>638</td>
</tr>
<tr>
<td>Calcium (db)</td>
<td>ISO 16967</td>
<td>[mg/kg]</td>
<td>7900</td>
<td>8900</td>
<td>7100</td>
<td>5700</td>
</tr>
<tr>
<td>Iron (db)</td>
<td>ISO 16967</td>
<td>[mg/kg]</td>
<td>64</td>
<td>251</td>
<td>35</td>
<td>457</td>
</tr>
<tr>
<td>Potassium (db)</td>
<td>ISO 16967</td>
<td>[mg/kg]</td>
<td>5800</td>
<td>3900</td>
<td>5600</td>
<td>4400</td>
</tr>
<tr>
<td>Magnesium (db)</td>
<td>ISO 16967</td>
<td>[mg/kg]</td>
<td>660</td>
<td>1100</td>
<td>790</td>
<td>1100</td>
</tr>
<tr>
<td>Sodium (db)</td>
<td>ISO 16967</td>
<td>[mg/kg]</td>
<td>&lt;72</td>
<td>&lt;76</td>
<td>69</td>
<td>140</td>
</tr>
<tr>
<td>Phosphorus (db)</td>
<td>ISO 16967</td>
<td>[mg/kg]</td>
<td>1900</td>
<td>1160</td>
<td>1450</td>
<td>1360</td>
</tr>
<tr>
<td>Silicum (db)</td>
<td>ISO 16967</td>
<td>[mg/kg]</td>
<td>599</td>
<td>1340</td>
<td>304</td>
<td>2760</td>
</tr>
<tr>
<td>heavy metals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chromium (db)</td>
<td>ISO 16968</td>
<td>[mg/kg]</td>
<td>&lt;1</td>
<td>1,78</td>
<td>&lt;1</td>
<td>1,22</td>
</tr>
<tr>
<td>Copper (db)</td>
<td>ISO 16968</td>
<td>[mg/kg]</td>
<td>6,68</td>
<td>7,56</td>
<td>5,70</td>
<td>7,58</td>
</tr>
<tr>
<td>Zinc (db)</td>
<td>ISO 16968</td>
<td>[mg/kg]</td>
<td>30,9</td>
<td>88,6</td>
<td>27,5</td>
<td>30,1</td>
</tr>
<tr>
<td>Lead (db)</td>
<td>ISO 16968</td>
<td>[mg/kg]</td>
<td>&lt;0,5</td>
<td>1,99</td>
<td>&lt;0,5</td>
<td>2,28</td>
</tr>
<tr>
<td>Mercury (db)</td>
<td>ISO 16968</td>
<td>[mg/kg]</td>
<td>&lt;0,05</td>
<td>&lt;0,05</td>
<td>&lt;0,05</td>
<td>&lt;0,05</td>
</tr>
<tr>
<td>Cadmium (db)</td>
<td>ISO 16968</td>
<td>[mg/kg]</td>
<td>&lt;0,1</td>
<td>&lt;0,1</td>
<td>&lt;0,1</td>
<td>&lt;0,1</td>
</tr>
<tr>
<td>Arsenic (db)</td>
<td>ISO 16968</td>
<td>[mg/kg]</td>
<td>&lt;0,5</td>
<td>&lt;0,5</td>
<td>&lt;0,5</td>
<td>&lt;0,5</td>
</tr>
<tr>
<td>Nickel (db)</td>
<td>ISO 16968</td>
<td>[mg/kg]</td>
<td>6,41</td>
<td>5,89</td>
<td>1,98</td>
<td>3,85</td>
</tr>
<tr>
<td>Ash melting behaviour</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>shrinking temp. SST</td>
<td>CEN/TS 15370-1</td>
<td>[°C]</td>
<td>630</td>
<td>920</td>
<td>1110</td>
<td>740</td>
</tr>
<tr>
<td>deformation temp. DT</td>
<td>CEN/TS 15370-1</td>
<td>[°C]</td>
<td>1120</td>
<td>1140</td>
<td>1200</td>
<td>1200</td>
</tr>
<tr>
<td>hemisphere temp. HT</td>
<td>CEN/TS 15370-1</td>
<td>[°C]</td>
<td>&gt;1550</td>
<td>1320</td>
<td>&gt;1550</td>
<td>&gt;1550</td>
</tr>
<tr>
<td>flow temp. FT</td>
<td>CEN/TS 15370-1</td>
<td>[°C]</td>
<td>&gt;1550</td>
<td>1330</td>
<td>&gt;1550</td>
<td>&gt;1550</td>
</tr>
</tbody>
</table>
Wine prunings – international use as fuel

Spain:
- **EU-project mixBioPells**
- 30,000 ha wineyards => 20,000 t prunings/a (??)
- mostly burned on fields
- some pellets are produced
- some Austrian pellet boiler manufacturers (dominating Spanish market) have developed boilers

Italy
- potential 0.7 – 0.8 Mio. t. particularly Veneto Region; 70 – 75,000 ha; ~ 0.1 Mio. t (db) biomass
- regional entrepreneurs developed equipments for harvesting of grapevine pruning and its utilization to produce energy
- various commercial and research projects
- Special focus on heavy metals (e.g. Cu) from treatments: below limits
- Production price pellets: 120.- - 130.- €/t
Wine prunings – briquette production in Kosovo

Company „Thermoinverz“, Krushë
- Very small production plant
- Production 100 t in 2017
- Briquetts are produced with a piston press
- Raw materials:
  - ~ 80% wine prunings
  - ~ 20% softwood sawdust
- Wine prunings are chipped and mixed with sawdust and pressed without drying (sensitive to raw material moisture)
- Manual bagging
- Sales price: € 160.- / t
- Customers appreciate longer burning time up to 1:15 h compared with wood-briquettes (30-35 min)
Quantity available, size and volumes of individual suppliers:

- Quantity not known and cannot be calculated; required:
  - Total planted area in ha
  - Amount of pruning – depending on species e.g.
    - “Polka” and “Mapena” clearcut after season, “
    - Willamette” planted in hedges like grapevines only partly cut (less than e.g. grapevines)
- Plants are grown in rows, distance 2.8-3 m: automated collection is possible
- Suppliers: smaller units
- **Quantity needs evaluation!**
raspberry prunings

Current use / competition:
  currently no use - burned on fields
  no use for mulching fields due to risk of diseases – removement preferred
  potential use as fertilizer
  one small pelet producer uses little?

Availability during year:
  October – November
  No price

Harvesting, collection, logistics: 
  cost for collection unknown;
  usually collected on collection places
  bulk density very low – collection and transport is problem
Quality raspberry

- Water content may vary: 10% - 50% drying appliances necessary, heat demand like fresh wood
- NCV close to wood, little less
- Ash content very high
- Ash melting behaviour: OK
- Nitrogen content: high
- Corrosive potential: high
- Heavy metals: different, depend on pesticide/fugizid
- Has potential as fuel; care is necessary!

| Sample 2017188 | Standard | unit | raspberry prunings "Polka" | raspberry prunings "Mapema" | raspberry prunings "Leposavic"
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>moisture content</td>
<td>ISO 18134-2</td>
<td>[%]</td>
<td>44.6</td>
<td>42.7</td>
<td>12.5</td>
</tr>
<tr>
<td>ash content 550°C (db)</td>
<td>ISO 18122</td>
<td>[%]</td>
<td>15.49</td>
<td>7.05</td>
<td>4.05</td>
</tr>
<tr>
<td>net calorific value (ar)</td>
<td>ISO 18125</td>
<td>[MJ/kg]</td>
<td>7.8</td>
<td>9.3</td>
<td>15.4</td>
</tr>
<tr>
<td>net calorific value (ar)</td>
<td>ISO 18125</td>
<td>[kWh/kg]</td>
<td>2.2</td>
<td>2.6</td>
<td>4.3</td>
</tr>
<tr>
<td>net calorific value (db)</td>
<td>ISO 18125</td>
<td>[MJ/kg]</td>
<td>16.0</td>
<td>18.0</td>
<td>17.9</td>
</tr>
<tr>
<td>net calorific value (db)</td>
<td>ISO 18125</td>
<td>[kWh/kg]</td>
<td>4.5</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Sulphur content (db)</td>
<td>ISO 16994</td>
<td>[%]</td>
<td>0.062</td>
<td>0.090</td>
<td>0.051</td>
</tr>
<tr>
<td>Chlorine content (db)</td>
<td>ISO 16994</td>
<td>[%]</td>
<td>0.241</td>
<td>0.236</td>
<td>0.023</td>
</tr>
<tr>
<td>Carbon content (db)</td>
<td>ISO 16948</td>
<td>[%]</td>
<td>43.7</td>
<td>49.0</td>
<td>49.4</td>
</tr>
<tr>
<td>Hydrogen content (db)</td>
<td>ISO 16948</td>
<td>[%]</td>
<td>5.4</td>
<td>5.8</td>
<td>5.8</td>
</tr>
<tr>
<td>Nitrogen content (db)</td>
<td>ISO 16948</td>
<td>[%]</td>
<td>1.14</td>
<td>1.77</td>
<td>0.85</td>
</tr>
</tbody>
</table>

**major ash forming elements**

| Aluminium (db) | ISO 16967 | [mg/kg] | 6190 | 503 | 342 |
| Calcium (db) | ISO 16967 | [mg/kg] | 12000 | 14000 | 8400 |
| Iron (db) | ISO 16967 | [mg/kg] | 5500 | 242 | 276 |
| Potassium (db) | ISO 16967 | [mg/kg] | 6800 | 10000 | 4200 |
| Magnesium (db) | ISO 16967 | [mg/kg] | 2600 | 2000 | 970 |
| Sodium (db) | ISO 16967 | [mg/kg] | 260 | <130 | 69 |
| Phosphorus (db) | ISO 16967 | [mg/kg] | 1380 | 1960 | 978 |
| Silicium (db) | ISO 16967 | [mg/kg] | 22400 | 1590 | 940 |

**heavy metals**

| Chromium (db) | ISO 16968 | [mg/kg] | 46.60 | 1.43 | <1 |
| Copper (db) | ISO 16968 | [mg/kg] | 14.00 | 4.28 | 8.97 |
| Zinc (db) | ISO 16968 | [mg/kg] | 25.6 | 10.3 | 7.0 |
| Lead (db) | ISO 16968 | [mg/kg] | 5.10 | <0.5 | 1.37 |
| Mercury (db) | ISO 16968 | [mg/kg] | <0.05 | <0.05 | <0.05 |
| Cadmium (db) | ISO 16968 | [mg/kg] | <0.1 | <0.1 | 0.12 |
| Arsenic (db) | ISO 16968 | [mg/kg] | 2.03 | <0.5 | 1.01 |
| Nickel (db) | ISO 16968 | [mg/kg] | 51 | 1.95 | <1 |

**Ash melting behaviour**

| shrinking temp. SST | CEN/TS 15370-1 | [°C] | 890 | 710 | 1060 |
| deformation temp. DT | CEN/TS 15370-1 | [°C] | 1210 | 1310 | 1250 |
| hemisphere temp. HT | CEN/TS 15370-1 | [°C] | 1250 | >1550 | >1550 |
| flow temp. FT | CEN/TS 15370-1 | [°C] | 1260 | >1550 | >1550 |
raspberry prunings – international use as fuel

Poland:
• Industrial combustion of various biomass species in CHP Bialystock
• ~ 1500 t raspberry prunings/waste
• No results in English

Serbia:
• RioRE Briquette (concept only?)

Very little literature available!
Collecting wine and raspberry prunings

- Removal of branches and shoots beyond the area of an orchard or plantation is:
  - more costly but
  - dendromass affected by diseases and pests are removed and
  - obtains the biofuel

- Collection by:
  - hand or
  - automatic
    - 1. first prepare the branches and shoots for removal by gathering them in the middle of the interrows
    - 2. collected and shredded by mowers (shredders) with collectors or
    - 2. baling technology is progressing as well (mainly for grapevine but also for berrys)

Source: Leszek et al., PROBLEMS WITH DERIVING THE FRUIT TREE PRUNED BIOMASS FOR ENERGY USE Agricultural Engineering 2014: 3 (151): 157-167
Bark:
- some potential in saw mills but total Kosovo is small;
- potential use for
  - briquettes (not pellets!) and
  - industrial combustion (main use in Europe especially in countries with big saw mills)
  - gardening (mulching; main use in e.g. UK)

Dung:
- Briquettes made in Kosovo were analyzed => unexpected good fuel properties
- Potential unknown

coffee waste:
- Residues from coffee production is used as fuel (e.g. Austria), has good fuel properties
- company Kraft Foods operates several biomass power plants with coffee grounds, which is obtained in large quantities in the industrial production of instant coffee.
- UK: used coffee is converted to oil and used for London busses:
- Germany: 500,000 t of coffee waste => various initiatives for collection
- Problem: collection and logistics
Straw (wheat straw):

- Potential very limited
- Suppliers are small, purchase and logisics will be difficult
- Fuel properties are very bad, not suitable for small scale appliances
- Price of raw material including logistics is high

Use for residential pellets or briquetts production is not recommended!
Summary: Potentials of alternative raw materials

Wine prunings:

- Total potential is limited but regional potential is interesting
- Suppliers are either small or medium and 1 large supplier (StoneCastle)
- Fuel properties are good
- Price of raw material is low
- Logistic systems to be developed

Use for residential pellets or briquetts production is recommended!
Raspberry prunings:

- Total potential is limited but regional potential is interesting
- Suppliers are either small or medium
- Fuel properties are medium-low but better than straw
- Price of raw material is very low, use of the material would support farmers!
- Logistic systems to be developed

Use for residential pellets or briquetts production should be considered and investigated!
How to connect supply and demand?

Internet based trade platforms:

- Example Poland: http://www.ebiomasa.pl
- Same platform may be used by buyers and sellers.
- Subgroups may be used to focus on certain plants.
Thank You!

Martin Englisch
BEA Institut für Bioenergie GmbH
A-1150 Wien, Avedikstrasse 21
T +43 1 890 93 91
martin.englisch@bioenergy.co.at
www.bioenergy.co.at