Results of Analysis on Supply & Demand, Economic Potential, and Barriers

(Draft results - subject to change)
OBJECTIVE AND SCOPE OF THE STUDY

Objective: Identify viable **investment options** and **policy measures** to increase the use of biomass for heating in the region in a **sustainable** manner.

Scope:
- Biomass supply and demand potential
- Heating options
- In-depth analysis for selected case studies
- Barriers and solutions

Funding: Western Balkans Investment Facility (and ESMAP); sponsored by the Energy Community Secretariat, World Bank as implementing agency.

CONSULTANT ORGANIZATION

**Consortium leader**
Tractebel Engineering - Part of ENGIE Group
Present in more than 20 countries and project in over 80
3,300 Employees
Certified experience in biomass

**Partner**
Centre for Renewable Energy Sources and Saving (CRES) - Greece
Long-term experience in biomass and Western Balkans

**Local support**
South East European Consultants - Serbia
OVERVIEW OF THE PROJECT TASKS

The project activities have been divided into six tasks

✓ (Task 1) Analysis of the biomass supply potential
✓ (Task 2) Assessment of heating systems in the target countries
✓ (Task 3) Assessment of economically viable biomass options for heating
✓ (Task 4) Analysis of key barriers and measures to increase the share of sustainable biomass-based heating

(Task 5) Detailed assessment of using biomass for heating in selected cities/sub-regions

(Task 6) Stakeholder roundtables/workshops at regional and country-level

Case Study I – Macedonia: Preparation of a feasible Developing Program for the replacement of old/traditional wood stoves at individual household level by more efficient models, with a focus on Skopje

Case Study II – Bosnia and Herzegovina: Analysis of the opportunities to introduce or increase the use of biomass in existing DH systems in Bosnia and Herzegovina, replacing oil, gas or coal fired boilers with biomass boilers and evaluating the possibilities for biomass-based CHP

Case Study III – Kosovo: Analysis of the possible supply options using forestry and agricultural biomass residues for District Heating of the city of Gjakova

Case Study IV – Kosovo: Evaluation of the possible replacement of fossil-fired HOBs with biomass boilers in public buildings in Pristina

Case Study V - Serbia, Bosnia and Herzegovina, Croatia: The use of available agricultural wastes and energy crops for sustainable, efficient, renewable heating solutions, in the cross-border region of Serbia, Bosnia and Herzegovina, and Croatia
HEAT DEMAND IN WESTERN BALKANS

**Fuel**
- Biomass: 3,329 ktoe
- Electricity: 1,680 ktoe
- LFO/HFO: 556 ktoe
- Natural gas: 1,146 ktoe
- LPG: 173 ktoe
- Coal (lignite): 981 ktoe
- Other: 18 ktoe
- DH HOB: 879 ktoe

**Heating appliances**
- Stoves: 1,537 ktoe
- Small HOB: 3,755 ktoe
- Electric appliance: 1,680 ktoe
- Multi-store buildings: 4,189 ktoe

**Building type**
- Stand-alone buildings: 3,754 ktoe
- Multi-store buildings: 53%
- Stand-alone buildings: 47%

**Fuel Consumption**

- **Albania**
  - Biomass: 20%
  - Electricity: 62%
  - LFO/HFO: 8%
  - LPG: 8%
  - Other: 2%

- **Bosnia and Herzegovina**
  - Biomass: 56%
  - Electricity: 22%
  - Coal: 26%
  - Natural gas: 7%
  - LFO/HFO: 3%

- **Croatia**
  - Biomass: 29%
  - Electricity: 22%
  - Natural gas: 39%
  - LFO/HFO: 7%
  - LPG: 3%

- **FYR of Macedonia**
  - Biomass: 39%
  - Electricity: 21%
  - Coal: 9%
  - Natural gas: 6%
  - LFO/HFO: 13%

- **Kosovo**
  - Biomass: 54%
  - Electricity: 28%
  - Coal: 9%
  - Natural gas: 20%
  - LFO/HFO: 7%

- **Montenegro**
  - Biomass: 59%
  - Electricity: 21%
  - Coal: 9%
  - Natural gas: 6%
  - LFO/HFO: 13%

- **Serbia**
  - Biomass: 41%
  - Electricity: 28%
  - Coal: 22%
  - Natural gas: 9%
  - LFO/HFO: 7%

**Other**
- CHP (TPP’s): 74 ktoe
• Current use based on woody biomass
• Agricultural residues – mainly untapped
• High level of unregistered woody biomass consumption
• Potential to increase woody biomass production by improving forest road infrastructure
• Significant potential for growing energy crops – large share of unused agricultural land in W-B countries
AVAILABLE BIOMASS TO SUPPLY INCREASED BIOMASS-BASED HEATING

- BIH: 104 ktoe
- MAC: 60 ktoe
- ALB: 52 ktoe
- CRO: 165 ktoe
- MNE: 69 ktoe
- SER: 436 ktoe
- KOS: 68 ktoe

Logging residue: 244 ktoe
Thinnings: 51 ktoe
Woody biomass: 564 ktoe
Prunings: 229 ktoe
Conversion of coppices: 14 ktoe
Sec. forestry residue: 17 ktoe
Wood outside of forest: 9 ktoe

Additional Biomass that could Supply Increased: 954 ktoe
Biomass-based heating

Straw: 390 ktoe
Agricultural biomass: 390 ktoe
### Costs of Biomass and Conventional Fuels for Heating in the Western Balkans

#### Biomass Feedstock

<table>
<thead>
<tr>
<th>Biomass Feedstock</th>
<th>Costs of Production</th>
<th>Harvesting/Collection</th>
<th>Forward Transportation to Forest Road</th>
<th>Transport to the Plant/Powerhouse</th>
<th>Cost of Reconstruction of Forest Roads</th>
<th>Biomass Storage</th>
<th>Pre-treatment</th>
<th>Transport to the End-Use Location</th>
<th>Biomass Fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stemwood</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
<td>+</td>
<td>Firewood</td>
</tr>
<tr>
<td>Thinnings</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
<td>+</td>
<td>Firewood</td>
</tr>
<tr>
<td>Logging residue</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Wood chips</td>
</tr>
<tr>
<td>Secondary forest residue</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Wood pellets</td>
</tr>
<tr>
<td>From the reconstruction of coppices</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Wood chips</td>
</tr>
<tr>
<td>From outside of forest</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Wood chips</td>
</tr>
<tr>
<td>Forest energy crops - Poplar</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Wood chips</td>
</tr>
<tr>
<td>Vineyard and fruit tree prunings</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Wood chips</td>
</tr>
<tr>
<td>Agricultural biomass</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Beales</td>
</tr>
<tr>
<td>Agricultural energy crops - Miscanthus</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>Beales</td>
</tr>
</tbody>
</table>

#### Costs in EUR/MWh

<table>
<thead>
<tr>
<th>Fuel Source</th>
<th>Cost (EUR/MWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pellets and briquettes (sec for residue-sawmill)</td>
<td>83.0</td>
</tr>
<tr>
<td>Wood chips (wood outside forest)</td>
<td>53.5</td>
</tr>
<tr>
<td>Wood chips (legume residues)</td>
<td>57.5</td>
</tr>
<tr>
<td>Wood chips (energy crops - Miscanthus)</td>
<td>45.6</td>
</tr>
<tr>
<td>Maize - corn cob</td>
<td>43.8</td>
</tr>
<tr>
<td>Maize - corn stover</td>
<td>44.6</td>
</tr>
<tr>
<td>Firewood (stemwood)</td>
<td>34.6</td>
</tr>
<tr>
<td>Firewood (thinnings)</td>
<td>28.7</td>
</tr>
<tr>
<td>Firewood (woody energy crops - poplar)</td>
<td>27.4</td>
</tr>
<tr>
<td>Coal (min)</td>
<td>131.7</td>
</tr>
<tr>
<td>HFO</td>
<td>83.0</td>
</tr>
<tr>
<td>Natural gas</td>
<td>53.5</td>
</tr>
<tr>
<td>Electricity</td>
<td>57.5</td>
</tr>
</tbody>
</table>

**Transport <50 km**

Electricity is the most expensive option for heating.
GATE FEE OF WOODY AND AGRICULTURAL BIOMASS IN THE WESTERN BALKANS

Firewood from stem-wood 40-80% more costly than wood chips

8.7-26.9 EUR/MWh <30 km
9.2-27.4 EUR/MWh <50 km
9.8-36.5 EUR/MWh <100 km
TRANSPORT OF BIOMASS

A key component to a viable biomass production / delivery system

<table>
<thead>
<tr>
<th>Biomass Type</th>
<th>Average costs of transport per 1 km, EUR/MWh</th>
<th>Recommended transport distance, in km</th>
</tr>
</thead>
<tbody>
<tr>
<td>Firewood (from stemwood)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firewood (from thinnings)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood chips (from logging residue)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood chips (from coppices)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood chips (from vineyard and fruit prunnings)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood chips (from wood outside of forest)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wood pellets and briquettes (from sawmill residue)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firewood (from thinnings)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firewood (from stemwood)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Cost of transportation of agricultural biomass 7-10 times higher compared to woody biomass
- The cost of transport, storage and pre-treatment of biomass 50-95% of the total delivered cost of the fuel
- Key requirement – to maximize energy density of biomass and gains in transport efficiency
### Private costs
- consumer perspective
- based on actual market prices
- VAT included
- cash flows discounted with a country specific WACC

### Social costs
- private costs + the costs of externalities (GHG, air pollution)
- measures the costs and benefits of the biomass heating to the society
- VAT not included
- cash flows discounted with a 10% discount rate in all W-B countries

*Multi-store buildings in BIH, CRO, KOS, MAC, SER – internal heating network in place
ALB, MNE – added costs of internal heating network*
# Economic Viability of Biomass Heating Options in the Western Balkans

<table>
<thead>
<tr>
<th>Heating option</th>
<th>Coal</th>
<th>HFO/LFO</th>
<th>NG</th>
<th>Electricity</th>
<th>Heat Pumps</th>
<th>Firewood Inefficient Stove</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>New DH HOBs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>New CHPs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Retrofitting DH HOBs (Fuel Conversion)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>New Small HOBs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Retrofitting Small HOBs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>New Individual Heating</strong></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Legend:**
- ![Green] Biomass heating more cost-effective than conventional
- ![Red] Biomass heating less cost-effective than conventional
- ![Yellow] Biomass heating similar in cost-effectiveness as conventional

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**Source:** [TRACTEBEL engie](https://tractebel.com)  
**Centre for Renewable Energy Sources and Saving**
**KEY FACTORS THAT IMPACT VIABILITY OF BIOMASS HEATING**

**Fuel Costs**
Expected increase in prices of fossil fuels and electricity make biomass heating more attractive.

**Capital costs**
One of the main disadvantages of biomass heating options is the higher capital cost. Could be decreased with the greater involvement of local suppliers.

**Conversion efficiencies**
Efficiency of fuel utilization significantly impact the total costs of heating.

**Full load equivalent operating hours (FLEOH)**
If low - lead to higher capital and O&M costs per unit of heat produced.
## FINANCIAL VIABILITY OF BIOMASS HEATING OPTIONS

When economically viable biomass heating option is not financially viable, or expected gains are not attractive to final consumers - incentives should be provided as the benefits for the society overweight the costs of the introduction of biomass heating

- Replacement of coal stoves with efficient firewood stoves in stand-alone buildings in BIH and SER
- Conversion of coal small HOBs into wood chip small HOBs in stand-alone and multi-store buildings in BIH and SER, and multi-store buildings in MNE
- Conversion of coal DH HOBs into straw DH HOBs in BIH and SER

### Stand-alone buildings

<table>
<thead>
<tr>
<th></th>
<th>ALB</th>
<th>BIH</th>
<th>CRO</th>
<th>KOS</th>
<th>MK</th>
<th>MNE</th>
<th>SER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual electric appliance replacement w/ efficient firewood stove</td>
<td>74%</td>
<td>54%</td>
<td>65%</td>
<td>45%</td>
<td>55%</td>
<td>62%</td>
<td>40%</td>
</tr>
<tr>
<td>Inefficient firewood stove - replacement with efficient firewood stove</td>
<td>51%</td>
<td>53%</td>
<td>53%</td>
<td>53%</td>
<td>53%</td>
<td>53%</td>
<td>53%</td>
</tr>
<tr>
<td>LFO small HOB - conversion to wood chips</td>
<td>61%</td>
<td>56%</td>
<td>60%</td>
<td>54%</td>
<td>49%</td>
<td>57%</td>
<td>62%</td>
</tr>
<tr>
<td>LPG small HOB - conversion to wood chips</td>
<td>31%</td>
<td>-</td>
<td>47%</td>
<td>58%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Coal stove - replacement with efficient firewood stove</td>
<td>-</td>
<td>-19%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>15%</td>
</tr>
<tr>
<td>Coal small HOB - conversion to wood chips</td>
<td>-</td>
<td>-32%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2%</td>
</tr>
<tr>
<td>NG small HOB - conversion to wood chips</td>
<td>-</td>
<td>-</td>
<td>21%</td>
<td>-</td>
<td>8%</td>
<td>-</td>
<td>28%</td>
</tr>
<tr>
<td>NG stove - replacement with efficient firewood stove</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>34%</td>
</tr>
</tbody>
</table>

### Multi-store buildings

<table>
<thead>
<tr>
<th></th>
<th>ALB</th>
<th>BIH</th>
<th>CRO</th>
<th>KOS</th>
<th>MK</th>
<th>MNE</th>
<th>SER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual electric appliance replacement with wood chips small HOB</td>
<td>52%</td>
<td>63%</td>
<td>77%</td>
<td>55%</td>
<td>67%</td>
<td>64%</td>
<td>53%</td>
</tr>
<tr>
<td>LPG small HOB - replacement with wood chips</td>
<td>49%</td>
<td>-</td>
<td>58%</td>
<td>66%</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>LFO small HOB - replacement with wood chips</td>
<td>70%</td>
<td>63%</td>
<td>66%</td>
<td>62%</td>
<td>56%</td>
<td>-</td>
<td>68%</td>
</tr>
<tr>
<td>Coal small HOB - conversion to wood chips</td>
<td>-</td>
<td>-7%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>37%</td>
</tr>
<tr>
<td>NG small HOB - replacement with wood chips small HOB</td>
<td>-</td>
<td>63%</td>
<td>35%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>40%</td>
</tr>
<tr>
<td>DH coal HOB - conversion to straw</td>
<td>-</td>
<td>-23%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4%</td>
</tr>
<tr>
<td>DH NG HOB - conversion to straw</td>
<td>-</td>
<td>-</td>
<td>23%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>47%</td>
</tr>
<tr>
<td>DH NG HOB - conversion to wood chips</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>19%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>DH HFO HOB - conversion to straw</td>
<td>-</td>
<td>-</td>
<td>27%</td>
<td>23%</td>
<td>-</td>
<td>-</td>
<td>41%</td>
</tr>
</tbody>
</table>
The vast economic potential calls for increased, programmatic efforts to promote and finance:

- Efficient biomass stoves
- Replacement of electric with biomass heating in the residential buildings
- Fuel switch to biomass in District Heating plants

### Installed heating capacity (MW) that could be economically supplied

<table>
<thead>
<tr>
<th></th>
<th>ALB</th>
<th>BIH</th>
<th>CRO</th>
<th>FYROM</th>
<th>KOS</th>
<th>MNE</th>
<th>SER</th>
<th>W-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>-with woody biomass</td>
<td>224</td>
<td>380</td>
<td>361</td>
<td>240</td>
<td>126</td>
<td>266</td>
<td>551</td>
<td>2,148</td>
</tr>
<tr>
<td>-with agricultural biomass</td>
<td>63</td>
<td>64</td>
<td>290</td>
<td>-</td>
<td>107</td>
<td>-</td>
<td>839</td>
<td>1,363</td>
</tr>
</tbody>
</table>
ECONOMIC POTENTIAL TO INCREASE THE USE OF BIOMASS FOR HEATING IN THE WESTERN BALKANS

Potential for Programmatic Approach to Promote Efficient Biomass Stoves in the Western Balkans

(assuming replacement of 10% of heat demand from inefficient wood stoves with efficient ones over a 10 year period)

<table>
<thead>
<tr>
<th></th>
<th>Annual replacement of inefficient stoves (ktoe)</th>
<th>Annually required efficient biomass appliances for replacement (MW)</th>
<th>Annual cost of replacement (M EUR)</th>
<th>Average annual fuel savings (ktoe)</th>
<th>Cumulative fuel savings for heating (2017-2026), ktoe</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALB</td>
<td>13</td>
<td>99</td>
<td>5.1</td>
<td>7</td>
<td>67</td>
</tr>
<tr>
<td>BIH</td>
<td>35</td>
<td>218</td>
<td>11.3</td>
<td>19</td>
<td>187</td>
</tr>
<tr>
<td>CRO</td>
<td>7</td>
<td>42</td>
<td>2.1</td>
<td>4</td>
<td>38</td>
</tr>
<tr>
<td>FYROM</td>
<td>19</td>
<td>111</td>
<td>5.7</td>
<td>10</td>
<td>101</td>
</tr>
<tr>
<td>KOS</td>
<td>32</td>
<td>147</td>
<td>7.7</td>
<td>17</td>
<td>170</td>
</tr>
<tr>
<td>MNE</td>
<td>6</td>
<td>36</td>
<td>1.9</td>
<td>3</td>
<td>34</td>
</tr>
<tr>
<td>SER</td>
<td>25</td>
<td>117</td>
<td>6</td>
<td>13</td>
<td>133</td>
</tr>
<tr>
<td>W-B</td>
<td>137</td>
<td>770</td>
<td>40</td>
<td>73</td>
<td>731</td>
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</table>
### Potential for Programmatic Approach to Promote Increased Use of Biomass Heating in the Western Balkans

<table>
<thead>
<tr>
<th></th>
<th>ALB</th>
<th>BIH</th>
<th>CRO</th>
<th>FYROM</th>
<th>KOS</th>
<th>MNE</th>
<th>SER</th>
<th>W-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Efficient firewood stoves (stand-alone buildings - MW)</td>
<td>0</td>
<td>39</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>175</td>
<td>313</td>
<td>527</td>
</tr>
<tr>
<td>Wood chips small HOBs (multi-store buildings - MW)</td>
<td>224</td>
<td>342</td>
<td>361</td>
<td>240</td>
<td>126</td>
<td>91</td>
<td>238</td>
<td>1,622</td>
</tr>
<tr>
<td>Share of electric heating replaced with biomass heating (%)</td>
<td>8%</td>
<td>48%</td>
<td>21%</td>
<td>19%</td>
<td>20%</td>
<td>89%</td>
<td>81%</td>
<td>28%</td>
</tr>
<tr>
<td>Share of total heat demand replaced with biomass heating (%)</td>
<td>5%</td>
<td>4%</td>
<td>5%</td>
<td>8%</td>
<td>4%</td>
<td>28%</td>
<td>9%</td>
<td>6%</td>
</tr>
</tbody>
</table>

### Fuel switch to biomass in District Heating plants in Western Balkans

<table>
<thead>
<tr>
<th></th>
<th>ALB</th>
<th>BIH</th>
<th>CRO</th>
<th>FYROM</th>
<th>KOS</th>
<th>MNE</th>
<th>SER</th>
<th>W-B</th>
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</thead>
<tbody>
<tr>
<td>Fuel switch to straw or wood chips in DH HOB coal (MW)</td>
<td>0</td>
<td>64</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>579</td>
<td>643</td>
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<tr>
<td>Fuel switch to straw or wood chips in DH HOB HFO (MW)</td>
<td>0</td>
<td>0</td>
<td>73</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>123</td>
<td>202</td>
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<tr>
<td>Fuel switch to straw or wood chips in DH HOB NG (MW)</td>
<td>0</td>
<td>0</td>
<td>217</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>137</td>
<td>354</td>
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<tr>
<td>New DH HOB using straw or wood chips (MW)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>101</td>
<td>0</td>
<td>0</td>
<td>101</td>
</tr>
<tr>
<td>Share of fossil fuels DH replaced with biomass DH (%)</td>
<td>0%</td>
<td>5%</td>
<td>17%</td>
<td>0%</td>
<td>100%</td>
<td>0%</td>
<td>50%</td>
<td>29%</td>
</tr>
<tr>
<td>Share of total heat demand replaced with biomass heating (%)</td>
<td>0%</td>
<td>1%</td>
<td>2%</td>
<td>0%</td>
<td>3%</td>
<td>0%</td>
<td>11%</td>
<td>4%</td>
</tr>
</tbody>
</table>
## Overview of the investments

<table>
<thead>
<tr>
<th>ESTIMATED INVESTMENTS (EUR)</th>
<th>ALB</th>
<th>BIH</th>
<th>CRO</th>
<th>FYROM</th>
<th>KOS</th>
<th>MNE</th>
<th>SER</th>
<th>W-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replacement of inefficient firewood stoves (Program for efficient biomass stoves)</td>
<td>51</td>
<td>113</td>
<td>21</td>
<td>57</td>
<td>77</td>
<td>19</td>
<td>60</td>
<td>399</td>
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<tr>
<td>Replacement of electric heating in stand-alone buildings with efficient firewood stoves</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>11</td>
<td>19</td>
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<tr>
<td>Replacement of electric heating in multi-store buildings with wood chips small HOBs</td>
<td>22</td>
<td>34</td>
<td>36</td>
<td>24</td>
<td>13</td>
<td>9</td>
<td>24</td>
<td>162</td>
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<tr>
<td>Retrofitting of DH HOB coal to straw/wood chips</td>
<td>0</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>142</td>
<td>158</td>
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<tr>
<td>Retrofitting of DH HOB HFO to straw/wood chips</td>
<td>0</td>
<td>0</td>
<td>21</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>36</td>
<td>59</td>
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<tr>
<td>Retrofitting of DH HOB NG to straw/wood chips</td>
<td>0</td>
<td>0</td>
<td>64</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>40</td>
<td>104</td>
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<tr>
<td>Construction of new DH HOB straw/wood chips</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>49</td>
<td>0</td>
<td>0</td>
<td>49</td>
</tr>
<tr>
<td>TOTAL</td>
<td>74</td>
<td>164</td>
<td>143</td>
<td>81</td>
<td>140</td>
<td>34</td>
<td>314</td>
<td>950</td>
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</table>

## Share of total heat demand replaced with biomass heating

<table>
<thead>
<tr>
<th>ALB</th>
<th>BIH</th>
<th>CRO</th>
<th>FYROM</th>
<th>KOS</th>
<th>MNE</th>
<th>SER</th>
<th>W-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>5%</td>
<td>5%</td>
<td>7%</td>
<td>8%</td>
<td>7%</td>
<td>28%</td>
<td>20%</td>
<td>10%</td>
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</table>
# Economic Potential to Increase the Use of Biomass for in the Western Balkans

## Reduction of CO₂ eq emissions

<table>
<thead>
<tr>
<th>Avoided emissions (ton)</th>
<th>ALB</th>
<th>BIH</th>
<th>CRO</th>
<th>FYROM</th>
<th>KOS</th>
<th>MNE</th>
<th>SER</th>
<th>W-B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replacement of inefficient firewood stoves (Program for efficient biomass stoves and boilers)</td>
<td>14,026</td>
<td>39,147</td>
<td>7,955</td>
<td>21,143</td>
<td>35,588</td>
<td>7,118</td>
<td>27,842</td>
<td>152,818</td>
</tr>
<tr>
<td>Replacement of electric heating in stand-alone buildings with efficient firewood stoves</td>
<td>0</td>
<td>86,297</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>218,015</td>
<td>939,093</td>
<td>1,243,404</td>
</tr>
<tr>
<td>Replacement of electric heating in multi-store buildings with wood chips small HOBs</td>
<td>283,449</td>
<td>762,591</td>
<td>345,741</td>
<td>640,524</td>
<td>554,278</td>
<td>113,367</td>
<td>713,960</td>
<td>3,413,909</td>
</tr>
<tr>
<td>Retrofitting of DH HOB coal to straw/wood chips</td>
<td>0</td>
<td>59,172</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>715,417</td>
<td>774,590</td>
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<tr>
<td>Retrofitting of DH HOB HFO to straw/wood chips</td>
<td>0</td>
<td>0</td>
<td>57,339</td>
<td>0</td>
<td>5,847</td>
<td>0</td>
<td>119,856</td>
<td>183,041</td>
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<tr>
<td>Retrofitting of DH HOB NG to straw/wood chips</td>
<td>0</td>
<td>0</td>
<td>128,312</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>100,519</td>
<td>228,831</td>
</tr>
<tr>
<td>Construction of new DH HOB straw/wood chips</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>124,378</td>
<td>0</td>
<td>0</td>
<td>124,378</td>
</tr>
<tr>
<td><strong>TOTAL AVOIDED CO₂ eq EMISSIONS (ton)</strong></td>
<td>297,475</td>
<td>947,206</td>
<td>539,346</td>
<td>661,667</td>
<td>720,091</td>
<td>338,499</td>
<td>2,616,687</td>
<td>6,120,971</td>
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</table>
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Team Leader  
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Key Heating Expert

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Key Biomass Expert

Panagiotis GRAMMELIS  
Key Heating Expert

Calliope PANOUTSOU  
Key Policy Expert

Biljana CEPUJNOSKA  
Key Energy Economist
ALBANIA: Economic viability of heating options – stand-alone buildings

Current heating

- Individual electric appliance
- Inefficient wood stoves

Leading economically viable biomass heating option

- New efficient firewood stove
- Small HOB-LFO
- Small HOB-LPG

Alternative economically viable biomass heating options

- New wood pellets small HOB
- New wood chips small HOB
- New wood pellets small HOB
- New wood chips small HOB

*includes construction of new internal heating network
ALBANIA: Economic viability of heating options – multi-store buildings

- **Current heating**
  - Individual electric appliance
  - Small HOB-LPG
  - Small HOB-LFO

- **Leading economically viable biomass heating options**
  - New wood pellets small HOB*
  - LPG small HOB - conversion to wood chips
  - New wood pellets small HOB
  - LPG small HOB - conversion to wood pellets
  - LFO small HOB - conversion to wood chips
  - New wood pellets small HOB
  - LFO small HOB - conversion to wood pellets
  - New wood chips DH HOB

- **Alternative economically viable biomass heating options**
  - New wood pellets small HOB
  - LPG small HOB - conversion to wood chips
  - New wood pellets small HOB
  - LPG small HOB - conversion to wood pellets
  - LFO small HOB - conversion to wood chips
  - New wood pellets small HOB
  - LFO small HOB - conversion to wood pellets
  - New wood chips DH HOB

*includes construction of new internal heating network
ALBANIA: Financial viability of heating options

Stand-alone buildings

- New efficient firewood stove
- New coal stove
- Coal small HOB - optimization
- New coal small HOB
- New inefficient firewood stove
- Coal small HOB - conversion to wood chips
- LFO/LPG small HOB - conversion to wood chips
- New efficient pellet stove
- New coal small HOB
- New wood chips small HOB
- New heat pump
- New pellet small HOB
- Coal small HOB - conversion to pellets
- LFO/LPG small HOB - conversion to pellets
- New wood chips small HOB
- New heat pump
- New pellet small HOB
- New LPG small HOB
- New electricity appliance
- New electricity small HOB
- New LFO small HOB
- LFO small HOB - optimization
- New LFO small HOB

Multi-store buildings

- Coal small HOB - optimization
- Coal small HOB - conversion to wood chips
- LFO/LPG small HOB - conversion to wood chips
- New coal small HOB
- New wood chips small HOB
- Coal small HOB - conversion to pellets
- LFO/LPG small HOB - conversion to pellets
- New pellet small HOB
- New LPG small HOB
- New coal DH HOB
- Individual Electricity Appliance
- New electricity small HOB
- New straw DH HOB
- New wood chips DH HOB
- LFO small HOB - optimization
- New HFO DH HOB
- New small HOB
- New wood chips CHP
- New straw CHP

Costs:
- Capital Costs
- O&M Costs
- Fuel Costs
- Network Losses

Costs in €/MWh.
BOSNIA AND HERZEGOVINA: Economic viability of heating options – stand-alone buildings

Current heating

Inefficient wood stoves

Individual electric appliance

Small HOB-LFO

Coal stoves

Small HOB-coal

Leading economically viable biomass heating option

New efficient firewood stove

LFO small HOB - conversion to wood chips

New efficient firewood stove

LFO small HOB - conversion to wood chips

Coal small HOB - conversion to wood chips

New efficient firewood stove

Alternative economically viable biomass heating options

New wood chips small HOB*

New efficient wood pellet stove

New wood pellets small HOB*

New wood chips small HOB

New efficient wood pellet stove

New wood pellets small HOB

New wood chips small HOB

New efficient wood pellet stove

New wood pellets small HOB

New wood chips small HOB

New efficient wood pellet stove

New wood pellets small HOB

New coal stove

New heat pump

New coal small HOB

New wood chips small HOB

New coal small HOB - optimization

LFO/LPG/NG small HOB - conversion to wood chips

New wood chips small HOB

New NG small HOB

New LPG small HOB

New LPG small HOB - optimization

LFO small HOB - conversion to wood pellets

New LFO small HOB

New LFO small HOB - optimization

New inefficient firewood stove

New electricity small HOB

New LFO small HOB

New LFO small HOB - optimization

New electricity small HOB*
<table>
<thead>
<tr>
<th>Capital Costs</th>
<th>O&amp;M Costs</th>
<th>Fuel Costs</th>
<th>Network Losses</th>
<th>Externalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal small HOB - conversion to wood chips</td>
<td>New wood chips small HOB</td>
<td>LFO/LPG/NG small HOB - conversion to wood chips</td>
<td>New coal small HOB</td>
<td>Coal small HOB - optimization</td>
</tr>
<tr>
<td>Coal DH HOB - conversion to straw</td>
<td>Coal DH HOB - conversion to wood chips</td>
<td>HFO/NG DH HOB - conversion to straw</td>
<td>HFO/NG DH HOB - conversion to wood chips</td>
<td>New NG CHP</td>
</tr>
<tr>
<td>New NG small HOB</td>
<td>LFO small HOB - optimization</td>
<td>NG DH HOB - optimization</td>
<td>HFO DH HOB - optimization</td>
<td>New wood pellet small HOB</td>
</tr>
<tr>
<td>Wood chips DH HOB - conversion to CHP</td>
<td>New LPG small HOB</td>
<td>New NG DH HOB</td>
<td>New HFO DH HOB</td>
<td>Individual electric appliance</td>
</tr>
<tr>
<td>New LFO small HOB</td>
<td>New small HOB</td>
<td>New HFO DH HOB</td>
<td>New Individual Electricity Appliance</td>
<td>New wood chips DH HOB</td>
</tr>
</tbody>
</table>
| LFO small HOB - optimization | Straw DH HOB - conversion to CHP | New wood chips CHP | New straw CHP | *

**BOSNIA AND HERZEGOVINA: Economic viability of heating options – multi-store buildings**

<table>
<thead>
<tr>
<th>MULTI-STORE BUILDINGS</th>
<th>Current heating</th>
<th>Leading economically viable biomass heating option</th>
<th>Alternative economically viable biomass heating options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small HOB-coal</td>
<td>Small HOB-LFO</td>
<td>Small HOB-NG</td>
<td>New wood chips small HOB</td>
</tr>
<tr>
<td>Individual electric appliance</td>
<td>New wood chips small HOB</td>
<td>New NG small HOB</td>
<td>LFO small HOB - conversion to wood chips</td>
</tr>
<tr>
<td>New wood pellets small HOB</td>
<td>New straw DH HOB</td>
<td>New wood pellets small HOB</td>
<td>New NG small HOB - conversion to wood chips</td>
</tr>
<tr>
<td>New CHP DH</td>
<td>Coal DH HOB - conversion to straw</td>
<td>New CHP DH</td>
<td>Coal DH HOB - conversion to wood chips</td>
</tr>
</tbody>
</table>

*includes construction of new internal heating network
BOSNIA AND HERZEGOVINA: Financial viability of heating options

Stand-alone buildings

- New coal stove
- Coal small HOB - optimization
- New coal small HOB
- New efficient firewood stove
- New coal small HOB
- Coal small HOB - conversion to wood chips
- LFO/LPG/NG small HOB - conversion to wood...
- New wood chips small HOB
- New heat pump
- New efficient pellet stove
- New wood chips small HOB
- New pellet small HOB
- Coal small HOB - conversion to pellets
- New heat pump*
- New NG stove
- LFO/LPG/NG small HOB - conversion to pellets
- New NG small HOB
- NG small HOB - optimization
- LFO small HOB - conversion to NG
- New pellet small HOB*
- New NG small HOB
- New LPG small HOB
- New inefficient firewood stove
- New electricity appliance
- New LPG small HOB*
- New electricity small HOB
- New LFO small HOB
- New electricity small HOB*
- New LFO small HOB
- LFO small HOB - optimization
- New LFO small HOB*

Multi-store buildings

- New coal small HOB
- Coal small HOB - optimization
- Coal small HOB - conversion to wood chips
- New wood chips small HOB
- LFO/LPG/NG small HOB - conversion to wo...
- Coal DH HOB - optimization
- New NG CHP
- Coal DH HOB - conversion to straw
- New pellet small HOB
- Coal DH HOB - conversion to wood chips
- HFQ/NG DH HOB - conversion to straw
- Coal small HOB - conversion to pellets
- LFO/LPG/NG small HOB - conversion to pellets
- HFQ/NG DH HOB - conversion to wood chips
- New NG small HOB
- NG small HOB - optimization
- LFO small HOB - conversion to NG
- New coal DH HOB
- HFO DH HOB - optimization
- New LPG small HOB
- NG DH HOB - optimization
- HFO DH HOB - conversion to NG
- wood chips DH HOB - conversion to CHP
- New straw DH HOB
- New wood chips DH HOB
- New electricity small HOB
- New HFO DH HOB
- New NG DH HOB
- Individual Electricity Appliance
- New LFO small HOB
- LFO small HOB - optimization
- Straw DH HOB - conversion to CHP
- New wood chips CHP
- New straw CHP
## CROATIA: Economic viability of heating options – stand-alone buildings

<table>
<thead>
<tr>
<th>Current heating</th>
<th>Leading economically viable biomass heating option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual electric appliance</td>
<td>New efficient firewood stove</td>
</tr>
<tr>
<td>Small HOB-NG</td>
<td>NG small HOB - conversion to wood chips</td>
</tr>
<tr>
<td>Inefficient wood stoves</td>
<td>New efficient firewood stove</td>
</tr>
<tr>
<td>Small HOB-LFO</td>
<td>LFO small HOB - conversion to wood chips</td>
</tr>
<tr>
<td>New wood chips small HOB*</td>
<td>New wood chips small HOB</td>
</tr>
<tr>
<td>New efficient wood pellet stove</td>
<td>New efficient wood pellet stove</td>
</tr>
<tr>
<td>New wood pellets small HOB*</td>
<td>New wood pellets small HOB</td>
</tr>
</tbody>
</table>

*includes construction of new internal heating network

<table>
<thead>
<tr>
<th>STAND-ALONE BUILDINGS</th>
</tr>
</thead>
</table>

- Coal small HOB - conversion to wood chips
- LFO/LPG/NG small HOB - conversion to wood chips
- New wood chips small HOB
- New efficient firewood stove
- New wood pellets small HOB*
- New NG stove
- New NG small HOB
- NG small HOB - optimization
- LFO small HOB - conversion to NG
- New heat pump
- New NG small HOB*
- New coal small HOB
- New efficient wood pellet stove
- Coal small HOB - optimization
- New heat pump*
- New wood pellet small HOB
- New NG small HOB*
- New coal small HOB
- LFO/LPG/NG small HOB - conversion to wood pellets
- New wood pellet small HOB*
- New coal stove
- New LPG small HOB
- New LPG small HOB*
- New inefficient firewood stove
- New LFO small HOB
- LFO small HOB - optimization
- New LFO small HOB*
- New electricity appliance
- New electricity small HOB
- New electricity small HOB*
CROATIA: Economic viability of heating options – multi-store buildings

**CROATIA**

**Current heating**
- Small HOB-NG
- Individual electric appliance
- New wood pellets small HOB
- New wood chips small HOB

**Leading economically viable biomass heating option**
- New wood chips small HOB
- Small HOB-LFO
- Small HOB-LPG

**Alternative economically viable biomass heating options**
- NG small HOB - conversion to wood chips
- New wood pellets small HOB
- New wood chips DH HOB
- New straw DH HOB
- New wood chips CHP
- LFO small HOB - conversion to wood chips
- New wood pellets small HOB
- New wood chips DH HOB
- New straw DH HOB
- LFO small HOB - conversion to wood chips
- New wood pellets small HOB
- New wood chips DH HOB
- New straw DH HOB

*includes construction of new internal heating network*
CROATIA: Financial viability of heating options

Stand-alone buildings

- Coal small HOB - conversion to wood chips
- LFO/NG small HOB - conversion to wood chips
- New efficient firewood stove
- New wood chips small HOB
- New wood chips small HOB*
- New NG stove
- New coal small HOB
- New NG small HOB
- Coal small HOB - optimization
- NG small HOB - optimization
- LFO small HOB - conversion to NG
- New coal stove
- New coal small HOB*
- New heat pump
- New NG small HOB*
- New efficient pellet stove
- New heat pump*
- New pellet small HOB
- Coal small HOB - conversion to pellets
- LFO/NG small HOB - conversion to pellets
- New pellet small HOB*
- New LPG small HOB
- New LPG small HOB*
- New inefficient firewood stove
- New LFO small HOB
- LFO small HOB - optimization
- New LFO small HOB*
- New electricity appliance
- New electricity small HOB
- New electricity small HOB*

Multi-store buildings

- New wood chips small HOB
- Coal small HOB - conversion to wood chips
- LFO/NG small HOB - conversion to wood chips
- New coal small HOB
- Coal small HOB - optimization
- Wood chips DH HOB - conversion to CHP
- Coal DH HOB - optimization
- New NG small HOB
- NG small HOB - optimization
- Coal DH HOB - conversion to straw
- LFO small HOB - conversion to NG
- Coal DH HOB - conversion to wood chips
- HFO/NG DH HOB - conversion to straw
- HFO/NG DH HOB - conversion to wood chips
- New pellet small HOB
- Coal small HOB - conversion to pellets
- LFO/NG small HOB - conversion to pellets
- New coal DH HOB
- NG DH HOB - optimization
- HFO DH HOB - conversion to NG
- New NG CHP
- New straw DH HOB
- New wood chips DH HOB
- HFO DH HOB - optimization
- New LPG small HOB
- New NG DH HOB
- New HFO DH HOB
- Straw DH HOB - conversion to CHP
- New LFO small HOB
- New wood chips CHP
- LFO small HOB - optimization
- New electricity small HOB
- Individual Electricity Appliance
- New straw CHP
FYR OF MACEDONIA: Economic viability of heating options – stand-alone buildings

STAND-ALONE BUILDINGS

FYR OF MACEDONIA: Current heating Leading economically viable biomass heating option Alternative economically viable biomass heating options

- Inefficient wood stoves
- Individual electric appliance
- New efficient firewood stove

- Small HOB-LFO
- LFO small HOB - conversion to wood chips
- New LFO small HOB - conversion to wood chips

- Small HOB-NG
- NG small HOB – conversion to wood chips
- New NG small HOB

- New wood chips small HOB
- New wood pellets small HOB
- New coal small HOB

*includes construction of new internal heating network

Coal small HOB - conversion to wood chips
New efficient firewood stove
LFO/LPG small HOB - conversion to wood chips
New wood chips small HOB
New wood chips small HOB*
New heat pump
New heat pump*
New coal small HOB
Coal small HOB - optimization
New coal small HOB*
New efficient wood pellet stove
New wood pellet small HOB
New wood chips small HOB
Coal small HOB - conversion to wood pellets
New coal stove
LFO/LPG small HOB - conversion to wood pellets
New wood pellet small HOB*
New LPG small HOB
New LFO small HOB
New inefficient firewood stove
LFO small HOB - optimization
New LPG small HOB*
New LFO small HOB*
New electricity appliance
New electricity small HOB
New electricity small HOB*
<table>
<thead>
<tr>
<th>FYR OF MACEDONIA</th>
<th>Current heating</th>
<th>Leading economically viable biomass heating options</th>
<th>Alternative economically viable biomass heating options</th>
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<tbody>
<tr>
<td></td>
<td>Individual electric appliance</td>
<td>New wood chips small HOB</td>
<td>New wood pellets small HOB, LFO small HOB - conversion to wood chips, New wood chips DH HOB</td>
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<td>Small HOB-LFO</td>
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*includes construction of new internal heating network
KOSOVO: Economic viability of heating options – stand-alone buildings

**STAND-ALONE BUILDINGS**

|-------------------------|------------------|--------------------------|---------------|---------------|------------------------|------------------------|--------------------------------|---------------------|-------------|----------------|----------------|-------------------------------|-------------------|-------------|------------------|-----------------|-------------|------------------|-----------------|-------------|------------------|-----------------|-------------|------------------|-----------------|-------------|------------------|-----------------|-------------|------------------|-----------------|-------------|------------------|-----------------|-------------|------------------|-----------------|-------------|------------------|-----------------|-------------|------------------|-----------------|-------------|------------------|-----------------|-------------|------------------|-----------------|-------------|------------------|-----------------|-------------|

**KOSOVO**

Current heating

- Inefficient wood stoves
- Individual electric appliance
- Small HOB-LPG
- Small HOB-coal
- LFO small HOB - conversion to wood chips

Leading economically viable biomass heating option

- New efficient firewood stove
- New wood chips small HOB*
- New efficient wood pellet stove
- New wood pellets small HOB*
- New heat pump*

Alternative economically viable biomass heating options

- New wood chips small HOB
- New efficient wood pellet stove
- New wood pellets small HOB
- New heat pump
- New LFO small HOB
- New LPG small HOB

*includes construction of new internal heating network
KOSOVO: Economic viability of heating options – multi-store buildings

**KOSOVO**

Current heating

Leading economically viable biomass heating option

Alternative economically viable biomass heating options

- New wood pellets small HOB
- New straw DH HOB
- New wood chips DH HOB

- New LFO small HOB - conversion to wood chips
- New wood pellets small HOB
- LFO small HOB - conversion to wood pellets
- New straw DH HOB
- New wood chips DH HOB

- LPG small HOB - conversion to wood chips
- New wood pellets small HOB
- LPG small HOB - conversion to wood pellets
- New straw DH HOB
- New wood chips DH HOB

**MULTI-STORE BUILDINGS**

- Individual electric appliance
- Small HOB-LFO
- Small HOB-coal
- Small HOB-LPG
- DH HOB-HFO
- HFO DH HOB - conversion to straw

*includes construction of new internal heating network*
KOSOVO: Financial viability of heating options

Stand-alone buildings

- New coal stove
- Coal small HOB - optimization
- New coal small HOB
- New efficient firewood stove
- New coal small HOB*
- New heat pump
- Coal small HOB - conversion to wood chips
- LFO/LPG small HOB - conversion to wood chips
- New wood chips small HOB
- New efficient pellet stove
- New heat pump*
- New pellet small HOB
- New wood chips small HOB*
- Coal small HOB - conversion to pellets
- LFO/LPG small HOB - conversion to pellets
- New pellet small HOB*
- New electricity appliance
- New inefficient firewood stove
- New electricity small HOB*
- New LFO small HOB
- LFO small HOB - optimization
- New LFO small HOB*
- New LPG small HOB
- New LPG small HOB*
- New wood chips, CHP
- New straw, CHP

€/MWh

Multi-store buildings

- New coal small HOB
- Coal small HOB - optimization
- Coal DH HOB - optimization
- Coal small HOB - conversion to wood chips
- New wood chips small HOB
- LFO/LPG small HOB - conversion to wood chips
- Coal DH HOB - conversion to straw
- New pellet small HOB
- Coal small HOB - conversion to pellets
- HFO DH HOB - conversion to straw
- LFO/LPG small HOB - conversion to pellets
- Coal DH HOB - conversion to wood chips
- HFO DH HOB - conversion to wood chips
- New coal DH HOB
- HFO DH HOB - optimization
- New electricity small HOB
- New straw DH HOB
- Individual Heat Application
- New wood chips DH HOB
- New HFO DH HOB
- New LFO small HOB
- LFO small HOB - optimization
- wood chips DH HOB - conversion to CHP
- New LPG small HOB
- Straw DH HOB - conversion to CHP
- New wood chips, CHP
- New straw, CHP
MONTENEGRO: Economic viability of heating options – stand-alone buildings

- New efficient firewood stove
- Coal small HOB - conversion to wood chips
- LFO/LPG small HOB - conversion to wood chips
- New wood chips small HOB
- New coal small HOB
- Coal small HOB - optimization
- New wood chips small HOB*
- New coal small HOB*
- New efficient wood pellet stove
- New heat pump
- New wood pellet small HOB
- Coal small HOB - conversion to wood pellets
- New coal stove
- LFO/LPG small HOB - conversion to wood pellets
- New heat pump*
- New wood pellet small HOB*
- LFO small HOB - conversion to wood pellets
- New wood chips small HOB*
- New efficient wood pellet stove
- New wood pellets small HOB*
- New inefficient firewood stove
- New LPG small HOB
- New LFO small HOB
- LFO small HOB - optimization
- New LPG small HOB*
- New electricity appliance
- New LFO small HOB*
- New electricity small HOB
- New electricity small HOB*

*includes construction of new internal heating network

- Current heating
  - Inefficient wood stoves
  - Individual electric appliance
  - Small HOB-LFO

- Leading economically viable biomass heating option
  - New efficient firewood stove
  - LFO small HOB - conversion to wood chips

- Alternative economically viable biomass heating options
  - New wood chips small HOB*
  - New efficient wood pellet stove
  - New wood pellets small HOB*
  - New wood chips small HOB
  - New efficient wood pellet stove
  - New wood pellets small HOB*
MONTENEGRO: Economic viability of heating options – multi-store buildings

Coal small HOB - conversion to wood chips
New wood chips small HOB
Coal small HOB - optimization
LFO/LPG small HOB - conversion to wood chips
New coal small HOB*
New wood chips small HOB*
New wood pellet small HOB
Coal small HOB - conversion to wood pellets
LFO/LPG small HOB - conversion to wood pellets
New wood pellet small HOB*
New coal DH HOB
New wood chips DH HOB
New HFO DH HOB
LFO small HOB - optimization
Individual Electricity Appliance
New LPG small HOB*
New LFO small HOB*
New electricity small HOB*
New wood chips CHP

Capital Costs
O&M Costs
Fuel Costs
Network Losses
Externalities

MONTENEGRO

Current heating
Leading economically viable biomass heating option
Alternative economically viable biomass heating options

Individual electric appliance
New wood chips small HOB*
Small HOB-coal
New wood pellets small HOB*
New wood chips DH HOB
New wood chips small HOB

*includes construction of new internal heating network
MONTENEGRO: Financial viability of heating options

Stand-alone buildings

- New coal small HOB
- Coal small HOB - optimization
- New coal stove
- New efficient firewood stove
- Coal small HOB - conversion to wood chips
- New coal small HOB*
- LFO/LPG small HOB - conversion to wood chips
- New small wood chips HOB
- New efficient pellet stove
- New wood chips small HOB*
- New heat pump
- New pellet small HOB
- Coal small HOB - conversion to pellets
- LFO/LPG small HOB - conversion to pellets
- New heat pump*
- New pellet small HOB*
- New inefficient firewood stove
- New LFO small HOB
- New electricity appliance
- New LPG small HOB
- LFO small HOB - optimization
- New electricity small HOB
- New LFO small HOB*
- New LPG small HOB*
- New electricity small HOB*

Multi-store buildings

- Coal small HOB - optimization
- New coal small HOB*
- Coal small HOB - conversion to wood chips
- LFO/LPG small HOB - conversion to wood chips
- New wood chips small HOB*
- Coal small HOB - conversion to pellets
- LFO/LPG small HOB - conversion to pellets
- New pellet small HOB*
- New coal DH HOB
- New wood chips DH HOB
- New HFO DH HOB
- LFO small HOB - optimization
- New LFO small HOB*
- New LPG small HOB*
- New electricity small HOB*
- Individual Electricity Appliance
- New wood chips CHP

Capital Costs
O&M Costs
Fuel Costs
Network Losses
VAT
**SERBIA: Economic viability of heating options – stand-alone buildings**

**Current heating**
- Inefficient wood stoves
- Individual electric appliance

**Leading economically viable biomass heating option**
- New efficient firewood stove
- Coal small HOB - conversion to wood chips
- LFO small HOB - conversion to wood chips
- NG small HOB - conversion to wood chips

**Alternative economically viable biomass heating options**
- New wood chips small HOB
- New wood pellets small HOB
- New wood pellets small HOB

*includes construction of new internal heating network*
SERBIA: Economic viability of heating options – multi-store buildings

Current heating

- Coal small HOB - conversion to wood chips
- New wood chips small HOB
- LFO/LPG/NG small HOB - conversion to wood chips
- Coal DH HOB - conversion to straw
- HFO/NG DH HOB - conversion to straw
- New coal small HOB
- Coal DH HOB - conversion to wood chips
- Coal small HOB - optimization
- Coal DH HOB - optimization
- HFO/NG DH HOB - conversion to wood chips
- New wood pellet small HOB
- Coal small HOB - conversion to wood pellets
- New straw DH HOB
- New NG small HOB
- LFO/LPG/NG small HOB - conversion to wood pellets
- NG small HOB - optimization
- LFO small HOB - conversion to NG
- Wood chips DH HOB - conversion to CHP
- New wood chips DH HOB
- New coal DH HOB
- HFO DH HOB - optimization
- NG DH HOB - optimization
- HFO DH HOB - conversion to NG
- Individual Electricity Appliance
- New electricity small HOB
- New HFO DH HOB
- New NG DH HOB
- New NG CHP
- Straw DH HOB - conversion to CHP
- New LPG small HOB
- New wood chips CHP
- New LFO small HOB
- LFO small HOB - optimization
- New straw CHP

€/MWH

Leading economically viable biomass heating option

- Small HOB-coal
- Small HOB-NG
- Individual electric appliance
- Small HOB-LFO
- Small HOB-HFO

Alternative economically viable biomass heating options

- Coal small HOB - conversion to wood chips
- NG small HOB - conversion to wood chips
- New wood pellets small HOB
- New straw DH HOB
- New wood pellets DH HOB
- New wood CHP
- New wood chips DH HOB
- LFO small HOB - conversion to wood pellets
- New wood pellets small HOB
- New straw DH HOB
- LFO small HOB - conversion to wood chips
- New wood pellets DH HOB
- New wood CHP
- New wood chips DH HOB

*includes construction of new internal heating network
SERBIA: Financial viability of heating options

Stand-alone buildings

Multi-store buildings

- New heat pump
- New efficient firewood stove
- Coal small HOB - conversion to wood chips
- New coal small HOB
- Coal small HOB - optimization
- New heat pump
- LFO/LPG/NG small HOB - conversion to wood chips
- New wood chips small HOB
- New coal stove
- New coal small HOB
- New wood chips small HOB
- New efficient pellet stove
- New NG stove
- New NG small HOB
- NG small HOB - optimization
- New pellet small HOB
- LFO small HOB - conversion to NG
- Coal small HOB - conversion to pellets
- New electricity appliance
- LFO/LPG/NG small HOB - conversion to pellets
- New NG small HOB
- New electricity small HOB
- New pellet small HOB
- New electricity small HOB
- New inefficient firewood stove
- New LPG small HOB
- New LPG small HOB
- New LFO small HOB
- New LFO small HOB - optimization
- New LFO small HOB

- New wood chips small HOB
- Coal small HOB - conversion to wood chips
- New coal small HOB
- LFO/LPG/NG small HOB - conversion to wood
- Coal small HOB - optimization
- Coal DH HOB - conversion to straw
- Coal DH HOB - optimization
- HFO/NG/DH HOB - conversion to straw
- Coal DH HOB - conversion to wood chips
- New pellet small HOB
- HFO/NG/DH HOB - conversion to wood chips
- New NG small HOB
- Coal small HOB - conversion to pellets
- NG small HOB - optimization
- LFO small HOB - conversion to NG
- LFO/LPG/NG small HOB - conversion to pellets
- New electricity small HOB
- Wood chips DH HOB - conversion to CHP
- New coal DH HOB
- New straw DH HOB
- Individual Electricity Appliance
- New wood chips DH HOB
- HFO DH HOB - optimization
- NG DH HOB - optimization
- New NG CHP
- HFO DH HOB - conversion to NG
- Straw DH HOB - conversion to CHP
- New HFO DH HOB
- New LPG small HOB
- New NG DH HOB
- New LFO small HOB
- LFO small HOB - optimization
- New wood chips CHP
- New straw CHP