Resource Potential and developing prospects of Forest Bio-energy in China

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Contents

• Energy and environment issues
• Transition from traditional to modern bio-energy
• Resource potential for forest bio-energy
• Status of forest bio-energy in China
• Forest bio-energy industrialization in China
Data sources: China Energy Statistical Yearbook 2008
Reserves of fossil energy resource in China

Unbalanced energy structure

The coal is the largest component

China: coal 91%, oil 5%, natural gas 4%

The world: coal 60%, oil 20%, natural gas 20%
Figure 5. The main fossil energy component of the World and China

The World

China

Data sources: Study on energy development strategy in China
Traditional using of biomass energy

- Until the middle of the 19th century, biomass use dominated the global energy consumption
- Wood fuels are the most prominent biomass energy sources
- With the rapid increase in fossil fuel use, the share of the biomass in total energy consumption declined greatly
- It still enjoys a significant share in energy consumption in developing nations
Modern using of biomass energy

• Transition from an inefficient and unclean traditional fuel to an efficient and clean fuel

• Depending on Modern biomass technologies

• Development of energy market

• Promotion of nations’ energy policies and strategies
Summary of forest bio-energy

• Quite advanced in some developed countries:
  USA, Canada and some European countries
• China still being in the early stage
  New initiatives and incentive policies being put forward

Features of forest resources in China

- Extensive distribution
- Great variety of forest species
- Abundant area in natural forest and plantation
- Vast wasteland, deserted mountain and bare sandy land for bush forest plantation
The seventh national forest resources inventory:

Forest area: 195.45 million hm²

Forest coverage: 20.36 %

Alive stumpage cumulation: 14.913 billion m³

Forest cumulation: 13.721 billion m³
Plantation area: 61.69 million \( \text{hm}^2 \)

Plantation Cumulation: 1.961 billion \( \text{m}^3 \)
### Types and quantities of forest biomass for bio-energy in China

<table>
<thead>
<tr>
<th>Woody biomass types</th>
<th>Available harvesting area (Million ha&lt;sup&gt;2&lt;/sup&gt;)</th>
<th>Available woody biomass technically (Billion tons per year)</th>
<th>Available woody biomass for energy (Billion tons per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Branches residues from forest production</td>
<td>142.79</td>
<td>0.153</td>
<td>0.04</td>
</tr>
<tr>
<td>2. Energy forest</td>
<td>3.03</td>
<td>0.048</td>
<td>0.03</td>
</tr>
<tr>
<td>3. Shrubbs coppicing</td>
<td>45.30</td>
<td>0.15</td>
<td>0.05</td>
</tr>
<tr>
<td>4. Branches residues from forest thinning</td>
<td>91.00</td>
<td>0.239</td>
<td>0.05</td>
</tr>
<tr>
<td>5. Branches residues from economic forest</td>
<td>21.40</td>
<td>0.15</td>
<td>0.03</td>
</tr>
<tr>
<td>6. Branches residues from harvesting of bamboo forest</td>
<td>4.84</td>
<td>0.05</td>
<td>0.01</td>
</tr>
<tr>
<td>7. Branches residues from trees outside forests</td>
<td></td>
<td>0.03</td>
<td>0.01</td>
</tr>
<tr>
<td>8. Branches residues from urban green trees pruning</td>
<td></td>
<td>0.04</td>
<td>0.02</td>
</tr>
<tr>
<td>9. Residues from nursery stock pruning</td>
<td></td>
<td>0.015</td>
<td>0.01</td>
</tr>
<tr>
<td>10. Discarded wood-based products</td>
<td></td>
<td>0.08</td>
<td>0.04</td>
</tr>
<tr>
<td>11. Fruits or seeds from oil plants</td>
<td>4.2</td>
<td>0.002</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>0.957</td>
<td>0.298</td>
</tr>
</tbody>
</table>
• Woody biomass from forest

Sea-buckthorn

Branchy tamarisk

Salix mongolica
Oil plants resources for bioenergy in China

- Six large families of oil plants in China
- About 197 species with more than 20% of oil content
- Artificial planting of some oil plants are available
- If taking the necessary cultivated measures, high yield can be obtained
- Main oil plants species and distributions

<table>
<thead>
<tr>
<th>Species</th>
<th>Area 1000hm²</th>
<th>Harvest Yield 1000 ton</th>
<th>Oil-content (seed)</th>
<th>Distributions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Xanthoceras sorbifolia</td>
<td>10</td>
<td>100</td>
<td>35-45</td>
<td>Inner Mongolia, Shanxi</td>
</tr>
<tr>
<td>Jatropha curcas</td>
<td>45</td>
<td>5</td>
<td>35-45</td>
<td>Sichuan, Yunan, Guizhou and Hainan</td>
</tr>
<tr>
<td>Sapium sebiferum</td>
<td>410</td>
<td>185</td>
<td>35</td>
<td>Guizhou, Hubei, Sichuan and Zhejiang</td>
</tr>
<tr>
<td>Ldesia polycarpa</td>
<td>30</td>
<td>10</td>
<td>28</td>
<td>Shaanxi, Guangdong, Guangxi, Hubei, Hunan, Guizhou, Yunnan and Sichuan</td>
</tr>
<tr>
<td>Pistacia chinensis</td>
<td>300</td>
<td>80</td>
<td>30-46</td>
<td>Middle China: Shaanxi, Hebei, Gansu, Shandong, Henan</td>
</tr>
<tr>
<td>Rhus succedanea</td>
<td>220</td>
<td>80</td>
<td>35</td>
<td>Middle China: Shaanxi, Guizhou, Hebei, Henan and Anhui</td>
</tr>
<tr>
<td>Aleurites fordii</td>
<td>1060</td>
<td>560</td>
<td>35-40</td>
<td>Guizhou, Hunan, Shaanxi and South China</td>
</tr>
<tr>
<td>Cornus wilsoniana</td>
<td>4</td>
<td>20</td>
<td></td>
<td>The Yangtze River Valley and Southwest China</td>
</tr>
</tbody>
</table>
• *Jatropha curcas*

Shrub or tree up to 2-5 m tall.  
Service life: 30-50 years

Seeds oil: 35-46%
• *Xanthoceras sorbifolia* Bunge

Oil content of the seed is 35 ~ 45%
• *Rhus succedanea*

Oil content of the dry fruit is 30% ~ 45%
• *Sapium sebiferum*

Oil content of the seed is 34%, dry fruit is 35%
• *Ldesia polycarpa* Maxim

Oil content of the seed is 28%
Dry fruit is 45%
Intensive management is important measure for high yield

Yield of main woody oil plants under intensive management in China

<table>
<thead>
<tr>
<th>Species</th>
<th>Oil content (%)</th>
<th>Seed yield (kg/hm²)</th>
<th>Average yield of wild forest (kg/hm²)</th>
<th>Initial stage (year)</th>
<th>Duration (year)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Aleurites fordii</em></td>
<td>49.4-58.6</td>
<td>3000-6000</td>
<td>547</td>
<td>3-4</td>
<td>10-20</td>
</tr>
<tr>
<td><em>Sapium sebiferum</em></td>
<td>22.8-41.6</td>
<td>2250-4500</td>
<td>451</td>
<td>3-8</td>
<td>20-50</td>
</tr>
<tr>
<td><em>Jatropha curcas</em></td>
<td>50.2-61.5</td>
<td>3000-6000</td>
<td>933</td>
<td>3-5</td>
<td>30-50</td>
</tr>
<tr>
<td><em>Pistacia chinensis</em></td>
<td>25.6-52.6</td>
<td>1500-4500</td>
<td>1130</td>
<td>5-8</td>
<td>50-100</td>
</tr>
<tr>
<td><em>Xanthoceras sorbilolia</em></td>
<td>55-67</td>
<td>1500-4500</td>
<td>1200</td>
<td>2-3</td>
<td>30-80</td>
</tr>
<tr>
<td><em>Cornus wilsoniana</em></td>
<td>33-36</td>
<td>3000-6000</td>
<td>2444</td>
<td>3-5</td>
<td>50-100</td>
</tr>
</tbody>
</table>
Demonstration *Jatropha curcas* plantations in Hainan Province, China
• Top-quality seeds can increase production of the oil plants
Two operating models of *Jatropha* plantation and biodiesel production in Hainan province: developed by private enterprises and by state-owned enterprises

1. BIO-ENERGY & CHEMICAL Company model (a private company)
Research & Development and cultivation base found in Hainan - South Manor

Seeds Resources Section

Cultivation Testing Section

Distribution of South Manor

Seeding Fostering Section

Experimental Section of Fertilizer
2. CNOOC NEW ENERGY BIO-ENERGY & CHEMICAL CO., LTD
(controlled by state-owned company, CNOOC)
Local biomass companies (*CNOOC*)

Hainan *Jatropha Curcas* Species Breeding Base
Woody solid fuel production

- Woody biomass pellets

Sawdust pellets  Red pine wood pellets  Switch grass pellets  Straw pellets
Woody solid fuel production

• Woody biomass blocky-shaped fuel

Sawdust fuel

Wood shaving fuel

Shrub fuel
( *Caragana microphylla*)
• Technologies of woody solid fuel production

✓ Biomass pellets technology began in 1990s in China, with low production capacity of 100~200 kg/h

✓ At present, capacity of main equipments used in China has been improved and reached 1~3 t/h

✓ In 2000 more than 40 small and medium-sized institutions were engaged in the research and production of biomass solid fuel in China.
• Equipment research

Equipment for biomass pellets production
Jiangsu Liyang Machine Factory

Henan Energy Research Institution
SKR-25 Machine for biomass pellets production

Biomass Energy Research Institution,
Central South University of Forestry and Technology
Technology of Woody Biomass Blocky-shaped fuel
School of Technology, Beijing Forestry University
• Application of woody solid fuel

✓ Still in demonstration stage
✓ Mainly used for industry boiler and hotel heating
✓ Lack of production standard and pricing system
✓ Few official records on production and trading volume
✓ High products cost and low purchasing power
✓ Less development and application of matched stoves
Power generation from forest bio-energy

- Bio-power generation is a high-efficiency way of forest biomass utilization
- Not yet used in China

Photo in Sweden
Power generation from forest bio-energy

• It has made a lot of achievements in some developed countries in wood biomass supply logistics, power conversion technology and electric marketing

• Progress is being made with the establishment of several small-scale projects in China

• China’s central government has put forward the bio-power target of 24 GW by 2020 with series of relevant policies
• Some forest bio-power factories in China

<table>
<thead>
<tr>
<th>Projects Name</th>
<th>Progress</th>
<th>Investment (Billion Yuan)</th>
<th>Scale (MW)</th>
<th>Types of fuel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tongliao Naimanqi Forest Bio-power Factory</td>
<td>Trial operation</td>
<td>0.267</td>
<td>24</td>
<td>Forest residues</td>
</tr>
<tr>
<td>Maowusu Biomass CHP Factory</td>
<td>In operation</td>
<td>0.241</td>
<td>24</td>
<td>Forest residues</td>
</tr>
<tr>
<td>Arxan Forest Bio-power Factory</td>
<td>Feasibility research</td>
<td></td>
<td>24</td>
<td>Forest residues</td>
</tr>
<tr>
<td>Jiangxi Boyang Kaidi Bio-power Factory</td>
<td>Trial operation</td>
<td>0.25</td>
<td>24</td>
<td>Forest and agricultural residues</td>
</tr>
<tr>
<td>Anhui Chao Bio-power Factory</td>
<td>Feasibility research</td>
<td>0.272</td>
<td>30</td>
<td>Forest and agricultural residues</td>
</tr>
<tr>
<td>Shandong Guoneng Danxian Bio-power Factory</td>
<td>In operation</td>
<td>0.3</td>
<td>24</td>
<td>Forest and agricultural residues</td>
</tr>
</tbody>
</table>

Data collected in June 2007
• Forest biomass supply for bio-power generation

✓ The principal constraints of forest bio-power generation are high costs and undeveloped supply logistics of forest biomass
✓ Outdated and small equipments are being used for forest biomass harvesting in China.
✓ Advanced technologies and equipments can be developed or induced from some developed countries for forest bioenergy.
Mechanized line for harvesting and chipping in Europe

Harvesting and comminuting processing of willow energy forest in Sweden

Centralized chipping and comminuting processing
Chipping and comminuting equipments being used in forest processing mills in China
Advanced equipments for shrub harvesting developed in China
Forest biomass supply for bio-power in Inner Mongolia, China

Naimanqi Case

Arxan Case

Legend
★ Power Plant (PL)
● Collection Site
• Forest biomass supply for bio-power in Inner Mongolia, China

Processing Factory in Arxan
• Naimanqi organization logistics

- There are 12 township agents and 96 village agents who arrange the wood fuel collection.
- The power plant signs contracts with all the village agents, whose work is supervised by the township agent.
• Arxan organization logistics

- The proposed power plant will contract with the three neighbouring Forestry Bureaus
- Four proposed collection sites would be built for wood fuel production
• Supply chains of the two cases

Naimanqi

- Skidding
- Hauling with tractor or mule-drawn vehicle
- Delivery:
  - Power Plant ←→ Agent
  - Chipping
- Storage
- Collection site
- Forest Land

Arxan

- Skidding
- Hauling with mule-drawn vehicle
- Delivery
- Chipping
- Storage
- Collection site
- Forest Land
- Hauling with tractor
Barriers of forest bio-energy industrialization

• Few specific strategies and policies for forest bio-energy and few detailed implementation schemes
• Some key technologies and devices depending on imports
• No quality control system such as relative criteria established
• Commercial bio-energy from forest biomass still being in its infancy
• No reflection on environmental benefits of forest bio-energy by the market
Measures for the development of forest bioenergy

• Accurate estimate of forest biomass resource available for bioenergy using

• Increasing finance in supporting technical research, including for forest biomass supply chain and for forest bio-energy production

• Government’s support, such as related legislative systems, economic compensation and trade mechanism for forest bio-energy
Thank You!