Zilkha Black® Pellets

The Clean, Renewable
Alternative to Coal

CONFIDENTIAL

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• Zilkha Biomass Fuels LLC builds, owns and operates manufacturing facilities which produce a proprietary “black” wood pellet

• The proprietary Zilkha Black® pellet seamlessly replaces coal in existing coal-fired power plants without additional capex required
  – Significantly reduces noxious emissions, including SO$_2$, NO$_x$ and mercury
Zilkha Track Record in Energy

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Summary Biography</th>
</tr>
</thead>
</table>
| Selim K. Zilkha       | Co-Owner         | Director and 50% owner of Zilkha Renewable Energy (Horizon Wind Energy) from 1998 to 2005  
                      |                  | Director of El Paso Corporation from 1999 until 2002  
                      |                  | CEO and sole director of Zilkha Energy Company from 1983 until 1998 |
| Michael Zilkha        | Co-Owner         | President and co-owner of Zilkha Renewable Energy (Horizon Wind Energy) from 1998 to 2005  
                      |                  | Executive VP and co-owner of Zilkha Energy Company from 1986 until 1998 |

Zilkha Energy Co.  

- Independent Oil and Gas Company; Largest Acreage Holder on the shelf in the Gulf of Mexico in 1997  
- Sold to Sonat for $1.2 Billion

Zilkha Renewable Energy Co.  
(1998-2005)

- Largest Independent Wind Power Developer in U.S.  
- Sold to Goldman Sachs in 2005; Sold to EDP in 2007 for $2.7 Billion

Zilkha Biomass Energy  
(2006)

- Manufacture and Marketing of Waterproof “Black” Wood Pellets  
- Patented Efficient Biomass Steam Explosion Technology  
- Will have invested $120 million by the end of 2012

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Zilkha Business Model

• The market for biomass fuels is driven by emissions
  – In Europe and Southeast Asia, the focus is on CO₂ reduction. Mandates and incentives are in place today

• Our target customers are European utilities who have experience burning biomass in pulverized coal-fired units, and Japanese coal-fired utilities due to new feed-in-tariffs

• We are serving this market with a better product—Zilkha Black® pellets
  – Patented Zilkha technology, NOT torrefaction
  – Hard, waterproof pellet with reduced dust
  – Drop-in replacement for coal with minimal capital investment
Advantages of Co-Firing Black Pellets vs. Solar and Wind

• Biomass power is dispatchable – can be base loaded
• Conversion/co-firing of black pellets in coal plants requires minimum capital
• Power plants are already connected to the grid
• Permitting is usually not an issue
• Shorter lead time for conversion vs. new build
• Permanent jobs are created from forest to power plant
<table>
<thead>
<tr>
<th>Type</th>
<th>Requirements for Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chips</td>
<td>Build new plant with fluidized bed or grate boilers. Capital costs $4,000 to $5,000/kW&lt;sup&gt;(1)&lt;/sup&gt;</td>
</tr>
<tr>
<td>Traditional White Pellets</td>
<td>Modify existing pulverized coal plants to handle water sensitive, fragile, dusty, hard-to-grind pellets. Capital costs $500&lt;sup&gt;(2)&lt;/sup&gt;-$900&lt;sup&gt;(3)&lt;/sup&gt;/kW</td>
</tr>
<tr>
<td>Zilkha Black® Pellets</td>
<td>Transport, store, handle, grind and burn like coal. Capital costs minimal</td>
</tr>
</tbody>
</table>

Source:
Technology At A Glance

- Manufacturing of Zilkha Black® Pellets is similar to the production of standard white pellets, with the addition of our patented thermal treatment process.

- The current annual production of white pellets is 15 million tonnes anticipated to grow to 50 million tonnes by 2020.

“White Pellet” Issues: Pellet Dust is Explosive
Serious Fire Risk in Ship Loading and Storage

- Fines = dust = very real explosion risk
- Explosion mitigation takes capital beyond that required to handle coal
- Venting during transportation
- Off-Gassing of CO, CO2, and CH4

Black Pellets vs. White Pellets

• Black pellets are waterproof, white pellets are not.
• Higher energy content per tonne, 19.50 Gigajoules (GJ)/tonne vs. 17.0 GJ/tonne.
• Higher bulk density (750 Kg/m$^3$ vs. 630 Kg/m$^3$).
• Resulting in 30% more GJ/m$^3$ and lower equivalent transportation cost per GJ.
• Reduced losses due to dusting between delivery port and burner tip.
• Lower operating cost due to reduced dusting, fewer safety issues.
• Significant avoided capital costs vs. white pellets conversion cost.
Black Pellets Cost Less Than White

Energy Cost Delivered To the Burner Tip (US$/GJ)

Burner Tip Cost
White Pellets vs. Zilkha Black Pellets ($/GJ)

All-In Cost To the Burner Tip 10% Lower for Black Pellets Vs. White Pellets

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Zilkha Black® Pellets Perform Like Common Coals

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Zilkha Black® Pellets (1)</th>
<th>Russian Coal #1, Grad (2)</th>
<th>Central Appalachian (Long Fork) (3)</th>
<th>Powder River Basin Coal-Eagle Butte (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moisture %</td>
<td>1.44</td>
<td>7.37</td>
<td>7.16</td>
<td>23.92</td>
</tr>
<tr>
<td>Ash, Dry %</td>
<td>0.72</td>
<td>14.1</td>
<td>11.52</td>
<td>4.65</td>
</tr>
<tr>
<td>Volatile, Dry %</td>
<td>78.53</td>
<td>35.92</td>
<td>31.23</td>
<td>33.95</td>
</tr>
<tr>
<td>Sulfur, S, Dry %</td>
<td>0.03</td>
<td>0.229</td>
<td>1.07</td>
<td>0.29</td>
</tr>
<tr>
<td>Calorific Value, BTU/lb</td>
<td>8,447</td>
<td>11,218</td>
<td>12,114</td>
<td>8,966</td>
</tr>
<tr>
<td>Calorific Value, kJ/kg</td>
<td>19,647</td>
<td>26,093</td>
<td>28,117</td>
<td>20,854</td>
</tr>
<tr>
<td>Carbon, C, Dry %</td>
<td>54.42</td>
<td>69.38</td>
<td>66.93</td>
<td>53.46</td>
</tr>
<tr>
<td>Hydrogen, H, Dry %</td>
<td>6.03</td>
<td>4.69</td>
<td>4.43</td>
<td>2.71</td>
</tr>
<tr>
<td>Nitrogen, N, Dry %</td>
<td>0.15</td>
<td>2.25</td>
<td>1.34</td>
<td>0.58</td>
</tr>
<tr>
<td>Mercury, ug/g</td>
<td>0.01</td>
<td>0.52 (5)</td>
<td>0.15 (7)</td>
<td>0.08 (7)</td>
</tr>
</tbody>
</table>

Source:
2) LQSi Data Statistical Results By Program. SGS Minerals Services Division. 2010.
Testing Black Pellets as Coal

- SGS, a world recognized leader in coal analysis
- Testing Zilkha Black® pellets to coal standards
- Input from various utilities requested for their unique requirements

- Sample preparation
- Proximate plus Ultimate analysis
- Analysis of ash – 13 major and minor oxides
- Trace elements lab preparation
- Trace elements: Ba, Be, Cd, Cr, Cu, Pb, Ni, V, Zn
- Trace elements: As, Se
- Mercury
- Chlorine
- Fluorine
- Fusion, (8-point, reducing and oxidizing on same sample)
- Hardgrove Grindability Index
Successful Black Pellet Co-Firing Trials

- Burned black pellets alongside PRB coal in varying percentage for emissions and combustion testing at Western Research Institute (WRI)

- Emission levels of SO$_2$ and mercury were reduced with increasing percentage of Black pellets blended with coal in fuel mix

- NOx emissions showed direct correlation between nitrogen content of fuel (<0.2% for black pellets)
Reduced NO$_x$ and SO$_2$

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<th>Run No.</th>
<th>Mesh Size Pellets</th>
<th>Ratio Coal to Black Pellets</th>
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<tbody>
<tr>
<td>1</td>
<td>200</td>
<td>100% coal</td>
</tr>
<tr>
<td>2</td>
<td>200</td>
<td>80% coal : 20% pellets</td>
</tr>
<tr>
<td>3</td>
<td>200</td>
<td>50% coal : 50% pellets</td>
</tr>
<tr>
<td>4</td>
<td>200</td>
<td>100% pellets</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
<td>80% coal : 20% pellets</td>
</tr>
<tr>
<td>6</td>
<td>50</td>
<td>50% coal : 50% pellets</td>
</tr>
<tr>
<td>7</td>
<td>50</td>
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Coal ground to 200 mesh for all tests
Reduced Mercury

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Coal ground to 200 mesh for all tests

Figure 5. Impact of the Fuel on Hg (total) Emission.
Black Pellets are Very Grindable

- WRI tests show that Black pellets achieve complete combustion and carbon burnout at particle sizes larger than coal
  - The objective of grinding Black pellets is to achieve complete carbon burn out during combustion, and no more
  - Due to high volatile content, Black pellets do not need to be ground as finely as coal to achieve complete combustion in the boiler

- Plant operators should consider the relationship between pulverizer settings and combustion performance. For example, co-firing Zilkha Black® pellets could allow utilities to burn a lower grade of coal

- Recent full-scale, third party testing of Zilkha Black® pellets in a power station indicate that Black pellets can be co-milled and co-fired with coal at a level of 70% biomass
Coal particles are milled to a size that allows them to burn out completely. This particle size is usually less than 0.1 mm.

Biomass particles contain a much higher fraction of volatile substances, and the general consensus for biomass particle size is that complete burn out occurs at 1-2 mm.

Zilkha Black® pellets can be ground to appropriate size in traditional coal mills.
Black Pellets Grind like Coal

Figure 7. Characteristic particle size vs. energy consumption in the CMT mill (picture from Wadenbäck, 2011, with the Zilkha data points added).
• A ZWZ value (ignition potential) above 6 [kJ/kg fuel/°C] is seen as satisfactory for producing a stable flame.

• Zilkha Black® pellets were found to do considerably better than all the reference fuels, including white wood pellets and a number of commercial coals, with a ZWZ value of 16.28 [kJ/kg fuel/°C].
Zilkha Certified Sustainable Biomass

- Zilkha Certified Sustainable Biomass (ZCSB) – Jointly developed with Peterson’s Control Union, international recognized certification body

- Based on EU RED (Renewable Energy Directive) Standard

- Zilkha Biomass is committed to sustainable sourcing:
  - Certified forests (FSC, SFI, PEFC and others)
  - SFI Certified Sourcing
Where is there Biomass in North America?

• British Columbia – Pine Bark Beetle Disaster
• US Southeast – Prolific Wood Basket
• Declining Markets for Timber, Pulp & Paper
B.C. Forest Industry Decimated by Bark Beetle

- Cumulative area of British Columbia affected by pine beetle is 43 million acres \(^{(1)}\)

- Recoverable biomass from BC is 322 million tonnes or >20 million tonnes per year\(^{(2)}\)

Source:
1) BC Ministry of Forests, Lands and Natural Resources
2) Assumes 15% recovery in 15 years at 50 tonnes/acre
New Supplies of Wood in North America

Wood Available From Pulp Plant Shutdowns

<table>
<thead>
<tr>
<th>Year</th>
<th>Wood Resource</th>
<th>Available for Pellets</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>140 million tonnes*</td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>-120 million tonnes*</td>
<td>20 million tonnes/year</td>
</tr>
</tbody>
</table>

Source: UNECE Timber Committee Market Forecasts, 2011
Biomass Supplier Relationships

- We have four experienced foresters on our team
- We have developed relationships with most of the large timber owners in North America
- We have term sheets with a number of them for long term supply contracts as an element of their portfolio management
Crockett, Texas Plant

- Commercial scale equipment
- Produces large quantities of Zilkha Black® pellets for full-scale testing

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• CPM Hammermill
• Pilot Scale Thermal Treatment Reactor
• CPM Pelletizer
• Small thermal treatment reactor for fast turn around
• Lab analysis of treated biomass and pellet quality
• Separate electric boiler
• Full time lab team supervised by a degreed chemist
Bulk Black Pellet Shipments

- Multiple shipments have been sent from the Port of Beaumont to European customers
- Pellets withstood heavy rain during pre-staging and loading
- Pellets handled with dozers, front-end loaders, and conveyors with no deterioration
- Minimal dusting at loading and unloading locations
Pellets withstood heavy rain during pre-staging and loading.

- Vessel twice initiated closure of hatches due to rain while black pellets were still able to be loaded.
- Trimmed pellets via dozer with no noticeable deterioration.

Findings by Control Union sampling:
- Net Calorific Value (AR) - 19,568 GJ/mt
- Ash – 0.51 % (dry)
- Fines <1mm – 1.5%
- Temperatures between 7 – 23° C
Trimming the Load
Pellets Arriving in Europe
Unloading in Europe

- Unloaded via mobile quay crane – half of cargo into trucks and half onto dock for further shipment via barge
- Pellets were low dust, durable, and low temperature
- Full-scale burns taking place in six power plants
Zilkha Black® Pellets Tested in Europe

Five full scale test burns in Europe

2,700 tonne test burn in the Netherlands, March 2012

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Helsingborg, Sweden – Pile outside since March 2012
How Many Black Pellets will Zilkha Supply?

- First large-scale plant, Selma, AL – 275,000 tpy – Q4 2014
- 18 total plants planned for North America
- Total Capacity ~ 4mm tpy by 2017+
- Additional volumes will be based on licensing of technology to third parties