

Integrating Biomass with District Energy based on Flexible Fuel Solutions

Case: Babina Greda Project Croatia

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Introduction

BioCHP - backbone of renewable energy systems

Introduction

BioCHP - one of the most effective means of generating REN

Global energy problem

- Global warming caused by greenhouse gas emissions

Main problems in energy industry

- Low efficiency based on separate generation of heat and power
- Emissions from combustion of fossil energy
- Instability of electricity networks

The solution = BioCHP

- Not dependent on weather conditions
- Generation of both power and heat
 - Heat must always be locally generated => something must be combusted
- Stable generation 24/7, over 8000 h/a
 - Very limited need of back-up power



*Efficient, reliable and weather independent renewable energy
BioPower9, Babina Greda, Croatia*



Modular BioPower plants

Energy from local biomass is a huge opportunity

- Utilization of local fuel resources and logistics
- Decentralization of power generation
- Security of supply
- Heat for local industry / community
- Benefits to local economy and employment



Local power plants are smaller than utility plants

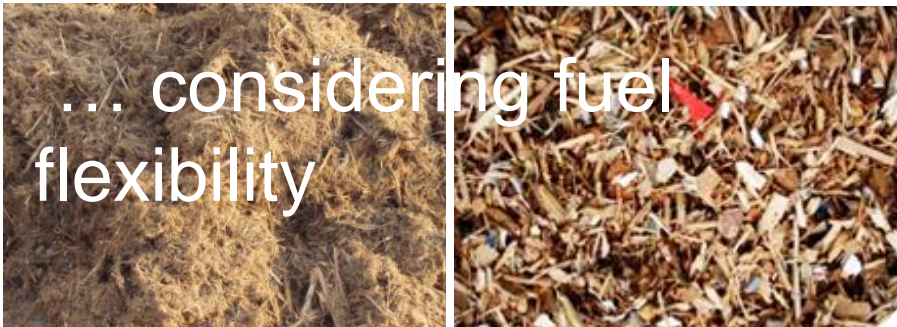
What is limiting the minimum size?

- CAPEX per kW_e increases as the plant size decreases:
 - Small plants require same number of auxiliary systems as larger ones
 - Engineering hours spent on permitting, design and automation remain unchanged
 - Installation and site costs are not very dependent on plant capacity
- Higher CAPEX should be compensated by OPEX:
 - Local fuel supply and efficient logistics
 - Utilization of heat if possible



Choice of fuel and fuel flexibility of combustion

Strategic decisions



Milled and sod peat
Pine
Spruce
Birch
Eucalyptus
Cedar
Poplar
Willow
Forest residues
Stumps
Sawdust
Olive bagasse
Reed canary grass
Compost rejects
Straw pellets
Sun flower seed husk
Rice husk
Sugarcane bagasse
Plywood residues
Recycled wood
Refuse Derived Fuel
Railway sleepers
Pulp and paper mill sludges
De-inking sludge and rejects
Waste water treatment sludge
Meat and Bone Meal
Tire Derived Fuel

Ability to use multiple fuels is an essential strength

Less dependency on any single fuel supplier means possibility to reduce fuel costs based on concrete alternatives

Selection of combustion technology

Rotating grate



Wood, bark, wood residues

Output **4-20 MW_{th}**

Bubbling fluidized bed (BFB)



Wood, bark, wood residues,
Demolition wood, agro fuels, sludges

Output **10-400 MW_{th}**

Circulating fluidized bed (CFB)



Wood, bark, wood residues,
Demolition wood, agro fuels, sludges
Sorted and industrial waste

Output **40-800 MW_{th}**

Modular design

Benefits of a design based on factory assembled modules

Fast time-to-market


- Fast project planning
- Fast permitting process
- Fast implementation
- Fast start-up

Solid bankability

- Minimized project risks
- Clear responsibilities
- Schedule & cost assurance
- Proven track-record



Feed water pump module in operation



Case Babina Greda BioPower 9 CHP-plant



Project financing

Project financing

Non-recourse or limited recourse loans

Fully non-recourse financing



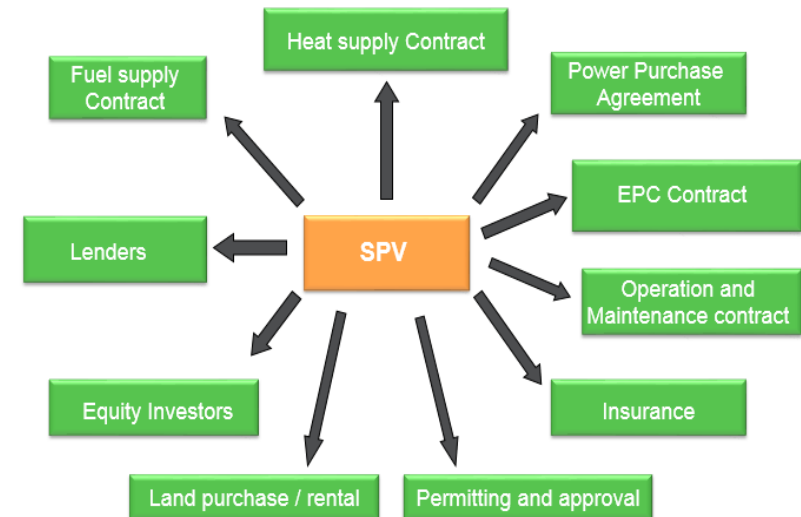
- The loan is merely secured by the agreements signed by the SPV

Key factors for success

- Technical credibility of the solution
- Selection of a potential site
- Delivery (implementation) model
- Optimized performance
 - High availability, output, fuel flexibility
- Long-term off-take agreements (PPA, heat)
- Secured fuel supply contracts
- Track-record and references of the technology supplier are vital

Limited recourse financing

- Majority of the loans have only the agreements as the collateral; but
- partially the sponsors or other parties have been forced to secure the loans with other means like bank guarantees.



Key elements needed for a successful power plant SPV

Financing of the project - Project financing

- Export credit guarantees and funding from the Finnish ECA (*export credit agency*) Finnvera and its subsidiary Finnish Export Credit (FEC)
- A major share of the debt financing came from FEC
- Negotiations for the financing started in parallel with the EPC contract negotiations in order to save development time in the complex process
- Finnvera/FEC provided their indication for the financing package to Uni Viridas
- Uni Viridas was active engaging their bank to the process in an early phase
- FEC always provides their funding through an arranger bank
- The arranger bank's role is significant as it needs to prepare loan documentation, assume document risk and residual risk exceeding the commercial and political risk over and above Finnvera cover.
- The arranger (Danske Bank) engaged yet a law office that structured loan documentation in cooperation with the two involved banks.



Project execution

Project management

- Notice to Proceed (NTP) in mid-November 2013
- Engineering phase in office
- Site works started immediately with excavations and soil improvements
- Nominated team was managing the engineering and execution throughout the project
- Project management functions moved to site when the main equipment installations started
- Commissioning and take-over summer 2015



Boiler erection – Economizer lift



Lifting of the reduction valve module. The heat exchanger module tower combines five process modules with an integral stair tower for turbine hall

Health and safety

High requirements for health and safety are crucial

- New and different working environment and customs in Croatia
- Weekly safety walks and documented inspections were held and shortcomings were reported and corrected
- Most of the reported risk observations and near miss cases were related to the use of personal protective equipment and working at height
- The most serious near miss incident happened during site internal road constructions where an asphalt truck hit and downed old overhead power lines crossing the site
- No loss time incidents (leading to absence from work for more than one day) were reported



Forced draft wet cooling towers in Babina Greda enable good performance in varying ambient weather conditions.

Summers in Slavonia are hot but winters can also be cold and snowy



Technology

BioPower9 technology – Babina Greda

Main performance data: 10 MWe + 0-16 MWth

Valmet in-house technologies:

- HYBEX BFB-boiler
 - Patented Hydro Beam grate
- DNA automation system
- Pulse jet fabric filter system (Valmet)
 - New design that considers future legislation
- Plant HVAC (Valmet Air-systems)

Other technology highlights:

- Push feeder storage system
- Fuel handling
 - Screening, iron removal
- Reaction type steam turbine plant
- Vacuum condenser
- Wet cooling towers



Primary air nozzles of the boiler become visible under the static sand bed during a sand removal test



Heating the BFB sand bed with the start-burner to 350°C (660°F) before solid fuel feeding

Heat supply

Drying kilns

- Drying of fresh lumber from local sawmills

Fuel drying

- Option for very high-moisture and low-grade fuels
- Improvement of combustion efficiency

District heating – an option for the future?



Drying kilns under construction



Operation

Operation

O&M by Valmet

- Mobilization of the O&M business and organization started during the commissioning phase of the plant
- A separate team worked together with the EPC-project members to plan and establish maintenance routines etc.
- Valmet's previously developed maintenance management systems
- Experience from life-cycle services to other similar plants



Boiler fuel feeding balancing bin - Fuel feeding is the key for efficient combustion and emission control

Operation

O&M by Valmet

- Remote connection to the DCS from Finland is frequently used when monitoring the performance and assisting in troubleshooting
- Annual service shutdowns are planned and executed together with local personnel and Valmet's Central European service organization
- Fuel, ash and sand samples were investigated and analyzed by Valmet's R&D experts
- Based on the results operating conditions and routines were fine-tuned to reduce the agglomeration of bed components.
- The plant has been running well and so far exceeding the guaranteed energy availability.



Sand silo being filled by a truck



Summary and conclusions

Summary and conclusions

- Biomass firing is still the only way of generating renewable power and heat efficiently on a 24/7 basis in large scale
- BioCHP plants
 - Increase regional reliability of power supply
 - Improve local employment in plant operation and maintenance as well as in wood fuel collection, handling and logistics
 - Reduce CO2 emissions ...
- Modular delivery model of the power plant enables fast and low risk power plant project implementation
- Good local co-operation and co-operation between the different stake holders is of crucial importance for the success of any project
- Babina Greda Project is based on firm feed-in-tariff, project development and project financing
- Feed-in-tariffs have been recently banned by EU
- The European bioenergy society is waiting with interest how the new subsidy mechanisms and auctioning processes will start working in practice



Thank you for your attention!



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