BIOMASS POWER AS A FIRM UTILITY RESOURCE: BIGGER NOT NECESSARILY BETTER OR CHEAPER

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***Abstract*—A rush to biomass power is underway in the U.S. with both public and consumer owned utilities proposing their first biomass power facilities. The average size of facility proposed is rising rapidly, supposedly to capture economies of scale. Unique to biomass, ever larger plants may not yield lower busbar costs. In many locales, a combination of fuel constraints, capped incentive programs, loss of local options and availability of combined heat and power (CHP) options lead to the optimization of the facility at a much smaller size. In the Oregon example included a 10 MWe CHP plant yields a substantially lower busbar cost than a 100 MWe stand alone plant.**

***Index Terms*—Biomass power, CHP, optimum size**

I. INTRODUCTION

The combination of high fossil fuel prices, mandates for renewable electricity and concern over greenhouse gas emissions have combined to create an interest in North American biomass power not seen since the passage of the Public Utility Regulatory Policy Act (PURPA) in the late 1970's.

Up to this point, North American biomass power development has been almost exclusively the province of independent power developers and the forest products industry, with but a handful of notable utility plants. If recent announcements are an indication, utilities are now proposing significant biomass power capacity and a crop of new developers are proposing ever larger facilities.

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II. SIZE IS CHANGING

To date, the fleet of biomass power facilities outside of the pulp and paper industry have averaged just 18-20 MWe each in size, with only a very few of 50 MWe or larger. New announcements are routinely 50 MWe or larger, with some biomass plants being proposed at 100 MWe. This paper will investigate the relationship of size to power cost for biomass power facilities utilizing traditional waste wood supplies. The paper will not focus on cofiring biomass with coal, nor will it cover energy crops for fuel, both of which are somewhat different subsets. The analysis here is applicable to forestry waste, agricultural waste and urban wood, the three major waste sources for current plants.

III. A DIFFERENT MODEL

Sizing and locating other firm utility resources such as coal or natural gas uses a very different model than biomass. In the case of a coal plant, the resource for the life of the plant is just below you or somewhere up the railroad track. In the case of gas, changing the size of the plant means nothing more than changing the diameter of the incoming gas pipe. The size is typically set by the future power needs of the utility, almost never by the resource.

It is so true that "all biomass is local". The high moisture content and low energy density means that long distance transport is out. Biomass is gathered across the landscape from disparate sources, many of which will ebb and flow over the life of the plant. Because of its public acceptance and availability in industrial and urban settings it is also the perfect renewable fuel for combined heat and power (CHP) applications. Because of these stark differences, it does not necessarily follow that a bigger biomass plant produces cheaper electricity or is more valuable to the utility.

As a general rule for biomass power, capital cost per MW and operation & maintenance cost per MWH go down as plant size goes up, while fuel cost per MWH goes up as plant size goes up. What is not captured in many simplified analyses is the role that applying biomass in a CHP situation on an industrial site can play in lowering overall busbar power cost. The host plant often has utilities on site to provide water supply and wastewater disposal, and much of the personnel can be shared such as maintenance, security, scalehouse, safety, etc. The host plant may have low cost fuel available, without transport cost. An electrical infrastructure is often in place to serve the host mill that is sufficient for a smaller biomass plant. Steam sales to the host may be 20% or more of total revenue with only modest loss of electrical revenue.

IV. ROLE OF INCENTIVES

Many incentives at the state and federal level are capped at a certain dollar value, making them less valuable as the plant size increases. At least the states of Georgia, Maryland, Oregon, New Mexico and South Carolina have such incentives, as well as the federal CHP credit for biomass.

V. LOCAL OPTIONS DISAPPEAR WITH SIZE

The disposal of ash from a small plant, for instance, may be beneficially applied to local farm fields, while that from a large plant overwhelms local needs and requires much more costly landfill disposal. While water for a small biomass CHP plant may be obtained from the host or local community, the large plant may require dry cooling in order to be permitted, with the ensuing higher capital cost and lower efficiency.

VI. PERMITTING COMPLICATIONS

A small biomass CHP facility typically is sited on an existing industrial/commercial site with appropriate zoning already in place.

In terms of air quality permitting, the small plant is, or can be cost effectively made, a "minor source" for all criteria air pollutants and thus extensive modeling is avoided. Typically, the small plant is not held to the same standards in terms of emission levels as a large plant because of the lower impact on local or regional ambient pollutant levels. In some cases, air quality permitting is simply a modification of the existing host site permit for a wood-fired boiler.

Permitting of a large biomass power facility also introduces new issues, such as whether the local resource is sustainable when measured against the long term fuel needs of the plant. A large plant may attract new powerful enemies such as elements of the forest products industry who fear that the plant will consume the very chips, pulpwood, shavings and sawdust they depend on for their raw material supply. Locals, comfortable with fueling the small plant with local resources, now look askance at bringing in large quantities of outside materials for burning in their airshed. Public agencies drag out the process as they try to balance these competing interests. In short, permitting a large plant introduces a level of uncertainty not present in small plant permitting.

VII. A PACIFIC NORTHWEST US EXAMPLE

It is instructive to see how all the above issues play out in an actual example. For our example, we have chosen a 10MWe biomass CHP plant serving a sawmill and a 100MWe stand alone facility, both located in the state of Oregon. Oregon was chosen as it is the largest producer of forest products in the U.S. and has active state incentive programs to support the installation of renewable energy facilities.

A side-by-side comparison of the two facilities is as follows:

Item	**10MWeCHP**	**100MWe Stand Alone**
Plant Design:	900 psig/900ºF stoker grate boiler Wet cooling tower Electrostatic precipitator Urea injection/NOx	1500 psig/950ºF fluidized bed boiler Air cooled condenser Baghouse Selective catalytic reduction/NOx Zero water discharge
Steam Customer:	Sawmill 50,000 lb/hr steam load@100 psig sat.	None

Interconnection:	to local 69KV serving sawmill through existing substation, no off site upgrades	to 115KV trunk nearby, upgrades to nearest 115KV/230KV substation required
Utilities:	Water supplied by sawmill Wastewater disposed by sawmill	City water
Ash Disposal:	Local farm land spreading	Local landfill
Fuel:	Mill residuals 86% (incl. fuel now burned, but not chips) Local forest slash 14% (from mill logging operations)	Mill residuals 11.5% Local urban wood 6.5% Local forest slash 4% Regional forest waste 78% (25 mile additional haul)
Incentives:	Federal Prod.Tax Credit (PTC) Oregon Bus. Energy Tax Credit (BETC) (50% income tax credit capped at $20MM) Federal Combined Heat & Power Tax Credit (7% of investment as ITC, year 1) Enterprise Zone Designation (5 yr. Property tax elimination) USDA Rural Devel.Grant ($500K)	Federal PTC Oregon BETC - - USDA Rural Devel.Grant ($500K)

VIII. EXAMPLE RESULTS

In both cases, a financial model was run to force via power revenue an unlevered after tax return of 12%. Surprisingly, the busbar power price required to yield this return was a full $10/MWH lower in the case of the 10MWe CHP plant, or 13% lower, than the 100 MWe plant. If the plants had been financed, the difference would likely have become larger for the following reasons:

1. The much greater fuel risk for the larger plant would lead to a higher percent equity requirement. In the case of the smaller plant, all of the fuel is supplied by, or under the control of the mill host. In addition, the mill has withheld its paper chips from the power plant because

of more lucrative markets elsewhere, but could be diverted to the power plant in the event of weather emergencies or market downturns as further fuel security.

2. Many rural locations have socioeconomic conditions that lead to designation as part of the federal New Market Tax Credit (NMTC) program. This program gives tax credits to lenders willing to lend in low income areas, but require a sponsoring organization with a capital allocation. One Oregon entity has $40 million remaining on its allocation, more than enough to fund the debt on the 10MWe plant at below market rates, but only a small fraction of the debt on the 100MWe plant.

3. Both these plants might qualify for a USDA federal loan guarantee, which will again lower interest rates. These loan guarantees have a maximum amount of $10 million, making the guarantee of far greater significance to the smaller plant.

IX.CONCLUSION

One conclusion that cannot be reached from this analysis is that the smaller plant will always be cheaper, since there is a degree of uniqueness to the jurisdiction chosen (OR). Other identified states that have similar size or dollar capped programs, however, include MD, SC, NM and GA. Also, participation in some programs may lower the value of other incentives, though these interferences will likely be taken up by Congress in 2009 with the intent of eliminating them.

Perhaps a more logical conclusion is that there is a unique optimum size for biomass in each location that uses data on fuel availability and costs, potential steam hosts and available incentives to arrive at the lowest required busbar power cost. Most biomass size versus cost studies done to date have failed to recognize this.

X. ROLE FOR UTILITIES GOING FORWARD

If the above thesis is correct; that there is a unique biomass solution in each location, the final question is what role does the electric utility play in this development. Developing small, optimized, unique, disbursed biomass resources that aggregate to a substantial resource would not seem to play to the strengths of most larger utilities. Utilities are good at planning and building large central stations identified in their Integrated Resource Plans, and have all of the experts to support such an activity. Attempting to utilize this same approach for a 10 MWe biomass plant with a variable steam customer and multiple fuel sources, would likely sink the project with overhead costs.

Perhaps a better approach is to issue well crafted “biomass only” requests for proposal (RFP’s) that match in time the utilities needs for new firm generation and/or additional renewable power and carbon offsets. A sophisticated evaluation matrix should be employed that is able to screen out proposals that can never be financed, utilize unproven technology or that rely on unidentified resources. The utility can then offer the contracts that will make the projects work.

It is important that biomass projects be developed across a broad spectrum. Developed correctly, biomass power can:

1. Bring large amounts of carbon neutral, or even carbon negative (if you consider the alternate fates of the fuel utilized) power on line to displace fossil fuels.

or investor owned and

2. Provide a displacement of fossil fuels in industrial/institutional heating or cooling applications.

3. Bring "end of line" reliability and voltage support to multiple rural locations.

4. Provide a firm source of renewable power with an availability and capacity factor to rival any coal or nuclear plant.

5. Provide new investment, employment and markets for rural farms and forests that have long needed an economic boost.

XI. BIOGRAPHY

William H. Carlson holds a BS (1969) in Mechanical Engineering from California Polytechnic State University. For many years he operated biomass, coal and gas-fired power plants for cooperative utilities, as well as for a large independent power producer. In 2003, he opened his own consulting firm offering biomass power development and technical services, primarily to forest products firms and independent power producers. His firm is also associated with Wellons, Inc., a supplier of turnkey biomass power facilities located in Vancouver, Washington. He is also the former Chairman of the Biomass Power Association and serves on the Boards of the California Biomass Energy Alliance, Western Governor's Association Biomass Task Force and 25 X 25.