

Current and future developments in domestic U.S. wood pellet manufacturing, and factors influencing scale and location.

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Summary. Wood pellet manufacturing and consumption began in the United States some three decades ago. In the intervening years, the industry has grown steadily, with a recent acceleration in response to rapidly rising fossil energy prices. Today, some 2 million tons per year are manufactured for domestic heating, and for export markets to supply rapid growth in Europe driven by EU carbon and renewable energy policies. Rising oil and gas prices in the U.S. are catalyzing technology advances in the use of pellet fuels for high efficiency/low emissions heating, industrial process heat, and combined heat & power technologies. The likelihood of regional or federal carbon emissions regulations will accelerate this trend. However, federal and state energy policy currently provides disproportionate incentives and subsidy investments for use of biomass in electric generation and cellulosic ethanol production, but not in thermal energy technologies -- despite the efficiency advantages of converting biomass into heat. Access to this finite renewable energy resource must be based upon parity in the application of incentives that are not biased in favor of certain technologies, but instead are based on policy outcomes such as energy efficiency, low air emissions, and mitigation of carbon emissions.

Keywords. [Forthcoming]

Introduction

Densified biomass fuels, most commonly in the form of wood pellets, have been manufactured in the United States since the late 1970's. The energy crisis of the 1970's and early 1980's prompted several early pioneers to modify grain pelletizers to compress dry sawdust as feedstock. Specially-engineered pellet stoves were developed with metered fuel and air feed and blower-driven heat exchangers, and a cottage energy industry was born.

The U.S. pellet industry grew slowly during its first two decades, with less than a dozen commercial manufacturers of pellet fuel and about the same number of appliance manufacturers until the 1990's. Since 2000, several factors have combined to accelerate development of a domestic pellet manufacturing industry. These include a growing public interest in American energy independence brought on by concerns resulting from the 9/11 terrorist attacks, the wars in Afghanistan and Iraq, and increasing political instability in oil producing regions of the world. In addition, growing public awareness of climate change and the need to mitigate carbon emissions has prompted serious attention on low carbon emitting energy technologies. The Katrina and Rita hurricanes of August 2005 prompted a major spike in demand for non-fossil fuel heating technologies, and a subsequent influx of investment capital in new pellet manufacturing capacity. Another wave of investment interest and new plant start-ups has been prompted by the record increases in oil prices during 2008.

What was a cottage industry some 30 years ago is now poised to play a significant role in heating, combined heat and power, and power generation. Policy-makers and the American public are waking up to the enormous potential of using pelletized biomass fuels to enhance America's energy security, lower carbon emissions, improve air quality, and strengthen local economies.

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The American Pellet Industry Today

There are now approximately 75 commercial manufacturers of wood pellet fuel in the United States (Pellet Fuels Institute - PFI, 2008). Most are concentrated in the greater northeast and northcentral states (Figure 1), although several new plants have come on line in the southern Appalachians and Gulf states since 2006. Many of these facilities produce less than 25,000 dry tons per year of pellet fuels. Most rely almost entirely on a stream of wood residues (dry and green sawdust, chips, shavings, grindings) from nearby wood product manufacturing. Several larger plants have come on line in the south since 2007, with the intent of producing for the export market in Europe, where demand exceeds locally-produced supply by several million tons/year. Collectively, the domestic wood pellet manufacturing industry has a production capacity now exceeding 2 million tons per year, with production in 2008 estimated at 1.4 million TPY (PFI, 2008).

Despite the fact that pellet fuel manufacturing has its origins in the U.S., sometime in the last 10 years the pellet industry in both Canada and Europe eclipsed that of the United States, in both number of manufacturing facilities and in total tons produced. Today, there are over 440 pellet manufacturing facilities in Europe (Figure 2; BioEnergy International, 2008), and annual production is estimated at 6 million metric tonnes, and growing rapidly. In Canada, approximately 40 manufacturers produced 2 million metric tonnes in 2008, with annual production projected to increase 50% within the next two years (Wood Pellet Association of Canada, 2008).

There are about 30 major manufacturers of pellet stoves, boilers and furnaces in the U.S. Sales of pellet appliances have increased steadily in recent years, with record sales recorded in the year following the 2005 hurricanes, and a new record forecast for the 2008/2009 heating season. The vast majority of appliances sold are stand alone stoves, with only a few domestic manufacturers of central heating hot water or hot air systems. PFI estimates that approximately 800,000 homes now use wood pellet fuel as a primary or secondary heat source.

Most growth in appliance sales has taken place in the northeast, where heating oil remains the predominant fuel for residential heating. Of the 8 million American homes that heat with oil, 6.2 million are in New England alone (U.S. Census Bureau, 2006).

The vast majority of pellet fuel is shipped in 40 lb. bags on one ton skids. Very little (estimated at less than 1%) of total production is shipped in bulk or used in central heating appliances such as boilers or furnaces.

This stands in stark contrast to Europe, where most pellet fuel is shipped and stored in bulk, and used predominantly in central heating boilers for residential, commercial and industrial space heating and process heat, as well as district heating of whole communities and cities. The number of commercial and industrial pellet boilers in the U.S. is very small by comparison to Europe.

Internationally, use of biomass pellet fuels for heat, combined heat and power, and utility-scale power generation has now far surpassed American consumption.

The American Pellet Industry in the Future

Pellet fuels, whether manufactured from wood or other cellulosic feedstocks, hold enormous potential to address America's energy challenges. Pellet fuels have decided advantages that make them an attractive choice for residential, commercial and industrial heating – compared to conventional fossil fuels. These include relative ease of transport and storage, non-toxicity, efficiency of combustion, comparatively low emissions, near carbon neutrality, and domesticization of energy expenditures.

For this potential to be realized, three things must happen:

- 1) Manufacturing facilities must be developed at a scale and in locations that maximize their benefit to the energy economy while optimizing the use of finite biomass resources;
- 2) The U.S. must move rapidly to adopt high efficiency, low emissions central heating and combined heat & power technology, with bulk distribution and use of pellet fuel; and
- 3) Federal and state energy policy must support and promote thermal renewable energy to an extent comparable to that currently provided electricity and transportation fuels.

Future of Pellet Manufacturing – Optimizing Feedstock Diversity, Scale and Location

Nearly all pellet fuel manufactured in the U.S. today is made from wood fiber. Most of this wood is derived from the residual by-products of other wood product manufacturing: sawdust, shavings, chips and grindings from the manufacture of lumber, furniture, flooring, cabinetry, millwork etc.

While lower grades of wood residues are regionally plentiful and available, domestic demand for “premium” grade pellet fuel – primarily for residential heating – requires access to clean, pure wood fiber. Pellet grade standards are administered by the PFI; the primary quality determinant that dictates grade is ash percentage (by weight) upon combustion. High bark, twig, foliage, root or dirt contamination in wood fiber will not produce a premium grade pellet.

Clean bark-free residuals, especially kiln-dried, are in increasingly short supply as the domestic U.S. wood product manufacturing industry has declined in output in recent years. While there is hope that our domestic wood products industry will rebound and flourish, it seems likely that these premium grade residuals will remain in short supply relative to growing demand. What was once considered a waste by-product of higher value-added wood product manufacturing is now a valuable energy commodity.

In the future, two things seem certain: one is that pellet manufacturing will rely to a far greater extent on wood fiber derived directly from timber resources – typically low grade species and stems that meet pulpwood specifications. The other is that pellet fuels will be manufactured from a much greater diversity of biomass feedstocks: grasses and other dedicated energy crops, agricultural residues, hybrid poplar and willow and other agro-forestry energy species, and blends of all of these. Both trends have implications to pellet quality that will necessitate a move toward stoves and boilers that can tolerate higher ash content – more on this elsewhere in this paper.

There is an economy of scale in pellet manufacturing. The sizable capital cost (particularly if drying of “green” feedstock is required) is such that plants that are much smaller than 25,000 tons per year are unlikely to provide an effective return on investment. Plants of this size have only succeeded in the past when they were located adjacent or near wood product manufacturers with a steady stream of residuals sufficient to support the facility. One would think that the larger the plant size, the lower the unit cost of capital and production. However, working against this is the distance the operator must go to procure sufficient wood resources to source the plant. The impact of this phenomenon became clear in the summer of 2008 when record diesel fuel prices dramatically impacted the cost of transporting wood. Several very large (500,000+ TPY projected output) plants had come on line in southern states, and quickly found their operating models impacted by soaring costs of transporting sufficient wood fiber to meet the sizable appetites of these “mega-plants”.

Cost of transport -- inescapably tied to the cost of diesel -- whether of inbound feedstocks or outbound finished product, will increasingly dictate the viability of pellet manufacturing. For a plant to succeed, it must be located in the “sweet spot” between proximity to market, and proximity to wood supply (with a bias toward wood supply because inbound feedstocks are typically green and up to 50-60% moisture;

outbound product is nearly bone dry). The challenge of this proposition is that proximity to market (populated areas) and proximity to wood supply (typically very rural areas) are almost by definition mutually exclusive!

The ideal size of the plant will also be dictated by the nature of wood supply, which can vary from one region to another. In the north-central and north-eastern states, commercial-scaled plants in the range of 50-100K tons/year seem like the optimal size. In the south, larger plants may be possible, especially in areas where other large volume wood product manufacturing (e.g. pulp, composite board products etc.) has declined, freeing up large available wood supplies. In the west, larger plants may be possible if more intensive forest management for fire control becomes politically acceptable on public lands.

Larger plants may be possible with a fundamental shift in public and private landowners' acceptance of more intensive forest management, similar to what occurs through much of Scandinavia and western Europe. For example, in the northeastern US annual forest growth exceeds wood harvesting by significant margins in many states (USDA Forest Service FIA). Low grade timber in overstocked forests, if more efficiently utilized (with proper safeguards for forest sustainability and biodiversity) can provide more fiber for use in pellet manufacturing and other energy uses. This fundamental shift may come if the value of wood as energy increases significantly and the economic benefits to landowners increase in time. But in the near-term it seems unlikely.

The introduction of new feedstocks in pellet manufacturing can also change the size and scale equation. Introduction of herbaceous energy crops such as switch grass, reed canary grass, and Miscanthus hold considerable promise, and could provide new revenue options for farmers in many regions. Woody biomass "crops" such as hybrid willow and poplar are also getting attention. These crops are intensively cultivated and can produce impressive annual yields of wood fiber per acre – far in excess of natural forest growth.

In addition, "urban waste wood" (e.g. street tree waste, wood from road and powerline right-of-way maintenance, clean and properly sorted construction and demolition wood, ground pallets etc.) represents a significant source of wood fiber for energy production.

However, for all of these new potential feedstocks to be viable, pellet stoves and boilers must be engineered to tolerate greater variability in fuel quality and especially higher ash content. And, pellet plants must be designed with maximum process flexibility to accommodate multiple feedstock types. This adds capital cost.

Central Heating and Bulk Distribution

As previously mentioned, an estimated 99% of all pellet fuel manufactured in the U.S. is distributed in plastic bags and used in standalone pellet stoves. This is in stark contrast to the expansion of pellet fuel use in Europe, the dramatic growth of which has occurred through central heating of homes and larger buildings, district heating, and utility-scale power generation (often through co-firing of wood pellets with coal), and distribution of pellet fuel in bulk directly to the consumer.

The benefits of bulk as compared to bagged fuel include:

- Less waste. No pallets or plastic bags to dispose of
- More convenient delivery into storage solution best suited for the customer
- No need to fill appliance hoppers daily with complete storage and transfer system
- Large volume bulk storage reduces frequency of delivery and allows use for larger buildings with commercial/industrial scale boilers.

Figure __ illustrates the convenience and efficiency afforded by bulk delivery into central heating technology, widely available in Europe but only just becoming available in the U.S. Bulk trucks deliver fuel, typically via pneumatic systems, directly to the home or business, similar to oil or propane delivery. Fuel is metered from bulk storage directly into the heating appliance. The entire system is fully automated and thermostatically controlled. New technology in Europe operates at efficiencies that compare favorably to the best oil and gas boilers – approaching 92-94%. High efficiency also means low air emissions, with particulate matter also comparable to the best oil and gas boilers available.

Efficient bulk delivery and the technology to use pellet fuels in bulk did not happen overnight in Europe. European Union governments, responding to carbon and renewable energy mandates, strongly supported the development of this technology through tax policy and direct subsidies to consumers.

Growth and expansion of the use of pellet fuels in bulk presents a “chicken and egg” scenario for American energy consumers. Entrepreneurs inclined to invest in the very expensive transport, storage and sales/distribution of boilers are reluctant to do so in the absence of well-developed market demand. Potential residential, commercial and industrial consumers inclined to install bulk storage and boilers are reluctant to invest the capital in the absence of reliable infrastructure to ensure delivery of fuel, and stable, predictable supplies of fuel. There is a logical role for state and federal governments to play in helping to catalyze this new technology through financing of risk capital, direct grants, or tax policy. This assistance can be phased out over time as the critical mass develops sufficient to drive growth by market forces alone.

Support of Federal and State Policy

Energy consumption in America can be divided roughly into thirds: one third electric generation, one third transportation, and one-third heating (thermal)(USDOE EIA). Federal and state energy policy has focused almost entirely on electric generation and transportation. State electric generation renewable portfolio standards now exist in 32 states (Database of State Incentives for Renewables and Efficiency), providing powerful incentives for investment in and development of solar, wind, hydro, biomass and other electric generation renewable energy technologies. Federal production tax credits exist for biomass, solar, geothermal and wind electric generation. In recent years, federal policy has strongly supported development of renewable transportation fuels such as grain-based and cellulosic ethanol and biodiesel, through strong research and development support, demonstration project funding, and direct production credits and subsidies.

Yet, virtually no such support exists for thermal renewable energy technologies (except for some limited residential tax credits). The use of biomass to produce thermal energy must compete for finite feedstocks with electric and (soon) transportation fuel technologies that are strongly supported through subsidies, an unlevel playing field that places biomass thermal at a competitive disadvantage. For example, in New Hampshire there are seven commercial wood-fired power plants, collectively consuming approximately 1.7 million green tons of wood biomass annually. Operating revenues at these facilities are supplemented by federal production tax credits and sale of renewable energy credits in New England. Biomass heating must compete for wood resources that are artificially elevated in cost by these subsidies, yet the same public policy goals that provide the rational basis for these subsidies are also met by using biomass to make heat – at much higher conversion efficiencies.

The Pellet Fuels Institute and the recently formed Biomass Thermal Energy Council have advocated for outcome-based energy policy, rather than technology –biased energy policy. These organizations believe that policy should encourage energy technologies that maximize efficiency, minimize carbon emissions, and reduce air emissions. Policy should support those technologies wit



1. Home Delivery of Pellets in Bulk

- Much like oil, gas, or propane
- Convenient - you don't need to be there

2. Sufficient Storage

- 1-3 deliveries a year
- Attractive and/or unobtrusive



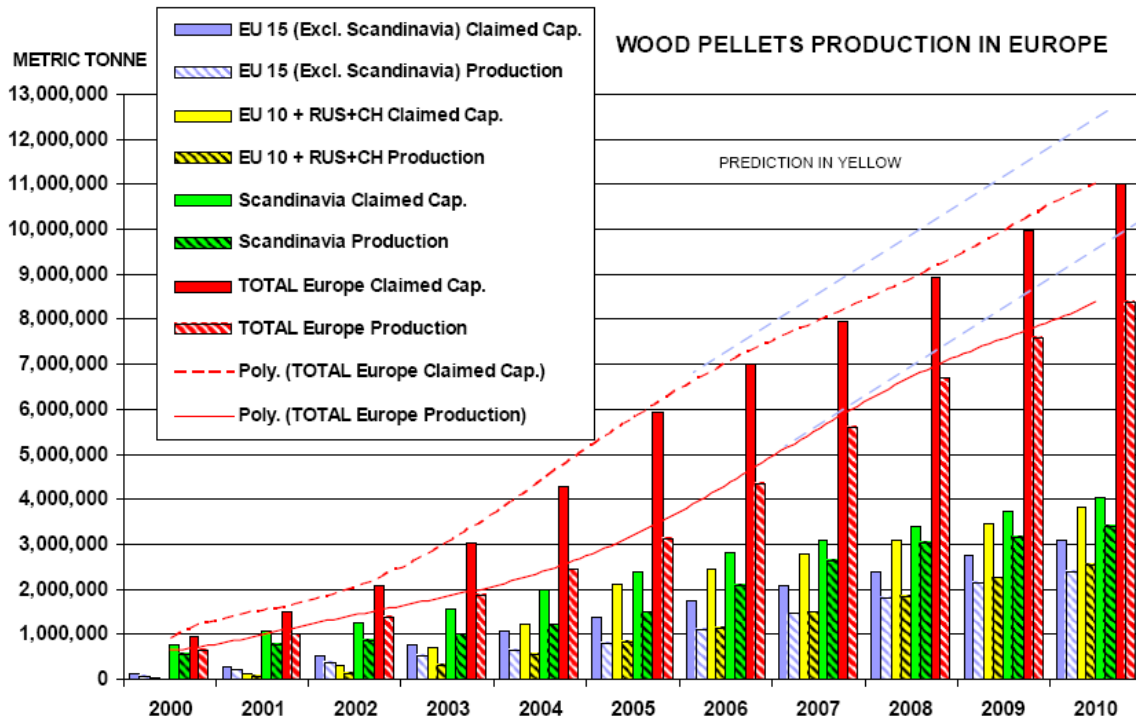
3. Fully Automated Central Heating System

- Boilers and furnaces support existing distribution system
- Automated feed system
- Self-ignition and self-cleaning
- Safety that is superior to propane or gas

4. Easy Installation/Service

- Simple venting
- Simple, once-a-year maintenance includes ash removal





The small output pellet plants that characterized

Thermal energy represents roughly one-third of total energy consumption in America, with electricity and transportation fuels representing the other two-thirds (USDOE Energy Information Administration, 2007). Yet thermal renewable energy technologies have received virtually no policy support or promotion at the state or federal level.

In the last decade, policy makers have put increasing emphasis on reducing fossil fuel consumption in the production of electricity and transportation fuels. State renewable portfolio standards, federal production tax credits and other subsidies, and the federal renewable fuels standard are a few of the many state and federal policies enacted to promote a transition to renewable fuels in electricity and transportation.

Scale and Location of Manufacturing

Diversifying Feedstocks

- Wood as predominant feedstock
- Roundwood
- Landscaping wood, urban waste wood
- Herbaceous energy crops, other agricultural residues

Trends in Domestic and Foreign Demand

- Domestic residential, commercial and industrial demand trends
- Export markets from U.S. manufacturing

Advancing Combustion Technology

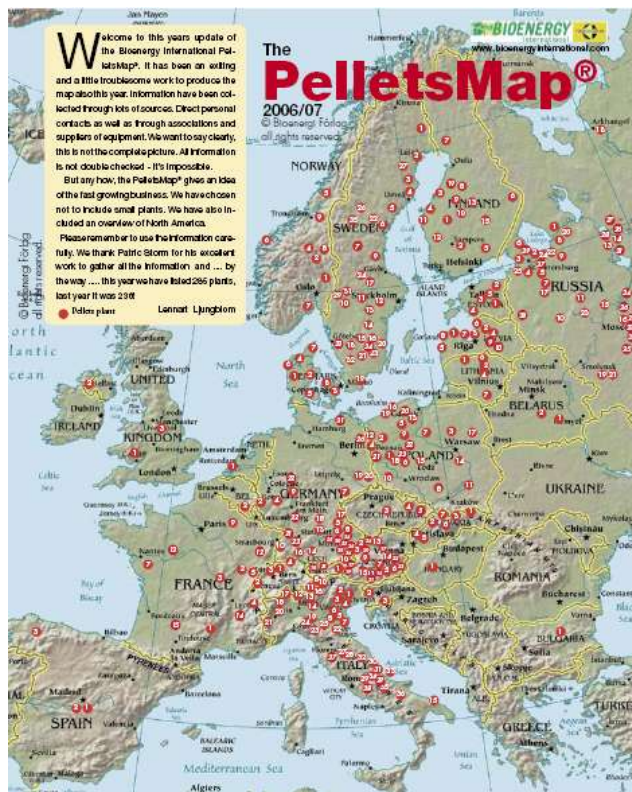
- Stoves
- Residential central heat
- Commercial/industrial boilers
- District heating
- Combined heat and power
- Commercial scale power generation

Role in Meeting Regional/National Energy Needs

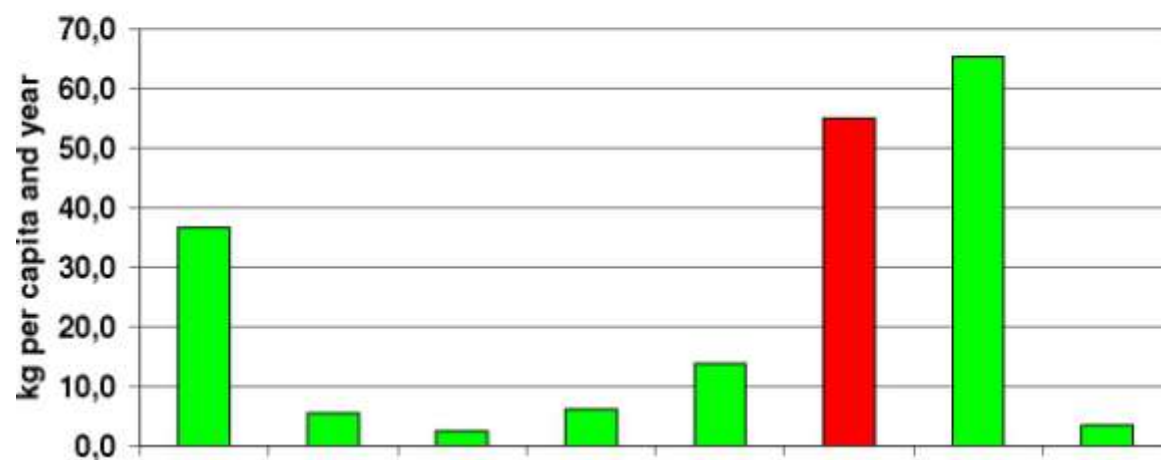
- Residential heating
- Commercial/industrial heating and process heat
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Policy, Research and Development Needs

Conclusion



per capita use of pellets as fuel for residential heating



References

[Forthcoming]