



WOOD ENERGY IN DEVELOPED ECONOMIES

An Overlooked Renewable

*Though it is often ignored in national conversations about renewables, wood energy dominates renewable energy portfolios in many developed countries—and is poised for exponential growth. **Francisco Aguilar** sets the record straight about this salient energy source.*

Considered to be the first form of energy harnessed by humans, wood was long the primary source of heat and illumination for people in every corner of the globe. Today, it is estimated that more than 2 billion people in developing countries rely primarily on wood and other forest products for their daily cooking and heating needs, causing the public to associate the use of such resources with tropical deforestation and poverty. Meanwhile, energy headlines in developed economies have been dominated by stories about coal and oil since the mid-1800s, making it easy to forget that the exploitation of those fossil sources by humans has been a relatively recent development.

Both ideas—that energy derived from forests is used primarily in developing nations and that its importance in the energy portfolios of developed economies is negligible—fail to capture the reality of current energy markets. Wood energy represents the leading source of renewable energy in many developed countries across North America and Europe. And in the United States, wood energy accounts for 25 percent of renewable energy consumption, second only to hydropower and more prominent than wind and solar energy. This high level of generation has been achieved thanks to healthy forest resources supported by a combination of recent market and policy developments.

Wood Energy in the Twenty-First Century

The term “wood energy” refers to energy derived from solid, liquid, and gaseous wood fuels, including raw firewood, processed charcoals, pellets, briquettes, residual fibers, and black pulping liquors. Some of these fuels can be sourced directly from forests or indirectly as by-products from the wood processing

and pulp industries, whereas others can be created from processed wood products that are recovered and repurposed at the end of their consumer life cycles. About 58 percent of wood fuels across the United Nations Economic Commission for Europe (UNECE) region—a group of 56 countries that includes the United States, Canada, European nations, the Russian Federation, and the Commonwealth of Independent States—come from indirect sources. The rest are attributed to direct sources (32.9 percent), recovered wood (3.8 percent), and unspecified supplies (5.4 percent).

Wood fuels are ultimately converted to energy through combustion using one of three main processes. Direct firing or co-firing with other fuels—such as coal—is likely the method most familiar to consumers and requires the least amount of pre-processing in order to render fuels usable. Woody feedstock can also be biochemically transformed (using chemicals or enzymes) into sugars for the production of biofuels, or thermochemically transformed (using heat, pressure, and catalysts) into biofuels and other co-products.

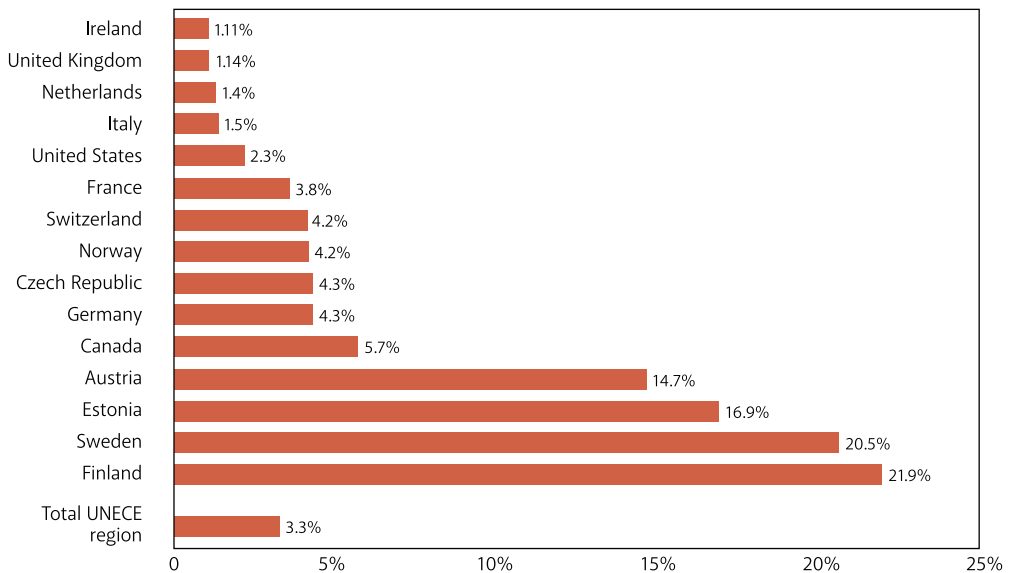
The wide range of feedstocks and conversion processes available today allows for a diversity of sectors that manufacture and use wood energy. Forest-based industrial producers, such as pulp and paper manufacturers, burn wood-based fuel to generate electricity or heat used internally to support production. So do plants designed to generate electricity or combined heat and power to sell to third parties. And residential consumers use wood-burning fireplaces or pellet stoves for home heating. Technological progress has allowed an increase in energy output while reducing the amount of associated pollution, including particulate matter, that limited wider adoption in the past.

Modern Wood Energy Markets

One of the most comprehensive sources of information about wood energy markets in developed countries comes from the Joint Wood Energy Enquiry, a survey of wood energy consumption in the UNECE region. The most recent results, from a 2011 Joint Wood Energy Enquiry answered by 27 UNECE member countries, revealed that wood energy accounted for 3.3 percent of the region's total primary energy supply (Figure 1). Although absolute wood energy consumption tends to fluctuate in the United States and Canada, the European Union has experienced an increase in consumption of more than 104 percent in the last two decades. Notably, the share of wood used for energy jumped during the recent recession, suggesting that energy production may have provided an alternative market for wood fibers while demand for more traditional products, such as paper and cardboard, declined.

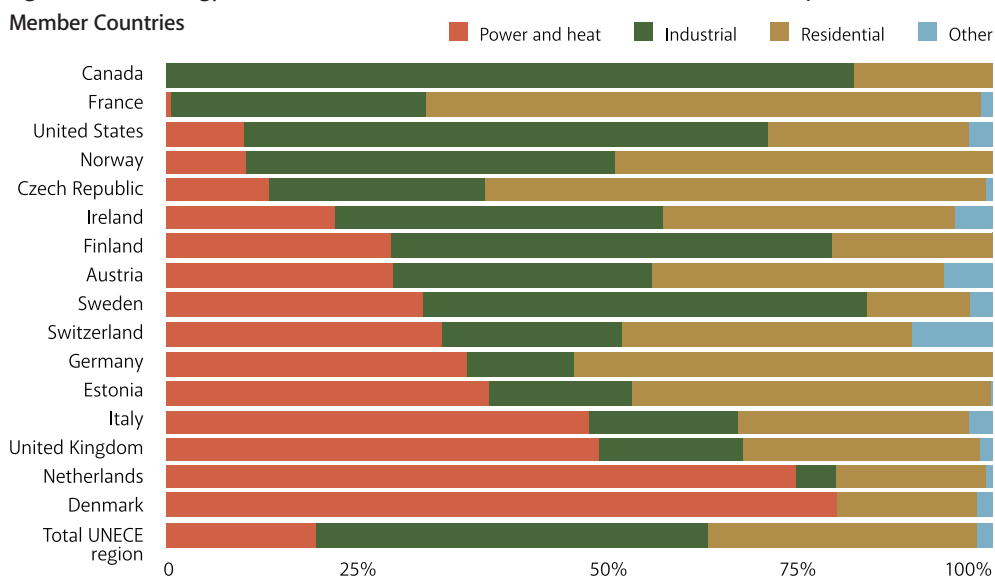
Overall, the industrial sector consumes the largest amount of wood energy at 47 percent—representing about 282.8 million cubic meters of wood—followed by residential consumers (33 percent), the power and heat sector (18 percent), and other undesignated uses (2 percent). These statistics are significant in highlighting the relationship between output and wood fuels, but they don't reveal the large variations among the ways that individual countries consume wood energy. Figure 2 on page 24 provides a fuller picture. Note that Canada's industrial sector is the largest consumer of wood energy at 83 percent, whereas the power and heat sector is dominant in Denmark (81 percent) and the Netherlands (76 percent). Additionally, half of all wood energy in Germany was shown to be consumed by the residential sector, while Austria has a near-equal balance among power and heat, industry, and residential wood energy usage.

Figure 1. Share of Wood Energy in Total Energy Supply in Select United Nations Economic Commission-for Europe (UNECE) Member Countries



Source: Joint Wood Energy Enquiry 2011, a survey of wood energy consumption answered by 27 UNECE countries. <http://www.unece.org/forests/jwee.html>.

Figure 2. Wood Energy Uses in Select United Nations Economic Commission for Europe (UNECE)



Source: Joint Wood Energy Enquiry 2011, a survey of wood energy consumption answered by 27 UNECE countries. <http://www.unece.org/forests/jwee.html>.

Historically, the amount of wood energy produced and consumed in an economy has been heavily dependent on the local availability of forest resources. In recent years, markets have become regional and reached almost global scale, thanks to renewable energy mandates and technological advances. The pelletization of wood, for example, allows producers to condense the energy content found in wood fuels. By making the transportation of wood fuels more cost-effective, these advances have helped to encourage the creation of a dynamic international market for wood energy that may further diminish proximity limitations. In the United States, for example, where forested area has remained stable over the last century and annual forest growth rates exceed removals and mortality, some of the excess biomass and by-products from the industry are pelletized and traded regionally and abroad. In 2013, US wood pellet exports to Europe reached nearly 3 million metric tons.

Despite technical advances, the growing wood energy market is still very much influenced by transportation costs and the location of nearby wood resources, explaining the vast differences in wood market involvement among UNECE members. Nordic and Baltic nations are by far the most invested consumers of wood energy; in Finland and Sweden, wood fuels generate more than 20 percent of total primary energy supplies—the largest of any developed countries. Conversely, countries such as the United Kingdom and Ireland, which lack the vast forests of their Scandinavian counterparts, reported the lowest levels of wood energy consumption in the survey. Still, some countries have already circumvented this link through imports; the Netherlands and Denmark both support higher-than-average per capita wood energy consumption by sourcing wood from a number of other countries. Their import of wood highlights the growing capacity of the international wood energy market.



This residential biofuel boiler burns wood pellets to supply the home with heat and hot water.

Renewable Energy and Mandates

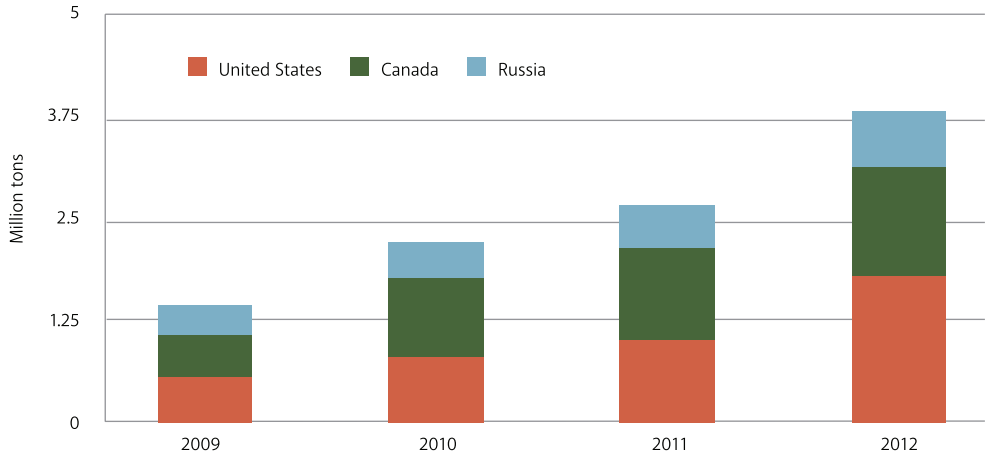
Wood energy's role in modern energy usage is often understated. Its renewable energy designation has made wood fuel a popular choice for countries seeking to meet specific renewable energy targets. The near-doubling of EU wood energy consumption since 1990, for example, is often attributed to the "20-20-20 by 2020" directive set by the European Parliament and the Council of the European Commission. Officially known as Directive 2009/28/EC, this policy requires that 20 percent of the total primary energy supply of participating countries comes from renewable sources, alongside a 20 percent increase energy efficiency and a 20 percent reduction in greenhouse gas emissions by the year 2020.

This increasing demand for renewables also has affected countries on the other side of the Atlantic; Canada's own wood energy use is declining, but its export of wood pellets—as well as that of the

United States and Russia—has dramatically increased as a result of European import needs (Figure 3). And the European Union is expected to double its demand for wood for energy from 435 million cubic meters in 2010 to reach 860 million cubic meters in 2030, which will likely require even greater reliance on imports.

Wood energy commonly qualifies under renewable portfolio standards adopted by many states across the United States. Recently instituted state-level mandates coupled with federal incentives under the Public Utility Regulatory Policies Act of 1978, and others, have resulted in greater use of wood in coal-fired power plants and dedicated boilers. According to data from the US Environmental Protection Agency, 89 coal-fired power plants use some quantity of biomass for the generation of power. For some power plants, incorporating wood as an energy feedstock can be fairly easy, requiring relatively modest investments in new infrastructure. Some estimates

Figure 3. EU Imports of Wood Pellets from Canada, Russia, and United States



Source: EuroStat.

suggest that about 10 percent of coal used by power plants in the northeastern United States could be replaced with available and cost-competitive woody materials.

Although wood is widely recognized as a renewable source of energy, its designation as a carbon-neutral alternative depends on many factors. Trees can be replanted to replenish stocks of harvested timber, and a significant number of regional and national forest management programs have been established worldwide to responsibly maintain the number of trees available for future harvests. Trees also absorb varying levels of carbon dioxide for use in photosynthesis. And although this does reduce the impact of wood fuel combustion on the environment, it takes time to fix carbon back into growing trees. Unquestionably, the better opportunities to reduce carbon emissions using wood energy arise from an integrated approach that maximizes forest productivity and energy conversion, minimizes greenhouse gas emissions along the supply chain, optimizes manufacturing by using by-products for energy, and promotes the replacement of non-renewable materials with wood products.

The Future of Wood Energy

The use of wood energy among many UNECE countries, and possibly even non-UNECE countries in Asia, is expected to continue climbing through 2020. But wood fuel's long-term usage in future energy portfolios will likely be decided by a number of uncertain factors that differ depending on the sector. The use of wood energy by the industrial sector is largely a function of wood product output. Overall economic growth and consumption of other wood products will have a large influence on future wood energy used by industry.

In the residential sector, any changes in competing energy prices might pose a risk to—or present an opportunity for—the expansion of wood energy consumption. The advent of inexpensive natural gas supplies in large areas of North America will likely cause a decline in its overall residential wood energy demand. But in some particular areas, such as the northeastern United States, wood energy is likely to remain price competitive and become a more prominent source of household heating. Whether natural gas becomes cheaply



Pelletization allows producers to condense the energy content found in wood.

available in Europe will affect residential wood energy use.

Natural gas will likely play an important role in how much wood energy is used in the power and heat sector, too, although renewable energy mandates will likely sustain or increase wood energy use unless there is a significant paradigm change in public policy.

Wood energy use is highly dependent on policy interventions and timber markets, and significant questions remain about the economic availability and feasibility of obtaining more wood fuels than are currently being generated. Additionally, any expansion in the use of wood resource for energy will need to be evaluated and justified on the basis of its impact on the environment, including potential forest depletion and net greenhouse gas generation. If the demand for wood energy continues to grow, materials that would otherwise go into the manufacturing of other wood products might be pulled into the wood energy market, requiring landowners to assess how much more wood they should allow to be removed from their forests. All these questions are

further dependent on whether timber and wood energy markets are able to produce competitive prices and, ultimately, profitable economic and environmental returns.

Wood energy is unique in that it requires the alignment of a diverse group of issues, including land management, energy production, socially acceptable environmental objectives, and varying methods of fuel production and combustion. This alignment involves participants at every stage of energy production, with forest owners, power generators, and industry members working to supply the energy requirements of policymakers and consumers. Studying the elements that make up this network—from management and economics to ownership and trade—can help foster a better understanding of how public policy influences the development of wood energy. ●

FURTHER READING

- Aguilar, Francisco X., ed. 2014. *Wood Energy in Developed Economies: Resource Management, Economics, and Policy*. New York: Routledge.
- Goerndt, Michael E., Francisco X. Aguilar, and Kenneth Skog. 2013. Resource Potential for Renewable Energy Generation from Co-firing of Woody Biomass with Coal in the Northern US. *Biomass and Bioenergy* 59: 348–361.