Chapter 6

Wood energy and competing wood product markets

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HIGHLIGHTS

- Modest expansion in US consumption of wood for energy - on the order of 150 percent over 2006 levels - could have a small impact on forest sector markets and trade over the next couple of decades, provided there is a substantial cushion of wood residue supplies from logging and mill residues due to a recovery in housing construction and increase in wood product output, along with excess supply of pulpwood due to stable to declining paper/paperboard production and increasing timber inventory.
- More significant forest sector market disruptions could occur with higher levels of wood energy consumption, with more limited growth in supply of wood residues, with more restrictive constraints on supplies of logging residues or with higher costs for residue supply.
- The composition of wood fuel supply changes as wood enbergy use increases- increases in the demand for wood fuel will result in increased use of higher valued wood fuel sources, such as mill fiber residues and pulpwood.
- Differences in global wood energy use, as well as differences in the US wood energy use, can affect US forest products markets. This effect will occur

whether the increased demand results from market forces or from domestic or international policies.

- Higher levels of US wood energy demand results in higher revenues to landowners, who then invest more intensive management (e.g. planting) and are also more likely to keep their land forested, which will increase future supply of wood products.
- The net impact of wood fuel demand on small-diameter roundwood markets depends on the complex interaction of small- and large-diameter roundwood markets and feedstock flexibility (species, roundwood/logging residue) of the wood fuel producer.
- A key demand factor affecting small-diameter roundwood markets is the potential recovery of the housing construction sector. An increase in demand for sawtimber results in increased sawlog production, which results in increased mill residue production—a primary wood fuel supply for pellet production.
- A key supply factor affecting small-diameter roundwood markets is the variation among subregions in available pulpwood inventory to meet both wood fuel and traditional fiber (e.g. wood pulp and panel) demands. Because of high transportation costs for wood fuel, subregional markets can be significantly affected by this supply constraint that occurs because of planting that occurred from two to 30 years ago.

6.1 Introduction

Understanding the effect of expanding wood energy markets is important to all wood-dependent industries and to policymakers debating the implementation of public programs to support the expansion of wood energy generation. A key factor in determining the feasibility of wood energy projects (e.g. wood boiler or pellet plant) is the long-term (i.e. 20–30 year) supply outlook for raw materials. Long-term supply of wood for energy, in turn, is directly affected by long-term demand from various markets using wood fuel for alternative demands (e.g. traditional wood industries).

Many sources of wood may be used as an energy feedstock, including (1) residues from sawmills and plywood mills that provide wood fiber suitable to make composite panels or wood pulp (mill fiber residue); (2) mill residues only suitable for fuel (mill fuel residue); (3) logging residue left behind after removal of pulpwood, sawlogs, or veneer logs; (4) pulpwood from forests; (5) urban wood waste from tree trimming, building construction, or demolition; and (6) pulpwood-size wood from short-rotation woody crops (SRWCs) grown on agricultural land.

The supply (quantity and price) of mill residue and logging residue is mainly determined by the production of traditional wood products such as pulp, plywood, and lumber (Ince et al., 2011a, 2012; USDOE, 2011; Skog et al., 2013). Logging residue is a currently underutilized by-product of harvesting operations, whereas mill residues, both fiber and fuel, are valuable by-products of milling operations. The short-term supply of pulpwood, sawlogs, and veneer logs from forests depends on: (1) the inventory of timber in the surrounding region; (2) recent silvicultural practices in managing for pulpwood production as well as sawlog and veneer production (e.g. age of harvests and density of stands); and (3) costs of harvesting. Long-term supply will be influenced by shifting of the forest stand age class distribution in the region and gain of land to forests (planting) or loss of forests to other uses (clearing/conversion). The supply of urban wood waste depends on management of urban trees, wood construction, and demolition of wood buildings. Wood supply from SRWC will depend on net revenue from producing SRWCs for energy versus net revenue from producing agricultural crops.

Market competition is partly determined by the physical characteristics of the wood that would make it a suitable input to other sectors of the wood products industry. Likely market competition will be centered on mill residue suitable to make panels or pulp, pulpwood from forests, and pulpwood from SRWCs. Each of these materials can be used for energy and for wood pulp and composite panels. However, it is unlikely there would be competition for mill residue that is suitable only for fuel, logging residue, or urban wood waste, because these have high bark content that is difficult to use in making pulp and composite panels.

Markets are dynamic, and as such the price for wood fuel will likely be influenced by three main trends. First, by the trend in aggregate demand for wood fuels; second, by the trend in supply of various wood fuels; and third, by the trend in demand for competing uses of wood (primarily for mill residue and pulpwood). The demand for competing uses for wood can include demand for exports, which in turn can be influenced by the cost of products and energy in other countries. In particular, cost of products in other countries can be influenced by demand for wood energy in those countries.

Policies, both international and domestic, can influence markets for wood energy. In the US, the 2007 Energy Independence and Security Act includes a requirement for production of cellulosic ethanol that has driven research and commercial test operations. Similarly, the 2009 EU Renewable Energy Directive requires that a percentage of EU electricity be supplied from renewable sources by 2020. This policy, and the subsequent member countries' policies implementing this requirement, has led to substantial production and exports of wood pellets from the US and Canada.

This chapter describes how potential trends in wood energy demand, wood fuel supply, and demand for other wood products can affect wood fuel prices, including prices for mill residue and pulpwood. We also describe how these prices affect competing markets for paper, panels, and lumber manufacturing. We use examples from several US markets with a focus on fuel supply. First, we give a simple example of how wood fuel stock demand can be met by a combination of multiple sources using supply and demand curves for wood in a region surrounding a wood energy facility. Next, we show three more complex examples using forest products market projection models to indicate how various levels of projected wood fuel demand will affect wood fuel prices; prices for lumber, panel, and paper products, and the production and trade of those products. We conclude with summary points about how wood fuel demand interacts with other wood product markets.

6.2 Structure of US wood fuel markets

Wood for energy generation can be supplied via a number of forest product market pathways. Natural or planted forests provide the initial supply of all wood in the form of sawtimber-sized trees from which sawlogs, veneer logs, and some pulpwood can be procured, or non-sawtimber-sized trees that provide mostly pulpwood. Trees also provide fuelwood, which is used directly or indirectly in the commercial, residential, and industrial sectors (see Chapter 1). In addition, a portion of wood that normally would be left following a commercial harvest can be removed if there is demand to use it for energy (see Chapters 4 and 5). Forest harvest guidelines can specify the portion that can be taken and still maintain ecological functions and animal habitat (Chapter 4). Wood can also be supplied from SRWCs if the net revenue is competitive with alternative agricultural crops (Figure 6.1; see also Ince et al., 2011a).

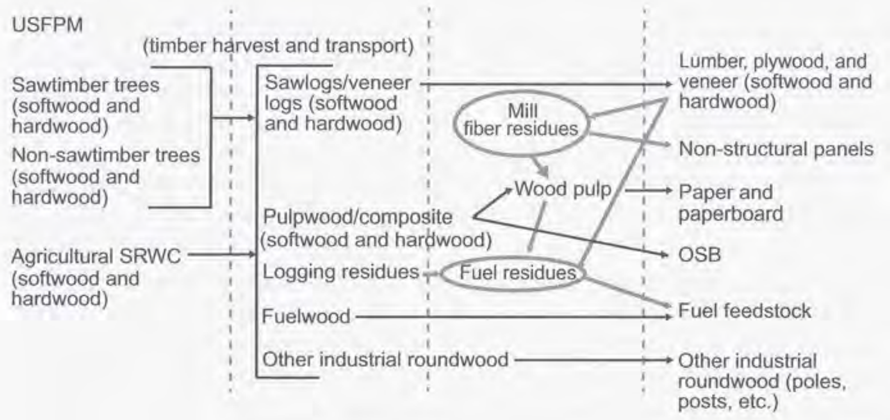

Figure 6.1 Forest products markets and wood supply structure

Source: Adapted from Ince et al. (2011a)

Three key production issues influence US wood fuel markets: (1) the production of logging residues as a by-product of harvesting operations; (2) the production of mill residues as a by-product of milling operations (the mill fiber and mill fuel residues noted above); and (3) the potential competition for wood fuel material among uses (for energy, wood pulp, and composite panel production). These three issues are discussed in more detail below.

Prices to supply sawlogs, pulpwood, fuelwood, and logging residue in a region are influenced by the synergies of supplying multiple products from the same forest area. Market prices for standing timber and logging residue are determined by the supply of timber in a region and demand for timber products in the form of sawlogs and pulpwood, or demand for wood fuel. The cost of harvesting a unit of wood can be lowered if there are markets for both sawlogs and pulpwood, and can be lowered even more if there is a market for lagging residues. Hence, demand for logging residue for fuel can actually lower the cost to supply sawlogs and pulpwood, and thus lower their prices to a limited degree. Production of wood fuel from logging residue is complementary to (i.e. supports) production of sawlogs.

The synergy of using logging residue along with sawlogs to keep wood fuel costs down can also be important in being able to supply wood at competitive costs from public land in the US West, where there is the need to remove trees to reduce fire hazard. A key driver of supply of wood from public land in the West is the objective to restore €orestland—with the aid of wood removals—to lower risk of fire or insect and disease attack.

The interaction between demand for lumber, panels, and paper and the supply of wood materials for solid wood, paper, and wood energy products adds another layer of complexity to wood fuel markets. Lumber and plywood mills generate residues that can, in turn, be used to make paper or composite panels. Therefore, the level of solid wood products manufacturing in a region can boost supply (i.e. lower cost) for wood used to make pulp and composite panels.

Likewise, the level of solid wood product manufacturing by producing residues can boost supply and potentially lower the cost of wood energy. Solid wood product manufacturing is complementary to the production of mill residue, which may be used as wood fuel or for pulp and composite panels. The extent to which increased residue production can be used for energy, either directly or by manufacturing charcoal, briquettes, pellets, or other densified energy products, depends on the local demand to use low-cost residue for pulp and composite panels. The demand for wood fuel competes for fiber mill residues that can also be used for pulp or composite panels. Currently, most mill residue is used for pulp or composite panel production or for wood energy within wood products mills.

The third production issue is competition between buyers of wood fuel feedstock. Wood fuel needed to meet energy demand may be drawn away from wood sources that primarily are used for other products, as wood fuel

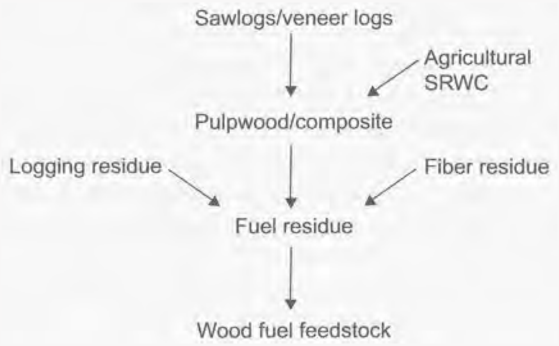

Figure 6.2 Cascading wood raw materials substitution possibilities to provide wood fuel feed stock

Source: Ince et al. (2011a)

prices increase (Figure 6.2). Here is a possible sequence of events linking wood energy prices and sources of wood fuel supply. Demand for wood energy will rely on the lowest-cost wood fuel residues. These mill residues could be drawn away from pulp or panel manufacturing. As the price for wood fuel continues to increase, other sources of supply, such as pulpwood from forests or mill fiber residues, will likely be redirected to energy use. With a further price increase, SRWCs may be used for energy. At sufficiently high prices, urban wood waste could be used. Finally, in thee very unlikely case of extremely high wood fuel prices, sawlogs and veneer logs could be drawn away from lumber and plywood to be used for wood energy.

6.3 Simplified framework for the analysis of wood fuel supply for energy and impacts on competing markets

The cost per unit to deliver amounts of wood fuel to a wood energy facility is determined by the sum of the supply curves for the several kinds of material available in the region. Costs include those related with the processing of wood fuel coming directly from the land or indirectly as residue from the manufacturing of wood products or recovered products.

Figure 6.3 shows how hypothetical supply curves for pulpwood and logging residue in a region would be added together. In Figure 6.3a, the current amount of pulpwood used for other purposes is q_1 and the price is p_{PW}. Figure 6.3b shows the amounts of logging residue that may be supplied with a quantity limit of q_4 at price p_1, given current levels of harvesting in a region.

The tital wood fuel supply from both these sources is shown in Figure 6.3c and corresponds to the horizontal sum of Figures 6.3a and 6.3b. In Figure 6.3c, until the price increases to p_{PW}, only logging residue will be supplied for

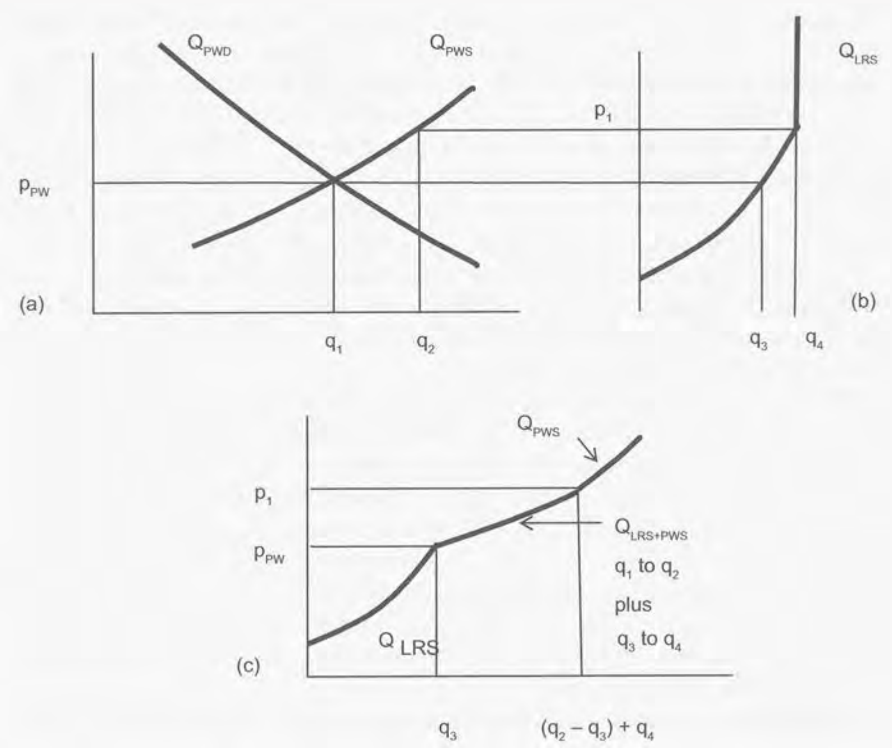

Figure 6.3 Wood fuel supply from a combination of logging residue supply and pulpwood supply

wood fuel. As price increases further, both logging residue and pulpwood will be supplied until price p_1 is reached. For prices higher than p_1, additional supply would be in the form of pulpwood.

Actual supply of wood fuels in a region for a facility will potentially be the sum of supply curves for mill residue, logging residue, hardwood pulpwood and softwood pulpwood, and possibly SRWCs, urban wood waste, and, potentially, imported wood for fuel.

6.4 Effect of projected increases in wood energy on US forest products markets

6.4.1 Projections for increases in US demand for wood fuels 2006–2030

This first example compares two projections for US forest product markets, one where demand for wood fuels increases by 48 percent between 2006 and

2030, and one where the increase is 173 percent Once et al., 2011b) (Table 6.1). The projected 48 percent increase by 2030 is based on the assumption that greater demand for wood fuels is driven by both a Renewable Fuel Standard (RFS) established in the US by the 2007 Energy Independence and Security Act and by a Renewable Energy Standard (RES) to produce 10 percent of US electricity from biomass (see Chapter 8 for details on the adoption of public policies to promote wood energy). We call this the RES 10 case. The projection with a 178 percent increase by 2030 is driven by the RFS and by a hypothetical RES of 20 percent. This is the RES20 case. In each case, we assume one-third of the biomass needed to attain the RFS and RES requirements will come from wood fuel and two-thirds from agricultural biomass (USDOE, 20 1 1).

Projections were made using the US Forest Products Module (USFPM), which operates within the Global Forest Products Model (GFPM). The USFPM Once et al., 201 la, 2011b) is a dynamic model of US timber harvest, forest product markets, and trade, and works within the larger partial equilibrium framework of the GFPM (Buongiorno et al., 2003). The model makes long-range projections of US and global forest sector production, consumption and trade, and prices for solid wood and paper products, as well as production and price for wood fuel. In 2006, US wood fuel production was about 113 million m^3 (54 million dry tonnes) and was composed of mill fuel residue and firewood.

Five key assumptions that influence how use of wood for energy affects wood and paper product markets were necessary for the projections. First, the US market for housing construction is assumed to recover after the 2007-2009 recession to a long-term average level. Second, total domestic demand for paper and paperboard is assumed to remain stable to declining. Third, demand for wood energy is assumed to increase in other countries in line with historic trends, raising wood prices overseas to a limited degree, and favoring export of more wood and paper products from the US. Fourth, the cost to deliver logging residue for fuel, at low initial demand levels, will be somewhat less than the cost of supplying pulpwood for fuel. Fifth, the increased revenue to landowners from sale of wood for energy for the RES20 compared with the RES10 case does not cause landowners to plant more forest or slow any conversions to non-forest compared with the RES10 case. The fifth assumption would likely not hold in reality. There would likely be extra forest growth due to new investments in intensified management (e.g. plantations) and retention (versus conversion) of forest, which would tend to increase supply and provide somewhat lower wood prices for the RES20 case than projected.

In the RES10 case, wood fuel demand increases to 166 million m^3 by 2030. Over this time, domestic production increases 48 percent for lumber and plywood/veneer, and 65 percent for oriented strandboard (OSB) and nonstructural panels. Production of paper/paperboard decreases by 6 percent. The increase in production of lumber and veneer requires an increase in harvest of sawtimber-size trees, which increases production of logging residue and mill fuel residue substantially. As a result, all the increase in wood fuel demand (from 113 to 166 million m^3) can be met by the availability of logging and mill fuel residues. There is no shifting of pulpwood or mill fiber residues for use as wood fuel. So, all the increase in mill fiber residue, a by-product from lumber and veneer manufacturing, can be used for OSB, nonstructural panels such as fiberboard, or wood pulp.

In the RES20 case, wood fuel demand increases to 308 million m^3 by 2030. Over this time, domestic production of lumber and plywood/veneer increases slightly more (52 percent) than for the RES10 case. The 2006–2030 production increase for OSB/nonstructural panels and paper/paperboard is approximately the same as for the RES10 case. For the RES20 case, wood fuel consumption in 2030 from logging residue is double that of the RES 10 case, and mill fuel residue use is about the same. Lumber and plywood/veneer manufacturing increases because payments for additional removal of logging residue (along with sawtimber) lower the cost of supplying sawtimber so more can be supplied at a given price. Because of this increase in production, net imports of lumber/plywood/veneer are less for the RES20 case in 2030 than for the RES 10 case. In the RES20 case, logging residue supply is depleted to the extent that its price rises and small amounts of pulpwood and mill fiber residue are consumed as fuel. The USFPM/GFPM projects about 6 percent of pulpwood and mill fiber residues would be consumed for energy.

Prices for sawlogs and pulpwood actually decrease between 2006 and 2030 for both the RES10 and RES20 cases because timber inventory in forests continues to increase. Because most wood fuel for both cases can be met from logging and mill residues, the 84 percent increase in wood fuel use between RES 10 and RES20 in 2030 does not cause any noticeable increase in sawlog or pulpwood prices between these cases. Also, projections suggest there would be no difference in price for softwood plywood, OSB and nonstructural panels, and a slightly lower price for softwood lumber and wood pulp between the RES10 and RES20 cases by 2030.

The study that evaluated these scenarios Once et al., 2011b) also explored the effect of other assumptions about future trends that could cause more disruptive impacts on US forest product markets. In a case where two-thirds of the biomass required in the US to meet renewable energy goals or a doubling of projected expansion in US wood energy consumption , the impacts were more disruptive, resulting in considerably higher volumes of pulpwood being used for energy and displacing production of wood pulp, OSB, and composite wood panels. However, US projected output and revenues for lumber and plywood producers would be boosted by higher demands and prices for mill residues, and timberland owners would obtain higher timber prices.

Additional cases were evaluated where the supply of logging residues was more restricted (less than 60 percent availability) or where the cost of logging residue recovery was higher so that modest demands for logging residue could raise their price to pulpwood price levels. Results were predictably greater use of pulpwood and fiber residues for energy, again disrupting fiber supply for wood pulp and composite panel producers.

One key conclusion is that modest expansion in US consumption of wood for energy could have a small impact on forest sector markets and trade over the next couple of decades. This could be the case if there is a substantial cushion of wood residue supplies from logging and mill residues, due to a recovery in housing construction and increase in wood product output, along

Table 6.1 Example 1: Forest Sector projections from base year 2006 to 2030 for two alternate wood energy increase scenarios

	Units	*Base year 2006 (historic)*	*RES10 2030*	*RES20 2030*	*Percent change from RES10 to RES20 (year 2030)*
Production					
Total US fuel feedstock, of which:	10^6 m^3	113	168	309	84
Logging residue	10^6 m^3	0	62	131	111
Mill fuel residue	10^6 m^3	67	87	91	5
Mill fiber residue	10^6 m^3	0	0	10	N/A
Traditional fuelwood	10^6 m^3	46	18	64	256
Pulpwood	10^6 m^3	0	0	14	N/A
Lumber/plywood/veneer	10^6 m^3	108	161	165	2
OSB and non-structural panels	10^6 m^3	28	46	46	0
Paper and paperboard	10^6 t	83	79	79	0
Net imports					
Wood fuel feedstock	10^6 m^3	0	0	0	N/A
Lumber/plywood/veneer	10^6 m^3	55	–25	–29	–16
OSB and non-structual panels	10^6 m^3	12	157	186	18
Paper and paperboard	10^6 t	8	–10	–10	0
Prices					
Softwood sawlogs	US$/m^3	74	62	62	0
Hardwood sawlogs	US$/m^3	77	65	64	–2
Softwood pulpwood	US$/m^3	36	34	33	–3
Hardwood pulpwood	US$/m^3	46	42	42	0
Wood fuel feedstock	US$/m^3	25	24	28	17
Softwood lumber	US$/m^3	193	183	177	–3
Softwood plywood	US$/m^3	306	269	270	0
OSB	US$/m^3	214	203	203	0
Non-structural panels	US$/m^3	308	329	328	0
Wood pulp	US$/t	429	427	421	–1

Source: Ince et al. (2011b)

with excess supply of pulpwood due to stable to declining paper/paperboard production and increasing timber inventory. A second finding is that more significant forest sector market disruptions could occur with higher levels of wood energy consumption, with more limited growth in supply of wood residues, with more restrictive constraints on supplies of logging residues, or with higher costs for residue supply.

6.4.2 Projections for increases in US demand for wood fuels, 2006–2060: RPA scenarios

Our second example compares three projections for the US forest products market where wood energy use increases 840 percent, 270 percent, and 70 percent between 2006 and 2060. Unlike the first example where the two scenarios were the same except for the wood fuel increase, these scenarios have various assumptions about global and US growth in gross domestic product and population, US housing starts, and biomass for energy.

The three scenarios are derived from the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emissions Scenarios (Nakicenovic and Swart, 2000). The cases with 840 percent and 270 percent increases in US wood fuel use are derived directly from the IPCC A2 and B2 scenarios, and the 70 percent scenario is a modified version of the IPCC A1B scenario. The IPCC scenarios were adapted for use in the US Forest Service Resources Planning Act Assessment (RPA) of 2010 (USDA FS, 2012), and are referred to as RPA HFW, RPA A2, and RPA B2. We show results of projections for scenarios RPA A2 (840 percent increase), RPA B2 (270 percent increase), and RPA HFW (70 percent increase). The latter is a modification of the IPCC A1B scenario, where wood fuel demand tracks the historical growth rate. The following discussion refers to projections for the RPA HWF, RPA A2, and RPA B2 scenarios (Table 6.2).

The composition of wood fuel supply changes as wood energy use increases. For scenario RPA A2 and a 840 percent increase in wood energy use, about 55 percent of wood fuel is composed of pulpwood and mill residues, or about 584 million m^3 by 2060 (Figure 6.4). For RPA B2 and a 270 percent increase in wood energy, about 25 percent of wood fuel comes from pulpwood and mill residues, or about 108 million m^3 by 2060 (Figure 6.5). The pulpwood/mill fiber residue portion accounts for 66 percent of total wood energy in 2060. For RPA HFW and a 70 percent increase in wood energy use, almost all wood fuels are provided by logging and mill residues through 2060, with a little provided by mill fiber residue (Figure 6.6). The pulpwood and mill fiber residues portion is limited to about 17 percent of total timber harvest in 2060. So, there is substantial difference in the wood energy competition for wood and fiber sources that are also used for panel and pulp, from near zero, to 25 percent, to 66 percent when wood energy increases 70 percent, 270 percent, and 840 percent, respectively.

Table 6.2 RPA Scenario profiles[a]

Characteristic	*Scenario RPA A2*	*Scenario RPA B2*	*Scenario RPA HFW*
IPCC general global description	Regionalism, less trade	Slow change, localized solutions	Globalization, economic convergence
IPCC global real GDP growth (2010–2060)	Low (3.2X)	Medium (3.5X)	High (6.2X)
IPCC global population growth (2010–2060)	High (1.7X)	Medium (1.4X)	Medium (1.3X)
IPCC global expansion of primary biomass energy production	Medium (3.1X)	Medium (3.2X)	Fuelwood demand follows historical trends in all countries[b]
US expansion of wood fuel production (2006–2060)	9.4X	3.7X	1.7X
US GDP growth (2006–2060)	Low (2.6X)	Low (2.2X)	Medium (3.3X)
US population growth (2006–2060)	High (1.7X)	Low (1.3X)	Medium (1.5X)

[a] Numbers followed by an "X" are the factors of change over the projection period. For example, US GDP increases by a factor of 2.6 times between 2010 and 2060 for scenario RPA A2.

[b] Not based on IPCC assumptions.

Sources: Ince et al. (2011a); USDA FS (2012)

The increase in wood energy demand in foreign countries can also affect US forest products markets by making imports to the US more expensive, and modify the effect that increasing US wood energy consumption will have.

If wood energy demand in other contries increases modestly compared with wood energy increase in the US, their increasing US wood energy demand may have only a small effect on US roundwood prices. The reason is that as demand for wood energy increases roundwood prices, there will be an incentive to import more roundwood and products from other countries where wood energy increase is modest and wood and paper price increases are modest. The RPA A2 scenario (relative to B2) has a low increase in global wood use for energy (Figure 6.7), but high increase in US wood use for energy (Figure 6.8). This means scenario RPA A2 can obtain more imports to halp meet increasing demand for wood and paper products increase than can RPA B2. For scenario RPA B2, foreign wood and paper prices are driven up by greater demand for wood fuel (Figure 6.9). Even though RPA A2 has a greater increase in GDP, which influences paper demand, a greater increase in housing

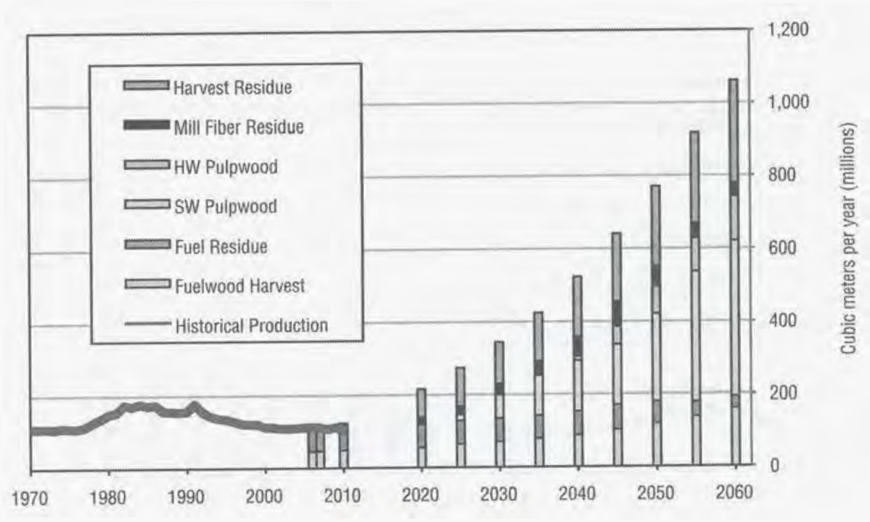

Figure 6.4 Annual US wood fuel production, 1970–2010, with projections for RPA A2 scenario (million m^3)

Source: USDA FS (2012)

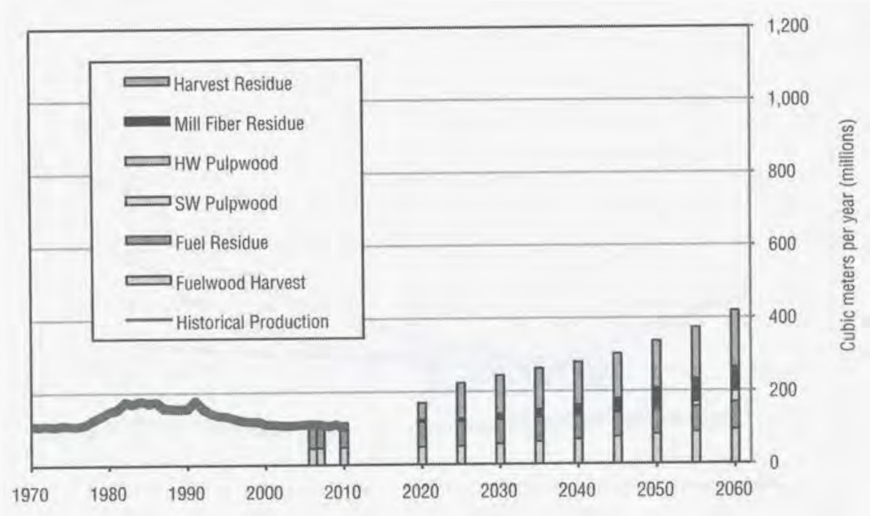

Figure 6.5 Annual US wood fuel production, 1970–2010, with projections for RPA B2 scenario (million m^3)

Source: USDA FS (2012)

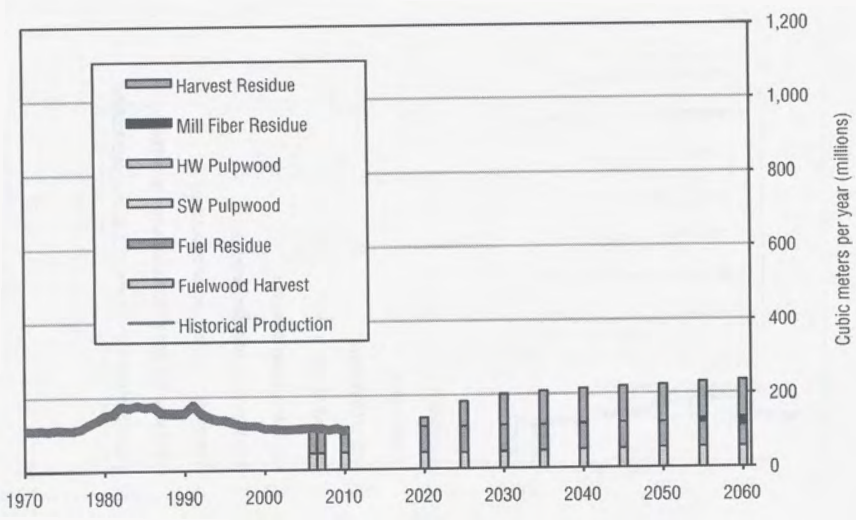

Figure 6.6 Annual US wood fuel production, 1970-2010, with projections for RPA HFW scenario (million m3)

Source: USDA FS (2012)

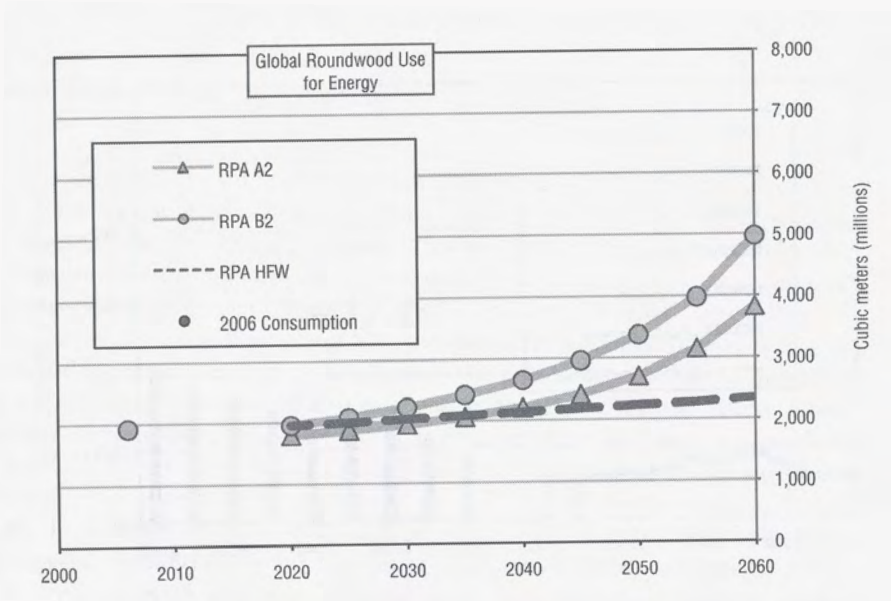

Figure 6.7 Projected global roundwood use for energy by RPA scenario (million m^3)

Source: USDA FS (2012)

demand, and a greater increase in wood energy use than for RPA B2, the average US roundwood price for RPA A2 is no higher than for RPA B2 out to almost 2050 (Figure 6.6). Increasing demand in A2 can, in large part, be met by increasing imports (Figures 6.10–6.12). This shows how a low increase in wood energy in other countries—even with increasing US demand for energy and other product—could contribute to keeping wood prices low in the US.

Another factor, in addition to low cost of imports, explains why projected US roundwood price for the RPA A2 scenario remains low and near the price for RPA B2. Scenario RPA A2 has higher timber harvest levels overall, which provides more revenue to forest landowners. With higher harvest and revenue for RPA A2, there is greater intensification of management for RPA A2 versus RPA B2, particularly due to expansion of softwood plantations in the US South. This expansion of faster growing plantations increases wood supply and lowers costs. A second likely response by landowners to increased revenue, to expand forest area or refrain from converting forest to non-forest, was not modeled in the projections for RPA scenarios A2 and B2. If it had been modeled, wood supply for A2 would likely have been somewhat higher and wood costs somewhat lower than projected.

Despite differences in the scenario assumptions that hamper direct comparison, these cases illustrate several key points. First, composition of wood

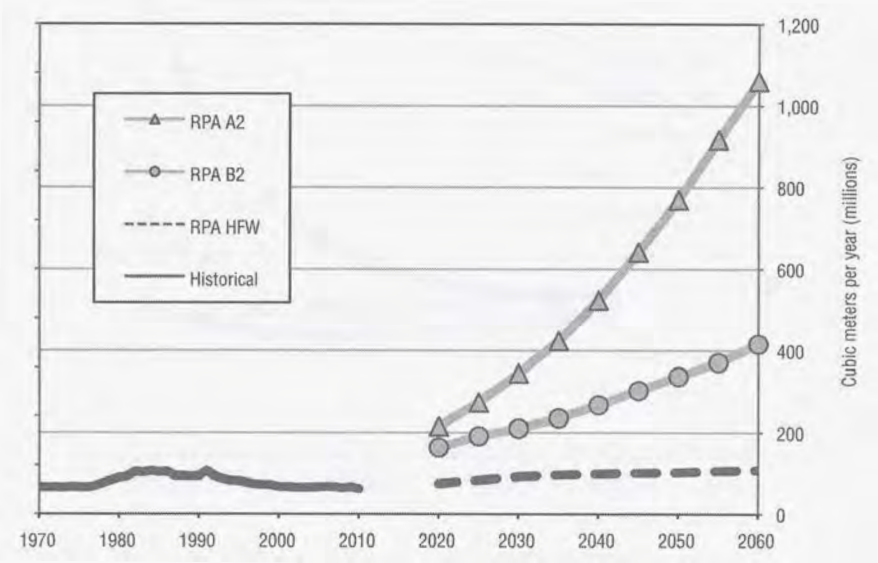

Figure 6.8 Annual US wood fuel consumption, 1970-2010, and projections for RPA scenarios (million m^3)

Source: USDA FS (2012)

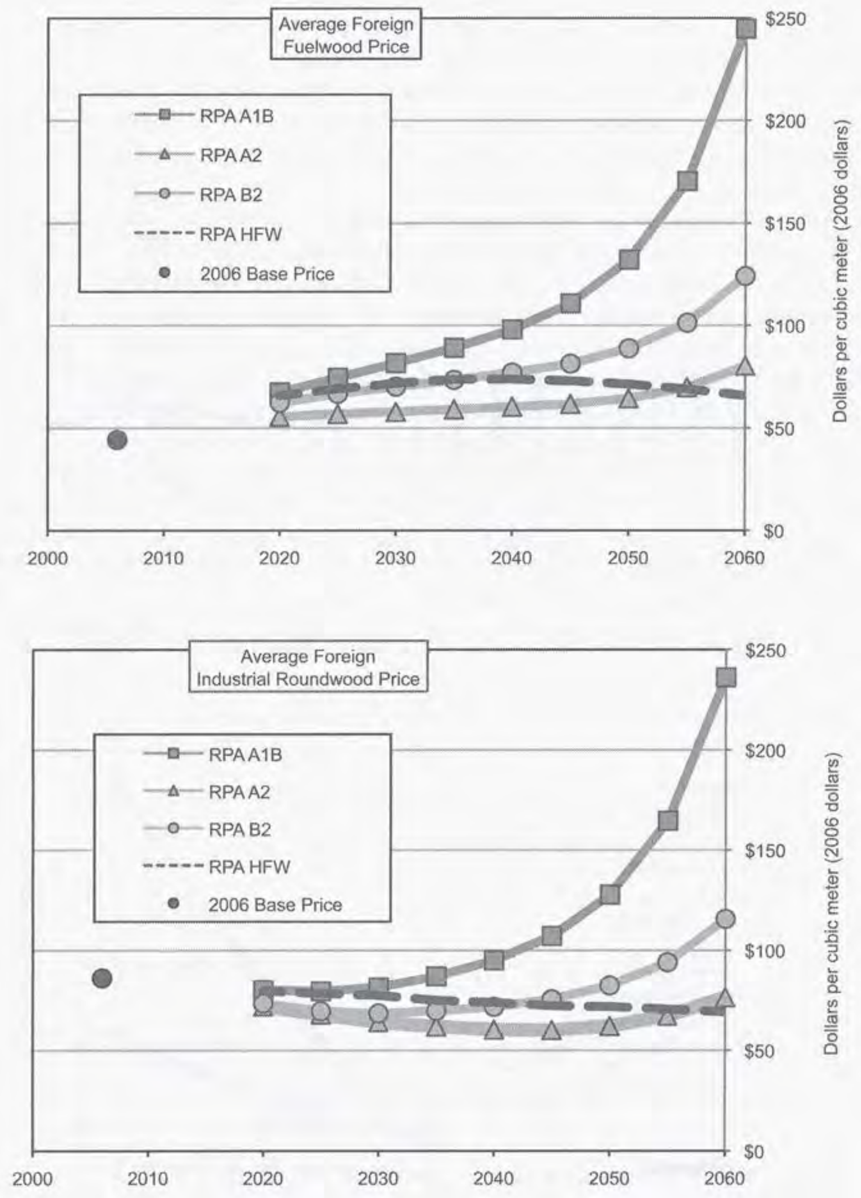

Figure 6.9 Projected weighted average delivered industrial roundwood prices for the US (top) and all foreign countries worldwide (bottom), by RPA scenario 2020–2060

Source: USDA FS (2012)

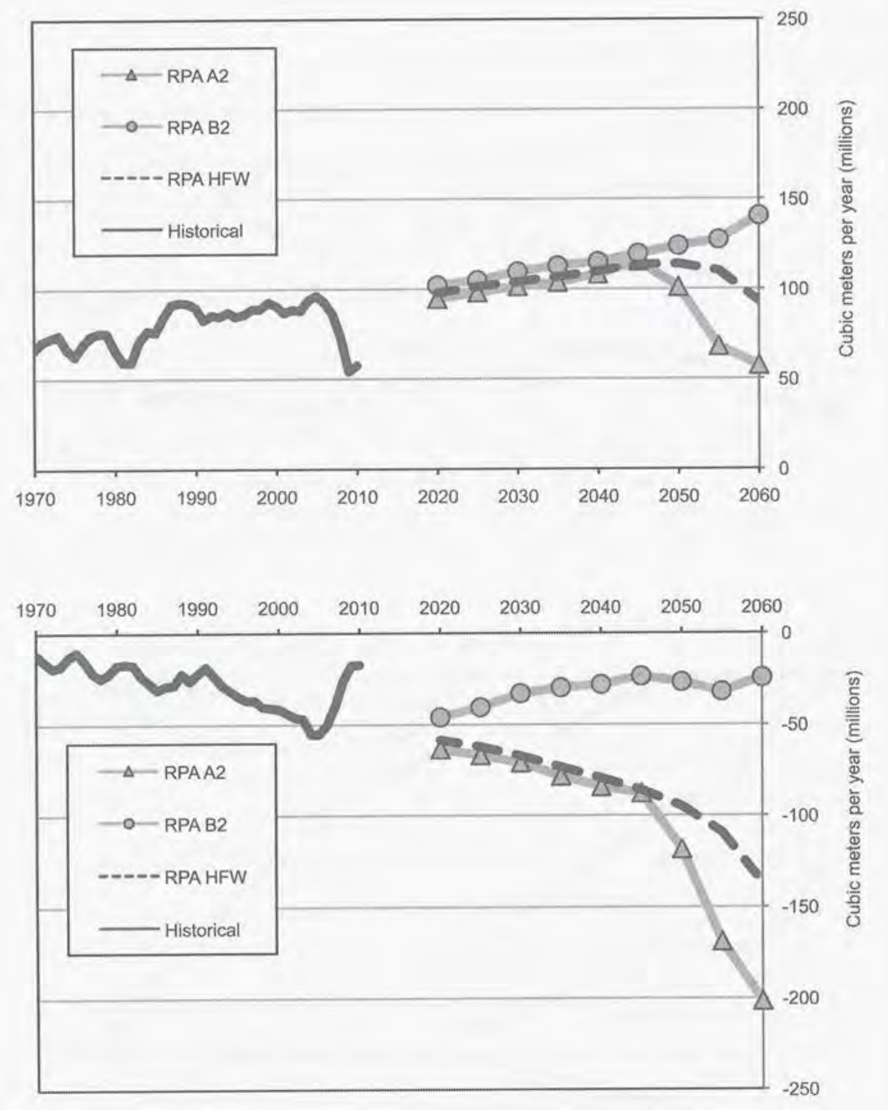

Figure 6.10 Annual US lumber production (top) and net exports (bottom), 1970–2010, with projections for the RPA scenarios (million m^3)

Source: USDA FS (2012)

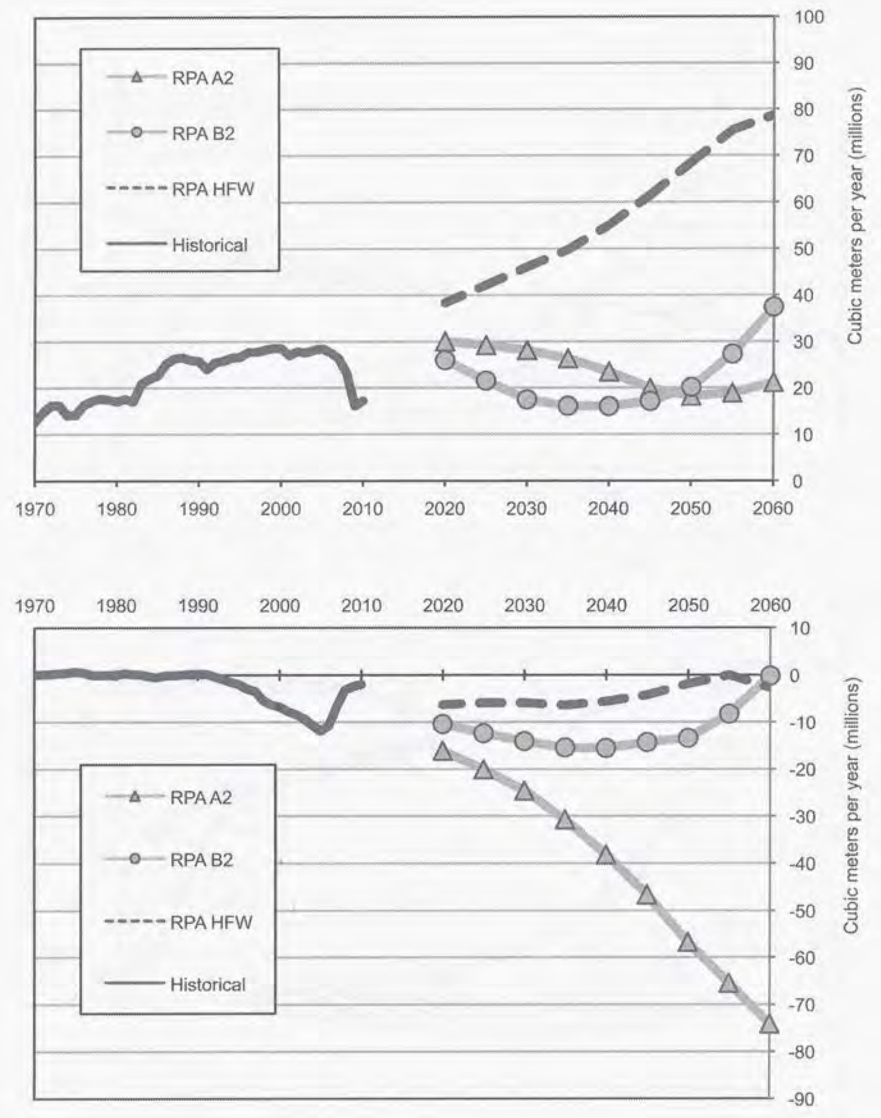

Figure 6.11 Annual US structural wood panel production (top) and net exports (bottom) 1970-2010, with projections for the RPA scenarios (million m^3)

Source: USDA FS (2012)

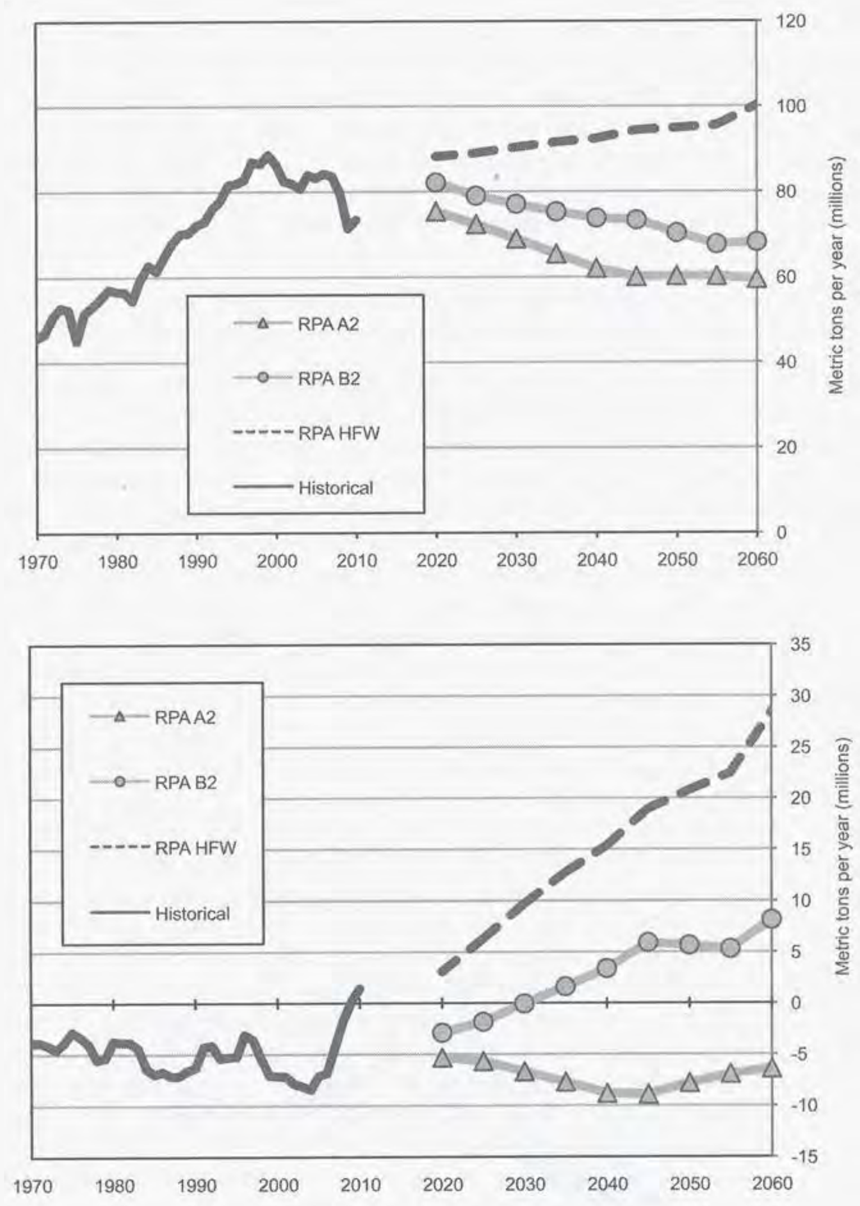

Figure 6.12 Annual US paper and paperboard production (top) and net exports (bottom) 1970-2010, with projections for the RPA scenarios (million m^3)

Source: USDA FS (2012)

fuel supply changes as wood energy use increases—increases in the demand for wood fuel will result in increased use of higher valued wood fuel sources such as mill fiber residues and pulpwood. Second, differences in global wood energy use, as well as differences in the US wood energy use, can affect US forest products markets. Third, higher levels of US wood energy demand result in higher revenues to landowners, who then invest in more intensive management (i.e. planting) and are also more likely to keep their land in forest, which will increase future supply of wood products.

6.4.3 Regional market impacts of housing demand and pellet markets on pine small roundwood in the US South

The first two examples illustrate the complex interaction of forest products on national and international scales in response to US and global energy demand. These same principles apply at a regional scale. For instance, the EU commitment to converting 20 percent of its energy consumption to renewable sources has led to a dramatic expansion in wood pellet capacity in the US South. Over 17 million green tonnes of capacity has been announced, and current production already exceeds 4.5 million green tonnes (Forisk, 2013). Most of this capacity is in the US mid-Atlantic and Gulf Coast regions, where access to timber resources and port facilities are favorable.

Some of this capacity is competing directly for pine small-diameter roundwood. Pine smalldiameter roundwood is <23 cm, pine small diameter sawtimber is 23-28 cm, and pine sawtimber is >28 cm diameter at breast height (dbh). Pine/mixed pine timberland accounts for 61 percent of the area in the subregion, and pine is 56 percent of growing stock volume. Traditional demand for the pine small-diameter roundwood resource, which is tied to packaging and absorbent materials, did not decrease during the 2007-2009 recession and has steadily increased since then. Further, expansion of pine plantation area in the South has slowed due, in part, to low prices and structural changes in corporate ownership of the resource. although energy demand for pine small-diameter roundwood in this region has the potential to increase returns to forest owners, small-diameter roundwood has traditionally been a less important income source for forest landowners in the South. Until housing construction recivers and pine sawtimber prices return to higher levels, forest owners will likely continue to postpone final harvest and perhaps consider other land use options after harvest.

Given this context, this example focuses on the importance of housing and sawtimber markets on providing wood fuels. The primary feedback paths examined are: (1) the impact of strong sawtimber markets on final harvest and planting decisions; and (2) the impact of increased availability of sawmill residues on pine small-diameter roundwood demand.

These simulations use the Sub-Regional Timber Supply (SRTS) model to examine a combination of increased sawmill production, significant pellet demand, and sawmill residue feedback from extra lumber production in the mid-Atlantic region (Abt et al., 2009). This model allows a “subregion” to be redefined as any area of the US South that is large enough to have adequate forest inventory data to be considered reliable (typically, this requires an area of approximately 405,000 ha of timberland). A more detailed discussion of bio-economic structure of the SRTS model and its application to bioenergy demand is found in Abt et al. (2012).

The simulations evaluate the potential effect of increased pine small roundwood demand from bioenergy in the form of pellets and the increase in pine sawtimber production as housing starts recover from the recession (Ince and Nepal, 2012). Seven USFS Forest Inventory and Analysis (FIA) survey units making up the mid-Atlantic coastal plain from Florida to Virginia were defined as the supply region. This region was selected because it hosts a significant portion of current and announced pellet production (Forisk, 2013).

Figure 6.13 shows the age class distribution of the pine plantation resource by state and FIA survey unit, which are the designated subregions for this analysis. Several of the regions show the effects of variable planting rates, particularly Southeast Georgia (GA SE) and the Northeastern Survey Unit of South Carolina (SC NE). These two regions alone show a 60,700 ha decrease in the 20–25year age class within five years. For northeastern South Carolina, the planting continues to decrease, resulting in 63 percent fewer plantation

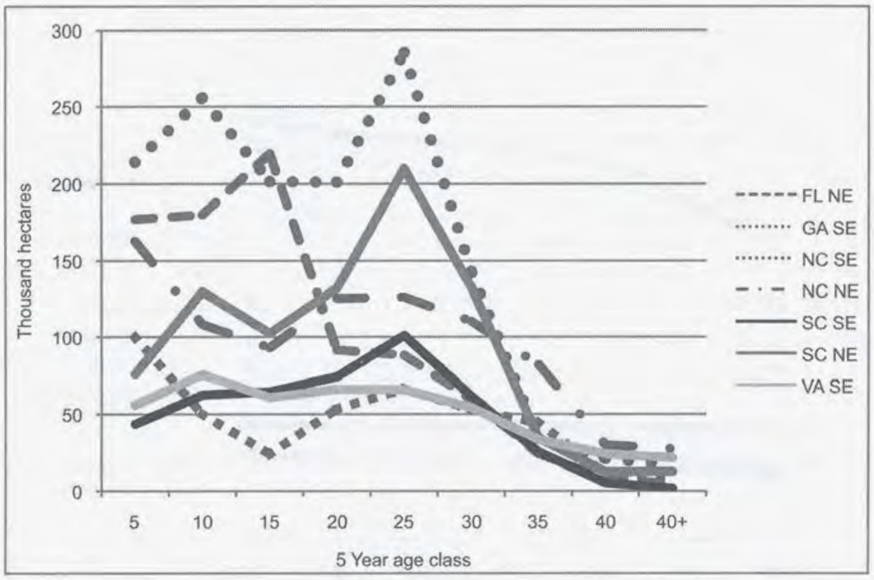

Figure 6.13 Age class distribution of the mid-Atlantic pine plantations by state and subregion (NE, northeast; SE, southeast)

hectares in the 0-5 year age class than in the 20-25 year age class. The significant variation among regions is important because high transportation costs cause supply for most facilities to be drawn from the local subregion. Figure 6.14 shows baseline demand scenarios by products class for traditional wood consumers. For traditional demands, we assume continued strong pine pulpwood demand and a strong housing recovery.

There are two baseline runs and two bioenergy runs, each with and without increased use of mill residue for pulpwood or pellets. The baseline runs assume strong pulp demand, strong demand for softwood lumber, and in some regions a decline in younger pine plantations. The bioenergy runns assume pellet demand will begin increasin g in 2014 and require 7.3 million tonnes by 2016 and thereafter. This pellet demand reflects approximately one-half of the announced capacity in the US South. This capacity was used to shift demand, although the outcome of the simulations may result in less than full utilization of this new capacity (i.,e. limited response of forest owners to increase harvest when timber prices rise—supply price inelasticity).

We assume that logging residue generated at harvest sites will be an important source of pellet feedstock and that this demand will be split between pine and hardwood species groups similar to current harvest patterns in the mid-Atlantic subregions. For these simulations, it was assumed that 15 percent of logging residues generated by total regional harvest would be used by pellet

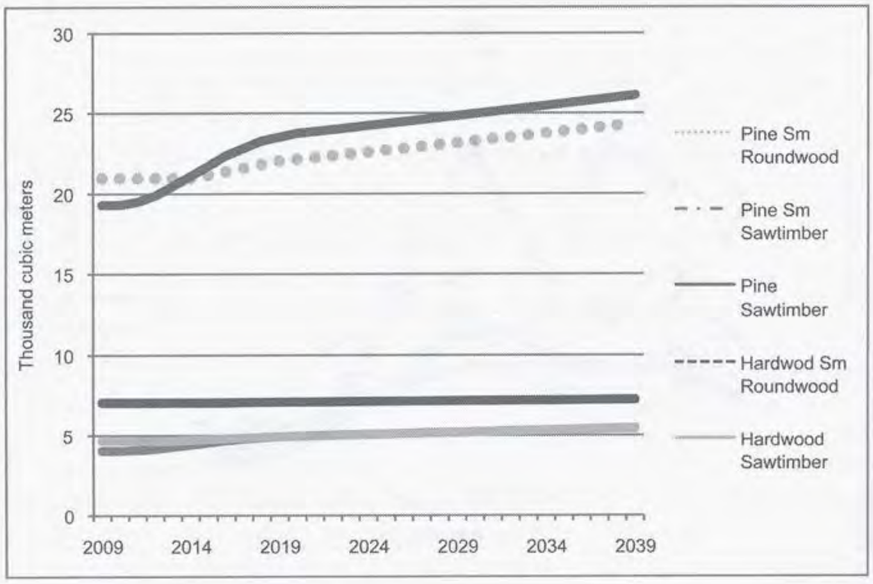

Figure 6.14 Baseline demands for traditional wood consumers

producers. We assume that wood pellet producers will be willing to utilize logging residues for about 25 percent of their feedstock. The regional implications of logging residue utilization in the US South are discussed in Galik et al. (2009). For example, a focus on logging residue utilization increases haul distance and could lead to concentration of wood energy capacity in areas of high roundwood prices.

The amount of mill residue from sawmills, including mill fiber and fuel residue, varies from 30 percent to 50 percent of log input, depending on average diameter of logs (Lupold Consulting, pers. comm.), with the higher percentage more likely in the southern than the northern part of the mid-Atlantic region. A range of scenarios were evaluated with different amounts of increased mill residue being available for pulpwood or pellets after 2009, but we discuss only the case where 50 percent of increased log input over 2009 levels can offset pulpwood or pellet demand. The assumed 50 percent factor for residue generation out of total sawlogs harvested may overstate the average availability of mill fiber and fuel residues to offset pulpwood or pellet demand. In these projections, mill residues generated in 2009 were assumed to be fully utilized (for pulp, composite panels, and fuel), and thus we considered only the marginal feedback of additional mill fiber and fuel residue supply from sawtimber production above the 2009 level.

We evaluate four scenarios. There are two “no-residue-feedback‘’ cases with no increase in availability of mill residue after 2009 as lumber production increases, one “baseline” case, and one “wood fuel” case. There are two residue-feedback cases where increases in mill residue can offset increases in pulpwood and pellet demand, one baseline case, and one wood fuel case. The no-residue-feedback cases are not very likely to occur, but we use them to compare with the residue-feedback cases to highlight the importance of the increased production of lumber, and associated generation of mill residues, in helping meet demand for increased pellet production and keeping prices down.

This example differs from the previous examples in important ways. First, this analysis addresses a small area of the US South with detailed price, harvest, and inventory data, but without linkages to national or international markets except through the assumed demand scenarios. Second, this analysis uses a 15 percent logging residue recovery rather than the 60 percent assumed above. The former reflects current utilization, given low roundwood prices, whereas the latter reflects what is technically possible under different economic conditions. Third, although the previous examples assumed an undifferentiated wood fuel market, this analysis specifically highlights the demand for wood fuel to produce pellets, primarily for export. Recovery rate and pellet demand are linked through the need for higher quality wood inputs for pellet production, essentially mill fiber residue, rather than mill fuel residue, which can be used for other wood energy uses such as electricity co-firing with coal. Fourth, land use change and plantation area change are explicitly modeled in SRTS using an econometric model of land use and assumptions regarding the transition of forests into and out of plantations. Finally, cross-price responses, which are explicitly modeled in USFPM, are incorporated in SRTS only through the harvest mechanism, where harvest is allocated across forest types and age classes reflecting historical harvest patterns, including the joint demand for all products. The results from these three examples, in spite of different model structures and assumptions, are robust and indicate that although market responses to wood fuel demands are complex, the modeling produces consistent results.

Figure 6.15a shows projections of pulpwood inventory, removals, and stumpage price in the US mid-Atlantic region for the baseline no-residue-feedback case. This is a case where pine pulpwood demand is increasing and the plantation base has lower in-growth from younger age classes (i.e. reduced rates of planting in the recent past). Pulpwood stumpage prices increase over the next decade, and sawtimber demand from the housing recovery leads to higher prices and increased planting over time. This allows inventory to recover and prices to return to near 2009 levels by 2040. Sawtimber demand is assumed to remain high over the projection period, and sawtimber prices continue to escalate as the effect of recent planting decline reaches the older age classes toward the end of the projection. Figure 6.15b shows that additional wood fuel demand exacerbates the pulpwood stumpage price bubble, but again increasing sawtimber prices and increased planting result in inventories that are higher at the end of the projection than the baseline + no-residue-feedback scenario.

Figures 6.15 c and 6.15d show results from simulations where the previous two scenarios are adjusted to allow an assumed 50 percent sawmill residue be used to offset to pine pulpwood demand. In the baseline + residue-feedback scenario, pulpwood price pressure is immediately reduced to below 2009 levels. The subsequent age class impact on supply brings prices only back to slightly above their starting point. In the wood fuel + residue-feedback demand scenario (Figure 6.15d), there is a pulpwood price bubble, but it is only slightly higher than the baseline + no-residue-feedback scenario, which was driven solely by supply constraints.

As noted in earlier examples, net impact of wood fuel demand depends on the complex interaction of small and large roundwood markets and feedstock flexibility (species, roundwood/logging residue) of the wood fuel producer. A key finding of this simulation illustrates how the medium run response of subregional timber markets to increased wood pellet demand will depend on demand influences from other sectors and on plantation supply influences that occurred 2–30 years ago. A key demand factor is the potential recovery of the housing construction sector. An increase in demand for sawtimber results in increased sawlog production, which results in increased mill residue production—a primary wood fuel supply for pellet production. A key supply factor is variation among subregions in available pulpwood inventory to meet

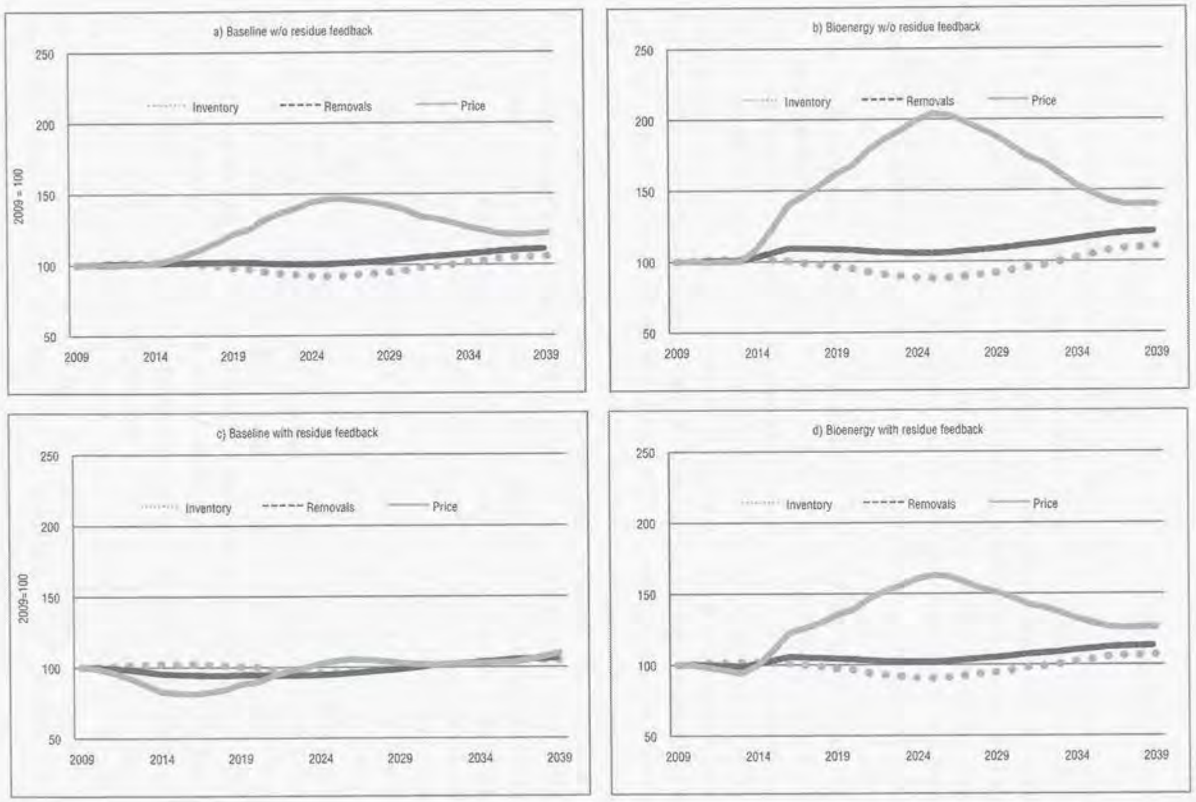

Figure 6.15 Mid-Atlantic pine small roundwood market impact—(a) and (c): market and inventory effects of sawmill residue on baseline demand; (b) and (d): market and inventory effects with increased wood fuel demand

both wood fuel and traditional (wood pulp and panel) demands. Because of high transportation costs for wood fuel, smaller markets will be significantly affected by this supply constraint.

6.5 Final remarks

Wood fuel can be supplied via a number of forest product market pathways. It can come from residues generated by co-products from the manufacturing of solidwood and paper products (e.g. logging residue, mill fiber residue, and mill fuel residue), or it can come directly from forests from pulpwood-size logs. It is very unlikely, due to high stumpage and harvest costs, that wood for energy will come from sawlogs. However, use of pulpwood or mill fiber residue for energy competes with the use of these inputs to make pulp or composite products.

In our examples, we evaluated the impact of wood energy demand on forest products markets by assuming that the cost to deliver notable amounts of logging residue and mill fuel residue for energy uses will initially be lower than the cost to deliver pulpwood or mill fiber residue (at low demand levels). However, the cost to obtain logging residue is a source of uncertainty in our evaluation because there is currently little use of logging residue. To the extent that low-cost logging residue or mill fuel residue is limited, there could be more rapid increase in pulpwood use or mill fiber use than in our examples.

Our first example compared two projections of forest products markets with identical increases in foreign demand for wood and paper products and for wood energy, identical US demand for wood and paper products, and two levels of increase (48 percent and 173 percent) in wood energy uses from 2006 through 2030. In these cases, increase in wood energy demand can be met by using logging residue and mill fuel residue without notably increasing sawlog or pulpwood prices, and may actually help decrease prices for softwood lumber and pulpwood due to the complementarity of production of sawlogs/pulpwood and logging residue during integrated harvest operations. A 173 percent wood energy increase would be more disruptive, resulting in considerably higher volumes of pulpwood being used for energy and displacing production of wood pulp, OSB, and composite wood panels. However, US output and revenues for lumber and plywood producers would be boosted by higher demands and prices for mill residues, and timberland owners would also obtain higher timber prices.

The second example evaluated three projections that differ in increase of US wood energy demand, global wood energy demand, US housing construction levels, and global and US population and GDP. One finding, given the complex differences among the scenarios, is that both US wood energy increases and foreign wood energy demand increases can impact US roundwood (pulpwood and sawlog) prices and production levels in the US. In addition, the impact of wood energy increases will also be influenced by the expected future US demand for housing and paper/paperboard. For example, for the RPA B2 scenario where wood fuel use increases 270 percent and 25 percent comes from pulpwood or mill fiber residue, there is no increase in roundwood prices (compared with the RPA HWF low wood energy case). This is due in part to relatively low levels of housing construction of RPA B2 assumptions. The impact of wood energy on roundwood prices and wood products would have been greater with a higher level of housing construction.

The third example focuses on the medium run interaction of wood fuel demand and pine pulpwood and sawtimber markets in the mid-Atlantic region of the US South. It projects the impact of: (1) constrained small roundwood supply due to historical periods of reduced planting; (2) recovery from the housing recession; and (3) the important link between sawtimber production and small roundwood consumption in the US South. Small-diameter pine roundwood prices and production have increased over the past 15 years due to increasing demand for packaging and absorbent end uses. Pine sawtimber prices, however, have decreased during this time. The resulting decrease in planting and stabilization in plantation area means that new wood fuel demand is entering a market with roundwood supply constraints in some regions and at a low point in sawmill residue availability. The key finding of this example is that recovery of the housing market is critical, not only for the resulting short-run increase in mill residue availability and associated reduction in small pine roundwood demand, but also for the resulting increase in planting opportunities due to resumption of final harvest for sawtimber and increased likelihood of planting due to higher sawtimber prices.

The complexity of supply and demand drivers that vary by region and over time presents a range of strengths, weaknesses, threats, and opportunities for influencing feedstock prices and quantities for use in wood energy, solidwood products, and paper products. A strength of wood fuel markets is that the prices and quantities will be affected by the wide range of sources for wood energy feedstocks in most regions, and new sources may be obtained as wood fuel prices increase. In addition, landowners can increase investments in forestland and management to produce more wood as demand increases, although increased supply will come after a time lag. The flexibility in wood fuel sources can nevertheless dampen competition for roundwood pulpwood and mill fiber residue, which are also used to make pulp and panels. A weakness and threat for managing supply wood fuel supply is the wide range of drivers of supply of wood for fuel, which complicate supply projections. Having many drivers also means wood energy users must watch policy changes that could influence the main drivers of national and sub-national wood supply and demand. Because of the many drivers of supply, these markets present opportunities to design and implement policies that could influence the supply of wood for energy (e.g. incentives and guidelines for using logging residue, incentives for using solidwood products, increasing efficiency in use of wood for energy and all products, and incentives for forest investment to grow wood for wood fuel and other products).

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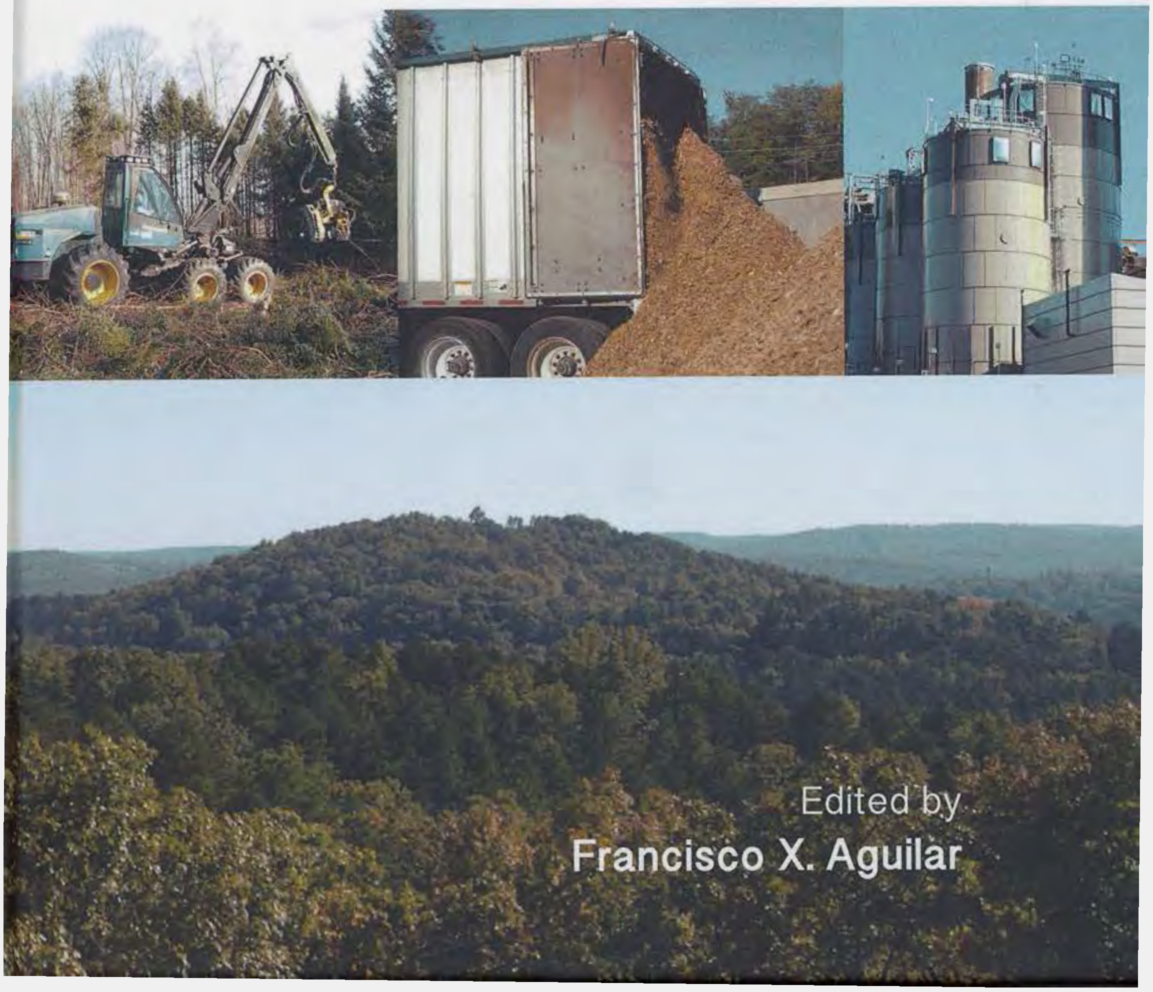

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