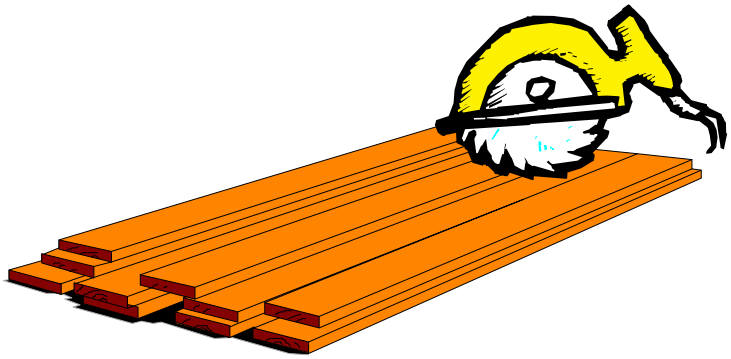
# Wood: Wood Residues

## COMMODITY PROFILE

North Carolina Department of Environment and Natural Resources
DIVISION OF POLLUTION PREVENTION AND ENVIRONMENTAL ASSISTANCE

MARKETS ASSESSMENT 1998



## OVERVIEW

Wood residues are generated in North Carolina by primary manufacturers, secondary manufacturers, users of wooden pallets and containers, wholesalers and retailers of wood products, and construction and demolition of residential and commercial properties. Primary manufacturers are firms engaged in the harvesting and processing of timbers into usable wood materials (i.e., lumber and plywood). Secondary manufacturers then use this lumber to make products, including manufactured homes, cabinets, flooring, siding, furniture, and boats. This report addresses the wood residues generated by primary and secondary manufacturers. (See the *Wooden Pallets* Commodity Profile for information on pallet waste and pallet processing residues, and the *Construction and Demolition Debris* Commodity Profile for information on wood from construction and demolition of commercial and residential structures.)

Wood residues are created in the form of bark, chips, sawdust, blocks, lumber and panel pieces, and discarded finished wood products. Historically, primary and secondary residues in the form of bark, chips, and sawdust have been recovered and reused as fuel, mulch feedstock for paper and other products, and animal bedding. Items such as blocks, lumber and panel pieces are more difficult to manage and often end up in landfills; these items typically require processing before they are marketable.

Slightly more than 10 million tons of wood residues were generated by primary manufacturers in North Carolina in 1997. About 99 percent of this material by weight was recovered for fuel and fiber use. Residues from primary manufacturing are generally reported as "green tons," which are heavier per volume than dry tons because of their higher moisture content. Generation of wood residue in the secondary manufacturing sector was difficult to determine. Estimates for this sector in 1997 ranged from 0.7 to 4.5 million tons.

**Figure 1. United States Recovery of Wood Residues in 1996 (Millions of Tons)**

| Wood type | U.S. Generation | U.S. Recovery | Recovery Rate |
|---|---|---|---|
| **MSW** | 15.4 | 5.2 | 34% |
| **Primary** | 117 | 108.8 | 93% |
| **Total** | 132.4 | 114.0 | 86% |

**Figure 2. United States and North Carolina Generation of Wood Residues in 1996 (Millions of Tons)**

| Wood type | U.S. Generation | N.C. Generation |
|---|---|---|
| **MSW** | 15.4 | 0.4 |
| **Primary** | 117 | 3.3 |
| **Total** | 132.4 | 3.7 |

A majority of primary wood residues are managed using well-established markets for bark, sawdust, and wood chips. Limited data are available on the management of secondary wood processing residues. Two key factors make recovery more difficult for this sector:

- Secondary manufacturers generate a higher portion of residue in the form of blocks and other pieces that are larger than wood chips.
- Many of these are small businesses, yet processing equipment to convert larger pieces of wood into marketable chips is expensive and requires large throughput to reach the economy of scale to make it profitable.

Sufficient demand exists for recovered wood residues in processed form (i.e. sawdust, wood chips). However, the ability of a generator to reach fuel and mulch markets cost effectively is affected by a variety of factors: processing cost, transportation cost, commingling of wood with other materials, seasonal production of residues, and seasonal need for mulches and fuels. The result of the interplay among these factors is often a slim profit margin for wood residues.

## SUPPLY

Estimates of the generation and recovery of wood residues vary greatly, depending on the source of generation and the emphasis of a particular study. This section attempts to estimate the wood residues generated by primary and secondary manufacturers in North Carolina based on information from two national studies and two North Carolina studies. The two national studies cited for this report were authored by David McKeever of the United States Department of Agriculture (USDA) Forest Products Laboratory at the University of Wisconsin and Phil Araman of the USDA Forest Service Brooks Forest Products Center at Virginia Tech. [1, 2]

### *National Estimates: McKeever*

The USDA Forest Service Products Laboratory completed a national study of wood residues based on generation in 1996.[3] The study addressed municipal solid waste (MSW), construction and demolition (C&D) waste, and primary timber processing residues. The MSW and primary timber processing residues are discussed in this section. (See the *Construction and Demolition Debris* Commodity Profile for information on C&D wood residues.)

McKeever's study defined the wood in MSW as generated by residential, commercial, institutional, and industrial sources and included wooden furniture and cabinets, pallets and containers, scrap lumber and panels from sources other than new construction or demolition activities, and wood residues from manufacturing facilities. Repaired or reprocessed pallets were not included in this generation estimate (see the *Wooden Pallets* Commodity Profile for information on pallet waste). McKeever's definition of commercial wood waste is the same as secondary manufacturing residues in this report.

This USDA study reported that wood residues generated in MSW totaled 15.4 million tons in 1996. Of this, two million tons (13 percent) were recovered for recycling or composting, 3.2 million tons (21 percent) were sent to combustion facilities, and 3.4 million tons (22 percent) were unacceptable for recovery due to contamination. The remaining 6.8 million tons, or 44 percent of generated wood residues, would be recoverable if markets could be found.

This study described primary wood processing residues as bark, sawmill slabs and edgings, sawdust, and peeler log cores generated by primary manufacturers. In 1996, 30.3 million tons of bark and 86.7 million tons of wood residues were generated in this category. All but five percent of the bark and six percent of the wood residues were used to manufacture other products, including paper, nonstructural panels, and fuel (Figure 1).

**Figure 3. Estimates of Wood Disposal in Landfills (Millions of Tons)**

| Landfill Type | U.S. Wood | South Wood | South Pallets | South Wood Excluding Pallets | N.C. Wood Excluding Pallets |
|---|---|---|---|---|---|
| **MSW** | 21.4 | 10.3 | 2.4 | 7.9 | 0.7 |
| **C&D** | 16 | 9.9 | 0.7 | 9.2 | 0.7 |
| **Total** | 37.4 | 20.2 | 3.1 | 17.1 | 1.4 |

Population based estimates of North Carolina's portion of this national generation are 0.4 million tons of wood residues in MSW and 3.3 million tons of wood residues generated from primary wood processing (Figure 2).

***National Estimates: Araman***

Another method of identifying the level of wood residues in North Carolina is to estimate the amount of these residues being landfilled. A survey conducted by Virginia Tech determined the types and amounts of wood residue being disposed in the United States. This survey included both MSW and C&D landfills. In order to examine the regionality of wood disposal, the United States was divided into regions. The southern region included North Carolina, Virginia, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, and New Mexico.

According to this study, in 1995 wood residues accounted for 21.4 million tons (7.3 percent) of the total waste received at MSW landfills in the U.S. This material included secondary wood processing residues, C&D debris, and pallets. Forty-eight percent of the wood disposed of in MSW landfills was disposed in the South. Additionally, 2.41 million tons of pallets were disposed of in MSW landfills in the South. Subtracting the pallet tonnage from the southern wood tonnage yields 7.9 million tons of wood residues disposed in MSW landfills in the south.

Another 16 million tons of wood were disposed of in C&D landfills in 1995; of this, 62 percent were disposed in the South. Another 0.7 million tons of pallets were disposed of at C&D landfills in the South. Subtracting the pallet tonnage from the southern wood tonnage yields 9.2 million tons of wood residues disposed in C&D landfills in the south.

North Carolina accounts for 8.25 percent of the people living in the southern region as defined in this study. Multiplying the wood residues in the south (excluding pallets) by 0.0825 yields the following population-based estimates of wood disposal in North Carolina: 0.7 million tons in MSW landfills and 0.7 million tons in C&D landfills (Figure 3).

***National Estimates Combined***

As described above, this report focuses on primary and secondary manufacturing residues. To ensure that C&D wood residues are not counted in this category, McKeever's estimate of C&D wood was subtracted from the Araman landfill numbers. McKeever estimates that 33.2 million tons of C&D wood residues were generated in the United States in 1996. Of this, 0.8 million tons were recovered, combusted or not usable. For the purposes of estimating the maximum amount of C&D wood waste landfilled in North Carolina, the population based portion of 33.2 million tons is 0.9 million tons. Subtracting this C&D waste from the Virginia Tech based estimate of wood waste landfilled in North Carolina suggests that 0.5 million tons of wood waste (from primary and secondary manufacturers) are landfilled in North Carolina each year.

***North Carolina Estimates***

North Carolina has a large and active primary and secondary wood products manufacturing sector. Primary research by the North Carolina Division of Forest Resources (DFR) of the Department of Environment and Natural Resources and the Energy Division of the Department of Commerce provided some clues to the magnitude of wood products manufacturing in the state.

Data on primary manufacturers are collected and reported by the DFR.[4] These data show that just over 10.2 million tons of residues were generated by this sector in 1997. The DFR also estimates that just over 10.1 million tons (99 percent) of these residues were managed for energy or fiber recovery. Figure 4 presents these generation and recovery data. Continued waste management improvements in this sector include introduction of saw blades that make narrower cuts and computerized cutting.

Commerce's Energy Division recently conducted a survey of secondary wood product manufacturers to determine the current generation and recovery of wood residues in this sector.[5] Sixteen percent of the companies surveyed (278 of the 1,700) responded. Survey participants were asked to list their use and disposal of sander dust, sawdust, shavings, coarse, bark, and other residues in 1995 in one

**Figure 4. Estimated Generation and Recovery of Wood Residues in North Carolina, 1997 (millions of tons)**

| Generating Sector | Generation | Recovery | Recovery Rate |
|---|---|---|---|
| **Primary wood producers*** | 10.2 | 10.1 | 99% |
| **Secondary wood producers**** | 0.7-4.5 | 0.6-3.9 | 14-87% |
| **Total** | 10.9-14.7 | 10.8-14 | 73-99% |

*David Brown, Division of Forest Resources
**Range is defined by data from Energy Division study.

**Figure 5. Reported Use of Wood Residues by Secondary Manufacturers in North Carolina in 1995**

| Wood Type | Hardwood | | Softwood | | Total | |
|---|---|---|---|---|---|---|
| **Use** | **Tons** | **Percent** | **Tons** | **Percent** | **Tons** | **Percent** |
| **Particleboard** | 36,230 | 6 | 20,482 | 21 | 56,712 | 8 |
| **Fuel** | 489,167 | 81 | 25,487 | 26 | 514,654 | 73 |
| **Litter** | 27,824 | 5 | 14,515 | 15 | 42,339 | 6 |
| **Other** | 51,755 | 9 | 37,996 | 39 | 89,751 | 13 |
| **Total** | 604,976 | 100 | 98,480 | 100 | 703,456 | 100 |

of four use categories. These use categories were particleboard, fuel, litter, and other. For the purposes of this assessment, "other" is assumed to be disposal. Since the survey respondents were not given another space to list other types of recovery, they may have recovery for something such as paper production in the "other" column. Since the survey focused primarily on recovery of residues, the materials listed in the "other" column probably did not capture all disposal methods. These factors and the low response rate make this data suitable only for a general estimate of wood residue generation and recovery. The total reported usage of each wood type is listed in Figure 5.

The survey respondents reported using 703,456 tons of wood residues and recovering 613,705 tons of these residues in 1995. Application of a 1.6 percent growth rate each year (based on population growth) yields an estimate of 726,000 tons generated by this sector in 1997 and 633,500 tons recovered. Comparing these results to McKeever's national estimates extrapolated to North Carolina, the residues generated by just 16 percent of the secondary manufacturers in North Carolina are almost double McKeever's MSW estimate for North Carolina (See Figure 2.)

To estimate the total wood residue generated by secondary manufacturers in North Carolina, data from respondents to the Energy Division study were scaled to the size of the industry. Assuming that the non-respondents generated residue at the same rate as the respondents, slightly more than 4.5 million tons of secondary wood residues are generated in the state. This number may overestimate generation for this sector, as the companies responding to the survey were typically the larger generators of wood residues.

The generators responding to the survey were also more likely to implement wood residue recovery than the average generator for two reasons. First, the larger the amount of residue generated, the more cost effective it is to install equipment to manage these residues for energy or fiber recovery. Second, because this survey focused on generation and recovery, those with recovery programs were more likely to fill out the survey. Although the recovery rate of the reporting secondary wood product manufacturers was 87 percent, actual recovery from this is probably lower. Assuming that the non-respondents to the survey recovered residues at the same rate as respondents, secondary wood processors in North Carolina recovered 3.9 million tons of wood in 1997.

Additional information on wood waste entering landfills comes from an informal survey of North Carolina's community waste management programs conducted by the Division of Pollution Prevention and Environmental Assistance in 1998. Program managers were asked to identify the top ten generators of industrial waste, to quantify how much waste was landfilled by each generator, and to identify the primary materials in each generator's waste stream. This survey attempted to identify large amounts of homogeneous waste entering landfills and target specific industries for waste reduction programs. Forty-nine waste man-

**Figure 6. Tip Fees for Wood Residues[9] (dollars per ton)**

| Feedstock | Range | Average |
|---|---|---|
| **Landscape Debris** | $6-25 | $13 |
| **Construction Lumber** | $10-45 | $31 |
| **Demolition Lumber** | $10-50 | $34 |
| **Stumps** | $20-75 | $47 |
| **Manufacturing Waste** | $10-80 | $44 |
| **Sawmill Residue** | $0-3 | $2 |

**Figure 7. Prices For Processed Wood[10] (dollars per ton, f.o.b. processor)**

| Product | Range | Average |
|---|---|---|
| **Mulch** | $2-65 | $24 |
| **Fuel** | $8-20 | $12 |
| **Compost Bulking Agent** | $2-27 | $13 |
| **Animal Bedding** | $15-25 | $21 |
| **Paper Making** | N.A. | N.A. |
| **Board Manufacture** | $15-20 | $18 |

agement program managers, or about 50 percent of the total, responded to the survey. The responses tended to represent more rural communities and counties with lower waste flow than non-responding counties. From these responses, nearly 40,000 tons of wood waste were identified as entering landfills in 1997. This large number for such a small sample size suggests a high presence of wood in the overall of North Carolina waste stream.

As noted earlier, national estimates of wood waste generated and disposed in North Carolina are probably low. Thus, the wood waste landfilled in North Carolina is at least 500,000 tons per year and probably higher. At 500,000 tons per year, wood residues from secondary wood product manufacturers, constitute six percent of waste entering of North Carolina's landfills. A significant portion (possibly more than 65 percent) of this wood material could be recovered, assuming the same management options as identified by McKeever.[6] In other words, North Carolina could reduce the total amount of waste going to landfills by four percent by targeting diversion programs to secondary wood product manufacturers.

## DEMAND

As stated earlier, sufficient market capacity exists for wood residues in useable form (generally sawdust and wood chips). Factors affecting whether wood residues are recovered include processing cost (for material that is larger than chips), transportation cost, commingling of wood with other materials, seasonal production of residues, and seasonal demand for mulches and fuels. This section discusses some of the markets for wood residues in North Carolina Recovery efforts include, but are not limited to, the following:[7]

- Use as fuel in wood-fired boilers and burners
- Use as feedstock in paper and building material (composite panels, particleboard, and insulation) manufacturing
- Production of ground covers (mulches) and animal bedding
- Use as bulking agent in composting facilities
- Pet litter
- Production of wood framing and trim pieces from small scraps (known as fingerjointing)

There are more than 500 recovered wood processing companies in the United States and Canada.[8] Most of these companies charge to accept wood residues, and a majority (88 percent) accept pallets and crates. Forty-eight percent take in landscape debris and C&D lumber. Tipping fees for wood residues at these facilities average $27.43 per ton. This recovered wood processing industry relies on mulch and fuel markets as major end users; 96 percent of the processors sell to mulch markets, while 79 percent sell to fuel markets. Other markets include compost bulking agents (63 percent), animal bedding (32 percent), board manufacture (26 percent), and paper manufacture (21 percent).

Since many processed residues sell for a low value per ton, most processing facilities charge a tipping fee to accept unprocessed wood and then sell the processed material in a competitive market. Figure 6 lists ranges and averages of tipping fees charged by recovered wood processors. Figure 7 lists ranges of prices at which processed wood is then sold.

North Carolina tipping fees are quite low compared to national averages. They range from $20 to $50 per ton

and averaged $26.75 in 1997. These low fees provide little incentive for wood waste generators to recover wood residues by diverting material from landfills.

The *National Wood Recycling Directory* lists 90 wood processing facilities in North Carolina, 55 of which are municipal operations (usually at landfills).[11] The facilities listed in this directory accept a combination of brush, tree waste, wood pallets, C&D wood, preservative treated wood, and engineered wood. These facilities produce mulch, fuel, manufactured products (such as fiberboard), compost, animal bedding, topsoil, or feedstock for paper manufacture. Thirty-seven of the companies listed in North Carolina accept brush, tree waste, or pallets only. The North Carolina *Directory of Markets for Recyclable Materials* includes 27 companies that accept sawdust and bark. Specific markets for processed wood residues are discussed in more detail below.

### *Mulch and Compost Markets*

Mulches and composts are two significant markets for wood residues. They tend to prefer bark and chip residues from primary wood processing rather than residues from secondary wood manufacture. Since wood residues from secondary manufacturing are kiln dried, they have a higher value in fuel markets. (See below.)

Mulches made from wood residues compete with mulches made from virgin wood chips and bark, as well as mulches made from yard trimmings. Wood mulches have more cellulose than bark mulches, which have higher lignin content. Cellulosic mulches break down and decompose faster than bark mulches. Some consumers prefer recycled wood mulch because it is less expensive, and they are more concerned with price than longevity.[12] Recycled wood mulch prices in the Southeast vary from free to $2.50 per ton ($10 per cubic yard)[13]; whereas bark and shredded hardwood mulch prices are $3.75 to $4 per ton.[14]

Previous studies have estimated the demand for compost in North Carolina to be 13,483,000 tons per year, with the vast majority of that (98 percent) due to agricultural uses.[15] The remaining markets were believed to be able to absorb 232,000 tons per year, which alone exceeded the estimated 1994 compost production of 121,400 tons. The current demand for compost is believed to exceed the current available supply, although specific demand estimates are not currently available.

Prices for finished compost vary widely across the United States and within the Southeast. Bulk sale prices for leaf compost, yard trimmings compost, manure compost, mixed solid waste compost, and biosolids compost in the Southeast ranged from $3 per cubic yard to $25 per cubic yard in a 1997 survey.[16] Average values for these products varied from $6 to $15 per cubic yard ($15 to $37.50 per ton). In Charlotte, North Carolina, bagged compost is sold for $3.50 to $4 for a 45 pound bag ($155 to $177 per ton), while bulk sales are $1.85 per cubic yard ($7.40 per ton).[17]

### *Fuel Markets*

Wood residues represent an alternative to the combustion of fossil fuels in many areas of the country. Three major factors affect the decision to process and use wood residues for fuel:[18]

- Availability, price and characteristics of the wood residues
- Design, engineering, performance, and cost of combustion equipment
- Regulatory issues (mainly air quality)

A recent survey of solid fuel users in North Carolina determined that, in 1996, there were 322 wood-fired boilers consuming 3,673,000 tons of wood residues (approximately 31 percent of the total wood residues generated).[19] Most of these facilities are generators of wood residues that combust residues for their energy value. Growth in this market is dependent on growth in the underlying wood products manufacturing industries. The average cost for wood residue fuel is $12 per ton (f.o.b. processor).[20] This is an energy equivalent value of $1.20 per million British thermal units (mmBTU).[21] By comparison, recent prices for natural gas have been on the order of $2.20 per mmBTU.[22]

Other North Carolina users of wood residual based fuels include three electric power generators, five paper mills, six brick manufacturers, and four textile plants. The major obstacle to increasing the amount of wood residues used as fuel by these non-generators appears to be the cost of retooling combustion units to handle wood residues and the transportation economics between sources of supply and end user facilities.

An emerging market for wood residues-derived fuels is the production of ethanol and methanol transportation fuels.[23]

### *Manufactured Products Markets*

Products suitable for manufacturing from wood residues include the following:

- Exterior siding (hardboard)
- Non-structural panels (particleboard, oriented strandboard, fiberboard)

- Fingerjointed wood lumber and trim
- Composite wood-plastic materials
- Containers and packaging (including pallets)

Comprehensive analysis of the potential demand for each of these types of products is not available. As an example of potential demand for one commodity, the annual plant capacity for production of particleboard and fiberboard in North Carolina is estimated at 7,000,000 tons.[24] Another 600,000 tons of plywood production capacity is also estimated to be available.[25]

Demand for wood residues in these markets was reported as poor by 65 percent of the wood residue processors responding to a survey.[26] One particleboard plant in New Mexico consumes 250 tons per day of recovered wood, paying about $20 per ton for clean wood residues; the average price for these residues is $18 per ton (f.o.b. processor).[27] Another company is building a 150,000 ton per year medium-density fiberboard plant in Riverside, California, which will be the first to make 100-percent recycled fiberboard. That company is also planning a second plant in Lackawanna, New York. Recent inquiries at Commerce also indicate interest by a fiberboard manufacturer interested in wood residues for fiberboard production.[28]

## SUPPLY / DEMAND RELATIONSHIP

Overall, the demand for wood residues appears to be greater than the supply. Primary manufacturers have well established markets for their residues although they continue to seek higher value markets. Secondary wood products manufacturers, in contrast, must often process their residue to marketable form for reuse by potential markets. This material is often only usable as ground-up woody mulch, which has a lower market value.

Transportation costs between the point of generation and the point of reuse limit recovery, which explains why many primary and secondary wood producers reuse wood residues onsite. In addition, painted and treated wood residues have little market demand. Producing marketable products from recovered wood requires careful attention to species selection, appropriate screening equipment to yield acceptably sized chips, sampling methodology and practice, and feedstock specifications, including contamination levels and moisture tolerances.[29] This is potentially problematic for smaller secondary wood residue generators (i.e., cabinet shops) who would need to process their mixed wood residues into a form suitable for reuse / remanufacture.

Another factor affecting both the generation of wood residues and their potential reuse is the underlying availability of timber in North Carolina. A recent evaluation by the USDA Forest Service concluded that North Carolina had a timber drain / inventory ratio of 2.3 percent, which translates into over 45 years of timber availability, without regrowth or replanting, at current harvesting rates. [30] Combined with a timber drain / growth ratio of 0.53, which indicates that new timber growth exceeds timber harvest, the availability of virgin wood materials in North Carolina is keeping downward pressure on stumpage prices. For example, sawtimber stumpage prices are estimated to be $48.71 per ton, and pulpwood stumpage prices are estimated to be $6.80 per ton. These relatively low prices make it difficult to process recovered wood for reuse especially if transportation costs have to be included.

## CONCLUSION

The recovery of wood residues from primary manufacturers is a mature, well-established practice. Generators of residues have existing reuse markets in place and continue to seek higher-value markets for their residues.

Less information is available on recovery of wood residues by secondary wood products manufacturers This group includes smaller generators, for whom processing and transport are more costly per ton of wood recovered. Also, little is known about wood residues generation and recovery in the manufactured housing industry, the commercial sector (i.e., building material supply centers, small cabinet shops, etc.), or the residential sector.

By conservative estimate, 500,000 tons per year of wood residues reached North Carolina landfills in 1997, constituting six percent of what was landfilled that year. Assuming that two-thirds of this wood waste is recoverable, North Carolina could reduce materials being landfilled by four percent by working with secondary manufacturers of wood products to reduce or recycle their wastes.

## RECOMMENDATIONS

North Carolina should pursue several efforts to increase recovered wood residue values and to increase recovery rates for components of the wood residues waste stream.

- Encourage recovery by secondary wood products manufacturers by educating them on their recovery options and encouraging them to work together to manage their residues.
- Quantify tonnage of wood residues coming from manufactured housing, commercial and residential sources, and secondary wood product manufacturers.
- Develop model procurement specifications for recovered wood residues targeted at the manufactured product market to increase the value of

recovered residues.

- Support economic and engineering programs to assist manufacturers in converting combustion units from fossil fuels to solid wood fuel.
- Develop model wood recovery processing systems that enable entrepreneurs to understand processing costs and configurations to meet various markets.
- Quantify the demand for recovered wood residues in the fuels and manufactured product markets.

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[10] Ibid.
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[30] McKeever, T. and Spelter, H., op. cit., p. 4.