Use of North American woody biomass in UK electricity generation: Assessment of high carbon biomass fuel sourcing scenarios

Appendix 6 Comments on questionnaire – parts 1 and 3.

Report for DECC
943/12/2014

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Table of contents

1 Introduction 1

2 Part 1 of questionnaire: context for organisations responding 1

2.2 Pellet production 6

3 Part 3 of questionnaire 9

3.1 Most influential factors which decide the current average rotation or harvest timing 9
3.2 Sources of fibre for pellets 17
3.3 Questions on costs and prices of fibre for pellets. 20
3.4 Additional comments from Canada 39
3.5 Additional comments from USA 40
3.6 References submitted as supporting evidence 42

1 Introduction

This appendix forms part of a report on the likelihood of certain biomass fuel sourcing scenarios in North America. The study included a questionnaire sent to stakeholders in the biomass fuel supply chain in North America and Europe. In addition to answering the questions in the questionnaire stakeholders provided comments on their responses. This appendix provides the comments that were made in association with the questionnaire responses. For background on the scenarios and why they are associated with high carbon impacts, please read the Technical report associated with this appendix.

The responses and comments provided in this appendix are for the first and final part of the questionnaire:

- Part 1 questions provide context on the stakeholders responding to the questionnaire
- Part 3 questions provide context on the management of forest in North America and the drivers for harvest.

Part 2 questions on the likelihood of the BEAC high intensity GHG emission scenarios are provided in Appendix 5.

2 Part 1 of questionnaire: context for organisations responding.

2.1.1 Q10 Do you manage this forest under a formal sustainable forest management framework?

US responses:

The majority of respondents said yes, but qualified this with 'all' or 'almost all' to around 50%. Responses included

- "1.6 Mha are certified to either ATFS, FSC or SFI Standard."
- "All of our forests are managed by professional foresters. We are triple CoC certified. We are SFI and FSC forest management certified"
- "In house management to SFI standard. Third party certified since 2001"
- "Lands are managed in house by professional foresters. SFI and FSC certification is done by a 3rd party company."
- "Managed in house by professional/registered foresters"
- "Most of the largest land management companies are SFI or FSC certified, this could comprise up to half of the material sourced. For uncertified material, the forests our region exhibit above 90% compliance with Best Management Practices."
- "We employ professional foresters at all of our forestry offices. We utilize the Sustainable Forestry Initiative (SFI) and have been third party certified for over 16 years on all of our lands. We also utilize SFI Fibre Sourcing to provide evidence of sustainability for wood purchased from third parties. We have a staff of environmental specialists, including wildlife biologists and forest hydrologists, who oversee our environmental management program"

Canadian responses

- "Preparing and implementing a forest management plan is a rigorous process. It includes stakeholder, public and Aboriginal community involvement at various stages. Forest management plans: must ensure sustainability while finding a balance of social, economic and environmental values are prepared by a registered professional forester with input from local citizens, Aboriginal communities, stakeholders and the public are prepared/approved for a 10-year period determine how much/where harvesting can occur, where roads can be built and how much forest will be renewed include opportunities for public involvement."
- "In Ontario, legislation includes Crown Forest Sustainability Act, Endangered Species Act, Forest Stewardship Council Boreal and Great Lakes standards."

- In Quebec we have a forest management policy under our las on sustainable development of land/country (La loi sur l'aménagement durable du territoire forestier du Québec).
- Forests are managed by Registered Professional Foresters.
- Certification schemes used included: PEFC, SFI, CSA, FSC (40-100% of the forests managed). 100% of forests managed under Provincial regulation e.g. Sustainable Forest Licence, supported by independent third party certification.

2.1.2 Q11 &12 Main products produced by forest products companies

For **US South** the main products are listed by percentage volume/weight and value below. Saw logs produced by respondents totalled over 11M green tons/y for those companies who provided quantities. Pulpwood totalled over 10M green tons/y for those respondents who provided quantities; pellets totalled over 240,000 green tons/y for those who provided quantities. However, most respondents provided percentages only. Most respondents said that saw logs and pulpwood were the main products by volume. "Saw logs are the greatest value product by a wide margin."

For **Canada** the main products listed were saw logs and pulpwood, including forest and sawmill residues (for paper and board). A number of respondents said they hardly used harvest residues. Some roundwood is sold for pellets, but it is a small volume compared to volumes to saw logs and paper and board. The value of wood to pellets is less than 10% of that to saw logs or pulpwood for paper or board. In some areas the value of wood pellets is less than 1% of saw logs and pulpwood for paper and board (e.g. in one region the value of saw logs and paper and board together was CA$13,000 million, but the value of pellet and harvest residues together was CA$3.4 million).

Main product by volume or weight	Response Count
Saw logs	13
Pulpwood (for paper or board)	13
Roundwood (for pellets)	9
Harvest residues	10
Other	5
answered question	**17**

Main product by value	Response Count
Saw logs	12
Pulpwood (for paper or board)	7
Roundwood (for pellets)	6
Harvest residues	6
Other	5
answered question	**16**

2.1.3 Question 13 – participants were asked to mark each source used.

Sources used to provide wood for pellets	Response Count
Sawmill residues	7
Forest residues with bark	7
Forest residues without bark	4
Thinnings	7
Unmerchantable wood	8
Roundwood from naturally generated coniferous forest	5

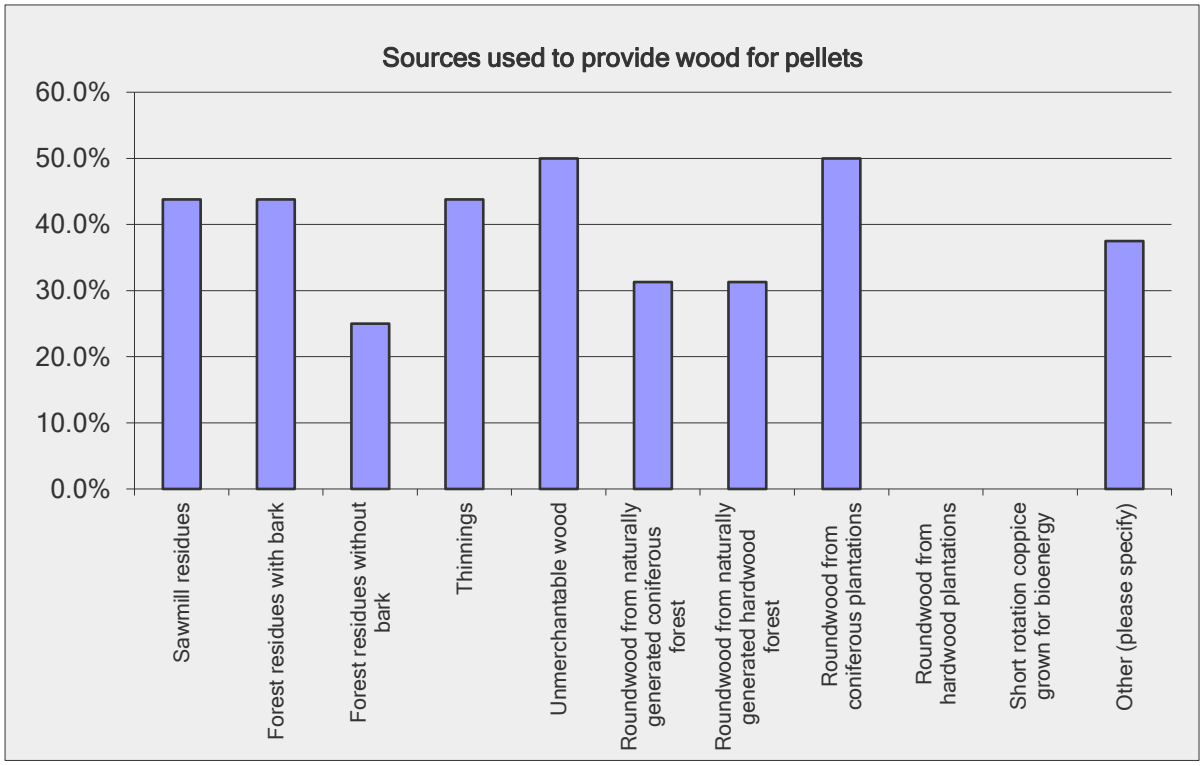
Roundwood from naturally generated hardwood forest	5
Roundwood from coniferous plantations	8
Roundwood from hardwood plantations	0
Short rotation coppice grown for bioenergy	0
Other (please specify)	6
answered question	**16**

Canada

- Most of the feedstock for pellets comes from saw mill residues (>88%) but some forest residues and unmerchantable wood is used.
- Over time this may change as competition for sawmill residues increases, to include non-economic stands, residues and forest derived biomass ("It is anticipated that an additional 2 million m³ of residues and forest derived biomass will be utilized")
- A number of respondents said they never use thinnings and never, or only occasionally, use feedstock from small privately owned forest.
- "Presently only a small proportion (<10% of harvest residuals are utilized)."

Comments from **USA**

- "We allocate wood to the market that brings the highest value to the stump."
- "(Land owners) sell a variety of fibre into the wood pellet market, based upon what residues are available from harvests from other industries. This fibre can include sawmill residues, forest residues without bark, thinnings, and unmerchantable wood. Thinnings and unmerchantable wood can come from roundwood from natural generated coniferous and hardwood forests, and roundwood from coniferous plantations if there is no other market to sell this fibre into after a harvest.
- "The sources are not likely to change. Our forests are capable of producing more wood than we are able to sell or consume. Increases in markets for other wood products could result in additional materials being made available to pellet markets. Saw logs are never sold or used for pellet production."



- "Percentages not likely to change significantly across company but sales will respond to local markets as they develop and close"
- "Sources not likely to change. Our forests are capable of producing more wood than we are able to sell or consume. Increases in markets for other wood products could result in additional materials being made available to pellet markets."
- "It is highly unlikely pellet/wood energy prices will ever challenge sawlog price as the driving determinant in the Southern US. If it ever rose to such levels, it would be uncompetitive with alternative energy generation options like wind/solar/etc."
- "Mix could change over time as regional demand changes, sawtimber demand could go up with increased construction"
- "This could always change as markets and mills change. We are always willing to sale any fibre product as the demand increases, as long as it does not hurt our sustainability or our best management practices."
- "Harvest levels will be driven by the sawtimber market (construction market). The sawtimber market has not fully recovered from the recent recession, but as it does more sawmill residuals will be available for all fibre users. Also, as the sawtimber market recovers, harvest rates should increase which will generate more pulpwood for pulpwood users. We do not expect rate of harvest or silvicultural decisions to be driven by pellet demand. In concert with sawtimber and pulpwood demand, increasing pellet demand will provide market signals to landowners to invest in forest management. The result should be more available wood of all types."
- "This is unlikely to change. The wood pellet industry has very low buying power within the forest products market and can only afford low-value fibre that is not in competition with other industries."
- "As construction markets improve, sawmill residuals will be pulled by markets into panel products."
- **Canadians** said that the main feedstock was sawmill residues, unmerchantable wood and forest residues were used occasionally and pre-commercial thinnings, commercial thinnings were potential feedstocks. Roundwood is rarely used in pellets in Canada.

2.1.4 Question 15

How pellet demand will be met in the long term (between now and 2030)	Total Score	Rank	
Increase use of forest residues	118	1	*most likely way of meeting pellet demand*
Divert pulpwood from non-bioenergy use	99	2	
Plant new plantations on abandoned agricultural land	66	3	
Other (*Comments provided*)	64	4	
Increase harvest by decreasing rotation length	62	5	
Convert naturally regenerated timberland to plantations	58	6	
Plant energy crops	47	7	*least likely way of meeting pellet demand*
answered question: 27			

Canadian comments

"With pulp mills closing at an alarming rate, we have merchantable wood (non sawlog or veneer quality) that could be used for pellet production"

"Roundwood left dead on the forest site after harvest of all commercial wood"

"Other - divert sawmill residuals from bioenergy use to pellet production and replace with forest residues for bioenergy"

US comments

These are not likely to change with time, except if saw timber demand increase and results in extra sawmill residues. There are a range of options that could be used, but that they are dependent on the locality, the market and management decisions about other forest products (most notably saw timber). Typical comments on future changes were:

- "**Harvest levels will be driven by the saw timber market** (construction market). The saw timber market has not fully recovered from the recent recession, but as it does more sawmill residuals will be available for all fibre users. Also, as the saw timber market recovers, harvest rates should increase which will generate more pulpwood for pulpwood users. **We do not expect rate of harvest or silvicultural decisions to be driven by pellet demand.**"
- "The **wood pellet industry has very low buying power** within the forest products market and can only afford low-value fibre that is not in competition with other industries"
- "**Our forests are capable of producing more wood than we are able to sell or consume**. Increases in markets for other wood products could result in additional materials being made available to pellet markets"
- "Pellet producers have no power to "divert" timber products";
- "Increase of forest residues" also includes the increased utilization of what would previously have been considered pre-commercial thinnings"
- "The **likelihood of decreasing final harvest age on most tracts is low, although the average age of all harvested wood could decrease due to increased utilization of younger thinnings**" "
- Paper mills have closed down since the '90s, so "Pulpwood demand in the SE US is lower than the demand in the mid 1990's due to decreased pulp and paper demand"
- "**Economic subsidies will allow pellet industry to pay higher prices and successfully compete with other forest products categories for available fibre**."
- "New plantations on agricultural land and from converting naturally regenerated timberland **will not be available** to meet pellet demand **by 2030** as these plantations will not reach rotation age until well after 2030. Some pre-commercial thinning wood may be available for harvest from these new plantations."
- "Unutilized materials and underutilized forest capacity. Forests in the US south currently produce more wood than is consumed, and with appropriate demand, this trend is likely to increase. Additional material can be provided without major changes to current forest management practices."
- "A major (option) that is missing is that **we could actually INCREASE rotation ages** to get **to increase multi-harvest combination of thinning for energy with a final sawlog harvest**. This could actually get the forests closer to Mean-Annual-Increment maximization"

  "Pellet demand, in addition to a recovering sawtimber market, will result in more timber coming to market and in greater investment in forest management by landowners in response to improved markets. Seventy+ years of history in the US South have shown that **as demand for timber increases, more timber is grown and forest inventories have actually increased**. A recent (2014) Duke University study by Galik and Abt suggests that a growing pellet market will result in an increase in forested acreage in the US South[1]."**"**
- "Wood pellets are typically sourced from residues and unmerchantable fibre that is felled during harvest but is unwanted or unusable by other forest products industries. The most probable answer from this selection would be for the industry to increase the use of these residues."
- "Increase of forest residues" also includes the increased utilization of what would previously have been considered pre-commercial thinnings.
- "Increase harvest by decreasing rotation length" but want to be very clear that the likelihood of decreasing final harvest age on most tracts is low though the average age of all harvested wood could decrease due to increased utilization of younger thinnings. In the case of "divert pulpwood

. [1] http://www.srs.fs.usda.gov/pubs/gtr/gtr_srs202.pdf

species from non-bio-energy use" this implies that there is always another market for this pulpwood to go to when 1) there likely is not if it can economically go into bio energy markets and 2) increased markets can allow landowners to increase the amount of pulp wood harvested by better merchandising, different thinning/stocking plans, and planting more forests. I would therefore suggest that "other" is similar to "divert pulpwood from non-bioenergy use" but without the word "divert"

- "Increase the use of in-woods chips (from pre- commercial thinnings and/or cleaning up areas after a commercial harvest, using forest residues)"
- "Wood pellets are typically sourced from residues and unmerchantable fibre that is felled during harvest but is unwanted or unusable by other forest products industries. The most probable answer from this selection would be for the industry to increase the use of these residues."

2.1.5 Questions on small scale woodland in the USA

A number of respondents brought to our attention the work by Butler et al on "Understanding and Reaching Family Forest Owners: Lessons from Social Marketing Research." Journal of Forestry October/November 2007. pp. 348-357. This included a woodland owners' survey that found that the top objectives for small forest owners was: beauty and scenery (70.9%); nature and biological diversity (56.9%); land investment (42.6%); part of home (62.6%); part of farm (43.5%); privacy (64.3%); pass land onto heirs (61.6%); non-timber forest products (10.4%); fire wood production (17.8%); timber production (19.6%); and hunting (39.1%). Owners rarely remove wood from their woodland (every 70-100 years). Additional comments were:

- "The land is managed but with no formal management plan."
- "Operate with clear forest management objectives and budgets but not with a detailed FMP that is quickly out of date as soon as it is written"
- "Multiple uses on forests of multiple sizes, ranging from small plot areas to regional-scale wilderness areas"
- "Trees are removed at various time period, mainly for forest health and economic reasons. The wood goes to saw logs and/or veneer and pulpwood, then OSB or other board mills and lastly pellet mills."

2.2 Pellet production

The levels of production in South USA from participants represented a significant proportion of the production in Southeastern USA.

2.2.1 Question 24 for pellet producers

Feedstocks most commonly used	Total Score	Rank	
Sawmill residues	49	1	*most common feedstock used*
Unmerchantable wood	39	2	
Forest residues - coarse	37	3	
Commercial thinnings	32	4	
Pre-commercial Thinnings	25	5	
Forest residues - fine	24	6	
Roundwood from plantations – softwood	20	7	

Roundwood from naturally generated forest – softwood	14	8	
Roundwood from naturally generated forest - hardwood	13	9	
Roundwood from plantations – hardwood	4	10	
Short rotation coppice grown for bioenergy	3	11	*least common feedstock used*
answered question: 14			

Comments from USA

- "The main feedstock for pellet producers are **sawmill residues, coarse and fine forest residues, thinnings, and unmerchantable wood**. Pellet producers use low-value fibre that is by-product and residue from other forest products industries"
- "These categories are not mutually exclusive. Roundwood could be thinnings, or unmerchantable wood, and also meets the BEAC definition of "coarse forest residue". This is a significant defect of the BEAC model that has considerable consequences in calculations that rely on these definitions."
- "We do not use saw logs for the production of pellets."

Participants thought sources of wood for pellets was unlikely to change in the future, but some commented:

- "Pine roundwood purchases may increase or in-woods chips/field chips may have to be used if we can't buy enough sawmill residuals."
- "Industrial pellets may use significantly more unmerchantable wood, pre commercial wood, thinnings and forest residues"
- "It is highly unlikely that the types of feedstocks used will change, however the relative proportions of the feedstocks used will likely shift over time, especially to include more sawmill residues as the housing market recovers. We use only small non-merchantable roundwood, not saw timber or any cypress roundwood, regardless of size"

The following feedstock could not be used by some producers:

- Roundwood from naturally generated hardwood forest
- Roundwood from hardwood plantations
- Short rotation coppice (also true in Canada)
- Forest residues with bark.

Comments were:

- "Our process is not designed to operate using any hardwood species. The plant process design does not allow for the use of large diameter logs; all roundwood is from thinnings or unmerchantable material."
- "Energy crops are not typically considered sustainable under European requirements. The pellet industry has been built around using low value surplus fibre in the marketplace, so energy crops would not make financial sense either."
- "Our sustainable forestry certifications restrict us from using fibre from SRC plantations established on cleared forestland. We cannot use stumps as our mills cannot process them because of their size. We use only small non-merchantable roundwood, not sawtimber or any cypress roundwood, regardless of size. We also note that there are little to no hardwood plantations in our operating area and so do not source that material."

Pellet producers use feedstock that is managed under a forest management policy (including Sustainable Forest Management, SFM): SFI, FSC and STF. The amount ranges from 1% to >50 %, (additional information provided indicates that the proportion is related to the amount of sawmill residues used as fibre for pellet production).

Participants were asked if they sourced wood from privately owned small scale forest. All respondents said yes, but mainly thinnings. They take the wood at a range of ages from 10 years to 20 years, then at time intervals such as 5-6 years after this. Typically the first cut was taken at 12-15 years.

Comments on the use of pellets were:

- "The key physical factors that affect the suitability of the feedstock are: chemical content, ash content, CV and the physical properties of the pellet (e.g. durability, fines etc.). All roundwood from conventional forestry operations is useable providing it is debarked, sawmill residues (excluding bark) are useable, as are a proportion of harvesting residues. Typically up to around 20% of the pellet fibre can be made up of harvesting residues which would contain a proportion of bark and needles etc. This material typically has a higher concentration of undesirable chemicals and a higher ash content. These chemicals can cause corrosion and damage in the boiler during combustion and therefore need to be limited or the boilers to be modified. Short rotation coppice and other energy crops also typically have high concentrations of less desirable chemicals and would therefore need similar mitigating action to be taken. When designing and setting up a pellet mill it is important to understand the exact mix of fibre that will be utilised, the proportion of hardwood and softwood, the typical moisture content and the density of the wood. All of these factors affect the efficiency of pellet production, the quality of the pellet, the amount of energy consumed during production and the level of maintenance required in the plant. Therefore, it is not desirable or efficient to regularly change the mix of fibre once the pellet mill is operational, consistency of the raw material is key to efficient operation and quality control."

2.2.2 Question 29 Do you use thinnings.

This question was asked separately of pellet producers. Nine US respondents said they used thinnings between 10 and 20 years; one said they used pre-commercial thinnings at 8 years. If more than one lot of thinnings were taken, the first thinnings were taken between 10 and 20 years and the subsequent thinnings were taken every five to six years after this to 30 years.

No Canadian respondent used thinnings.

"Roundwood could be thinnings, or unmerchantable wood, and also meets the BEAC definition of "coarse forest residue". This is a significant defect of the BEAC model that has considerable consequences in calculations that rely on these definitions. We expect to use mainly thinnings, with some low grade material from clearcut sites, some in woods chipped material and some sawmill residuals. The plant is designed to use softwoods, so any hardwood use would be incidental."

"The decision for age of thinnings is based upon the sawtimber market, as thinnings are used to clear the weaker fibre from the forest and allow the remaining fibre more access to nutrients and sunlight, making the trees more valuable as sawtimber."

Pellet producers in the USA said the use unmerchantable wood, round wood from naturally regenerated forests and from coniferous plantations. Two organisations said they took roundwood from hardwood naturally regenerated forests and forest residues. Three organisations said they used forest residues.

Non-Bioenergy use

Non-bioenergy producers said that they use millions of cubic metres/year of wood. Figures were > 20 million green tons/year of lumber products and >2 million tons/y of paperboard for some respondents.

Trade organisations

Trade organisations participating in the survey said that their organisations covered close to 100% of pellet producers in the USA.

Funding

The organisations participating in this survey were funded by a wide range of sources, including Government, commercial contracts, public donation, foundation grants and private gifts.

3 Part 3 of questionnaire

3.1 Most influential factors which decide the current average rotation or harvest timing

3.1.1.1 Questions 183 and 184 (USA)

Most influential factors that decide the current average rotation or harvest timing in South East USA	Response Count for Naturally regenerated forest	Response Count for Plantation
Financial return from saw log market is the major factor influencing harvest timing.	17	18
Financial return from roundwood/pellet demand is the major factor influencing harvest timing	1	1
Financial return from chip-n-saw and pulpwood demand is the major factor influencing harvest timing	6	8
Any of the above, the major factor has varied over time	8	6
Licence conditions influence harvest timing more than market conditions	0	0
Other	13	7
answered question	**25**	**25**

- "Varies over time and location; Sustainability of the forest is always a consideration."
- "Financial and land condition objectives of the owning entity, family, non-forest industry corporate, forest industry, government. Timber prices will be a factor but so will macro-economic conditions and land condition objectives."
- "There are other reasons for owning forest land and these reasons will dictate the land owners' decision for rotation age and harvest timing. Such reasons include beauty, biological diversity, investment, part of home, part of far, privacy, non-timber forest products, firewood, hunting, recreation, etc.[2]" (3 responses)
- "For Pine forests: very little would be naturally regenerated forests and so usually conversion would follow harvest and would be dictated by the economic value of the higher and better use. I would also like to be clear that the unmanaged forest that I speak of is rarely a large carbon store or a bastion of ecological virtue."
- "Financial needs and objectives of the forest owner." (3 responses)
- "Naturally regenerated forests are mostly hardwoods as pine occurs in plantations. These natural hardwoods are not managed on a regimented harvest schedule like pine is. Much of it can only be accessed in particularly dry weather. Therefore harvests are opportunistic and driven by sawlog prices along with weather and current economic circumstances."

3.1.1.2 Questions 185 & 186 (East Canada)

The current average rotation age for naturally regenerated forests in East Canada was given as 40-120 years, depending on the type of forest and local conditions. For plantations is was given as 50-100 years.

[2] B. T J. Butler, M Tyrrell, G Feinberg, S VanManen, L Wiseman, and S Wallinger. "Understanding and Reaching Family Forest Owners: Lessons from Social Marketing Research." Journal of Forestry October/November 2007. pp. 348-357. This report provides a long list of objectives that influence landowner decisions

Most influential factors which decide the current average rotation or harvest timing in East Canada	Response Count for Naturally regenerated forest	Response Count for Plantation
Financial return from saw log market is the major factor influencing harvest timing.	6	4
Financial return from roundwood/pellet demand is the major factor influencing harvest timing	0	0
Financial return from chip-n-saw and pulpwood demand is the major factor influencing harvest timing	2	2
Any of the above, the major factor has varied over time	1	1
Licence conditions influence harvest timing more than market conditions	8	4
Other (please specify)	4	4
answered question	***14***	***10***

- "Rotation determined by sustainable harvest based on the ecological/biological capacity of the forest. Regulated (legal) annual allowable harvest."
- "Provincial forest policy"
- "Ontario's forests are directed by the Crown Forest Sustainability Act. Rotation or harvest timing would be influenced by the CFSA."

3.1.1.3 Questions 187 & 188 (Pacific Canada)

The current average rotation age for naturally regenerated forests in Pacific Canada was given as 60-100 years, depending on the type of forest and local conditions. For plantations is was given as 30-80 years.

Most influential factors which decide the current average rotation or harvest timing in Pacific Canada	Response Count for Naturally regenerated forest	Response Count for Plantation
Financial return from saw log market is the major factor influencing harvest timing.	3	5
Financial return from roundwood/pellet demand is the major factor influencing harvest timing	0	0
Financial return from chip-n-saw and pulpwood demand is the major factor influencing harvest timing	1	1
Any of the above, the major factor has varied over time	0	0
Licence conditions influence harvest timing more than market conditions	5	2
Other (please specify)	6	5
answered question	**9**	**8**

- "Rotation determined by sustainable harvest based on the ecological/biological capacity of the forest. Regulated (legal) annual allowable harvest."
- "Crown Forests BC's Chief Forester sets the Annual Allowable Cut. License conditions set out extraction percentages"

- "Recent efforts at disease control (pine bark beetle) have influenced felling decisions, and plans to recover from the damage will affect AAC allocations into the future."
- "BC legislation and approved forest management plans over ride; rotation determined by sustainable harvest based on the ecological/biological capacity of the forest. Regulated (legal) annual allowable harvest."
- "Private lands run for profit"

3.1.1.4 Questions 189 & 190 (Boreal Canada)

The current average rotation age for naturally regenerated forests in Boreal Canada was given as 60-100 years, depending on the type of forest and local conditions. For plantations is was given as 60-100 years.

- "For spruce dominated upland forest units (includes balsam fir) the minimum operable age is generally set at 80 years with no upper age limit. For the lowland spruce forest units the minimum operable age is generally set at 100 years with no upper age limit. For jack pine the minimum operable age is generally set at 60 years with an upper limit of 135 years, for birch 70 years with an upper limit of 135 years, and for poplar 60 years with an upper limit of 135 years."

Most influential factors which decide the current average rotation or harvest timing in Boreal Canada	Response Count for Naturally regenerated forest	Response Count for Plantation
Financial return from saw log market is the major factor influencing harvest timing.	5	3
Financial return from roundwood/pellet demand is the major factor influencing harvest timing	0	0
Financial return from chip-n-saw and pulpwood demand is the major factor influencing harvest timing	1	1
Any of the above, the major factor has varied over time	2	2
Licence conditions influence harvest timing more than market conditions	9	4
Other (please specify)	5	5
answered question	**14**	**10**

Comments

- "Any of the above, the major factor has varied over time"
- "Rotation determined by sustainable harvest based on the ecological/biological capacity of the forest regulated (legal) annual allowable harvest."
- "Ontario's forests are directed by the Crown Forest Sustainability Act. Rotation or harvest timing would be influenced by the CFSA."
- "To our understanding there are virtually no plantations in Boreal Canada"

3.1.1.5 What is the current average rotation for naturally regenerated forests and plantations in South East USA?

Responses were:

- Naturally regenerated forest - hardwood 35-80 years
- Naturally regenerated forest - softwood 35-60 years
- Plantation – hardwood: Not applicable
- Plantation - softwood 25-35 years

The factors influencing this are listed below:

Most influential factors which decide the current average rotation or harvest timing in USA	Response Count for Naturally regenerated forest	Response Count for Plantation
Financial return from saw log market is the major factor influencing harvest timing.	5	3
Financial return from roundwood/pellet demand is the major factor influencing harvest timing	0	0
Financial return from chip-n-saw and pulpwood demand is the major factor influencing harvest timing	1	1
Any of the above, the major factor has varied over time	2	2
Licence conditions influence harvest timing more than market conditions	9	4
Other (please specify)	5	5
answered question	**14**	**10**

3.1.1.6 Question 195 What drive the thinning of forests or plantations?

Reasons for thinning forests or plantations	South East USA	East Canada	Pacific Canada	Boreal Canada	Total
They are thinned to optimise financial return from saw log or large dimension round wood demand	19	2	1	3	22
They are thinned to optimise financial return for roundwood/pulpwood demand	6	1	1	1	8
Licence conditions or regional regulations	0	4	3	4	6
A combination of the above	6	4	1	2	12
other (please specify)	0	3	3	3	4
				answered question	**37**

Canadian comments

- “Thinning is rare. Only occurs from time to time as government make work projects.”
- “In East Canada social and environmental considerations are also used to decide.”
- “Very little in Ontario because of tenure system and lack of financial incentive.”
- “Social and environmental considerations are also used in decisions.”

US Comments

- “They are thinned to maximize returns for all forest products in combination. Thinning does not simply optimize the financial return of the saw logs, but it does so by increasing forest productivity and improving forest health. It concentrates growth on the remaining trees so that they reach sawlog size sooner, improving the overall return on investment.”

3.1.1.7 Questions 196 &197 How do expected short term changes in pellet prices/ pulpwood/round wood demand affect management decisions on rotation length/harvest timing or the replacement of naturally regenerated forests with plantations?

How expected changes in pellet prices/pulpwood/round wood demand affect management decisions on rotation length/harvest timing or the replacement of naturally regenerated forests with plantations	Responses: Short term changes	Responses: Long term changes
Management decisions are very responsive to changes in pellet/pulpwood/roundwood prices	6	4
Management decisions are moderately responsive to changes in pellet/pulpwood/ roundwood prices	3	9
Management decisions are weakly responsive to changes in pellet/pulpwood/roundwood prices	9	19
Management decisions are not influenced by changes in pellet/pulpwood/roundwood prices	16	5
State or Province regulations are an important influence on management decisions	11	11
Other (please specify)	13	13
answered question	**37**	**38**

Canadian Comments

- "Management decisions are moderately responsive to pulpwood/roundwood prices but pellet prices have no bearing on these decisions as the producers cannot afford pulpwood prices in the short term."
- "In the long term, if roundwood prices drop because of reduced pulp demand, pellet demand will have a moderate impact on decisions, the impact will be reduced because of the lower pricing."
- "Rotation is set on biological and ecological principles"
- "Any changes would happen within the requirements of provincial legislation and SFI certification."
- "Long term expectations are critical for the decision to keep land in forest at all, but less important for short-term management choices of existing forests (unless such weak expectations incentivises liquidation and conversion to urban or agricultural uses with better long-term prospects)."
- "In the long term, if roundwood prices drop because of reduced pulp demand, pellet demand will have a moderate impact on decisions, the impact will be reduced because of the lower pricing."
- "Management decisions are not based on short-term data."
- "State or Province regulations are an important influence on management decisions."

US Comments

- "BMPs in the southeast US are mostly voluntary, but still followed by roughly 90% of harvesting landowners."
- "Demand should have been an answer option. There are also two questions (rotation length and replacement of naturally regenerated forests)"
- "Such decisions are long-term decisions and will not be impacted by short term price changes"
- "Pellet/pulpwood/roundwood demand and pellet/pulpwood/roundwood price are not the same thing. In addition, all forest management decisions are long term; for instance, a first thinning might be made at 14 years old, and this would be classified as a long-term decision." (7 responses)

- "Thinning is a long term decision that is rarely affected by the short term price of pulpwood."
- "Forest management involves long-term decisions to maximize a return on investment. This is best achieved by planning for the highest value output – saw timber."
- "Sawlog pricing is the primary determinant in rotation length and harvest timing."
- "Long term expectations are critical for the decision to keep land in forest at all, but less important for short-term management choices of existing forests (unless such weak expectations incentivises liquidation and conversion to urban/agricultural uses with better long-term prospects).
- "Rotation length and harvest timing will not be affected by pellet prices. However, landowners might decide to plant stands more densely based on pellet/pulpwood prices in order to have more volume at thinning. Such prices would have no influence on replacement of natural forests with plantations."
- "It is possible that small some management decisions may change in response to a new market like pellets, but not decisions like harvest length or conversion to plantations. Some decisions influenced by this market may be things like the timing or number of thinnings."
- "It is worth mentioning here that forestry is a long term business. The long term expectation for future prices influences management. When a forest owner plants trees, the soonest opportunity to thin for a pulpwood market is generally around 14 years. If the expectation for pulpwood prices 14 years from now is strong, the forest owner can increase planting density to increase the amount of pulpwood produced in 14 years. If it is weak, planting density can be reduced."

3.1.1.8 Questions 199 – 213 What factors other than the market, influence decisions about the way forests and plantations are managed?

Most influential factors (other than market) which influence decisions about the way forests and plantations are managed	South USA		East Canada		Pacific Canada		Boreal Canada	
(1 = most influential; 6=least influential)	**Rank: Naturally regenerated forest**	**Rank: Plantations**	**Rank: Naturally regenerated forest**	**Rank: Plantations**	**Rank: Naturally regenerated forest**	**Rank: Plantations**	**Rank: Naturally regenerated forest**	**Rank: Plantations**
Federal Government policy or regulations	3	1	5	5	4	4	4	5
Forest products industry	1	3	3	4	2	2	3	4
State regulations	1	2	1	1	1	1	1	1
Conservation requirements	5	4	2	3	2	3	2	2
There are no other factors that influence management decisions	6	6	6	6	6	6	6	6
Other (please specify below)	4	5	4	2	5	5	5	3
answered question	**25**	**22**	**14**	**10**	**10**	**6**	**15**	**9**

Canadian comments

- “Ontario's forests are directed by the Crown Forest Sustainability Act. Rotation or harvest timing would be influenced by the CFSA.”
- “Crown forests dominate. Forest certification”
- “Boreal Forest Agreement.”
- “Forest certification” (this comment was common among Canadian respondents)
- “Ecological and biological principles; People's need (job programs). Conservation requirements can also limit the amount of managed forests.”
- “There are no real plantations in Ontario”

- "Given that 94% of forests are publicly owned the national strategy is a key driver. "Canada's forests will be maintained and enhanced, for the social, cultural, environmental and economic well-being of all Canadians, now and in the future[3]."
- "Forest products and jobs/job programs"
- "Conservation requirements can also limit the amount of managed forests."

US comments

- "Non-industrial owners have a wide variety of management objectives (conservation, aesthetic, family, etc.) which are more important than any market or regulations." (variation of this from 4 other respondents)
- "Most corporate landowners subscribe to forest industry certification standards - a key influence."
- "Most forestland in the Southeast lacks adequate mandatory regulations. More than 80% of forests are privately owned and logging operations are conducted with few restrictions and little oversight. Practices such as large-scale clearcutting, old-growth logging, wetland logging and the conversion of natural forests to plantations are mostly unregulated and are often practiced in sensitive habitats with little protection for species[4]. (submitted by three other respondents)
- "Owner objectives and markets are the most significant drivers: these operate within the policy and regulatory environment. Owners objectives are varied, as evidenced by the Forest Service National Woodland Owners Survey."
- "The state and federal regulations refer to BMPs and environmental laws. Also refers to the incentives for private forest owners land ownership."
- "We have a robust business leasing forest land to hunting clubs. Since hardwoods are secondary to pine plantations as a financial driver, hunting lease prices can be a factor in harvest decisions and the way hardwoods are managed to optimize overall revenue."
- "Government taxation has had a major influence on the structure of ownership and management as have state practice requirements/guidelines and in some places conservation requirements. Family landowners and some corporate owners may have additional conservation/ recreation goals that influence management. Most corporate landowners subscribe to forest industry certification standards - a key influence."
- "Markets have a major influence on how forests, natural or planted, are managed and there is ample evidence that the presence of robust markets results in stable or increasing timberland acreage. [5]
- "The Sustainable Forestry Initiative commitment influences management. For example, requirements on adjacency, i.e. delaying harvest on stands that are immediately adjacent to fresh harvests. Another example is special management considerations for sensitive species of wildlife or plants. Conservation requirements include state forestry BMPs, which are tied to federal regulations like the Clean Water Act. Conservation requirements also include commitments under conservation easements, habitat conservation plans, and other special management areas."
- "Markets are the one consistent factor influencing the way plantations are managed. All the other options are also considered when making management decisions, including best management practices, policy and regulation and conservation, environmental and landscape factors."

[3] http://www.ccfm.org/pdf/CCFMCanForStratBklt.pdf
[4] See: http://www.nrdc.org/energy/wood-pellet-biomass-pollution.asp
[5] Abt, K., R. C. Abt, C. S. Galik, and K.E. Skog. 2014. Effect of Policies on Pellet Production and Forest in the U.S. South: A technical document supporting the Forest Service update of the 2010 RPA Assessment. USDA General Technical Report SRS-202."

3.2 Sources of fibre for pellets

3.2.1.1 Questions 215 – 221 What are the most likely sources of wood if new sources were mobilised to meet fibre demand for pellets?

Most likely sources of wood if new sources were mobilised to meet fibre demand for pellets	South USA	East Canada	Pacific Canada	Boreal Canada
1=most likely new source	*Rank*	*Rank*	*Rank*	*Rank*
Sawmill residues	2	1	2	1
New plantations would be established from conversion of naturally regenerated forests	6	9	6	8
New plantations would be established on abandoned agricultural land	8	9	6	8
Unmanaged wood would be brought back into management	1	4	5	4
Energy crop plantations would be established	9	8	6	7
Forest residues would be extracted as part of operations at the roadside	5	2	1	2
Displacement of roundwood/pulpwood for non-bioenergy markets	4	3	3	3
The area of harvest of naturally regenerated forest would be expanded	10	5	6	5
Current naturally regenerated forest would be harvested more frequently	7	6	6	8
Other (please specify below)	3	7	4	6
answered question	**25**	**15**	**8**	**14**

Comments from Canada

- "Surplus of fibre now in our regular harvesting operations targeting saw logs"
- "East Canada: Unmanaged wood would be brought back into management"
- "In all cases, AAC (of the forest law) has to be respected for SFM purposes."
- "Currently unutilized merchantable fibre would be used"
- For Pacific Canada: "Diseased and burnt timber will be made more accessible to pellet producers." "Sawmill residues will decline as AAC is reduced due to mountain pine beetle."
- For Boreal Canada: "In all cases, AAC (of the forest law) have to be respected for SFM purpose." "Currently unutilized merchantable fibre would be used."

Comments from USA

- "Increased forest productivity in existing plantations will be the source of new volume in the US South. Forest productivity has increased nearly 50% in just the last 15 years alone and will continue to increase with each rotation."
- ""The US South is the largest forest products economy in the world by a large margin and has the largest installed plantation base in the world by a large margin[6]." Continued increase in productivity position the South to be able to respond to increased demand for traditional forest products as well as pellets for energy (Munsell and Fox, 2010). The resource is not static;

[6] Dr. Michael Clutter, former Dean of the University of Georgia Warnell School of Forestry and now VP of Forest Investment Associates in an address at the 2015 Forest Landowners Association Annual Meeting.

improvements in genetics, the understanding of soil nutrition, vegetation control and other factors have led to increased timber yields/acre accomplished over shorter rotations. Productivity has increased 50% in just the last 15 years. It is reasonable to expect productivity to continue to increase and this increase in productivity will result in many of the BEAC scenarios being irrelevant, even if bio-energy demand increases. It appears to us that there is little appreciation in the UK or the EU for the well documented ability of plantations in the US South to produce more wood more quickly with each succeeding generation of plantations. The forest resource, including the plantation resource, in the US South is vast and one reason it is vast is the robust market for forest products that has provided a financial incentive for landowners to retain their forest land and invest in its management. While the pellet market will only marginally contribute to that financial incentive, it can contribute. Another source will be denser plantings on pine plantations, with expanded thinnings from one to two or even three. Increasing plantation productivity and the possibility of increasing thinnings are the overwhelmingly most likely sources of additional wood. All other scenarios are much less and even highly unlikely."

- "Increased forest productivity in existing plantations will be the most likely new sources of wood in the South USA. Forest productivity has increased 50% in the last 15 years, and will continue to improve with every rotation, as forest managers use the data collected in each rotation to adjust practices to increase the productivity of later rotations. Munsell and Fox (2010)[7] found that "Southern US pine plantations that are managed using intensive agro-ecosystem methods could contribute to a balanced, sustainable, and diverse renewable US energy system. Substantial improvements in growth associated with the implementation of intensive systems could, in many cases, nearly double the amount of biomass produced. Financial analyses also demonstrate that owners could likewise benefit from monetary returns stemming from intensive management. Results indicate that pine plantations managed intensively for a mixture of products on existing forestland and high-density plantings for dedicated biomass supply, at least initially, could profitably supply biomass at current prices in the southern US." (Also from 3 other respondents)
- "Another source will be denser plantings on pine plantations, with expanded thinnings from one to two or even three. All other scenarios are much less and even highly unlikely."
- The first source of wood to be mobilized is surplus pulpwood available because of the closure of paper mills. 20 paper plants with a potential demand of 22.6 million tons of pulpwood have closed in the US South since 1998. We work with pellet plants to locate in the areas where previous demand has disappeared and the surplus is the greatest. In addition to the existing surplus, additional wood for pellet production will come from the dramatic increases in forest productivity on existing plantations. Some 95% of this is in existing plantations. 0% of this is in creating new plantations. We have increased plantation productivity by 54% since 1998, the same year that paper mill closures began."
- "The main new source of wood will be from improved productivity of existing stands. USDA data shows that in the US South between 1953 and 2012, forest inventories grew from 5.2 billion m^3 to over 10.8 billion m^3. In the same period annual removals (total harvest) grew from 194 m3 p.a. to 284 million m^3 in 2011. The surplus of growth over removals in 2011 was 204 million m^3.[8]"
- "The most likely initial source will be slack pulpwood demand, followed by residues from both the forest and any unused mill residues. Overtime, management would shift to specifically build in interim thinnings of industrial lands, etc."
- "I am assuming an increase in price for material which would draw amounts from various sources even if those sources are currently used for other purposes. Displacement of current pulpwood uses would draw on the same sources as current pulpwood. Current pulpwood use would go down slightly and be shifted to other regions as pulpwood use of pellets goes up."

3.2.1.2 If energy crops were to be grown for bioenergy, which is the most likely source of land that would be used?

USA: Most answered abandoned agricultural land.

[7] Munsell J R and Fox T R (2010) An analysis of the feasibility for increasing woody biomass production from pine plantations in the southern US. Biomass and bioenergy 34(12) 1631-1642

[8] http://www.fia.fs.fed.us/library/brochures/docs/2012/ForestFacts_1952-2012_Metric.pdf

Comments from Canada

- "Abandoned agricultural land or land that is currently unmanaged forest."
- "Crown lands would require an environmental assessment for this to happen." "It is unlikely because of the costs of doing it."

Comments from US

- "Many crops are very specific to other soil and climatic conditions that prevent their use for pellets."
- "Farmers are always on the lookout for sources of income. Currently energy crops are not desired by power generators and this scenario is highly unlikely."
- "Abandoned Ag land can be converted to energy crops more cheaply than the other choices. However we understand that this source of feedstock for pellets may not be allowed due to sustainability regulations (in Europe)" (Variations on this answer were given by 5 other respondents)
- "It is unlikely that energy crops will be grown for producing pellets. There is some possibility that energy crops will someday be grown for liquid biofuels and this most likely would occur on abandoned agriculture lands."
- "Because of the chemistry challenges energy crops are unlikely to be used for industrial wood pellet production as previously discussed. Importantly the time window (2027 subsidy expiry) does not present sufficient time for crop development and payback."

3.2.1.3 What factors currently determine the management of small scale forest?

Canada: Most answered conservation, saw log market incentives or land use changes that increase the value of the land.

Comments from Canada

- "Small forest landowner objectives are highly variable, mostly opportunistic, and largely non-responsive to wood markets, unless it is simply inability to maintain/compete against alternative agricultural or urban development pressure."

USA: Most answered sawlog market incentives, conservation or pulpwood markets.

Comments from USA

- "Small forest landowner objectives are highly variable, mostly opportunistic, and largely non-responsive to wood markets, unless it is simply inability to maintain/compete against alternative agricultural/urban development pressure."
- "Management would be influenced by the short and long range objectives, financial and ecological and recreational of the small land owners. They could vary of the life times of the land owners."
- "While price of fibre may dictate harvest, the forest management is dictated by other decisions."
- A number of respondents quoted the work by Butler et al cited in Section 1.1.5.

3.2.1.4 How often are trees and other wood removed from small scale woodland?

Canada and USA: Most answered occasionally or rarely

3.2.1.5 Question 227: What are the main markets for wood from small scale wood land?

Canada: mainly saw log and pulpwood or logs or wood for local biomass heat/land owners own use.

USA: saw logs, pulpwood, OSB or other board mill, pellets

Comments from USA

- "Multiple markets and will be determined by what market yields the best financial return at the time of harvest or the time the landowner needs the money." (4 other respondents made similar comments)
- "Wood is merchandized and delivered to markets that produce the best financial returns. These markets can vary widely depending on location."

- "The market in the US South is quite robust and overall nearly any landowner will have at least a few markets where they could sell their wood."
- "Across the South USA, trees from these harvests are merchandized to different markets, depending on tree size and product demand. These markets vary by location and include all of the above, plus ply mills and export markets."

3.3 Questions on costs and prices of fibre for pellets.

The following prices were provided by respondents in the USA. Stumpage prices come from Forest2Market's Stumpage Price Database and delivered prices cited come from Forest2Market's Delivered Price database, which includes scale ticket information on eight million truckloads of delivered timber in the South USA annually.

South East USA - naturally regenerated	Answers $/green ton		
	Range low	Range high	Av
• Average range for stumpage price over past three years for naturally regenerated coniferous forest	10.58	33.24	21.93
• Average range for pulpwood price over past three years for naturally regenerated coniferous forest	6.65	12.55	9.61
• Average range for saw timber price over past three years for naturally regenerated coniferous forest	17.47	38.59	28.05
• Average range for stumpage price over past three years for naturally regenerated hardwood	5.28	31.69	18.49
• Average range for pulpwood price over past three years for naturally regenerated hard wood forest	5.35	12.91	9.14
• Average range for saw timber price over past three years for naturally regenerated hardwood forest	24.33	42.7	33.53
	Source for above: Forest2Market		

Av price for wood from plantations	Answers $/green ton		
	Range low	Range high	Av
• Average range for stumpage price over past three years for intensively managed coniferous plantations	6.21	27.81	17.01
• Average range for pulpwood price over past three years from intensively managed coniferous plantations	7.17	14.75	10.96
• Average range for saw timber price over past three years from intensively managed coniferous plantations	12.75	34.51	23.63
• Average range for stumpage price over past three years from intensively managed hardwood plantations	2.29	21.8	12.04
• Average range for pulpwood price over past three years from intensively managed hardwood plantations	5.19	12.9	9.03
• Average range for saw timber price over past three years from intensively managed hardwood plantations	19.25	37.57	28.43
	Source for above: Forest2 Market		

US comments

- "Additional prices can also be found in Timber Mart South and Wood Resource International. These are available as a subscription service" "Industry datasets provide objective data"
- "Prices are location dependent (so it is meaningless to ask for average prices)"

3.3.1.1 Questions 236 – 239

Main factors that influence the market price of wood	South East USA pulpwood prices	East Canada roundwood prices	Pacific Canada roundwood prices	Boreal Canada roundwood prices
Market supply	77%	58%	83%	50%
Market demand	94%	83%	83%	83%
Costs of extraction or harvesting, including stumpage	77%	75%	67%	67%
Labour costs	77%	42%	33%	33%
Transport costs	82%	50%	67%	50%
Other (please specify below)	35%	8%	0%	17%
answered question	***17***	***12***	***6***	***12***

Comments from Canada

- "The US/Canadian exchange rate"
- "Market demand is the most variable factor/the main factor."
- "In British Columbia fuel costs for transport are important."

Comments from USA

- "Sustainability certification costs, if required for market access, could for practical extent and purposes eliminate small landowners from the supply pool. Those costs are high enough and dependent on economy-of-scale such that small landowners in the US south will not be able to compete at likely prices that are competitive globally with industrial practices or with alternative renewable energy options (even though by environmental impact they are likely superior to US and global industrial operations)."
- "Stumpage and transportation are the greatest sources of variability. Stumpage variability is caused by the influences of supply and demand." (2 respondents provided variations on this comment)
- "Due to the recent housing recession sawmill residuals have been is short supply and there has been a surplus of saw logs. As housing returns to normal over the next several years there will be a greater demand for saw logs and a greater supply of residual chips resulting in increasing sawtimber prices and decreasing pulpwood prices." (3 respondents provided variations on this comment)
- "The greatest sources of variability in the component parts of delivered pulpwood prices are stumpage and transportation. Stumpage, according to the coefficient of variation, is the most variable: hardwood pulpwood (25) and pine pulpwood (15). Transportation costs range have a coefficient of variation from 8-9. Stumpage variability is caused by supply and demand influences, and transportation cost variability is caused by diesel prices and inflation. As housing starts return to pre-recessionary levels, which Forest2Market's housing start forecast predicts will hit 1.6 million units annually in 2020 and remain at or above that level through 2030, sawmill residuals will be more widely available, and this will reduce demand for pulpwood, sending pulpwood prices lower." (2 other respondents provided variations on this comment)
- "The most variability exists in stumpage prices and transportation prices. Stumpage price changes based on supply and demand forces and transportation varies based on cost of fuel and other economic influences like inflation. Forest2Market's housing forecast indicates that housing units will remain steady from 2020-2030, making sawmill residuals readily available and reducing the demand for pulpwood, thereby reducing the price for pulpwood."

3.3.1.2 Question 240 How would current pulpwood, roundwood or pellet prices need to change to encourage an increase in harvest rate

How current pulpwood, roundwood or pellet prices would need to change to encourage an increase in harvest rate	No change	Slight increase (less than 10%)	Large increase (up to 100%)	Very large increase (more than twice current price)	A price change would not result in an increased harvest rate	Other factors dictate harvest timing	I don't know	Total
South East USA- pulpwood prices	0	0	6	5	4	1	2	18
East Canada - roundwood prices	1	0	4	1	3	1	2	12
Pacific Canada - roundwood price	1	0	1	0	3	1	1	7
Boreal Canada - roundwood prices	1	0	4	0	4	1	3	13
							answered question	**28**

Comments from Canada

- "The harvest rate on public lands is defined by AAC calculations by the Chief Forester"

Comments from USA

- "Industrial owners will be much more price sensitive, but still constrained by BMPs, water and wildlife regulations, etc."
- "Very large increase (more than twice current price). Such an increase is extremely unlikely regardless of how the pellet market evolves.
- "Using basic growth and yield models, if you assume 2 thinnings at double the current average pulpwood price, harvest rotation only increases by 1 year. An increase in price this large is extremely unlikely." (A variation on this comment was provide by two other respondents)
- "A pulpwood price increase could be a modest contributor to a decision to decrease rotation in combination with other larger factors, but this possibility is limited by these two factors: 1- The difference between the price of saw logs and of pulpwood is more important than the absolute price of each because this determines how much it pays to invest additional growing time to receive the price increment. A decrease in sawlog pricing is a larger determinant. 2- Growth trumps; Even when you model the same price for saw logs and pulpwood (something which has never occurred), the sheer rate of growth dictates waiting for harvest to a point when growth begins to moderate."
- "Shorter rotations would produce smaller trees that are not suitable for sawn wood production. The pellet market could not afford to pay more than the saw log market. There is a substantial surplus of fibre to meet any increase in demand. A change in prices would not result in an increased harvest rate

because pellet price does not drive this change rotation length is driven by total crop economics. Response to increased demand is NOT decreased rotations[9]."

3.3.1.3 Question 241 How would current pulpwood, roundwood or pellet prices need to change to encourage an increase in thinning?

How current pulpwood, roundwood or pellet prices would need to change to encourage an increase in thinning	No change	Slight increase (less than 10%)	Large increase (up to 100%)	Very large increase (more than twice current price)	A price change would not result in an increase in thinnings	Other factors dictate thinning timings	I don't know	Response Count
South East USA- pulpwood prices	0	3	8	0	1	3	3	18
East Canada - roundwood prices	1	0	1	0	0	5	4	11
Pacific Canada - roundwood price	1	0	0	1	1	1	1	5
Boreal Canada - roundwood prices	0	0	0	2	0	4	5	11
							answered question	**28**

Comments from Canada

- "Not very sure on this, but generally our government projections indicate price is relatively non-responsive to energy demand (e.g. RPA modelling projects an increase of 5+ times current energy demand to have a substantial price response due to slack in the pulp market and forest production system). Actual management changes are likely to be site specific. Even small increases in price/demand would be beneficial (though perhaps insufficient)."
- "The tenure system does not give long term rights to companies"
- "Very large increases (more than 2x current rate) in Boreal Canada"
- "East Canada: Thinnings provide small amount of biomass - currently uneconomical to recover"
- "For all regions: No change – harvest rate is dictated by provincial policy"

Comments from USA

- "In South USA other factors dictate thinnings timings"
- "The purpose of thinning is to get a biological response in standing volume to yield more sawtimber volume. Thinning is driven by the sawtimber market alone." (A variation on this comment was provided by 2 other respondents)

[9] See also a recent blog from the USDA http://blogs.usda.gov/2015/06/08/study-finds-increasing-wood-pellet-demand-boosts-forest-growth-reduces-greenhouse-gas-emissions-creates-jobs/

- "Such an increase is extremely unlikely given the pellet market. A growth and yield model that assumes two thinnings at double the current average pulpwood price may increase the rotation age by one year. Such an increase is extremely unlikely no matter how the pellet market evolves."
- ""Thinning is based on the silvicultural strategy. The purpose of thinning is to get an appropriate biological response in the remaining standing timber stock. This is the primary factor driving thinning regimes. So the number of thinnings in a rotation will be mainly driven by the sawtimber market, but higher priced pulpwood may cause denser planting at origin and heavier thinnings." (A variation on this comment was provided by 4 other respondents)
- "The purpose of thinnings is to help the remaining fibre in the forest have more access to nutrients from the sun and soil, making a stronger, healthier end product (sawtimber). The number of thinnings done are driven by the demands for the sawtimber market. Large increases in price for pulpwood may cause increased planting and heavier thinnings, but this is unlikely to occur."
- "There is no need for price to change – just for a market to exist where there is no suitable market currently. Owners can move from no-thin to a thinning regime. This would be driven by the proximity to the market, a new market or increased demand could increase/or cause the re-commencement of thinning in that catchment area. If there was insufficient suitable forest within a reasonable catchment then higher delivered pulpwood costs (to cover increased haulage rates) could facilitate additional thinning from a wider catchment area, although this is likely to be very limited. Where thinning is already taking place, it is likely that a large increase in price would be necessary to add an extra thinning."

3.3.1.4 Question 242 How would current pulpwood, roundwood or pellet prices need to change to encourage an increase in removal of forest residues?

How current pulpwood, roundwood or pellet prices would need to change to encourage an increase in removal of forest residues	No change	Slight increase (less than 10%)	Large increase (up to 100%)	A change in prices would not result in an increase in the removal of forest residues	Other factors dictate the removal of forest residues(please comment below)	I don't know	Response Count
South East USA pulpwood prices	0	2	7	3	7	2	20
East Canada roundwood prices	0	0	7	1	1	3	12
Pacific Canada roundwood prices	0	0	3	1	1	1	6
Boreal Canada roundwood prices	1	1	6	1	1	4	13
						answered question	**30**

Comments from Canada

- "Residue processes today do not warrant removal because of the excess of roundwood available"
- Boreal Canada roundwood prices: there is "significant quantity of wood available on our management units."

- "Harvest rate is dictated by provincial policy"
- "If industry paid more for wood supplies... then more would find its way to a mill"

Comments from USA

- "There would need to be critical mass of equipment capacity to handle removals to roadside in addition to and increase in price. The price would have to persist at a higher level to encourage investments in the equipment needed."
- "A large increase, although highly unlikely, would give suppliers incentives to purchase more chippers, but the market would have to increase for this to happen."
- "Demand for residues is low and pellet producers do not seem to like this feedstock. Logging contractors would have to have confidence in a long-term demand before investing in the equipment needed to handle forest residues. The main market for residues currently is the pulp and paper business for power production but the market is small and spotty. The BEAC definition of residues is quite broad and may include some small roundwood."
- "A market for residues from pulp and paper, the capacity of suppliers to collect and deliver residues, and alternative fuel costs will dictate an increase in residue removals."
- "Currently, a majority of residues (that are) removed from the forest are used by the pulp and paper industry in boilers. Transportation and delivery costs can create an increase or decrease of residue removals. These would not be tied to the price or demand for pellets."
- "A market for residues from pulp and paper and pellet manufacturers must exist. The price of residues will need to make it possible for suppliers to invest in the equipment necessary to collect residues. The cost of collection will have to be low enough to support a reasonable profit margin for suppliers."
- "Because BEAC's definitions of pulpwood, roundwood and forest residues overlap, it is not possible to give a clear answer to the question. If material used be removed as pulp for a paper mill but is now removed as feedstock for pellets, is there any increase in removal? If a forest product cannot be sold it is a residue of the harvesting for other products. In any event, factors other than a change in pulpwood prices are likely to change behaviour. Access to contractors with suitable machinery, owner objectives, combined with a large increase in price would be needed to make a substantive change in removals."

3.3.1.5 Question 243

How current prices for pulpwood would need to change to encourage conversion of naturally regenerated forest to plantation in the US South	No change	Slight increase (less than 10%)	Large increase (up to 100%)	A price change would not encourage replacement of naturally regenerated forest with plantation	Other factors dictate the replacement of naturally regenerated forest to plantation	I don't know	Response Count
	0	1	4	5	6	3	19
						answered question	**19**

Comments from USA

- "The calculation would have to include the opportunity cost of future sawlog harvests (and pulpwood harvest) forgone on the forest land converted."
- "Saw timber markets, landowner objectives and other agricultural markets" (this response from 4 respondents)
- "The investment to convert naturally regenerated forest to a pine plantation commonly exceeds $300/acre. Current prices for pulpwood do not create a return on investment that is high enough to justify the investment. Sawlog pricing is required achieve the needed return.
- "There would be no conversion of naturally regenerated hardwood stands to plantation pine because the crop would not be eligible for Renewable Obligation support. Material from such stands would not meet sustainability criteria. The establishment of a new market – with no price increase – is sufficient to re-establish confidence in growers and may encourage higher levels of management input to naturally regenerated conifer stands: including planting, weeding, fertilising. The history of the last 70 years in the South shows that forest owners have responded to new demand by increasing the productivity of their forests."

3.3.1.6 Question 244

How current prices for pulpwood would need to change to encourage conversion of abandoned agricultural land to plantation in the US South	No change	Slight increase (less than 10%)	Large increase (up to 100%)	A price change would not encourage the replacement of abandoned agricultural land to plantation	Other factors dictate the replacement of abandoned agricultural land to plantation	I don't know	Response Count
	0	0	9	1	7	3	20
						answered question	**20**

US Comments

- "Alternative fate is likely urban or agriculture, not unmanaged forest"
- "Sufficiently long contracts, or solidly established and continuing market would be needed at sufficient prices to warrant investment."
- "There is an enormous difference in 10% and 100% which is where most of the action will occur"
- "A price change would not encourage the replacement of naturally regenerated forest to plantation"
- "Saw timber markets, landowner objectives and other agricultural markets" (Variation on this received from 4 respondents)
- "New plantations also need a sawlog market expectation. UK wood pellets are not going to offer a large increase because the subsidy ends in 2027 and wood paying capability is too low."

3.3.1.7 Questions 245 & 246 How much does a perception of future market saw log prices influence the decision by forest owners to defer harvest?

	It has no influence	It has a small influence	It has a moderate influence	It has a large influence	Other (please specify)	Response Count
How much does a perception of future market saw log prices influence the decision by forest owners to defer harvest?	0	0	8	17	0	25
How much does a perception of future market pulpwood/roundwood prices influence the decision by forest owners to defer harvest?	2	9	12	2	2	27

Comments from Canada

- "For Canada, the forest owner is the government, so companies cannot control this."
- East Canada: "Currently limited market for biomass - saw logs are the market"

Comments from USA

- "The influence would depend on the short term versus long term financial goals or needs of the landowner, but they would usually consider longer term returns and expect some fluctuation in markets."
- "You have to consider cash flow and you can only defer for so long. But the perception of future saw log prices is a definite consideration."
- "If sawlog prices dropped by 25% and the landowner believed they would recover in a short time, depending on other economic factors, the landowner would be motivated to wait for price recovery. In the meanwhile, the trees keep getting bigger."
- "Deferring a thinning to wait for better pulpwood prices is not in the landowner's best financial interest. Forest stands become overcrowded, tree mortality begins to occur, and the development of saw logs for harvest slows down. However, when pulpwood prices are low thinning backlogs do develop especially when the cease to provide a profit. There is a little bit of leeway in the timing before significant damage to the silvicultural regime occurs (maybe two years)."

3.3.1.8 Question 247

	Never	Infrequently	Sometimes	Frequently	Always	Response Count
Do pre-commercial thinnings (whole trees) have a market?	6	12	9	5	0	32

Comment from Canada:

- "This is the new market we hope energy demand will fulfil, as it would provide substantial benefits both economically and environmentally."

Comments from USA

- **"**This is the new market we hope energy demand will fulfil, as it would provide substantial benefits both economically and environmentally."

- "Market sold to: pulpwood and pellets" (submitted by 3 respondents)
- "Again, there is a definition problem. If they have a market, they have value. The market for such materials is spotty. Only around 5% of our land has access to such markets. We would like to have dependable markets for this material in order to facilitate reforestation."
- "By definition, pre-commercial means no market exists for the material. In practice, however, this could be classified as forest residues." (a variation on this response was given by 4 respondents)
- "Market they are sold to: Any tree that has a market is commercial. Thinnings are merchantable and are therefore commercial. So this question is illogical."
- "As a matter of practice, pine plantations can be managed to perform a first thinning after the thinning achieves merchantability."
- "This material could be used by the pulp and panel industry or by the wood pellet sector. It would depend on the proximity of the market to the forest."

3.3.1.9 Question 248 Are any of the following factors likely to influence forest owners' decision on who they sell wood to?

Factors which are likely to influence forest owners' decision on who they sell wood to	Yes definitely	Yes, but needs to be combined with competitive price	Yes, but only in areas close to a pellet mill	No, market price is main determinant	No, market price and level of demand are main determinants	No, other reason (please specify)	I don't know	Response Count
Perceived stability of the pellet market	1	5	1	10	7	1	2	27
Long term contracts for fibre for pellet	1	5	4	9	5	1	3	28
							answered question	**28**

Comment from Canada

- "Market price and level of demand are main determinants." (given by four respondents)
- "Long term contracts for fibre for pellet - yes but needs to be combined with competitive price" (given by three respondents)
- "Pellet fibre is very low value and entirely a spot market"

Comment from USA

- "Forest owners generally don't sign long term contracts for supplying wood so they don't need to have that long a view on the pellet market to sell into it. Longest contracts I'm aware of are 3 years." (2 respondents gave a variation on this response)
- "The pellet market offers an incremental extra return especially in areas where other markets have gone away. As such the pellet market can be a contributor to extra investment in forests and improved management. However the primary driver of returns will continue to be the sawtimber material."

3.3.1.10 Question 249 Is the current market price for pellets sufficient to encourage forest owners to bring unmanaged forest back into management?

21 responses to this question were no, two were yes and two were I don't know.

Comments from USA

- "Seldom but sometimes at close locations; probably not at large scale."
- "While higher pulpwood prices might produce small, incremental change in management practices by allowing some small landowners to make small investments to produce some income and improve aesthetics, a change in pellet prices will not."
- "More than likely this will be other factors (sawlog markets, aesthetics) that will aid landowner decisions to bring land back into management."
- "While higher pulpwood prices might produce small, incremental change in management practices by allowing some small landowners to make small investments to produce some income and improve aesthetics, a change in pellet prices will not." (This response received from two respondents).

- “Markets for low quality wood fibre provide a financial tool to conduct forest improvement operations. However, at current prices, if they have not already done so, there is no reason to believe that it would occur.”
- “The pellet market offers an incremental extra return especially in areas where other markets have gone away. As such the pellet market can be a contributor to extra investment in forests and improved management. However the primary driver of returns will continue to be the sawtimber material”

3.3.1.11 Question 250 What is the current price for wood from energy crops?

Comment from Canada

- "We don't have a large wood energy market. The price of other energy sources are too low."
- "Prices are location dependent, so this is a meaningless question."

Comment from USA

- "I'm not aware of any operational woody energy crops in the South USA" (This comment from 3 respondents)
- "This is such a tiny percentage of forestry in the South US, I was not able to find any data on it. Additionally, pellet producers cannot use this type of feedstock in their product."
- "The use of energy crops is not permitted by pellet customers so this question is irrelevant"

3.3.1.12 What price is needed to encourage landowners to plant energy crops?

There was a range of answers from CA$ 40-more than CA$73; and from US$40-59. A large proportion of respondents said "I don't know"

3.3.1.13 What price is needed to encourage forest owners to plant energy crops?

Most respondents said "I don't know".

Estimates were CA$40 to more than CA$73 and US$ 30-59/green ton.

3.3.1.14 Question 255 What is the average price for fibre for pellets[10]

- Canada: most respondents not willing to share price. Where they did price was CA$20-38/ green tonne or CA$50-80/oven dried tonne. This depended on location within region.
- "There is considerable variation with location."

3.3.1.15 Question 256 How much does the price of softwood in the US South need to rise to make it too expensive for pellet production?

How much does the price of softwood in the US South need to rise to make it too expensive for pellet production?	Response Count
No change	1
Slight increase (less than 10%)	1
Large increase (up to 100%)	3
Very large increase (more than twice current price)	0
Long term contracts mean that this situation is unrealistic	0
I don't know	0
Other (please specify)	7
answered question	**12**

US comments

- "Insufficient answer options. Between 15%-20% increase over current delivered prices.
- "Data from Forest2Market's Delivered Price database suggests 15-20% of current delivered price. We believe that the number would be closer to a 10% increase would begin to make pellet production unprofitable."
- "10-30% increase"
- "A relatively small amount, likely less than 20%"

[10] Fibre prices are available from TMS, F2M and WRI http://woodprices.com/ http://www.timbermart-south.com/ http://www.forest2market.com/

3.3.1.16 Question 257

How much does the price of hardwood in the US South need to rise to make it too expensive for pellet production?	Response Count
No change	0
Slight increase (less than 10%)	0
Large increase (up to 100%)	3
Very large increase (more than twice current price)	0
Long term contracts mean that this situation is unrealistic	0
I don't know	2
Other (please specify)	5
answered question	**10**

US Comments

- "Data from Forest2Market's Delivered Price database suggests 10-15% of current delivered price. We believe the number would be closer to a 10% increase would begin to make pellet production unprofitable." (This response twice)
- "A small amount – likely less than 15%"

3.3.1.17 Question 258 How much does the price of fibre in EC need to rise to make it too expensive for pellet production?

How much does the price of fibre in East Canada need to rise to make it too expensive for pellet production?	Response Count
No change	0
Slight increase (less than 10%)	4
Large increase (up to 100%)	1
Very large increase (more than twice current price)	0
Long term contracts mean that this situation is unrealistic	0
I don't know	2
Other (please specify)	1
answered question	**8**

3.3.1.18 Question 259 How much does the price of fibre in PC need to rise to make it too expensive for pellet production?

How much does the price of fibre in Pacific Canada need to rise to make it too expensive for pellet production?	Response Count
No change	1
Slight increase (less than 10%)	2
Large increase (up to 100%)	0
Very large increase (more than twice current price)	0
Long term contracts mean that this situation is unrealistic	0
I don't know	1
Other (please specify)	3
answered question	**7**

3.3.1.19 Question 260 How much does the price of fibre in Boreal Canada need to rise to make it too expensive for pellet production?

How much does the price of fibre in Boreal Canada need to rise to make it too expensive for pellet production?	Response Count
No change	0
Slight increase (less than 10%)	5
Large increase (up to 100%)	0
Very large increase (more than twice current price)	0
Long term contracts mean that this situation is unrealistic	1
I don't know	2
Other (please specify)	2
answered question	**10**

- "Long term contracts mean that this situation is unrealistic."

3.3.1.20 261 What price have pellet mills charged UK pellet users over the past year?

Most respondents not willing to share. CA$180/tonne FOB or CA$190 – 210/tonne

US$160-210/tonne CIF UK.

- "Pellet prices are cost based and determined by the specifics of each particular pellet plant (e.g. location, scale, financing structure, fibre type and availability, utility and production costs etc.)"

3.3.1.21 Question 262

Factors which influence the price pellet mills charge UK pellet users	Response Count
The contract for fibre supply	11
Supply/demand for pulpwood	7
Transport costs	10
Currency exchange rates	9
Sustainability costs	7
other (please specify)	10
answered question	**16**

Comments from Canada

- Supply/demand for pulpwood – "Still too expensive for pellets"
- Currency exchange rates – "recent high variation"
- "Wood cost; it's readily available but it's a high percentage of the total cost of pellets"
- "Energy costs linked to fibre"

Comments from USA

- "wood cost; it's readily available but it's a high % of the total cost of pellets"
- "sawmill residuals influence price greatly and are most variable in terms of available volumes for raw materials"
- "Long term offtake agreements"
- "Cost & delivered cost (Stumpage, transport, production) +capital + shipping - all of these are intrinsically linked."
- "All these factors affect the price. In different geographies, different factors may be the most influential or the most variable. In markets with long shipping distances that may be a major

factor, in others the stumpage costs. The term of the supply is also material, spot prices may vary considerably from those in long term contracts."

3.3.1.22 Question 263

Other factors which influence the pellet market now and to 2030	Response Count
Now - UK Government sustainability requirements	19
Now - Demand for pellets from other regions	14
Now - Demand from non-bioenergy market	15
Now - Future uncertainty	13
Now - Other (please specify)	4
To 2030 - UK Government sustainability requirements	15
To 2030 - Demand for pellets from other regions	16
To 2030 - Demand from non-bioenergy market	15
To 2030 - Future uncertainty	11
To 2030 - Other (please specify)	5
answered question	**22**

A number of respondents were not willing to share this information.

- "All these factors affect the market, any one of them may be the most important at any particular time, or in a particular location. It is highly likely that all these factors will still be in play in 2030, perhaps with the sustainability requirements being somewhat more settled – but note that FSC and PEFC standards have been around for 20 years and are still developing"

3.3.1.23 Q 264 What other factors influence this market?

- "Wood pellet exports from the U.S. doubled from 1.6 million tons in 2012 to 3.2 million tons in 2013. They increased again by nearly 40 percent from 2013-2014 and are expected to reach 5.7 million tons in 2015. Demand is so high that in the past two years, the Southeast United States, has witnessed a boom in pellet mill development. Some of these mills are owned and operated by European electric utilities in an effort to secure their supply of pellets into the future, principally to meet EU-mandated emissions targets. As a result, pellet production is expected to further skyrocket, with high estimates at 70 million metric tons by 2020. The United Kingdom, the Netherlands, and Belgium are today's top importers of U.S. wood pellets.[11]" - This evidence submitted by three participants

3.3.1.24 Question 267 Price for pellet users

US$ 160-210/t

- "Pellet producers are price takers - if they could set the price, the price charged would be much higher."

3.3.1.25 Question 269

Main factors which influence the price for North American pellets	Response Count
Stumpage	9
Competing demand for pellets	8
Competing demand for pellet feedstock by non-bioenergy sector	6
Agreed indexing in long term contracts	8

[11] References: U.S. Energy Information Administration. "UK's Renewable Energy Targets Drive Increases in U.S. Wood Pellet Exports." http://www.eia.gov/todayinenergy/detail.cfm?id=20912; Wood Resources International LLC, "Global Timber and Wood Products Market Update," news brief, October 11, 2012; United States Department of Commerce. International Trade Administration. Renewable Energy Top Markets Study. "Sector Case Study: Biomass Pellets." http://export.gov/build/groups/public/@eg_main/@reee/documents/webcontent/eg_main_070720.pdf

Comminution costs	2
Transport costs in North America	7
Sea freight costs	8
Transport costs in UK	3
Port handling costs	3
Auditing and analysis costs	2
Labour costs	3
Currency exchange rates	7
Insurance costs	2
Regulation requirements	5
Other (please specify)	4
Comments	3
answered question	**13**

Other factors in Canada: fibre and energy costs.

US Comments

- "Agreed indexing in long term contracts - of course only related to contracts and these are usually a function of costs (stumpage, shipping, fuel, inflation)"
- "Transport costs to UK are not in CIF price"
- "Currency exchange rates are important"
- "Logging costs are important"
- "All these factors are pertinent in North America, but different factors have differing relative importance at different times. Cost profiles are different for newly developed plants versus existing plants that see Europe as a new market; sea freight costs are more important for west coast Canadian suppliers than those in east Canada. Some of the factors are inter-linked i.e. stumpage and competing demand or pellet feedstocks; there can be multiple indices in long term contracts (stumpage, oil)."

3.3.1.26 Question 270

Factors which will increase prices over the next 15 years	Response Count
Stumpage	6
Long term contract indexing	7
Labour costs	5
Energy costs	4
In land transport costs	6
Freight costs	5
Currency exchange rates	2
Insurance costs	3
Cost of finance	3
Auditing and analysis requirements	5
Costs of regulations – sustainability, carbon, health and safety etc.	8
Other (please specify below)	3
answered question	**11**

Note: some respondents said they used stumpage for fibre costs.

- Additional comments from Canada: "Currency exchange rates"
- Additional comment: "all of these factors may increase price"

3.3.1.27 Question 271

Factors which will decrease prices over the next 15 years	Response Count
Stumpage	0
Long term contract indexing	2
Labour costs	0
Energy costs	0
In land transport costs	0
Freight costs	0
Currency exchange rates	4
Insurance costs	0
Cost of finance	2
Auditing and analysis requirements	1
Costs of regulations – sustainability, carbon, health and safety etc.	1
Other (please specify below)	2
answered question	**9**

- Comment from Canada "Supply & demand – buyers don't care about production costs or if the producers are profitable."
- Comment from US: "The exchange rate fluctuation could potentially decrease pellet prices from one year to another. We see it this year with ENplus pellets. Last year pellet producers could get a premium for ENplus pellets but this year they are priced the same as industrial pellets (lower price)"

3.3.1.28 Question 272

What would make you change your business model for pellet procurement or leave the market?	Response Count
Small price increase	3
Large price increases (to 50% higher than current)	7
Very large price increases (Over 50% higher than current prices)	2
Government regulations	5
Increased sustainability requirements	4
Other (please specify)	7
answered question	**13**

Comment from USA; "Current prices, with the current exchange rate, is not sufficient for pellet producers in the US to make a profit, so already there are players leaving the market and consolidation."

3.3.1.29 Question 276

Has the price of pulpwood been impacted by demand for fibre for pellets over the past two years?	Response Count
Yes I have witnessed increased competition for pulpwood for pellets, but I am not concerned about it	1
Yes I have witnessed increased competition for pulpwood for pellets and it affects a small proportion (less than 10%) of my fibre supply	0
Yes I have witnessed increased competition for pulpwood for pellets and it affects my fibre supply moderately (affecting more than 10% and less than 40% of my fibre supply)	1

Yes I have witnessed increased competition for pulpwood for pellets, and it affects my fibre supply significantly (more than 40% of my fibre supply)	1
No, I am not affected by demand for pulpwood for pellets	5
Other (please specify in comments box below)	1
answered question	**9**

- Comment from US: "The Forest Service recently released a report entitled, "Effect of Policies on Pellet Production and Forests in the U.S. South,[12]" Findings include - Prices for pulpwood grade softwood in the coastal south will more than double by 2020 from where they would have been absent increases in bioenergy-related wood demand. Pellets are estimated to account for 73% of bioenergy-related wood demand in the coastal south during the projection period. Hardwood stumpage prices are projected to rise 34% by 2020 relative to where they would have been absent bioenergy demand. Further data from TimberMart South and Forisk clearly shows the upward price trend, of both stumpage and delivered pulpwood prices, vis-à-vis the trend of the southeast U.S. demand for wood pellets – again, primarily for export to the UK. Timber Mart South Southeast US Pulpwood Stumpage prices and the relationship to wood consumption for pellet mills in the southeast US shows a 25% increase in pine pulpwood stumpage prices since 2011 and a 60% increase in hardwood pulpwood stumpage prices. A more recent report from Forisk indicates that, assuming that other market factors such as pulp/OSB production and the availability of residual sawmill chips remain unchanged, average pine pulpwood stumpage prices across the South could increase by 31 percent from 2014 to 2019 as a result of increased bioenergy demand, with 97 percent of the increase being pellet related."
- "The difference between delivered prices for sawtimber and pulpwood is unusually low due to the recent housing recession. Also, the inclusion logging and transportation costs in delivered prices masks the difference in the stumpage value of these products. Landowners make decisions based on stumpage prices. As the housing market recovers the value of saw logs will increase and the volume of sawmill residuals will increase, lowering the price of pulpwood and restoring the traditional price differential between the two products."
- "None of the wood purchased by our pellet mill is suitable for production at our saw mill."

3.3.1.30 Question 277

Has the price of saw logs been impacted by demand for fibre for pellets over the past two years?	Response Count
Yes I have witnessed increased competition for saw log roundwood for pellets, but I am not concerned about it	0
Yes I have witnessed increased competition for saw log roundwood for pellets and it affects a small proportion (less than 10%) of my fibre supply	1
Yes I have witnessed increased competition for saw log roundwood for pellets and it affects my fibre supply moderately (affecting more than 10% and less than 40% of my fibre supply)	0
Yes I have witnessed increased competition for saw log roundwood for pellets, and it affects my fibre supply significantly (more than 40% of my fibre supply)	0
No, I am not affected by demand for saw log roundwood for pellets	7
Other (please specify in comments box below)	1
answered question	**9**

Comments from Canada

- "Board manufacturers, cardboard paper plants, dryers, biomass power plants and pellet mills all compete for sawmill residues in Eastern Canada."

[12] Prepared by Karen Lee Abt, Robert C. Abt, Christopher S. Galik, and Kenneth E. Skog.

Comment from USA

- "The sawlog market has been relatively flat the past 2 years. Some pellet mills rely heavily on residuals from sawmills. When the market is down, that means less residuals are available for end users that are using mill residuals."

3.3.1.31 Question 278

Has the price of sawmill residues been impacted by demand for fibre for pellets over the past two years?	Response Count
Yes I have witnessed increased competition for sawmill residues for pellets, but I am not concerned about it	0
Yes I have witnessed increased competition for sawmill residues for pellets and it affects a small proportion (less than 10%) of my fibre supply	0
Yes I have witnessed increased competition for sawmill residues for pellets and it affects my fibre supply moderately (affecting more than 10% and less than 40% of my fibre supply)	3
Yes I have witnessed increased competition for sawmill residues for pellets, and it affects my fibre supply significantly (more than 40% of my fibre supply)	2
No, I am not affected by demand for sawmill residues for pellets	4
Other (please specify in comments box below)	0
answered question	**9**

3.3.1.32 Question 279

What would make you change your business model for fibre procurement or leave the market?	Response Count
Small price increases	0
Large price increases (to 50% higher than current)	6
Very large price increases (Over 50% higher than current prices)	2
Government regulations	1
Increased sustainability requirements	1
Other (please specify)	3
answered question	**9**

3.3.1.33 Question 280

What are the main factors that will influence the price for North American fibre?	Response Count
Stumpage	6
Competing demand for fibre	3
Competing demand for fibre feedstock by pellet sector	2
Agreed indexing in long term contracts	0
Comminution costs	1
Transport costs in North America	5
Sea freight costs	1
Port handling costs	0

Auditing costs for sustainability	0
Labour costs	4
Currency exchange rates	1
Insurance costs	2
Regulation requirements	4
Other (please specify)	4
answered question	**9**

Comments from Canada:

- "Transport costs are largest single cost item and distances getting longer"
- "Labour costs Worker shortages are here now."
- "Logging costs"
- "Stumpage has the potential for big impacts"
- "Regulation requirements wood supplies at risk with new regulations."
- "Supply & demand" or "competing demand for fibre"
- "Currency exchange rates"
- "Sea freight costs can be volatile"

US Comment

- "These factors in combination, not singly"
- "A significant and sustained decrease in housing demand"

3.3.1.34 Question 281 What factors will increase price over next 15 years?

Canadians indicated that almost every part of the supply chain and associated costs (e.g. insurance) was likely to increase. Comments were:

- "Very little in our world goes down in price over time. Fibre costs are important." (2 respondents)
- "Currency exchange rates"

US respondents showed that almost evert part of the supply chain and associated costs was likely to increase. Comments were:

- "Campaigning organizations and public opinion against the forest products industry"

3.3.1.35 Question 282: What factors will decrease prices over next 15 years?

Both US respondents and Canadians did not think any part of the supply chain costs would decrease. A common comment was "Prices will not decrease."

3.4 Additional comments from Canada

- "As a society – we are trying to find ways to reduce GHG emissions and bioenergy is one mitigation actions that is being explored. I may have missed it – but **I did not notice any reference in the survey to the use of the biomass that is used for bioenergy but that could be used for other long-lived products instead.** All our own research is showing that in many cases – we achieve far greater mitigation benefits where we can use the wood for long-lived products that (a) retain the carbon and (b) achieve higher substitution benefits than bioenergy uses. So when we explore policies involving bioenergy uses – in Canada or in the EU – should we not include scenarios in which we explore how else the wood could be used – and what the mitigation benefits of those alternative (non-bioenergy) uses might be?"
- "I've just had some moments into the beginnings of the survey. I have to say that this is an order of magnitude – or more – more complicated that any survey I've ever participated in. I'm sorry to say that I can't proceed to answer the survey questions. The clincher for me was when I encountered the notion of indicating what I consider to be the "most likely" scenarios. I have a strong bias against the notion of "most likely" – my philosophy is that nobody has grounds for

projecting likelihood of scenario outcomes. It becomes mere speculation, guess, or even desire. Even the IPCC backed off putting likelihood onto the climate-change scenarios for the globe."

Additional comment received after webinar:

- "I participated earlier this year in your survey of Canadian stakeholders to evaluate the BEAC for pellets produced here. I have just looked at the CIF webinar of your June 24 preliminary report and am a bit surprised by the preliminary results that you present there. I hope it is not too late to give you some additional information.

  I am … quite familiar with the operational and procurement side of the pellet industry. The industry has been present in Canada for over 30 years and has run almost **exclusively to my knowledge on sawmill residues.** The nature of the residues has varied over time with the original productions using mostly bark and currently using mostly sawdust. **Regional markets differences do occur but the industry is and will be based on residuals for some time until there is significant price increase to pay for the extraction of fibre.**

  To that extent I believe you have failed to notice that one of the significant market developments that has occurred around pellet feed stock is the evolution of the paper industry. **With the decline of this industry over the last decades there has been a very large reduction of pulp wood consumption, a reduction of more than the increase of pellet production or its most realistic forecasts.** The numbers I have obtained from Statistics Canada and the Quebec Ministry of Natural Resources show a decline of pulp chips from 7.5 Million tonnes per year in 2005 to 5.25 Million tonnes in 2014 whilst pellet production levels have increased from 146,000 metric tonne (mt) to 341,000 mt, an important growth but far less than the decline in pulp and paper fibre use. Those numbers are significantly higher both nationally and continental wide but the gap is still there and in fact probably growing.

  I believe the trend will continue and that at several sawmills we will see a shift from producing wood chips for pulp to using it for energy and pellets. In fact I believe that most of the wood baskets that have started to use forest residues to make pellets worldwide, including the US south and Ontario, have in fact seen major reductions in pulp use that has forced these markets to find other venues for the fibre that is/was already extracted for other markets, and pellets has been taking only part of that volume.

  I therefore believe that saying that increasing the production of wood pellets in Canada might reduce carbon stocks is a counterfactual that omits the local market realities and should not be considered as probable in your report. The proper counterfactual for Quebec and most of Canada should be that pellet production increases will be through increased use of sawmill residues, with chips formerly destined to the pulp industry becoming increasingly part of those residues."

3.5 Additional comments from USA

- "Note for Sawmill residues, there are two types - 1) "clean" residues or chips suitable for making paperboard and 2) "dirty" residues or chips (fuelwood) suitable for bioenergy use…. We like others in our industry use major quantities of wood for energy. So not only are pellet manufacturers competing with traditional users of pulpwood for making paperboard, pellet mills are also competing with and using "biomass" material that is traditionally used by the pulp and paper industry for energy that greatly improves the energy efficiency of the industry. The forest products industry is a leader in the production of renewable energy. More than 65 percent of the on-site energy needed to produce paper products is derived from carbon-neutral biomass fuel. Carbon-neutral biomass materials include spent pulping liquors, bark, wood, wood scraps, wood by-products, and process residuals."
- Costs for Biomass *figure redacted temporarily.*
- I wanted to write in response to your request for input from the (our) Society as DECC reassesses its biomass policies. We appreciate your endeavour to elicit input from the US conservation community. There are substantive concerns over the use of woody biomass both from the perspective of carbon accounting and from the perspective of increased pressure to conservation areas of concern to us, both designated Important Bird Areas and other high value forestlands such as bottomland hardwoods. These issues are of concern to us both as climate policy solutions and as landscape management issues.

I have not been able to block out sufficient time to respond to your survey, due to work on a number of clean energy and bird conservation policy issues domestically. However, I do want to indicate that our views of the issues largely track those of other American NGOs who are responding to your survey, especially those of Southern Environmental Law Center and NRDC. We look to the same studies that they are citing in their work and focus on the same concerns. With regard to the carbon issues, you can assume our concerns mirror those expressed by these other organizations and by the scientists who have gone on record expressing concerns about the carbon debt potential in early years of biomass use.

For your consideration, I am forwarding one additional bit of information that shapes our view of the landscape impacts. The attached map overlays the potential sourcing areas of US pellet plants with designated and potential future Important Bird Areas. The sister attachment discussing priority forest mapping provides a high level overview of the conservation focus and methodology used in prioritizing forest areas for our conservation work. These priority forest blocks are now in the process of being reviewed and approved as new IBAs. We recently prepared this overlay map for use in a document for EU policymakers and I am forwarding some of the information that was provided for that endeavour. This does not reflect an additional analysis of bottomland hardwood impacts which we also hope to complete, but nonetheless provides you a good snapshot of potential risk to IBAs and other forest areas of concern. I hope you will be able to consider it as well at DECC (see below and attached). Most land in this part of our nation is in private ownership, rather than public lands, with only voluntary efforts protecting the landscape, if at all. Thus, any intersection of sourcing areas and conservation priority areas is assumed to represent a threat until proven otherwise. Further, certain ecosystem types, such as bottomland hardwoods, have declined and the loss of habitat is believed to be a principal cause of species population declines for a number of bird species of concern.

I regret that I was unable to be responsive in the format you had requested but hope that you will find this input, and that of our US colleagues, helpful to your decision making. Our work indicates that climate change is the single largest threat to the future health of bird populations in our nation, so we are deeply interested in seeing zero carbon resources used more broadly and quickly, and places which can serve as climate strongholds protected and managed well. In that context, I urge DECC to closely scrutinize how sustainable practices will be enforced and verified, and to ensure that the country's policies will lower GHG emissions over the next 20 years.

3.6 References submitted as supporting evidence

Abt, R C.; Abt, K 2014. Chapter 6: Wood energy and competing wood product markers. In: wood energy in developed economies Resource management, economics and policy. Routledge, New York., 2014; pp. 161- 188.

Abt, R C 2014, "Projected Impacts of Enviva Feedstock Demand in Southeastern Virginia and Northeastern North Carolina," May 12, 2014, page 3 and Figure 6.

Abt, K., Abt, R., Galik, C. and Skog, K. 2014. Effect of Policies on Pellet Production and Forests in the U.S. South: A Technical Document Supporting the Forest Service Update of the 2010 RPA Assessment. Gen. Tech. Rep. SRS- 202, Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station http://www.srs.fs.usda.gov/pubs/gtr/gtr_srs202.pdf

Alavalapati, J., Lal, P., Susaeta, A., Abt, R. and Wear, D. 2013. Forest Biomass-Based Energy. In: Wear, David N.; Greis, John G., eds. The Southern Forest Futures Project: Technical Report. Gen. Tech. Rep. SRS-GTR-178 Asheville, NC: USDA-Forest Service, Southern Research Station, pp. 213-260. http://www.srs.fs.fed.us/pubs/gtr/gtr_srs178/gtr_srs178_213.pdf

Allen, H. 2007. The development of pine plantation silvicultural in the southern United States. Journal of Forestry 105: 337-347.
http://www.ingentaconnect.com/content/saf/jof/2007/00000105/00000007/art00005

Audubon Society IBAs: http://netapp.audubon.org/iba http://web4.audubon.org/bird/iba/prioritizedibas.htm

Birdlife International IBAs: http://www.birdlife.org/americas/programmes/important-bird-and-biodiversity-areas-ibas-americas

Brazee, R.J Dwivedi P., Optimal Forest Rotation with Multiple Product Classes RJ Forest Science 61 (3), 458-465

Bullard, S., Allen, J., White, T. and Alavalapati, J. 2014. Letter to Gina McCarthy, Administrator, EPA, transmitting Science Fundamentals of Forest Biomass Carbon Accounting. National Association of University Forest Resources Programs. http://www.naufrp.org/support.asp

Buchholz T and Gunn J "Carbon Emission Estimates for Drax biomass power plants in the UK sourcing from Enviva Pellet Mills in U.S. Southeastern Hardwoods using the BEAC model," report prepared for the Southern Environmental Law Center, May 27, 2015 (https://www.southernenvironment.org/uploads/audio/2015-05-27_BEAC_calculations_SE_hardwoods.pdf

Butler, B.,Tyrrell, M., Feinberg, G., Van Manen, S., Wiseman, L. and Wallinger, S. "Understanding and Reaching Family Forest Owners: Lessons from Social Marketing Research." Journal of Forestry October/November 2007. pp. 348-357. http://dx.doi.org/10.5849/jof.14-009

Carter, J. 2013. Export Wood Pellet Facilities' Raw Material Delivered Cost Trends - US South. F2M Market Watch, August 16. http://www.forest2market.com/blog/exportwood-pellet-facilities-raw-material-delivered-costtrends

Clutter, F., Abt ,R., Greene, W., Siry, J. and Mei, R. 2010. A Developing Bioenergy Market and Its Implications on Forests and Forest Products Markets in the United States. http://nafoalliance.org/images/issues/carbon/resources/A-Developing-Bioenergy-Market-and-Its-Implications-on-Forests-and-Forest-Products-Markets-in-the-US-4-2010-Clutter-et-al.pdf

Mail on Sunday (2015) http://www.dailymail.co.uk/news/article-3113908/How-world-s-biggest-green-powerplant-actually-INCREASING-greenhouse-gasemissions-Britain-s-energy-bill.html

Daigenault, A, Sohngen, B. and Sedjo, R. 2012. Economic Approach to Assess the Forest Carbon Implications of Biomass Energy. Environmental Science and Technology 46: 5664-5671. http://www.researchgate.net/publication/224768383_Economic_Approach_to_Assess_the_Forest_Carbon_Implications_of_Biomass_Energy

Dogwood Alliance. June 11, 2015. http://www.dogwoodalliance.org/2015/06/uncovering-the-truth-investigating-thedestruction-of-precious-wetland-forests/ and http://www.dogwoodalliance.org/wpcontent/uploads/2015/06/05-13-15-InvestigationFlyer.pdf

Enviva (2015) Field Observations: See “Enviva Data for Trader EUTR Compliance, Version 3, February 2015”

EPA. 2007. Biomass Resources. In: Biomass Combined Heat and Power Catalog of Technologies, pp. 11-20. U. S. Environmental Protection Agency Combined Heat and Power Partnership. http://www.epa.gov/chp/documents/biomass_chp_catalog_part3.pdf

Evans, J.M., R.J. Fletcher, Jr., J.R.R. Alavalapati, A.L. Smith, D. Geller, P. Lal, D. Vasudev, M. Acevedo, J. Calabria, and T. Upadhyay. 2013. Forestry Bioenergy in the Southeast United States: Implications for Wildlife Habitat and Biodiversity. National Wildlife Federation, Merrifield, VA, EX. Summary 6-7 and text at pp 45-73
https://www.southernenvironment.org/uploads/pages/file/biomass/nwf_exec_summary.pdf
http://www.nwf.org/pdf/Conservation/NWF_Biomass_Biodiversity_Final.pdf

Extension.org. 2014. Cost Factors in Harvesting and Transporting Woody Biomass. http://www.extension.org/pages/70339/costfactors-in-harvesting-and-transporting-woodybiomass#.VV3-y8vbL3i

Forest2 market (2015) Stumpage Price Database

Forest2Market analysis of data describing forest inventory from the Forest Inventory and Analysis (USFS) inventory data

Forest2Market’s Delivered Price database, which includes scale ticket information on eight million truckloads of delivered timber in the South USA annually. http://www.forest2market.com/products/forest2mill/delivered-price-benchmark-us-south

Forisk Consulting. 2014. How Wood Demand from Bioenergy Affects Forecasted Pulpwood Prices in the South. September/October Newsletter. http://forisk.com/product/wood-demandbioenergy-affects-forecasted-pulpwood-pricessouth/

Fox, T., Jokela, E., Allen, H. 2007. The development of pine plantation silviculture in the southern United States. Journal of Forestry 105: 337-347. http://www.ingentaconnect.com/content/saf/jof/2007/00000105/00000007/art00005

Galik, C., Abt, R. and Wu, Y. 2009. Forest Biomass Supply in the Southeastern United States – Implications for Industrial Roundwood and Bioenergy Production. Journal of Forestry 107(2): 69-77. http://research.cnr.ncsu.edu/sofac/Galik_Abt_JoF.pdf

Galik, C. and Abt, R. 2015. Sustainability Guidelines and Forest Market Response: An Assessment of European Union Pellet Demand in the Southeastern United States. GCB Bioenergy, May. http://onlinelibrary.wiley.com/doi/10.1111/gcbb.12273/full .

Gan, J. and C. Mayfield. 2007. The Economics of Forest Biomass Production and Use. In: Hubbard, W.; L. Biles; C. Mayfield; S. Ashton (Eds.). 2007. Sustainable Forestry for Bioenergy and Bio-based Products

Gan, J. and Smith, C. 2006. Availability of Logging Residues and Potential for Electricity Production and Carbon Displacement in the USA. Biomass and Bioenergy 30(12): 1011-1020. http://www.sciencedirect.com/science/article/pii/S0961953406001322

Ince, Peter J.; Kramp, Andrew D.; Skog, Kenneth E.; Yoo, Do-il; Sample, V. Alaric 2011. Modeling future U.S. forest sector market and trade impacts of expansion in wood energy consumption. Journal of Forest Economics 17(2): 142-156. Skog, Kenneth E.

Iriarte, L. and Fritsche, U. 2014. Impact of Promotion Mechanisms for Advanced and Low iLUC Biofuels on Markets. IEA Bioenergy, Task 40: Sustainable International Bioenergy Trade. http://www.bioenergytrade.org/downloads/t40-low-iluc-pellet-august-2014.pdf

Joshi, O., Grebner, D., Munn I., Hussain A. and Gruchy, S. 2013. Understanding Landowner Preferences for Woody Biomass Harvesting: A Choice- Experiment Based Approach. Forest Science 59(3): 549-558. http://www.ingentaconnect.com/content/saf/fs/2013/00000059/00000005/art00005

Joshi, O., Grebner, D., Hendersen, J. and Gruchy, S. 2015. Landowners, Bioenergy, and Extension Strategies. Extension Journal 53(2): Feature 2FEA3. http://www.joe.org/joe/2015april/a3.php

Joshi, O. and Mehmood, S. 2011. Segmenting Southern Non-Industrial Private Forest Landowners on the Basis of their Management Objectives and Motivations for Wood-Based Bioenergy. Southern Journal of Applied Forestry 35(2): 87-92. http://www.ingentaconnect.com/content/saf/sjaf/2011/00000035/00000002/art0000

Kinney, S. 2014. Demand for Pulpwood in the U.S. South: Historical and Future. F2M Market Watch http://www.forest2market.com/blog/demand-forpulpwood-historical-and-future

Kittler, J. 2013. Forest Bioenergy and Biodiversity: Commitment to Sustainable Sourcing. Pinchot Institute for Conservation. http://www.pinchot.org/doc/510

Lang, A. 2014. Reconciling US Pine Pulpwood Forecasts with Projected UK Wood Pellet Demand. Forisk Consulting. http://www.forisk.com/blog/2014/05/10/reconciling-us-pine-pulpwood-forecasts-projected-uk-woodpellet-demand/

Lang, A., Mendell, B., Garrett, D. and Clark, H. 2015. How Can Global Demand for Wood Pellets Affect Local Timber Markets in the U.S. South? Forisk Research Quarterly (2nd Qtr). http://www.forisk.com/blog/2015/06/02/how-canglobal-demand-for-wood-pellets-affect-localtimber-markets-in-the-u-s-south/

Love, J. 2011. An Analysis of the Feasibility of Forest Biomass Production from Pine Plantations in Georgia. Georgia Forestry Commission. http://www.gfc.state.ga.us/utilization/economicimpacts/AnalysisoftheFeasibilityofForestBiomassProductionApr2011.pdf

Mendell, B., Hamsley, A. and Sydor, T. 2011. Woody Biomass as a Forest Product: Wood Supply and Market Implications. National Alliance of Forest Owners/Forisk Consulting. http://www.forisk.com/wordpress//wpcontent/assets/NAFO-US-Wood-Markets-Report-102411.pdf

Mendall, B. and Lang, A. 2013. Update and Context for U.S. Wood Bioenergy Markets. National Alliance of Forest Owners/Forisk Consulting. http://nafoalliance.org/images/issues/carbon/resources/Update-and-Context-for-US-Bioenergy

Mendall, B. and Lang, A. 2014. Wood Bioenergy Markets and Forestland Owner Decisions: 2010 – 2013. National Alliance of Forest Owners/Forisk Consulting. http://nafoalliance.org/images/issues/carbon/resources/Forisk-Wood-Bioenergy-Markets-and-Forestland-Owner-Decisions-2010-2013-1-2014.pdf

Mendell, B., Lang, A. and Sydor, T. 2011. Woody Biomass as a Forest Product: Wood Supply and Market Implications. National Alliance of Forest Owners/Forisk Consulting. http://www.forisk.com/wordpress//wpcontent/assets/NAFO-US-Wood-Markets-Report-102411.pdf

Mendell, B., Lang, A. and Sydor, T. and Freeman, S. 2010. Availability and Sustainability of Wood Resources for Energy Generation in the United States. American Forest & Paper Association/Forisk Consulting. http://nafoalliance.org/images/issues/carbon/resources/forisk-forest-resource-study-july-2010.pdf

Miner, R., Abt, R., Bowyer, J., Buford, M., Malmsheimer, R., O'Laughlin, J., Oneil, E., Sedjo, R. and Skog, K. 2014. Forest Carbon Accounting Considerations in US Bioenergy Policy. Journal of Forestry 112(6):591-606. http://www.safnet.org/documents2014/ForestCarbonAccountingConsiderations_nov2014.pdf

Munsell, J. and Fox, T. 2010. An analysis of the feasibility for increasing woody biomass production from pine plantations in the southern United States. Biomass & Bioenergy 34: 1631- 1642. http://www.sciencedirect.com/science/article/pii/S0961953410001868

NCASI 2010 Current and Potential Capabilities of Wood Production Systems in the Southeastern U.S. Results have been published in a special issue of Biomass and Bioenergy (Vol. 34, Issue 12, December 2010). http://www.ncasi.org/News/Forestry- Environmental-Program-News/22-08/Woodproduction-systems-in-the-U-S--South.aspx

NRDC 2015 Wood Pellet Feedstock Investigation in Ahoskie, North Carolina: December, 2014 http://www.nrdc.org/energy/forestsnotfuel/

NRDC 2015a "Think Wood Pellets are Green? Think Again," May 2015 http://www.nrdc.org/land/files/bioenergy-modelling-IB.pdf

Paula, A., Bailey C., Barlow R. and Morse, W. 2011. Landowner Willingness to Supply for Biofuel: Results of an Alabama Survey of Family Forest Landowners. Southern Journal of Applied Forestry 35(2): 93-97. (http://www.ingentaconnect.com/content/saf/sjaf/2011/00000035/00000002/art00007)

RISI. 2014. Biomass Focus. North American Woodfiber & Biomass Markets. January. http://www.risiinfo.com/Marketing/Indices/NAWBM_sample.pdf

Sedjo, R. and Tian, X. 2012. Does Wood Bioenergy Increase Carbon Stocks in Forests? Journal of Forestry 110: 304-311. http://www.watreefarm.org/JFor110-6-304.pdf

Skog, K. E.; Abt, R. C.; Abt, K. 2014. Chapter 6: Wood energy and competing wood product markers. 1) In: wood energy in developed economies Resource management, economics and policy. Routledge, New York., 2014; pp. 161-188

Southern Environmental Law Center Memo to UK and EU Policy Makers, June 2, 2015, RE: "New Study Shows Drax/Enviva Reliance on Southeast U.S. Hardwoods for Pellets Will Result in Greater Carbon Emissions Than Continued Reliance on Coal, both at https://www.southernenvironment.org/uploads/audio/2015_06_02_Cover_letter_to_UK_EU_Re_SIG_report.pdf

Stephenson and MacKay 2014, p79 : Current and Potential Capabilities of Wood Production Systems in the Southeastern U.S. Results have been published in a special issue of Biomass and Bioenergy (Vol. 34, Issue 12, December 2010). http://www.ncasi.org/News/Forestry-Environmental-Program-News/22-08/Woodproduction-systems-in-the-U-S--South.aspx

Stuber, D. 2014. Stumpage Market Trends in the U.S. South: Timber Prices. Forest2Market http://blog.forest2market.com/stumpage-markettrends-us-south-timber-prices

Trainers Curriculum Notebook, pp. 213-216. Athens, GA: Southern Forest Research Partnership, Inc. http://www.forestbioenergy.net/trainingmaterials/fact-sheets/module-6-fact-sheets/factsheet-6-2-the-economics-of-forest-biomassproduction-and-use/

USDA. June 24, 2015. National Woodland Owner Survey. http://www.fia.fs.fed.us/nwos/results/

USDA U.S. timber outlook of recent economic recession, collapse in housing construction, and wood energy trends. Gen. Tech. Rept. FPL-GTR-219. Madison, WI: U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. 18 p.

U. S. Environmental Protection Agency Combined Heat and Power Partnership. http://www.epa.gov/chp/documents/biomass_chp_catalog_part3.pdf

USFS Data on forest inventory publically available from the US Forest Service's Forest Inventory and Analysis (FIA).

United States Securities and Exchange Commission, Form S-1 Registration Statement, Enviva Partners, LP (October 27, 2014) ("Enviva IPO"). The Enviva Partners, LP filing with the US Securities and Exchange Commission can be accessed at http://www.sec.gov/Archives/edgar/data/1592057/000119312514383777/d808391ds1.htm

Wear D.N. and Greis J. G. 2013 "The Southern Forest Futures Project: Technical Report" Chapters 5 and 10. http://www.srs.fs.fed.us/pubs/gtr/gtr_srs178.pdf

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