Ricardo Energy & Environment

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

Executive Summary

Report for DECC
943/12/2014

Customer:

DECC

Customer reference:

943/12/2014

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Date:

27 April 2016

Ricardo-AEA reference:

Ref: ED60674- Issue Number 2

Executive summary

The objectives of the work

Large scale biomass electricity generation plants in the UK import wood pellets from around the world but particularly from North America. The UK Department of Energy and Climate Change (DECC) commissioned a study in 2014 to assess the potential impact of these imports on carbon emissions, which resulted in the development of the Biomass Emissions and Counterfactual (BEAC) model[1]. Stephenson and Mackay (2014) used the BEAC model to estimate the additional carbon impact of UK demand for pellets from North America, using a series of paired scenarios-and-counterfactuals from the model. Each scenario compares the carbon emissions from the supply and use of pellets to a counterfactual designed to represent what could have happened in the absence of UK pellet demand in forests in North America. Stephenson and Mackay (2014) identified a series of low carbon scenarios, which could supply the potential UK bioenergy electricity demand. It also, however, identified a number of potential scenarios that could result in high carbon emissions. The BEAC model does not indicate the likelihood of any of the scenarios.

In 2015 DECC commissioned Ricardo Energy & Environment to assess the likelihood of the high carbon scenarios identified in the BEAC modelling occurring in North America to meet demand for biomass in UK electricity generation between now and 2030. Specifically, the study aimed to:

- Develop an evidence base of qualitative and quantitative evidence on the likelihood of the selected BEAC biomass source scenarios associated with the highest greenhouse gas emissions.
- Analyse these data to provide DECC with a qualitative and quantitative assessment of the likelihood of each relevant scenario.
- Provide an assessment of the strength of the data/uncertainty associated with the results of the analysis.

Stephenson and Mackay (2014) identified 28 potential scenarios that could be associated with high net greenhouse gas (GHG) emissions (in comparison with coal or gas fired electricity generation) as a result of demand for pellets from the UK biomass electricity sector up to 2030. One scenario 22a, although low carbon, was also considered as it forms a pair with a scenario, 22b, that is high carbon. Eleven additional carbon scenarios that were not considered in Stephenson and Mackay (2014) but which were identified in the BEAC model as possibly having a high GHG intensity were also included in this study (total number 40) in order to understand if these scenarios might also be likely in the North American pellet supply chain.

Methodology

The likelihood that the high GHG emissions scenarios happen is determined not only by supply and demand, but also by a complex interplay of other factors influencing the North American forestry sector. The response of the forestry sector to demand for pellets is not straightforward but may depend on a number of drivers/constraints such as:

- the willingness and ability of the forest land managers to react to demand for fibre for pellets
- the impact of changes in demand for other forestry products (e.g. saw timber and panel board products)
- the location of the forest relative to pellet mills, a low carbon transport network and alternative forest product markets
- the general economic situation (including the value of land for alternative uses)
- the availability of equipment for harvesting and comminution
- regional and national regulations and

[1] https://www.gov.uk/government/publications/life-cycle-impacts-of-biomass-electricity-in-2020

- the personal objectives of private landowners, particularly in the Southeast USA where private owned forest is a high proportion of the wood resource.

In this study we used a number of sources to uncover evidence on both likelihood that a scenario could occur and any factors that would result in the scenario or constrain it. This evidence was provided by stakeholders in North America and the UK through responses to a questionnaire on the scenarios, by a literature review examining the factors that influence forestry in North America and by economic modelling of supply responses to pellet demand in Southeast USA:

- The questionnaire for stakeholders asked questions about the context of their understanding of pellet supply; about their opinion of how likely the scenarios are and how widespread they might be; and about factors that drive or constrain fibre supply for pellets.
- The literature review examined information on factors that might result in or constrain pellet supply in Canada and Southeast USA (including demand for other forest products; forestry practice, ownership, regulation and policy; economics/financial return; and reported pellet supply strategies).
- The modelling was done using a forest sector model developed to model forest resource in Southeast USA; the US Southeast Sub-Regional Timber Supply model (SRTS). This model is a recursive dynamic model. This means that it simulates forestry and bioenergy decisions by allocating resources across owners and sub-regions to clear the market for the current time period and then updates resource and market conditions between periods as it moves through time. Market simulations from a recursive dynamic model should be viewed as a likely market response to a policy and market shock based on current price effects.

In each of these activities we sought information not only on whether the high carbon scenarios are likely, but also on what factors are likely to influence the supply response to pellet demand. This enabled us to understand what the major drivers or constraints would be for each scenario. The evidence from these three sources was brought together in an analysis tool that considered firstly the evidence from the questionnaire of stakeholders and then added the evidence from the literature and SRTS modelling to provide an overall likelihood ranking for each scenario. The results are reported in depth in a Technical Report available with the analysis tool on the DECC web site.

Stakeholders approached

The number of people qualified with the broad range of experience and expertise required to understand the likelihood of the pellet supply scenarios is relatively small. Our project partners, Applied GeoSolutions (USA), Professor Robert Abt of North Carolina State University and Professor Tat Smith of University of Toronto identified the stakeholders for the questionnaire using their considerable knowledge of the forestry sector in their countries. This resulted in identification of 156 key stakeholders. Of these, 56 responded to the questionnaire (36%). These respondents represented the full range of the stakeholder groups in the North American pellet supply chain in the USA and most of the range in Canada (Canadian NGOs declined to participate).

The majority of people who responded to the survey had considerable experience: either they or their organisations had at least 5 years' experience in the field. These stakeholders included organisations involved in or representing the interests of forestry ownership and management; pellet production; pellet users; non-bioenergy wood users; government regulation (including Provincial level experts in Canada); senior academics; and NGOs (including trade associations and conservation organisations). Two types of stakeholders were represented by a relatively small number of respondents: non-bioenergy fibre users and environmental NGOs[2].

[2] There were only two organisations that were purely involved in non-bioenergy products, although six of the forestry sector organisations produced large quantities of non-bioenergy products. There were four NGOs.

High carbon scenarios that the study found were the most likely

Of the 40 scenarios considered in this study, the respondents to the questionnaire considered 5 were considered likely or moderately likely (now or in the future). Four of these five are high carbon scenarios. These are given below along with their expected scale:

- *4a[3] Coarse forest residues, removed from forests in Southeast USA, continuously over the time horizon*. The scenario was considered moderately likely now and more likely in the future. This scenario could be common in the vicinity of pellet mills.
- *5a Fine forest residues, removed from forests in Southeast USA, continuously over the time horizon*. The scenario was considered moderately likely, but at low scale (i.e. that this will not happen very often or be relevant to a large part of the supply chain).
- It is worth noting that the majority of respondents commented that it is unlikely that coarse and fine residues would be extracted separately in both USA and Canada, as it is expensive to separate them.
- *14a Additional wood from intensively-managed pine plantation, in Southeast USA with harvesting every 25 years, against a counterfactual in the absence of pellet demand of a frequency of harvest at every 35 years, given the current low demand for saw timber*. The scenario was considered to be likely now by respondents, but there was no consensus or it was thought to be unlikely in the future. If the scenario happened it would not be widespread. Comments on this scenario qualified the responses received. The main issue was that intensively managed pine plantations would not be managed on a 35 year rotation as described in the counterfactual (trends in the US Southeast are for shorter rather than longer rotations, so the counterfactual is unrealistic. Additionally the financial return drops off significantly with longer rotation length). However, respondents thought that there is a possibility that additional harvest from plantations would be used in pellet production, for example, additional fibre could be taken from intensively managed plantations through changes to thinning regimes rather than rotation length though this was not a scenario in the earlier BEAC model. This would most probably happen through planting at higher density and introducing additional thinning early in the plantation growth.
- *30a Additional wood from the conversion of unmanaged forest into production in Southeast USA, against a counterfactual of the forest remaining unmanaged*. The scenario was considered likely now but there was no consensus in future, and it was thought that the practice would happen only at moderate scale, near to pellet mills. The definition used for unmanaged forest in our study was the UN Food and Agriculture Organisation (FAO) definition of unmanaged forest as 'forest without a management plan'. The vast majority of forest land in Southeast USA is 'managed' in that it is under the influence of human management for a land management objective, whether or not that objective includes harvest or not (Oswalt et al. 2014). A large proportion of naturally regenerated timberland is privately owned by families and very little of this comes under a management plan. These forest owners bring their timberland back into management at harvest and it was this situation that respondents thought could occur if the price for pellet fibre was sufficiently high enough. On the other hand our study found that it is extremely unlikely that land set aside for conservation would be brought into timber production, because many of these lands are legally protected from harvest. Respondents asked for a clearer definition of 'unmanaged' and said that family owned timberland could be regarded as 'under managed' rather than unmanaged.

The fifth scenario considered likely or moderately likely is scenario 22a, which has a negative GHG intensity over 40 years.

[3] The scenario numbers are those used in the BEAC report (Stephenson and Mackay 2014).

- *22a Additional wood from the conversion of a naturally-regenerated coniferous forest in Southeast USA that is harvested every 50 years, to an intensively-managed pine plantation that is harvested every 25 years, against a counterfactual of continued harvesting every 50 years, and leaving to regenerate naturally*. The scenario was considered likely but it would not be widespread. It was also identified as a potential pellet fibre supply scenario in the SRTS modelling. This scenario was included in the study as one half of a pair of scenarios, the other being 22b, which has a GHG intensity greater than 200 kg CO2e/MWh over 40 years and where the harvest rotation is only 20 years. Scenario 22b was considered by respondents to be unrealistic for softwood raw timber use[4].

All other scenarios were considered unlikely or no consensus could be reached and it was agreed that they would not be very widespread. A large number of the respondents commented on some of the terminology used in the Stephenson and Mackay (2014), which they found ambiguous and said made interpretation of the likelihood of the scenarios difficult. Further detail on these scenarios is provided in this report, where we have also drawn attention to the terminology referred to above.

Key messages

In addition to the results for likelihood presented above, the key findings from the analysis of the scenarios are:

- The most likely sourcing strategies for fibre for pellets in Southeast USA are sawmill and pulpmill residues, forest residues (depending on their definition, as noted above), increased harvest of thinnings from plantations and additional roundwood used for fibre for pellets in USA (e.g. by increased harvest of pulpwood and diversion from other non-bioenergy supply). Increased harvest of thinnings from plantations is not considered in BEAC; and diversion from other non-bioenergy supply was only considered with indirect impacts outside of USA in our study, but the respondents to the questionnaire thought that this displacement would most likely be within the Southeast USA region. The use of residues is examined, but the wide differences in definition of residues needs to be considered.
- Responses to the questionnaire and results from the literature review in Canada indicated that for the foreseeable future pellet fibre supply will be derived from a combination of primary and secondary manufacturing co-products (e.g. sawdust) and possibly harvest of standing unutilized Annual Allowable Cut (AAC) at the same time as harvest for other more valuable forest products. Any forest derived supply strategy must be considered within the AAC as stated in Provincially approved management plans and within Provincial forest policy in Canada. Examination of the impact of pellet demand on the proportion of AAC utilized has not been quantified to date, and would be necessary to further quantify how pellet demand affects harvest for that assortment in addition to more valuable forest products.
- There was no consensus on 20 of the high carbon scenarios in Stephenson and Mackay (2014). The reason for the no consensus result was due to two issues: (i) important differences in how respondents interpreted the scenarios or (ii) the number of 'I don't know' responses that influenced the results. An example of (i) is the scenarios for the conversion of naturally regenerated forest to intensive pine plantations in Southeast USA, where there was no overall consensus on the likelihood of these scenarios in the future, even where (in the case of 22a) respondents said it sometimes happens now. With regards to (ii), our analysis assigned no consensus to scenarios where there were a high proportion of 'I don't know'

[4] From Stephenson and Mackay (2014): "owing to the increased growth rate, an intensively-managed Loblolly plantation that is harvested every 20 years, has a similar non-soil carbon stock to a naturally-regenerated Loblolly forest that is harvested every 50 years (Scenario 22b), whereas an intensively-managed Loblolly plantation that is harvested every 25 years, has a greater non-soil carbon stock than a naturally-regenerated Loblolly forest that is harvested every 50 years (Scenario 22a)."

answers (e.g. 6 out of 15 responses were 'I don't know'). One set of scenarios where 'I don't know' responses were important was Scenarios 19-21. These examined the displacement of pulpwood for pellet use, causing indirect impacts in land use change elsewhere. The most common response to these scenarios is that they are very unlikely, but the number of 'I don't know' responses has resulted in no consensus overall. For all of the no consensus scenarios if they were to occur it was thought that they would only occur at a very low level (i.e. they would not be a common strategy for pellet fibre supply).

- The remaining 15 high carbon scenarios with their counterfactuals identified in Stephenson and Mackay (2014) were not thought to be a realistic representation of forestry practice in North America by the forestry sector and therefore not representative of how increased pellet fibre would be sourced.
- With the exception of scenario 22a (explained earlier), the low carbon scenarios in BEAC were not tested in this study, but respondents to the survey and sources in the literature asserted that these represent the more likely sources of fibre for pellets.

Factors influencing fibre supply include:

- Those factors that influence fibre supply for pellets within a 50 mile radius of a pellet mill and close to transport hubs for Europe are the most important. These include drivers such as Government support for bioenergy; costs such as harvest costs, labour costs etc.; and constraints such as sustainability requirements. Each of these influence the financial return from pellet fibre and therefore the supply strategies that are feasible. The financial return from the main forest product, saw timber, is important in determining strategies for pellet supply. The recent recession has decreased demand for saw timber, which in turn has decreased the availability of sawmill co-product. Demand for small roundwood has not been affected by this recession to the same extent. This has resulted in increased demand for pulpwood from small roundwood, while at the same time decreasing availability of sawmill co-products and higher prices for pulpwood have been experienced in some regions. The impacts of this situation is discussed in detail in Chapter 6 of the report. However, the financial return from pellets *alone* is not sufficient to drive harvests either in Canada or Southeast USA. Strategies for fibre supply for pellets are thus likely to be integrated with general forest management and harvest for other forest products and will change as the overall economic situation develops (particularly changes in demand in the construction sector).
- Fibre price is the most significant cost in pellet production and this is a function of a number of variables:
    - The source of fibre for pellets (i.e. co-product versus small round wood)
    - The location of the fibre relative to the pellet mills. Location influences a number of other variables (such as transport costs, price of fibre etc.), so it is not possible to extrapolate from one region to another.
- Pellet fibre availability is a function of saw mill residue and small roundwood availability. In our questionnaire some respondents said that pellet production impacts the market of other wood products that rely on these feedstocks, but only moderately and a number of respondents said there was no impact. This is likely to be location dependent and responses may be influenced by location of the respondent and their own personal experience. Forest2 Markets (2015) recently examined this situation and found that "it is likely that price for pine pulpwood would have increased without incremental demand from pellets, especially when other factors such as supply restrictions and weather are taken into account".
- The price that buyers are able to pay for the pellets will influence the supply strategy. In this study pellet producers identified that they could not afford a 20-30 per cent sustained increase

in price of fibre over a period of months without having to reconsider their business model. This is supported by independent analysis (e.g. Pöyry 2014).

Important messages on the interpretation of BEAC are:

- The study exposed issues with the interpretation of some BEAC scenarios:
    - The BEAC analysis in Stephenson and Mackay (2014) does not explicitly consider the impact of economics, rather it models the greenhouse gas impacts of scenarios informed by a literature review and stakeholder engagement. BEAC scenarios contain implicit economic assumptions by changing rotation length or converting land to plantations. Our work has shown that financial return (i.e. economics) is important in determining whether or not the scenario happens. Respondents to the questionnaire frequently commented that it might be possible for a scenario to occur in theory, but it would be unlikely in practice because it does not make economic sense based on the returns that pellets provide, their limited market compared to other forest products and the potentially limited period that demand for fibre for pellet production is expected to last. The use of changes in rotation as envisaged by Stephenson and Mackay (2014) was generally considered uneconomic by our survey respondents.
    - The counterfactuals for a number of scenarios are difficult to prove. For example, scenarios 10-13 where changes in rotation age for naturally regenerated forests were suggested. Respondents said it is not possible to know how a forest would be managed in the absence of pellet demand. They also said it is not correct to assume that the forest would be harvested on a longer or shorter rotation. Faced with a better financial return from converting the land in some other way land owners in the USA may opt for different choices, which could also be valid counterfactuals.
    - In Canada forestry laws and regulations have been negotiated over more than two decades and are designed with the intention of ensuring sustainable forest management. This continuing process provides the back drop to pellet supply strategies. Permitted harvest is determined as a balance of a number of objectives including economic return and social and environment objectives. Considerable time and resources are used to draw up agreed management plans. Canadian respondents to the questionnaire found some of the scenarios in BEAC difficult as they are contrary to the Canadian forest management process.
    - Definitions are important and should not be open to interpretation, but we found respondents were defining some terms differently, particularly those for forest residues, managed/unmanaged land and ‘additional wood’.

In addition to the above our study also uncovered the following factors that influence of pellet impact:

- The small size of pellet markets both by volume and value compared to other forest product markets. These other markets give higher value or financial return than pellet markets and tend to dominate decisions about harvest and replanting/regeneration of forests. Pellet demand alone is therefore unlikely to drive forest stand rotation length or harvest choices. This was supported in all three evidence sources in this work.
- Much of the carbon and ecological impact of market demands on North American forests can be controlled through sufficient and appropriate approaches to and regulation of forest management.

The SRTS modelling included limitations as follows:

- The SRTS modelling runs included (of necessity) certain limitations and assumptions; e.g. the region studied, assumptions about pellet demand and assumptions related to recovery of the housing market etc. Restrictions on the modelled geographic area did not allow displacement of fibre supply to other neighbouring regions in the USA ('leakage'). This resulted in a higher price for fibre than would have happened if leakage had been allowed. This is discussed in detail in Chapter 6 of the report.
- SRTS modelling also examined carbon impacts on a different basis to BEAC. In the SRTS modelling increased pellet demand was shown to have no impact on the overall negative carbon levels in the standing stock (it may even increase due to increased planting). However, it could lead to a switch from slower-growing naturally regenerating forests to faster growing pine plantations. This may cause other issues, including possible impacts on biodiversity, water quality and landscape which it was beyond the study remit to examine. Further discussion of the modelling of carbon in SRTS is provided in Section 6.4 of the report.

References

Forest2Market, 2015. Wood supply Market Trends in the US South 1995 – 2015. Prepared for the National Alliance of Forest Owners, US Endowment for Forestry and Communities and the US Industrial Pellet Association.

Oswalt, S., W. Smith, P. Miles, and S. Pugh, 2014. Forest Resources of the United States, 2012: A Technical Document Supporting the Forest Service Update of the 2010 RPA Assessment. General Technical Report GTR-WO-91. US Department of Agriculture, Forest Service, Washington, DC.

Pöyry, 2014. The risk of indirect wood use change. Report for Energie Nederland

Stephenson A L and Mackay D J C, 2014. Scenarios for assessing the greenhouse gas impacts and energy input requirements of using North American woody biomass for electricity generation in the UK. Available from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/349024/BEAC_Report_290814.pdf

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