Scottish Government Draft Budget 2016-17

Written submission to the Infrastructure and Capital investment Committee

Jan Bebbington and Matthew Brander (Universities of St Andrews and Edinburgh, respectively) on consequentialist lifecycle accounting for low carbon infrastructure: a briefing note

Introduction

Carbon accounting is an important part of evaluating any pro-climate change investment, including those aimed at developing low carbon infrastructure. This briefing note introduces a less well known form of carbon accounting (consequentialist life cycle assessment – CLCA, hereafter) to further discussion of infrastructure investment. The data presented in this paper draws from a Scottish Funding Council sponsored study which explores the carbon accounting implications of the University of St Andrews investment in a bioheat plant in Guardbridge. Further details of this project can be obtained from Jan Bebbington.

Consequentialist life cycle carbon assessment

The key characteristic of CLCA is that it seeks to understand the broadest array of possible impacts from a decision and refers to these knock on effects as being 'marginal' changes (that is, changes at the margin of the whole system, given a decision point). For example, if organisation A uses locally produced biomass, this may mean that an existing/alternative user of that biomass has to use a new source of biomass (or use an alternative product altogether). The new source of biomass/product that has to be sought is the marginal system, and its associated emissions are those arising from organisation A's decision to use biomass. The links, however, between organisation A's choices and the change in the marginal system might be far removed from each other. Likewise, it is not possible to say exactly which marginal system change will be experienced. Rather, a range of possible effects can be identified for consideration (termed scenarios). How to prepare A CLCA can be found in Ekvall and Weidema (2004), and Weidema et al (2009), with the general structure for the CLCA taken from the International Reference Life Cycle Data System Handbook (European Commission et al. 2010), see also Plevin et al. 2014.

Application of CLCA to a bioheat plant

Seven scenarios (along with a variety of sub-scenarios) were modelled in the University of St Andrews study, and are summarised here (with the details for a sample of these expanded upon so you can see the principles of CLCA):

1. *Overseas production* where increase in demand for wood chips increases the production at the world marginal supplier of biomass. Given that supply of woodchips in the UK is constrained, the marginal supply is overseas production. Two sub-scenarios were included: 1.1 – where the harvested forest is replanted and 1.2 where the harvested forest is not replanted.

2. *Local production of biofuel* where increase in demand for wood chips is met from local wood resources that would otherwise not be harvested/utilised (e.g. harvesting of shelter belts, small farm woodlands, wooded steep-sided gullies supply the biomass).

3. *Thinnings* are used for bioheat plan and this increase in demand for wood chips makes increased thinning of existing productive forestry economically viable.

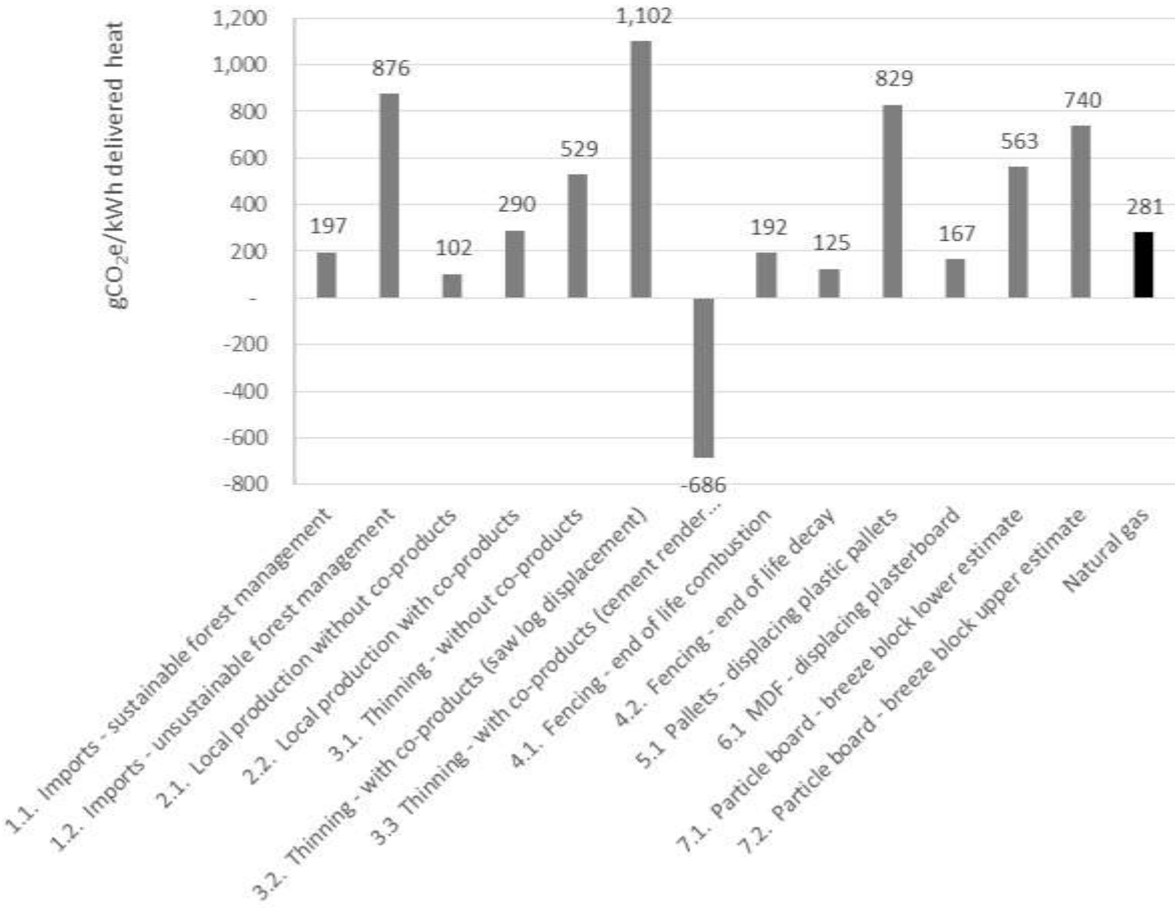
4. *Fencing* impact arise as the increase in demand for wood chips displaces the use of wood for fence posts and increases the production of concrete posts.

5. *Pallets* impact arise as the increase in demand for wood chips displaces the use of wood for pallets.

6. *MDF* impacts arise as the increase in demand for wood chips increases biomass market demand for wood fibre and reduces production of medium density fibreboard (MDF), and increases the production of plasterboard.

7. *Particle board* impacts arise as the increase in demand for wood chips increases biomass market demand for wood fibre and reduces the production of particleboard, and increases the production of breeze blocks.

The selection of scenarios was informed by a number of principles and heuristics from the consequential LCA guidance (Ekvall & Weidema 2004; Weidema et al. 2009). The resulting calculations (which are subject to numerous assumptions and caveats) mean that at the level of the marginal system the life cycle impact of creating additional bioheat capacity might increase or decrease carbon emissions against the baseline of (in this instance) using gas to supply the heat load that is currently required by the University of St Andrews. The Figure below presents the results from the consequential LCA, which, by convention within the field of LCA, are expressed in gCO_2e per functional unit, i.e. gCO_2e/kWh of delivered heat. There is a very wide variation in the results, depending on the scenario modelled. All the scenarios with emissions lower than 281 gCO_2e/kWh (the natural gas reference case) suggest that the bioheat plant will reduce emissions, and all the scenarios with emissions higher than the reference case indicate the bioheat plant will increase emissions.



To clarify what this data implies we run through scenario 1. Under this scenario, if the eventual (ie marginal) effect of diverting biomass to a new bioheat plant is that imports of woodchip increase (and if that woodchip comes from sustainably managed forests) then there is an overall decrease in emissions from the whole system. If, however, the imported woodchips come from unsustainable forestry then the overall effect is an increase of emissions.

Implications of the work

The purpose of presenting a high level summary of this work to the committee (a full report on the project will be available early in 2016) is to highlight several implications:

First, the corporate inventory method does not appear to be entirely sufficient for informing decisions on climate change mitigation. By comparison with the CLCA it is clear that the emission sources/sinks included in the corporate inventory do not reflect all the sources/sinks affected by the decision at hand. This limitation with corporate greenhouse gas inventories is recognised to some extent in the GHG Protocol *Corporate Standard*, which states that "some companies may be able to make changes to their own operations that result in GHG emissions changes at sources not included in their own inventory boundary" (WBCSD/WRI 2004, p.61). However, the *Corporate Standard* also states that corporate GHG inventories "provide business with information that can be used to build an effective strategy to manage and reduce GHG emissions" (WBCSD/WRI 2004, p.3) and that accounting "for emissions can help identify the most effective reduction opportunities." (WBCSD/WRI 2004, p.11), without the accompanying caveat that corporate inventories are not designed to capture the total consequences of the reduction options under consideration.

At the same time, however, there are a large number of caveats and uncertainties associated with the CLCA results. Firstly, a large number of assumptions and modelling choices are made when implementing these methods, and the selection of alternative parameter values will alter the results. Secondly, the range of scenarios tested is not exhaustive, and there are many other plausible scenarios that could be modelled (e.g. a scenario in which wind-blown trees are utilised, or in which increased demand for biomass increases tree planting (Daigneault et al. 2012; Favero & Mendelsohn 2013; Latta et al. 2013)). Thirdly, the results are presented for each individual scenario, whereas in reality there is likely to be a mix of marginal systems affected by the decision (Ekvall & Andræ 2006; Mathiesen et al. 2009), and also a transition between combinations of scenarios over time. Fourthly, the relative probability of each scenario is not quantified, and it is not possible to infer that one scenario or outcome is more likely than another (although an initial review of the evidence suggests a strong case for increased overseas production). Fifthly, the analysis focuses solely on the decision to implement the bioheat plant, and does not include consideration of possible future decisions that are enabled as a result of the Guardbridge Energy Centre (e.g. new technologies which could use the Guardbridge to St Andrews pipe-work after the bioheat plant is decommissioned).

Notwithstanding these caveats it is still possible to draw some conclusions from the findings, especially when the range of possible outcomes is *itself* recognised as a key finding (Borjesson & Gustavsson 2000). Normative decision theory suggests that decision-making must be based on an understanding of the consequences of the decision in question (Lasswell & Kaplan 1950), while the results of this study suggest that the emissions impact of the bioheat plant is unknown (i.e. it could be positive or negative). One possible response when faced with this level of uncertainty is to seek alternative climate change mitigation options, such as wind energy or geothermal heat pumps, which may not involve the same extreme range of possible outcomes.

Finally, we would suggest that there is a potential, at the Government level, for consideration of the wider impacts of organisational level initiatives. It might be that Government shaping of other policy areas (such as forestry) might make marginal impacts less problematic. What the appropriate responses might be are beyond the scope of the work undertaken, but the outcomes of the work suggests that this is an area where further scrutiny might be warrented.

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