Institution: University of Aberdeen

Unit of Assessment: 6 - Agriculture, Veterinary and Food Science

Title of case study: Carbon-calculating: reshaping public policy for the development of Scottish windfarms

1. Summary of the impact

The Scottish Government is aiming to generate all of its electricity through renewable energy sources by 2020. Research by the University of Aberdeen has produced a freely available tool – the Windfarm Carbon Calculator – that has overhauled the planning process for windfarm developments in Scotland. In changing public policy and planning regulations, and informing the public debate, Aberdeen's calculator is helping the Government fulfil its pledge to become "the green energy powerhouse of Europe" while protecting some of the country's most environmentally fragile areas. It continues to guide the actions of politicians, planners, the wind industry, NGOs and community groups.

The claimed impact therefore is on: the environment, economy and commerce, public policies and services, practitioners and services.

2. Underpinning research

The Scottish Government is promoting electricity generation by renewable sources to meet its target of 100 per cent renewable electricity generation by 2020. Windfarms situated on peatlands, usually located on exposed sites and less productive than managed mineral soils, offer high energy returns and reduced investment costs. However, one hectare of peatland can contain 5,000 tonnes of carbon (http://www.newscientist.com/article/dn9722-grouseshooting-popularity-boosts-global-warming.html). Installation of wind turbines can rapidly decompose peat, releasing carbon into the atmosphere, thus lengthening the time for carbon payback and destroying sensitive wildlife habitats.

Research at the University of Aberdeen led by Jo Smith, Professor in Soil Organic Matter and Nutrient Modelling, coincided with an increase in the mid-2000s in plans to develop windfarms on peatlands without considering the carbon emissions cost. The importance of soil carbon to total greenhouse gas emissions was highlighted in a seminal paper lead by Aberdeen researchers in 2005, on emissions of greenhouse gases from European soils, one of the first to provide dynamic simulations of changes in soil carbon across Europe [1]. Carbon losses from organic soils were identified as a key uncertainty because these soils hold large amounts of carbon and so, if poorly managed, have potential to emit large quantities of greenhouse gases. The findings inspired a £500,000 grant [7] from the Scottish Executive (SERAD) to develop a new model ECOSSE (Estimating Carbon in Organic Soils – Sequestration and Emissions) to quantify greenhouse gas emissions from organic soils.

Simulations using ECOSSE [2,3] revealed the scale of the potential threat to Scottish peatlands and high potential carbon emissions that could result from widespread conversion of Scottish peatlands. The data revised estimates for carbon stored in organic soils in Scotland and Wales upwards by 30 per cent for Scotland and 20 per cent for Wales. Recognising an urgent need to factor potential greenhouse gas emissions into planning applications for windfarms, the Scottish Government provided further funding [8] for Aberdeen to design a simplified model that could be used to calculate emissions at each proposed site.

Led by Jo Smith, University of Aberdeen researchers and their partners created a carbon calculator for estimating potential carbon emission savings that can be achieved if windfarms are developed on peatland or forested land [4-6]. The methodology estimated the carbon payback time for the windfarm; the time required for net carbon losses associated with the windfarm to be balanced by carbon savings through clean energy. Net carbon losses include loss of carbon from infrastructure; from carbon stored in peat and forest; loss of carbon-fixing potential of peatland and forest; and carbon savings due to habitat improvement. The calculator, published in 2008, enabled planners to avoid developments on sensitive sites, while permitting developments with

good management on sites where a windfarm does not result in degradation of sensitive soils. Developments to the calculator continue – the latest version was released in 2011 – and will improve its user friendliness and take into account further extraneous factors like the impact of sheep grazing, housing and road construction. Other lead Aberdeen academics were Dr Dali Nayak, Research Fellow (2007-present), and Pete Smith, Professor of Soils & Global Change (2001-present). Aberdeen led the research, receiving scientific input from the James Hutton Institute (formerly Macaulay Institute); Forest Research and the Universities of Edinburgh and Glasgow.

3. References to the research

[1] Smith JU, Smith P, Wattenbach M, Zaehle S, Hiederer R, Jones RJA, Montanarella L, Rounsevell MDA, Reginster I, Ewert F. (2005). Projected changes in mineral soil carbon of European croplands and grasslands, 1990-2080. *Global Change Biology,* 11, 2141–2152. *(cited 104 times on WOK).*
Regional scale simulation of changes in soil carbon with climate and land use change
[2] Smith JU, Coleman K, Gottschalk P, Bellarby J, Richards M, Nayak D, Hillier J, Flynn H, Wattenbach M, Aitkenhead M, Yeluripurti J, Farmer J, Chapman S, Towers W, Bell J, Milne R, Thomson A, Skiba U, Evans C, Bradley I, Whitmore A, Falloon P, Smith P. (2010). Estimating changes in national soil carbon stocks using ECOSSE – a new model that includes upland organic soils. Part I. Model description and uncertainty in national scale simulations of Scotland. *Climate Research,* 45, 179-192. *A new model developed at the University of Aberdeen to simulate carbon and nitrogen dynamics in peat soils as well as in mineral soils and a range of scales from plot to regional.*
[3] Smith, JU, Gottschalk, P, Bellarby, J, Chapman, S, Lilly, A, Towers, W, Bell, J, Coleman, K, Nayak, DR, Richards, MI, Hillier, J, Flynn, HC, Wattenbach, M, Aitkenhead, M, Yeluripurti, JB, Farmer, J, Milne, R, Thomson, A, Evans, C, Whitmore, AP, Falloon, P, Smith, P. (2010). Estimating changes in national soil carbon stocks using ECOSSE – a new model that includes upland organic soils. Part II. Application in Scotland. *Climate Research,* 45, 193-205. *Application of the new model to Scotland.*
[4] Nayak, DR, Miller, D, Nolan, A, Smith, P, Smith, JU, (2010). Calculating carbon budgets of wind farms on Scottish peatlands. *Mires & Peat* 4, Article 09, http://www.mires-and-peat.net/. *Full description of the carbon calculator for windfarms on peats that has been adopted by Scottish Government in planning.*
[5] Smith, JU, Graves, P, Nayak, DR, Smith, P, Perks, M, Gardiner, B, Miller, D, Nolan, A, Morrice, J, Xenakis, G, Waldron, S, Drew, S. (2011). Carbon implications of windfarms located on peatlands – update of the Scottish Government Carbon Calculator tool. *Scottish Government Final Report,* CR/2010/05, pp. 69. *Development of the carbon calculator to include detailed forestry management on windfarms.*
[6] Smith, JU, Nayak, DR, Smith, P. (2012). Avoid constructing wind farms on peat. *Nature* 33(489). *Application of the carbon calculator to determine the impact of predicted future conversion to a low carbon economy on the carbon savings possible when siting windfarms on peats.*

Relevant funding:

- [7] ECOSSE project, Scottish Executive (SERAD), Dec 2003 to Nov 2006. £499,870
- [8] Validation of changes in soil carbon stocks in Scotland and use of data to develop the ECOSSE model, Scottish Government (RERAD), Sept 2007 to July 2008. £89,855
- Calculating carbon savings from windfarms on Scottish peatlands – revision of guidelines, Scottish Government (RERAD), Oct 2007 to Jan 2008. £35,142
- ECOSSE 2, Welsh Assembly Government, Jan 2009 to Apr 2009. £24,500
- QESM Methane, NERC, Apr 2009 to Dec 2009. £47,000
- Pilot project to determine the suitability of integrated administration and control system (IACS) data to provide land use change data for annual greenhouse-gas emission estimates, Scottish Government (RERAD), May 2010 to July 2010. £45,523
- Carbon implications of windfarms located on peatlands – update of the SG carbon calculator tool, Scottish Government (RERAD), Oct 2010 to Aug 2011. £50,002

4. Details of the impact

The Scottish Government's decision to publish the University of Aberdeen's windfarm carbon calculator online in 2008 [a] attracted immediate attention from the national media, and transformed the politically sensitive debate over the development of windfarms on Scottish peatlands. Carbon calculations are now an integral part of the planning process, having progressed rapidly from a point where carbon considerations did not factor in the conversation, even though the impetus for windfarm construction is powered by global pledges to reduce emissions.

The development of the calculator has involved years of in-depth negotiations between the Aberdeen academics and regulatory bodies (Scottish Executive, Scottish Environment Protection Agency, Scottish National Heritage), NGOs (RSPB, John Muir Trust, National Trust) and industry (Scottish Renewables, Scottish Power, Forestry Commission) to ensure the tool is accepted by all. There are five key beneficiaries; Smith has communicated with all main parties through regular meetings. The windfarm industry has a tool that helps it demonstrate the environmental credibility of a proposed site and speeds up the planning process, evidenced by the successful application for Freasdail Windfarm in 2012 [f]. Community groups and NGOs have free access to a transparent methodology that allows cases to be made against unsuitable developments. Planning authorities can quickly check the carbon payback time of a planned development. Wider society, which recognises the urgent need to reduce greenhouse-gas emissions by replacing fossil fuels, has a tool that ensures the envisaged benefits of windfarms are achieved. The Scottish Government has been able to claim on its website that it is "a world leader in advancing new scientific research on the carbon impact of wind farms on peatlands, as part of our wider drive to promote best practice for energy developments" [j].

The controversial 103-turbine wind farm in Shetland – the third biggest in Scotland – received government approval in April 2012. The calculator informed three years of wrangling between developers Viking Energy [b] and community groups like Sustainable Shetland [c] opposed to the plans. Following carbon calculations, in September 2011 Viking agreed to scale back its proposals, reducing the number of turbines from 150 to 127. But Ministers went further and granted consent for only 103 turbines, which still provided an estimated £30m in annual income for the local community, according to BBC news. The case encouraged the Scottish Government to fund amendments to the windfarm carbon calculator and energy minister Fergus Ewing launched a revised model in June 2011. He issued a requirement that all new windfarm Section 36 planning applications must use the calculator "for assessing carbon losses and savings" in developments that generate 50MW of electricity or more [d]. Ewing said: "Planning authorities, like all public bodies, have a duty to take account of the emission effects of their decision-making, and they should encourage developers to use the carbon assessment tool for all wind farms on peat as a matter of good practice" [g]. The Government is considering an extension of the regulations to smaller sites.

The long-term environmental impact of the decision is clear: developments on sensitive peatlands are avoided and sensitive habitats protected. Furthermore the carbon calculator has opened up opportunities for land restoration. Calculation of the impacts of different management strategies of windfarm sites encourages developers to use their financial resources to instigate peatland restoration and good practice to achieve a reduced carbon payback time. If developments are focused on disturbed sites, extra resources available for restoration from the industry can have a positive impact on these habitats. But Aberdeen's research also provides a scientific basis on which decisions can be made; it has contributed rationale to debates where preconceived ideologies often cloud judgement. The carbon calculator encourages developments on peatlands that are not sensitive. For example, Black Law windfarm in Lanarkshire is sited on an area previously used for mining so the damage resulting from the development is much reduced. Aberdeen's research was cited in a Sunday Herald article [e] in July 2008 to support criticism of a call by Scottish Conservative MEP, Struan Stevenson, to ban wind farms from all peatlands. His opponents, including Scottish Renewables, accused Stevenson of 'bad science', quoting Smith's published paper and referencing the carbon calculator.

Further research published in *Nature* by Smith has shifted the public debate further [6]. Based on new calculations the academics assert that all developments on pristine peatlands should be avoided [h]. The recommendation was made in a letter to *Nature* and covered by the *Daily Mail* and *The Press and Journal*. The John Muir Trust has used this to support its lobbying for a Wild Land Designation in Scotland. The Scottish Government is considering the allocation of further funding to Aberdeen to explore how the calculator can be adapted to assess wider use of peatlands.

Claimed impact as defined by REF therefore is that: the Aberdeen work has had an impact on public policy and services by stimulating public debate, through changes to regulations and through implementation of new technology, the Carbon Calculator. It has impacted practitioners and services that have used the research findings in conducting their work. Further, it has had an impact on the environment by planning decisions being informed by the work.

5. Sources to corroborate the impact

[a] The Scottish Government, 2008. Calculating carbon savings from wind farms on Scottish peat lands – A New Approach. http://www.scotland.gov.uk/Resource/Doc/229725/0062213.pdf (accessed 27/11/12). *1st publication of the carbon calculator on the Scottish Government website.*
[b] Viking energy, 2010. Environmental impact statement. Appendix A16.6. Carbon payback calculations. http://vikingenergyfiles.opendebate.co.uk/files/Appendix-A16.6-Carbon-Payback-Calculations.pdf (accessed 22/05/12). *Viking Energy carbon payback calculations for planned site on Shetland – calculations done using the carbon calculator.*
[c] Sustainable Shetland, 2010. Carbon payback. http://www.sustainableshetland.org/environment/carbon_payback.htm (accessed 22/05/12). *Sustainable Shetland's rebuttal of the Viking Energy carbon calculations.*
[d] The Scottish Government, 2012. Wind farm savings on peatlands. http://www.scotland.gov.uk/Topics/Business-Industry/Energy/Energy-sources/19185/17852-1/Csavings (accessed 22/05/12). *Latest Scottish Government advice on calculating carbon payback time.*
[e] Sunday Herald, 2008. Ban on building wind farms on peat bogs is 'bad science'. http://www.robedwards.com/2008/07/ban-on-building-wind-farms-on-peat-bogs-is-bad-science.html (top of the article gives publication date as 2006 but this is incorrect – it's 2008; accessed 24/05/12). *Reports in Sunday Herald opposing amendment to European directive on renewable energy by MEP Struan Stevenson that included a moratorium on building wind farms on peats*
[f] RES, 2012. Freasdail Windfarm Development. http://www.freasdail-windfarm.co.uk/the-project/environmental-impact-assessment.aspx (accessed 27/11/12). *Environmental impact statement from Freasdail Windfarm including calculations provided by the carbon calculator.*
[g] Business Green, 2012. Scotland launches wind farm carbon calculator. http://www.businessgreen.com/bg/news/2079722/scotland-launches-wind-farm-carbon-calculator (accessed 24/05/12). *Industry article on how the carbon calculator will help the planning process.*
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[i] Windfarms on healthy peatlands should be avoided, say carbon experts. http://www.jmt.org/development-peat.asp (accessed 26/11/12). *John Muir Trust opinion piece on constructing windfarms on peatlands.*
[j] Scottish Government web-site on wind farms and carbon. http://www.scotland.gov.uk/Topics/Business-Industry/Energy/Energy-sources/19185/17852-1/CSavings