

The Importance of Revenue Sharing for the Local Economic Impacts of a Renewable Energy Project: A Social Accounting Matrix approach[†]

Abstract

Ambitious renewable energy targets are requiring investments in new renewable capacity in areas where acceptance could be affected by the potential economic benefits to the locality. At the same time, new renewable energy projects, primarily for onshore wind capacity, might offer a route by which peripheral economic development policies can be supported. The economic impacts of these projects are difficult to quantify using Input-Output techniques, but can be more appropriately handled within a Social Accounting Matrix (SAM) framework. We use a SAM for the Shetland Islands, off the north coast of mainland Scotland, to evaluate the potential local economic and employment impacts of a large proposed onshore wind energy project. Sensitivity analysis reveals the relative importance of the level of “Community Benefit” payments, ‘local sourcing’ of intermediate inputs and the level of community ownership of the project to the size of these impacts. In the Shetland case, by a substantial margin, local ownership confers the greatest economic impacts for the local community.

Keywords: renewable energy; rural economic impacts; revenue sharing; community ownership

JEL codes: Q42, R15, O18

1. Introduction

Recent UK and Scottish government policy has sought to increase the share of electricity generated from renewable energy technologies. As stated in the 2007 Energy White Paper (DTI, 2007), renewable energy technologies can contribute to UK energy diversity as well as to meeting national environmental targets. While most energy issues in Scotland are reserved to the UK Government, some aspects of policy have been devolved to the Scottish Government. These include responsibility for encouraging the development of renewable energy technologies at the regional level, as well as powers under Section 36 of the Electricity Act (1989) for all electricity generating projects with an installed capacity greater than 50MW (Allan *et al*, 2008a). The current Scottish Government has set a target that by 2020, 50% of electricity generated in Scotland will come from renewable energy sources (Scottish Government, 2007a). First, it is likely that a significant share of this target will be met by on- -shore wind capacity, but local residents can be reluctant to accept such developments for a variety of welfare reasons. It is therefore important that methods are developed to ensure that the potential benefits to the local community are accurately identified. Second, much of this new renewable capacity will continue to be located in peripheral areas, away from existing population centres. A key part of Scottish Government policy is that peripheral areas experience economic development, and such development could be strengthened through the deployment of renewable technology.

In order for renewable targets to be met, it is important that the siting of any new capacity is acceptable to the population local to the development. In practice, the anticipated economic impact is likely to be critical in determining whether the host community agrees to the implementation of any renewable energy project¹. Therefore, it may be important for the success of the Scottish and UK government's renewable energy

targets that the economic development potential of windfarms be explicitly acknowledged and quantified, wherever possible. Scottish Government strategies for peripheral area economic development (Scottish Government, 2007b) are also likely to be affected by the development of renewable energy projects and the involvement of local businesses and residents in their operation.

Impact analyses typically employ some form of Keynesian multiplier framework to examine the system-wide effects of local economic development initiatives. These are demand driven models that identify the knock on effects of increased local expenditure on local economic activity that is generated directly or indirectly by changes in intermediate and labour demand. The most sophisticated of these studies employ input-output (IO) tables. These tables capture the structure of linkages among the production sectors of the local economy (Miller and Blair, 2009). The IO models that can be developed using these databases have, however, certain drawbacks when used for identifying the economic development impact of onshore windfarm projects. The most important weakness in the present context is that the projects themselves do not typically have strong backward linkages into the local economy through purchases of intermediate inputs or labour (Allan *et al*, 2007)². Low intermediate backward linkages for an operational onshore windfarm would be reflected in a low (i.e. close to unity) IO output multiplier. This signifies low indirect and induced impacts on economic activity from the windfarm. Indirect effects capture the extent to which a change in demand for the output of a sector (the direct effect) changes demand for the output of other sectors as inputs are required to produce that additional output, and as inputs to the production of sectors which are indirectly stimulated. A change in output also changes the income earned by workers across the economy. Induced effects describe the additional impact on economic activity from the spending of this income (Miller and Blair, 2009).

However, while windfarms generally have low intermediate linkage with their host economies, they can generate significant property income flows, a portion of which may remain in the local economy. These flows are not typically identified and incorporated in IO models. In particular, a Social Accounting Matrix (SAM) analysis of the economic impacts may provide a much more useful approach. Loveridge (2004) gives an overview of regional economic impact models, including Input-Output and SAM analyses). He notes that conventional demand-driven IO and SAM modelling assumes there to in essence an entirely passive supply-side³.

While an IO table only shows linkages associated with industrial production, a SAM (which encompasses the information in an IO table) provides details of all monetary flows within an economy. These would include transfers between agents, including profit payments (Round, 2003 and Thorbecke, 1998). As such, they provide a fuller framework for impact analysis, one which is arguably more suited to the examination of a rural economy, where such transfer flows may be significant (Roberts, 2005 and Newlands and Roberts, 2006). A SAM consequently is a natural framework in which to explore the impact of alternative assumptions about the distribution and uses of income flows associated with the windfarm development.

Work by Trent and Stout-Wiegand (1985) found stronger local support for energy projects in rural locations where economic benefits were anticipated for the local area⁴. These benefits could be in the form of income flows from the development to the local community, which might, given their size, represent a major stimulus to the local economy. Further, the Centre for Sustainable Energy (2005, p. 6) argues that: “The routine provision of meaningful benefits to communities hosting wind power projects is likely to be a significant

factor in sustaining public support and delivering significant rates of wind power development". Two alternative ways in which direct payments can be made to the local community is through Community Benefit (CB) schemes and local ownership⁵. In this paper, we demonstrate for the small, rural economy of the Shetland Islands how a Social Accounting Matrix (SAM) might be used to provide quantitative estimates of the possible economic impacts of renewable energy developments which incorporate such financial mechanisms. We establish how the scale and nature of the impacts vary with Community Benefit payments and with any ownership share held by the local community.

CB is "a 'goodwill' contribution voluntarily donated by a developer for the benefit of communities affected by development where this will have a long-term impact on the environment" (Highland Council, 2006, p. 1). Such payments must not be seen as "buying" planning consent and the level of any CB payments agreed should not influence the planning decision (Forward Scotland, 2006). These payments should compensate the residents of affected communities for the disruption caused during pre-planning, construction and the operation of the turbines, including any loss of visual or environmental amenity.⁶ While the level of CB varies between schemes, such payments are made in most operational developments, and tend to be greater for the more recent projects. CB payments are not the only financial links which operational windfarms can have with the communities in which they are located, but they are the most common way in which local communities benefit from the development.

There have been, to the authors' knowledge, no previous studies using IO and SAM models to examine the regional impact of windfarm developments, although these are widely applied tools for multi-sectoral regional impact analysis for energy developments (Loveridge, 2004). Tourkolas *et al* (2009) use employment multipliers derived from an IO

table for Greece to estimate the indirect and induced effects of lignite and natural gas power plants in Greece. They found that a 330MW lignite power plants created 450 man-years of employment per TWh generated, while a 476MW natural gas plant created 95.3 man-years of employment per TWh generated. Rose *et al* (1982) use an IO model to examine the distributional impacts from energy development projects, focusing on a geothermal energy development in California. This found the distribution of total income would become more unequal, particularly if the new jobs created by the energy project are not filled by local residents. Unlike Rose *et al* (1982), in this paper we examine the impact of a renewable energy development using a SAM rather than IO model. We show that an IO model is not able to appropriately deal with the types of income flows that would be a feature of renewable energy projects. Swenson (2006) and Swenson and Eathington (2006) explore the economic impact on a regional economy of a biofuel development using both an IO and SAM multipliers approach. They identify that ownership, and the local retention of profits, can increase the scale of the economic impact. Their work on biofuels is possibly the closest in spirit to this paper.

This paper proceeds in the following way. In Section 2 we set out the current ownership structure for the proposed windfarm on Shetland - "Viking Energy". In Section 3 we identify the revenues, expenditures and the distribution of profits for this windfarm if it were to become operational. These estimates embody plausible assumptions about ownership and backward linkages between the operational development and the Shetland Islands economy. We emphasise the fact that in this paper we do not examine the economic impact of the construction phase of the proposed windfarm. Rather we focus on the effects of the longer-term annual flows of incomes to the Islands' economy from the proposed operational windfarm facility. In Section 4 we present results for two scenarios. In the first, there is no local ownership of the operational windfarm, but Community Benefit payments

are made. In the second, there is local retention of a significant portion of the ongoing profits from the windfarm through the level of community ownership proposed for the Viking Energy project. We carry out sensitivity analysis in Section 5, where we vary: the scale of CB payments; the degree of intermediate input sourcing within the local economy; and the extent of local ownership of the renewable energy project. In Section 6 we conclude with a discussion of policy implications.

2. Outline of the Viking Energy scheme

We use the 600MW onshore windfarm that has been proposed for the Shetland Islands in order to illustrate the issues raised in identifying the impact of renewable energy developments on local economic activity. This choice is made for three reasons. Firstly, island economies are useful for study purposes, given the ease of defining the spatial boundaries of economic activity. Secondly, there exists an excellent recent set of economic accounts for the Shetland economy, offering a snapshot of the Islands economy for the year 2003 (Newlands and Roberts, 2006). Finally, a proposal has been made for this windfarm to be jointly owned by Viking Energy Ltd (VEL)⁷ and Scottish and Southern Energy (SSE). VEL is a limited liability company, with 90% of its shares now owned (as of December 2007) by the Shetland Charitable Trust (SCT).⁸

SCT is able to take on the required financial responsibilities for a project of this size due to the considerable reserves which have been built up over the last thirty years through the deal to establish and operate the oil terminal at Sullum Voe. Shetland was the nearest land for many of the North Sea oil fields identified in the early 1970s, and an oil terminal at Sullum Voe began processing oil in 1978 (Wills, 1991). The local residents received monies linked to the activity at the oil terminal through “Disturbance Payments”, which were paid

until August 2000. In total, it is estimated that Disturbance Payments of £80 million were received by the local community. These monies helped the local community to build up a fund, which is now managed by SCT. From August 2000, SCT now “chiefly relies on funds generated by investments on the world’s Stock Exchanges” (Shetland Charitable Trust, 2009). As of December 2007, the reserves of SCT were estimated at £220 million (Wills, 2007). The proposed windfarm investment would represent around 25% of SCT’s existing reserves.⁹

SCT has a board of 23 members and awards grants to organisations and projects “where there is a clear benefit to the Shetland community” (Shetland Charitable Trust, 2009). These include charitable projects and schemes across the Shetland Islands. During the year to 31st March 2009, the Shetland Charitable Trust spent £12.5 million on charities, projects and property maintenance.¹⁰

It is expected that the revenues to the community from having an ownership role would be substantially greater than typical CB payments. Clearly, such revenues may be considered as compensation for the community taking on larger risks in the early stages of the windfarm development. Shetland Islands Council (2004, p. 1) stated early on that “the project, by its nature is being developed on behalf of the people of Shetland to try to ensure that a substantial portion of the wealth creation potential of the Shetland landscape stays here, for the benefit of the local community”. The council also notes that the potential size of the development could offer an opportunity on a comparable scale to the previous oil terminal development at Sullum Voe¹¹.

As of mid 2005, VEL and SSE Generation (a subsidiary of Scottish and Southern Energy) each had proposals for a 300MW onshore windfarm in the central mainland of

Shetland. Following a Memorandum of Understanding in July 2005, a “General Partnership” between these two organisations was signed in January 2007 (Shetland Islands Council, 2005 and 2007a), giving VEL and SSE Generation an equal share in this partnership. . Figure 1 shows the current proposed ownership structure for the Viking Energy Partnership operational windfarm on Shetland.

[Figure 1]

With an expected total construction budget in the region of £580 million (Viking Energy, 2007b), and each partner required to fund 50% of this investment, the total cost of the project to Viking Energy Ltd would be £290 million. It is stated that an equity investment of 10% is “common”, but that “up to 20% of half of the capital cost would be required to achieve commercial finance” (Viking Energy Ltd, 2007b). We thus assume that the total cost to VEL is met through an equity investment of £58 million (20% of the capital cost), made by its owners in proportion to their share of VEL ownership – and so £52.2 million by SCT and £5.8 million invested by the owners of the remaining 10% equity in VEL. The remainder of the initial investment in the project is met by commercial borrowing.

3. Methods

Some important characteristics of the Shetland Islands’ proposed windfarm are common to many developments of this type in remote or peripheral areas. The Shetland electricity network is currently not connected to the UK mainland transmission network, so all local demands for electricity must be met by local generation. More importantly in the

current context, at present electricity generated on the Shetland Islands therefore cannot be exported to the UK mainland. The electricity produced by a 600MW island windfarm would dwarf the existing electricity demands on the Shetland Islands. These are currently met by a 67.2MW capacity diesel-fired generator at Lerwick Power Station and the operation of a 3.68MW five-turbine windfarm at Burradale that provides up to 18% of electricity demand on the Islands (Energy From the Edge, 2007). There are a number of small scale (i.e. individual building-level) renewable energy projects that include the use of wind power to supply electricity for twelve public halls. The proposed 600MW onshore wind development consequently only makes economic sense if the generated power can be exported to the British transmission grid, most likely via an undersea cable link to the mainland of Scotland. For the purposes of this paper we assume that all electricity generated is exported from Shetland through such a link. We discuss recent estimates of the costs of this transmission link in Section 5.6.

The Social Accounting Matrix for the Shetland Islands describes the income flows in the year 2003 throughout the economy of the Islands (Newlands and Roberts, 2006). It has five accounts which detail: the incomes and expenditures of thirty-one production sectors (identified in Appendix 2 in Allan *et al* (2008b)); the returns to the factors of production, labour and capital; the forms of income accounts; the household account, providing income and expenditure details for three categories of households¹²; and the local government account. For each of these accounts, the SAM satisfies the identity that gross inputs (expenditures) match gross outputs (incomes). The SAM also includes all other transactors that make purchases or transfers with the Shetland economy, including central government, capital account, savings, tourist spending and trading with the rest of Scotland, the rest of the UK and the rest of the world.

We now briefly outline how the proposed windfarm can be incorporated within a SAM for the Shetland Islands. Essentially we consider two alternative scenarios. In both of these scenarios there is an additional production sector, corresponding to the VEP windfarm. In each scenario there is also an additional row and column, showing the earning (row) and distribution (column) of the profits from the VEL windfarm among agents within the Shetland Islands. Note that we do not currently model the impact of the construction phase of the windfarm¹³.

Our first step is to identify the transactions that would be likely to occur in the Shetland economy if the windfarm becomes operational. We therefore set out our assumptions regarding the revenue and operational expenditures for the windfarm in the course of a year once it is in full operation. Section 3.1 identifies the sources of revenue for the windfarm and their levels, while Section 3.2 identifies the nature and levels of expenditures. Section 3.3 shows how the distribution of profits from the windfarm might be treated under two scenarios. In Scenario A the community's link to the project is through Community Benefit payments, and in Scenario B the community makes an investment in the ownership of the project, and therefore retains a larger share of the profits¹⁴. In the text, the revenue and expenditure figures have been calculated in 2003 prices, to make them consistent with the base year of the SAM.

3.1 Windfarm operational revenue

Total revenue for an onshore windfarm in the UK consists of four elements: the sale of electricity generated; the sale of Renewable Obligations Certificates (ROCs) earned in relation to the amount of electricity generated; income from buyout payments made by electricity suppliers unable to source ROCs and so paying the buyout price¹⁵; and the sale of

Climate Change Levy Exemption Certificates (IPA Energy Consulting/Brodies, 2003). All these elements are linked to the amount of electricity generated by the operational windfarm in any year. These revenues are shown in Table 1 and explained in the subsequent text. Summing across all sources, total annual revenue for the offshore 600MW windfarm is estimated to be £146.5 million (in 2003 prices) equating to an average of £65.03/MWh in 2003 prices.

[Table 1]

3.2 Windfarm operational expenditures

Total expenditures for an onshore windfarm in the UK consist of seven elements. We show our estimates for each of these expenditure for the Viking Energy project in Table 2. First, there are the costs of employing local workers to operation and maintain the facility (O&M). Second, there may be local purchases of inputs for parts required for operation and maintenance. Third and fourth, there are taxes paid to central and local government. Fifth, there are parts required for operations and maintenance which will be imported into the Shetland Islands. Sixth, there are charges for access to, and use of, the GB electricity transmission network, while the seventh category of operational expenditures comprises residual rents paid to capital. With the exception of business rates, payable to local government, and charges for use of the GB electricity transmission network these elements are typically related to the amount of electricity generated by the windfarm in any year.

[Table 2]

In calculating the figures for Table 2, we assume that the Viking Energy (2008) estimates of total operational expenditures include the costs of employment, local purchases (covering parts and equipment for operation and maintenance) and both local and central government taxes but exclude Transmission Network Usage of System (TNUoS) charges. Viking Energy (2008) give total operational costs as £16/MWh. We assume that any difference between total operational expenditures and the sum of these three elements is spent on imports to Shetland. The TNUoS charges which will apply are then estimated. Finally, payments to capital are treated as the residual between total windfarm revenues and the sum of all other expenditures.

From the expenditure figures summarised in Table 2, we can construct the new column representing the Viking Windfarm on Shetland. The expenditure breakdown is given in Figure 2. The first figure under each category reports the value of this expenditure in £ million, while the second reports the share of total expenditure in each category.

[Figure 2]

Note that over ninety per cent of expenditure is on imports to Shetland, including expenditures on TNUoS charges, and payments to capital. Backward linkages from the operational windfarm (i.e. local intermediate purchases and local wage payments) are very small, relative to turnover. Direct employment by the operational windfarm is estimated at 53.65 FTE employees. Local tax payments are a further linkage between the windfarm and the local economy, but in standard Input-Output models such payments are considered leakages from the economic system. Where such payments are recycled back into the local economy, there will be additional positive economic impacts. The potential importance of

local payments to capital (i.e. profits to owners) can clearly be seen. In Section 3.3, we explain our assumptions for two scenarios for the distribution of these profits.

3.3 Treatment of profits in the SAM

As stated in Section 3 above, we add a row and column into the SAM representing respectively the profit income to, and distribution of profits from, the windfarm. The row is constructed to show that operational profits are earned in the new windfarm sector, while the column shows the distribution of these profits across all possible beneficiaries, i.e. local households, local (and central) government and transfers out of Shetland. Since we are considering a standalone single-region SAM for Shetland, it is assumed that transfers of income away from the Shetland economy will have no economic feedback effects on to the Shetland economy.¹⁶ We consider two scenarios, labelled A and B. Each scenario implies a different distribution in the windfarm profit column. In both Scenario A and Scenario B we use plausible assumptions about the destination of these profits across all possible transactors. We vary a number of key assumptions in sensitivity analysis in Section 4. Table 3 shows the total profits by destination under each scenario in the central cases.

3.3.1 Scenario A: £3000 per MW Community Benefit payment

As noted by Viking Energy (2008), “the project will have to pay land rentals to landowners under the footprint of the proposed windfarm. The main landowner just happens to be the Shetland community”. We estimate that rental payments to landowners imply a £1.3 million payment to the Shetland Islands Council annually (the major owner of the land on which the windfarm will be located), and a total of £0.2 million being distributed annually among local households¹⁷. The SAM for Shetland identifies three separate

categories of households – those with no children, those with children and retirees. Seventy-five per cent of total rental payments to households is estimated to go directly to households with children. Households without children and retired households receive respectively 23 per cent and 2 per cent of total rental payments to households.

Renewable energy developers may also make Community Benefit (CB) payments. Existing CB payments from operational windfarms to local communities lie between an equivalent of £1000 and £5000 per MW per year¹⁸. In our Scenario A, we assume that there is no local ownership of the operational onshore windfarm, and so Community Benefit payments are made in each period by the owners of the windfarm to the Island community. We assume CB payments in Scenario A are equivalent to an annual payment of £3000 per MW installed capacity.

Under Scenario A all the remaining profits from the windfarm will be earned by a firm based outside Shetland. This represents a leakage of revenues from the local economy, and we assume that these profits have no additional economic impact on Shetland. From the preceding analysis, we can construct the new column for the Shetland SAM representing the distribution of profit income from the Viking Windfarm on Shetland between transactors under our central case of zero local ownership, but CB payments equivalent to £3000/MW. These are shown in Table 3. Under Scenario A 96 per cent of total profits are repatriated from Shetland as transfers to the project owner, with a combined total of £3.30 million remaining in the Shetland Islands economy. This comprises £0.21 million as land rental payments to Shetland Islands householders, £1.37 million to the SIC through taxes paid to local government and land ownership and £1.72 million to the SCT as Community Benefit payments.

3.3.2 Scenario B: 50% local share of ownership

One of the unique aspects of the development of the Viking Energy windfarm is that the Shetland Charitable Trust (SCT) will invest a significant portion of their reserves of community funds in the project for a 45 per cent share of ownership profits from the operation of the development. This level of community ownership in renewable energy, while not unprecedented, would be the first of its kind for a project of this scale in Scotland.

For ease of analysis, we assume that the SCT will spend its receipts from profits in the same pattern as existing Local Government expenditure in the base year of the SAM. We could explore alternative treatments of the profits earned by the community by constructing a different expenditure vector, but in the absence of any relevant information, we do not pursue this here. Further, but also not explored in this paper, as with revenue gained during the operation of Sullum Voe (Wills, 1991), we would also want to assess the implications of revenues being accrued to build up financial reserves (“rainy day” funds) for the longer-term benefit of the Island community.

We calculate the profits retained, and spent, by the Shetland Charitable Trust in the following way. From total profits, we subtract the payments to landowners specified above. From the remainder we subtract half, which goes to the partner to the Viking Energy partnership – SSE Generation. This is estimated as £34.4 million. The ownership stake in Viking Energy Ltd held by the directors of Shetland Aerogenerators Ltd is held by individuals and not community groups, and so we make the assumption that their profit income is not spent locally¹⁹. This is therefore a further leakage from Shetland of £3.44 million, leaving £31.0 million as the annual operational profit income accruing to the Shetland Charitable Trust (before interest payments). With commercial borrowing being used to raise 80% of the

investment needed for the Shetland Island's ownership stake in Viking Energy Ltd, we assume that 50% ownership requires upfront investment of £290 million, and that 20% of this (£58 million) is met from existing SCT revenues. This leaves required commercial borrowing of £232 million. Deflating to 2003 prices produces a total borrowing figure of £209.7 million. It is difficult to predict the rate of interest which would be payable by SCT for this borrowing, but we assume that this borrowing is funded through a loan on which the interest and capital is repaid over 20 years through fixing the level of nominal payments. Taking an indicative rate of interest of 4.25%, gives an annual interest figure of £15.7 million.²⁰ Subtracting the debt repayment charge of £15.7 million from SCT total profits gives a retained income for SCT of £15.3 million. This is in addition to the payments made to the Shetland Islands Council and land rental payments made to households. We assume the same aggregate rental payments to landowners, and their distribution, as discussed above for Scenario A. We assume that, since the community has an ownership stake in the project, it does not receive CB payments as well. In total therefore, we estimate that £16.86 million annually will be retained and spent in the Shetland Islands economy under Scenario B.

The distribution of profit income under Scenario B is given in absolute numbers and the respective shares are given in the last two columns of Table 3. In this scenario, £16.86 million remains within the Shetland Islands economy, over five times as much as is retained in Scenario A. The land rental payments to Shetland Islands householders and taxes paid to local government are the same, but now £15.27 million (previously £1.72 million) is paid to the SCT as co-owner of the operational windfarm. In total the Viking Energy windfarm would retain around 24% of the total operational profits within the Shetland economy.

[Table 3]

4. Results: Direct Impacts, IO results and SAM results for Scenarios A and Scenario B

The local (Shetland) economic impact of the island windfarm is estimated using the SAM for Shetland with the additional column and row for the Viking Energy windfarm, showing sales and purchases, and the appropriate additional column and row showing the treatments of profit incomes under the two central scenarios²¹. With the new element of final demand, that of electricity exports from Shetland to the rest of the UK, totalling £146 million, the new levels of GDP and employment can be calculated. These are then compared to the base line levels of these variables (for 2003) and the differences can be attributed to the operation of the 600MW windfarm.

As with Input-Output (IO) analysis, SAM modelling is a commonly used multi-sectoral general equilibrium modelling approach. Such models, however, make a number of restrictive assumptions (Round, 2003). Conventional IO and SAM modelling assumes that economic activity is demand-driven²². Therefore, any changes in economic competitiveness are not systematically modelled. In production, it is assumed that sectoral expenditure coefficients remain constant: in effect, that average and marginal costs of production remain equal and constant as output expands (McCann, 2001). If the output of a particular sector increases by 5%, for instance, the sector will increase its demand for all inputs by 5%. These assumptions are a good approximation in regions where there are unemployed resources or for a regional economy where all constraints on supply are relaxed in the long-run (McGregor *et al.*, 1996).

4.1 Results from two scenarios

Given the assumptions for operational revenue and expenditure and the distribution of profits detailed through Section 3, our results for GDP and employment are shown in Table 4. While we focus the discussion that follows on the results using the SAM for Shetland under Scenarios A and B, we also report the results obtained under a Type 1 and Type 2 IO analysis.

[Table 4]

The second and third columns of Table 4 reveal that using the conventional IO approach the knock-on (i.e. the difference between the direct effect and the Type 1 (direct and indirect) effect) economic impact of the Viking Energy Windfarm under the assumptions detailed above is zero. That the Type 1 impact on GDP and employment is the same as the direct impact reflects the assumption that the Windfarm sector sources none of its intermediate inputs from within the Shetland economy. The Type 2 effects on GDP and employment are reported in column 3 of Table 4. The additional impact on GDP is still very small, with the GDP multiplier value 1.01. For employment 23 additional jobs are generated through indirect and induced effects, representing a Type 2 employment multiplier of 1.43.. These results confirm that the IO approach to estimating the economic impact of renewable energy projects is limited, where significant income flows are generated that do not accrue to other firms in the region through additional purchases, or through significant direct employment. A SAM analysis provides a much more useful approach for examining the impact of such monetary flows within a rural or regional economy.

The results from Scenario A and Scenario B are shown in the final two columns of Table 4. These effects are large relative to the Shetland Island economy as a whole, particularly for GDP. In the initial SAM, the Shetland GDP and employment level were £333.4

million and 9109 FTEs. The direct impact of the Viking Energy windfarm therefore raises GDP and employment by 21.8% and 0.6% respectively. A windfarm with an installed capacity of 600 MW, no local ownership, but plausible assumptions for the level of community benefit is estimated to raise GDP by 24% and to raise Shetland employment by almost 3%. Retaining 24% of the profits returned from this project within the Shetland Islands raises GDP by 30.9% and employment by 9%.

4.2 Scenario A

Under this scenario, including the operation of the windfarm itself, the sum of direct, indirect and induced effects on the Shetland economy is an increase in GDP of £78.9 million, with an additional 270 FTE jobs. Direct GDP and employment for the hypothetical 600MW windfarm is £72.6 million and 54 FTE jobs respectively. There are thus low indirect and induced benefits to Shetland GDP, which in this scenario come through the assumed Community Benefit payments, additional employment, additional taxation revenues to Shetland Local Government and payments to Shetland residents. The GDP multiplier is 1.09, while the employment multiplier is 5.00. The high employment multiplier is primarily due to the low employment intensity of the windfarm and high employment-intensity of the sectors that are assumed to benefit from the additional SCT spending.

4.3 Scenario B

Under this scenario, the sum of direct, indirect and induced effects on the Shetland economy is an increase in GDP of £95.0 million, with an additional 831 FTE jobs. Direct GDP

and employment for the hypothetical 600MW windfarm is £72.6 million and 54 FTE jobs respectively. There are thus significantly greater indirect and induced benefits to the Shetland economy under this scenario compared to Scenario A. The GDP multiplier rises compared to Scenario A, to 1.31, while the employment multiplier value of 15.39) is more than tripled between Scenarios A and B.

4.4 Sectoral distribution of impacts

The sectoral economic activity and employment impacts identified under the various methods and assumption are given in Figure 3. The overall height of the column is made up of the sectoral results under the Type 2 IO, then the additional impact of Scenario A, and finally the additional impact of Scenario B. The Type 2 IO results are generally very small, and principally concentrated in those sectors where household expenditures are focused, as detailed in the base year SAM for Shetland. All sectors show a positive stimulus. This is because we assume that there is no crowding out of economic activity, for instance, through higher wages and prices. This characteristics applied to all the models employed here.

The second portion of each stacked column is attributable to the additional impact of the Scenario A assumptions. Under Scenario A, the “Public administration”, “School education” and “Social work” sectors are stimulated the most – increasing by 6.98 per cent, 6.98 per cent and 5.22 per cent respectively. These are all sectors in which local government purchases are concentrated. Clearly our assumption about the use of community funds is crucial for these sectoral results, as well as those found under Scenario B.

[Figure 3]

The impacts on sectoral economic activity under Scenario B are shown as the upper portion of each column. While the pattern of sectoral change is similar to Scenario A, there is a marked increase in the scale of the expansionary effect. Again, those sectors in which local government expenditures are focused record the largest changes. The “Public administration”, “School education” and “Social work” sectors increasing by 26.5 per cent, 26.5 per cent and 19.7 per cent respectively.

5 Results: Sensitivity Analysis

5.1 Sensitivity to levels of Community Benefit payments: Scenario A

As discussed above (and detailed in Appendix 1 in Allan *et al*, 2008b) a wide range of Community Benefit payments have been agreed between the owners of operational windfarms in Scotland and their local communities. In this section, we explore the impact that alternative levels of CB payments might have on the local Shetland economy. In these simulations, we assume zero local ownership as well as zero intermediate inputs sourced locally. We vary the levels of Community Benefit payments between zero and £6000/MW (which, for this upper bound, relates to an annual payment to the Shetland community of £3.4 million in 2003 prices).²³

, If community benefit payments are varied under Scenario A for the Shetland economy, each additional £500/MW increases GDP and employment by £340,000 and almost 12 FTE jobs. We can solve the model to find the level of Community Benefit payments under Scenario A that would to produce the same impact upon local GDP and employment as the

results generated in Scenario B. This is a Community Benefit payment of around £26,700/MW. This is well beyond the range of conventional Community Benefit payments for operational windfarm projects in Scotland, and shows the importance of ownership in securing access for the local community to the profit stream from the renewable energy development.

5.2 Sensitivity to local sourcing of intermediate inputs: Scenario A

One key area for policy is the extent to which renewable projects are embedded in the economy in which they operate. In this case, it has been noted that if the 600MW project were undertaken on Shetland, the Council would explore the economic viability of using local manufacturing facilities for elements of construction. In this paper, we abstract from the construction phase of the project. However, in theory the same argument extends to the local sourcing of intermediate inputs for the operation and maintenance of the windfarm. For the proposed windfarm we estimate annual operating (i.e. non-wage, and non-tax) costs of £24.1 million (in 2003 prices). There would be beneficial local economic impacts from local sourcing of the replacement parts and servicing needed by the windfarm.

Simulation exercises suggest low changes in economic impacts from quite sizeable increases in the share of operating expenditures sourced locally²⁴. For example, increasing the share of intermediate inputs sourced from the Shetland economy from zero to 10%, increases Shetland GDP and employment by £2.2 million and 89 jobs respectively. Increasing the local sourcing within this range also produces changes at the sectoral level, as would be expected. Percentage changes in sectoral outputs with the 10 per cent of intermediate inputs being sourcing case are shown in Figure 4.

[Figure 4]

As with Figure 3, the height of each column in Figure 4 shows the change in output in each Scenario. Under Scenario A, where local sourcing is 0% the lower part of each column shows the expected sectoral change. With increased local sourcing, there are large percentage increases in the output of the “Other manufacturing”, “Other food and drink processing”, “Mining and quarrying” and “Communications” sectors. The output of all these sectors increases by a greater percentage amount than that of the “Public administration” and “School and education” sectors, the big sectoral “winners” under the Community Benefit scenario presented above. With zero per cent local sourcing, the output of the “Other manufacturing”, “Other food and drink processing”, “Mining and quarrying” and “Communications” sectors increased by 2.1 per cent, 2.0 per cent, 1.5 per cent and 2.3 per cent respectively. Where local sourcing is 10 per cent, the corresponding total²⁵ increase in output in these sectors are 21.1 per cent, 15.2 per cent, 4.3 per cent and 7.6 per cent.

5.3 Sensitivity to ownership profits retained locally: Scenario B

We now investigate the impact of varying our assumption about the extent of local ownership. Increasing the share of ownership profits retained locally by 5% increases the estimate GDP impact by £4.1 million, and increases the employment impact by 143 FTE jobs. With zero ownership, the impact on Shetland GDP is £76.9 million, with an increase in local employment of 270. In contrast, fifty per cent of ownership revenue retained locally gives a

total GDP impact of £117.8 million, and increases employment on Shetland by 1625 FTE jobs. As with previous sensitivity results, the marginal impact on employment change from increases in profits retained locally is significantly greater than the marginal impact on GDP change.

5.4 Joint sensitivity to local ownership and local sourcing of intermediate inputs

As reported above given changes in the absolute level of community benefit payments (Section 5.1) and degree of local sourcing (Section 5.2) will produce linear changes in output. As is the marginal impact of altering the scale of local ownership. Jointly varying these elements produces linear and additive impacts on Shetland GDP and employment²⁶.

We see clearly that local ownership matters significantly more for local economic impact than does local sourcing of intermediate inputs, in this case at least²⁷.

5.5 Discussion

The estimates we report are, of course, dependent on our assumptions, although we have attempted to make these transparent. One of the most significant of these in the present context is the assumed existence of a transmission line connection between the Shetland Islands and the UK mainland transmission network. One report has put the cost of constructing this connection, from Shetland to mainland Scotland using a 300kV HVDC, at £300 million (TNEI, 2007). However, the high cost of a transmission connection to the mainland, and the uncertainty surrounding the decision to construct the necessary connection, make the Shetland wind project a high-risk project: without the connection, the project has no commercial future.

We have made assumptions regarding the level of TNUoS charges which would be paid by a generator on Shetland seeking to export electricity to the UK transmission network. It is argued elsewhere that the charges as currently set are “penal to island renewables in contravention to European Union directives and should be challenged” (Xero Energy Ltd, 2007). Uncertainty surrounding the likely charges adds to the degree of risk associated with the project as a whole, which may limit the participation of the private sector in developing these proposals:

“[There is] a high degree of regulatory uncertainty surrounding the connection and charging arrangements that will be applied to the Scottish islands. Decisions need to be made quickly as to how security factors will be calculated for subsea links, what the applicable TNUoS charge methodology might be, how ‘Section 185 capping methodology’ will be implemented and whether TEC trading can actually be utilised in Scotland by renewable generators.” (TNEI, 2007)

The UK Government recently announced (BERR, 2008a) that no capping scheme would be required for Orkney and Shetland, and was only marginal for the Western Isles. This will be disappointing for those areas which were seeking discounted connection charges. Two consultants reports (IPA Energy and Water Economics, 2008; Econnect, 2008) were provided as background to the Government’s decision, and argued that, among other things, the higher capacity factor which would be expected for onshore wind in these areas suggested that potential returns to investors could be significantly greater than comparable generation on the Scottish mainland. Clearly, the proportionate impact of the windfarm development will be significantly greater for the Shetland economy than for the Scottish or

UK economies. Where the proposed project on Shetland may be required to finance any element of the cost of supporting a link to the UK mainland, the revenues retained locally would be likely to be diminished, possibly very significantly, with a knock-on effect upon local economic activity.

6. Conclusions

Conventional cost benefit analyses tend to ignore the local economic development impact of new renewable energy projects. However, such effects may be critical to the acceptance of such projects by host communities, and therefore the ability of the UK and Scottish governments to meet their targets for renewable energy. Conventional Input-Output impact, or financial appraisal, analyses are however not ideally suited to exploring the effects of projects that have little direct linkage, in terms of intermediate purchases and employment, to host economies, but may generate significant benefits in terms of income flows. Most onshore windfarm developments in the UK are of this type. An analysis based on a Social Accounting Matrix approach is able to account fully for the income flows while accommodating any direct linkage effect that may exist.

Our analysis of a proposed windfarm development on the Shetland Islands suggests that local revenue sharing arrangements are vital for the scale of the local economic impact in regions that are hosting renewable energy developments, while local sourcing of operations and maintenance inputs has much smaller additional effects. The deployment of the increased funds available for community purposes proves crucial to the scale of the estimated impacts. Not surprisingly, improvements in Community Benefit have a positive effect on the host region. However, these benefits are very modest relative to those that

could be secured from any shared-ownership scheme. Both types of benefit may prove useful in persuading local communities to host renewable energy projects even given some deterioration in their local environment.

Two key assumptions here are that revenues to the local community are all spent in the year in which they are generated, and that this spending occurs in the same pattern as local government expenditure in the base year. Both of these assumptions could be examined further as greater information became available about the likely use of the relevant income flows²⁸. Also, where the expenditure of these revenues has supply-side effects the present analysis is unable to capture them.

Further development of this SAM-based approach is feasible. First, alternative income sharing arrangements could be explored. For example, in practice, some portion of community profits may be held in a “rainy-day” fund to finance future expenditures. Some onshore wind developments have proposed raising capital through share issues directly to individuals (with local residents given priority). Secondly, where data permit, the approach can be extended to include more than one region. Such methods are, like IO, however, based on an assumption that there are extensive underutilised resources in the host region. This may not be a reasonable assumption for some local or island economies²⁹. Where long-term supply-side constraints are apparent, as, for example, in Jersey (Learmonth *et al.*, 2007), it would be more appropriate to analyse the economic development potential of renewable energy projects using Computable General Equilibrium (CGE) models, in which the supply-side of the economy can be more appropriately treated.

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References

Allan, G.J., McDonald, J., McGregor, P.G. and Swales, J.K. (2008a) A distinctive energy policy for Scotland? Fraser of Allander Economic Commentary 32 (1) June 2008, 46-61.

Allan, G.J., Ault, G., McGregor, P.G. and Swales, J.K. (2008b), The importance of revenue sharing for the local economic impacts of a renewable energy project: A Social Accounting Matrix approach, Strathclyde Discussion Papers in Economics, No. 08-11, October 2008

Allan, G.J., McGregor, P.G., Swales, J.K. and Turner, K. (2007) Impact of alternative electricity generation technologies on the Scottish economy: an illustrative Input-Output analysis. Proceedings of the Institute of Mechanical Engineers, Part A: Journal of Power and Energy 221, 243-254.

Department for Business Enterprise and Regulatory Reform (BERR) (2008a) Adjusting transmission charges for renewable generators in the Scottish islands under Section 185 of the Energy Act 2004: Government statement and call for views on evidence base. Published 28th June 2008, available online at <http://www.berr.gov.uk/files/file46776.pdf>.

Department for Business Enterprise and Regulatory Reform (BERR) (2008b) Renewables Obligation Consultation: Government Response. 10th January 2008, available online at <http://www.berr.gov.uk/files/file43545.pdf>.

Crabtree, J.R., Leat, P.M.K., Santarossa, J. and Thomson, K.J. (1994) The economic impact of wildlife sites in Scotland. Journal of Rural Studies 10, No. 1, 61-72.

Centre for Sustainable Energy (2005) Community benefits from wind power: a study of UK practice and comparison with leading European countries. A report for the Renewables Advisory Board and Department of Trade and Industry, URN Number 05/1322.

Courtney, P., Hill, G. and Roberts, D. (2006) The role of natural heritage in rural development: an analysis of economic linkages in Scotland. *Journal of Rural Studies* 22, 469-484.

Department of Trade and Industry (2007) Meeting the Energy Challenge: A White Paper of Energy, May 2007.

Econnect (2008) 2116 validation of Relative Economics of Wind Farm Projects in the Scottish Island's study: Technical note 2. Report for Department for Business Enterprise and Regulatory Reform, March 2008, available online at <http://www.berr.gov.uk/files/file46740.pdf>.

Energy from the Edge (2007) Renewables Energy Projects. Shetland Island Council <http://www.energyfromtheedge.com/shetland-and-renewables.php>.

European Wind Energy Association (EWEA) (2009) Wind Energy – The Facts. Earthscan, London.

Forward Scotland (2006) Communities and Renewable Energy: Opportunities for Engagement. September 2006, available online at <http://www.forward->

scotland.org.uk/Library/Download-document/148-Communities-and-Renewables-The-Opportunities.html.

Highland Council (2006) Progress report on community benefit from renewable energy development. Report by the Chief Executive to the Highland Council Sustainable Development Select Committee, 13th September 2006,

<http://www.highland.gov.uk/NR/rdonlyres/7BD48DCF-2A2F-4CB2-B60D-8B8D6B838E86/0/CommunityBenefitupdateSept2006.pdf>.

IPA Energy Consulting/Brodies (2003) An Evaluation of Alternative/Renewable Energy Schemes. Final report to Comhairle Nan Eilean Siar and The Highland Council, December 2003.

IPA Energy and Water Economics (2008) The relative economics of wind farm projects in the Scottish Islands. Final report to Department for Business Enterprise and Regulatory Reform, June 2008, available online at <http://www.berr.gov.uk/files/file46739.pdf>.

Learmonth, D., McGregor, P.G., Swales, J.K., Turner, K.R. and Yin, Y.P. (2007) The importance of the regional/local dimension of sustainable development: An illustrative Computable General Equilibrium analysis of the Jersey economy. *Economic Modelling* 24(1), 15-41.

Loveridge, S. (2004) A typology and assessment of multi-sector regional economic impact models. *Regional Studies*, 38 (3), 305-317.

McCann, P. (2001) *Urban and Regional Economics*. Oxford University Press, Oxford.

McGregor, P.G., Swales, J.K. and Yin, Y.P. (1996) A Long-Run Interpretation of Regional Input-Output Analysis. *Journal of Regional Science* 36 (3), 479-501.

Miller, R.E. and Blair, P.D. (2009) *Input-Output Analysis: Foundations and Extensions*. 2nd Edition. Cambridge University Press.

Moran, D. and Sherrington, C. (2007) An economic assessment of windfarm power generation in Scotland including externalities. *Energy Policy* 35, 2811-2825.

Newlands, D. and Roberts, D. (2006) *Shetland Regional Accounts 2003*. University of Aberdeen Business School and A B Associates, January 2006.

O'Herlihy and Co. (2006) *Windfarm Construction: Economic Impact Appraisal*. Report for Scottish Enterprise, March 2006.

Psaltopoulos, D. and Thomson, K.J. (1993) Input-output evaluation of rural development: a forestry-centre application. *Journal of Rural Studies* 9(4), 351-358.

Roberts, D. (2005) The role of households in sustaining rural economies: a structural path analysis. *European Review of Agricultural Economics* 32(3), 393-420.

Rose, A., Nakayama, B. and Stevens, B. (1982) Modern energy region development and income distribution: An input-output analysis. *Journal of Environmental Economics and Management* (9), 149-164.

Round, J. (2003) Social Accounting Matrices and Sam-Based multiplier analysis. Chapter 14 in The Impact of Economic Policies on Poverty and Income Distribution: Evaluation Techniques and Tools, Bourguignon, F. and Pereira da Silva, L.A. (eds.), World Bank, 301-320.

Scottish Government (2007a) Scottish Budget Spending Review 2007. The Scottish Government, November 2007, available online at <http://www.scotland.gov.uk/Resource/Doc/203078/0054106.pdf>.

Scottish Government (2007b) The Government Economic Strategy. The Scottish Government, November 2007, available online at <http://www.scotland.gov.uk/Resource/Doc/202993/0054092.pdf>.

Shetland Charitable Trust (2009), Shetland Charitable Trust website, available at <http://www.shetlandcharitabletrust.co.uk/index>, accessed 2nd December 2009.

Shetland Charitable Trust (2009b), Annual Report and Accounts for the year to 31 March 2009, published 3rd November 2009 and available online.

Shetland Charitable Trust (2009c), November Grant Awards, published 4th December 2009 and available online.

Shetland Islands Council (2004) Report no: DV0810-F: Viking Energy Ltd, Project Update. Report from Principal Officer – Business Technical Support to Economic Development Forum, 24th November 2004.

Shetland Islands Council (2005) Report no: DV024-F: Viking Windfarm – Memorandum of Understanding – Between Viking Energy Ltd and Scottish and Southern Energy plc. Report from Principal Development Officer to Executive Committee, 6th July 2005.

Shetland Islands Council (2006) Report no: DV017-F: Viking Energy – Structure, Governance and Finance. Report from Project Manager to Executive Committee, 9th May 2006.

Shetland Islands Council (2007a) Report no: DV079-F: Viking Windfarm – Partnership Agreement – Between Viking Energy Ltd and Scottish and Southern Energy. Report from Principal development Officer to Special Shetland Islands Council, 12th January 2007.

Shetland Islands Council (2007b) Report no: F-026-F: Viking Energy Ltd.: Community Ownership and Company Structure. Report from Head of Finance to Shetland Islands Council, 12th September 2008.

Swenson, D. (2006) Input-outrageous: The economic impacts of modern biofuels production. ECON Staff Report, Iowa State University, published June 2006. Available online at http://www.econ.iastate.edu/research/webpapers/paper_12644.pdf.

Swenson, D. and Eathington, L. (2006), Determining the regional economic values of ethanol production in Iowa considering different levels of local investment. Research for the BioEconomy Working Group at Iowa State University, published September 2006. Available online at http://www.econ.iastate.edu/research/webpapers/paper_12687.pdf.

Thorbecke, E. (1998) Social accounting matrices and social accounting analysis. In *Methods of Interregional and Regional Analysis*, Isard, W. (ed.), Ashgate, Aldershot, Brookfield, USA.

Tourkolias, C., Mirasgedis, S., Damigos, D., and Diakoulaki, D. (2009) Employment benefits of electricity generation: A comparative assessment of lignite and natural gas power plants in Greece. *Energy Policy* (37), 4155-4166.

Trent, R.B. and Stout-Wiegand, N. (1985) Support for Industrial Development: The Role of Anticipated Benefits to the Local Area. *Journal of Rural Studies* 1(4), 369-374.

TNEI (2007) Assessment of the Grid Connection Options for the Scottish Islands. Report to Highlands and Islands Enterprise, March 2007, <http://www.hie.co.uk/HIE-economic-reports-2007/tnei-grid-study-june-07.pdf>.

Viking Energy (2007a) Viking Energy clarifies reasons for change in shareholding. Press release issued 11th December 2007, <http://www.vikingenergy.co.uk/downloads/VE%20press%20release%20-%20clarifying%20shareholding%20sale%2011-12-07.pdf>.

Viking Energy (2007b) Viking Energy clarifies investment risk. 12th December 2007, http://www.vikingenergy.co.uk/news_detail.asp?item=23.

Viking Energy (2008) Various pages on website. <http://www.vikingenergy.co.uk/>.

Wills, J. (1991) *A Place in the Sun: Shetland and Oil – Myths and Realities*. Mainstream Publishing, Edinburgh.

Wills, J. (2007) Sounding off: A silver collection for BP? *Shetland Today*, 7th December 2007.

Xero Energy Ltd (2007) Grid connection for the Scottish islands: A strategic viewpoint.

Report prepared for Highlands and Islands Enterprise, Orkney Islands Council, Shetland

Islands Council and Comhairle Nan Eilean Siar, published 20th June 2007.

Figure captions

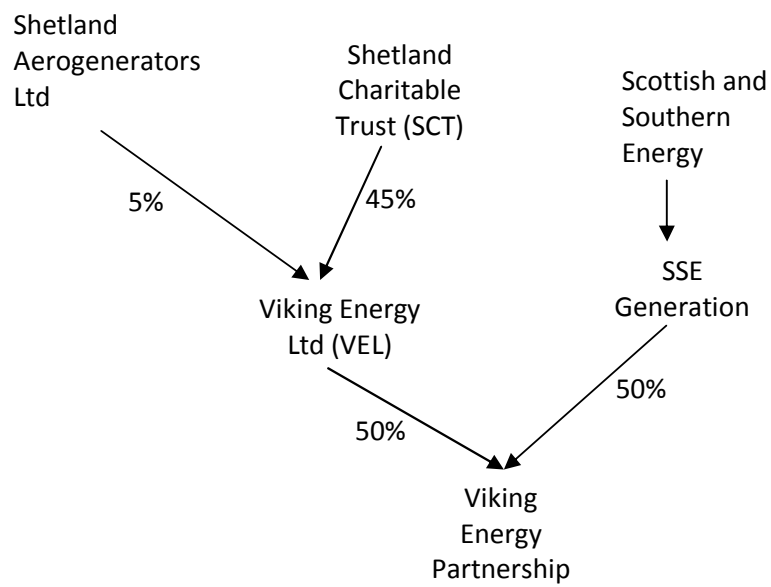
Figure 1: Ownership structure of the Viking Energy windfarm on Shetland, as of July 2008

Figure 2: Expenditures by category for an operational 600MW windfarm (£million and percentages of total expenditure, 2003 prices)

Figure 3: Sectoral impact from 600 MW island windfarm, Type 2 IO, Scenario A and Scenario B

Figure 4: Sectoral impact from 600MW island windfarm, Scenario A, with 0 per cent and 10 per cent local intermediate inputs sourcing

Figure 1



Notes: Percentages relate to the share of ownership of the total Viking Energy Partnership.

SSE Generation is a fully-owned subsidiary of Scottish and Southern Energy.

Figure 2

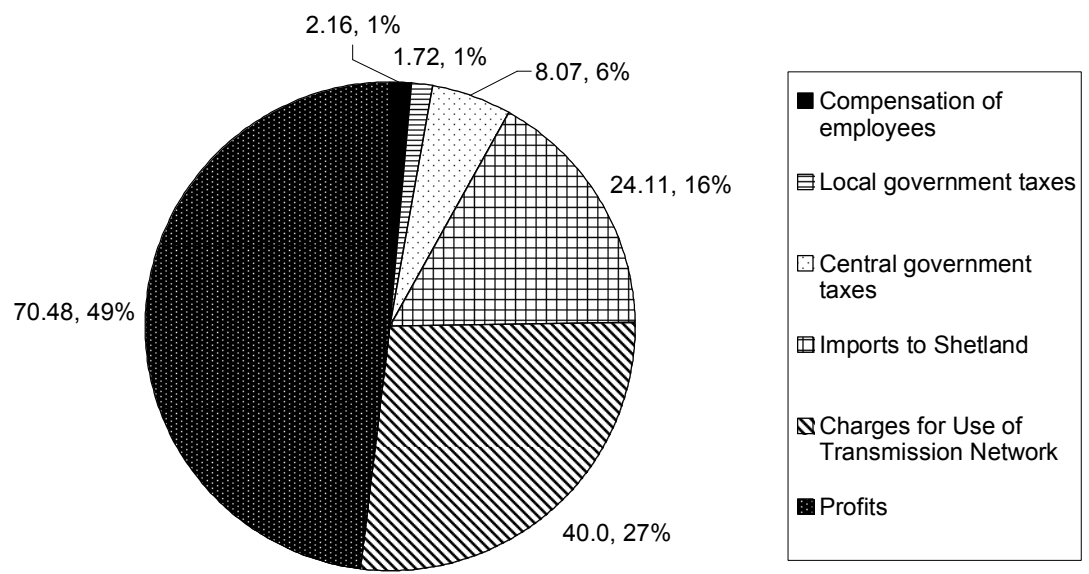


Figure 3

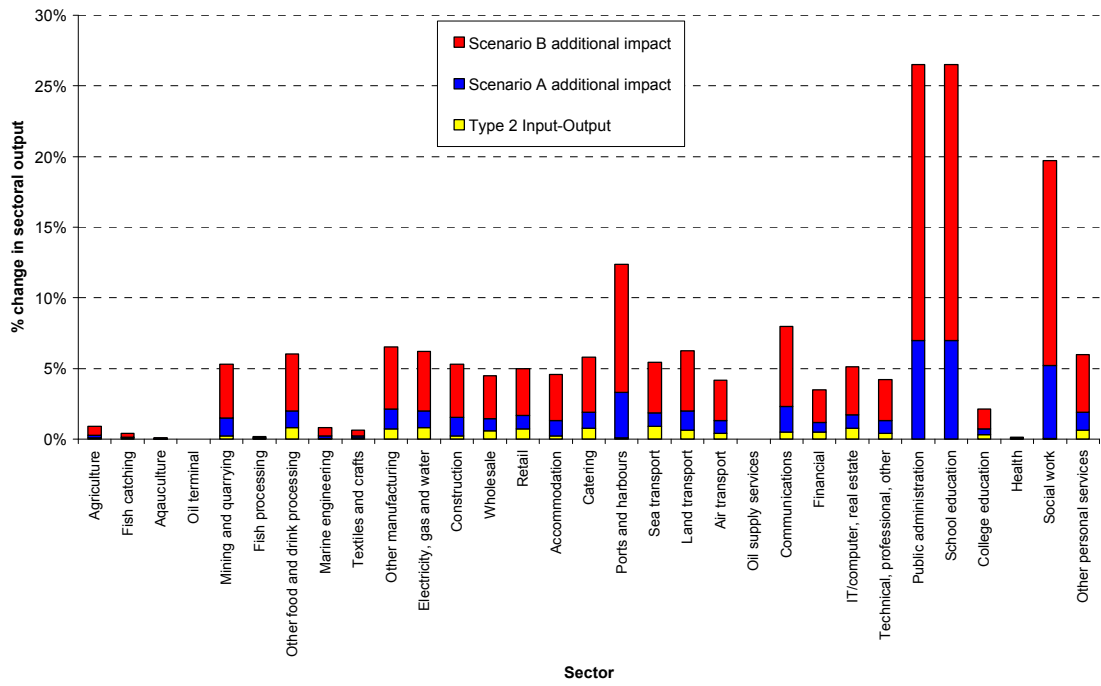


Figure 4

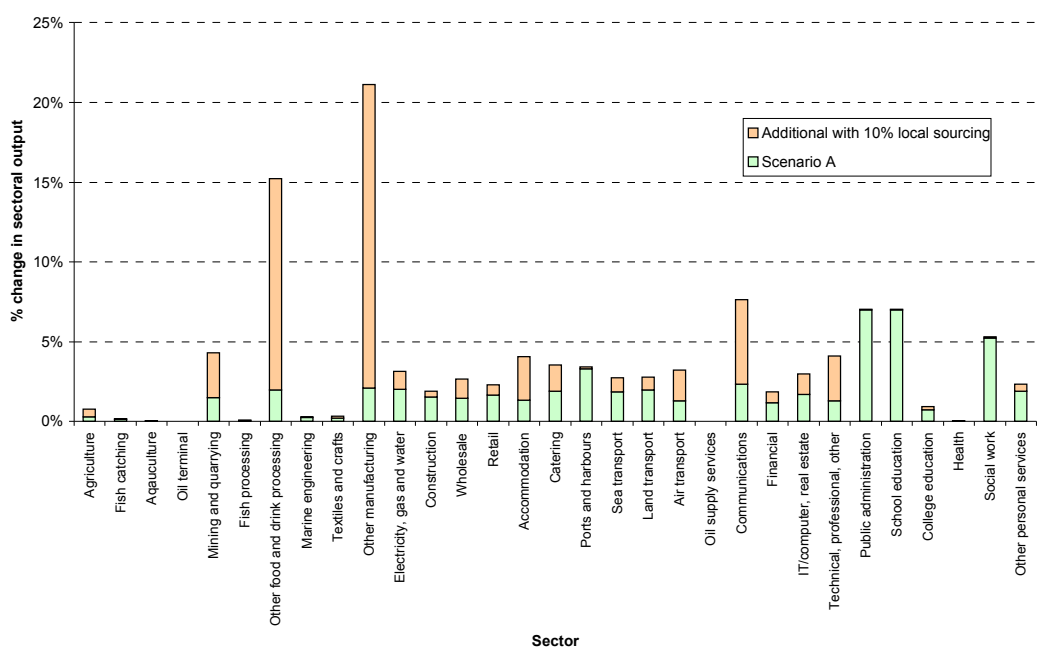


Table headings

Table 1: Operational revenues of 600MW island windfarm, by category

Table 2: Operational expenditures by 600MW island windfarm, by category

Table 3: Distribution of profit income under Scenario A and Scenario B, absolute value (£mn) and share (%)

Table 4: Impact on Shetland of 600MW island windfarm, Direct and under Scenario A and Scenario B, absolute changes in GDP (£mn) and employment (FTE jobs) and GDP and employment multipliers

Table 1

<i>Revenue category</i>	<i>Unit value assumed</i>	<i>Total estimated annual revenue (2003 prices)</i>
Sale of electricity	£30 per MWh	£67.6 million
Sale of Renewable Obligations Certificates (ROCs)	£26.59 per MWh (=per ROC)	£59.9 million
Recycled value from ROC buyout fund	£5 per MWh	£11.3 million
Climate Change Levy Exemption Certificates	£3.44 per MWh	£7.8 million
<i>Total</i>	<i>£65.03 per MWh</i>	<i>£146.6 million</i>

Table 2

<i>Expenditure category</i>	<i>Total estimated annual expenditures (2003 prices)</i>
Local employment for O&M	£2.2 million
Local purchases of inputs to O&M	£0.0 million
Taxes paid to central government	£8.1 million
Taxes paid to local government	£1.7 million
Imports to Shetland	£24.1 million
Charges for use of Transmission Network	£40.0 million
Payments to capital (i.e. ownership profits)	£70.5 million
<i>Total</i>	<i>£146.6 million</i>

Table 3

		Scenario A		Scenario B	
		£mn	%	£mn	%
<i>Rental payments to landowners</i>	<i>Households with children</i>	0.16	0	0.16	0
	<i>Households without children</i>	0.05	0	0.05	0
	<i>Retiree households</i>	0.00	0	0.00	0
	<i>Shetland Islands Council</i>	1.37	2	1.37	2
<i>Community Benefit payments</i>	1.72	2	0.00	-	
<i>Retained Ownership Profits</i>	0.00	-	15.27	22	
<i>Expatriated Profits</i>	67.18	96	53.62	76	
<i>Total</i>		70.48	100	70.48	100

Note: Columns may not sum due to rounding.

Table 4

		Input-Output used for impact analysis		Social Accounting Matrix used for impact analysis	
		Type 1 • production sectors endogenous	Type 2 • production sectors and households endogenous	Scenario A: • 0% local ownership • 0% local sourcing of inputs • £3000/MW CB payments	Scenario B: • 50% local ownership • 0% local sourcing of inputs • 23.9% of profits retained on Shetland
	Direct Impact				
GDP (£million)	72.6 (ΔGDP_I)	72.6	73.4	78.9 (ΔGDP_{TA})	95.0 (ΔGDP_{TB})
GDP multiplier		1.00	1.01	1.09	1.31
Employment (FTE jobs)	54 (ΔE_I)	54	76	270 (ΔE_{TA})	831 (ΔE_{TB})
Employment multiplier		1.00	1.43	5.00	15.39

Note to table: GDP multiplier = $\Delta GDP_{Tn} / \Delta GDP_I$; Employment multiplier = $\Delta E_{Tn} / \Delta E_I$, where n refers to Scenario A or B respectively.

¹ Note that in this paper we are not carrying out a full CBA. Rather we are examining one impact of renewable energy initiatives crucial for their acceptability which is omitted from conventional cost-benefit analyses (CBA) of energy projects (for instance, Moran and Sherrington, 2007). Impact analysis, of which this paper is an application, focuses on the effects on local economic activity.

² IO studies looking at the economic impact of sectors on rural areas include Psaltopoulos and Thomson (1993) and Crabtree *et al.* (1994), while Courtney *et al.* (2006) estimate local income and employment multipliers to quantify the indirect and induced economic impacts of “natural heritage” businesses on the local economy.

³ This would be consistent with sufficient spare capacity so that all additional demand for employment, for instance, could be met without an increase in the real wage. See also endnote 33.

⁴ The four energy developments they studied were a coal liquefaction plant, two coking plants and an industrial park for coal-based enterprises proposed for a county in northern West Virginia.

⁵ Financial interactions between renewable energy developments and the community in which they are based could also include the following: sponsorships to or donations of local projects; the provision of apprenticeships; and training or educational opportunities, such as providing tours or participating in other community projects. All projects will make payments to the local community through local business rates and through payments to the landowners on which the project is based. These are discussed at the appropriate sections which follow and are an integral part of our analysis.

⁶ Appendix 1 in Allan *et al* (2008b) shows the level of CB payments made by each of the fifty-seven operational windfarms in Scotland (as of summer 2008).

⁷ A company formed to represent Shetland Islands Council’s interests in large-scale wind energy development in Shetland.

⁸ The remaining 10% are held between the four directors of Shetland Aerogenerators Ltd (Shetland Islands Council, 2006). The ownership stake of the Shetland Charitable Trust was previously held by Shetland Islands Council (as raised in Shetland Islands Council (2007b), and confirmed by Viking Energy (2007a))

⁹ As would be expected, with assets principally held in equity the recent financial market turbulence has impact on the asset holdings of SCT. As of the end of March 2009 the SCT had managed funds of £143.0 million, down £50.0 million from the same period one year earlier. Stock markets have typically rebounded since March 2009, with the FTSE 100 index up almost 38% between end March and end December of 2009.

¹⁰ In November 2009, for instance, the Shetland Charitable Trust awarded grants totalling £39,915 between seven projects in the Shetland Islands, ranging from £265 towards the transport costs of the “Little Tikes” group, to £15,300 to help with annual running costs for the “Sandwick Youth and Community Centre” (Shetland Charitable Trust, 2009c).

¹¹ See Wills (1991) for a discussion of the agreement reached between the Shetland Islands Council and the users of this oil terminal.

¹² These are households with children, households with no children and retiree households.

¹³ Our focus is on the economic impact of the ongoing revenues from the operational stage of the windfarm. Constructing onshore windfarms can create significant opportunities for local companies, although a large portion of the construction expenditures are likely to be on goods and services imported into the region. It is likely that such opportunities would be in the construction of access routes and roads to the development, rather than for the turbine erection services where “the engagement of local contractors for this activity is likely to be negligible” (see O’Herlihy and Co. Ltd, 2006). The impact of the construction phase could be incorporated into this analysis, but the effects would, of course, be transitory.

¹⁴ More detail on each of these items of revenue and expenditure are provided in Appendix 3 in Allan *et al* (2008b).

¹⁵ The total revenue from this fund is distributed back to those generators earning ROCs.

¹⁶ This seems reasonable given the small scale of the Shetland economy when compared to the UK economy as a whole.

¹⁷ We assume that the land on which the windfarm would be sited would otherwise not have productive use, and so renting the land to the windfarm does not reduce revenues to the landowners. We do not explore this assumption in sensitivity analysis since it would have a negligible impact on our results.

¹⁸ Appendix 1 in Allan *et al* (2008b) describes those Community Benefits payments for windfarms in Scotland that are linked to the transmission network, and operational as of April 2008.

¹⁹ In practice, these directors' share may be retained locally as these directors are likely to be Shetland Islands residents.

²⁰ Viking Energy (2007b) reports that the debt taken on by the community would be paid off within 10 to 11 years, so our figures for annual debt repayments may be lower than would be required, making our economic impact for this scenario optimistic. It may be said that the usual lifetime of onshore wind turbines of around 20 years (EWEA, 2009) could mean that a 20-year debt repayment horizon would be more conventional for such renewable energy capacities. Our results are reported here as being the economic impact under the situation where the windfarm exists and is operational, against that which is the (2003) level of economic activity as defined in the SAM.

²¹ There is, of course, a different SAM matrix for Scenarios A and B, giving the assumptions about the distribution of profits in each case.

²² Variations of this approach, in which supply can drive quantities, or in which price changes can be modelled, do exist, but they are unable to model quantities and prices simultaneously.

²³ These results for local (Shetland) GDP and employment impacts can be seen in Table A4.1 in Appendix 4 of Allan *et al* (2008b).

²⁴ The results of this sensitivity analysis are shown in Table A4.2 in Appendix 4 of Allan *et al* (2008b).

²⁵ That is, compared to the base year data.

²⁶ These can be seen in Figure 8 and Figure 9 of Allan *et al* (2008b).

²⁷ These can be seen in Figure 10 and Figure 11 of Allan *et al* (2008b).

²⁸ This would be straightforward using the modelling approach developed in this paper, but we do not pursue sensitivity given space constraints.

²⁹ Even if there were short-run supply constraints, so that wages (and rental rates) would be pushed up in the short-run, in a small island economy it might be reasonable to assume that in-migration (and investment) occurs until wages (and rental rates) return to their original (i.e. pre-shock) levels. This would generate similar results to IO, though population levels would differ (as would welfare effects), see McGregor *et al* (1996).