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THE IMPORTANCE OF REVENUE SHARING FOR THE LOCAL ECONOMIC IMPACTS OF A RENEWABLE ENERGY PROJECT: A SOCIAL ACCOUNTING MATRIX APPROACH

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The Importance of Revenue Sharing for the Local Economic Impacts of a Renewable Energy Project: A Social Accounting Matrix Approach

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Abstract
As demand for electricity from renewable energy sources grows, there is increasing interest, and public and financial support, for local communities to become involved in the development of renewable energy projects. In the UK, "Community Benefit" payments are the most common financial link between renewable energy projects and local communities. These are "goodwill" payments from the project developer for the community to spend as it wishes. However, if an ownership stake in the renewable energy project were possible, receipts to the local community would potentially be considerably higher. The local economic impacts of these receipts are difficult to quantify using traditional Input-Output techniques, but can be more appropriately handled within a Social Accounting Matrix (SAM) framework where income flows between agents can be traced in detail. We use a SAM for the Shetland Islands to evaluate the potential local economic and employment impact of a large onshore wind energy project proposed for the Islands. Sensitivity analysis is used to show how the local impact varies with: the level of Community Benefit payments; the portion of intermediate inputs being sourced from within the local economy; and the level of any local community ownership of the project. 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*, 2008). 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, 2007). It is currently likely that a significant share of this target will be met by on-shore and off-shore wind capacity, and that much of the new capacity will continue to be located in peripheral areas, away from existing population centres.

Conventional cost-benefit analyses (CBA) of energy projects can be an important input into the planning process. CBA analysis quantifies the relevant market and non-market impacts, and indicates whether an individual project makes a positive or negative contribution to economic welfare. However CBA analyses typically neglect the local economic development impacts of such projects.[1] Moran and Sherrington (2007) perform a CBA for an onshore windfarm proposal (the Clyde 620MW development in South Lanarkshire, Scotland). They consider the market and non-market costs and benefits of the project. Market costs include capital investment, operation and maintenance, extra balancing costs to the grid and land rental payments. Key non-market costs are CO_2 emissions during manufacture and construction and visual and noise use and non-use disamenity value. Market benefits are: output revenues, avoided fuel costs and avoided GDP losses, while non-market benefits are the avoided emissions of CO_2. Omitted from this analysis is the local economic stimulus that might arise from the development. However, in practice this is likely to be critical in determining whether the host community agrees to the implementation of any renewable energy project. 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.

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. The most sophisticated of these studies employ input-output (IO) tables that capture the structure of linkages among the production sectors of the local economy (Miller and Blair, 1985). 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 captured by a low (i.e. close to unity) IO output multiplier, signifying low indirect and induced impacts on economic activity from the windfarm[3].

However, while windfarms generally have low intermediate linkage with their host economies, they can generate significant 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. While an IO table only shows linkages associated with industrial production, a SAM provides details of all monetary flows within an economy. This would include transfers between agents, including profit payments. 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. Recently, Roberts (2005) uses SAM-based analysis to explore the transmission of economic disturbances between rural households and rural businesses for the Western Isles region of Scotland. More details on Social Accounting Matrices can be found in Round (2003) and Thorbecke (1998).

It has been acknowledged 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" (Centre for Sustainable Energy, 2005a, p. 6). Similarly work by Trent and Stout-Wiegand (1985) found stronger local support for projects which were anticipated to be beneficial for the local area[4]. Two alternative ways in which direct payments can be made to the local community is through Community Benefit (CB) schemes and local ownership[5]. 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 a renewable energy development. 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). Such 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. Appendix 1 shows the level of CB payments made by each of the fifty-seven operational windfarms in Scotland. 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. As mentioned in footnote 5, CB payments do not reflect the only financial links which operational windfarms can have with the communities in which they are located, but are perhaps the most obvious way in which local communities benefit from the development.

Over the last few years, in an increasing number of renewable energy projects the local community has taken an ownership share. One reason for this is the increasingly prevalent view that the problems faced in rural Scotland might be best addressed through social enterprises: "businesses with primarily social objectives – wider than employment provision and contribution to public revenue through tax –

that reinvest the surplus of their operations in the business or in the community rather than seeking to maximise profit for shareholders and owners" (Zografos, 2007, p. 38). Recent Scottish Government policy has acknowledged the potential for this ownership model, and has made changes to planning policy to support such developments (Scottish Government, 2007). Scottish Planning Policy 6 (SPP6): Renewable Energy (Scottish Executive, 2007, p. 6) explicitly states that "there is potential, particularly in rural areas, for communities to invest in ownership of renewable energy projects or to develop their own local projects for local benefit… planning authorities should put in place positive policies to enable communities to develop such initiatives…". On CB payments, SPP6 states that "local authorities may facilitate and encourage such initiatives" (Scottish Executive, 2007, p. 6). Since devolution, and the founding of the Scottish Parliament with powers to encourage renewable energy, the planning system has been recognised as a major tool through which policymakers can aid the growth of renewable energy technologies[6].

Financial support for Scottish communities wanting to develop renewable energy projects is available through a number of avenues, including the National Lottery Growing Community Assets programme, while advice and practical experience on seeking funding from these sources is provided by groups such as the Highlands and Islands Community Energy Company. This body started as a subsidiary of Highlands and Islands Enterprise, a government backed economic development agency, and will shortly become an independent not-for-profit group in its own right – Community Energy Scotland – extending the range of its remit across Scotland. At the UK level there is also advice for communities looking to secure benefits from renewable energy developments (e.g. Centre for Sustainable Energy, 2007, and TLT Solictors, 2007).

The 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 development and the Shetland Islands economy. 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 illustrate the issues raised in identifying the impact of renewable energy developments on local economic activity using the 600MW onshore windfarm that has been proposed for the Shetland Islands. 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. Second, 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, it is proposed that this windfarm would be jointly owned by Viking Energy Ltd (VEL)[7] and Scottish and Southern Energy (SSE). 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. 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 scale with Sullum Voe[8].

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 signed in July 2005, a “General Partnership” between these two organisations was signed in January 2007 (Shetland Islands Council, 2005 and 2007a), giving each VEL and SSE

Generation an equal share in this partnership. VEL is a limited liability company, with 90% of its shares now owned (as of December 2007) by the Shetland Charitable Trust.[9] 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 (2007b)).

With an expected total construction budget in the region of £580 million (Viking Energy, 2007b), and each partner required to find 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.

SCT is able to make an initial investment on this scale due to the considerable reserves which have been built up over the last thirty years from the revenues received through the deal with BP to establish and operate an oil terminal at Sullum Voe. As of December 2007, the reserves of SCT were estimated at £220 million (Wills, 2007) and so, while substantial, such an investment would represent around 25% of SCT's existing reserves.

Figure 1 shows the current proposed ownership structure for the Viking Energy Partnership operational windfarm on Shetland. Under Scenario B, presented in Section 3, we quantify the potential economic impact on Shetland of the revenues which might be retained locally under this ownership structure.

[Figure 1]

3. Methods

Some important characteristics of the proposed windfarm on the Shetland Islands 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 GB 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.

A SAM details the flow of money between sectors and final demand categories in an economy for a given spatial scale in a specific time period, most commonly a year. As with Input-Output tables they provide a snapshot of an economy and can be used for both accounting and, accepting certain assumptions, for modelling purposes (Thorbecke, 1998). Where IO tables provide details of income from production activities, SAMs include full details on all incomes, including, for instance, income from transfers (such as pension receipts, or other government transfers) or income from savings. 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 (Newlands and Roberts, 2006).

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 (these are given in Appendix 2); the returns to labour and capital factors of production; the forms of income accounts, showing where returns to labour and capital factors were earned; the household account, providing incomes and expenditures details for three categories of households in the Shetland Islands[10]; 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 might be considered within a SAM for the Shetland Islands. This requires the creation of an additional row and column in the table, corresponding to the operation of Viking Energy windfarm. The row contains one value, the exogenous exports of electricity from Viking Energy to the rest of Scotland. The column quantifies the intermediate purchases (from other production sectors in Shetland) and from imports and primary inputs, including payments to wages and payments to other value added. We also identify a separate row and column showing the distribution of profits from the windfarm across transactors within (and outside) the Shetland Islands economy and the domestic expenditures derived from such profits. Note that we do not currently model the impact of the construction phase of the windfarm[11].

Our first step is to identify the transactions which 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. Section 3.1 gives the sources of revenue for the windfarm, 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 – Scenario A, in which the communities link to the project is through Community Benefit payments, and Scenario B, in which the community makes an investment in the ownership of the project, and therefore retains a share of the profits. More detail on each of these items of revenue and expenditure are provided in Appendix 3. In the text, the revenue and expenditure figures have been calculated in 2003 prices, to make it 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 price[12]; 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. More details on each element are provided in Appendix 3.

[Table 1]

The amount of electricity produced will be a function of the rated capacity of the windfarm and the capacity factor (i.e. the expected electricity generated as a proportion of output if the farm was operated at maximum capacity for 100% of the time). We follow Viking Energy Ltd (2008) in assuming the 600 MW onshore windfarm capacity has a realisable capacity factor of 45%, implying an annual production of 2,365,200 MWh. The value of the electricity is obviously uncertain, but Viking Energy Ltd (2008) assume a range of between £20 and £40 per MWh. We assume the mid-point of this range is achieved, perhaps through the selling of output from the windfarm through a fixed-price Power Purchase Agreement (PPA). At £30 per MWh (in 2005 prices), the total revenue from sales of electricity is estimated as £67.6 million, after deflation to 2003 prices.

Accredited renewable generation in the UK earns Renewable Obligation Certificates (ROCs) for each MWh of electricity produced. Electricity supply companies must provide certificates to cover a growing share of the electricity they supply, and so renewable generators are able to sell their ROCs in a GB-wide market (which operates, in theory, independently of the sale of the electrical output of the windfarm)[13]. Viking Energy Ltd (2008) assume a unit price for each ROC of £26.59. This gives annual revenue from ROC sales (in 2003 prices) of £59.9 million. This is only £8 million less than the total revenues from the sale of electricity and reflects how important the ROC support mechanism is for the economics of onshore wind generation. Further, where electricity suppliers are unable to source ROCs to cover the required share of electricity they supply, they must pay the buyout price for each certificate they are short. The total value of the resulting buyout fund is recycled back to accredited renewable generators in proportion to each generator's share of total ROCs submitted in that period. Viking Energy Ltd (2008) assumes a recycled value per ROC of £5, implying annual (2003 prices) revenue from this source of £11.3 million. The figures we employ thus assume a price of £31.59 per ROC (including both the sale and recycled buyout elements).

Finally, renewable electricity generators also earn Climate Change Levy Exemption Certificates (LECs). The current rate for these LECs is 4.3p/kWh. Viking Energy Ltd (2008) assume that 80% of this rate is achieved, so each LEC earns 3.44p/kWh, giving a total additional revenue per year of £7.8 million in 2003 prices.

Summing across all sources of revenue, 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.

3.2 Windfarm operational expenditures

Total expenditures for an onshore windfarm in the UK consist of seven elements, and 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 maintain the facility. 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. Fifthly, 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. As with operational revenue, more details on the elements of expenditures are provided in Appendix 3.

[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 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 (covering parts and equipment for operation and maintenance) 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.

Local employment

Figures for the employment directly required by an operational windfarm vary depending on the assumptions made about the type and number of turbines, their need for servicing and the extent to which appropriately qualified staff can be sourced with the local economy. We estimate that the windfarm would have 53.65 FTE employees, meaning a total compensation of employees figure (after adjustment to 2003 prices) of £2.2 million.[14]

Local purchases

The island windfarm will make purchases from a range of intermediate sectors, locally and from the rest of Scotland, the rest of the UK and the rest of the world. As in Allan *et al*. (2007), we initially assume that there are no purchases from the Shetland economy from the operation of the windfarm, so that all elements required for production are imported into the Shetland economy. We explore the effects of changing this assumption in our sensitivity analysis.

Taxes paid to local and central government

We assume that taxes paid on products to central government make up the same proportion of total expenditure as was the case for the wind generation sector in Scotland in Allan *et al*. (2007). On a turnover of £146.6 million, the windfarm would contribute a total of £8.1 million in taxes to central government. For taxes paid to local government, the established mechanism is through payments of local business rates. We assume that the payments from the operational windfarm to local government in Shetland amount to £3000 per MW per year (in 2005 prices), giving a total annual payment from the windfarm (from rates) to local government of £1.7 million (in 2003 prices).

Imports to Shetland

We make the assumption that total imports to Shetland of parts for operations and maintenance constitute the residual between total operating expenditure after subtracting payments to wages and local and central government. The residual figure here is £24.1 million (in 2003 prices).

Charges for use of Transmission Network

All generators with installed capacity of greater than 10MW and suppliers of electricity connected to the transmission network (i.e. not to the distribution network) must apply for Transmission Entry Capacity (TEC), for which an annual Transmission Network Usage of System (TNUoS) charge is levied. Generators pay in relation to the size of the installed capacity, and their location in one of twenty one zones set by Ofgem. The major island groups of Scotland (i.e. Shetland, Orkney and the Western Isles) are not connected to the transmission network, and so do not have TNUoS tariffs. Uncertainty surrounding the likely TNUoS charges are reflected in the wide range of possible values used by Viking Energy for the Shetland windfarm, of between £40 and £100 per kW of installed capacity per year. We assume a TNUoS charge of £70 per kW per year, the mid point between these two figures. This translates to an annual payment by the operational windfarm of £40.0 million (in 2003 prices).

Payments to capital (Profits)

Since the column and row totals of the windfarm-augmented SAM must be equal (i.e. gross expenditures must equal gross revenues), we treat payments to capital as the residual income remaining after all the expenditures detailed above have been deducted from total revenue. As shown in Table 2 above, this totals £70.5 million per annum.

From the expenditure figures and summarised in Table 2, we can construct the new column representing the Viking Windfarm on Shetland. These are 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 payments) are very small, relative to turnover. 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 economic impacts. The potential importance of 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 an additional 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 to any of these regions from the Shetland economy will have no economic feedback effects on to the Shetland economy.[15] 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.

3.3.1 Scenario A

Rental payments to landowners

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". The Shetland SAM for identifies three categories of households – those with no children, those with children and retirees. In all, 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 the three categories of households featured in the SAM. Seventy-five per cent of this total 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.

Community Benefit payments

As noted above, renewable energy developers may also make Community Benefit (CB) payments. These are negotiated on a facility-by-facility basis and are currently the most widely used route by which owners of renewable energy projects provide funds to local communities. These payments are either based upon the installed capacity of the windfarm – and so the developer makes fixed real payments per MW annually (rising in line with inflation) – or payments are dependent on the productivity of the windfarm, and made per MWh of electricity actually generated. In some cases, lump-sum Community Benefit payments may also be made, but these are not linked to the operational activities of the windfarm (although they are likely to vary with capacity). Where lump-sum payments are made, these tend to occur whenever the construction of the windfarm is complete. Appendix 1 shows that a number of windfarm projects in Scotland combine all three of these Community Benefit mechanisms.

Existing CB payments from operational windfarms to local communities (described in detail in Appendix 1) lie between an equivalent of £1000 and £5000 per MW per year[16]. 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 equivalent to an annual payment of £3000/MW installed capacity. In sensitivity analysis in Section 4, we examine the economic impact of varying the level of this payment[17].

Transfers of profits outside Shetland

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 Shetland economy, and we assume that these profits have no additional impact on the Shetland economy.

Scenario A: Summary of distribution of profit income

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 represented in Figure 3. As with Figure 2, the value of profits to each category is given first (in £million), and the shares of total profits are given second. In the central case, almost 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.

[Figure 3]

3.3.2 Scenario B: 50% local share of ownership

Rental payments to landowners

We assume the same aggregate rental payments to landowners, and their distribution, as discussed above for Scenario A.

Community Benefit payments

We assume that since the community has an ownership stake in the project it does not receive CB payments as well.

Profits retained locally

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 50 per cent share of ownership profits from the operation of the development. As stated in Section 2 above, the remaining balance to fund SCT's 50% investment in the project costs will come from commercial borrowing. 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. The community funds held by Shetland Islands Council, through the SCT, make this level of investment in the proposed windfarm feasible for the Shetland community. It has been estimated that, as of late 2007, reserves of the SCT total around £214 million (Wills, 2007).[18]

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 an alternative expenditure vector, but in the absence of any relevant information, we do not pursue this further here. In fact, any charitable trust would be able to direct funds to projects as it desired, and so, in practice, their use of funds is unlikely to reflect exactly the pattern of existing local government spending. Further, as with revenue gained during the operation of Sullum Voe (Wills, 1991), we would also want to explore 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 the half share which goes to the partner to the Viking Energy partnership – SSE Generation – as this is earned by the subsidiary to Scottish and Southern Energy from its ownership stake in the operation of the windfarm. 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 locally[19]. 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). As discussed in Section 2, while a significant equity investment will be made by SCT in the upfront costs of the project, we assume that 80% of its share of the total project costs is raised through commercial borrowing, for which a commercial rate of interest will be payable. The specific terms of this borrowing will depend upon conditions in the market at the time that funds are sought. As stated in Section 2, 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 is towards the upper end of the size of the total equity investment that will be made by SCT. This leaves required commercial borrowing of £232 million. Assuming that these prices are in 2007 prices, 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 take an indicative rate of interest of 7.5%, giving an annual interest figure of £15.7 million. Subsequent years of operation will mean that the interest payment will either be lower, or this nominal repayment will be made in each year, in which case the original debt would be paid off in around 14 years[20]. Subtracting the debt repayment charge of £15.7 million from SCT total profit revenues 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. In total therefore, we estimate that £16.86 million annually will be retained and spent in the Shetland Islands economy under Scenario B.

Scenario B: Summary of distribution of profit income

We can now construct the new column for the Shetland SAM representing the distribution of profit income from the Viking Windfarm between transactors under Scenario B where the local community have a significant ownership stake. These results are represented in Figure 4. Again, the value of profits in each category is given first, and the share of total profits is given second. 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 as in Scenario A. But now £15.27 million (previously £1.72 million) is paid to the SCT as co-owner of the operational windfarm. In total the proposed organisation of the Viking Energy windfarm would retain around 24% of the total operational profits within the Shetland economy. Again, we explore the impact of varying this share in sensitivity analysis in Section 5.

[Figure 4]

4. Results: Direct Impacts, Scenario 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 additional column and row showing the treatments of profit incomes under the two central scenarios[21]. 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 (Miller and Blair, 1985). Conventional IO and SAM modelling assume that economic activity is demand-driven. Variants exist to this approach, in which supply can drive quantities, or in which price changes can be modelled, but is it not possible to model quantities and prices simultaneously. As such, any changes in economic competitiveness cannot be systematically modelled. In production, it is assumed that sectoral expenditure coefficients remain constant, in effect, that average and market costs of production remain equal and constant as output expands. Production functions are linear, so that with constant expenditure coefficients there are constant returns to scale between inputs and output (McCann, 2001). If output of a particular sector increases by 5%, for instance, the sector will increase its demand for all inputs by 5%. These assumptions are typically understood to be 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 3.

[Table 3]

These effects are large relative to the Shetland Island economy as a whole, particularly for GDP. In the initial SAM, the GDP of Shetland and level of employment were £333.4 million and 9109 respectively. The direct impact of the Viking Energy windfarm therefore raises GDP and employment respectively by 21.8% and 0.6%. 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 the Shetland economy, 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. This 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.

The sectoral economic activity and employment impacts can be seen in Figure 5. All sectors show a positive stimulus. This is because we assume that there is no crowding out of economic activity, for instance, through raising prices and drawing in labour or capital from other sectors. 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. This shows that our assumption about the use of community funds is crucial for sectoral results.

[Figure 5]

4.3 Scenario B

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 £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 in Scenario B (15.39) is more than tripled.

The estimated impact on aggregate GDP and employment is very large – raising these by 28.5 per cent and over 9 per cent respectively. The impacts on sectoral economic activity is shown in Figure 6. While the pattern of sectoral changes is similar to Scenario A, note the change in the scale of the vertical axis. 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.

[Figure 6]

5 Results: Sensitivity Analysis

5.1 Sensitivity to levels of Community Benefit payments

As discussed above (and detailed in Appendix 1), a wide range of Community Benefit payments have been made 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). We show the results for local (Shetland) GDP and employment impacts in Table A4.1 in Appendix 4. We see that the marginal percentage impact of an additional £500/MW on employment are ten times as large as for GDP.

We can solve the model to find the level of Community Benefit payments necessary to be paid to the local community under Scenario A to produce the same impact upon GDP and employment as the results seen in Scenario B. We find that this is 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

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 possibility of using local manufacturing facilities for elements of construction, if doing so was economically viable. As noted above, in this paper we abstract from the construction phase of the project, but in theory the same argument extends to the local sourcing of elements for the operation and maintenance of the windfarm. For a windfarm we estimate annual operating (i.e. non-wage, and non-tax) costs of £24.1 million (in 2003 prices). We would expect there to be beneficial local economic impacts from local sourcing of the parts and servicing needed by the windfarm.

We consider the impact of varying our assumption about the extent of local sourcing for intermediate inputs. In both scenarios presented above, we assumed zero per cent of operating costs were spent locally. Five alternative scenarios are considered, and compared against the results obtained for Scenario A:

- 5 per cent local sourcing
- 10 per cent local sourcing
- 15 per cent local sourcing
- 20 per cent local sourcing
- 50 per cent local sourcing

In all cases, the payments to the community through Community Benefit payments remain at £3000/MW, taxes paid to local government remain unchanged, as do payments to the council/community and private households for land rental. All that varies in the five scenarios shown above is that greater shares of the intermediate purchases are made within Shetland, with an equivalent decrease in imports into Shetland.

As we have no information about the sectoral purchases of the proposed windfarm (for the cases where positive purchases are made directly from local economy), we construct an “expected” expenditure vector to represent the pattern of local purchases. This is based upon the expenditure vector for the Shetland Marine engineering sector (sector 8 in the original SAM), as we might expect that any local purchases made in the operation and maintenance of the Viking Energy windfarm would require purchases similar to those of this manufacturing sector.

The results of this sensitivity analysis are shown in Table A4.2 in Appendix 4. Further increasing the degree of local sourcing – reading down the columns in Table A4.2 – it is clear that there are low expected economic impacts from quite sizeable increases in the portion of operating expenditures sourced locally. To increase local sourcing to 20% only increases the change in GDP by 6%. If the (publicly borne) costs of providing appropriately skilled staff, facilities, and equipment were large, it might be expected that these would outweigh any expected economic boost to the local economy. As with the results reported in Section 5.1, the marginal proportionate impacts on employment change are significantly greater than for GDP.

Increasing the local sourcing to 10 per cent of operating expenditures produces changes also 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 7.

[Figure 7]

Compare Figure 7 with Figure 5, where local sourcing is 0%. 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 output of these sectors increases in total[22] by 21.1 per cent, 15.2 per cent, 4.3 per cent and 7.6 per cent respectively.

5.3 Joint sensitivity to Community Benefit payments and local sourcing of intermediate inputs

In previous subsections either the share of local sourcing of intermediate inputs or the level of community benefit payments respectively remained constant. We now report the aggregate impacts when these categories are jointly varied. Figures 8 and 9 show the GDP and employment impacts of simultaneously varying the CB payments and the degree of local sourcing.

[Figure 8]

[Figure 9]

Scenario A occurs with zero per cent share of intermediate inputs sourced locally, and Community Benefit payments of £3000/MWh. In this scenario, the estimated GDP impact on Shetland is £78.9 million and the impact on Shetland employment is 270. Starting from this central case and increasing the share of intermediate inputs sourced locally has little impact upon the aggregate GDP effect. (See also Table A4.2 in Appendix 4). Also, simultaneously varying the amount of Community Benefit from the central case scenario has a similarly muted effect on aggregate output change in the Shetland economy.

5.4 Sensitivity to ownership profits retained locally

Varying the degree of profits which are retained locally will clearly have implications for the scale of the local economic impact. We now investigate the impact of varying our assumption about the extent of local ownership. Seven alternative scenarios are considered, and can be compared against the results obtained from both Scenario A and Scenario B (recall from Section 3.3.2 that in Scenario B around 22% of ownership profits are retained within the local economy through the SCT's stake in ownership):

- 5 per cent
- 10 per cent
- 15 per cent
- 20 per cent
- 50 per cent
- 75 per cent
- 100 per cent

In all cases, the payments to the community through taxes paid to local government remain unchanged, as do payments to the council/community and private households for land rental. All that varies in each scenario is the portion of total profits that remains within the Shetland Islands. Thus, for scenarios with higher share of locally retained profits, the large leakage of profits from Shetland evident in Figure 3 is reduced. In each of these scenarios, we make the further assumption that there are no Community Benefit payments, given that there is community ownership. Local sourcing of intermediate inputs remains at zero per cent. Table A4.3 in Appendix 4 shows the impacts on GDP and employment for both the central case and when we increase the share of local ownership.

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.

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

In previous subsections we have kept constant either the share of local intermediate inputs sourced locally or local ownership of the proposed onshore windfarm. We now report the aggregate impacts when these shares are jointly varied. The effects on Shetland GDP are summarised in Figure 10.

[Figure 10]

We take as a reference scenario the one with zero per cent share of intermediate inputs sourced locally, and zero per cent local ownership. Figures 10 and 11 then show the sensitivity of the GDP and employment change figures to variations in the degree of local ownership and the share of intermediate inputs sourced locally. For the reference scenario, the estimated GDP impact on Shetland is £76.9 million. Increasing the share of intermediate inputs sourced locally has little impact upon the aggregate GDP effect. (See also Table A4.2 in Appendix 4). However, varying the share of ownership from the reference scenario has a much more dramatic impact. The same pattern is observed for the estimated Shetland employment impact, shown in Figure 11. Local ownership matters significantly more for local economic impact than does local sourcing of intermediate inputs, in this case at least.

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 varied, as greater information became available about the likely use of the relevant income flows. Where the expenditure of these revenues has positive supply-side effects the present analysis is unable to capture them.

[Figure 11]

5.6 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 report, 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 report, 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 report, 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.

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 small 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.

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 is not a reasonable assumption for some local or island economies. Where 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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Appendix 1: Operational Scottish onshore wind farm Community Benefit regimes

Name	**Capacity (MW)**	**Year commissioned**	**Initial lump sum to community?**	**Approximate equivalent annual CB figures per installed MW (£)**	**A fixed annual payment(normally index-linked)?**	**An annual payment linked to output?**
Ardrossan	24	2004	Y	750	Y	N
Artfield Fell	19.5	2005	-	-	-	-
Beinn an Tuirc	30	2001	N	c. 2500	Y	Y
Beinn Ghlas	8.4	1999	N	1109	Y	N
Ben Aketil	23	2007	N	1391	Y	Y
Bilbster	3.9	2008	-	-	-	-
Black Hill	28.6	2007	N	c. 2500	Y	Y
Black Law A	97	2005	N	1000	Y	N
Black Law B	27.6	2006	N	1000	Y	N
Bowbeat	31.2	2002	N	2000	Y	N
Boyndie Airfield	20	2006	N	700	Y	N
Braes O'Doune	72	2007	Y	1389	Y	N
Bu Farm	2.7	2002	Y	2222	Y	N
Buolfruich	13	2005	N	0	N	N
Burradale	1.98	2000	-	-	-	-
Burradale extension	1.7	2003	-	-	-	-
Burray	0.85	2005	N	235,294	N	Y[a]
Causeymire	55	2004	Y	1150	Y	N
Cruach Moor	29.75	2004	N	765	Y	N
Crystal Rig	62.5	2004/2007	Y	700	Y	N
Deucheran Hill	15	2001	N	c. 2500	Y	N

Dummuie	10.4	2007	N	c. 2000	Y	N
Dun Law	17.6	2000	N	2000	Y	N
Earlsburn	35	2007	N	1000	Y	N
Farr	92	2006	Y	1157	Y	N
Findhorn Foundation	0.75	2006	N	c.350	Y	n
Fintry (the FREE turbine)	2.5	2007	N	20,000-40,000[c]	N	Y[c]
Forss 1, Hill of Lybster	2.32	2003	N	0	N	N
Forss, Extension of Hill of Lybster	5.2	2007	N	0	Y[b]	N
Gigha Community	0.675	2004	N	c118,500	N	Y[d]
Greendykeside Wind Farm	4	2007	-	-	-	-
Hadyard Hill, Barr	120	2006	N	1000	Y	N
Hagshaw Hill	15.6	1995	N	1090	Y	N
Hare Hill	13	2000	-	-	-	-
Hill of Balquhindachy	0.85	2007	N	c. 2000	Y	N
Hill of Eastertown	1.7	2007	N	c. 2000	Y	N
Myres Hill	1.9	2001	-	-	-	-
Novar	17	1997	N	1000	Y	N
Paul's Hill	64.4	2006	N	700	Y	N
Rothes (Cairn Uish)	50.6	2005	N	700	Y	N
Sigurd	1.3	2000	-	-	-	-
Spurness	11	2005	N	2273	Y	Y

Wind Farm						
Tangy	12.75	2002	N	c. 2500	Y	N
Thorfinn, Burgar Hill	2.75	2002	-	-	-	-
Wardlaw Wood	18	2006	-	0	-	-
Windy Standard	21.6	1996	N	641	Y	N
WWB Burgar Hill	6	2001	Y	1250	Y	N

Sources: Power stations taken from BWEA database of UK renewable energy facilities in Scotland and various websites. The authors are responsible for any errors or omissions from the above table and would welcome any comments on, or corrections to, these data. We acknowledge the other types of financial links, aside from CB payments, which may exist between operational windfarms and the local community, in footnote 5.

Notes:

[a] Burray project was fully funded by local investment, so all revenues to owners remain within Orkney.

[b] A Community Benefit scheme will be established, but no details have yet been confirmed.

[c] The Fintry community have ownership of a turbine at the Earlsburn windfarm. Constructed at the expense of the developer of the Earlsburn site, the community receives between £50,000 and £100,000 per year over the first 15 years of this project, with anticipated revenues of between £400,000 and £500,000 once the turbine has been paid back from revenues.

[d] The Gigha Community own and operate the windfarm, with returns (net profit, after payment of tax and interest) of around £80,000 for the most recent year. The windfarm is expected to be debt free in 2009, when the net profit to the Isle of Gigha Heritage Trust – acting on behalf of the community – could rise to between £100,000 and £150,000.

“Y” in the last two columns indicates that some of the annual Community Benefit is based upon a fixed amount, which might be indexed-linked, or linked to the annual output of the windfarm. “N” indicates that this is not the case.
Cells marked with “-“ indicate that we are awaiting responses from the owner of the windfarm to our request for further information.

Appendix 2: Production sectors in Social Accounting Matrix for Shetland, 2003 (Newlands and Roberts, 2006)

Sector number	Name	SIC 2003 code
1	Agriculture	01,02
2	Fish catching	05.01
3	Aquaculture	05.02
4	Oil terminal	11
5	Mining and quarrying	10,12,14
6	Manufacturing: Fish processing	15.20
7	Manufacturing: Other food and drink processing	15 (excluding 15.20)
8	Manufacturing: Marine engineering	35.11, 35.12
9	Manufacturing: Textiles and crafts	17,18
10	Other manufacturing	19 -34, 35 (excluding 35.11 and 35.12), 36, 37
11	Electricity, gas and water supply	40,41
12	Construction	45
13	Wholesale	51
14	Retail	50, 52
15	Accommodation	55.1, 55.2
16	Catering (including pubs and social clubs)	55.3, 55.4, 55.5
17	Ports and harbours	63.1, 63.22 (part)
18	Transportation, Sea	61
19	Transportation, Land	60, 63.21
20	Transportation, Air	62, 63.23
21	Oil supply services	63.22 (part)
22	Communications and Supplier Services	64
23	Financial services	65, 66, 67
24	IT/computer related and real estate services	70, 71, 72
25	Technical, Professional, other business services	73, 74
26	Public administration - Local/Central	75 (part - local government)

27	School Education	80.1, 80.21
28	College Education	80.22, 80.3
29	Health	85.11, 85.12, 85.14 (part)
30	Social work and other services	85.13, 85,14 (part), 85.20, 85.3
31	Other community, social and personal services	75 (part - central government), 80.4, 90 - 93,95 - 97,99

Appendix 3: Detailed assumptions for revenues and expenditures for an operational 600MW onshore windfarm on Shetland

A2.1 Revenues

A2.1.1 Sale of electricity

As noted in the text, the amount of electricity produced in any period by the operational windfarm will be a function of the rated capacity of the windfarm and the capacity factor (i.e. the electricity generated as a proportion of the maximum output if the farm was operated at maximum capacity for 100% of the time). See Sinden (2005) for an introduction to the analysis of the UK wind resource, and the estimation of the possible energy that might be extracted from it. The Burradale Wind Farm, beginning operation on Shetland in 2000, currently has five-turbines and a total of 3.68MW of installed capacity. This windfarm has recorded an operational annual capacity factor of 52%. Per unit of installed capacity, this makes the Burradale Wind Farm the most productive in the world (Energy from the Edge, 2007). Viking Energy Ltd (2008) assumes a 45% capacity factor meaning that an operational windfarm with an installed capacity of 600MW would produce 2,365,200MWh in a year[23]. This is more conservative than the 48% capacity factor used for Shetland in IPA Energy and Water Economics (2008), although Econnect (2008) note that a major developer in the region has advised that a range of 45-48% is appropriate.

The value of the electricity produced is obviously uncertain, but may be assumed to lie in the range of £20 to £40 per MWh (Viking Energy, 2007). We assume an average price of electricity of £30 per MWh electricity produced, giving a total (in 2003) prices of £67.6 million.

A2.1.2 Sale of Renewable Obligations Certificates (ROCs)

The Renewables Obligation is a requirement on electricity suppliers to provide a growing portion of their electricity from accredited renewable energy generation (Ofgem, 2007). Each accredited generator earns one Renewable Obligations Certificate per MWh of generation[24]. The electricity supply company must provide certificates to Ofgem (who administer the ROC programme) covering a growing share of their electricity sales during each year. The share of generation for which ROCs must be provided began at 3% of electricity supplied in 2002-3, is 9.1% in 2008-9 and will rise to a current maximum of 15.4% in 2015-16, where it is currently proposed to remain until March 2027. Certificates can be bought from accredited generators which use renewable energy sources, traded in the ROC market by intermediaries or traded between suppliers. This creates a market for a good that can be sold independently of the electricity generated by the windfarm.

Viking Energy Ltd (2008) assume a ROC price of £33.24, but since electricity is sold through a PPA, they assume that a discounted ROC value equivalent to 80% of this price is received. This gives a unit price for each ROC of £26.59[25]. With the annual (MWh) generation figure above, this gives annual revenue from ROC sales (in 2003 prices) of £59.9 million.

A2.1.3 Recycled value from ROC buyout fund

Where electricity suppliers cannot provide ROCs for their requirement they must pay the buyout price, set by Ofgem, for each certificate which they are short. This began at £30.00 in 2002-3, was set at £33.24 in 2005, and increases annually in line with RPI inflation. This effectively sets a "ceiling price" on the premium paid for renewable electricity generation, and "limits the cost of compliance to the supplier and hence the costs to the consumer" (REIC, 2002). All suppliers who are not able to meet the share of generation necessary through submitting ROCs must pay the buyout price for each ROC they are short, with these payments collected into a buyout fund. The total value of the buyout fund is recycled back to accredited renewable generators in proportion to each generator's share of total ROCs submitted in that period. For the five years between 2002-3 and 2006-7, the buyout price paid by suppliers in Scotland for each ROC was £23.55, £23.70, £19.99, £10.21 and £16.04 respectively (Ofgem, various years). In 2005-6, the buyout price was considerably lower due to a far greater share of suppliers obligations met by ROCs (86%) and thus a significantly smaller buyout fund to be redistributed – down from £17.6 million in 2004-5 to £7.1 million in 2005-6. Viking Energy Ltd (2008) assume a recycled value per ROC of £5, implying an annual (2003 prices) revenue of £11.3 million.

A2.1.4 Sale of Climate Change Levy Exemption Certificates

As well as ROCs, electricity generation from renewable sources has, since 2001, also earned Climate Change Levy Exemption Certificates (LECs). These are paid by the consumer of electricity, and the current rate for these LECs, which are set in the Finance Act, is 4.3p/kWh. Viking Energy assume that 80% of this rate is achieved, so each LEC earns 3.44p/kWh. This means additional revenue to the 600MW windfarm (in 2003 prices) of £7.8 million in a typical year. Unlike the sources of revenue detailed in Sections A2.1.1-A2.1.3, this revenue will not vary with either the price of electricity or changes in the nature of the ROC market.

A2.2 Expenditures

We employ Viking Energy estimates of total operational expenditures include the costs of employment, local purchases, and both local and central government taxes (but exclude Transmission Network Usage of System (TNUoS) charges). In their publicly stated calculations, Viking Energy employs an average operational cost estimate of £16/MWh, lying at the midpoint between estimates of £14/MWh and £18MWh. Previous work for Scottish Enterprise (O'Herlihy and Co, 2006) uses a figure of £17/MWh for the operational expenditures for Scottish windfarms. For the purposes of this paper, we follow Viking Energy (2008), and assume £16/MWh for the total of these operational costs. As explained in Section A2.1 above, this exemplar windfarm is expected to generate 2,365,200 MWh per year. This then implies total annual operational expenditures of £37.8 million. We obtain independent estimates of local employment, local purchases and taxes paid to local and central government below. We assume that any difference between total operational expenditures and the sum of these three elements (covering parts and equipment for operation and maintenance) is spent on imports to Shetland.

The TNUoS charges which will apply are then estimated. Finally, payments to capital are calculated as the residual between total windfarm revenues and the sum of all other expenditures. In Section A2.3, we consider the central case assumption about the use of the windfarm's profits.

A2.2.1 Local employment

In terms of the employment directly required by an operational windfarm, estimates vary depending on the assumptions made about the type and number of turbines, their need for servicing and the extent to which appropriately qualified staff can be sourced with the local economy. Viking energy, for instance, say that there will be 80 full-time equivalent skilled positions during the operational stage for the windfarm (this compares to an estimated 110 FTE jobs created during the construction stage). We consider this to be towards the upper end of possible direct employment impacts for the windfarm for a number of reasons.

O'Herlihy and Co (2006) estimate that 30 days servicing a year are required for a (2MW) turbine, and that an FTE servicing worker will work 220 days per year, at an average hourly rate of £11. Using these same figures, the 600MW planned windfarm, therefore, would require 6000 servicing days a year, and with 220 days per worker per year, gives a total of 27.3 FTE servicing workers required per year. Using an average hourly wage as given by O'Herlihy and Co (2006), the total direct costs would be £19,360 (2005 prices). Previous IO work (Allan *et al.*, 2007) found average total labour costs for wind generation to be £42,342 per worker per year (2000 prices). Currently, we have used the mid-point between 27 and 80 for the number of FTE employees of the windfarm (53.65) and the higher labour cost figure (from Allan *et al.*, 2007), giving a total compensation of employees figure (after adjustment to 2003 prices) of £2.2million.

A2.2.2 Local purchases

The island windfarm will make purchases from a range of intermediate sectors, locally and from the rest of Scotland, the rest of the UK and the rest of the world. Previous work has shown that the backward linkages between operational Scottish onshore windfarms and intermediate sectors in the Scottish economy is very low (Allan *et al.*, 2007). Clearly, the portion of expenditures for the windfarm that are made locally will have implications for the local economic impact, and we will explore this in the sensitivity analysis.

Viking Energy talks about securing some of the business of the operational Shetland windfarm, through support and logistical businesses and engineering fabrication. At the construction stage of this windfarm, O'Herlihy and Co (2006) notes that "capital expenditure is, and will be, non-Scottish without intervention". Proposals for Viking Energy are that a local manufacturing facility should be considered for "components such as the turbine blades", but notes "this will not be advanced unless there is confidence in the sustainability of such a venture". We do not include the construction phase here, and it is assumed that if there is any replacement necessary that these are not sourced from within the Shetland economy. Even if a local manufacturing base, skilled in constructing turbine blades, for instance, is developed, this may have little impact on the sourcing of continuing expenditures.

As with the work in Allan *et al*. (2007), we initially assume that there are zero purchases from the Shetland economy from the operation of the windfarm, so that all elements required for production are imported into the Shetland economy. We explore the effects of changing this assumption in our sensitivity analysis.

A2.2.3 Taxes paid to local and central government

In terms of taxes paid on products to central government, we assumed the same portion of total expenditure as was the case for the wind generation sector in Scotland in Allan *et al*. (2007). This was 5.5 per cent of turnover, so that, for a turnover of £146.6 million, the windfarm would contribute a total of £8.1 million (in 2003 prices) in taxes to central government.

For taxes paid to local government, the established mechanism is through payments of local business rates. O'Herlihy and Co Ltd (2006) assume these to be around £2500 per installed MW (in 2005 prices). We assume that the payments from the operational windfarm to local government in Shetland amount to £3000 per MW per year, giving a total annual payment from the windfarm (from rates) to local government of £1.7 million (in 2003 prices).

A2.2.4 Imports to Shetland

We make the assumption that total imports to Shetland of parts for operations and maintenance constitute the residual between total operating expenditure (calculated in 2.2 above) after subtracting payments to local wages for local employment and payments to local and central government. The residual figure here is £24.1 million (in 2003 prices).

The local content of intermediate purchases is assumed to be zero (as explained above), but this assumption is varied in later sensitivity analysis. Imports from the rest of Scotland, the rest of the UK and the rest of the world do not drive any economic activity in the (single-region) SAM model we employ here, so the division among these transactors is not be important for our results. However, we make the working assumptions that 83 per cent of imports come from the rest of the UK (including 43 per cent from the rest of Scotland), with 17 per cent coming from the rest of the World.

A2.2.5 Charges for use of Transmission Network

All generators with installed capacity of greater than 10MW and suppliers of electricity connected to the transmission network (i.e. not to the distribution network) must apply for Transmission Entry Capacity (TEC), for which an annual Transmission Network Usage of System (TNUoS) charge is levied. Generators pay in relation to the size of the installed capacity, and their location in one of twenty one zones set by Ofgem. Charges are designed to recoup the costs to National Grid (who operate the Great Britain transmission system) of maintaining the transmission system (Xero Energy Ltd, 2007). Only twenty seven per cent of the total cost is recouped from generators, with the balance paid by suppliers of electricity.

As mentioned above, these charges differ dependent on what “zone” generators are located in. Designed by Ofgem to be cost reflective, generators and suppliers are charged more the further away the generation facility is from centres of demand for electricity. The outcome of this is that charges are low in the south of England, where demand is strong and currently there is a “paucity” of generation, and high in the north of Scotland, where the opposite is the case (DTI, 2005). The full generation tariffs by zone are given in Table A2. The islands of Scotland (i.e. Shetland, Orkney and Western Islands) are not connected to the transmission network, and so are not currently included in this table.

Table A2: Generation transmission charges, 2005/6

Zone	*Zonal tariff (£/kW)*
Skye	23.10
North Scotland	20.93
Western Highlands	18.92
Peterhead	18.16
Cruachan	15.85
Central Highlands	15.36
Argyll	13.44
Stirlingshire	12.61
South Scotland	11.82
Dinorwig	8.71
North East England	8.09
Anglesey	6.12
Humber, Lancashire and SW Scotland	4.91
South Yorkshire and North Wales	3.12
Midlands and South East	1.32
North London	-0.22
Oxon and South Coast	-0.70
South Wales and Gloucester	-2.55
Wessex	-4.95
Central London	-5.71
Peninsula	-8.04

Source: DTI (2005), Table 1

For generators in Scotland, those connected to the transmission network at 132kV are not subject to the charge, since this is not classed as a transmission line in

England and Wales. Plants with installed capacity of less than 10MW are not charged either.

These charges are designed to encourage generation facilities to be located closer to centres of community demand, minimising losses from the transmission network and therefore reducing overall costs to the consumer. The charges were accepted by Ofgem in February 2005, however the charges which would apply for the Orkney/Shetland and Western Isles were not set out at this time. A cap on the charges from these Islands was announced in March 2005, but the charging regime has yet to be finalised. These charges have unsurprisingly attracted significant criticism from renewable energy advocates and politicians in Scotland. These groups have argued that these charges are excessive, and penalise precisely those peripheral areas of Scotland and the UK, which often have the greatest renewable energy resource. This is seen as putting at risk the declared UK renewable energy targets by rendering what otherwise would be viable renewable energy projects uneconomical.

Uncertainty surrounding the likely scale of the charges are reflected in the wide range of possible values used by Viking Energy for the Shetland windfarm, of between £40 and £100 per kW of installed capacity per year. A number of authors (including Xero Energy Ltd, 2007) have implied that this charging methodology is in contravention of European Commission policy, which states:

> "Member states shall ensure that the charging of transmission and distribution fees does not discriminate against electricity from renewable energy sources, including in particular electricity from renewable energy sources produced in peripheral regions, such as island regions".

One other perspective on the levels of TNUoS charges is that the proposed charges are appropriate, and entirely in line with the current remit of Ofgem to minimise the cost of electricity paid by consumers. If developments in remote areas are to be encouraged it would seem that either the remit should be changed, or existing support mechanisms (e.g. such as ROCs) should be banded by area (perhaps as well as by technology) to encourage specific developments in specific areas.

A2.2.6 Payments to capital

Since the column and row totals of the windfarm-augmented SAM must be equal (i.e. gross expenditures must equal gross revenues), we treat payments to capital as the residual income remaining after all the expenditures detailed above have been deducted from total revenue. As shown in Table 2 above, this totals £70.5 million per annum.

A3.1 Distribution of profits

A3.1.1 Rental payments to landowners

To estimate the total rental payments to each category of landowners, we need four pieces of additional information:

- What determines the annual payments by the owners of the windfarm to owners of the land on which the windfarm sits?
- What portion of the land planned for the Viking Energy windfarm is under alternative types of ownership (i.e. owned by council, private landowners and crofters respectively)?
- How are land rental payments to private landowners disaggregated across the three household categories?
- At every stage, what portion of the payments to each category of landowner remains within the Shetland economy?

On the first question, O'Herlihy and Co (2006) suggest that the annual payments to landowners are made in relation to the size of the windfarm, i.e. per installed capacity (in MW). In this paper we also assume this, and follow O'Herlihy and Co (2006) in using annual payments of £3k per MW (2005 prices) installed. For the 600MW Viking Energy windfarm this suggests an annual rental payment of £1.7million (in 2003 prices). We now need to attempt to disaggregate this total land rental payments between the categories of land ownership.

Published information on the location of the proposed windfarm, and the correlation of that to existing ownership of land on Shetland, is not publicly available. In the absence of this information, and in the knowledge that these will likely be incorrect, we proceed on the assumption that of all the land used by the windfarm, the Shetland Islands council/community owns 80 per cent, private landowners (without crofters) own 10 per cent and private landowners (with crofters) own the remaining 10 per cent. Following the quotation from Viking Energy above, we split the rental payments to private landowners with crofters 50:50, such that five per cent of total rental payments to landowners are assumed to go to resident crofters, and private landowners receive 15 per cent in total.

For private landowners, we assume that half (fifty per cent) of these are resident in Shetland, with the implication that half of the payments from the windfarm to private landowners are transferred out of Shetland. We assume that all payments made to crofters remain in Shetland.

For the distribution of private landowner incomes (remaining in Shetland) across household categories we have used the distribution of income from rentals from the existing SAM. Using these shares means that we allocate 12.3 per cent of these total funds to households with no children, 85.1 per cent to households with children and 2.6 per cent to retired households. Alternative assumptions could be made, but they would not have a significant impact upon aggregate results. For the distribution of crofters' income, we have used the pattern of incomes from self-employment. This gives 37.8 per cent of these funds to households with no children, 61.0 per cent to households with children and 1.1 per cent to retirees.

Appendix 4: Results from sensitivity analysis

Table A4.1: GDP and employment impacts of variations in level of Community Benefit payments

	Level of Community Benefit payments (£k)												
	0	*0.5*	*1*	*1.5*	*2*	*2.5*	*3*	*3.5*	*4*	*4.5*	*5*	*5.5*	*6*
GDP impact	76.7	77.2	77.5	77.9	78.2	78.6	78.9	79.2	79.6	79.9	80.3	80.6	80.9
Marginal increase in GDP (%)	-	0.65	0.39	0.52	0.39	0.51	0.38	0.38	0.51	0.38	0.50	0.37	0.37
Employment impact	199	211	223	234	246	258	270	282	294	305	317	329	341
Marginal increase in employment (%)	-	6.03	5.69	4.93	5.13	4.88	4.65	4.44	4.26	3.74	3.93	3.79	3.65

Table A4.2: Impact on Shetland of 600MW island windfarm, sensitivity in GDP and employment to level of local sourcing of intermediate inputs under Scenario A

Degree of local (i.e. Shetland) sourcing	*GDP change (£million)*	*Marginal increase in GDP change (%)*	*Employment change (FTE jobs)*	*Marginal increase in employment change*
Zero per cent (Scenario A)	78.9		270	
5 per cent	80.0	1.39	314	16.30
10 per cent	81.1	1.38	359	14.33
15 per cent	82.2	1.36	403	12.26
20 per cent	83.3	1.34	447	10.92

Table A4.3: Impact on Shetland of 600MW island windfarm – with variation in the extent of ownership profits retained locally

Percentage of residual profits retained locally	*GDP change (£million)*	*Marginal increase in GDP change (%)*	*Employment change (FTE jobs)*	*Marginal increase in employment change*
5 per cent	81.0		341	
10 per cent	85.1	5.06	484	41.94
15 per cent	89.2	4.82	627	29.55
20 per cent	93.3	4.60	769	22.65
Scenario B	95.0	1.82	831	8.06
50 per cent	117.8	24.00	1625	95.55
75 per cent	138.3	17.40	2338	43.88
100 per cent	158.8	14.82	3051	30.50

Table headings

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

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

Table 3: Impact on Shetland of 600MW island windfarm, Direct and under two scenarios

Table 1

Revenue category	*Unit value assumed (2005 prices, before deflation)*	*Total estimated annual revenue (2003 prices)*
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
Total	*£65.03 per MWh*	*£146.6 million*

Table 2

Expenditure category	*Total estimated annual expenditures (2003 prices)*
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
Total	*£146.6 million*

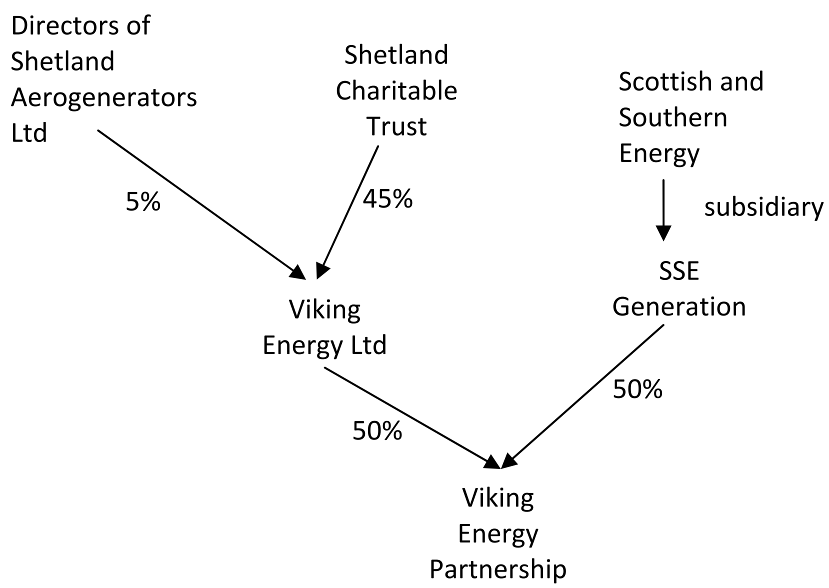
Table 3

	Direct Impact	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
GDP (£million) GDP multiplier	72.6 (ΔGDP_I)	78.9 (ΔGDP_{TA}) 1.09	95.0 (ΔGDP_{TB}) 1.31
Employment (FTE jobs) Employment multiplier	54 (ΔE_I)	270 (ΔE_{TA}) 5.00	831 (ΔE_{TB}) 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.

Figure captions

Figure 1



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

Figure 2

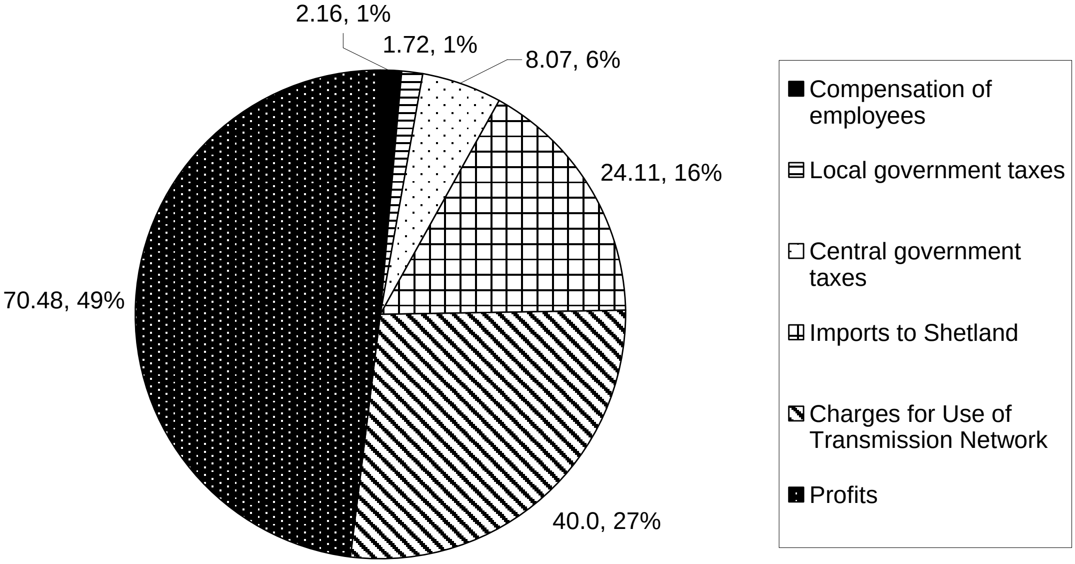

2.16, 1%
1.72, 1%
8.07, 6%
24.11, 16%
40.0, 27%
70.48, 49%
Compensation of employees
Local government taxes
Central government taxes
Imports to Shetland
Charges for Use of Transmission Network
Profits

Figure 3

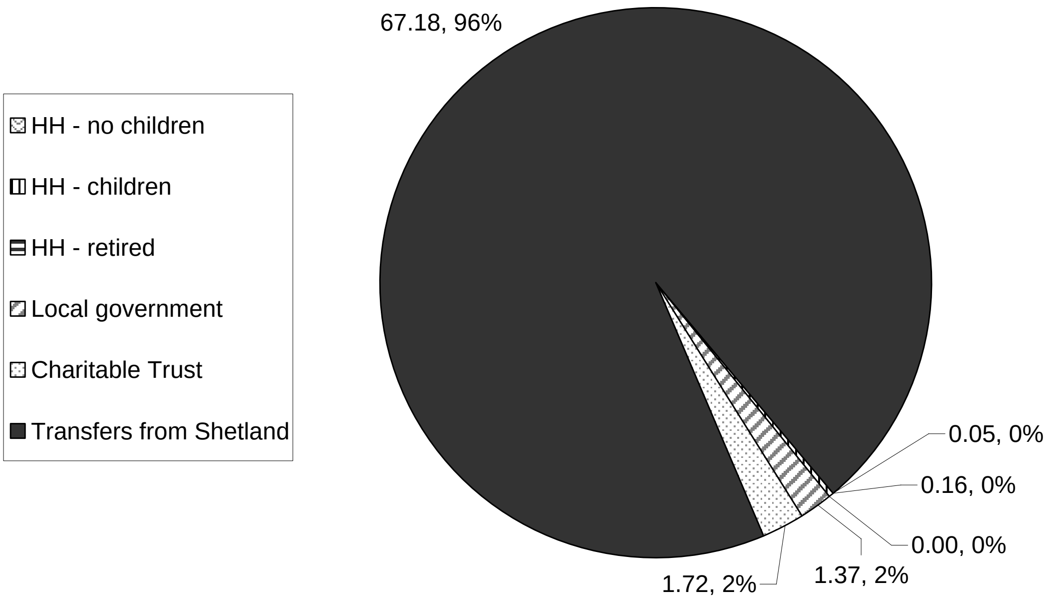
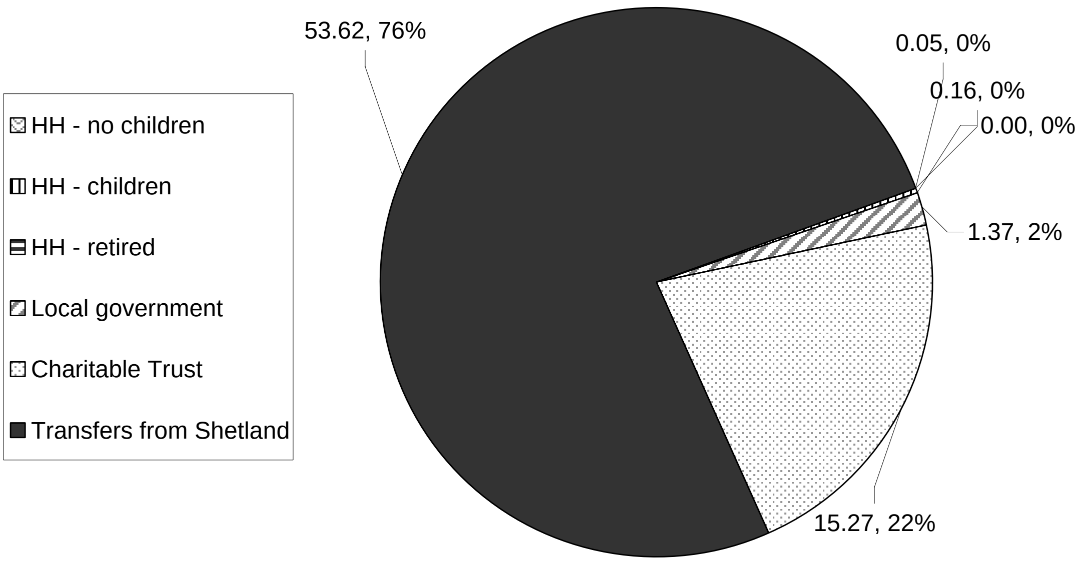

67.18, 96%
HH - no children
HH - children
HH - retired
Local government
Charitable Trust
Transfers from Shetland
0.05, 0%
0.16, 0%
0.00, 0%
1.72, 2%
1.37, 2%

Figure 4



HH - no children
HH - children
HH - retired
Local government
Charitable Trust
Transfers from Shetland
53.62, 76%
0.05, 0%
0.16, 0%
0.00, 0%
1.37, 2%
15.27, 22%

Figure 5

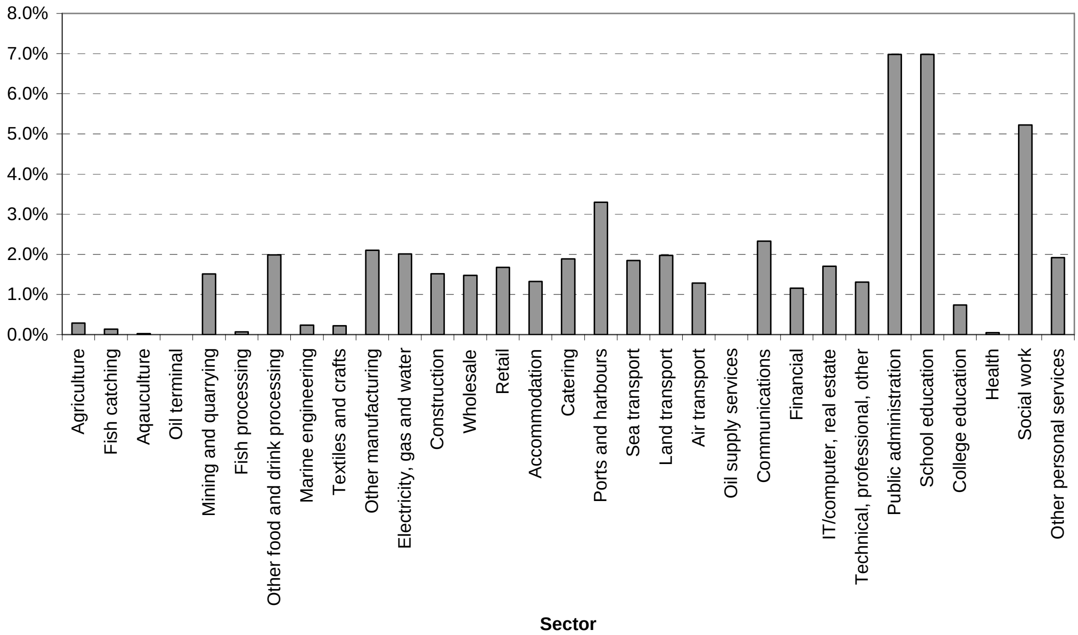
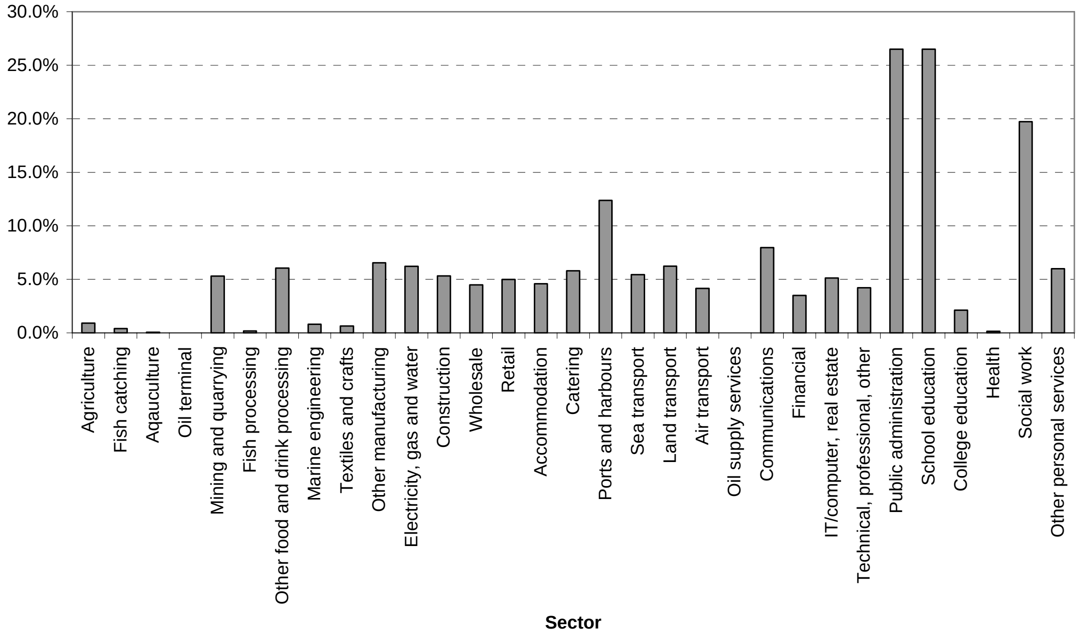

8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
Agriculture
Fish catching
Aqauculture
Oil terminal
Mining and quarrying
Fish processing
Other food and drink processing
Marine engineering
Textiles and crafts
Other manufacturing
Electricity, gas and water
Construction
Wholesale
Retail
Accommodation
Catering
Ports and harbours
Sea transport
Land transport
Air transport
Oil supply services
Communications
Financial
IT/computer, real estate
Technical, professional, other
Public administration
School education
College education
Health
Social work
Other personal services
Sector

Figure 6



30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
Agriculture
Fish catching
Aqauculture
Oil terminal
Mining and quarrying
Fish processing
Other food and drink processing
Marine engineering
Textiles and crafts
Other manufacturing
Electricity, gas and water
Construction
Wholesale
Retail
Accommodation
Catering
Ports and harbours
Sea transport
Land transport
Air transport
Oil supply services
Communications
Financial
IT/computer, real estate
Technical, professional, other
Public administration
School education
College education
Health
Social work
Other personal services
Sector

Figure 7

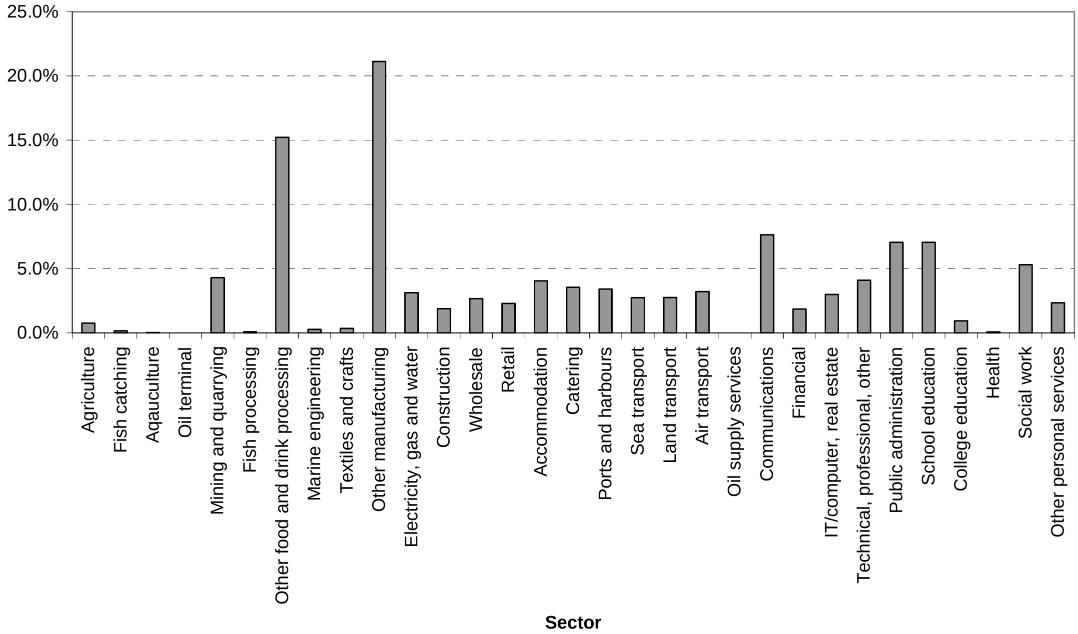

25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
Agriculture
Fish catching
Aqauculture
Oil terminal
Mining and quarrying
Fish processing
Other food and drink processing
Marine engineering
Textiles and crafts
Other manufacturing
Electricity, gas and water
Construction
Wholesale
Retail
Accommodation
Catering
Ports and harbours
Sea transport
Land transport
Air transport
Oil supply services
Communications
Financial
IT/computer, real estate
Technical, professional, other
Public administration
School education
College education
Health
Social work
Other personal services
Sector

Figure 8

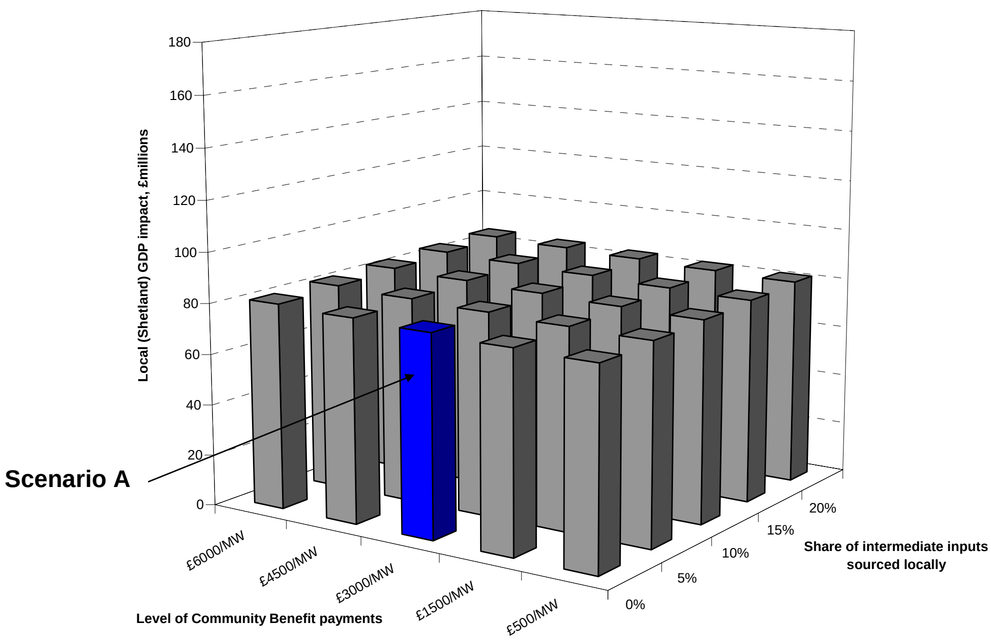

Scenario A
Local (Shetland) GDP impact, £millions
0
20
40
60
80
100
120
140
160
180
£6000/MW
£4500/MW
£3000/MW
£1500/MW
£500/MW
Level of Community Benefit payments
0%
5%
10%
15%
20%
Share of intermediate inputs sourced locally

Figure 9

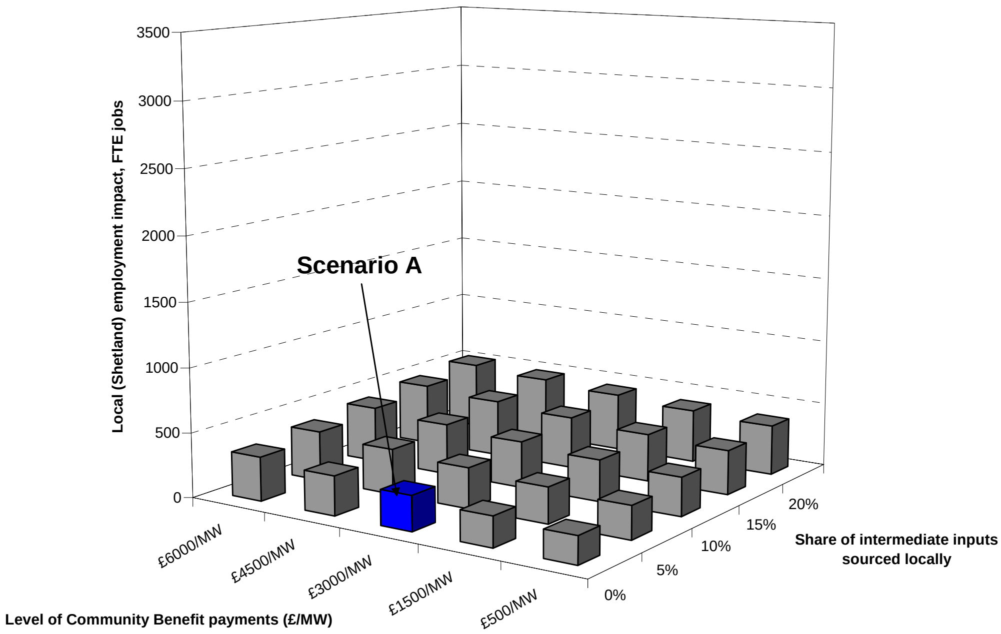

Scenario A
Local (Shetland) employment impact, FTE jobs
3500
3000
2500
2000
1500
1000
500
0
£6000/MW
£4500/MW
£3000/MW
£1500/MW
£500/MW
Level of Community Benefit payments (£/MW)
0%
5%
10%
15%
20%
Share of intermediate inputs sourced locally

Figure 10

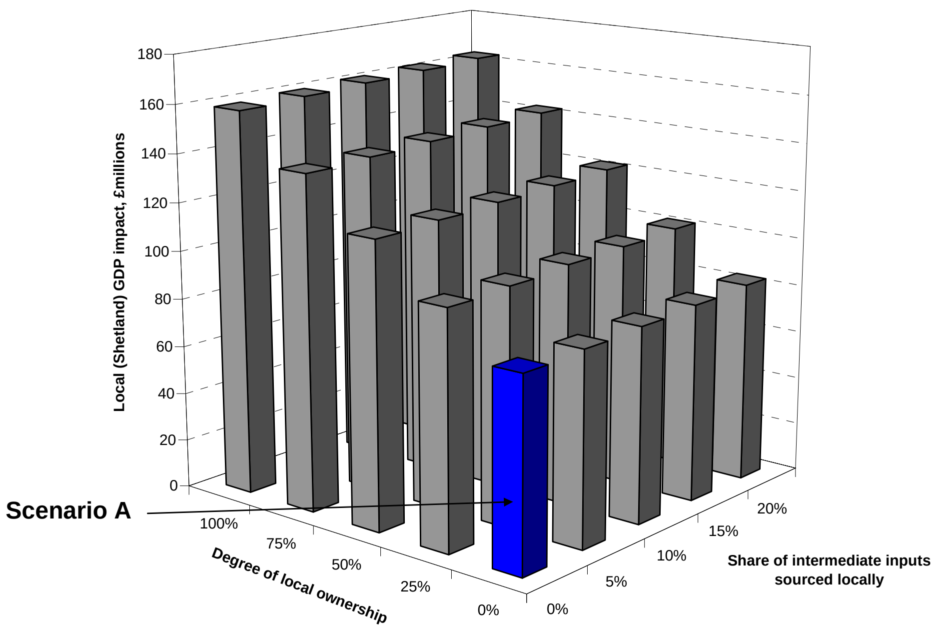
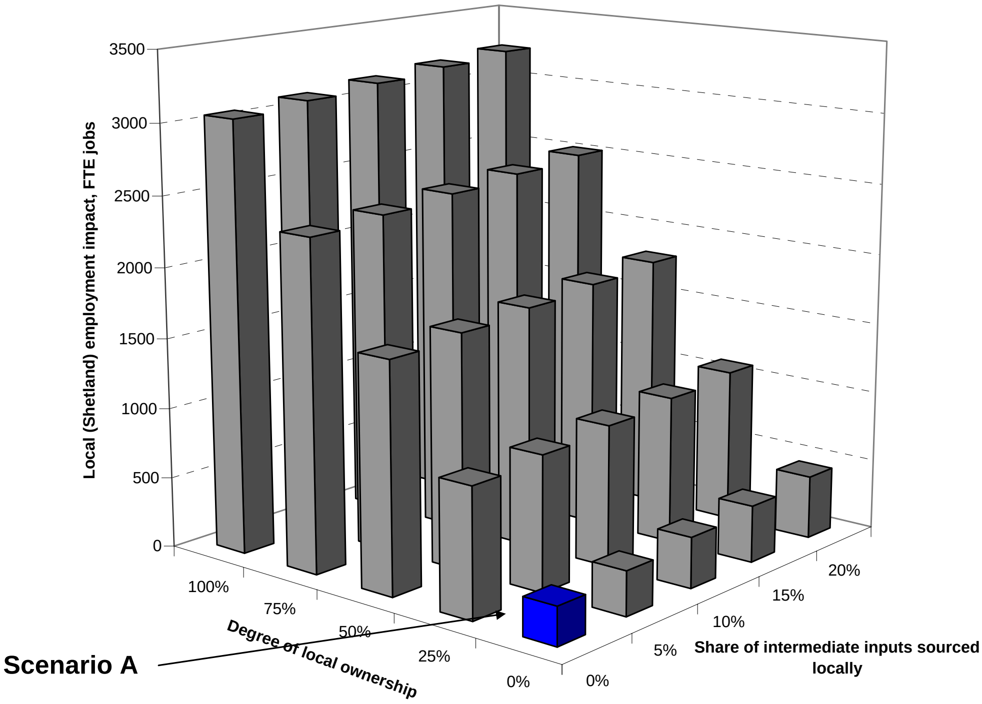

Scenario A
Local (Shetland) GDP impact, £millions
180
160
140
120
100
80
60
40
20
0
100%
75%
50%
25%
0%
Degree of local ownership
0%
5%
10%
15%
20%
Share of intermediate inputs sourced locally

Figure 11



Local (Shetland) employment impact, FTE jobs
3500
3000
2500
2000
1500
1000
500
0
100%
75%
50%
25%
0%
Degree of local ownership
0%
5%
10%
15%
20%
Share of intermediate inputs sourced locally
Scenario A

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[1] This probably reflects the influence of earlier UK Treasury Green Book guidance, which generally assume that employment associated with local regeneration would be "crowded out" in the UK as a whole, so that any employment stimulus in the host economy would be matched by equal contractions elsewhere (HM Treasury, 2003).
[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] *Indirect effects* capture the extent to which an 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. An change in output will change 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, 1985).
[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] Other 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, and these are discussed at the appropriate sections which follow, and considered in our analysis.
[6] Revisions to the planning systems were published in 2000 (Scottish Executive, 2000) and a revised Planning Advice Note in 2002 (Scottish Executive, 2002).
[7] A company formed to represent Shetland Islands Council (SIC)'s interests in large-scale wind energy development in Shetland.
[8] See Wills (1991) for a discussion of the agreement reached between the Shetland Islands Council and the users of this oil terminal.
[9] The remaining 10% are held between the four directors of Shetland Aerogenerators Ltd (Shetland Islands Council, 2006).
[10] These are households with children, households with no children and retiree households (Newlands and Roberts, 2006).
[11] 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.
[12] The total revenue from this fund is distributed back to those generators earning ROCs.
[13] Under a PPA the counterpart to the contract will pay the renewable energy generator a fixed amount for output which generally will cover all components of revenue, and so the ROC will not be sold separately from the electricity.
[14] Our calculations are close to the estimate of VEL of 55 FTE workers directly employed during the operation and maintenance stage of the project (Viking Energy, 2007).
[15] This seems reasonable given the small scale of the Shetland economy when compared to the UK economy as a whole.
[16] In Appendix 1 we describe only the Community Benefits payments linked to transmission network connected onshore wind projects in Scotland that are operational as of April 2008.
[17] In scenarios where there is local ownership, we assume that there are no CB payments.
[18] Shetland Islands Council (2008) details the current dues levied on users of the Sullum Voe harbour, which is owned and operated by Shetland Islands Council as Harbour Authority. Wills (1991) provides a detailed analysis of the growth of council reserves in Shetland through revenues linked to the construction and operation of the Sullum Voe Oil Terminal on Shetland. Wills (2007) updates this to include details of negotiated changes to the levies paid by users of the harbour and terminal since 1991.
[19] In practice, these directors' share may remain locally as these directors are likely to be Shetland Islands residents.

[20] Viking Energy (2007b) reports that the debt taken on by the community's would be paid off within 10 to 11 years, so our figures for annual debt repayments may be slightly higher , making our economic impact for this scenario conservative.

[21] There will, of course, be a different SAM matrix under Scenario A from Scenario B, giving the assumptions about the distribution of profits in each case.

[22] That is, compared to the base year data.

[23] 600 (MW rated capacity) x 0.45 (assumed capacity factor) x 8760 (hours per year) = 2,365,200 MWh per year estimated generation.

[24] "Banding" of the ROCs has been proposed (BERR, 2008b), under which higher numbers of certificates would be given to renewable energy generators using alternative generation technologies. Under the proposed changes, onshore wind would continue to earn 1 certificate per 1 MWh.

[25] Independent estimates from an advisor to renewables energy developers suggested ROC prices in PPAs would currently be around the £45 to £50 per ROC range, although this would include the recycled value from the buyout fund.