

SIEMENS

Clyde Wind Farm Extension – Impact Analysis

June 2015

In association with:



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Siemens

To be a truly sustainable business, Siemens has to be profitable, but we also have a responsibility to understand the way we affect people's lives, the environment and local communities. To do this we work hard to better understand how the work that we do as Siemens and with our customers impacts society.

This report details work that we have done in association with SSE and PwC to understand the economic, environmental and social impacts of building an onshore wind farm. Whilst we have looked at the positive benefits to the economy, jobs and training we have not shied away from

creating more transparency on negatives such as the environmental cost of manufacturing, installing and operating the onshore wind farm. This greater depth of information will help ourselves and our customers make more informed decisions on the true value that such a project delivers.

I believe that it is the duty of responsible businesses to look at the broader financial and society impact measures when making key business decisions.

Juergen Maier

Chief Executive, Siemens plc

PwC

Siemens has used selected elements of PwC's Total Impact Measurement and Management framework to understand the impacts it deemed the most material from its contribution to the Clyde Extension project covering manufacturing, installation and servicing.

We commend Siemens for applying this thinking to its contributions, as one constituent of the entire supply chain, to the Clyde Extension and its collaboration with SSE to better understand how their impact fits into the broader impact of the entire wind farm project.



It is the duty of responsible businesses to look at the broader financial and society impact measures

SSE

Already the results detailed within this report have helped SSE to better understand the impact of our developments and operations. Together with Siemens we've been able to assess the total contribution to the UK and Scottish economies from the construction of Clyde Extension – £108.2m and £76.1m respectively.

Without this new analysis from Siemens, SSE's largest contractor for Clyde Extension wind farm, SSE's estimation of this economic contribution would be 20% lower than we now know it actually is. In other words, this study demonstrates the impact to the UK economy from onshore wind is way beyond

anything anyone in the industry has understood until now.

To date, no turbine manufacturer has undertaken such a detailed exercise as this analysis by Siemens and, until now, project developers like SSE were 'blind' to the impacts beyond the first tier supplier. Sophisticated understanding of the detailed sustainability impacts of development throughout the supply chain is a mark of the growing maturity of onshore wind as an established global industry.

Alistair Phillips Davies
Chief Executive, SSE Plc



About this impact study

Siemens Wind Power (SWP) has undertaken an impact study using PwC's Total Impact Measurement and Management (TIMM)¹ framework and with the support of PwC to assess the impact of Siemens' contribution to the Clyde Extension through the phases of manufacturing, installation and servicing. The objective was to estimate in monetary terms the economic, social and environmental direct impacts of SWP and the indirect impacts of the SWP supply chain of Clyde Extension wind turbines during their lifetime. Through the analysis of Gross Value Added (GVA) and

1. <http://www.pwc.com/totalimpact>

employment impacts, the assessment of greenhouse gas emissions (GHGs) and air pollutants, and the human capital of Clyde-trained apprentices, SWP has been able to present the positive value of the Clyde Extension to Europe, the UK and, in particular, Scotland.

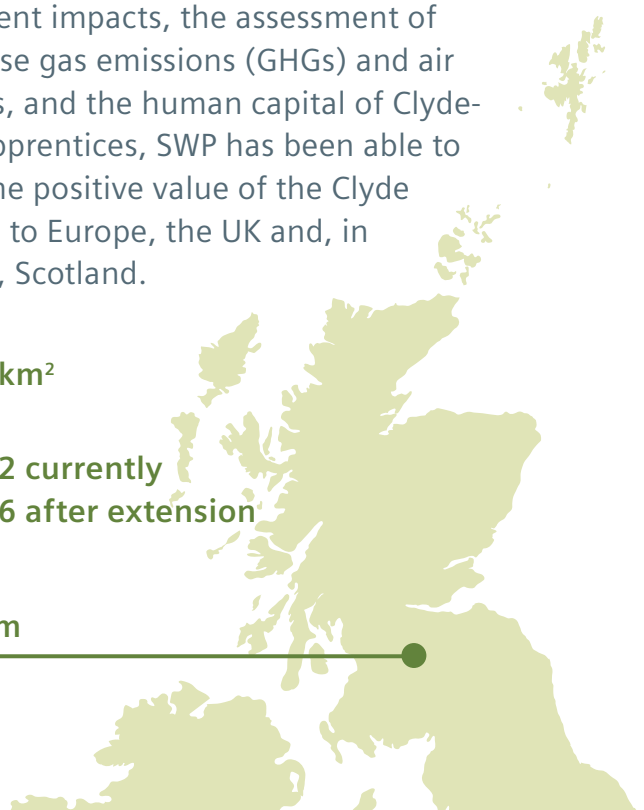


47km²



152 currently
206 after extension

Clyde
Wind Farm





The Clyde extension will generate a further 173MW of renewable energy

About the Clyde Wind Farm

The 47 square kilometre Clyde wind farm, currently one of Europe's biggest single consented onshore wind farms, is located between the towns of Biggar and Moffat in South Lanarkshire. Officially opened by Scotland's First Minister, Alex Salmond, Clyde started exporting energy to the national grid in June 2011. With 152 wind turbines, it has a total installed capacity of 350 megawatts (MW), producing enough energy to power approximately 250,000 homes.

In July 2014 the Scottish government gave consent to an extension that will see an

additional 54 turbines installed in the area between existing sections. The Clyde extension will generate a further 173MW of renewable energy bringing the total capacity of the wind farm to just over 500MW, providing enough power for approximately an additional 125,000 homes.

The 54 wind turbine extension will be undertaken in three key phases: manufacturing, installation, and a 20 year service plan.

Approach to this impact study

This study represents a gross analysis, which does not take into account the extent to which part of these impacts might have happened anyway in the absence of the project. Data on capital expenditure, direct employment, supply chain purchases, and financial accounts were provided by SWP to PwC and have not been audited by PwC. This study only looks at the impact of SWP and its supply chain. It does not consider the involvement of any other businesses working on the Clyde Extension.

Scope

This impact study included a UK and Scotland-level analysis and a global analysis, with slight differences in scope:

- The UK & Scotland analysis covered economic, environmental, and human

capital impacts of Siemens' contribution to the Clyde Extension. The global analysis only covered economic and environmental impacts.

- In terms of the economic analysis, data from Siemens on direct impacts were added to data from two separate input-output models². The first, a global model which covered indirect economic contribution and indirect employment only, and the second, a UK & Scotland model which covered indirect and induced impacts along with the associated employment.

The respective scopes for the UK & Scotland and global analyses are summarised in the table below.

	UK & Scotland analysis	Global analysis
Impact areas	Economic: GVA, employment Environmental: GHG, air pollution Social: Human capital	Economic: GVA, employment Environmental: GHG, air pollution
Value chain	Economic: Direct, indirect, induced Environmental: Direct, indirect Social: Direct	Economic: Direct, indirect Environmental: Direct, indirect
Project phase and timing	Manufacturing, Installation (occurs in 2016) Servicing (occurs 2017 to 2036) <i>NB: social impacts considered for Installation and Servicing phases only</i>	

2. Input-output models describe models describe how different industries of an economy relate to each other. These models can be used to estimate how activity by one company stimulates activity elsewhere in the economy. 3. See <http://www.pwc.co.uk/naturalcapital> for more information on PwC methodologies for valuing environmental impacts.

Methodology

Economic

Direct GVA and employment are estimated using SWP's own financial and employment data for the Clyde Extension. For the UK and Scotland, indirect and induced impacts are derived using SWP expenditure data and UK national and Scotland regional input-output models. For the global analysis, indirect impacts are estimated using SWP expenditure data and a global input-output model.

Environmental

SWP has performed a lifecycle assessment (LCA) of its onshore wind turbines. The LCA quantifies the direct and indirect emissions of greenhouse gases and six types of air pollutants (SO_x, NH₃, PM₁₀, PM_{2.5}, VOCs, and NO_x) associated with manufacturing, installation, and servicing. To attach a monetary value to these emissions, PwC methodologies for valuing GHGs and air pollution emissions were applied³.

Social

Human capital impact is assessed on the basis that qualifications earned through SWP's apprenticeship schemes are expected to increase an individual's productivity and expected future earnings. To estimate the human capital impact of the apprenticeship programmes, SWP data on the number of apprentices and earnings were combined with UK government data on earnings uplift and growth associated with the relevant types of qualification. We attributed this impact to Clyde on the basis of the share of total training spent on Clyde and adjusted for double counting with wage impacts measured as part of the economic impact assessment by only counting additional wages earned by apprentices when not working on Clyde.

PwC's TIMM Framework

In recent years an increasing number of companies have started to use impact measurement as a way to move beyond traditional reporting to understand the costs and benefits of their activities for society. More sophisticated ways of doing this include the monetary valuation of impacts such as air pollution and training programmes.

Benefits from measuring and managing impact

With this understanding management can better understand the consequences of decisions, evaluate trade-offs and steer the business in a way that optimises both the benefits to society and the bottom line. Achieving this requires all material impacts to be considered holistically across the value chain.

PwC's Total Impact Measurement & Management Framework (TIMM)

PwC's TIMM framework is a flexible tool, which uses robust methodologies to measure and value (in monetary terms) the most material impacts of any business activity across economic, social, environmental and fiscal dimensions. It covers both market impacts (which ultimately cause changes in the Gross Domestic Product (GDP) of a country or local area) and non-market impacts (impacts which have societal costs or benefits, but are not reflected in markets – for example, negative health impacts of air pollution). This framework can be applied at the level of a product, a project, a site or even an entire global organisation.





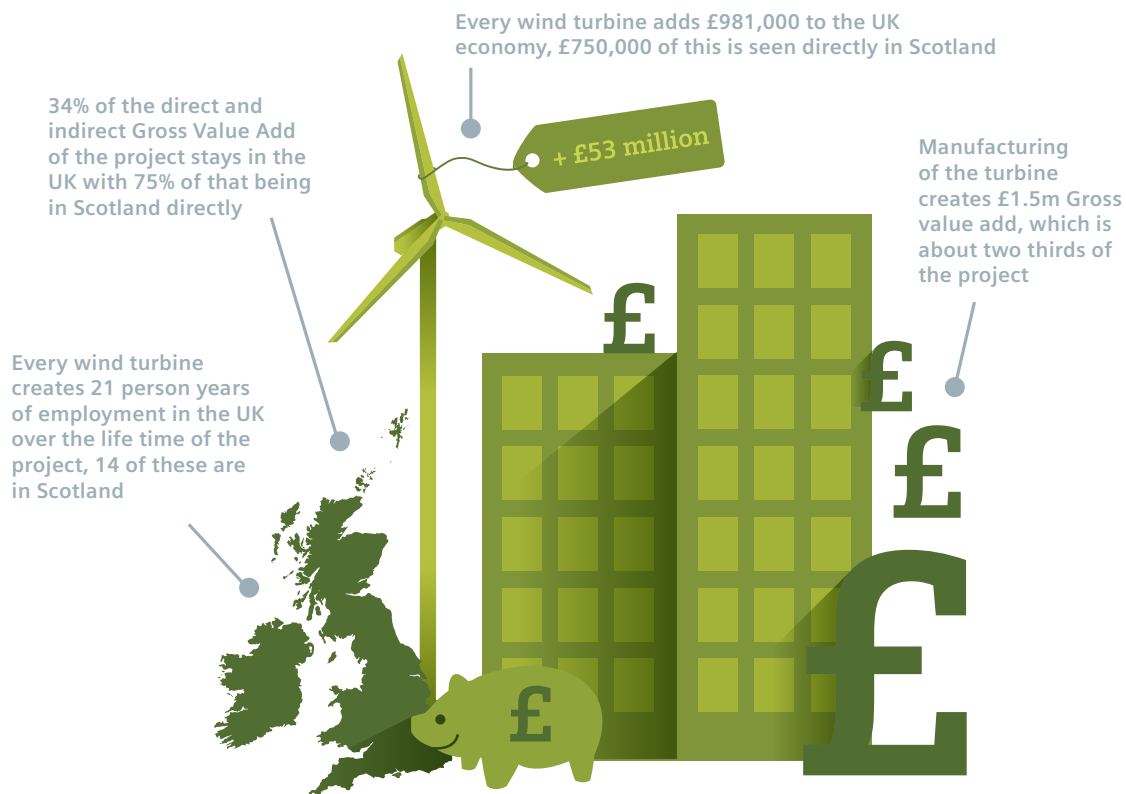
Economic Impact

Two indicators were used to estimate economic impact: Gross Value Added (GVA) and employment. GVA measures the value generated in the economy, and represents the difference between the value of goods and services sold and the goods and services used in their production. Totalling the GVA of all individual companies is equivalent to a country's Gross Domestic Product (GDP)⁴.

Global direct and indirect economic impacts were estimated using direct impact data completed with estimates of indirect impacts derived from a global input-output model. The global direct and indirect impacts of a single wind turbine at Clyde amounts to a present value of over £2.2 million of GVA over its lifetime and supports 50 person

years⁵ of employment. For all turbines on the extension this value is £121m of GVA and 2,700 person years of employment. The UK represents 34% of the GVA (£41m) and 25% of the employment (some 660 person years); and Scotland represents 76% of this GVA and 82% of employment. In total Scotland creates 26% of the global GVA (£31.5m) and 20% of employment (some 540 person years).

The induced impacts for the UK were estimated using a UK national input-output model. Total direct, indirect, and induced benefit to the UK across all 54 turbines for Clyde Extension is estimated at £53 million of GVA and over 1,000 person years of employment.



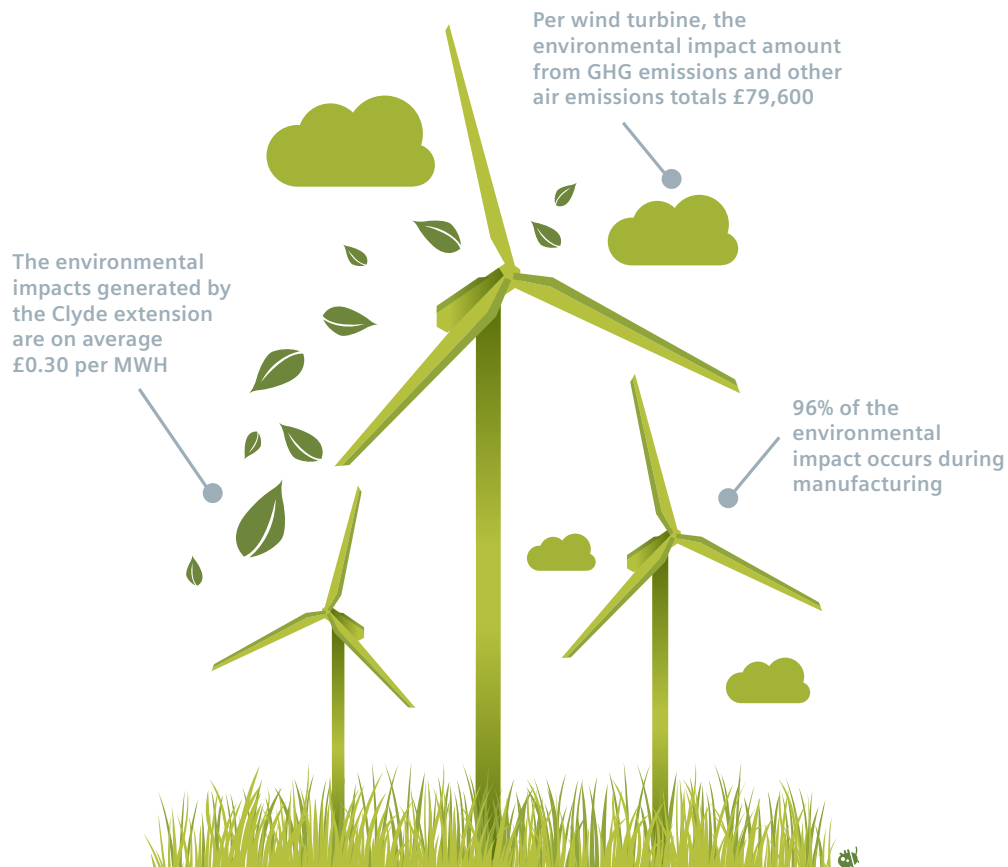
4. After adjusting for taxes and subsidies on products - components of GDP which are not included in the calculation of GVA.
5. A "person year" of employment is the equivalent of employing an individual for a full year



Environmental Impact

The study assessed greenhouse gas emissions (GHGs) and other harmful air emissions. Results show that the turbine manufacturing phase represents 96% of the overall impact, with the installation phase accounting for 3%, and the service phase around 1%. This equates to an environmental cost from GHGs and other air emissions of £0.30 per megawatt hour

(MWh)⁶ for Siemens' manufacturing, installation and servicing activities. This is significantly lower than the impact of GHG emissions and other air emissions generated by UK high voltage electricity production mix as, for example, wind power avoids significant environmental impacts associated with burning fossil fuels.



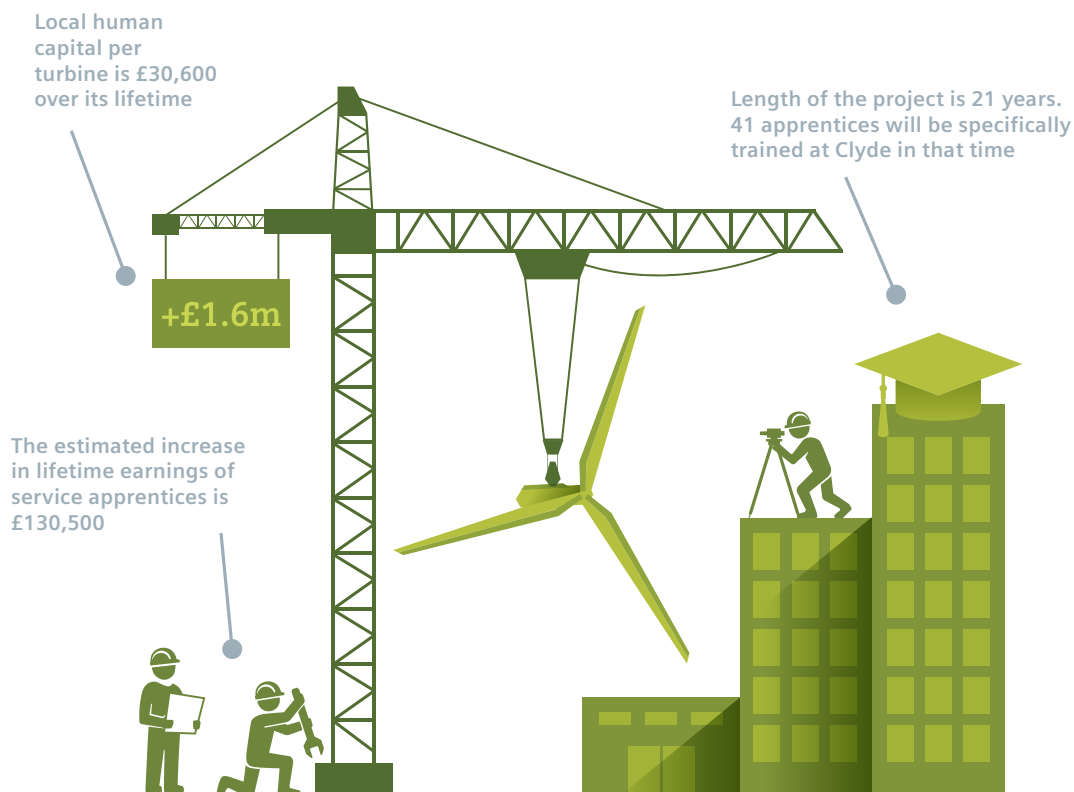
6. The calculation is based on a turbine electricity production of 259,254 MWh. This has been calculated for a wind turbine SWT 3.2 – 113



Human Capital Impact

Over the 21 years of installation and servicing, the Clyde Extension will be used as the training ground for employees participating in two Siemens apprenticeship programmes. The human capital impact is assessed by estimates in increased lifetime earnings associated with the qualifications obtained through the apprenticeships. Based on UK government data⁷, these

apprentices are estimated to increase their expected lifetime earnings by over 11% (£126,000 for installation apprentices and £130,500 for service apprentices). After adjusting for training time spent onsite, the human capital impact attributable to the Clyde Extension is estimated at £1.6 million.



⁷.Department for Business, Innovation and Skills (BIS), 2012



Economic – Powering Jobs and Wealth

One of the key objectives of conducting the impact study was to estimate the economic impact of Siemens Wind Power's (SWP) contribution to the Clyde Extension on the UK, Europe and the rest of the world, with specific analysis on Scotland.

The study used two indicators to estimate economic impact: Gross Value Added (GVA) and employment. GVA measures the value generated in the economy, and represents the difference between the value of goods and services sold and the goods and services used in their production. Totalling the GVA of all individual companies is equivalent to a country's Gross Domestic Product (GDP)⁸. All GVA figures are in present value terms, discounted back to 2015. Employment is measured in "person years". One person year of employment is the equivalent of employing an individual for a full year.

GVA and employment are divided into three tiers:

1. Direct contribution: GVA and employment attributable to SWP's own activities
2. Indirect (supply chain) contribution: GVA and employment associated with SWP supply chain expenditure
3. Induced (employee spend) contribution: GVA and employment in the wider economy as a result of wages being spent by the employees of SWP and its suppliers on goods and services such as food, accommodation and fuel

At a global level, direct and indirect economic impacts were estimated by combining SWP financial and employment data for direct impacts with estimates of indirect GVA and employment derived from a global input-output (IO) model (see Methodology for further detail, page 7).

8. After adjusting for taxes and subsidies on products - components of GDP which are not included in the calculation of GVA.



The total economic benefit to the UK across all turbines on the wind farm generates £53 million and over 1000 person years of employment

£+ £2.2m global GVA per turbine

These results show the global direct and indirect economic impact of a single wind turbine at Clyde amounts to over £2.2 million of GVA over its lifetime and supports 50 person years of employment. Around two thirds of the overall project impact occurs during the manufacturing phase with £1.5 million GVA and 69% of the employment. The 20 year servicing phase accounts for about one fifth of the total economic impact of a wind turbine and generates an estimated £0.5 million of GVA and supports 11 person years of employment. The installation phase accounts for 12% of GVA and 9% of employment impact.

Examining the results by geographical distribution shows that 34% of GVA is generated in the UK, similar to that for Denmark where the turbines are manufactured, and 25% of the employment is generated in the UK (compared to 13%

for Denmark). Scotland represents 76% of the UK GVA and 82% of UK employment. In total Scotland creates 26% of the global GVA and 20% of employment. This is driven largely by the sourcing of turbine towers from Scotland.

The above global comparison considers direct and indirect impacts only. For the UK, induced impacts have also been estimated using a UK national input-output model. The present value of the induced impacts are estimated at £0.3m and 7.3 person years per turbine. For all turbines on the Extension the value is £15m of GVA and some 390 person years of employment. Total direct, indirect, and induced benefit to the UK across all 54 turbines for the Clyde Extension is estimated at £53 million of GVA and over 1,000 person years of employment⁹.

9. Indirect and induced impacts derived from the UK national input-output model.



Environmental – Keeping Production Clean

Siemens Wind Power's focus in measuring the environmental impact of Clyde Extension was to estimate in monetary terms the change in wellbeing experienced by people as a result of changes in the environment associated with the manufacture, installation and service of the wind turbines for Clyde. By placing a monetary value on environmental impacts it is easier to incorporate them in decision-making, enabling better outcomes for the environment and society.

The study focused on greenhouse gas emissions (GHGs), the cause of changes in

global climate, and other air emissions that reduce the quality of air and cause a negative impact on health, and on the natural and built environment.

It is not surprising that the manufacturing phase of the project, which concerns the extraction and production of raw materials causes the highest impact. The results of the study show that, per wind turbine, the environmental impact from GHG emissions and other air emissions totals £79,600, with the manufacturing phase representing 96% of the overall impact. This is driven by extraction and processing of raw material in



The installation phase accounts for just three per cent of the total environmental impact and the servicing phase only one per cent



£79,600 environmental impact

places like China where there are significant health issues associated with air pollution. Siemens Wind Power recognises this as an improvement opportunity to work with its supply chain to create cleaner production in the future.

The emissions impact of the following two phases have a comparatively minimal impact on health and the environment, with the installation phase accounting for just 3% of the total environmental impact and the servicing phase only 1%. Both of these phases happen entirely at Clyde Extension, although impacts of GHGs are global.



Human Capital – Generating Future Skills

Siemens Wind Power has invested heavily, and continues to invest, in the training of its apprentices and up-skilling of trained technicians. The two apprenticeship programmes that were assessed for the Clyde Extension impact study relate to the phases of installation and servicing and show how the training and qualifications gained through the programmes have a positive impact on the lifetime earnings of Siemens Wind Power apprentices trained throughout the 21 year lifespan of the wind farm.

The ‘Installation and Commissioning’ and

‘Mechanical and Electrical Engineering’ apprenticeship programmes are delivered from Siemens Wind Power’s Energy Service Training Centre and lead to a National Vocational Qualification (NVQ) Level 3. Participants will be trained specifically at the Clyde Extension for between nine months and 25 months depending on the programme they are enrolled on; the benefit to Clyde being not just an economic one, with apprentices living and investing locally, but having highly trained technicians committed to the wind farm throughout its 21 year lifespan.



Clyde-trained apprentices are estimated to increase their expected lifetime earnings by over 11 per cent



41 apprentices trained

The human capital impact in this study is assessed by estimating increased lifetime earnings associated with the qualifications obtained through the apprenticeships. Based on UK government data¹⁰, these apprentices are estimated to increase their expected lifetime earnings by over 11% (£126,000 for installation apprentices and £130,500 for service apprentices). After adjusting for training time spent onsite, the human capital impact attributable to the Clyde Extension is approximately £30,600 per turbine (based on future earnings increase). This amounts to over £1.6 million across the 54 turbines at Clyde Extension.

Apprentices will also benefit from up-skilling across that period through the continuous training that will allow them to keep pace with technological changes in the business and to meet exacting health and safety standards.

10. Department for Business, Innovation and Skills (BIS), 2012

Concluding Remarks

The purpose of conducting the impact study was to show with clarity and transparency the impact of the Clyde Extension to Europe, the UK and Scotland. It is clear that from the impacts covered in this study the positive economic and human capital gain from the Clyde Extension turbines far exceed the estimated negative environmental impacts resulting from GHG and atmospheric emissions. 34% of global direct and indirect GVA and 25% of global direct and indirect employment is generated in the UK and approximately 76% of the UK economic impacts are generated locally in Scotland. Including induced impacts, this represents an additional £53 million GVA and over 1000 person years employment to the UK.

Through Siemens' apprenticeship programmes, the Clyde Extension will create highly skilled wind turbine technicians who will make a significant contribution to the local economy over the wind farm's 21 year lifecycle. Based on UK

government data, these apprentices are estimated to increase their expected lifetime earnings by over 11%.

The 20 year service phase, which takes place entirely at the Clyde Extension represents less than 2% of the total environmental impact of the wind farm and, whilst Siemens Wind Power recognises the clear improvement opportunity of working with its supply chain to reduce GHG emissions and air pollutants, it also recognises that wind power is amongst the cleanest source of energy generation.

Siemens Wind Power is proud to be a trusted partner of SSE and a market leader in an industry that is successfully generating clean energy from renewable sources.



£53m UK benefit



1,000 years employment



75% of UK GVA stays in Scotland



It is clear from the research findings that the positive economic gain from the Clyde Extension turbines far exceed the negative environmental impacts

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