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# **Local Content in the UK Offshore Wind industry**

The Role of CfD in developing the UK Offshore Wind Supply Chain

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## Abstract

The United Kingdom is the world leader in Offshore Wind (OW) with total installed capacity over 5GW which is expected to reach 15GW by 2025 (Scottish Enterprise, 2016). Moreover, the UK is widely recognized for its stable policy regime and the level of regulatory and price support in the OW sector that have attracted foreign OW project developers from across the world.

The cost reduction is important for the UK OW industry in order for the electricity generated from the OW power to be competitive with the other RE sources as well as the traditional energy sources like oil and gas, and thus be affordable for the end consumer. The UK Government is committed to enable further cost reduction in the industry, thus improving cost competitiveness of the electricity generated from OW in order to fully realize its OW potential to be able to meet the RE and climate change targets.

This paper analyzes the extent of the UK content in the major segment of the UK OW supply chain, the *Balance of plant*. *Balance of Plant* is one of five major OW supply chain segments involved in the development of an offshore wind farm project. The other segments are *Development and Consent*, *Wind Turbine, Installation & Commissioning* and *Operations & Maintenance*. *Balance of Plant* is involved in the manufacturing and supply of all the OW farm components besides *Turbines* and represents one of the largest procurement choices in OW projects, after *Turbines*, which significantly affects the level of *local content* (LC) in the UK OW industry. *Balance of Plant* has the smallest share of the UK content compared to other OW segments. However, it is estimated to have the most potential for cost reduction in the UK OW sector given that the UK manufacturing capacity within this segment will increase, which will allow eventually obtain economies of scale that will contribute to cost reduction.

The paper presents the analysis of the UK content in the UK OW projects. Both OW projects, that have to comply with local content requirements (LCRs) meaning that they have to award a proportion of the main contracts to UK based companies, and those OW projects that do not have LC obligations, have been analyzed to determine whether the UK Government policy claims on LCRs in the OW industry succeed in enhancing LC in the UK OW industry. Given that the UK Government is likely to increase its UK content expectations (BVG Associates, 2017), the practical limits of the UK content within *Balance of Plant* have been considered. The conclusion has been drawn on whether it is realistic to grow the UK content in this segment thus contributing to cost

reduction and development of the UK OW industry. Furthermore, the reasons for the small share of LC in the Balance of Plant segment of the OW projects with LC obligations are highlighted in this report.

## Abbreviations

<b>CAPEX</b>	Capital Expenditures
<b>CFD</b>	The Contract for Difference
<b>DECC</b>	The UK Department of Energy and Climate Change
<b>DECC</b>	Department of Energy and Climate Change
<b>DEVEX</b>	Development Expenditures
<b>EA1</b>	East Anglia One
<b>EMR</b>	Electricity Market Reform
<b>EOWDC</b>	European Offshore Wind Deployment Centre
<b>EU</b>	European Union
<b>FDI</b>	Foreign Direct Investment
<b>FIT</b>	The Feed-In Tariff
<b>GVA</b>	Gross Value Added
<b>GW</b>	Gigawatt
<b>LCOE</b>	The Levelised Cost of Electricity
<b>LCP</b>	Local Content Policy
<b>LCR</b>	Local Content Requirements
<b>MW</b>	Megawatt
<b>OPEX</b>	Operational Expenditures
<b>OWIC</b>	Offshore Wind Industry Council
<b>OWPB</b>	Offshore Wind Programme Board
<b>RO</b>	The Renewables Obligation
<b>SME</b>	Small & Medium Sized Enterprises
<b>TOTEX</b>	Total Expenditures
<b>TWH</b>	Kilowatt Hour
<b>UKCS</b>	United Kingdom Continental Shelf

<b>EPC</b>	Engineering Procurement Construction
<b>EPCI</b>	Engineering, Procurement, Construction and Installation
<b>CPS</b>	Cable Protection Systems
<b>EWEA</b>	European Wind Energy Association
<b>BP</b>	Balance of Plant
<b>I&amp;C</b>	Installation and Commissioning
<b>K&amp;M</b>	Kuntze and Moerenhout
<b>LC</b>	Local Content
<b>ICTSD</b>	International Center for Trade and Sustainable Development
<b>GGGI</b>	Global Green Growth Institute



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# 1. Introduction

The following chapter starts with the section on the motivation behind choosing the topic for the research and the background of this study. Furthermore, the research relevance as well as research questions and objectives of this study are introduced. Concluding the chapter, the thesis outline is presented.

## Background and Motivation

During my studies at NTNU, especially after having taken courses on Global Governance of Sustainable Supply Chains, Industrial Marketing and International Business and Knowledge Management, I have been introduced to the renewable energy industry and challenges and opportunities connected to the integration of renewable energy into our societies. While working on various assignments I have learned a number of tools and frameworks that could help analyze RE industry.

These courses have sparked my interest for the Renewable Energy (RE) sector even more and I decided to immerse myself in the RE industry by working at SINTEF as an intern on the Internationalization of Norwegian Offshore Wind Industry (InNOWiC) – project, funded by the Research Council of Norway. There I have learned more about the research done within the OW sector and I narrowed down my interest of study to a single market. I have chosen the UK offshore wind market to be the object of this research, as it is the world leader of OW power generation as well as it is a huge market for international suppliers to the OW sector.

Throughout the internship, I have been working on various assignments both on my own initiative and according to instructions, like doing a market analysis and supply chain mapping in the UK offshore wind market as well as analyzing areas throughout offshore wind projects lifecycles in the UK in which increasing local content is important. My main focus was on the UK market, but I also looked at other European and the US markets.

Besides, as a part of my internship assignments, I was writing a paper together with another intern on “Local Content Policies and Requirements in the Offshore Wind Industry”, and an internship assignment about the state of the offshore wind market in the UK with focus on the UK content in the OW farms. It allowed me to gain a good insight of the various political measures imposed on

foreign developers in RE markets and a better understanding of a specific OW market such as the UK.

In my internship assignment, I looked specifically at the LC in the UK offshore wind supply chain as well attempted to analyze the extent of the UK content in the UK OW supply chain and the weakest tiers within the British supply chain where local content could be increased were identified.

Thus, my personal interest for the rapidly growing RE industry, skills gained through the above-mentioned courses at NTNU as well as experience and a better understanding of a specific OW market gained during the internship at SINTEF helped me to narrow down my research topic.

Therefore, in this Master Thesis I will analyze the extent of the UK content in the major OW segment involved in the development of an offshore wind farm project, *Balance of Plant*, which is involved in the manufacturing and supply of all the OW farm components besides turbines, to identify British capabilities as well as the weakest tiers in this major OW segment in the UK OW market. Besides, the study attempts to understand whether or to which degree policy claims on LCRs succeed in enhancing LC in OW projects in the UK sector.

### **Relevance of the Research:**

The UK is currently the market leader in the OW in the world, in terms of wind resource and location, installed capacity, the level of regulatory and price support and the stability of the policy regime within the OW energy sector (Crown Estate, 2015: 3). The UK's leadership in OW has proved to be highly effective and the UK OW industry is one of the most attractive destination for RE investment.

In order to meet its 2020 renewable energy targets, it is argued that the UK will have to fully realize its offshore wind potential. According to these 2020 targets, at least 15% of energy needs must be generated by the renewable sources, which includes a target to generate 30% of electricity from wind, solar and other low-carbon sources by the end of the decade (The Guardian, 2017).

However, despite a significant cost reduction achieved in recent years (Offshore Wind, 2017), OW electricity cost is still much higher than that of other RE sources, particularly solar electricity, exceeding them approximately more than two times. And recently, it has been announced by the UK Government that 2020 targets are likely to be missed (The Guardian, 2017).

Thus, in order for the UK to fully realize its OW potential to attempt to meet 2020 targets, a significant cost reduction is needed in the OW sector as well as the development of a highly competitive domestic OW supply chain. It was stressed on many occasions by the UK state officials that cost reduction and the development of a strong domestic supply chain must go together and, by no means, be mutually exclusive (Offshore Wind, 2017; Wind Power Offshore, 2016).

Therefore, the UK government is encouraging foreign OW developers to do business in the UK by providing various government incentives and financial support. As well as the Government is applying pressure on local content, encouraging foreign OW developers to award a proportion of the main contracts to UK based companies. The OW developers are contributing in such a way to the development of the domestic OW industry, in order to be eligible to bid for a Contract for Difference (CfD) (Gov.UK, 2017; Wind Power Offshore, 2016; BVG Associates, 2017).

Thus, the UK government is striving to continue cost reduction in the OW sector through supporting and developing the domestic OW supply chain and industry by applying pressure on LC and encouraging developers to select suppliers which are located in the UK.

The Department for Business, Energy and Industrial Strategy announced that the UK Government is going to extend CfD financial support mechanism, under which the LC obligations are imposed on the OW project developers, beyond 2020 given that cost reduction will continue (Gov.UK, 2017). Thus, industry players must find ways to enable further cost reduction. Moreover, some concerns have been expressed, that the current UK content expectation of 50% may be raised on the grounds that oil and gas industry is providing more LC (BVG Associates, 2017). For this reason, according to BVG Associates (2017) the UK Government may use it as a benchmark to raise the UK content expectation in the OW industry as well.

In this paper, I analyze the UK content in the OW projects that have no LC obligations and the CfD OW projects that as such have to comply with local content requirements. This research focuses specifically on LC in such major offshore wind segment as *Balance of Plant*. The reason behind choosing this sector is that it is a part of CAPEX, that according to BVG Associates (2015: 5), delivered the smallest share of the UK content in the British OW farms. Therefore, I am interested in researching the UK capabilities within the OW segment, Balance of Plant, that has little local content. Moreover, I will attempt to provide an insight as to why the UK content is so poorly represented in that segment in comparison to other segments. In addition, this study investigates

whether the UK content was increased in the offshore wind farms that have local content obligations compared to those OW farms that do not have to comply with LC obligations to see whether the content requirement policy have an effect on increasing local content within the UK offshore wind supply chain.

### **Research Questions and Thesis Outline:**

This study aims to get a better insight into the UK content in the domestic OW supply chain in order to identify British capabilities as well as the weakest tiers in the major offshore wind segments in the UK OW market. Moreover, the study attempts to understand whether or to which degree policy claims on LCRs succeed in enhancing local content in the OW projects in the UK sector. Therefore, the following research questions and objectives have been formulated:

*Research Question 1:* What is the extent of the UK content in the major offshore segment in the UK OW farms: Balance of Plant?

*Research question:* Do policy claims on LCRs in the OW industry succeed in enhancing LC in the OW projects in UK sector?

- Does Britain have the necessary conditions for successfully implementing LCRs and continue increase the UK content within the domestic supply chain, specifically *Balance of Plant*?
- Are there practical limits of the UK content? According to the report “The UK content analysis of operating offshore wind farms” (Gov.UK, 2015) the UK content is poorly represented in manufacturing and construction (only 18%). Is it realistic to grow the UK content in manufacturing and construction and deliver a stronger, more competitive supply chain within this phase?
- What are the reasons for little UK content in the weakest tiers of the British OW supply chain?

*Research Objective:* Based on the quantitative analysis of the OW supply chain databases of the UK OW projects, empirical studies of the policy and industry reports on the UK OW supply chain capabilities as well as interviews with the UK OW industry representatives, formulate whether the CfD financial support mechanism succeeds in the development of the UK OW supply chain weakest segment, Balance of Plant, and whether it is possible to increase the UK manufacturing capacity to further contribute to cost reduction in the sector.

The master thesis proceeds as follows: The present chapter, *Chapter 1*, introduced the motivation behind choosing the topic for the research and the background of this study. Concluding the chapter, the research relevance as well as the research questions and objectives of this study were introduced.

In *Chapter 2*, the *Global Production Network* (GPN) approach is presented as the main theoretical framework for the discussion on *Local Content* (LC) in the *Offshore Wind* (OW) sector. The definition of the LC and *Local Content Requirements* (LCRs) is given as well as the current state of the LCRs in the OW industry along with the arguments in favor and against LCRs are summarized. This is followed by a literature review of the UK Government reports on the state of the UK OW industry and the extent of the UK content in the domestic OW market as well as industry reports on the UK capabilities in the domestic OW market.

In the first part of *Chapter 3* the research methods and research design are presented. Furthermore, the methods of data collection are outlined and the reflections on the challenges faced during the research process.

*Chapter 4* presents an introduction to the UK OW market as this market is the main focus of the current study. The chapter outlines the regulatory framework for the UK content in the domestic OW sector. Furthermore, the chapter presents an overview of a supply chain involved in the development of a typical offshore wind farm.

*Chapter 5* starts with the analysis the current state of the LCRs in the UK OW sector. Furthermore, the chapter presents the analysis of the collected data on the extent of the UK content in several OW farms in the UK (CfD projects: Dudgeon, Hornsea Project 1, Burbo Bank Extension and non CfD projects: Rampion, Greater Gabbard and Hywind). This is followed by the presentation of the findings in the major OW segment: *Balance of Plant*.

Subsequently, a *Conclusion* summarizes the key aspects of this thesis and presents the main conclusions of the study as well as provides several recommendations for further research.





## 2. Theoretical Background of the Research

The main objective of the following chapter is to provide the theoretical foundation for the present research, by providing an understanding of the LC. The first section of this chapter introduces *the Global Production Network* (GPN) approach, which is my thesis's main theoretical framework for the discussion on *Local Content* (LC) in the *Offshore Wind* (OW) sector. The definition of the LC and *Local Content Requirements* (LCRs) is given as well as the current state of the LCRs in the OW industry are summarized introduced. The chapter is concluded by the literature review of the UK Government reports on the state of the UK OW industry and the extent of the UK content in the domestic OW market as well as industry reports on the UK capabilities in the domestic OW market.

### **The Global Production Network perspective:**

The problem of LCRs in the OW sector can be explored and studied from different perspectives, as academic literature employs quite a variety of theoretical frameworks to address various issues of LCRs in the RE sector. It is therefore reasonable to employ a specific theoretical approach such as the *Global Production Network* (GPN) approach and continue the discussion on the LCRs using this perspective which will in turn form the basis of this study.

The GPN approach is the analysis framework that helps to understand how global industries are organized and governed. Moreover, the framework is used to explain how these relationships affect the development and upgrading opportunities of the various regions and firms involved (Coe et al., 2008: 267). The GPN framework was developed by the following researches from Manchester (UK), Henderson (2002); Dicken and Henderson (2003) and Coe (2004).

The reason for choosing this specific approach to address LCRs is due to the fact that this framework addresses and acknowledges the complex nature of the relationship between the TNC and the host-state (in our case between foreign OW project developers and suppliers and the United Kingdom) and how this relationship influences international trade (Dicken, 2015).

The complexity and the nature of this relationship between the host-state and focal firms is determined by a various of factors. The GPN perspective provides a very extensive framework for analysis and is built upon a number of conceptual categories that could be helpful in analyzing the relationship between host-states and focal firms. Therefore, in order to narrow down the focus this

study will focus on the following conceptual categories: *territorial embeddedness and power* (bargaining power of the resource holding state, in our case the UK that controls access to its OW market, and the bargaining power of the OW project developers in the OW supply chain). These categories have been chosen as they are relevant for the topic of the thesis and they are reflecting and explaining the relationship between the host country and focal firms in the OW industry with regard to LCRs.

*Territorial embeddedness* suggests that elements in GPNs are grounded in specific locations. The territorial embeddedness affects focal firms as well as the nation-states they are located in. Thus, host-states have an opportunity to capture possible value created from production within their territories which is vital for regional economic growth and social development (Dicken, 2011: 231).

However, focal firms that are located in a particular host-state are also affected by such territorial embeddedness. The reason for this is that the host-state possesses certain economic, political and social characteristics as well as it can adopt certain measures to control their economies and protect domestic industries. There are a variety of elements like infrastructure, access to skilled labor, as well as business and cultural environment that all together influence focal firms' strategies and actions in the host-states (Henderson et al., 2002: 451-452).

Thus, the UK, as a host state, is striving to attract foreign energy companies to develop OW projects in the UK, by providing government incentives, stable policy regime as well as the UK Government is keen to make sure that British OW supply chain will benefit properly from the its decision to support this new sector. Thus, the UK Government developed a special mechanism, *Contract for Difference* (CfD) support scheme, through which it requires foreign OW project developers to contribute to the development of the local OW industry. And if the project developer is willing to gain access to the market and get financial support it has to comply with the UK requirements.

Another element of the framework that is determining the complex nature of firm-state relations is the *relative bargaining powers of TNCs and host-states* (in our case, the UK Government and foreign OW project developers and suppliers willing to enter the British OW market). By introducing this concept, the GPN approach recognizes that focal firms and host-states have different priorities in their relationship and, thus, pursue their own interests (Henderson et al. 2002).

First of all, focal firms are striving to augment and expand their locational flexibility. By doing so, they are searching for opportunities that allow them to take advantage from those geographical

locations that offer better quality and cost of production units, as well as a greater variety and availability of those units. However, focal firms may face significant obstacles in form of regulatory measures adopted by host-states. Host-states utilize their power to apply such regulatory measures in order to capture as much as possible of the value created from production within their territories, protect and develop infant industries. Therefore, host-states are striving to embed a TNC's activities as strongly as possible in the local/national economy (Dicken, 2011: 231).

Thus, focal firms are striving to get access to the market on conditions beneficial to them, and the main goal of the host-state in such a situation is concentrated on protecting domestic industry and influencing focal firms in such a way that they contribute to the economic development of the host-state.

Thus, a focal firm willing to enter a new market, access to which is controlled by the host-state, is forced to comply with the host-state regulations in order to gain access to it. So, if the host-state controls access to the market, it actually has the greater extent of bargaining power over the firms. This is something that Dicken calls *obligated embeddedness* and it is likely to occur if two conditions are satisfied:

- 1) There is an asset that is embedded within the host-state
- 2) This asset is of great importance to a focal firm in order to realize its business goals.

The asset could be for example, a huge nation market, cheap and highly qualified labor, and abundant supply of raw materials as well as various government incentives. It is important to note that the precondition for this obligated embeddedness to occur is that the host-state must control access to that resource and have the power to exercise it (Dicken, 2011: 231).

When focal firms and host-states find themselves in such situations when they pursue different goals, they are getting themselves into an unceasing and complex process of negotiation and bargaining, in which each actor can exercise power. Their relative power depends on the extent to which each of the actors possesses and controls the assets sought by the other party (Dicken, 2011: 226). Obviously enough, the scarcer the resource being sought after whether by a focal firm or a host country, the greater the relative bargaining power of the party that controls the access to that resource and vice versa. (Dicken, 2011: 232)

Thus, in the case of the UK OW market, the host-state, United Kingdom, controls the access to the resource, which is in our case the abundant OW resource, ocean territory, financial support and a

huge domestic OW market which growth is guaranteed through the RE and climate change targets. Thus, foreign OW project developers that are willing to enter the UK OW market, access to which is controlled by the UK, are forced to comply with the UK regulations in order to gain access to it. The UK has a great extent of the bargaining power which it exercises. The OW industry is very dependent on the government subsidies, otherwise the cost of the electricity produced by the OW will not be competitive in comparison to other power sources. The UK Government provides an unprecedented level of financial support and in order for the foreign OW project developers gain access to this support they must comply with the UK requirements, like LCRs.

Additionally, we have focal firms that may have unique technologies and know-how, and this allows focal firms to increase their bargaining power in the negotiation with the host-state.

The GPN approach acknowledges the importance of host-state power in the OW sector. Host-states is regulating its economy by trying to control what happens within its boundaries. (Dicken, 2011: 178) Moreover, by attempting to control what is happening within their boundaries, host-states are not just intervening in the OW market, but by doing so they are actually helping to establish such renewable markets and “underpin their mere existence”. (Dicken, 2011: 179)

So, naturally, the GPN approach allows us to acknowledge not only the complex nature of the firm-state relations and their relative bargaining power in the negotiating process over the access to sought after assets, but it also allows us to look at the state as a *regulator*. Meaning that the host-state strives to manage its economy and it has the power to exert significant regulatory functions and adopt a variety of measures in order to regulate how its economy operates. (Dicken, 2011: 178) In particular, the host-state, in our case the UK, can determine the rules of operation in its domestic OW sector for the foreign OW project developers and suppliers with which they must comply in order to gain access to the OW market in the UK, and the Government incentives.

Dicken argues that host-states can employ a variety of strategies that are enabling them to control and to stimulate their economic activity, influence the investment within their boundaries as well as regulate the foreign firms’ operations within their territory. Moreover, by using those strategies the states are also able to shape the flow of trade and investment at the international scale. (Dicken, 2011: 179)

Dicken continues that despite the fact that there are no two states that are alike in how and what measures they introduce to manage their economies, as these measures are influenced by various

circumstances different states find themselves in. It is, nonetheless, possible to identify certain themes and patterns. (Dicken, 2011: 179) Thus, the choice of precise policy measures depends not only on the cultural, social and political structures, institutions and practices in which the state is embedded, but the host-state will also be influenced by: “the size of the national economy, especially that of the domestic market, its resource endowment, both physical and human, its relative position in the world economy, including its level of economic development and degree of industrialization.” (Dicken, 2011: 179)

Of all the measures used by nation-states to regulate their international economic position, trade policies have the longest history. In general, policies towards imports are restrictive in comparison to export policies which are stimulatory in their nature. (Dicken, 2011: 182) Such regulatory policies effect both imports and FDI and are usually divided into two categories:

- Tariff barriers which are taxes levied on the value of imports that increase the price to the domestic consumer and make imported goods less competitive in price terms than otherwise they would be (Dicken, 2011: 182)
- And nontariff barriers which include quotas, embargoes, sanctions, levies and other restrictions and are frequently used by large and developed economies. (Investopedia, 2017)

States impose nontariff barriers in order to control the amount of trade that it conducts with another economy, in order to ensure its own interests. And LCRs, which is the focus of this study, is one of the most common form of such nontariff barriers (Investopedia, 2017).

Together with various trade strategies mentioned above, host-states are also taking measures directed at foreign direct investment in order to control this investment in order for the domestic economy to benefit from it as much as possible. There is a complex flow of investment on the international level and what effects FDI has on the national economies, whether negative or positive, is a matter of great concern for the nation states. (Dicken, 2011: 183)

If we look at FDI from the national perspective that such investment can be divided into outward investment by domestic firms and inward investment by foreign firms. There is a very limited number of governments that adopt a totally closed policy in regards to FDI, however, the degree of openness differs remarkably from state to state. (Dicken, 2011: 183)

<b>Policies relating to inward investment by foreign firms</b>	
<b>Entry</b>	Government screening of investment proposals. Exclusion of foreign firms from certain sectors or restriction on the extent of foreign involvement permitted. Restriction on the degree of foreign ownership of domestic enterprises. Compliance with national codes of business conduct (including information disclosure).
<b>Operations</b>	Insistence on involvement of local personnel in managerial positions. Insistence on a certain level of local content in the firm's activities. Insistence on a minimum level of exports. Requirements relating to the transfer of technology. Locational restrictions on foreign investment.
<b>Finance</b>	Restrictions on the remittance of profits and/or capital abroad. Level and methods of taxing profits of foreign firms.
<b>Incentives</b>	Direct encouragement of foreign investment: competitive bidding via overseas promotional agencies and investment incentives.

*Table 1. Policies relating to inward investment by foreign firms (Dicken, 2011: 184)*

The table 1 summarizes the major types of national FDI policy. Historically host-states are more concerned about how to regulate inward investment by foreign firms than outward investment by domestic firms. And as it was mentioned earlier there are no two nation states that are taking the same policy in regards to inward FDI. Developed countries are characterized by a more liberal approach towards inward FDI than developing countries. (Dicken, 2011: 183)

Various performance requirements are a part of different FDI strategies adopted by host-states in order to protect domestic industries and capture the most value from these investments. LCRs or insistence on a particular level of LC in the focal firm's operations in the host-country are among such regulatory measures.

Thus, according to the GPN approach, host-states are “containers of distinctive business practices and cultures – within which firms are embedded – and also regulators of business activity” (Dicken, 2011: 183). Due to the fact that firms are operating and embedded within the host-state's boundaries, host-states possess the power to determine two factors of fundamental importance to foreign firms:

- First of all, they determine the terms on which foreign firm may gain access to markets and/or resources;
- Secondly, host-states determine the rules of operation with which foreign firms must comply when operating within a specific national territory (Dicken, 2011: 224)

## **Definition of the “Local Content” and “Local Content Requirements”**

In order for countries to protect their RE industries and make them more competitive, a lot of countries, both developing and developed, are coming up with the ways to develop their local industries and support local suppliers by introducing *Local Content Requirements* (LCRs).

*Local Content Requirements*, hereinafter referred to as *LCRs*, going to be the central concept of this research and therefore it is important to give a proper definition. LCRs are certain rules that several jurisdictions adopt as a protective measure with two powerful appeals: create jobs at home rather than abroad and channel business to local firms rather than foreign firms (Hufbaue et al., 2013: 4).

There are various definitions of LCRs that could be found in policy documents, research papers, dictionaries and the media. The most comprehensive definitions of the LCRs will be presented in this section below.

According to the International Center for Trade and Sustainable Development (ICTSD) (Stephenson, 2013) LCRs are “policy measures that typically require a certain percentage of intermediate goods used in the production processes to be sourced from domestic manufacturers.”

Another definition of the LCRs is provided by Svend Hollensen (Hollensen, 2011) in his book “Global Marketing”. Hollensen (2011: 193) defines LCRs as follows: “laws stipulating that a specified amount of a good or service be supplied by producers in the domestic market”. According to Hollensen (2011) such protectionist measures adopted by the host-state can claim that domestically produced goods or services must constitute a certain percentage of the end product. LCRs are imposed for the most part on foreign companies that assemble products from foreign made components that are more cost and quality competitive than those offered in the host country (Hollensen, 2011: 193).

Hollensen also highlights the purpose of these policy measures which is to force domestic and for the most part foreign owned companies to utilize local resources, particularly labor, in their production processes (Hollensen, 2011: 193). Hollensen argues that LCRs are adopted in order to help protect local producers, both domestic ones and localized foreign-owned firms, from the price advantage that some companies based in other low-wage countries might have (Hollensen, 2011: 193).

Hollensen argues however that it is possible for foreign companies to overcome such requirements. Nowadays foreign-owned firms can circumvent LCRs by locating production facilities inside the country that is imposing these restrictions (Hollensen, 2011: 193). Hollensen also highlights that LCR are not explicitly used by developing countries, as one might assume. According to “Essentials of Global Marketing” the European Union (EU) has a 45 per cent local-content requirement for foreign-owned assemblers (Hollensen, 2011: 194).

Many definitions of the LCRs that are nowadays given in various sources are based on the definition developed by Jan-Christoph Kuntze and Tom Moerenhout (2013). For this reason, the definition of LCRs will be based on the definition provided by them.

Kuntze and Moerenhout define LCRs as a specific policy measure and a performance requirement in accordance with which foreign or domestic investors have to source a certain percentage of intermediate goods from local manufacturers or producers, who could be both domestic producers or localized foreign-owned firms. Moreover, they argue that LCRs are often coupled with other policy measures to encourage green growth (Kuntze and Moerenhout, 2013). Thus, LCRs is, in a broader sense, a very popular protectionist tool to favor domestic industries over foreign competitors.

Thus, according to the definition given above, if a foreign energy company is willing to enter a market in a jurisdiction where LCRs are adopted, then the company must derive a certain amount of the final value of a good or service from domestic firms, either by purchasing from local companies or by manufacturing or developing the good or service locally (Ankeny, 2016).

Furthermore, such a performance requirement can be adopted at the state, sub-state or regional levels (Kuntze and Moerenhout, 2013). Often, the legislation foresees a gradual increase of the percentage of inputs that needs to be sourced locally.

The LCRs can take various types of forms in the legislation and policy documents. Moreover, even the term itself “LCRs” can come by different names, and therefore it is important to identify what forms can this restrains take, in order to understand whether or not a particular country imposes LCRs in the RE sectors in the first place.

Gary Hufbauer and Jeffrey Schott (2013) suggest(ed) the following list of LCRs that were observed since January 2008:



- Classic mandatory LCR percentages for goods or services;
- Tax, tariff, and price concessions conditioned on local procurement;
- Import licensing procedures tailored to encourage domestic purchases of certain products;
- Certain lines of business that can be conducted only by domestic firms;
- Data must be stored and analyzed locally or products must be tested locally (Hufbauer and Schott, 2013: 1-7).

Thus, LCRs in the RE markets span from the requirement to purchase a certain percentage of local goods or services, to produce locally or to use only local infrastructure, imposed by foreign jurisdictions on energy companies willing to enter their markets (Hufbauer and Schott, 2013).

### **The Challenge of the LCRs in the OW industry**

Even though imposing LCRs in the OW industry on foreign OW developers may seem as a rational way that governments can choose to protect and boost growth in their local offshore wind industries, according Jan-Christoph Kuntze and Tom Moerenhout (2013) up to this date, there is no empirical research to support such a claim. Moreover, various research on the LCR in the RE sector suggests that in some cases these measures can be counterproductive.

Ideally, an energy company will go for the best price and quality when finalizing their procurement decisions in order for the end product, in our case electricity generated by the OW energy, to be cost competitive and affordable to the customers. According to Cathleen Cimino-Isaacs and Jan Zilinsky (2016) the adoption of LCRs can come at quite a high cost for the industry. LCRs are in fact prohibited under WTO treaties as well as they are not allowed under the EU competition law and are considered to be quite a controversial protectionist measure (WTO, 2017). And LCRs in the offshore wind industry are no exception in this regard.

A lot of countries, including the UK, are committed to delivering OW electricity at the lowest cost possible to consumers in order for the OW electricity to be able to compete with fossil fuels and other RE sources. However, the generation cost of this type of energy is still considerably higher than those of the onshore wind and solar generation costs, exceeding them more than two times (Figure 1) (Wind Power Monthly, 2016).

## COMPONENTS OF GENERATION COSTS: INSTALLATION

Installation costs vary across plant diversity and region, particularly for hydro and nuclear

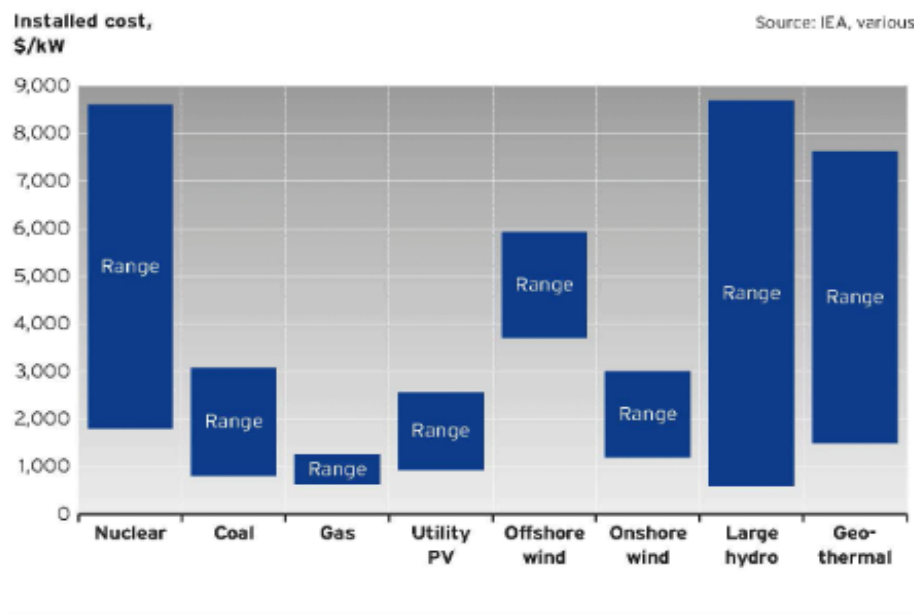


Figure 1. Energy generation costs: Installation (Wind Power Monthly, 2016).

As could be seen from the figure above, as of 2016 OW has still one of the highest generation costs in comparison to other RE generating technology that are currently available on a commercial scale (Edwards, 2011). And the high cost of energy generated by OW farms is, in fact the most prominent challenge that the OW industry has been facing (Edwards, 2011). In response to this challenge, the OW industry is committed to reduce costs as rapidly as possible.

However, despite the fact the cost of producing electricity in the UK OW farms has fallen 32 percent in the past four years and thus meeting a government target four years early (Tisheva, 2017), the generation cost of this type of energy is still two times higher than those of the onshore wind and solar generation costs.

Another challenge for the OW industry is to foster the domestic supply chain while also providing cost-effective solutions. While developing the domestic supply chain, OW industry actors acknowledge a vital importance to reduce costs of energy generated from OW. According to Pierre Tardieu, Senior Political Affairs Advisor from European Wind Energy Association (EWEA,) the OW industry needs to lean on the efficient global supply chain in order for the costs to keep going down (Smith, 2014). Thus, the adoption and implementation of the LCRs in the OW sector is at odds with this logic.

By complying with the LCRs energy companies have to let go of potentially cheaper and, in some cases, better in terms of quality products or services. This may lead to the increase of the domestic production costs and thus transfer higher prices to consumers (Cimino-Isaacs and Zilinsky, 2016). So, in theory, LCRs prevent energy companies from being free to source cheaper and higher quality foreign components (Edwards, 2011). Therefore, in this regard, LCRs do not sound like a reasonable measure to take for the policy makers who should be interested in driving the costs of producing electricity from offshore wind farms down. Following this logic, host-countries should not be forcing energy companies to invest in production facilities that are not economically viable over the long term.

However, the reality shows that LCRs can have positive impact on the growth of the domestic offshore wind industry (Cimino-Isaacs and Zilinsky, 2016). The implementation of the LCRs can bring, as was mentioned earlier, negative effects. However, there are some significant positive effects as well. LCRs can contribute to the development of the domestic RE industry through increase of the domestic manufacturing, which allows obtain economies of scale thus considerably contributing to cost reduction. China, for example, can in fact be considered as a positive example. Although 70% Chinese content requirement is no longer present, it has been removed since the end of 2009 (Smith, 2014), without Chinese content requirements being in place it is highly unlikely that China could have established such a strong local wind industry and domestic supply chain from 2004 - 2009 (Smith, 2014). Without enforcing LCRs in the Chinese RE industry, it would arguably not be able to become the largest wind turbine manufacturing base and the largest wind turbine market in the world (Wind Power Monthly, 2014).

Energy companies are being increasingly faced with various protectionist regulations that they have to comply with in foreign RE markets. Even such markets as the UK OW market, with no mandatory LCRs, energy companies are adjusting their production decisions to reflect their localization strategies as they are reliant on the government support and incentives (Cimino-Isaacs and Zilinsky, 2016). And as it was mentioned earlier there might be a trade-off in the implementation of LCRs in the OW sector between developing a local industry (which brings such benefits as job creation for local populations and fostering the development of domestic supply chain) and achieving lower prices for electricity generated from the OW (IRENA, 2017).

Even though more than 100 LCRs have been adopted by different countries in the period from 2008 till 2013, there were approximately only twenty of such policy measures introduced in the RE

sector around the world (Stephenson, 2013). And despite the fact that the majority of LCRs are more popular in the distractive industries, according to ICTSD, the possible impact of LCRs in the RE sector on international trade was estimated to be almost over \$100 billion annually (Stephenson, 2013). Since LCRs have been introduced in the RE sector for quite a short period of time, it is therefore considered to be quite difficult to estimate the effectiveness of such protectionist measures (Stephenson, 2013).

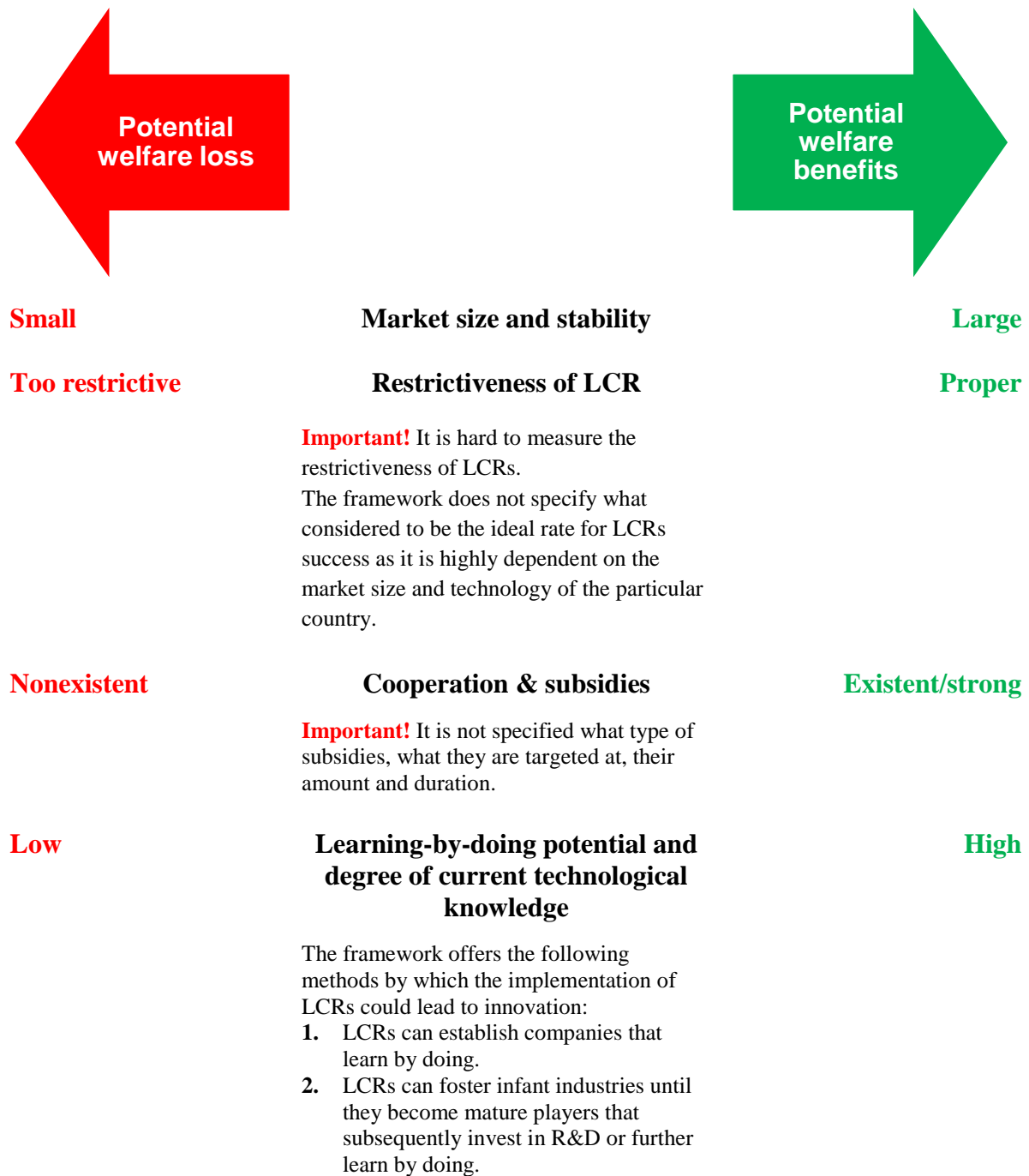
### **Kuntze and Moerenhout framework for the effectiveness of LCRs**

In order to come closer to an understanding whether or not the United Kingdom has proper conditions for potential LCRs positive effects on the development of the UK OW industry, the following theoretical framework, proposed by Kuntze and Moerenhout will be used in this paper.

Jan-Christoph Kuntze and Tom Moerenhout (2013) in their work “Local Content Requirements and RE – a good match?” offered a comprehensive theoretical framework to evaluate the effectiveness of industrial policy measures such as LCRs in the field of RE.

In their attempt to learn from the successful Chinese experience in developing the wind industry using LCRs, Kuntze and Moerenhout developed this framework to help identify the basic conditions that the market needs to have in order to implement successful and effective LCRs, that will develop the domestic RE industries (See *Figure 2*) (Kuntze and Moerenhout, 2013).

## Basic conditions for LCRs effectiveness in the RE sector



*Figure 2. Adapted from the theoretical framework proposed by Kuntze and Moerenhout for identifying basic condition for LCRs effectiveness in the RE sector (Kuntze and Moerenhout, 2013).*

What is worth paying attention to is what the actual perfect level of LCRs restrictiveness is in the RE sector. In the table above the restrictiveness of LCRs is divided into two extremes such as “too restrictive” and “proper”. However, the framework does not specify what is considered to be an ideal rate for LCRs success. As mentioned, this is often country, market, and technology-specific (Kuntze and Moerenhout, 2013: 11)

Moreover, Kuntze and Moerenhout (2013) warn that “cooperation and subsidies” does not offer any information about what type of subsidies are present in the market, what they are targeted at, their amount and duration. They emphasize that the question about subsidies in the RE sector is vital as the higher the level of financial support the governments provide the more attractive this market is for the foreign developers (Kuntze and Moerenhout, 2013: 11).

When analyzing the LCRs for the RE sector one needs to understand the following terms: “welfare loss” and “welfare benefit”. Kuntze and Moerenhout argue that the following framework can be mainly applied to a particular state or a market. The reason for this is that it is very likely that while some welfare benefits, such as employment and other economic benefits, can make oneself useful for and benefit one country, there is very high possibility that the growth prospects of other countries will be harmed (Kuntze and Moerenhout, 2013: 11).

Therefore, this framework for the most part deals with the development of the domestic RE industry, rather than with achieving benefits for the whole RE industry (Kuntze and Moerenhout, 2013: 12).

When estimating LCRs effectiveness in the RE industry one needs to take into account the fact that it is hard to measure the innovation potential of LCRs. The reason for this is that an innovation is a very dynamic process that occurs discontinuously. Nonetheless, the following two methods by which the implementation of LCRs could lead to innovation are outlined (Kuntze and Moerenhout, 2013: 11): LCRs can establish companies that learn by doing as well as LCRs can foster infant industries until they become mature players that subsequently invest in Research and Development (R&D) or continue to learn by doing.

With the help of this framework I will attempt to explain the elements of existing LCRs in the UK OW and identify whether or not the UK OW industry has the basic conditions for a positive effect of LCRs on the development of the industry.

## Literature Review on Offshore Wind in the UK

The United Kingdom is the global market leader in offshore wind (BVG Associates, 2017). The Government has set up a goal to generate to 15% of energy needs from renewable sources by 2020 (Harvey, 2017) and in order to meet this renewable energy targets, it is argued that the UK has to fully realize and take full advantage of its offshore wind potential (Crown Estate, 2015: 3). Thus, the UK strives to make its OW industry more competitive and the Government is committed to support the emerging sector by providing an unprecedented regulatory and price support within the UK offshore wind energy sector in order to attract a number of foreign OW developers to do business in the UK (Crown Estate, 2015: 3).

A number of industry reports on the diversification opportunities of oil and gas industry in the UK OW industry as well as British OW supply chain capabilities have been published. “A Guide to Offshore Wind and Oil & Gas Capability” published on behalf of Scottish Enterprise (Gillespie, 2011) highlights what significant market opportunities are available to the British oil and gas supply chain within the OW sector in the UK. The reports is important to the current study in regard to the UK content in the domestic OW supply chain, as it presents a wide range of opportunities which the British oil and gas supply chain can exploit. Especially interesting are, so called, “Green light opportunities” for the oil and gas companies within the major offshore segments. This information is of interest to the current study as it provides industry players’ insights on the challenges for cross-sector transfer that will help identify the reasons behind little or slow increase of the UK content in several major offshore segments within the British OW projects (Gillespie, 2011).

“The UK Offshore Wind Supply Chain: A Review of Opportunities and Barriers” is a study conducted by Mathew Chin, Siemens (2014) for the Offshore Wind Industrial Council (OWIC). The study provides an overview of the UK OW supply sectors, such as Substations, Towers, Foundations and Cables as well as it provides the insight into these segments readiness to compete with the overseas suppliers in the UK OW market (Chin, 2014: 4). Chin argued that such segments of the UK OW supply chain like inter array cables, substation structurers, turbine foundations and towers represent huge potential for technology innovation and further cost reduction, achieved through economies of scale. However, these segments are a part of *Capital Expenditures* (CAPEX) of OW developers and to this date. UK content is very poorly represented in CAPEX.

“UK offshore wind supply chain: capabilities and opportunities” is another report on the capabilities of the UK OW supply chain which was prepared by BVG Associates for the Department for Business, Innovation and Skills (Roberts et al., 2014). The report presents British OW supply chain’s strengths and weaknesses as well as the potential for businesses in each segment to benefit economically from the growth in OW industry development. Like in the Mathew Chin study, the report acknowledges the importance of growing the UK content across the segments of the UK OW supply chain as this practice represents a great potential for further cost reduction. The report argues that those offshore segments that have little UK content, namely *Turbine supply*, *Balance of Plant* and *Installation and Commissioning*, have the best potential to cut costs (Roberts et al., 2014).

The UK government recognizes its responsibility and importance to deliver electricity generated by the offshore wind at the lowest cost possible to the end customers. Thus, one of the most important priorities in the OW sector is cost reduction. Further cost reduction will allow electricity generated from OW wind to be more competitive against other renewable electricity sources as well as traditional electricity sources like oil and gas (Crown Estate, 2015). Therefore, the following report provides an overview of cost reduction opportunities in the UK OW industry. “The Offshore Wind Cost Reduction Pathways Study” is a comprehensive study that identifies and quantifies cost reduction opportunities for the UK offshore wind industry. The research is commissioned by the Crown Estate (2012) and is evidence-based. It provides an insight into various drivers and dependencies of OW costs as well as it encourages the governmental bodies, OW project developers, the OW supply chain to align future activities in order to achieve the increased cost reductions by 2020 (Crown Estate, 2012: 3).

The above-mentioned studies on the British OW supply chain capabilities in the UK OW market have been based on data acquired before the UK Government pursued its initiative to require UK content through CfD which was broadly interpreted as a way of encouraging developers to select suppliers who are located in the UK wherever possible (Wind Power Offshore, 2016). As it was mentioned earlier the current research is focused on studying the extent of the UK content in the domestic OW supply chain as well as whether or not the British content has increased across domestic OW supply chain after the Government claim on local content. Therefore, the above-mentioned reports will be used as a benchmark against which I will analyze the UK content in CfD



OW projects, that have local content obligations, and non CfD projects with no or very little LC obligations placed on them.

Given that the UK Government has recently announced that it is keen on making the CfD support system available beyond 2020, it is interesting to analyze why some OW segments are more successful than others in securing main contracts for supply, manufacturing or installation services thus growing local content. Moreover, what hinders other OW segments from increasing local content.

Moreover, BVG Associates, who have developed the methodology for measuring the UK content in future wind farms on behalf of the Crown Estate and the Offshore Wind Programme Board, have expressed concerns that the UK is likely to raise its expectations in regards to the UK content in the domestic OW sector (BVG Associates, 2017). According to Alun Roberts, Associate Director BVGA (BVG Associates, 2017) the current expectations of the UK content of 50 % may be raised to unrealistic levels.

“The UK Content of Operating Offshore Wind Farms” (Renewable UK, 2015) is an analysis of the UK content of wind farms in operation conducted by the BVG Associates and commissioned by the Crown Estate. This is yet another analysis that provides findings on the extent of the UK content in OW farms before the UK Government claim on LC.

For this reason, among others, I believe that it is necessary to monitor how the extent of the UK content varies in different OW projects, in terms of LC obligations, and across different OW segments, specifically *Balance of Plant*, as this is the segment with the greatest potential to cost reduction (Chin, 2014). As well as it is important to consider some practical limitations of the UK content in the domestic OW supply chain, now that concerns have been expressed about the UK government’s intentions to further increase their expectations of the UK content.

The UK, indeed, has some excellent OW companies and as it was highlighted in the above-mentioned reports on the UK supply chain capabilities in the domestic OW sector, there is room for more (Roberts et al., 2014; BVG Associates, 2017; Crown Estate, 2015). However, some UK OW segments have more potential to engage in the OW supply chain than the others. The reasons for that will also be discussed in this research.

As of Spring 2017, studies on the UK content in the UK OW industry have largely focused on the UK OW supply chain capabilities as well as the economic benefit such UK based companies can

get if they engage in the OW industry as well as what economic benefits the oil and gas supply chain might get if it diversifies into the OW sector. However now, with the newly introduced support system, CfD, which implies that the OW project developers have to award a share of main contracts to the UK based firms, it is important to understand whether or to which degree policy claims on LCRs succeed in enhancing local content in OW projects in the UK sector. And this can be achieved by studying the UK content in the domestic OW supply chain in order to identify British capabilities as well as the weakest tiers in the major offshore wind segments in the UK OW market.

### 3. Research Methods

The following chapter presents and discusses the research methods and research design as well as methods of data collection that have been employed in this research.

#### Research Strategy and Design

This study aims to analyze the extent of the UK content in the domestic *Balance of Plant* to identify British capabilities as well as the weakest tiers in this major OW segment in the UK OW market. Besides, the study attempts to understand whether or to which degree policy claims on LCRs succeed in enhancing local content in OW projects in the UK sector.

Therefore, the current research combines both quantitative and qualitative research approaches. The reason for conducting the mixed-method research derives from the nature of the research questions.

The *Research Question 1* on the extent of LC in the UK major OW segment requires to conduct analyses of excel databases with a number of various stakeholders involved in the development of the OW project. The quantitative research approach is important as it allows the collection of empirical data necessary to provide an answer to the second research question. In order to conduct a quantitative analysis and identify the extent of the LC in the British *Balance of Plant* supply chain, the stakeholders provided by the 4COffshore supply chain databases must be linked to particular segments of the OW supply chain in order to filter to the single segment *Balance of Plant*. The extent of the UK content throughout various segments of *Balance of Plant* will be calculated based on the proportion of the contracts the OW project developers awarded to the UK based suppliers and their value. Given that the quantitative data must be analyzed to provide an answer to the first research question, the current research requires the quantitative research approach.

The qualitative research approach will be used to understand the meaning of the conclusions produces by the quantitative method in order to answer the *Research Question 2*. Qualitative methods examine the “why “and “how” of decision making, not just “what, where, when, or who”. Besides it has a strong basis in the field of social science to understand government programs.

Empirical data on the extent of the UK content gathered by using the *Quantitative Research Method*, will help to understand whether the LC obligations placed on the UK (CfD) OW projects have contributed to enhancing local content in the OW projects in UK sector. Moreover, qualitative research method will allow to derive conclusions as to **why** the UK content varies throughout the UK domestic supply chain, as well as **why** there is still little local content in the OW projects that have local content obligation and whether it is possible to grow the UK content in the Balance of Plant.

When it comes the *research design*, which is a framework for the collection and analysis of data that determines how the chosen methods will be applied to answer the research questions (Bryman, 2012: 46), the *case study design* has been chosen. Case studies are based on any mix of the quantitative and qualitative data (Yin, 2003: 1). Moreover, one of the purposes of the case study is to explain causal links and describe interventions.

The choice of the case study design is determined by the nature of the research, which is both quantitative and qualitative, and the research questions that are focused on explaining the causal links between policy claims on LCRs in the OW industry and the varying extent of the local content in various segment of the UK OW supply chain. Given that this research focuses on a single offshore wind market segment in the UK and its challenges with regard to LC in the domestic OW supply chain, the research design can be further specified as a single-case study research design.

### **Methods Of Data Collection**

There are a variety of techniques that can be used to collect data in a quantitative research study, however, all of them are geared towards numerical collection. This is achieved by coding the qualitative data of interest into numerical values (Harvard Law School, 2017). During the internship at SINTEF I was responsible for mapping out supply chains for various OW projects, including those in the UK, by linking various stakeholders involved in the development of OW projects to specific OW supply chain segments that they were representing. OW segments were further divided into a number of suppliers that were serving their respective OW segments.

Thus, all the stakeholders involved in the development of the UK OW projects, that will be analyzed in this research, were categorized and linked to their respective OW supply chain segment

by me during the internship and some databases, specifically the CfD OW projects, were prepared for the purpose of this research on my own initiative.

The finding on the analysis of the extent of the UK content will be presented in the Pivot Diagrams, made with the help of Excel analysis tools to visualize the extent of the UK content in OW farms, specifically a number of contracts awarded to the UK-based and foreign suppliers.

In order to answer the *Research Question 2*, which also requires a qualitative research approach, empirical data is collected through the quantitative analyses of the UK content. In order to understand the meaning of the conclusions produced by the quantitative method, empirical data gained from interviews and the analysis of the UK OW capabilities reports and policy documents will be used. Interviews as a source of empirical data as well as studies of policy documents, industry reports and news articles are the most common methods used to generate data in qualitative research (Savin-Baden & Major, 2013).

Initial focus of the master thesis was to research the challenges the Norwegian OW project developers, like Statoil, and Norwegian OW suppliers have to deal with in regards to the UK domestic supply chain as well as how the LC obligations placed on OW project developers are affecting the Norwegian OW developers and suppliers.

Therefore, I conducted informational interviews with the Scottish government OW policy advisor as well as two interviews with the managers of the Norwegian suppliers that are working for a number of the UK OW projects. It proved to be difficult to get an informational interview with Statoil, which was supposed to be the focus of the case study, and the information gained through the interviews with Norwegian supplier's managers was not enough to cover the problem formulated above. The informants insisted that the information they provided during the interviews is completely anonymized and that neither the informants' nor companies' names are used in any reports. The reason for this is that some of the information could be considered to be sensitive and a little critical of the UK offshore wind strategy and may not necessarily reflect the company's official opinion.

The interviews conducted allowed me to better understand how the LCR system works in the UK which allowed me to redirect focus of my research. Thus, a representative of a Norwegian supplier that is working with a number of OW projects in the UK mentioned that the main burden to comply with a specific requirement for local content is on the OW project developers that have secured

CfD contract and LC is determined in terms of contract value. Therefore, Norwegian OW suppliers do not have to comply with any LCRs and therefore there is no challenges connected to complying with LC obligations. The basic principle is to engage with the local supply chain via a series of 'Meet the buyer' events in the proximate region to the project. Information and contacts are collected and when it is economic and appropriate to do so, a local supplier will be asked to pre-qualify with the company and will then be able to bid on work in the usual competitive manner.

Therefore, the focus of the master thesis has been redirected from researching the challenges the Norwegian OW project developers and suppliers experience in regards to LCR, to researching whether UK Government policy claims on LCRs in the domestic OW industry succeed in enhancing local content in the OW projects in UK sector.

## **4. Introduction to the UK OW Market and a Typical OW Supply Chain**

The following chapter provides an introduction to the UK Offshore Wind industry and outlines the regulatory framework for the UK content in the domestic OW sector. Moreover, the chapter presents an overview of a supply chain involved in the development of a typical offshore wind farm.

### **The UK Offshore Wind Market:**

Since October 2008 the UK remains to be the global market leader in OW industry with more installed capacity than any other country in the world (Renewable UK, 2017). The OW resource in the UK is unprecedented, being the windiest country in Europe the UK is considered to be able to power itself several times just by using OW power (Renewable UK, 2017).

According to a new study by Simon Watson, Professor of Wind Energy at Loughborough University (Watson, 2016) the UK is estimated to be able to install approximately up to 675 GW in the UK waters of economically feasible OW. According to Watson (2016) 675 GW would be enough to cover more than six times the country's current electricity demand.

Given that the present UK total installed capacity of OW is a little bit over 5 GW (Renewable UK, 2017) there is, by all means, an ample room for more. However, to achieve more rapid deployment of OW, major challenges must be overcome (Watson, 2016; Renewable UK, 2017). The OW projects are getting bigger and bigger and going further offshore. And the further offshore the OW farm is to be built, the higher installations costs rise (Renewable UK, 2017). This is one of the reasons as to why the UK OW industry is highly dependent on the Government financial support. Without subsidies, at this stage of the OW industry development, the electricity generated from the OW is not going to be competitive on its own compared to other RE sources like, solar electricity and other traditional sources of energy, like oil and gas.

Driven by the need to reduce greenhouse gas emissions and secure home-grown energy supplies, energy generated from OW is currently the fastest growing RE type in the UK (Renewable UK, 2017). The offshore wind in the UK represents an enormous RE resource being able to cover the UK electricity need more than 6 times alone (Watson, 2016).

In order to reach international climate goals, major markets around the world, including United Kingdom, have set goals to increase their percentage of renewable sources in their domestic electricity consumption (Ulstein, 2016). Therefore, the UK commitment to support and further develop the OW industry has been driven by its renewable energy/climate change targets (The Crown Estate, 2014: 2). Moreover, the UK government and the industry argue that the OW sector represents a huge economic opportunity for the UK and domestic offshore supply chain (The Crown Estate, 2014: 2).

The UK government is committed to support the emerging sector by providing an unprecedented regulatory and price support framework within the UK OW energy sector. The Renewables Obligation (RO) and Contracts for Difference (CfDs) that have been introduced as a part of the UK Government's programme for Electricity Market Reform (EMR) are two of the most important mechanisms for electricity price support for OW in the UK (Gov. UK, 2015).

Not only the UK is the global market leader in offshore wind but it also has the most attractive location for offshore wind investment in the world (BVG Associates, 2017). According to the "Guide to Offshore Wind and oil and gas capability" (Gillespie et al., 2011: 7) the UK has done more than any other country in the world to support the development of the domestic OW industry. The Renewables Obligation (RO) that was introduced in 2002 by the Department of Energy and Climate Change (DECC) with the purpose to serve as an incentive for energy companies to generate their electricity from renewable sources. RO is among the most important pieces of legislation within the UK OW sector in helping the UK to transition from fossil fuels to renewable energy (Gillespie et al., 2011: 7).

In accordance with the RO all licensed electricity suppliers are obligated to generate an increasing percentage of power from renewable sources, including offshore wind (Gillespie et al., 2011: 7). The RO is a story of success for the UK RE industry since its introduction in 2002 as the total share of total RE generation has increased more than three times from 1.8% to 6.64% (Gillespie et al., 2011: 7). To date, the UK financial support of the RE sector accounts to approximately £1.42 billion per year (Gillespie et al., 2011: 7).

The UK OW market has indeed enjoyed a longstanding reputation as the world's most attractive investment environment as well as it has been at the forefront of attracting new investors into the sector (Gov. UK, 2017). The Table below demonstrates the existing investors in the UK OW



pipeline as of May 2015 (Gov. UK, 2017). As it could be seen from the figure below the UK OW market has received investment from across the world (Crown Estate, 2015: 3).

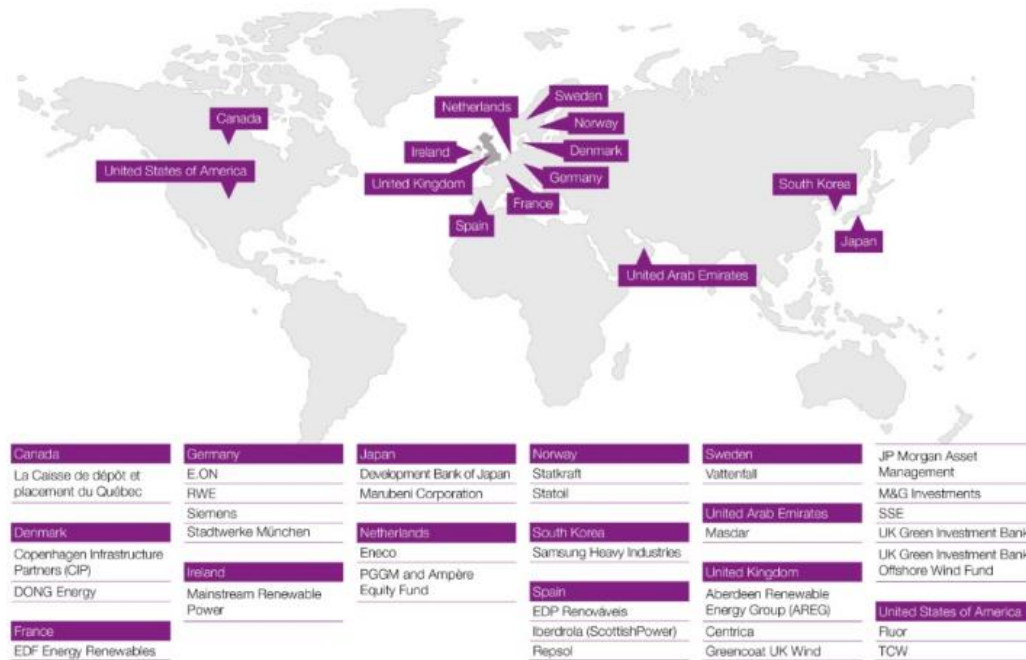


Figure 3. The existing investors in the UK offshore wind pipeline as of May 2015 (Gov. UK, 2017).

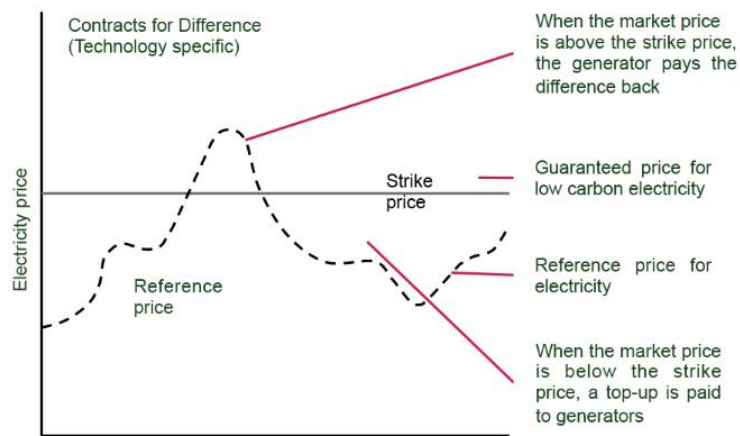
In order for the UK to meet its 2020 renewable energy targets, it is argued that the UK has to fully realize and take full advantage of its OW potential (Crown Estate, 2015: 3). The UK government is looking to make the domestic OW industry more competitive in order to secure energy security, contribute to job creation in the country as well as attract investment to the sector.

The UK government recognizes its responsibility and importance to deliver electricity generated by the OW at the lowest cost possible to the end customers. One of the ways to bring down costs is by developing the UK OW industry: through contributing to the development of innovations and technologies in the OW sector, developing and increasing British OW manufacturing capabilities to achieve economies of scale, etc. This OW industry development can be achieved by attracting international OW developers to do business in the UK.

Thus, the UK, as a host state, has an important task. While attracting foreign energy companies to develop their OW projects in the UK, by providing government incentives, stable policy regime, the government, of course, is keen on retaining this investment inland. The UK task, therefore is to make sure that British offshore wind supply chain will benefit properly from the UK government's

decision to support this new sector as it was stressed by a number of the UK government officials on several occasions (Wind Power Offshore, 2016).

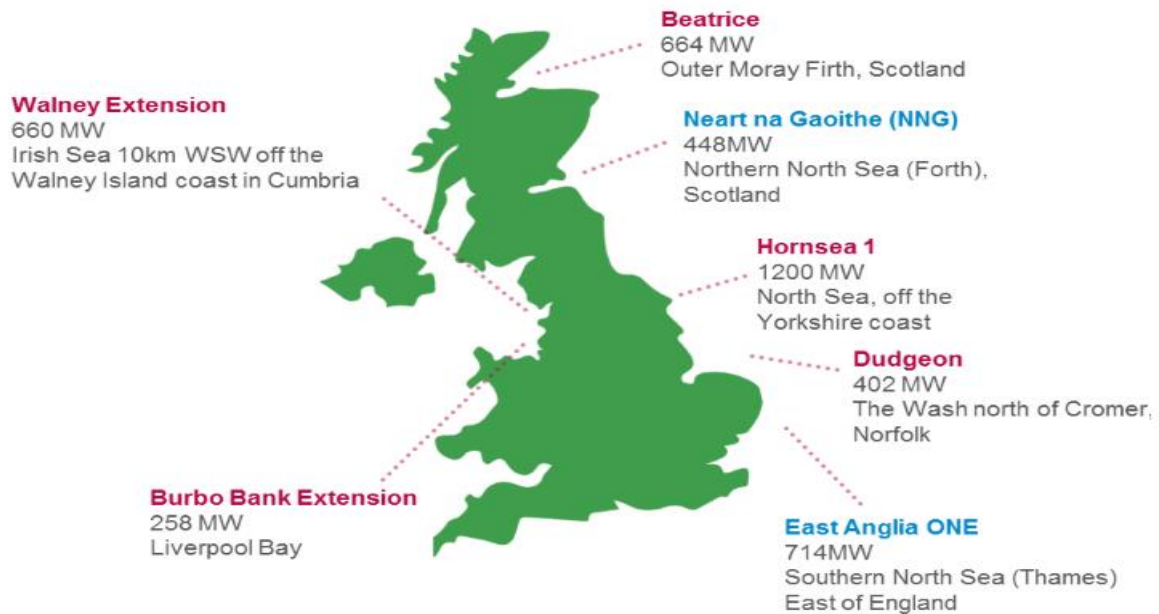
To this end, in 2013 the UK Government developed a special mechanism, *Contract for Difference* (CfD) support scheme, through which it requires a foreign OW project developer to contribute to the development of the local OW industry. It is important to show how the developer will contribute to the growth of the UK OW industry as this will determine whether or not the company will get access to the market. According the UK Government webpage on the “Contract for Difference” (2017) “the CfD is a private law contract between a low-carbon electricity generator and a government-owned Low-Carbon Contracts Company” (Gov. UK webpage, 2017). The CfD operates on the basis that generator is paid the difference between the strike price, which is basically a price for electricity generated from OW that reflects the cost of investment in the OW technology, and the reference price, which is a measure of the average market price for electricity in the U.K. market (See *Figure 4* below). Moreover, if the market price for the OW electricity will exceed the strike price generators would be required to pay back the difference (Gov. UK, 2017).



*Figure 4. Administrative strike prices for offshore wind (Gov. UK, 2017).*

It was announced in 2014 by the UK government that developers of renewable energy projects, including the OW projects, would be required to submit a ‘satisfactory’ supply chain plan to be eligible to bid for a Contract for Difference (Gov.UK, 2017; Wind Power Offshore, 2016; BVG Associates, 2017). Only the OW projects with a capacity of approximately 300MW and more are required to submit such a plan, as they are considered big enough to have an effect on the

development of the local supply chain (Gov.UK, 2015). As of 2016, the following OW projects presented below (See *Figure 5* below) have been awarded CfD (Gov. UK, 2017).



*Figure 5. Projects awarded Contracts for Difference (Gov. UK, 2017)*

The initiative to require the UK content through CfD support scheme was broadly interpreted as a way of encouraging OW developers to select OW suppliers who are located in the UK wherever possible. According to BVG Associates (2016) British ministers have left no doubt for OW developers and suppliers that this is what they want from the OW developers and British OW suppliers (Wind Power Offshore, 2016). Through this mechanism, the UK government will be able to support British suppliers and encourage foreign offshore wind developers to consider the local suppliers so that they can win offshore wind supply chain contracts and thus bring jobs and growth to local people (Wind Power Offshore, 2016).

The UK government is striving to apply pressure on LC without violating the EU competition law, targeting only those projects with capacity of more than 300MW whose developers want to secure CfDs (Gov.UK, 2017). Moreover, according to BVG Associates (2016), the Government’s intention is for local suppliers “to raise their game and take meaningful steps to mature the industry” (BVG Associates webpage, 2016). They should be fully engaged in industry programs

to reduce costs as well as they must understand what their skills gaps are and be doing something about it (BVG Associates, 2016).

According to BVG Associates (2017), the UK Government is expected to develop a series of industrial strategies with regard to the development of the domestic OW industry. What becomes a matter of concern is that the UK may raise its local content expectations in the UK OW supply chain to unrealistic levels, from 50%, which is the current vision of the UK content in the UK OW supply chain, to 65% of the UK content (BVG Associates, 2017; Catapult, 2017).

According to the UK Offshore Renewable Energy Catapult (2017) study, it was estimated that the 65% of the UK content in the OW supply chain can be achieved in 2030. However, according to Alun Roberts, Associate Director at BVG Associates, the practical limits of the UK capability in the OW supply chain must be taken into consideration, such as recognizing that the UK economic capacity does not allow the UK to build large vessels, as well as the UK does not mine iron or copper and “have little prospect of disrupting the global supply chains for large electrical components such as transformers” (BVG Associates webpage, 2017).

The 65% of the UK content in the domestic OW supply chain implies that the UK has managed to realize its supply chain’s full potential (BVG associates, 2017). According to Alun Robert’s estimates, 65% of the UK content means that **all wind turbines, both inter-array and export cables and substations** are manufactured and supplied by the British or UK-based manufacturers as well as **all of the OW farms’ components** are to be installed by the UK based OW companies (BVG Associates, 2017). Despite the financial support offered by the UK government to develop the OW industry, the above-mentioned scenario of 65% of the UK content in the domestic OW supply chain is unlikely (BVG Associates, 2017).

As it was mentioned earlier, the UK government has set up a goal to achieve 50% of UK content in offshore wind farms by 2030 (Renewable UK, 2015: 4). According to the report by BVG Associates (2015) “The UK content analysis of operating offshore wind farms” which was commissioned by the Crown Estate to monitor the local content in the OW farms, the UK OW industry is on track to reach this goal of 50 % UK content. As of 2015 the UK content in OW is approximately 43% (TOTEX, which is a total budget of an OW farm) (Renewable UK, 2015: 4). The share of the UK content considerably varies across various OW segments, like operation and maintenance, initial development stages and manufacturing and construction (Renewable UK,

2015: 4). Below is the breakdown of the extent of UK content presented as a share of the OW farm's *Operational Expenditures* (OPEX), *Development Expenditures* (DEVEX) and *Capital Expenditures* (CAPEX) (Renewable UK, 2015: 4). As of 2015, the share of the UK content in the OW projects are as follows:

- OPEX - Operation and maintenance stages - 73% UK content.
- DEVEX - Initial development stages - 57% UK content
- CAPEX (for ex. turbine supply comes from abroad) - Manufacturing and construction phases - 18% UK content (Renewable UK, 2015:4).

Given that the *Turbine Supply*, *Balance of Plant* as well as *Installation and Commissioning* are a part of CAPEX, which is represented by only 18% of the UK content, it is evident that there might be some challenges within these segments of supply chain. Thus, the scenario of achieving 65% local content by 2030 is somewhat ambitious, but not impossible (BVG Associates, 2017). The major challenges will be further discussed in this chapter when analyzing supply chain databases of the OW projects in the UK.

Despite the fact that the share of the UK content is poorly represented in these OW segments, those are the domestic OW segments that are estimated to have the most potential at contributing to even further cost reduction (Roberts et al., 2014; BVG Associates, 2017; Crown Estate, 2015). The UK, has some excellent OW companies that are constantly developing and investing in R&D activities to be able to meet the growing demand, like JDR, that has pioneered the design of inter-array cables in the offshore energy industry, contributing to cost reduction targets with innovations such as aluminum cores (JDR Cables, 2016) and Offshore Structures (Britain) that is prepared for large scale production of transition pieces for monopile foundations (Offshore Structures UK, 2017), but there is definitely a room for more (Roberts et al., 2014; BVG Associates, 2017; Crown Estate, 2015). The UK is yet to deliver a stronger, more competitive supply chain within *Manufacturing and Construction*.

Therefore, the UK government is not only interested in encouraging foreign OW developers seeking financial support to engage the UK OW supply chain in their projects but it would be ideal to do so in the sectors that have the most potential for cost reduction, such as *Turbine Supply* (Specifically Towers), *Balance of Plant* and *Installation and Commissioning*. According to a study by BVG Associates (2015) on the extent of local content in operational OW farms, manufacturing

and construction phases (CAPEX), has a huge potential to cost reduction through innovation and increased manufacturing, achieving economies of scales (BVG Associates, 2015:5).

## **A Typical Offshore Wind Supply Chain**

The following section will provide an overview of the typical OW farm costs as well as the major OW supply chain segments that are involved in the development of the project. As much of the LC requirement is met by awarding a proportion of the main contracts to UK-based companies and LC is determined by contracts value, the OW farm costs overview is necessary, as it helps understand which contracts awarded to the UK-based suppliers are significantly affecting the level of local content in the UK OW industry. Thus, the OW project development consist of the following five elements, introduced in the Guide to an Offshore wind farm, published on behalf of the Crown Estate (Crown Estate, 2013): development and consent, wind turbine, balance of plant, installation and commissioning, operations and maintenance.

When analyzing the LC in the British OW supply chain it is important to remember that, first of all, there is no OW farm that is alike, and, second of all, all OW farms are built and operated differently. OW farm developers are facing and dealing with a variety of challenges that require different solutions (Crown Estate, 2013). Such challenges include the scale of a wind farm, water depth and distance from shore. Optimal solutions to tackle these problems are yet to be developed. (Crown Estate, 2013)

Furthermore, the report (Crown Estate, 2013) stresses the fact that OW supply chain may change due to the rapid pace of innovation in the OW industry. It is very difficult to predict the exact type of technology and process that will be used in the OW farm development process in the years to come. Just less than twenty years ago very few experts could predict the emergence of turbines with electricity generation capacity of 5MW with rotor diameters over 120m (Crown Estate, 2013: 4).

Thus, there is no typical OW project. All OW farms are considerably different in their size as well as they are built at varying distance from the shore. The characteristics of the OW farms provided by the Crown Estate report (2013: 4) are applicable for an OW farm of approximately 500 MW built at around 50 miles from the shore. Crown Estate report (2013: 4) uses these characteristics

when calculating approximate costs and as well as form judgements about processes used in the development of an offshore wind farm.

The report (Crown Estate, 2013) divides OW farms suppliers into several groups based on what services these suppliers provide. The list of suppliers is only indicative and not exhaustive. As it was mentioned above, rapid technological advancements in the OW industry does not allow to make any accurate predictions in regards to any new potential suppliers coming into picture. Thus, the list of suppliers includes only those that have proven capability, and excludes those that have likely future capability as well as those suppliers that are situated far from the UK (for example in US or China) (Crown Estate, 2013). Thus, the following major OW segments are involved in the OW projects development:

**Development and Consent** represents approximately 4% of OW farm CAPEX, which is approximately £60 million for a typical 500 MW OW farm and is managed by an OW farm developers (Crown Estate, 2013: 9). Various types of environmental, coastal process, met station and sea bed surveys, as well as front-end engineering and design and human impact studies are done within the Development and Consent (Crown Estate, 2013: 9). According to the report on the UK content by BVG Associates (2015: 5) the largest variation in UK content came in DEVEX.

Given that this stage is largely undertaken by the OW project developers and due to the fact that many of the services provided during stage may be contracted out to companies in the same country as that of the development team, the UK content is very well represented within this stage (Roberts et al., 2014: 14). As of 2014, the majority of the OW farms have been designed by the UK based firms (Roberts et al., 2014: 14).

**Wind turbine:** One 5 MW wind turbine costs approximately 6 million pounds. Wind turbines as well as its components are supplied by turbine manufacturers. (Crown Estate, 2013: 20) To date there are two main suppliers of wind turbines and its components that dominate the UK OW market, Siemens and Vestas, both of which have headquarters in Denmark (Windpower Monthly, 2015).

Even though that currently none of the turbines and its major components are manufactured in the UK, it is going to change soon. Siemens which is a German firm, together with its partner Associated British Ports, has invested £310m in the UK offshore wind turbine manufacturing, assembly and logistics (Offshore Wind, 2016). This turbine manufacturing facility is situated in direct proximity to the North Sea and large offshore wind farms, such as Race Bank (Siemens,

2016). The investment in the manufacturing of turbines which represents one of the largest procurement choices of an OW farm is going to significantly contribute to cost reduction once the facility obtains repeat orders and obtains economies of scale.

Nacelles are assembled by wind turbine manufacturers themselves, components to which, however, are usually sourced from external suppliers (Crown Estate, 2013: 20). Rotors as well as nacelles are also designed by an OW manufacturer. The next component of an offshore wind turbine is Tower, which is a steel structure that supports the nacelle. Most typical suppliers of Tower in the OW market have manufacturing and assembly plants located in the UK (Offshore WIND, 2013), and according to the Crown Estate (2013: 40) it is likely that others will establish its tower manufacturing and assembly sites in the UK port locations.

**Balance of plant** is the segment that will be analyzed in this research on the extent of the UK content as well as the factors that hinder and/or facilitate the growth of LC. *Balance of Plant* represents a very large segment within the OW supply chain which includes basically all components of the OW farm except for the turbine. *Balance of plant* constitutes around 30%, or approximately £ 400 - 500 million, of total OW project's CAPEX (Crown Estate, 2013: 44).

*Balance of Plant* includes all aspects of the cable (export and array cables as well as cable protection), turbine foundations (foundation structure, transition piece, crew access system, J-tubes, scour protection, sacrificial anode), offshore substation (electrical system, facilities, structure) and onshore substation supply (Roberts et al, 2013: 31; Crown Estate, 2013: 44-50).

Export and array cables account for approximately 60 and 20 million of pounds for a typical 500 MW OW farm respectively (Crown Estate, 2013: 45). According to the Guide to an Offshore Wind Farm by Crown Estate (2013: 47) turbine foundations represent the single biggest *Balance of Plant* cost which accounts for up to 300 million pounds for a typical 500 MW OW farm with 100 turbines. Therefore, if main contracts for turbine foundation fabrication and supply will go to the UK based firms, the UK content share in the British OW supply chain will significantly increase. Offshore and onshore substation account for around 50 and 40 million pounds respectively (Crown Estate, 2013: 51-53).

It is argued in a number of reports on the UK OW capability (Roberts et al, 2013: 31; Gillespie, 2011; Chin, 2014; BVG Associates, 2017; Crown Estate, 2015; Crown Estate, 2013: 44) that an increasing UK manufacturing capability within this segment represents a significant opportunity



for further cost reduction in the industry, and the UK Government recognizes the importance of raising the UK content within this stage. Balance of Plant is estimated to have the most potential for cost reduction in the UK OW sector given that the UK manufacturing capacity within this segment will increase, which will allow eventually obtain economies of scale that will contribute to cost reduction.

As was discussed in the Introduction to the UK OW market part, the UK content is very poorly represented in CAPEX (Renewableuk, 2015). And the balance of plant along with project management, turbine supply, installation and commissioning represent CAPEX of an OW project. That is why it is reasonable to look through various segments of balance of plant to identify what portion of the total cost of an OW farm they represent. This will allow to understand better the extent of British content in the OW project. Since this research focuses on studying the UK OW capabilities it is therefore important to analyze the extent of local content in the weakest tier of British OW supply chain such as balance of plant (Renewableuk, 2015: 5).

**Installation and commissioning** accounts to approximately the same costs as *Balance of Plant*, which is up to £400 million for a typical 500MW wind farm (Crown Estate, 2013: 54). The segment refers to installation and commissioning of balance of plant components and turbines (Crown Estate, 2013: 54). Besides, installation and commissioning is a part of CAPEX of an offshore wind project where the UK content is underrepresented according to the analysis by BVG Associates (Renewableuk, 2015: 5). However, it is this stage of an OW farm development that gave its largest contribution of LC in comparison to other CAPEX elements (Renewableuk, 2015: 5). Therefore, the analysis of the UK content will also focus on the extent of local content within the components of the *Installation and Commissioning* to get a better picture of the UK OW capabilities within this sector and factors that hamper the growth of the UK content. Foundation and turbine installation as well as export and array cables laying represent the biggest installation and commissioning costs, accounting to 100, 140, 80 and 60 million pounds respectively (Crown Estate, 2013: 54-59).

**Operations and maintenance:** The largest contribution to UK content in total expenditures (TOTEX) came from Operation and Maintenance, which costs are around £25-40 million, which is not a lot in comparison to other OW segments, especially Balance of Plant (£400-500m), Installation and Commissioning (£ 400m) and Turbines (£6m for a turbine). For that reason, it has

been decided not to look into the O&M as this segment represents the smallest share of the OW project total costs (Renewableuk, 2015: 5).

Figure 6 below summarizes the costs of a typical 500 MW offshore wind project.

Approximate cost of a typical 500 MW OW farm by sectors		
	Total cost	Break down by components and processes
<b>Development and consent</b>	£60 m	= approx. <b>4%</b> of total cost of an OW farm
<b>Wind turbine (No UK content)</b>	£600 m	£6 million for one 5 MW wind turbine
<b>Balance of plant (little UK content)</b>	£400 – 500 m	= approx. <b>30%</b> of capital cost of an OW farm: <ol style="list-style-type: none"> <li>1. <b>Export cable</b> = £60 million</li> <li>2. <b>Array cables</b> = £20 million</li> <li>3. <b>Turbine foundations</b> = £300 million</li> <li>4. <b>Offshore substation</b> = £50 million</li> <li>5. <b>Onshore substation</b> = £40 million</li> </ol>
<b>Installation and commissioning (little UK content)</b>	£400 m	Total cost of I.&C is divided into the following sectors: <ol style="list-style-type: none"> <li>1. Export cable-laying = £80 million</li> <li>2. Array cable-laying = £60 million</li> <li>3. Foundation installation = £100 million</li> <li>4. Turbine installation = £140 million</li> <li>5. Offshore substation installation = £10 million</li> <li>6. Construction port = £10-15 million</li> <li>7. Sea based support = depends on the vessel size</li> <li>8. Commissioning = varies, included in the scope of supply of a wind turbine</li> </ol>
<b>Operations and maintenance</b>	£ 25 -40 m	<ol style="list-style-type: none"> <li>1. Operations = £ 25 – 40 million</li> <li>2. Maintenance = included 5 years under warranty</li> </ol>

Figure 6. Own creation, adapted from the *Guide to an Offshore Wind Farm* published on behalf of the Crown Estate (Crown Estate, 2013: 9-69).

The next chapter, *Chapter 4*, introduces the analyzes the current state of the LCRs in the UK OW sector as well as it will present the analysis of the collected data on the extent of the UK content in several OW farms in the UK.

## 5. Analysis of the Findings

The first part of the following chapter analyzes the current state of the LCRs in the UK OW sector. Furthermore, the chapter presents the analysis of the collected data on the extent of the UK content in several OW farms in the UK (CfD projects: Dudgeon, Hornsea Project 1, Burbo Bank Extension and non CfD projects: Rampion, Greater Gabbard and Hywind). This is followed by the presentation of the findings in the major OW segment: *Balance of Plant*.

### **Analysis of the UK OW market in regards to basic conditions for potential LCR effectiveness for the development of the UK OW supply chain**

According to the study on the UK OW industry (Catapult, 2017) the UK Government could possibly raise the UK content expectations in the OW supply chain up to 65% (Catapult UK, 2017) but the BVG associates associate Director argues that with the current UK OW supply chain capability this is a highly unlikely scenario (BVG Associates, 2017). Therefore, it is reasonable to analyze the UK OW market and determine whether it has the necessary conditions for successfully (with regard to the development of the supply chain) implementing LCRs. The UK Government has also announced that they will transition from the ROC to CfD, The RO support scheme will close to new OW projects in 2017 (Gov. UK, 2015).

Given that CfD imply local content and that only OW project over 300MW have to submit satisfactory supply chain plans to win auction, and that more and more OW projects are getting bigger and much more than 300MW like Hornsea 1 and 2 that are together going to generate more than 3000MW which is more than half of the UK total installed capacity to this date (4COffshore, 2017). It means that the majority of OW projects in the UK are expected to award a share of their contract to the UK suppliers. Therefore, it is reasonable to assess the UK OW market whether it satisfies the conditions for successful increase of the UK content in the supply chain.

According to the K&M framework (2013) that is used to analyze whether the market has the necessary conditions for the potential success of the LCRs that is expected to result in technological innovations, cost reduction achieved by the economies of scale as well as job creation for the local populations, the UK OW market satisfies most of the conditions presented in the framework.

## Analyzing conditions for potential effectiveness of LCRs on the UK OW industry/domestic supply chain

Element	Level	Analysis
<b>Market size and stability</b>	<b>Large</b>	<p>The UK is striving to reach the 2020 RE targets as well as the reduction of CO2 emissions =&gt; thus - high demand for RE, particularly OW;</p> <p>The UK is committed to develop the OW industry, as it is imperative to reach the RE and climate change targets.</p>
<b>LCRs restrictiveness</b>	<b>Not obligatory</b>	<p>LCRs are only applied on the OW project developers with capacity over 300MW who are seeking the UK Government financial support though CfD;</p> <p>The concept of a LCRs is very vague the further down the supply chain one goes =&gt; more clarity must be achieved.</p>
<b>Cooperation &amp; financial incentives</b>	<b>Existent &amp; strong</b>	<p>The cooperation in the OW industry is good, the dialog between the UK Government and the OW industry players is established;</p> <p>The UK financial support framework within the offshore wind energy sector is unprecedented.</p>
<b>Innovation Potential &amp; Degree of Current Technology Knowledge</b>	<b>High</b>	<p>Forty years of offshore expertise in the British oil and gas sector;</p> <p>The oil and gas supply chain is estimated to decrease the cost of offshore wind operation by around 20%, through the application of their knowledge and expertise (Subsea UK, 2011: 3).</p>

Table 2. Own creation adopted from the K&M (2013) theoretical framework. Analyzing conditions for potential effectiveness of LCRs on the UK OW industry/domestic supply chain

To this end, this section uses the effectiveness framework developed by Kuntze and Moerenhout (2013) to explain whether or not the UK has the necessary preconditions for successful implementation of LCRs with regard to technology innovation creation, development of a successful and competitive supply chain and job creation for the local population. The framework investigates four determinants of effectiveness.

Thus, the five LCRs effectiveness indicators in regards to the technological innovation, cost reduction and green jobs creation for the locals are as follows (Kuntze and Moerenhout, 2013: 11):

- Market size and stability;
- Restrictiveness of LCR;
- Cooperation and subsidies;
- Learning by doing potential and degree of current technological knowledge;

#### *Market Size and Stability:*

When the *Market Size and Stability* is concerned, the UK currently is the global market leader in the offshore wind. The UK possess an enormous wind resource that can power the UK over six times covering the British total electricity needs (Crown Estate, 2015: 3). Moreover, there is a huge demand for electricity generated from renewable sources, offshore wind in particular as the UK is striving to reach its 2020 renewable energy targets as well as the target to lower CO2 emissions by at least 80% of 1990 levels by 2050 (The CCC UK, 2017). According to this, 2020 targets at least 15% of energy needs must be generated by the renewable sources, which includes a target to generate 30% of electricity from wind, solar and other low-carbon sources by the end of the decade (The Guardian, 2017). In order for the UK to remain on track to reaching those targets, the UK has to fully realize its OW potential. Thus, the UK has a large market for OW as well as the government is committed to develop the OW industry (Crown Estate, 2015: 3).

#### *Restrictiveness of the LCRs:*

When it come to the second element of the K&M framework (2013) *Restrictiveness of the LCRs*, it is important to emphasize that the UK currently does not have local content quotas and LCRs are not mandatory (Wind Power Offshore, 2016). One of my respondents from the Scottish Government has confirmed that LCRs are, indeed, “not mandatory but LC is something that is sought and OW projects using local content in the OW supply chain and boosting local jobs will have an edge when trying to win CfD”. As of yet the only pressure in regard to the UK content is

applied on the OW project developers who want to secure the UK Government financial support in a form of CfD (UK Gov., 2017). Such a rule applies only to the OW projects which capacity is over 300MW (UK Gov., 2017). Thus, it can be concluded that the UK has proper LCRs, applying only to those OW projects developers who are seeking to secure the UK Government financial support through the CfD auction, as well as the OW project capacity will have to be larger than 300 MW.

According to my informant (anonymous), who represents one of the Norwegian OW suppliers located in the UK “to this end, much of the LC requirement is met by awarding a proportion of the main contracts to UK based companies”. The respondent stressed that the onward supply chain is also required to submit Supply Chain Plans where the additional proportion of the UK content is identified in addition to the LC guaranteed by the OW project developers. The respondent also mentioned that at the bidding (and win) stage, these supply chain plans are largely speculative. In the run up to the start of the project all suppliers will be encouraged to develop a level of local supply chain engagement but as of yet the British OW market has not been through a complete CfD project cycle so it is very unclear as to the extent to which the supply chain will actually be required to engage. Thus, more clarity must be achieved with the concept of a LCRs, as the concept is very vague the further down the supply chain you move. The suppliers can find themselves having to commit to unnecessary obligations in order to win a contract. Whereas the required level of the UK content is already guaranteed through the OW developers contracting strategy. As of yet, the main burden of complying with the LCR is on the OW project developers and is determined in terms of contract value.

#### *Subsidies and Cooperation:*

Another element of the K&M framework that must be considered when analyzing whether the UK OW market has the necessary conditions for the LCRs effectiveness in terms of technology innovation boost and job creation for local people, is *Subsidies and Cooperation*.

To date, the UK is the world’s OW industry leader in terms of the level of regulatory and price support framework and stable policy regime within the UK offshore wind energy sector (Crown Estate, 2015: 3). As it was earlier discussed the UK’s leadership in OW has proved to be highly effective and the UK offshore wind industry is one of the most attractive destination for renewable

energy investment, largely thanks to the financial supports provided by the UK Government (Crown Estate, 2015: 3).

The UK government is committed to minimizing costs of RE electricity and OW electricity in particular for the customer (Gov. UK, 2015). And subsidies and financial support provided by the UK government are vital for ensuring affordability of the electricity generated by the OW for consumer (Gov. UK, 2015) as well as they are essential in attracting FDI to the domestic market. According to a number of industry reports and policy papers (Roberts et al., 2014; BVG Associates, 2017; Crown Estate, 2015; Gov. UK, 2015; Chin, 2014: 4) the United Kingdom has a longstanding reputation for operating stable and predictable regimes to support investment in renewable electricity infrastructure.

The recently-introduced CfD and already established Renewables Obligation mechanism “offer long-term predictable index-linked yields from proven infrastructure assets” (Gov. UK, 2017). Both these support schemes are established in UK primary legislation (Gov. UK, 2017).

Moreover, the level of the Government and OW industry cooperation is quite good as the dialog between the UK Government and OW industry players is established through a number of institutions (Gov. UK, 2015). Such institutions like the Offshore Wind Programme Board (OWPB), Offshore Wind Industry Council (OWIC) and RenewableUK among others, have been established to ensure an effective dialog between the Government and the OW industry players.

OWPB steers a collaborative, long-term programme of work that aims to deliver cost reduction and enable growth of a competitive UK-based supply chain as the offshore wind industry grows and matures. It has a membership drawn from across the industry and government to ensure an effective dialog (Gov. UK, 2017).

OWIC is a senior Government and industry forum that was established in order to drive the development of the world-leading offshore wind sector in the UK (The Crown Estate, 2015).

RenewableUK is the UK’s leading renewable energy trade association, with over 580 corporate members active in the wind. A not- for- profit organization, RenewableUK is the sector’s central point of information and a united representative voice for our members (Renewable UK, 2017).

*Innovation Potential and degree of current technological knowledge:*

Another element of the K&M analysis framework is *Innovation Potential and degree of current technological knowledge* of the UK OW market (Kuntze and Moerenhout, 2013: 11).

The United Kingdom has an enormous expertise in offshore engineering, platform deployment, and marine operations that is transferable to OW industry (Cable et al., 2013: 71). To this day, the United Kingdom Continental Shelf (UKCS) remains an important oil and gas province for the UK and more than 97% of total oil production in the UK comes from offshore fields (Eia.Gov., 2015). The UK oil and gas industry ability to transfer its offshore expertise to the OW market is remarkable and is vital to potential cost reduction in the OW sector (Subsea UK, 2011: p.19). The British oil and gas sector plays a significant role in the development of the offshore wind industry in the UK though carrying out such activities as installation and commissioning, as well as operation and maintenance (Subsea UK, 2011: p.19). *Installation and Commissioning* is the major OW segments which accounts to approximately 30% or £400 million of all wind farm's capital costs (CAPEX) according to the guide to an offshore wind farm (Crown Estate, 2013: 44). As it was previously discussed the installation and commissioning is a part of CAPEX where the UK content is underrepresented according to the analysis by BVG Associates (Renewableuk, 2015: 5). However, it is exactly this segment that is estimated to have the greatest potential to cost reduction, given that the UK based suppliers will be awarded contract in comparison to other elements within CAPEX (project management, turbine supply and balance of plant) (Renewableuk, 2015: 5).

More than forty years of deployment and immense offshore expertise is considered to play a significant role in helping the UK OW industry to cut down costs related to development of the offshore wind projects (Roberts et al., 2014; BVG Associates, 2017; Crown Estate, 2015; Gov. UK, 2015; Chin, 2014: 4).

The UK offshore wind sector represents a great diversification opportunity for the British oil and gas sector. By applying their engineering and platform deployment skills, as well as knowhow of marine operations it can be possible to shorten offshore wind project development timescales, reduce operational downtime and, of course, add significant value through application of their knowledge in the oil and gas sector (Subsea UK, 2011: 3).

The UK Government is serious in its pursuits to exploit their oil and gas offshore expertise in developing their offshore wind industry. In 2011, Scottish Enterprise has published a "Guide to Offshore Wind and Oil Gas Capability" in order to provide a baseline against which the UK oil



and gas industry could exploit the significant offshore wind market opportunities available to the oil and gas supply chain. A wide range of opportunities in the offshore wind sector are listed in the report where the oil and gas supply chain can add the greatest value throughout the offshore wind project lifecycle (Subsea UK, 2011: 3).

The report suggests the oil and gas supply chain could potentially decrease the cost of offshore wind operation by around 20%, through the application of their knowledge and expertise (Subsea UK, 2011: 3).

To sum it up, it is evident that according to the K&M framework (2013), the UK OW market does have the good conditions for the LCRs effectiveness in developing the domestic OW industry as well as the supply chain (see Table 2).

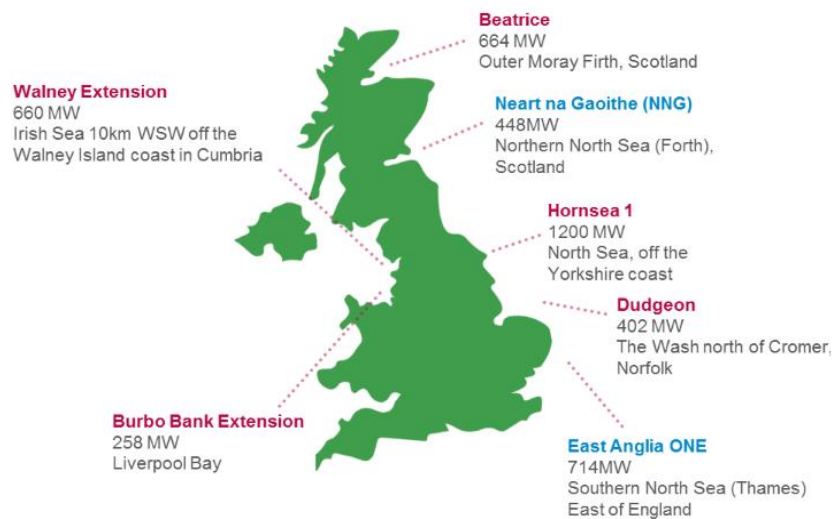
However, when willing to grow local content is important to consider not only the above listed factors but also the practical limits of the domestic OW supply chain and its capabilities. Particularly it is important to explore various factors that may hinder growth of the UK content in such major OW segments as *Balance of Plant* and *Installation and Commissioning*. These are the segments where the increased share of local content is estimated to actually have a very positive effect on the developments of the UK OW industry and further cost reduction (Roberts et al. 2014: 8-9). Nonetheless, those are also the segments of OW projects with the least UK content in comparison to others (BVG Associates, 2015: 5). Since the offshore wind projects are going deeper and getting bigger in terms of power, the installation costs are getting higher as well (Offshore Support Journal, 2017). Therefore, it is only logical that the UK government is willing to financially support through CfD those OW projects that are contributing to the development of the domestic OW industry, cost reduction and technological innovation development among other things (Gov. UK, 2015). To this end, Balance of Plant and Installation and Commissioning will be analyzed on the extent of the UK content, whether or not the extent of LC increased in the CfD projects in comparison to OW projects with little to none LC content obligations and what are the factors that hinder and inhibit the growth of the UK content in those segments.

The next part of *Chapter 4* provides a short overview of a typical 500MW offshore wind farm. Given that much of the LCR in the UK is met by OW project developers awarding a proportion of the main contracts to the UK based companies, it is important to understand what the typical OW

projects costs are. Knowing the costs of an OW farm it is thus possible to understand to what extent contracts awarded to the British suppliers will contribute to the UK content growth.

### **Analysis of the 4COffshore databases of the UK offshore wind farms**

In order to get an overview of the UK content (in local content) in the UK OW farms, seven offshore wind projects will be analyzed. Figure XXX shows OW projects which have been awarded Investment Contracts (Gov. UK, 2017). Dudgeon, Hornsea 1 and Burbo Bank Extension are among OW projects which will be analyzed on the extent of the UK content along with other OW projects that do not have LC obligations placed on them, Rampion, Greater Gabbard, Hywind and Walney 1 and 2.



*Figure 4, Projects awarded Contracts for Difference (Gov. UK, 2017)*

When analyzing the LC share in the British OW projects, it is reasonable to compare projects prior and after the political claim of LC in order to see whether or not the LC share increased in the CfD projects and in what sectors. However, the CfDs is a relatively new mechanism, legislated for in the UK's Energy Act 2013 (Crown Estate, 2015). Therefore, it will take some time for the OW supply chain in the UK to adjust to new increase in demand. Therefore, timing may not make it possible to observe any significant difference in the UK content share among the OW projects, with little LC obligations placed on them, and those CfD projects that have a specific requirement

for LC where much of the requirement is met by awarding a proportion of the main contracts to UK based companies.

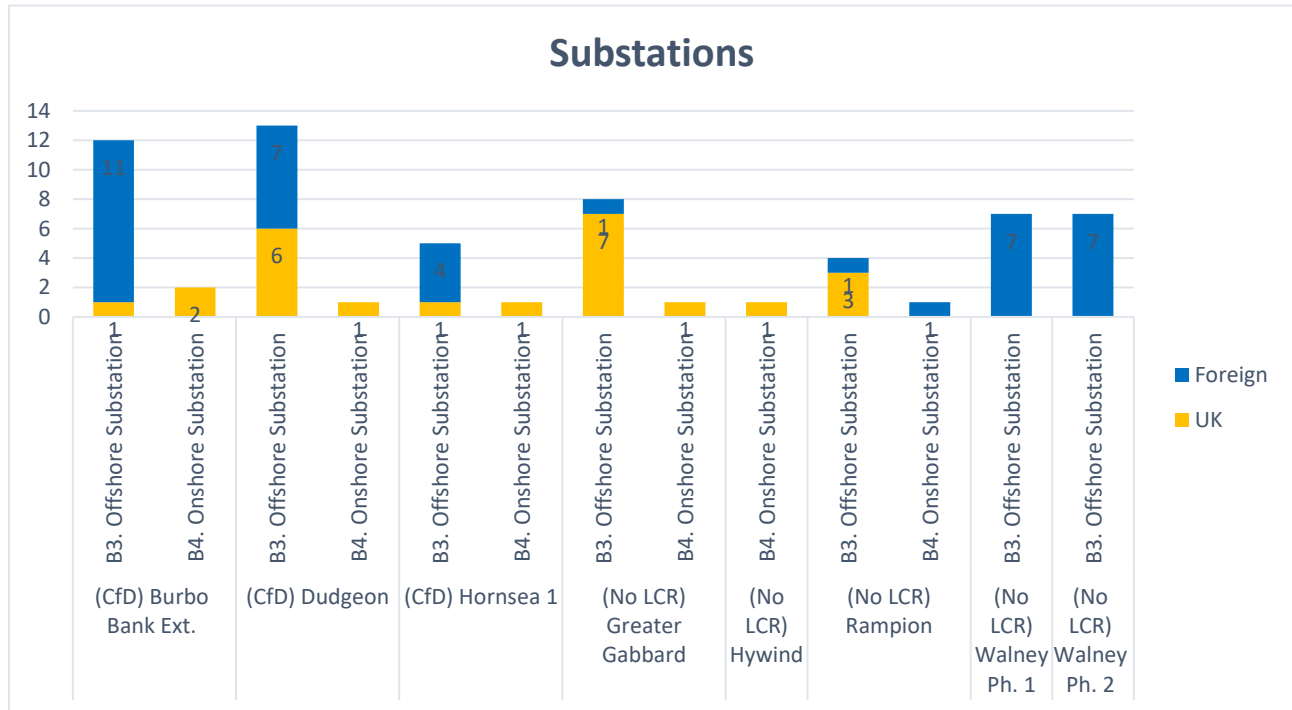
Thus, the current UK OW supply chain analysis focuses on identifying the UK OW industry capabilities throughout the major OW segments, *Balance of Plant* that have a small share of LC but is argued to have the most potential for cost reduction if the amount of UK based suppliers increases (Roberts et al, 2013: 31; Gillespie, 2011; Chin, 2014).

The *Balance of Plant* cost represents a major proportion of the CAPEX, which has the smallest share of the UK content (RenewableUK, 2015) and represents approximately 500 million pounds of a typical OW farm total costs (see Table XXX, overview of OW farm). After turbines, *Balance of Plant*, particularly turbine foundations, are likely to be the largest procurement choices in OW projects, significantly affecting the level of LC in the UK OW industry. The UK is committed to continue cutting costs in the OW sector and the *Balance of Plant* is the sector that along with *I&C* has the greatest potential for cost reduction given that the share of LC within the supply chain is increased, which will help achieve economies of scale and thus lower OW electricity costs. It is therefore important to explore any practical limits of the domestic supply chain within this sector. Besides, it is reasonable to pinpoint well-established suppliers within this segment that have a potential to grow and meet the increasing demand. Thus, it would be possible to have a better picture of the UK OW capabilities that could be exploited within this segment by foreign as well as British OW project developers.

### **Substations:**

In order to analyze the UK content in the Substation supply chain that is serving the UK OW projects, I have analyzed the 4COffshore (2017) supply chains of eight UK OW projects excel databases. Each of the OW projects databases include various stakeholders involved in the development of a particular OW farm. The data on the OW projects stakeholders can be found on the 4COffshore website, the supply chain databased have been prepared by me as a part of my internship assignment. The graphs used in this section are created by me based on the supply chain data provided by the 4COffshore.

Thus, the *Figure 7* shows that almost all of the analyzed UK OW projects, besides Walney Phase 1& 2, have used a number of the UK based suppliers to fabricate and supply onshore and offshore substations and its major components.



*Figure 7, Own creation, based on data from 4COffshore excel databases*

The contracts awarded included a wide spectrum of products and serviced provided by the UK companies, which included but were not limited to manufacturing and supply of major components for the offshore and onshore substations, engineering procurement and construction (EPC) contracts for topside offshore substation platforms as well as detailed design of substation topside and foundations etc. (4COffshore, 2017).

The analysis of the excel databases of the UK OW projects has proven that the UK domestic Substation *market* is well established. Based on the analysis of the suppliers involved in this OW segment, the only non-British substation components that were imported are the larger components of the offshore substation electrical systems which accounts for around £30m for substation (£50m is a total cost of offshore substation (Crown Estate, 2013:51)) and include power transformers, protection systems to protect electrical items as well as switchgears (4COffshore database, 2017).

However, this segment is not without any challenges. The analysis of the OW projects supply chain databases (4COffshore, 2017) showed that the UK domestic offshore and onshore substation

fabrication market is highly competitive (See table XXX Companies) which results in some specific challenges for the UK substation suppliers (Chin, 2013:15). The major challenge yet is financial difficulties, that came as a result of something that Chin (2013: 15) describes as “peaky nature of the workflow”, high costs of maintaining a workforce as well as the fact that demand for facilities rises and drops very irregularly ultimately resulting in shutting down of some manufacturing facilities (Chin, 2013:16).

According to one of my informant (Anonymous), another major challenge that local suppliers are facing, that can actually be applied to other major OW segments within *Balance of Plant*, is that the OW developers constantly have a temptation to go from one supplier to another in order to reach a better price level or quality of a sought-after product or service. This practice of switching suppliers is not necessarily good for the local substation suppliers who instead are looking for contracts with repeat orders. Repeat orders are vital not only for suppliers but for OW developers as well, as it is exactly what serves as a stimulus for local suppliers to keep their focus on the OW supply chain rather than going for their traditional oil and gas sector. Moreover, according to Chin (2013:15) repeat order contracts, that are in some instances difficult to acquire for the local suppliers, are indeed enabling innovation and help achieve cost reduction.

Another challenge for UK substation components manufacturers is that not all of them are able to keep up with demand change for certain onshore and offshore substation components, like platforms (The Crown Estate, 2013: 15). Increasingly more and more OW farms are going further away from the shore and thus such projects require HVDC technology, that is used to maintain electrical losses to a minimum. Platform topsides for such HVDC substations are much heavier and can be around 12 thousand tones. Thus, not all of the British substation foundation fabricators are ready to supply the platforms needed for such HVDC stations. And in such instances major components for substation are imported from the global market players able to satisfy the demand (The Crown Estate, 2013: 15).

The UK Governments, OWIC and key industry players recognize the importance of supporting this segment (The Crown Estate, 2013). However, in order for the substation manufacturing segment to stay competitive, the UK suppliers must be able to keep up with the demand and be ready to deliver larger orders so that they could secure repeat order contracts and thus further develop their expertise in offshore wind sector, enable innovation and contribute to cost reduction.

The analyses showed that the CfD projects, despite having LC obligations placed on them, most of the contracts for substation manufacturing and supply went to overseas firms rather than to the ones that are based in the UK.

### Array and export cables:

When it comes to the UK capabilities within the cables segment it is evident from the analysis of the UK OW projects in the *Figure 8* that none of the export supply came from the UK. Most of the contracts for array cables manufacturing and supply, on the other hand, went to the UK suppliers.

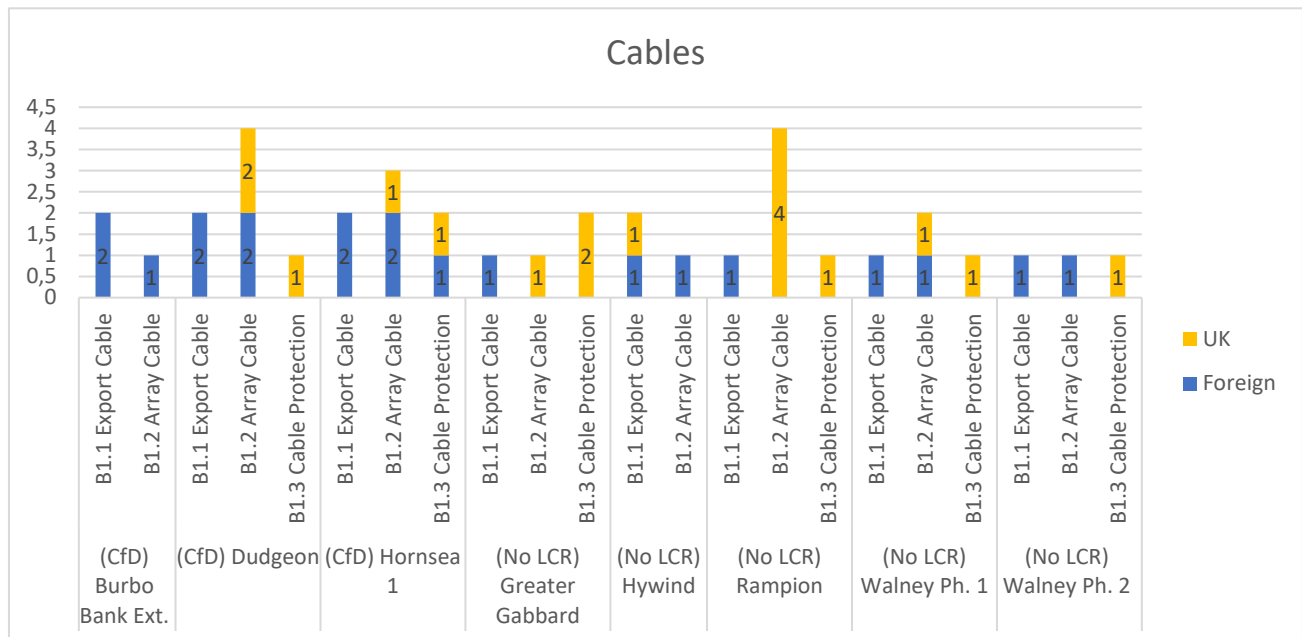


Figure 8, Own creation, based on data from 4COffshore excel databases

JDR Cable Systems is an array cable market leader in the UK and currently the only UK manufacturer of array cables for the OW industry (Wind Power Offshore, 2014). JDR has captured all the design and manufacture of array cables contracts for all but one OW projects (4COffshore, 2017).

Thus, the analysis of the supply chain databases showed that the UK array cable supply segment within the balance of plant have been performing strongly and achieved a success in the market. According to Wind Power Offshore (2014) British array cable manufacturer, JDR, have supplied over 40% of array cable length used in UK wind farms as of the end of 2012 and has also secured

contracts for later projects like Rampion, Dudgeon and as well as Greater Gabbard for which it supplied around 140 km, 95 km and 200 km of array cable respectively (4COffshore, 2017).

Moreover, British suppliers are not only present in the array cable supply segment but they have a proven capability in providing rigging teams, array cable installation equipment as well as cable protection systems and various types of proving and testing of cables for the offshore projects (4COffshore, 2017).

The success of this segment in the UK can be explained by the high cost of the array cable transportation. For this reason, most of the OW farm developers find it more reasonable to have array cables supplied by the UK based companies as there is no economic advantage from imported product. Moreover, according to the Crown Estate report (2014: 32) the UK government encourages foreign array cable manufacturers without presence in Europe to set up their manufacturing facilities in Europe or in the UK, in particular, in order to avoid high transportation costs, which is the main factor for choosing the UK manufacturers of array cables in the first place.

Subsea export cables manufacturers, on the other hand, have next to no presence in the UK. According to earlier reports on the UK OW supply chain capabilities (Chin, 2014; Crown Estate, 2013) there were no manufacturing facilities of export cables in the UK before the year 2012. The analysis of the OW projects have shown that there indeed has been no UK supply of export cables to OW farms. However, Balfour Beatty Plc, a company located in the UK, has been awarded a contract that includes the engineering, procurement, construction and installation (EPCI) of the onshore substation and onshore cabling for the Hywind OW project, making it the only OW project that is getting export cables supplied by a British firm (4COffshore, 2017).

According to Wind Power Offshore (2014) JDR is likely to start supply export cables in the nearest future and has made important steps towards the manufacturing of subsea cables. The company has received a UK government grant with a total cost of £2 million to assist export cable development (Wind Power Offshore, 2014). That is an important step for the UK OW industry as the manufacturing of the export cables in the UK have a potential to further cut costs of the OW generated electricity. A strong UK market will create a preference for UK supply like in the case with inter array cables, because of the high transportation costs.

Local array cable suppliers are already preferred over the foreign ones by the OW developers, however, in the long run British array cable suppliers must be able to keep up with the demand and

increase capacity as well as facilitate the supply of higher voltage array cables that are going to be sought-after for the future OW projects.

JDR cables, for example, is already being able to supply significant lengths of array cable and had contracts from a number of the UK OW projects. As of 2017, the JDR is the only company in the UK that is ready to supply a higher voltage innovative 66 kV cables. This technology has been developed in order to keep up with the increased demand for higher voltage cables (JDR Cables, 2016). This is a very important milestone for the company, JDR has pioneered the design of inter-array cables in the offshore energy industry, contributing to cost reduction targets with innovations such as aluminum cores (JDR Cables, 2016). However, despite the fact that the company invested in R&D activities to meet the demand for higher voltage cables and contribute to cost reduction, a further investment is needed to manufacture these cables.

According to the JDR's Chief Technology Officer, James Young, the company is steadily moving to higher voltage energy networks. The development of the high voltage inter-array cables was done in close collaboration with the full OW supply chain, developers and other stakeholders (JDR; 2016). The close collaboration with the supply chain throughout the whole development process is important as it gives the confidence to potential customers that this new cable is thoroughly qualified to meet the future needs of the OW sector in the UK waters. Chief Technology Officer of JDR highlights that the JDR is the only supplier of inter-array cables with zero failures in service (JDR; 2016).

Thus, the UK already has a well-established power cable manufacturing capability of lower voltage (33 kV) and is on the way to be able to supply array cables with voltage rating up to 66kV. The leading British array cable and cable protection system suppliers, like JDR and Tekmar, are committed to and investing in long term OW technology developments (JDR, 2017). The array cable sector is argued to have a great potential for further development with very little investment risk (Crown Estate, 2014). The reason for this is that the manufacturing capacity used for OW array cables can also be utilized in other sectors as well like oil and gas, which are typically associated with higher profit margins (Crown Estate, 2014).



## Turbine foundations:

In terms of the turbine foundation supply, the British firms did capture some contracts for turbine foundation supply. However, their activity in the sector is very limited and the share the contracts they have been awarded is quite small (4Coffshore, 2017). According to the report by Marine industries (2014: 43) the only project to use all UK-sourced turbine foundations, the monopile type, so far has been the shallow-water Scroby Sands project of 3MW turbines which was completed in 2004 (Maritime Industries, 2014: 43).

After having analyzed the 4Coffshore supply chain databases I have noticed an interesting trend; all OW projects with LC obligations, Burbo Bank Extension, Hornsea 1 as well as Dudgeon, have been using either UK fabricated transition pieces for their turbine foundations or davit cranes for transition pieces manufactured on the UK fabrication facilities. While the OW projects without such LC obligations have used imported foundations and major components to them (Figure 8).

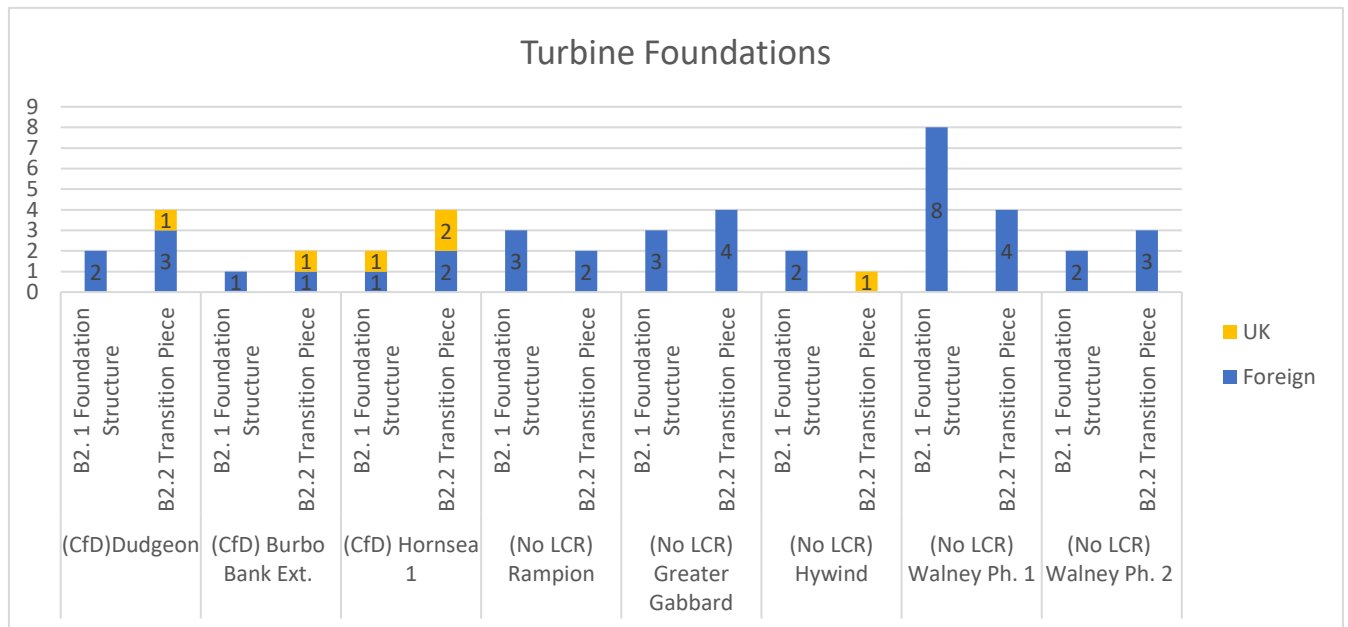


Figure 8, Own creation, based on data from 4COffshore excel databases

As of 2013, most of the industry players argued that there is unlikely to be significant logistic savings from local supply of monopiles and transition pieces (Maritime Industries, 2013: 44). Despite the fact that the supply chain for turbine foundations did not have presence in the UK market the OW developers did not experience any problems with foreign suppliers as the turbine foundations and their major components have been transported to the UK using relatively low cost

vessels (Maritime Industries, 2013: 44). Therefore, the main argument for not investing in British manufacturing facilities was that such a move will not have a significant contribution to the cost reduction and the development of this segment in the UK requires significant investment (Maritime Industries, 2013: 44) as well as there are a number of challenges that are yet unsolved (Crown Estate, 2013: 17). First of all, the main challenge so far is that the full British potential turbine foundation demand significantly exceeds the capability of the British foundation manufacturers. Besides, there are uncertainties in regards to the development of the foundation technology as it is highly dependent on the turbine size, which is constantly and rapidly increasing (Crown Estate, 2013: 17). Moreover, the competition from the established facilities outside the United Kingdom is very strong.

The analyses of the UK OW supply chain have shown that despite those challenges highlighted in various industry reports like UK OW supply chain opportunities and barriers (Crown Estate, 2013) and UK OW supply chain: capabilities and opportunities by Maritime Industries (2013) today, we can observe some boost in manufacturing of transition pieces for turbine foundation in the country (Offshore Wind, 2015).

So, currently a new transition piece supplier has emerged in the UK, Offshore Structures (Britain) Bladt/EEW-SPC JV. The company is a joint venture between the German steel fabricator EEW Special Pipe Constructions GmbH and the Danish steel construction company Bladt Industries A/S. To date, it has already finished the project Burbo Bank Extension and is currently working on fabricating and supplying transition pieces to the Walney Extension and Hornsea Project One (4COffshore, 2017) all of the projects are CfD projects with LC obligations.

The company's manufacturing facilities are located on the River Tees and the location has a direct access to sea as well as the plant is ready to provide customers with large-scale steel structures. Moreover, the manufacturing facilities are prepared for large scale production of transition pieces for monopile foundations (Offshore Structures UK, 2017).

The Offshore Structures (Britain) is a perfect example of two foreign companies to draw on each other's experience and expertise and contribute to the development of the UK OW supply chain. As it was mentioned above, there are still some uncertainties as to whether bringing the fabrication of turbine foundations to the UK will significantly cut costs, so there is no significant incentives for OW developers like in the case of array cables to invest in the local manufacturing facilities.

However, the cost advantage will only arise in the case of turbine foundation supply only if the production of a product increases. This can be achieved by imposing LC obligations on the OW developers through CfD auctions. Even though this mechanism has not been working for too long, it is somewhat uncertain whether it was indeed LC obligations imposed on the Burbo Bank Extension, Hornsea, Walney Extension OW projects that made them award contracts for transition pieces manufacturing to the UK based firm instead of the overseas suppliers with broader expertise and track record. Thus, the UK government interference in a form of requiring LC in winning CfD projects may in the long run significantly improve the UK turbine foundation manufacturing capacity.

Moreover, besides the boost in the supply of transition pieces for turbine foundation, other services related to turbine foundations have been supplied by the UK based companies. Granada Material Handling have managed to capture some share of the davit cranes for transition pieces' supply contracts. Dudgeon, East Anglia One and Hywind are the OW projects that have been using Granada's davit cranes for their transition pieces.

After turbines, foundations are likely to be the largest procurement choices in OW projects, significantly affecting the level of local content in the UK OW industry. According to the Crown Estate report (Chin, 2014: 16) the turbine foundation manufacturing represents a huge potential for the UK OW market.

One of the biggest gain in cost reduction so far have been the supply chain methods and economy of scale. This has been achieved by each farm becoming bigger, and different contract methods. In the near future, the economy of scale will be taken a step further by an even further increase of wind farm sizes, in combination with standardization of interfaces (Ulstein, 2016).

### **The reason for little UK content in the CfD OW projects**

The analysis of the 4COffshore supply chain databases has shown that there was no increase of the UK content in the CfD projects (Dudgeon, Hornsea Project One and Burbo Bank Extension) across the traditionally strong segments within the Balance of Plant like Array Cables and Substations. But on the contrary, one of the CfD offshore wind projects, Burbo Bank Extension, imported all of its array cables along with export cables. While Dudgeon and Hornsea Project One have imported 1/2 and 1/3 of total array cable supply respectively.

Besides, there was not any significant increase in a number of contracts for supply and manufacture of onshore and offshore substations awarded to the UK substation manufacturers. However, despite the fact that most of the contracts for the supply and manufacturing of substations and its major components went to the foreign suppliers, one contract stood out. Namely, a contract for detailed design and manufacturing of substation topsides and foundations for the Burbo Bank Extension offshore wind farm (Dong Energy, 2017). According to the 4COffshore database (2017) Dong Energy, which is the Burbo Bank Extension project developer has standardized the design across its offshore wind projects, namely Burbo Bank Extension and Walney Extension as well as Race Bank and awarded a contract to the UK based firm, Atkins. By standardizing the design of the substation topsides and foundations across its projects and DONG obtained economies of scale, which in turn contributed to significant cost reduction within the substation manufacturing and supply segment.

However, despite little to no increase in the UK content in the two traditionally strong segment of the Balance of Plant, Cables and Substations, a significant manufacturing boost of transition pieces for turbine foundations has been observed. I call it “significant” due to the following two factors. First of all, before CfD financial support mechanism has been introduced, all of the UK offshore wind projects have been importing the turbine foundations along with their major components. Thus, there have been no domestic manufacturing of the turbine foundations and its components. And second of all, turbine foundations are the second largest procurement choices in the offshore wind projects, which significantly affects the level of local content in the UK OW industry.

Therefore, the fact that the CfD offshore wind projects have awarded contracts for supply and manufacturing of transition pieces for turbine foundations to the UK based firms is a step forward towards the development of the UK OW industry and further cost reduction. Further cost reduction can be achieved if more transition pieces are manufactured in the UK which will allow achieve economies of scale and contribute to cost reduction.

There has been no turbine foundations and transition pieces manufacturing activity in the UK due to the fact that there are no logistical savings from the domestic supply of turbine foundations and its components (monopiles and transition pieces). According to the BVG Associates (2014: 44), one of the main arguments of the offshore wind projects developers not to invest in the development of the turbine foundation supply chain in the UK is that they have not experienced any problems

with the fact that the existing turbine foundation supply chain was not located in the UK. There were no problems connected to the offshore wind projects delivery and turbine foundation components transportation costs are low (BVG Associates, 2014: 44). Thus, the main argument for importing these components and not invest in the UK manufacturing facilities is due to the fact that no significant cost reduction can be achieved in this segment (Chin, 2014). Development of the turbine foundation manufacturing in the UK requires significant investment and the costs connected to the development of the UK turbine foundation manufacturing will further be transferred to the customers. Therefore, there are no incentives and economic benefit for OW project developers to invest in such local manufacturing facilities.

The analysis of the 4COffshore databases shows that the CfD projects that have local content obligation have invested in the domestic turbine foundation facilities thus helping the turbine foundation supply chain obtain economies of scale and contribute to the cost reduction. This will not have happened if it was not for local content obligations that have been imposed on the CfD projects. The analysis shows that the CfD projects have contributed to the increase of the UK content in such segments of the UK offshore wind supply chain within the Balance of Plant that are otherwise neglected by the offshore wind project developers due to high investment costs and no instant economic benefits but that have great potential for cost reduction given that economies of scale will be obtained.

Given that the total demand for the turbine foundation for the UK OW projects significantly exceeds the current UK capacity (Chin 2014), further investment in the domestic turbine foundation supply chain is needed. If the CfD financial mechanism is following the principle that I have outlined above, namely that the local content obligations are imposed on the offshore wind project developers to increase the UK content in the otherwise neglected segments of the supply chain, then next OW projects that will secure CfD contracts will also grow UK content in the domestic turbine foundation supply chain.

But why the UK content share in the CfD offshore wind projects has not increased in the cables and substation supply chain given that these OW projects have local content obligations and are supposed to contribute to raising local content? According to a number of reports on the UK offshore wind supply chain opportunities (Chin, 2014; BVG Associates, 2014; Crown Estate, 2013; Renewable UK, 2015) these are the segments of the domestic supply chain that are already

preferred by the offshore wind project developers due to factors highlighted in the above section. But not only has the UK content not increased in these segments but even a share of contracts for design, manufacturing and supply of these major offshore wind farm components went to the foreign suppliers. One might argue that CfD projects, with local content obligations placed on them, will invest in the manufacturing facilities wherever possible, and traditionally strong supply chain segments like array cables and substations which have established manufacturing facilities will benefit even more from such local content requirements.

However, as it has been highlighted earlier in this report, the demand for cable supply still exceeds the UK manufacturing capability and the manufacturing capacity in the UK must be further developed to meet the increasing demand. The CfD projects, however, use a share of foreign cable suppliers for their projects. This allows offshore projects that have not been awarded CfDs to exploit the UK domestic cable supply chain capabilities, which is economically more beneficial as the transportation costs for imported cables is high and can be transferred to the end consumer. Investment in the UK array cable supply chain is something that is done by the OW project developers even without imposing local content obligations as investing in such manufacturing facilities is economically beneficial for project developers.

According to UK offshore wind capabilities reports array cable supply is usually contracted separately from installation (Chin, 2014; BVG Associates, 2014; Crown Estate, 2013; Renewable UK, 2015). However, recently an increasing number of OW project developers prefer to combine the supply and installation contract packages in order to reduce the number of contractual interfaces (Chin, 2014; BVG Associates, 2014; Crown Estate, 2013; Renewable UK, 2015). This can be applied not only to the cables supply segment of the OW supply chain. Following this logic, Dudgeon wind farm has awarded a contract for more than half of the total offshore wind farm array cable supply to the foreign firm, VolkerWessels Boskalis Marine Solutions (VBMS B.V.) (4COffshore Dudgeon, 2017). The contract included not only the supply of array cables but also design, installation, terminations and testing of inter-array cables with a total length of 100 kilometers (4COffshore Dudgeon, 2017). This accounts for more than half of the total OW farm capacity. VBMS B.V is also contracted to install the export cables.

Another CfD project that imported a share of array cables is Hornsea Project One. DONG Energy has contracted Nexans to supply and terminate a total of 139km of the array cables, which is one

third of the the Hornsea Project One farm's total array cable capacity (Offshore Wind, 2017). DONG has already used cable supplied by Nexans for several of its other OW projects and is committed to continue the long-term business relationship with this supplier (DONG Energy, 2017). Thus, DONG has awarded a contract to Nexans that includes the supply of array cable and accessories, as well as installation for Hornsea Project One (DONG Energy, 2017). Moreover, Nexans is contracted to install the internal cabling of all three transformer stations for Hornsea Project One (DONG Energy, 2017).

Burbo Bank Extension, on the other hand, has imported all of its cable, both export and array cable (4COffshore, 2017). DONG is also the project developer for the Burbo Bank Extension and due to its commitment to maintain long-term relationship with Nexans, all of the inter-array cables have been supplied by this foreign supplier (Dong Energy, 2017). Thus, the nature of the contracts, that combine the cable supply and installation packages, awarded to the foreign suppliers as well as the commitment of the OW developer, in our case DONG Energy, to continue the business relationship with the foreign supplier, may explain why the cable supply segment has not seen any increase in local content in the CfD projects.

All in all, the CfD projects have invested in the UK turbine foundation facilities thus helping the turbine foundation supply chain to obtain economies of scale and contribute to the cost reduction in the UK offshore wind industry. This will not have happened if it was not for local content obligations that have been imposed on the CfD projects. The analysis of the databases has shown that the CfD projects contributed to the increase of the UK content in such segments of the UK offshore wind supply chain that have a steep learning curve which deters investment and that is otherwise neglected by the offshore wind project developers due to high investment costs and no instant economic benefits.

Thus, such large offshore wind segments of the UK OW supply chain that requires significant investment and have no instant economic benefit for the project developers, rely on the local content obligations imposed on the project developers under the CfD in order to secure contracts from them. Once such segments of the UK supply chain obtain economies of scale, which can be secured through a sufficiently large pipeline of work, the cost reduction in the sector will be achieved and an increasing number of offshore wind developers would start contracting the UK based manufacturers even without the local content obligations.





## 6. Conclusion

Since October 2008 the UK remains to be the global market leader in the offshore wind industry with more installed capacity than any other country in the world (Renewable UK, 2017). However, the UK has to increase its percentage of offshore wind electricity in its domestic electricity consumption and achieve a more rapid deployment of offshore wind projects in order to reach its international renewable energy targets and climate change goals (Watson, 2016; Renewable UK, 2017).

Therefore, the UK commitment to support and further develop the OW industry has been driven by its renewable energy and climate change targets (The Crown Estate, 2014: 2). And the UK government is striving to support the emerging sector by providing an unprecedented regulatory and price support framework within the UK offshore wind energy sector, like the Contracts for Difference (CfDs). But while providing the financial support to the foreign offshore wind project developers, the UK Government is striving to ensure that the foreign OW project developers, while benefiting from the subsidies provided by the government, are also contributing to the development of the British offshore wind supply chain. Thus, the foreign OW developers that are seeking financial support from the UK Government in the form of CfDs are expected to invest in the UK OW supply chain segments that have great potential for further cost reduction in the OW industry but at the same time require high level of investment and are neglected by the OW developers due to no instant economic benefits.

Therefore, the main focus of the current study was to explore the extent of the UK content in the CfD offshore wind projects, i.e. Dudgeon, Hornsea Project One and Burbo Bank Extension, that have to comply with the local content requirements imposed by the host-state. The CfD OW projects have been compared to the offshore wind projects without such UK content obligations, i.e. Rampion, Greater Gabbard, Hywind, Walney Phase 1 and Walney Phase 2. As well as the study attempted to answer whether the policy claims on LCRs in the UK offshore wind industry succeed in enhancing the UK content in the domestic offshore wind supply chain.

In order to investigate the above described problems, the current research has employed the GPN approach which is the analysis framework that helps to understand how global industries are organized and governed. The Global Production Network framework was developed by the researches from Manchester, Henderson (2002); Dicken and Henderson (2003) and Coe (2004).

The reason for choosing this specific theoretical approach to address local content obligations that the foreign offshore wind project developers have to comply with is due to the fact that the GPN framework addresses and acknowledges the complex nature of the relationship between the OW project developers and suppliers and the host-state, the United Kingdom. Moreover, the framework explains how this relationship influences international trade (Dicken, 2015).

In order to explain the relationship between the host state, the UK, and the focal firms, the foreign OW project developers and suppliers, study focuses on the following conceptual categories: *territorial embeddedness and the bargaining power* of the resource holding state, in our case the UK that controls access to its OW market, and the *bargaining power* of the OW project developers in the OW supply chain. These categories have been chosen as they are relevant for the topic of the thesis and they are reflecting and explaining the relationship between the UK, host-state, and OW project developers and suppliers in the OW industry with regard to LCRs.

In terms of the research strategy, the current research combines both quantitative and qualitative research approaches. The reason for conducting the mixed-method research derives from the nature of the research questions. Analyses of the 4COffshroe offshore wind projects' supply chain data bases, interviews with the UK Government and the UK offshore wind supply chain representatives as well as the analysis of various policy documents, industry reports and news articles have been the main source of empirical data of this research.

One of the main contributions of the current study is that it attempts to investigate the issue of the local content obligations from the perspective of both the host-state and the foreign offshore wind project developers, both of whom have different priorities in their relationship and, thus, pursue their own interests. The United Kingdom is striving to develop and protect the domestic OW industry and it also controls the access to the sought-after resource. The sought-after resource in our case the abundant offshore wind, financial support and a huge domestic OW market which growth is guaranteed through the UK government commitment to the international renewable energy and climate change targets. The foreign offshore wind project developers are striving to gain access the UK offshore wind market, access to which is controlled by the UK Government. Therefore, foreign OW project developers are forced to comply with the UK regulations in order to gain access to the market, valuable government incentives and financial support.

This can be considered as a valuable contribution to the academic literature on the topic of the local content obligations in the offshore wind industry and the complex relationship between the host-state and the foreign offshore wind project developers and suppliers in the offshore wind industry that is dictated by the different interest both of these parties pursue.

## **Summary of the findings**

As it was mentioned above, the current research focuses on the investigation of the extent of the UK content in the OW projects that have to comply with local content obligations and compares them to the OW projects that do not have to comply with any local content regulations, in order to find out whether the UK policy claims on LCRs in the OW industry succeed in enhancing the UK content in the UK based OW projects. The study made an attempt to answer the following two research questions:

*Research Question 1:* What is the extent of the UK content in the Balance of Plant, the major offshore segment in the UK OW supply chain?

*Research question 2:* Do policy claims on LCRs in the OW industry succeed in enhancing LC in the OW projects in UK sector?

When answering the first research question the 4Coffshore supply chain databases have been analyzed with regard to LC in the UK OW projects that have to comply with the LC obligations and those that do not. Moreover, the extent to which the UK content varies through the UK OW industry sectors (Towers, Substation structures, Turbine Foundations, Array and Export Cables) have been analyzed. Thus, answering the first research question has resulted in the following findings:

First of all, the CfDs is a relatively new mechanism, legislated for in the UK's Energy Act 2013 (Crown Estate, 2015) therefore, it will take time for the British offshore wind supply chain to adjust to new increase in demand. However, the analysis shows that the boost in the UK manufacturing activity in the CfD OW projects can already be observed.

The first offshore wind supply chain segment that has been analyzed is *Substations*. The analysis of the excel databases of the UK OW projects has proven that the UK domestic Substation market is well established. Based on the analysis, the only foreign substation components that were imported are the larger components of the offshore substation electrical systems which accounts for around

£30m for substation (£50m is a total cost of offshore substation (Crown Estate, 2013:51)) and include power transformers, protection systems to protect electrical items as well as switchgears (4COffshore database, 2017).

Furthermore, the analysis of the OW projects supply chain databases (4COffshore, 2017) showed that the UK domestic offshore and onshore substation fabrication market is highly competitive which results in the major financial challenge for the British suppliers. Due to the high costs of maintaining a workforce as well as the fact that demand for facilities rises and drops very irregularly ultimately resulting in shutting down of some manufacturing facilities (Chin, 2013:16).

One of my informants (anonymous) highlighted another challenge within the supply chain segment. According to him, the OW developers constantly have a temptation to go from one supplier to another in order to reach a better price level or quality of a sought-after product or service. And this practice of switching suppliers is not doing anything good for the local substation suppliers who instead are looking for contracts with repeat orders. Repeat orders are vital not only for suppliers but for OW developers as well, as it is exactly what serves as a stimulus for local suppliers to keep their focus on the OW supply chain rather than going for their traditional oil and gas sector. Moreover, according to Chin (2013:15) repeat order contracts contribute to boosting innovation as well as they help obtain economies of scale thus achieving cost reduction.

Moreover, the demand for the substation components significantly exceeds the UK current substation manufacturing capabilities and the local suppliers are not able to keep up with demand. Besides, not only the substation manufacturing facilities. In order for the substation manufacturing segment to stay competitive, the UK suppliers must be able to keep up with the demand and be ready to deliver larger orders so that they could secure repeat order contracts and thus further develop their expertise in offshore wind sector, enable innovation and contribute to cost reduction.

Another major offshore wind segment that has been analyzed is *array and export cables*: according to the analysis of the supply chain databases, none of the export supply came from the UK. Most of the contracts for array cables manufacturing and supply, on the other hand, went to the UK suppliers. The success of this segment in the UK can be explained by the high cost of the array cable transportation. For this reason, most of the OW farm developers find it more reasonable to have array cables supplied by the UK based companies as there is no economic advantage from imported product. Subsea export cables manufacturers, on the other hand, have next to no presence

in the UK. According to earlier reports on the UK OW supply chain capabilities (Chin, 2014; Crown Estate, 2013) there were no manufacturing facilities of export cables in the UK before the year 2012. The analysis of the OW projects have shown that there indeed has been no UK supply of export cables to OW farms.

*Turbine foundations* is the offshore wind supply chain segment that represents the major procurement choice of the OW project and therefore it significantly affects the extent of the UK content in the domestic offshore wind supply chain. While the previous two supply chain segments have not seen any significant increase of the UK content in the CfD projects, the turbine foundation supply chain has experiences significant boost in manufacturing facilities in the CfD OW projects.

After having analyzed the 4Coffshore supply chain databases I have noticed an interesting trend; all OW projects with LC obligations, Burbo Bank Extension, Hornsea Project One as well as Dudgeon, have been using either UK fabricated transition pieces for their turbine foundations or davit cranes for transition pieces manufactured on the UK fabrication facilities. While the OW projects without such LC obligations have used imported foundations and major components to them. It was argued that it is unlikely to be significant logistic savings from local supply of monopiles and transition pieces. And despite the fact that the supply chain for turbine foundations did not have presence in the UK market the OW developers did not experience any problems with foreign suppliers. The reason for this is that turbine foundations and their major components have been transported to the UK using relatively low cost vessels (Maritime Industries, 2013: 44).

The main argument for not investing in British manufacturing facilities was that such a move will not have a significant contribution to the cost reduction as well as the development of such offshore wind segment in the UK requires significant investment (Maritime Industries, 2013: 44) as well as there are a number of challenges that are yet unsolved (Crown Estate, 2013: 17). Besides, there are uncertainties in regards to the development of the foundation technology as it is highly dependent on the turbine size, which is constantly and rapidly increasing (Crown Estate, 2013: 17). And, the competition from the established facilities outside the United Kingdom is very strong.

When answering the second research question on whether policy claims on LCRs in the OW industry succeed in enhancing LC in the OW projects the following main finding have to be highlighted. First of all, the answer to the research question is yes. Despite the fact that offshore wind projects, that have to comply with the LC obligations, did not significantly increase the UK

content in the traditionally strong supply chain segments like array cables and substation supply, they have invested in the UK turbine foundation manufacturing facilities. Investing in this supply chain segment, that represents one of the largest procurement choices in OW projects, significantly affects the level of local content in the UK OW industry. Thus, all of the three CfD offshore wind projects that have been analyzed in this study have contributed to helping the turbine foundation supply chain to make the first step in obtaining economies of scale and contribute to the cost reduction in the UK offshore wind industry. This will not have happened if it was not for local content obligations that have been imposed on the CfD projects. The analysis of the databases has shown that the CfD projects contributed to the increase of the UK content in such segments of the UK offshore wind supply chain that have a steep learning curve which deters investment and that is otherwise neglected by the offshore wind project developers due to high investment costs and no instant economic benefits.

Thus, such large offshore wind segments of the UK OW supply chain that requires significant investment and have no instant economic benefit for the project developers, rely on the local content obligations imposed on the project developers under the CfD in order to secure contracts from them. Once such segments of the UK supply chain obtain economies of scale, which can be secured through a sufficiently large pipeline of work, repeat order contracts, the cost reduction in the sector will be achieved and an increasing number of offshore wind developers would start contracting the UK based manufacturers even without the local content obligations.

### **Recommendations for further research:**

As it was mentioned throughout the research, the Contract for Difference (CfD) financial support is a relatively new mechanism in the UK offshore wind industry. Therefore, it will take time for the UK domestic supply chain to adjust to the increase in demand that is dictated by the local content obligations imposed on the foreign OW project developers. The UK domestic supply chain is constantly developing in order to meet the increasing demand as well as it is changing due to the local content requirements. Therefore, more research is needed to explore whether and how the UK content is increasing in other major offshore wind segments, that represent significant procurement choices in OW projects, significantly affecting the level of local content in the UK OW industry. Other major OW supply chain segments have not been analyzed in this research due to time constraints. Such offshore wind supply chain segments include: *Wind Turbine* and *Installation and*

*Commissioning* that represent £600m and £400m of a typical 500MW offshore wind farm total costs.

With regard to the topic of the current study I would also suggest the following, when studying local content in the *Balance of Plant* and *Wind Turbine* supply segments one needs to also study the UK content in the *Installation and Commissioning* segment. As it was mentioned in *Chapter 4: Analysis of the findings*, the supply and the installation are usually contracted separately, however now, the OW project developers are keen to combine the supply and installation packages in order to avoid contractual interfaces. This can significantly affect the extent of the UK content in this or another offshore wind supply chain segment. Moreover, many of the offshore wind project developers are committed to maintaining business relationship and in many instances, they choose the suppliers they have been working with on the previous projects. Therefore, studying the nature of contracts within the supply and installation segments is important when trying to explore how LC obligations are affecting the local offshore wind supply chain and will be a valuable contribution to the discussion on the LCR in the UK OW industry.





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