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Methodology and Implementation Plan for the Offshore Wind Power Resource Assessment

Deliverable1: Comparison of Offshore Wind Farm Development Methodologies

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1 INTRODUCTION

SgurrEnergy has been appointed by CRESP to assist with the development of a methodology leading to production of an implementation plan to exploit the offshore wind resource of the Fujian province.

2 OVERVIEW

While offshore wind farm development has been around since the early 1990s exploitation of large areas of the seabed for the purpose of offshore wind farm development has only begun in the last 5 years. There is therefore a limited database of examples from which to derive information for the purpose of comparison with regard to the likely large scale deployment sought by Fujian province.

SgurrEnergy believes that the scale of development sought by Fujian province will be equal to or greater than the largest European projects and therefore project building blocks will be in the range 300MW to 500MW.

3 COMPARISON OF METHODOLOGIES

3.1 Comparison of Offshore Wind Farm Development Targets and Policies

The first offshore wind farms were developed in Europe, largely as a response by Governments to the shortage of suitable onshore sites. The characteristics of offshore wind energy developments in selected European Union (EU) countries, the USA and Canada are shown in Table 1.

In 2000, countries in the EU set ambitious targets for renewable energy generation to be met by 2010 which has required the creation of specific policies needed to turn these targets into projects. With reference to Table 1, where offshore wind farm development targets have been set these are substantial and multi-GW. Renewable energy policy in the EU and North America has been designed to encourage electricity generation from renewable energy sources with emphasis on deriving economic benefits.

Some EU Governments initiated demonstration programmes to identify planning requirements and guidelines for developers. However, an open tendering process has resulted in interest from developers which is the development route preferred by many Governments, as in the case of Denmark. (It is worth noting that all of the initial offshore wind farm developments were balance sheet financed by major utilities whereas the most recent offshore wind farm developments have been project financed). Information on the impacts and performance of the offshore wind farm developments is generally fed back to the sponsoring Government by way of monitoring and evaluation undertaken by the developer.

The licensing and policy institution varies between countries. There are strong links between those countries with the greatest progress in offshore wind farm development and those who have a top-down approach to licensing and policy, namely Denmark and the UK. Countries in which national and regional Governments have responsibilities for different stages of offshore wind farm development have experience longer development timescales in relation to the planning stage. As projects are increasingly developing further from the shore, offshore wind energy policy and licensing is more appropriately dealt with at national level.

The EU countries, the USA and Canada have been funding research and development of renewable energies since the 1970s. An area for development for all of the countries studied is the high voltage grid capacity, which, in most cases, will require reinforcements in order to accommodate the extra load from large offshore wind farms.

An area in which the policy of the EU countries studied differs is in site identification. The Governments of Denmark and the UK have identified zones in which offshore wind farm developments are allowed or encouraged. Another approach adopted by the Netherlands is to identify zones in which development is not allowed. Other countries have so far assessed sites for development on a case by case basis. The more pro-active approach of Denmark and the UK assists developers in the initial development phases. An area of improvement in policy for all the countries studied is to outline a clear scope of study which assists developers in the early stages of development. An assessment of the positive impacts of offshore wind developments may also reduce site constraints and encourage further development.

All the countries studied have offered financial incentives to encourage offshore wind farm development. The schemes vary between countries but most have found feed-in tariffs, which guarantee the price paid for a kilowatt hour of offshore wind energy, as the most effective approach in conjunction with an obligation to energy distributors to purchase from renewable energy sources.

3.2 Operational and Proposed Offshore Wind Farm Developments

Examples of offshore wind farm developments installed since 2001 and proposed developments are given in Table 2. The table is arranged in order of actual or proposed construction date to highlight progressive trends in offshore developments.

The general trend is towards increasing installed capacity of offshore wind farms and it is worth noting that the scale of planned projects is increasing with Thornton Bank and Bokum West considering installed capacities of 300MW and 1000MW respectively. This is a result of growing confidence in the industry and economies of scale. Turbine manufacturers are facilitating large scale developments by designing larger turbines for the offshore market such as the Vestas V90 and the REpower 5M which have rated capacities of 3MW and 5MW respectively. Several turbine manufacturers plan even larger turbines.

Exploitable water depths are increasing, with the current economic limit at around 25m, as is distance from the shore, with Thornton Bank and Bokum West being located 27km and 45km from the shore respectively.

Costs are provided where these have been made available. Costs for recent projects range from €1.9m - €2.6m. This is an increase of around 60-70% in 5 years, which has resulted form increased turbine costs and increased risk premiums.

3.3 Offshore Wind Farm Development Methodologies

Offshore wind farm developments follow the same basic steps. These are:

1. Identification of primary search areas
2. Identification of secondary search areas through the production of constraint maps
3. Prioritise potential sites based on key factors affecting capital cost and energy yield
4. Consult with appropriate organisations
5. Perform a high level economic assessment to identify the most appropriate routes

6. Characterise the sites
7. Undertake a final design of the wind farm
8. Perform an economic assessment and decide on whether to develop or not.

These areas are discussed in more detail below.

3.4 Fujian Offshore Wind Farm Development Methodology

Fujian province is for most aspect of offshore wind farms development no different from anywhere else. The key issue specific to the Fujian province here is the frequency and strength of typhoons and this will have to be given special attention.

3.4.1 Primary Search Area Identification

With reference to **Figure 1**, two options are presented for identification of primary search areas, namely 0 – 25m water depth and 25 – 50m water depth. The first band, 0 – 25m, covers that range of water depths that are currently being targeted by offshore wind farm developers, as discussed in Section 3.2. The second range, 25 – 50m, could potentially be exploited in the future, as has been demonstrated by the Beatrice project in the Scottish North Sea, which is a demonstration project deployed in 50m of water.

If the necessary information was made available this exercise would be straightforward requiring highlighting of areas enveloped by the 25m and 50m sea bed contours. SgurrEnergy has not yet been able to source the information required to produce primary search area maps.

A second criteria placing the wind farm shore-side boundary greater than 10km from the shore is arbitrary. When the wind blows from the mainland out to sea the effect of the land in terms of reducing wind speed and promoting turbulence can prevail for as much as 50km from the coast. As the primary reason for taking wind farm developments offshore is to exploit higher wind speeds and reduced turbulence levels compared to onshore some degree of separation between the coastline and the wind farm boundary is desirable.

To specify an appropriate separation between the coastline and an offshore wind farm boundary, detailed knowledge of local wind character is required and of particular interest is the wind rose. If winds blow towards the coast then separation can be less compared that required where to winds blow mainly from the mainland to the coast. Offshore wind speed measurements will also enable determination of an appropriate location for the offshore wind farm boundary.

The coastal topography is also extremely important as the influence of topographic features, for example hills and ridges, can propagate for many times their height. A recognised rule of thumb is that the influence of a topographic feature on wind flow can extend for 20 times the height of the feature. In SgurrEnergy's experience this is an underestimate.

From discussions with CMA it does not look as though it will be possible to obtain quality data for the purposes of wind flow modelling. SgurrEnergy will therefore use a number of basics rules to try and identify the shore-side boundary of the primary offshore wind farm search area.

3.4.2 SECONDARY SEARCH AREA IDENTIFICATION

The exercise described in Section 3.4.1 above will enable identification of fairly large areas that could be exploited for the purpose of offshore wind farm development. These areas need to be overlaid with constraints that can be many and varied. A selection of these is discussed below.

It is assumed that it will be possible to construct offshore wind farm both within and outside territorial waters that shall be assumed to extend 12 miles from the coastline until a detailed map showing the formal territorial boundary can be provided.

3.4.2.1 Policies and Regulations (Land Use)

Policies and regulations may dictate the size of projects or areas that have been earmarked for development as has been done in several other countries.

3.4.2.2 Shipping Routes

Shipping routes in Europe follow well defined corridors marked by navigation buoys and are concentrated around major ports. Offshore anchorages are often used to decant material from large ships that may not be able to gain access to ports into smaller more navigable ships.

It would normally be possible to define shipping corridors and constraints around offshore anchorages based on information presented in navigation charts and discussions with relevant statutory bodies. However, SgurrEnergy has not been able to obtain any basic information on which to base a picture of the shipping route constraints.

3.4.2.3 Fishing Grounds

Fishing grounds can be very important for local and national economies and must therefore be treated with a high degree of sensitivity. Discussions with government bodies and relevant stakeholders is therefore advised at an early stage, such that these areas can be clearly identified on the constraint map.

3.4.2.4 Environmental Constraints

Environmental constraints will require early consultation with the relevant statutory authorities. Such constraints can include, but are not limited to the following:

- Designated or considered world heritage sites or areas over which there is special protection orders, such as reefs
- Bird, fish or sea mammal breeding areas
- Bird, fish or sea mammal migration routes

Details maps of the location of such areas are required to enable these to be added to the constraint maps.

3.4.2.5 Radar

Radar is employed to track civil and military ship and aircraft movements and release of detailed information about these installations could be problematic. However, as large wind turbines can have an impact upon radar installations it is essential that planning is undertaken to enable turbines to be sited in locations that are not in the *field of view* of radar installations. Further discussion is required between SgurrEnergy and CMA to enable the necessary information to be released to SgurrEnergy to enable this constraint to be adequately considered in the overall constraint map.

3.4.2.6 Naval/Military Exclusion Zones

Areas of the sea could potentially be excluded due to the requirements of the military, for example missile or other weapons testing whereby munitions are fired from the coast into the sea. Similarly, certain areas of the sea may be used for sea trails for ships or other equipment or naval exercises. SgurrEnergy does not need to know what activities are likely to be conducted in such areas, all we require are the co-ordinates of exclusion zones such that appropriate constraint maps can be constructed.

3.4.2.7 Archaeology, Wrecks & Munitions

Areas of the seabed my be protected due to the presence of archaeology that has now below sea level, ships that have sunk due to weather or warfare or munitions or other hazardous materials that have been dumped at sea and should remain undisturbed.

3.4.2.8 Major Infrastructure Constraints

The routes of major power cables, gas and oil pipelines, gas and oil platforms, telecommunications links and cables all need to be clearly identified and appropriate safeguarding zones defined around these.

3.4.2.9 Mineral Extraction

Areas of the seabed in the UK are designated for the purpose of mineral extraction by dredging. Such areas must be identified for the purpose of constraint mapping.

3.4.2.10 Grid Connection and Capacity

Nodes into which offshore wind farm power export cables can be connected and the capacity of these nodes must be identified and specified.

This issue is crucially important as it will have a major bearing on the likely project economics. For example, as the distance to a point of grid connection increases the overall cost will increase. However, larger projects will be more able to accommodate being farther from a point of grid connection compared to a small project.

3.4.2.11 Seabed Conditions

Some knowledge of seabed conditions is required to gauge which foundation type is most appropriate. For example, gravity base, piling and such like are very influenced by the geology and condition of the seabed.

3.4.2.12 Noise and Visual Impact

Placing wind farms in the offshore environment is in itself mitigation regarding noise and visual impact and these issues are unlikely to have a determining impact upon the siting of offshore wind farm location.

3.4.3 Priority Site Selection

Without undertaking the exercise described in Section 3.4.2 it will not be possible identify potential offshore wind farm locations and prioritise these.

3.4.3.1 Policies and Regulations (Development Priority)

A target for offshore deployment would be of use here. Comparing targets observed in Europe and North America with the potential for China, we could be looking at several thousand MW. We should be looking at say ten projects of a size of 300MW - 500MW.

3.4.3.2 High Level Wind Resource Map

CMA has produced an onshore wind resource map for Fujian province and has advised SgurrEnergy that this will be extended to cover the offshore region within the month. A map of this nature will be required to enable the areas with the highest energy yield to be identified. It is unlikely that such estimates will have an accuracy better than ±25%. However, as a minimum the data can be used to rank sites and highlight what are likely to be the most economic opportunities.

3.4.3.3 Extreme Wind Speeds

It will be essential for the development of offshore wind farms in the Fujian province to produce maps showing the probability of encountering extreme wind speeds for the two main IEC classifications, namely IEC Class I, 70m/s, and IEC Class II, 59.5m/s. This map will further develop the constraints map and enable buildable and financable sites to be identified.

3.4.3.4 Operational Experience of Existing Onshore Wind Farms

As a sanity check it would be worth discussing the experiences of existing operators of onshore wind farms to establish if the predictions of average and extreme wind speeds make sense.

3.4.3.5 Outline Wind Farm Design

The exercise described in Sections 3.4.3.1 and 3.4.3.2 will enable the identification of number of areas suitable for deployment of offshore wind turbines. At this point it would be sensible to produce preliminary designs based on the most appropriate technology for further discussion as described below.

3.4.3.6 Aviation and Marine Safety

The constraint maps discussed in Section 3.4.2 are the staring point. On completion of a provisional design that will show the actual height and area of a proposed development it is essential that early discussions are undertaken with the appropriate authorities.

3.4.3.7 Seabed Geology and Seismicity

It will not be possible to suggest a foundation design appropriate for the sites in question without developing a better understanding of the seabed and its associated seismic risks.

3.4.3.8 Sea State Averages

General long term sea state conditions are used to compare sites for their relative weather windows and delay risks for during wind farm construction, for the expected wind farm accessibility during the operation phase.

3.4.4 PRELIMINARY ECONOMIC ASSESSMENT

3.4.4.1 Provisional Energy Yield

A provisional energy yield would need to be produced based on fairly generic information and the European experience regarding energy losses, and downtime due to availability and such like.

3.4.4.2 Capital Expenditure

Using data from the European experience capital expenditure estimates will be made for sites based on the distance of the site form the grid connection point, the potential size of the sites, appropriate foundation technology and turbine technology.

3.4.4.3 Operational Expenditure

Using data from the European experience operational expenditure estimates will be made for sites based on the distance of the site form a serviceable port, access technology options and turbine technology.

3.4.4.4 Power Purchase Price

All of the countries involved in offshore wind farm development employ a subsidy mechanism to encourage the development of offshore wind farms. Fujian is not likely to be different and for this reason three power price levels will be identified.

3.4.4.5 Provisional Financial Model

The most promising areas can be compared in a provisional financial model.

3.4.4.6 Policies and Regulations (Cost of Energy)

National and local targets for renewable energy along with pricing policies for wind energy will be a reference for determining if the provisional financial models are within the scope of acceptance by governments. These policies and regulations are expected to vary by region, and will change with time, therefore the decision to stop or to proceed with further site selection may be different for the same input variables.

3.4.5 SITE CHARACTERISATION

3.4.5.1 Wind Measurements

Produce a specification for measurement at the areas of most interest.

3.4.5.2 Climate Measurement

Produce a specification for measurement at the areas of most interest.

3.4.5.3 Sea State Measurements

Produce a specification for measurement at the areas of most interest.

3.4.5.4 Seabed Geotechnical Investigation

Produce a specification for measurement at the areas of most interest.

3.4.5.5 Environmental Baseline

Produce a specification for environmental assessment at the areas of most interest.

3.4.5.6 Policies and Regulations (Investigation Standards)

The site investigation steps need to conform with local standards related to those procedures, such as techniques for environmental baseline survey, building codes for offshore structures and related regulations.

3.4.6 Final Wind Farm Design

The data listed with regard to site characterisation will be required to enable a final design of wind farm to be undertaken and formalise the following:

- Turbine Selection
- Foundation Design
- Grid Connection & Capacity
- Construction Equipment
- Access Techniques

3.4.7 Economic Assessment

The finalized design from Section 3.4.6 will be used to update the preliminary economic assessment to have a stop go decision.

4 CONCLUSIONS

SgurrEnergy has summarised the various methodologies applied throughout the world with regard to exploitation of the offshore wind power resource.

The summary presented in this document can be developed into an implementation plan if the information necessary to enable primary search areas to be identified can be provided, followed by the information needed to produce constraint maps.

If the information needed is not provided then SgurrEnergy will have to be advised of preferred development areas.

Table 1 - Comparison of Worldwide Offshore Wind Farm Development Targets and Policies

	UK	Denmark	Germany	The Netherlands	Belgium	Ireland	Sweden	Spain	USA	Canada
Installed Offshore Capacity 2005	80 (MW)	423 (MW)	-	-	-	25.2 MW	23 MW			
Planned Offshore Capacity 2005	650MW (Round 1) 6 GW (Round 2)	400 MW	2.2 GW	220 MW	216-300MW	250 MW	870 MW	500 MW	560 MW	320 MW
Government Targets										
Targets for renewables	10% by 2010, 20% by 2020	29% by 2010	12.5% by 2010	5% by 2010	6% by 2010	15% by 2010 and 33% by 2020	60% by 2010	12% by 2010	-	3.5-50% by 2008-2016
Targets for offshore renewables	-	4000 MW by 2030	-	6000MW by 2020	-	-	-	-	-	-
Government Policy										
General Renewable Energy Policy	Increase use of renewable energy to help reduce greenhouse gas emissions and greater diversity of energy supply and provide economic benefits to UK.	Economic efficiency, market-based solutions and international approaches to environmental issues.	Increase share of renewables in electricity supply.	Demand and supply: Consumers have freedom to choose green energy and incentives given to producers.	To keep in line with EU directives.	Government policies and support measures to increase renewable energy supply.	Secure access to energy on internationally competitive terms and facilitate transition to ecologically sustainable society.	Market deployment strategies to encourage renewable energies.	Financial incentives	Promote energy self reliance and energy diversity
Offshore policy	Encouraged due to shortage of suitable onshore sites.	Target set for offshore development as onshore development is close to saturation.	Higher remuneration than for onshore wind.	New incentives for offshore as land use issues limit onshore installations. Government aims to meet targets with fiscal incentives and financial instruments.	2 scenarios developed by Belgian Science policy.	Explore offshore wind resource.	Investment subsidy for plants in difficult locations	Same as Onshore: Programme for Promotion of Renewable Energies	Reduce cost of electricity by 0.05c/kWhr by 2012.	-
Demonstration programme	Yes	2 demonstration projects but later competitive development preferred.	-	Yes, for near shore wind farms	-	-	Yes	-	-	-
Open tenders	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Licensing and policy institution	National Government	National Government	The 4 Länder (Provinces) with coastline regulate development up to 12 nautical miles from the shore. Federal Government regulates developments further out to sea.	Provinces within 1km from shore, after which National Government	Regional Governments	National Government	National Government	National Government	State if less than 3 nautical miles from shore. Federal if 3-12 nautical miles from shore, but consulting with states over transmission issues.	Province

Table 1 - Comparison of Worldwide Offshore Wind Farm Development Targets and Policies

	UK	Denmark	Germany	The Netherlands	Belgium	Ireland	Sweden	Spain	USA	Canada
Technology development[2]										
R&D funding policy	Stimulate development of renewable and sustainable energy where they will be economically beneficial and environmentally attractive.	Wind receives highest funding including funding for wind turbine systems.	Yes	Programmes for energy efficiency and technology.	Yes	Stimulate deployment of renewable energies that are close to market and develop technologies that have prospects for the future.	To promote commercial applications where possible particularly for new technology with higher efficiency and lower environmental effects.	Development of Cleaner energy systems.	To research, develop and deploy renewable energy technology.	To develop and commercialize advanced renewable energy technologies that can serve as cost effective and environmentally responsible alternatives to conventional energy generation.
Grid capability	Improvements required	Improvements required	Improvements required	Yes for realisation of 6000MW	Yes, will optimize integration of wind power into grid	Improvements required	Improvements required	Improvements required	Yes (centralized to decentralized)	Yes (centralized to decentralized)
Site designation										
Method	Strategic Environmental Assessment (SEA) for round 2 led to identification of 3 areas for development.	Designated areas in which the benefit to developers is that the grid operator pays connection. Outside of these areas, the turbine owner pays connection.	Strategic review undertaken to identify potentially suitable areas.[1]	Areas are excluded on basis of conservation, shipping routes, mineral extraction, etc. rather than designated.	Government guidelines for identifying suitable locations.[1]	No	No	No	No	No
Territorial Waters (within 12 nautical miles from coast)	Allowed, but few projects underway.	Allowed	Allowed	Excluded for conservation unless near shore (<1km).	No	-	-	-	-	-
EEZ (Exclusive Economic Zone)	Allowed	Allowed	Allowed	Allowed	Allowed	-	-	-	-	-
Applications outside preferred zones	Only in exceptional conditions (revised legislation required).	Allowed but extra cost for connection.	Allowed but no guaranteed price.	No preferred areas.	Former applications refused.	-	-	-	-	-
Economic conditions										

Table 1 - Comparison of Worldwide Offshore Wind Farm Development Targets and Policies

	UK	Denmark	Germany	The Netherlands	Belgium	Ireland	Sweden	Spain	USA	Canada
Main market mechanisms[3]	Renewable Obligation Certificates (ROCs)	-	Feed-in tariffs	-	Obligation to source renewable energy and trading using Green Certificates	Feed-in tariffs and EU support. Single market for gas and electricity in all of Ireland (inc. Northern Ireland)	-	Generators can also choose to sell electricity within the market and receive a premium rate as incentive.	Renewable energy portfolio: encourages increasing percentage of generation from renewable sources while maintaining, stable, predictable competitive market for generators.	-
Investment subsidies	10% capital grants to Round 1 developments.	In designated areas, grid connection paid for by grid operator.	Higher rates for power generated by offshore wind farms with period of benefits extending as distance offshore increases.	No longer available	Priority access to grid	-	Yes	Yes	-	No
Credits	-	-	-	-	-	-	-	-	Tax credit of 1.5c/kWhr	Tax credit of 1 c/kWhr for first 10 years operation
Fiscal incentives	Yes	Yes	Low interest loans.	Yes	Yes	-	-	Low interest loans.	-	-
Feed-in tariffs	-	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-	Yes
Renewable Obligation/Green Certificates	ROCs main incentive for development.	Green Certificates	Grid system operators must give priority to renewable resources.	-	Yes	-	Yes	-	-	-
Guaranteed energy price	-	-	Yes	-	Fixed price for offshore.	-	Yes	Yes	-	-

[1]Offshore Wind Energy in the North Sea Region, University of Groningen, 2005.
[2]Renewable Energy: Market Policies and Trends, International Energy Agency, 2004.

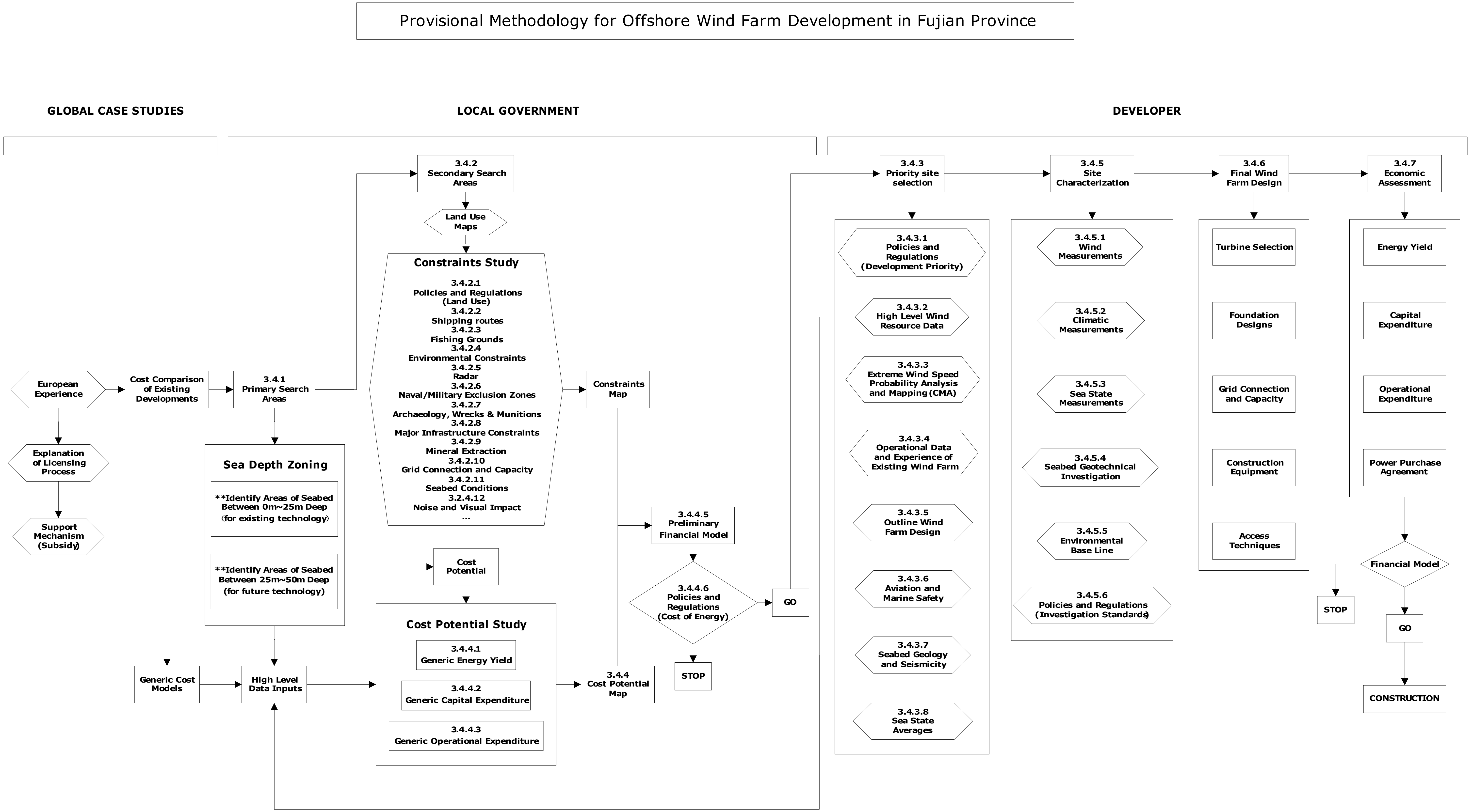
[3]Offshore Wind Experiences, International Energy Agency, 2005.

Table 2 - Comparison of Offshore Wind farm Attributes

Country	Sweden	Denmark	Denmark	UK	Ireland	UK	The Netherlands	Denmark	The Netherlands	Belgium	Germany
Name	Yttre Stengrund	Middelgrunden	Horns Rev	North Hoyle	Aklow Bank	Scroby Sands	Near shore wind park	Nysted	Egmond aan Zee	Thornton Bank	Borkum West
Project Summary											
Year built [1]	2001	2001	2002	2003	2004	2004	2004	2004	2007	Pilot expected 2006/2007	Pilot expected 2008
Turbine type and size[1]	NEG Micon NM72	Bonus 2MW	Vestas V80 2MW	Vestas V80 2MW	GE 3.6MW	Vestas V80 2MW	Vestas V90 3MW	Bonus 2.3MW	Vestas V90	Siemens 3.6MW - 5MW	Repower 5MW turbines
Project Capacity[1,2]	10 MW	40 MW	160 MW	60 MW	25.2 MW	60 MW	108 MW	158 MW	108 MW	Initial 21.6MW Phase 1 120MW Phase 2 300MW	Initial 60MW Extension 1000MW
Number of turbines[1, 2]	5	20	80	30	7	30	36	72	36	6 (pilot) increasing to 18 (phase 1), then an additional 36 (phase 2)	12 initially, then 208 turbine extension
Energy Output (GWh/year)	33	101	600+	200	-	171	300	-	986	-	260/4300
Water depth	8m	2-6m	6.5-13.5m	7- 11m	5m	3- 12m	16-22m	6-9.5m	20m	10-24m	30m
Approx. distance from shore	5km	2-3km	14-20km	8km	10km	3km	8km	9km	10-18km	27-30km	45km
Layout	Single row	Curved row	Rectangular layout in rows 560m apart	5 x 6 rectangular grid	-	Rows of 10, 9, 9 and 2	4 rows	-	4 rows	7 rows	-
Average wind speed	-	-	9.7m/s at 62m	-	-	-	-	-	-	-	9.3m/s at 90m
Measurement	-	-	-	Dedicated Site Mast	-	-	Nearby oil & gas platforms	-	-	Nearby offshore met. platforms	-
Construction											
Seabed conditions	Boulders and glacial Till	-	Firm sand and gravel	Sand (mixed sediment with clay and some gravel)	-	Large sandbank	Sand and Gravel	-	-	Sand (sand banks)	-
Foundation	Steel monopile	Gravity (concrete caisson)	Monopile	Steel monopile	Steel Monopile 15m depth into seabed	4.2m diameter monopile	-	-	-	-	-
Costs											
Capital cost (€ m)[3]	13	51.3	300	105.7	-	107.1	-	268.8	250	100 (pilot), 500 (final phase)	138
Cost per MW (€ m/MW)	1.3	1.3	1.9	1.8	-	1.8	-	1.7	2.3	1.7	2.3

[1] British Wind Energy Association website: www.bwea.com
[2] Figures are cumulative

[3] Offshore Wind Experiences, International Energy Agency, 2005



** Primary search criteria may be modified on completion of subsequent steps

Contract No. A2-B12-CS-2007-004

CMA
National Consultant:

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Date:_______________________

SGURRENERGY
International Consultant:

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Date:_____________________________

CRESP

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Date:_______________________