Marine Energy in Costa Rica: Development procedures compared to the UK

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Abstract — **This paper looks at the difference between the UK's and Costa Rican procedural requirements for the installation of marine energy devices. Costa Rica has a history of implementing renewable energy sources to produce electricity, such as hydro-electric systems. This knowledge and the UK's expertise in marine energy policy and legislation are used to make comparisons on the individual procedures when a development of this kind is being proposed. Recommendations are made on measures which could be introduced into both countries procedures in order to have more efficient guidelines for marine energy projects.**

***Keywords*— Costa Rica, UK, Marine Energy, Tidal Energy, Procedures**

I. Introduction

Over the recent decades marine energy has been gaining momentum. The possibility of using the ocean's movement as a source to generate electricity has encouraged researchers and companies around the world to find the best way to take advantage of the planet's largest natural resource. The utilisation of the ocean as an energy resource can be used to help reduce the dependence on fossil fuels.

Using marine energy resources to produce electricity is not completely new, dams that store the tides' ebb and flood variation have been used for many years [1] and are still considered an option in the electricity portfolio. From the La Rance Barrage to the proposed Swansea Tidal Lagoon (STL), the conversion of the potential energy available from a tidal range to generate electrical energy is considered as another alternative to fossil fuels. However, the construction of the barrage/dam and its effect to the marine environment is a major factor against the development of projects of this nature.

At present the feasibility of developing tidal lagoons, as a commercially viable technology, is under discussion in the UK. Tidal stream energy research and development is growing rapidly around the world, with the UK and Canada [2] leading the way. Other countries are starting to contribute to the field creating more possibilities for this technology to be implemented in the near future. Variations and combinations of the available designs are being studied so this technology can be used around the world including areas which until now have not been considered [3], such as Costa Rica.

Another way of extracting energy from the sea is from wave energy. The designs of this technology to date have been wide and varied and a convergence of the equipment design is still not been agreed upon. Various companies are testing the devices in several locations, mainly Australia and the UK.

Ocean Thermal Energy Conversion (OTEC) is a marine renewable energy technology that can be used in areas of the world such as the tropic regions [4]. Electricity is extracted from the ocean by using the thermal gradients present through the water column. Fluid is heated in the system operating on the same principle as a refrigerator. The heated fluid is then used to drive a turbine. One more alternative is to vaporise warm water in a low pressure container to directly drive the turbine with steam. The resulting steam can also be condensed into freshwater as a useful by-product, and combination of previous options is also a possibility, as a hybrid system [5, 6]. The first operating plant of this technology is working now in Hawaii and it has a capacity of 100 kW [7].

Last but not least, offshore Wind energy is considered in some cases as marine energy because of the location and how the wind and waves vary with each other. This technology is the most established one from the marine energy group: there were 3,018.5 MW of new projects installed in Europe during 2015 [8]. Many devices are available in the market and recent studies looked to improve manufacturing and maintenance, as well as to increase efficiency and better materials.

The UK is leading the research related to Tidal Lagoons, Tidal Stream Turbines and Wave Energy Converters. They are also investing in, and installing offshore Wind Turbines due to the large available wind resource and the benefit of not affecting the landscape [9]. Although many of the studies being made for tidal stream and wave energy is directed at the technical design and development, research has also been directed towards policy, social, economic and environmental impact to determine the policy and requirements for commercially viable deployment of the technology.

Costa Rica, on the other hand, has experience with installing renewable energy technologies according to their needs [10]. This paper aims to establish the current situation for marine renewable energy in Costa Rica and the UK, and so compare how the latter's experience can be used as a reference/guide for Costa Rica for the deployment of marine energy devices.

II. Renewable Energy in Costa Rica

Costa Rica is a small Central American country that has shown its commitment to renewable energy and the care of the environment. During the year 2015 it achieved 100% of its electrical production from renewable energy sources for more than 200 days [10]. In regular operation, it produces more than 90% of its electricity from renewable energy sources, with the rest from fossil fuels. There is a commitment from the government to maintain and improve these levels [11].

A. Current Electricity Situation

There was a commitment from the Costa Rican government to be carbon neutral by 2021. However this was changed, at the 2015 Conference of Parties in Paris (COP21), to 2100. The idea is to reduce the carbon emissions measured in 2012 by 25% in 2030 and by 50% in 2050 [12]. To accomplish these ambitious goals it is necessary to carry on with the 'green' electricity production.

The major responsibility of administrating and deciding what is next in the country's demand and supply is the Instituto Costarricense de Electricidad (Costa Rican Institute of Electricity, ICE). ICE is in charge of planning the biggest power plants that are to be deployed in future years and determining what resources are going to be used next whilst taking into consideration their social, economic and environmental impact [13]. ICE is a state owned company, therefore economically the net earnings expected in a project are not as high as the ones expected by private investors.

The latest 'Electric Generation Expansion Plan' outlined by ICE is to 2035 and considers different paths that can be taken depending on the circumstances, giving priority to renewable energy options: hydro, wind, biomass, geothermal and solar. However, to fulfil the electricity demand, a hydroelectric and a geothermal plants will have to be built [14]. These two projects are controversial at the moment, the former because the dam will result in the flooding of areas with aboriginal value [15] and the latter because it might intervene with a national park where environmental regulations are strict [16]. If the afore mentioned projects are not developed, high efficiency natural gas turbines will be part of the new energy matrix [14].

Error! Reference source not found. shows the generation matrix structure in Costa Rica as of 2014, hydroelectric power (1,768 MW) is the main contributor to electricity generation in Costa Rica, with geothermal the second biggest contributor (195 MW), which although is a much smaller contributor is more reliable in terms of climatic variations. Energy generated from wind turbines (894 MW) has been gradually integrated into the electric grid (144 MW as of 2014) because the intermittency of the resource requires power backup along with the growth of the wind farms. Electricity from biomass is produced by private companies with agreements on selling their excess to ICE, and by doing so reduce the residuals from their own production process. However, legal limitations cap the level of excess electricity that the private producers can sell to ICE [14].

Costa Rica's location also provides excellent possibilities of using the sun's energy all year round. The first large scale solar energy project (1 MW) was integrated into the grid, in 2012 [17], by ICE. Depending on the results further installations may be introduced [10].

Even with a high level of renewables meeting the country's energy demand there is still a need for fossil fuel derived supply as a back-up source. Biogas, biofuels and municipal solid waste use for electricity production is in an early stage in the country and its growth will depend on the regulations of how to implement it in the country [14].

The technology available at this time allows for the use of the previously mentioned resources. Research and development of new options can be considered and implemented in the future as their availability comes to fruition.

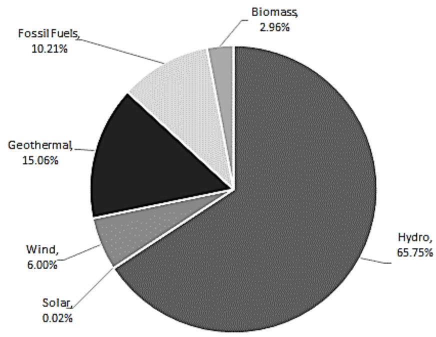

Fig. 1 Costa Rica's Electricity Generation Matrix as of 2014. [11]

1) Experience with Renewables: From the use and implementation of technology developed to produce electricity using renewable sources, Costa Rica has become a world leader in the area. For over six decades the country has been working on creating a renewable based electricity grid and provide a continuous high quality service to the consumers [10]. The results have given the knowledge and experience in the administration of natural resources, economy and energy policies that make the country an example for others to follow.

Sustainability is a major concern when it comes to a power plant project. The government's plan for energy entails a focus on the sustainability of electrical development, which includes more engagement from the citizens, improvement of the environmental guidelines, improvement of the governing of environmental aspects, and further consideration of environmental and social impacts [11].

B. Future Plans

In Costa Rica's plan for 2014-2035, various scenarios are presented. The plans proposed are limited to a few new renewable energy projects and potentially natural gas projects depending upon the result of the previously mentioned new hydro and geothermal plants.

The plan for power plants to be installed in the next 20 years includes fixed projects, which are ready to start operation at a determined date, and free projects, whose start is dependent on what is found to be the appropriate path for the country [14]. From the moment the plan was published to the time of writing, some free power plant installations have gone forward, such as geothermal power plants. Geothermal and hydro free power plants are on standby depending mostly on Environmental Impact Assessments (EIA), government regulations related to the use of National Parks' areas to produce electricity and agreements with the local communities. The fossil fuels considered in this plan include bunker fuel, diesel and natural gas; all of them used in high efficiency turbines and/or engines.

Other 'non-conventional' renewable sources are considered as part of the plan, but their use relies on the improvement of their technology so they can become economically viable. Marine energy is not one of them, but if further developments in the technology make this resource feasible, they will be included in the plan and be introduced in the electrical energy supply mix. Simply put, the plan is flexible and can consider all solutions that best suit the country. At the moment, initial steps in marine energy include the resource characterisation [18].

III. Marine Energy in the UK

In the UK marine energy is being considered as one of the possible major sources for its national grid because of the high amount of available resource that the country possesses. In the last two decades the UK has been leading research related to the use of marine resources to produce electricity with less impact than tidal barrages, i.e. tidal stream turbines, tidal lagoons and wave energy convertors. Other renewable sources are, meanwhile, used and incorporated into the grid such as wind and solar, but the dependency on fossil fuels to produce electricity must decrease [9].

A. Renewable Energy in the UK – Current Situation

According to the Kyoto Protocol, the UK has to reach a 15% renewable energy use by 2020. In order to accomplish this goal it has been decided that 30% of its electricity must be generated from renewable sources [9]. By the end of 2015 the UK produced 26.9% of its electricity using renewable sources [19].

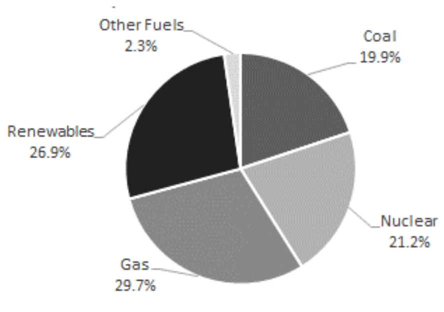

Fig. 2 Electricity generation in the UK at the end of the fourth quarter of 2015. [19]

The amount of renewable sources in the generation of electricity has been increasing in the last decade so as to achieve the goals from the Kyoto Protocol.

Fig. 2 shows the full electricity matrix for the UK. The input from fossil fuels (coal, gas and others) is more than 50% of the total, whereas the rest is divided between renewables and nuclear. The UK's government policy is to close all coal-fired power stations and retire the majority of the ageing nuclear fleet by 2025 [20]. By doing so, the country requires more implementation of renewable sources in the energy mix, which will not be without its difficulties due to its intermittency. It takes time to introduce a new renewable energy plant into the grid and then adjust the latter to the variability of the source. Investment in the UK has been focused towards photovoltaics and offshore wind plants during the last decade. As with all new technology the investments have initially required subsidies, which over time have been reduced [21] decreasing the 'popularity' for these renewables, therefore it is likely that the energy matrix will have more mature and highly efficient gas turbines which can respond quickly to the demand.

B. Marine Energy in the UK

The UK has one of the largest marine resources in the world. At the moment, tidal lagoon projects are the ones that might be incorporated into the grid in the near future [1].

Given the UK's geographic location, it has the capacity to produce large amounts electricity from offshore wind power plants (17.4 TWh by the end of 2015), making the UK the largest producer of electricity using this technology [22]. Tidal stream and wave power are also options that have been integrated to the grid through prototype testing [3]. In the future, these two technologies will be used as a reliable source of power because of their predictability. However, the capital expenditure has to reduce with the economy of scale, and the operation expenses to be determined in real working conditions so project plans are more realistic to all stakeholders [23].

Tidal lagoons have been promoted for the last decade as an alternative option to barrages, as the environmental impact is lower. Swansea Tidal Lagoon and the Severn Barrage in Wales have been the biggest projects mentioned in the UK, with Swansea's being closer to the construction stage. The experience gained from the planning and policy required can be used as a reference for future projects in the country and abroad.

C. Procedures in the UK – Over 100 MW projects

From Swansea's Tidal Lagoon (STL) project (320 MW) the bureaucratic process to build a power plant using marine resources in the UK is now described. Since the project is going to be located in Swansea the procedure to follow is according to the legislature specified for England, Wales, and the EU [24].

The first step in a large marine energy project is to choose the location, the geography of the country will help determine what locations are useful for tidal and/or wave energy power plants. Along with measurement data and general computational models that have estimated the resources available in the country, a location is preselected and an economic assessment is conducted. These steps are repeated until a location is found that is economically viable [23].

After a location is decided the project needs to be designed by the developers according to what they want to do, then legislation rules must be followed depending on jurisdiction.

According to the Planning Act 2008, for a marine power plant it must be determined if it classified as a National Significant Infrastructure Project (NSIP). NSIPs are large scale developments related to energy, transport, water, waste water and general waste. Power plants qualify as a NSIP if they produce over 100 MW or 50 MW for onshore wind farms. Once a project is considered a NSIP, the permits required for its development are granted through a Development Consent Order (DCO) managed by the UK Planning Inspectorate and granted by the Secretary of State. Besides the DCO, the developers must determine if they need another permit depending on the location and consultees that must be considered. The consultees that have to be involved with a specific project can be found on the Regulations [25].

The STL characteristics made it a NSIP because of the project's nature: generating plant of over 100 MW. The location of the plant in Wales requires the developer to consult (as part of many others) the Welsh Government, and it was determined that through Natural Resources Wales (NRW) they also require a Marine Licence for the development to start construction [26]. Other permits are needed depending on the statutory consultees, the land that needs to be used/leased/bought and the requirements for these may vary.

1) The Development Consent Order: The DCO is managed by the UK Planning Inspectorate, and for this project the final decision is made by the UK's Secretary of State for Energy and Climate Change who considers the recommendations given by the Inspectorate. The process in order to get a DCO consists of six stages [27]: -

1. Pre-application: The developer (applicant) communicates with the statutory consultees that apply to their project, with the local authorities, the community and the affected persons. They must gather all the information required to complete the application form. There is no defined time limit for this stage, it is dictated by the applicant (3 years for the STL). This ends with the submission of the application to the UK Planning Inspectorate.
2. Acceptance: The Planning Inspectorate reviews the submitted application and has 28 days to accept or refuse it. If refused, the interested parties have 6 weeks to challenge the result. Once the application has been accepted the Inspectorate makes all the documents publicly available.
3. Pre-examination: After the application is accepted, the applicant has to publicise the results and get interested parties involved in the discussion. Interested parties have 28 days to register to be part of the process. The Inspectorate selects members to form a panel of examiners who have a preliminary meeting with the interested parties.
4. Examination: This begins after the preliminary meeting, with the panel reviewing the application and the interested parties give written reports with their analysis, opinions and concerns. During this period more hearings can be held, if necessary. The review can last up to six months with a further three months for the panel to write a recommendation (approval or refusal) report to the Secretary of State. For the STL, local authorities were invited to submit Local Impact Reports to the Inspectorate.
5. Decision: The Secretary of State has three months to make the final decision and inform the developer.
6. Post decision: After the decision has been made, the developer has six weeks to challenge the final report through a judicial process.

The whole process can take many years to be completed, for the STL case it took around four and a half years. Most of the time is taken in completing the application documents since they have to be very detailed and include studies from different specialists. The application requires [27]: -

- An application form with details of the developer, development and reference to the documents that will be attached, and payment of the respective fees.
- An Environmental Statement (ES) when the project is considered an EIA development.
- A draft DCO.
- An explanatory Memorandum of the draft DCO.
- A book of reference (when required under the DCO).
- A flood risk assessment.
- A statement if the proposal results in any sort of nuisance during construction or operation along with mitigation procedures.
- A report identifying European regulated sites and providing information on how they will be affected.
- Reasons for any compulsory acquisition, interest or right over land, together with a statement detailing how the acquisitions will be funded.
- A detailed land plan specifying any: -
  - Land that is required or affected.
  - Land where powers of compulsory acquisition or rights to use is proposed.
  - Land where it is proposed to extinguish easements, servitudes and other private rights.
  - Land with special category and replacement land.
- A detailed works plan which includes: -
  - The proposed location and alignment of development and works.
  - Any limits within development, works and deviations.
- A plan with new or altered means of access (if necessary).
- A plan which details the following (when applicable), with details of the effects of the installation on them: -
  - Any statutory and non-statutory sites of nature conservation.
  - All habitats of protected species, important habitats or other diversity features.
  - All water bodies in a river basin management plan.
- A plan with statutory and non-statutory sites of historic environment (when applicable).
- A plan with information detailing Crown land that needs to be used (when applicable).

- Any other plans such as details of design, external appearance, layouts of buildings and structure and/or similar (when applicable).
- Any other documents that are required to provide a complete set of details in support of the application.
- Specific documents depending on the type of project. In marine energy projects are required: -
  - For offshore generating stations: Details of proposed installation of any cable; and statement to whether applications for safety zones will be made.
  - For construction of dam or reservoir, a statement setting out what, if any, recreational amenities will be made.

2) Marine Licence: In the case of the STL a Marine Licence had to be requested via NRW, as stated above. This permit allows the developer to start their project in the sea. It currently takes at least 16 weeks to obtain the licence once the application has been accepted [26].

For an application to be accepted, it is necessary to have certain documents attached and a fee must be paid for the application to be processed. The requirements for this license are similar but less detailed than the ones for the DCO, therefore the developer can obtain all the information required, put it together and then prepare the documents as requested by each of the institutions.

3) Environmental Statement (ES): All marine power plants are considered as EIA developments in the UK according to Schedule 1 of The Infrastructure Planning (Environmental Impact Assessment) Regulations 2009.

The developer can request a scope of the ES, which will detail what information must be included in the statement. The developer may include in its documentation a list of the consultees they have approached to create the application and the commission may contact them again and/or consult other bodies that may have input on the project. There is a list of the consultees that need addressing when a project is an NSIP [28].

The Secretary of State determines what items have to be included in the EIA, as part of the ES. For example the STL were required to include the following items [29]: Coastal processes, sediment, transport and contamination; marine water quality; intertidal and sub-tidal benthic ecology; fish, including recreational and commercial fisheries; marine mammals; coastal birds; terrestrial ecology; seascape, landscape and visual assessment; navigation and marine transport assessment; onshore transport assessment; air quality; hydrology and flood risk; land quality and hydrogeology; noise and vibration; marine archaeology; terrestrial archaeology and historic landscape; economy, tourism and recreation; and mitigation and monitoring.

It is also recommended that the ES includes [28]: -

- A Water Framework Directive Compliance Assessment. This is an assessment to determine if the new development would deteriorate or achieve a good status of the surface and ground waters. The assessment must include the current status and indicate what mitigation will be used to reduce the effects caused by the development [30].
- A Habitats Regulation Assessment (HRA). This is an assessment made to ensure that the biodiversity of specific natural habitats and wild species in European Member States is maintained when a project is developed [31]. The HRA consists of three stages [32]:
  - *Stage 1:* Screening with the relevant statutory and non-statutory bodies to determine if there are likely to be any significant effects on the European site(s). Screening matrices provided in the regulations must be attached to the report.
  - *Stage 2:* If the conclusion from Stage 1 is that likely effects exist, an appropriate assessment has to be documented. The report has to include evidence of the project's impact on the integrity of the sites, a description of mitigations considered, a schedule with the timing of said mitigations, cross references to consent development obligations that secure the mitigation measures, a statement of residual effects that may impact integrity of the site and evidence that the applicant has consulted and regarded comments from consultees. Integrity matrices provided in the regulations must be attached to the report.
  - *Stage 3:* An assessment is required which identifies and measures the alternatives considered. This must show beyond reasonable scientific doubt that the project will not affect the integrity of a European site.
  - *Stage 4:* If the project has proven that there are no alternative solutions or the effects cannot be reduced or avoided, the project can obtain the required consent if it is proven that it must be carried out for imperative reasons. This applies in cases where the development has IROPI status (Imperative Reasons of Overriding Public Interest), where compensatory measures must be undertaken.
- Sites of Special Scientific Interest (SSSI). These sites are protected by law to conserve their wildlife and geology. Depending on where they are located the procedure to get a consent for undertaking work in these places varies; in the case of STL, Natural Resources Wales was responsible for issuing the permit if the area was considered SSSI. NRW provides specific guidelines on what needs to be done to keep the site protected depending on the characteristics of the development. The same occurs for protected areas under the European law [26].
- A Health Impact Assessment (HIA). An HIA is defined as "A combination of procedures, methods and tools by which a policy, programme or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population" [33]. The process to obtain an approved HIA is in stages similar to other permits mentioned before. In Wales, an HIA is provided by the Wales Health Impact Assessment Support Unit (WHIASU), and they offer guidance and advice to whomever is undertaking an HIA [34].

- Other regulatory regimes and impacts that are outside of the actual project itself.

It is also specified that the applicant must review that all the consultees' requirements are covered in the Environmental Statement in order to obtain the DCO and the Marine Licence.

4) Other Permits: As mentioned before, in order to get the DCO the developer must state what other permits have been requested along with the DCO and the Marine Licence. Also, the Secretary of State must be informed on how the other permits are moving forward. The general entities that must be considered are: -

- Safety Zone Scheme [35]: This scheme applies to 'territorial waters adjacent to England, Scotland and Wales and to the waters in the UK Renewable Energy Zone'. Every offshore renewable energy installation (OREI) must apply for a Safety Zone Scheme permit. The safety zones are proposed to minimise disruption to users of the sea during construction, decommissioning and maintenance of a project's life. The application has to be made to the Maritime and Coastguard Agency's Navigation Safety Branch. For tidal and wave devices the application must include: a description of the installation; information on anchor spread and penetration of devices; the extent of the movement of the device; the proposed location of moorings and power cables; for tidal devices, tidal stream rates in the area of installation; for wave devices, range of sea states of operation; basic information, with drawings, about the installation; where safety zones are being applied; the location of sub-sea cables; the location of electric cable connections and offshore platforms housing connection equipment; details of any navigational marking that has been specified for the installation; details of marking and lighting of individual devices within the installation; an appropriate navigational risk assessment; and an up to date vessel traffic survey.
- Crown Estate Land [36]: In order to build a marine energy project, a lease must be requested from the Crown Estate, who own the seabed in the UK. Agreements can be made between both parties depending on the project.
- Local Planning Authorities [37]: Depending on the location, these entities must be recognised and contacted. Information about the project must be given and all permits required accordingly must be requested. These include but are not limited to transportation of abnormal loads, temporary road traffic orders, street works, and building regulations.
- Local port or harbour authority: Depending on the location the regulations vary and the authorities must be contacted to determine whether a permit is necessary or not depending on the project scope.
- National Grid: To determine how the connection to the grid will be made depending on the size, location and the intended agreement with the transmission company.

D. Smaller Projects

When there is a plan to develop an offshore electricity generation project with a size between 1 and 100 MW, planning permission is required and is given by the Secretary of State. The Department of Energy and Climate Change (DECC) manages the application with a similar procedure to the one of the DCO but on smaller scale. Besides, a marine licence is required and given by the Marine Management Organisation (MMO). Other permits required must be obtained depending on the relevant consultees recommendations [37].

For projects smaller than 1 MW a consult must be made to the respective marine authority and the MMO to determine what procedures to follow in regards to the specific characteristics of the development [38].

IV. Marine Energy in Costa Rica

In order to explain the procedures to follow once a marine project is proposed for development in Costa Rica, it is necessary to understand how the electricity market works there.

A major public company -ICE- is in charge of the planning from a broader point of view. They generate, transmit and distribute electricity around the country. There are smaller public companies that generate and distribute as well, but their input to the grid is not relevant enough when compared to the power plants operated by ICE [13]. Finally, private investors can also be part of the system but they are limited (at the moment) by the amount of electricity that ICE provides, since their contribution is limited by a percentage (15%) of the total installed in the country, and the capacity of each private plant cannot surpass 20 MW [39].

Considering that the private participation in the electricity market is limited by ICE's own development of new projects and the size of a proposed power plant, this paper will focus on how the ICE (from now on 'the developer') would approach a new marine energy project of any scale and what changes might be required in procedures in order to make this happen.

A. Current procedures for electricity generation projects

Similar to any other renewable energy project, the developer has to make a feasibility study and determine the scope of the project they want to develop. Once this is done, permits and studies need to be requested. The basic steps that need to be followed to begin a project are described below.

To start, an Environmental Impact Assessment has to be created if the Secretaría Técnica Nacional Ambiental (Environmental Technical Secretary, SETENA) dictates so, depending on the information provided in a Document of Environmental Evaluation (D1) [40], which, for a renewable energy project, must include: basic engineering, geology, a quick archaeological study of the project area; basic characterisation of the project area and its influence areas; climate data of the project area; and an evaluation using a matrix with marks that show: consumption and effects of the water, energy, and flora and fauna; negative and positive impacts on air, soil and humans; and other risks [41].

The D1 has guidelines that allow the developer to complete an electronic form appropriately depending on the project that is being proposed. The electronic form indicates with colours when the impact is considered significant depending on the mark that is obtained when the guidelines are followed. If the colour of the mark changes, the developer can detail on a referenced annex the environmental measures that they will take to mitigate the impact for each action that needs it. Depending on the final result and impact mitigation, SETENA determines a category for the project: low impact, moderate low impact, moderate high impact and high impact.

If a project is considered as moderate high impact (and no regulation plan) or high impact, SETENA will have four weeks to inform the developer the final classification and what type of Environmental Impact Assessment tool they must follow. Otherwise, SETENA has 10 days to inform the developer if their project is environmentally viable. All electricity generation projects are considered as high impact projects, therefore the developer must prepare an EIA [13].

SETENA has three instruments that have to be used to create the EIA: Estudio de Impacto Ambiental (Environmental Impact Study, EsIA), Plan-Pronóstico de Gestión Ambiental (Plan-Forecast of Environmental Management, PPGA) and Declaración Jurada de Compromiso Ambiental (Sworn Declaration of Environmental Commitment, DJCA). All electricity generation projects must use the EsIA and the PPGA as part of the EIA. The EIA must include [42]: -

- A front page, index and list of authors.
- An Environmental Impact Declaration:-
  - Technical summary of the study.
- An Introduction.
- General Information, detailing: -
  - The developer's representatives.
  - The Professional team that created the EIA.
  - The Reference terms.
- A project description including details of : -
  - The location with maps and plans.
  - The relevant politic - administrative location.
  - The technical justification of the project and options.
  - The agreement with urban planning for the use of land.
  - The estimated project and influence areas.
  - The project phases and their respective activities.
  - The construction stage description.
  - The operation stage description.
  - The closing stage description with details of activities required for the closure.
- A Physical Environment Description, including specific site on the: -
  - Geology.
  - Geomorphology.
  - Hydrology with details of superficial and underground waters
  - Natural threats.
  - Air quality.
  - Soil.
  - Climate.
  - A Biologic Environment Description including an introduction with a biological description and details of the terrestrial, marine and water environments.
- A Socioeconomic Environment Description, including An introduction and description of methodology and important concepts and details of: -
  - The present use and ownership of land in nearby sites.
  - The population characteristics.
  - Road safety and conflicts of vehicular traffic.
  - Available emergency services.
  - The basic services.
  - The local perception on the project and its impacts.
  - The community infrastructure.
  - Any archaeological sites.
  - Any historic and cultural sites.
  - The landscape.
  - Maps of socially sensible locations.
- Environmental Diagnosis including: -
  - The methodology used to identify the project impacts.
  - A project description and options.
  - Details of elements that cause environmental impacts.
  - Details of any environment factors susceptible to impact.
  - Details of the environmental impacts that the project and its options will cause.
  - A selection of project options from at least three options.
  - A map of integral environmental susceptibility compared to the components of the project.
- Impact Assessment and Corrective Measures, including: -
  - A qualitative and quantitative analysis of impacts using the matrix given by SETENA.
  - Details of prevention, mitigation, control, avoidance and/or compensation measures of impacts considered in the physical, biological and socioeconomic environment.
  - An analysis of the cumulative and synergistic effects of other projects in construction and operation.
  - A synthesis of environmental impact assessment.
- PPGA, including: -
  - Details of practice and actions that must be done to prevent, control, decrease or compensate negative impacts and maximise positive impacts.
  - Details of the Project Organisation.
  - A summary of the PPGA with SETENA's guidelines.
  - A monitoring plan.
  - An execution chronogram.
  - A post operation environmental recovery plan.
  - The environmental Management costs.
- Risk Assessment and Contingency Plans, including: -
  - An environmental risk sources by stage.
  - An environmental risk assessment.
  - A contingency plan.
- Environmental Quality of the project and influence areas (direct and indirect), including: -
  - A general analysis of the environmental situation in the project and influence areas.
  - A forecast of environmental quality of the project and influence areas from implementation.
  - A summary of the project's environmental obligations.

- Bibliography References and annexes.

Details of all the sections required are specified in the guidelines provided by SETENA, including the matrix evaluation methods and format.

The EIA must be presented at the project location's City Hall for reference, the document showing the received signature must be given to SETENA along with the EIA when the application is ready for submission. A fee must be paid when the application is submitted.

SETENA has a maximum of 12 weeks to determine a resolution but in reality this process might take up to 24 months! During revision SETENA can ask the developer to modify and/or add information to the EIA in order to make the project feasible. Once the project is approved, SETENA will announce the preparation of the DJCA and will determine a warranty deposit value for environmental fulfilment that can go from 1% to 4% of the total cost of the project depending on a case by case basis [13].

After the EIA has been delivered and SETENA has given an authorisation for the project to move forward, the developer must request an authorisation from the Autoridad Reguladora de Servicios Públicos (Regulatory Authority of Public Services, ARESEP) to provide the public service of electricity generation. The Directorate of Energy Services is in charge of handling this request where the developer must show the environmental viability resolution given by SETENA, information of the developer, maps and location of the project. After all the documentation has been validated, the Directorate will inform the developer and will call for a public audience through the Directorate of User Protection where anyone can attend and oppose to the project if they need to. In the case where someone doesn't have the resources to provide a technical study that justifies their concern, ARESEP will provide a technical expert to make the study as requested by the user [43].

Once the audience is finalised, acts and reports are given to the Executive Board who have up to two months to give a resolution where all parties' opinions have been considered.

The tariff for selling electricity is also determined and controlled by ARESEP and its Directorate of Energy Services. The developer must present to the Directorate an application that justifies technically the cost request, a public audience will be called and 30 days after the event the ARESEP can dictate their resolution. This application can be made at the same time with the Concession previously described.

Finally, construction permits need to be obtained in order to begin with the development of the project. In Costa Rica, the regional governments – municipalities – are the ones in charge of collecting the tax equivalent to 1% of the construction cost for the projects made under their jurisdiction. In order to obtain this construction permit, the developer must validate the maps and plans with different authorities depending on the characteristics and location of the project. In general, for renewable energy projects the developer must contact the Colegio Federado de Ingenieros y Arquitectos (Federate College of Engineers and Architects, CFIA), the Ministry of Public Works and Transportation, the Health Ministry, Municipality, the Fire Brigade, the Costa Rican Institute of Tourism, and any other relevant consultee that the entities might recommend [13].

When all the relevant bodies have approved the plans, the developer must go to the municipality that corresponds to the project and provide this approval, the SETENA approval, pay the tax and a soil use permit given by the municipality along with the plans approval which must follow the regional regulations and local urban plan. In order to commence the construction, the developer has to pay an annual patent for operation that varies depending on the location.

Moreover, to start operations the developer has to request a sanitary functioning permit given by the Health Ministry which is valid for 5 years. To apply for the sanitary permit, the developer has to submit the application along with the soil use permit, the location permit given by the Ministry of Health, the authorised plans (by all required entities), environmental viability permit given by SETENA and any other document that might be requested depending on the situation [13].

Then, when all these permits are obtained, unless otherwise requested, construction can begin.

1) *Marine Licence:* At the moment, there is no specific procedure in Costa Rica to obtain a Marine licence for the use of renewable energies. Procedures and permits are described for the construction of ports or developments near the coast, there is a law for the maritime terrestrial development, but there is no reference to marine energy projects [44]. In the CFIA's Construction Projects Sub-classification Manual 2014 [45] it is stated that projects in the marine area are required to have a regulation plan that includes the scope of the project, there is no such thing for marine energy yet. However, the reference for ports, marines, piers, fish receivers, and others, where the Insituto Nacional de Vivienda y Urbanismo (National Institute of Housing and Urbanism, INVU) and the Instituto Costarricense de Turismo (Costa Rican Institute of Tourism, ICT) are the ones in charge of dealing with the plans authorisation, can be used.

V. Lessons Learned - Comparison

After describing and understanding the UK's and Costa Rica's generation projects permits and procedures requirements it is possible to compare both scenarios and learn from both situations. Costa Rica has experience in determining and planning for a variety of renewable energies in the electricity matrix and the UK has the knowledge required for marine energy as leaders in research on the subject. Where it comes to the procedures the main differences are:

A. *Centralised system*

The UK has a more centralised system and more clear procedures for developers to follow depending on the type of project that wants to be created. Costa Rica's bureaucracy requires the developer to contact different entities and determine on their own what is required for a specific case. When it comes to marine energy project, it would be useful to have a specific entity in charge of giving the guidelines for a project of its kind.

The UK has managed to create NSIP's regulations allowing the developer to deal mainly with one entity instead of bouncing back and from one office to another avoiding repetition of documents.

Costa Rica should implement a more 'open to public' approach, similar to the UK's, where developers can find the information they need online with clear links to the entities that need to be consulted, procedures and contact information.

B. Marine Licence procedure

The UK has very clear divisions and types of permits required depending on the size of an offshore (and onshore) energy project. Costa Rica needs to create a plan or guideline for projects of this type on any size if a proposal comes at some point, since at the moment the lack of one would immediately stop any intention on building a new marine energy power plant. Previous plans made for ports, marines or even the ones used for the water concessions can be used as reference.

A marine lease method must also be established with construction, maintenance, operation and closing requirement procedures well specified. The Safety Zone Scheme used by the UK can be also used as a reference for the other users that will be affected by the project. Different entities and users involved in the use of the resource should gather a data base to determine what areas are permitted to use for marine energy.

C. Environmental Impact Assessment

Even though the methods in both countries are different the final result is very similar. Considering the information available without having a specific project it is noticeable how the details on what an EIA must have are clearer in the Costa Rican legislation, which is probably one of the aspects that put them in the top list of environmentally conscious countries. The main difference would be the length of the procedures, where the time limits given by SETENA are not always fulfilled, therefore the process inside the organisation must be improved to ease up the practice.

Once resources have been determined, SETENA should include details of the different stages of a marine power plant to be included in the EIA for the specific case. The EIA should work jointly with the Marine Licence. Requirements should adapt to different technologies since wave, tidal, offshore wind and even OTEC have different impacts.

D. Electricity companies

The legislation in the UK allows for private developers to propose new renewable energy projects giving more freedom and more possibility of projects in the market. The law in Costa Rica limits the private sector to get involved and leaving one entity to make all the decisions in regards to what projects should be done. A change in legislation might allow for smaller developers to create new projects and diversify the electricity matrix management. The fact that ICE is a regulator and participant at the same time creates a conflict of interests in the electricity sector growth.

E. Public involvement

In Costa Rica the involvement with the public is decided by the developer on how much they intend to engage with the community and then the people's opinions are considered once the EIA is already made. ICE has always considered the people's involvement in their projects and how to benefit the community around their projects in order to have more acceptance and make the projects go smoother. In a marine energy project as the one proposed for the STL, the company involved the community from the early stages as is required by legislation and their opinions are considered for the approval and analysis of all the documents presented by the developer.

Costa Rica could implement this system, where all documents, including communication between entities, are available to everyone online and in physical form if they are requested, so the community can feel they are part of the development and not just affected by it. This method makes the process more efficient as well because if there are technical studies suggested by interested parties that can delay/stop a project, they would be considered at early stages and not when the EIA has been approved. The UK could also consider implementing ARESEP's methodology where an interested participant cannot afford a technical study, the cost is covered by the authority.

However, it is important to remark that a study showed that over 80% of people strongly agree that Costa Rica should invest in renewable energies [46], whereas in the UK only around 50% feel that way [47]. Therefore, the methods in each country must adjust to their respective population. It is agreed that in both scenarios that the benefits to the people must be informed to the community for a project to move forward.

In Costa Rica a preliminary survey determined that 45.5% [46] of the population confirmed that marine energy should be used more to produce electricity. This percentage shows that, in the future case where developments of this kind are proposed, the community might be open to support them.

F. Tariffs

Even though it was mentioned before that in Costa Rica the private sector should be more involved in the electricity generation market, the tariffs might contradict this statement. Since in Costa Rica a public company is the one that produces and manages the electric system, the financial gain from projects are not required to be as high as the one a private company would look for. In the UK, using STL as a reference, a project might not be developed if the tariffs are not friendly enough with the user and good enough for the developer to be financially feasible [24]. A balance must be found between both methods where the cost to the final consumer will not be too high and that the project is attractive for the developer to make it. In the case of marine energy specifically, it is necessary that the technology advances so the costs can be competitive with other more mature renewable sources and fossil fuels.

G. Tendering

Tendering is used in both countries, though in different ways. In Costa Rica it is offered only for generation projects where the limit is 50 MW and the project is proposed by ICE or 20 MW if a private company wants to get involved on their own. However, transmission and distribution is already settled by the public companies in charge depending on the location. Again, the limitations given by the law doesn't allow the private sector to get involved as it wants but as it is decided by ICE.

The UK's system allows different companies to get involved in different parts of the electricity distribution and tendering is offered by the company that needs to get the electricity to the final user.

VI. Conclusions

The UK's procedures allow developers to follow instructions in a more efficient way because a central body entity manages the application and indicates what external consultees must be contacted. Costa Rica could use a similar approach reducing the bureaucracy that the process requires.

A marine lease and licence procedure for Costa Rica needs to be created so it is possible to propose new marine energy developments. The Safety Zone Scheme, Marine Licence and Marine lease from the Crown Estate can be used as reference to determine the required guidelines. The EIA manual should be adapted to the different marine technologies and permits for the license and the EIA should work jointly.

Social involvement in the development of energy projects is necessary. A combination of both approaches would create a better system, where the people in the UK are more aware and supportive of the benefits of using renewables and the involvement of the audience in Costa Rica in the early stages might reduce delays of almost consolidated projects.

Finally, Costa Rica's market managed and used by the same company stalls the electricity matrix and its growth, a legislation that allows more involvement of the private sector could ease the construction of smaller scale projects, and allow for tendering even in transmission lines giving the consumer different options. When the economy of scale, the resource characterisation and the technology for marine energy make Costa Rica a feasible location for this type of projects, smaller developers may be interested in participate and maybe even provide electricity to isolated coastal regions.

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