EnFAIT

Date of issue: February 2019

Deliverable ID: D 3.4

ENFAIT
ENABLING FUTURE ARRAYS IN TIDAL

Array Commercialisation Strategy

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement number 745862.

Document History

DOCUMENTATION SHEET	
Project Acronym	EnFAIT
Project Title	Enabling Future Arrays in Tidal
Grant Agreement number	745862
Call identifier	H2020-LCE-2016-2017
Topic identifier	LCE-15-2016
Funding Scheme	Research and Innovation Programme
Project duration	60 months (July 2017 – June 2022)
Project Officer	Dana Dutianu (INEA)
Coordinator	Nova Innovation Ltd
Consortium partners	Nova Innovation, ELSA, SKF, University of Edinburgh, Mojo Maritime, Wood Group, HMK, RSK Environnement, ORE Catapult
Website	www.enfait.eu
Deliverable ID	D 3.4
Document title	Array Commercialisation Strategy
Document reference	EnFAIT-EU-0037
Description	Report setting out the benefits of tidal energy and providing advice on how to build the market.
WP number	WP 3
Related task	T 3.4
Lead Beneficiary	Wood Group
Author(s)	David Cunningham Wood Plc
Contributor(s)	Alan Mortimer Wood Plc
Reviewer(s)	Robert Clayton and Andrew MacGillivray, Wood Plc. Garry Connor and David Mack-Smith, Nova Innovation.
Dissemination level	PUBLIC - This document in whole, or in part, may be used in general and public dissemination.
Document status	Final
Document version	1.0

REVISION HISTORY					
Version	**Status**	**Date of issue**	**Comment**	**Author(s)**	**Reviewer**
0.1	Draft	13-Dec-2018	Initial draft for review	David Cunningham	Robert Clayton
0.2	Draft	23-Jan-2019	Minor edits	David Cunningham	Alan Mortimer
0.3	Report	25-Jan-2019	Minor edits	David Cunningham	Andrew MacGillivray
1.0	Final	27-Feb-2019	Version for issue	David Cunningham	Gary Connor

Contents

1 The Project

1.1 Introduction

A Funding Grant was awarded from the European Union's Horizon 2020 research and innovation programme in January 2017 to demonstrate a grid-connected tidal energy array at a real-world tidal energy site, propelling tidal energy towards competing on a commercial basis with alternative renewable sources of energy generation – Enabling Future Arrays in Tidal (EnFAIT). This was in response to the call *LCE-15-2016: Scaling up in the ocean energy sector to arrays* to generate significant learning through demonstration of cost-effective tidal arrays.

This document is produced to estimate the potential benefits of tidal array technology and the impact on target markets, considering economics, lifecycle assessment, infrastructure and logistics. It is to provide advice on capacity building and planning through to market assessment and policy design. It is to be submitted to satisfy deliverable D3.4 of the EnFAIT project and to be also made available for public dissemination.

2 Array Commercialisation Strategy – Executive Summary

2.1 Introduction

The key enabler to stimulate installation growth for emerging new energy systems is the provision of a supportive, stable and cost-effective regulatory system. The current levelized cost of energy (LCOE) for tidal stream power is substantially higher than that of wind and solar. If the sector is to realise its true potential from this vast, predictable, and energy dense resource, it requires an appropriately supportive regulatory regime. The renewable power sector has witnessed cost reduction of 85% and 51% for solar and wind respectively over the last 10 years[1] based upon progressive government backed regulatory structures. There is no fundamental reason why the tidal stream sector cannot achieve similar cost reduction to enable commercialisation of this sub-sector.

2.2 Regulatory Drivers

To assess the optimal route of commercialisation for the tidal sector, Wood has reviewed the different types of regulatory regime and subsidy mechanisms, their attractiveness and inherent risks, which have been set out in Section 3.

The success of feed-in tariff mechanisms, green tradeable certificates and tendering mechanisms has been the key driver stimulating the market adoption of wind and solar power generation. With an effective regulatory policy in place, it is highly probable the tidal stream market could also develop to a scale at which it provides a substantive and cost-effective contribution to the electricity generation mix.

[1] Source data: BNEF.

In summary, the main aim of a tidal stream policy mechanism includes:

- Energy independence and a reduction in emissions of greenhouse gases from fossil fuel combustion.
- Encourage the development of non-intermittent and predictable emission free power sources to stabilise grid operation.
- Accelerate the adoption of tidal stream technology by leveraging economies of scale, consequently delivering a lower levelised cost of electricity supply.
- Promote distributed power generation as a means for reducing network costs and increasing reliability/redundancy while stimulating market competition.
- Provide sufficient subsidies to stimulate tidal stream growth, while avoiding excessive profits for developers and owners and also providing value for money for consumers of electricity.
- Provide investor security, transparency/simplicity, cost effectiveness and the ability to drive innovation, jobs and wealth.

2.3 Value Creation from Tidal Stream Development

In Section 4.1 we provide high level analysis of the gross value added (GVA) benefits to be gained from supporting the tidal stream industry. Taking the UK as an example, estimates developed by the Offshore Renewable Energy Catapult predict a net cumulative benefit to the UK of €1.6 billion GVA by 2030, consisting of €1.8 billion from the domestic UK market and €1.3 billion GVA from exports, offset by €1.5 billion of regulatory support. It is clear from the cost benefit analysis that regulatory support for tidal stream sector should be a priority, particularly for regions in which rich tidal resources are combined with a need to regenerate coastal communities.

EnFAIT

3 Regulatory Policy

This Section provides an overview of the different types of regulatory regime and subsidy mechanisms. The attractiveness and inherent risks to stimulate project development is also discussed.

There are four broad policy mechanisms for encouraging the development of tidal stream generation:

- Fixed Feed-in Tariff (FiT) for every unit (MWh) of production which may also include a portion of wholesale electricity price exposure.
- Green certificates issued for every unit (MWh) of production which may also include a portion of wholesale electricity price exposure.
- Tax allowances and grants for the developer/owner to offset the capital costs, which may also include green certificates or a FiT mechanism.
- Competing bid and auction system which may involve the award of FiT, green certificate mechanism or contract for difference (CfD)

3.1 Early Government Policy

In response to the signing of the Kyoto Protocol in 1997, the first renewable energy subsidy mechanisms were launched, with governments initially favouring FiT based regulatory structures due to their simplicity and appeal to developers and investors. FiT policies were highly effective in driving installation growth in countries such as Germany, Spain and Italy. However, governments failed to keep FiT subsidies in step with supply chain cost reductions, particularly in the period from 2009 to 2013, which resulted in abnormally high commercial returns for developers and momentous growth in installation levels. As a consequence of this costly and overheating market, governments enacted untimely intervention and, in some instances, retroactive changes in policy (e.g. in Spain and the Czech Republic) resulting in boom and bust market dynamics.

The initial failure of FiT based mechanisms led governments to consider the adoption of competing bids and auctions as an alternative cost-effective method for stimulating renewable energy development. However, early adopters of the competing bid and auction mechanism also experienced unexpected consequences from government policy. In South Africa developers took advantage of price declines in the lengthy period between the granting of a tariff award and the start of the procurement and construction process. Despite these unexpected consequences of government policy, legislators have become more adept in structuring and streamlining regulatory processes to reduce the opportunity for developers to generate anomalous financial returns at the expense of the consumer.

3.1.1 Recent Developments

Increasingly we are witnessing governments using a competing bid and quota mechanism combined with the award of a FiT which may include a CfD[2]. Additionally, there has also been a move away from green certificates towards FiT structures which are also subject to meeting annual quotas and / or competing

[2]FiTs with a contract for difference (CfD) prevents the over-compensation of generators, in the event of the wholesale price exceeding the strike price. In the event of this occurrence generators must repay the difference back to the applicable regulatory body.

bid mechanisms. The reduced popularity of tradeable green certificates has been driven by governments seeking to reduce the ability of developers to 'game' the market and take opportunistic profits where there are imbalances in the wholesale electricity supply. We see evidence of these regulatory changes particularly in the mature markets of Europe (e.g. Germany, Italy, Spain, France and the UK).

Preferential low interest rate loans, grants and tax allowances (both production and capex based) have also fallen from government favour due to government austerity and the high-profile corporate collapse (e.g. Solyndra and Beacon Power) of some projects and technology providers. Essentially, responsibility for these investments rests with government bodies who may not be in the best position to make informed judgments into project and technology viability.

Although there is growing government support for quota and competing bid mechanisms it is evident that it clearly favours the least-cost supplier rather than considering a holistic approach to decarbonising and balancing the grid. Current government policy in the UK for example, has led to an imbalance in the mix of renewable technologies dispatching power to the grid, with wind and solar dominating new capacity additions. To balance grid frequency and meet peak demands and provide more effective methods to decarbonise power delivery support should be provided for alternative non-correlated (to wind and solar) renewable power systems such as deep geothermal, tidal energy, sustainable biomass and renewable heat-based systems.

For the tidal stream sector to flourish it will initially require a carved-out access to a subsidy mechanism which allows developers to reach financial close alongside private investment. The current cost of tidal stream is circa 6 times the cost of wind and solar; however, with learning and economies of scale it would be reasonable to assume costs would fall once the technology has matured to provide more balance and diversification risk reduction for power delivery.

Table 1 summarises Wood's assessment of the attractiveness of the four main regulatory mechanisms for promoting the adoption of renewable energy generation.

Table 1: Summary Evaluation of Different Support Mechanisms for Renewable Energy Development

	Investor security	Simplicity	Proven success	Cost Effectiveness	Promoting a mix of technologies
Feed-in tariff	✓✓✓	✓✓✓	✓✓✓	✓✓	✓✓✓
Quota system	×××	×××	×××	×××	×××
Investment subsidies/tax breaks	✓✓	✓✓	✓	✓	✓✓
Competing bidding/Auction	×	✓✓	✓✓	✓✓✓	×××

In the following sections we provide more details of different types of regulatory regime and subsidy mechanisms both direct and indirect.

3.2 Review Regulatory Support Mechanisms

3.2.1 Feed-In Tariff Mechanism

FiTs offer a secure long-term electricity sale agreement, generally through a government owned body/utility, network operator or retailer.

Regulatory bodies can administer FiTs in a number of different ways. Historically, the award of a FiT involved a developer taking a project through the consenting and permitting process in order to access the applicable subsidy. However, FiTs are now largely awarded through an auction system. FiTs are seen as a temporary measure until such times as renewable energy systems can reach grid parity. To this end, tariffs in Europe have dropped by around 80% since their peak in 2008, reflecting the fall in capex costs for wind and solar.

FiT schemes are generally thought to be the most attractive incentive mechanism from the perspective of developers and investors. This is because long term revenues for a system can be modelled with certainty to create a bankable financial model for a project. This risk associated with a FiT supported project is low; however, as with any power sale agreement, it is important to consider the credit worthiness of the organisation offering the FiT and the stability of the political environment.

In some cases, FiTs have been retroactively altered to affect existing projects. In early 2014, the Greek government retroactively cut the solar FiT. In late 2013, several Australian state governments proposed retroactive cuts to FiT schemes, but these were withdrawn due to adverse public reactions. Retroactive changes to FiT schemes are rare and in general, government FiT schemes are seen as a secure and bankable long-term income for renewable energy projects.

3.2.2 Investment Based Mechanisms

Investment-based mechanisms are commonly applied to offset an element of the capital expenditure against a developer/owner's tax (e.g. corporation and value added taxes) which are commonly known as tax credits. Typically, the subsidy is dependent on installation costs (and therefore capacity) rather than on the annual electricity production.

Tax allowances also come in the form of production tax credits for the developer/owner based on production revenue (e.g. $/kWh). The US Production Tax Credit (PTC) has operated based on offering credits which are available to forward with a project if they are able to build a business case and find and secure a power purchase agreement. The US investment and production tax credits have been successful in their ability to drive investment and renewable energy deployment. Importantly if this regulatory mechanism keeps in step with supply chain LCOE reductions it can provide better transparency in the merchant pool price by avoiding the subsidy at the point of consumption. Additionally, the consumer is better protected from paying higher utility bills with the subsidy met by larger commercial corporate entities.

3.2.3 Capital Grant Schemes

Grants and soft favourable loans have been commonly used to promote the development of nascent renewable energy generation technologies and to assist in project development where there are insufficient local funding sources. Germany has notable success with the likes of state KfW Bank which is mandated to invest in renewable energy projects in Germany and via its international offices. The US has also offered cheap loans into solar PV sector specifically targeting original equipment suppliers (OEMs) with innovative technologies. In the UK, tidal stream projects have benefited from regional and local funding sources co-investing alongside private investment.

3.2.4 Innovation Based Subsidy Mechanisms

To incentivise investment in nascent renewable technologies which are currently unable to compete with mature wind and solar solutions, some governments are considering a hybrid model involving a combination of revenue support with investment tax credits. Other considerations include the use of corporate Power Purchase Agreements (PPA) which allows the power off-taker (or third party) to receive tax relief. If these regulatory mechanisms are legislated it would provide an ideal route for innovation and investment in addition to avoiding further distortion of the merchant pool electricity price.

3.2.5 Quota Mechanisms

Quota systems can be implemented in a variety of methods. The main principle is that the government compels producers, providers or consumers of electricity to have a defined share of renewable electricity in its generating mix. Quota systems are also known under 'Quota Obligation' or 'Renewable Portfolio Standard' (e.g. USA). While the quota is imposed, the price is set through competition between different project developers and also different technologies. A quota system does not need to be combined with other support tools. However, quota obligations are commonly combined with a Tendering and/or Tradable Green Certificate mechanism.

3.2.5.1 Tendering

Under the auspices of a tendering scheme, developers submit projects and indicate the wholesale price they would like to receive for the produced electricity. The entity with the lowest production costs will be best positioned to request the lowest price and will finally acquire the order. The project developer enters a contract which guarantees that the electricity will be bought over a defined period of time (e.g. via a power purchase agreement). The difference between the current market price and the contracted price in the power purchase agreement represents the value that needs to be financed either by a public promotion fund or a levy on the electricity bill.

For large scale installations, tendering has a major drawback. In order to be able to participate in bidding procedures, a project incurs considerable planning costs. Planning costs in the case of non-acceptance of a project are non-refundable which undoubtedly reduces the attractiveness for developers and investors. To alleviate the initial development risk a limited number of governments (e.g. Netherlands) have completed certain planning and development activities (e.g. environmental impact assessment, geotechnical surveys etc) to mitigate the potential for a failed bid.

Administering of tendering schemes is complicated and relatively expensive. For this reason, it is usually reserved for multi-megawatt commercial installations rather than small scale renewable energy projects.

3.2.5.2 Tradable Green Certificates (TGC)

TGC resemble the Tendering mechanism. Instead of entering a PPA, in a TGC scheme, prices are re-set on a frequent basis, often reflecting changes in the cost of energy procurement. Due to market forces in supply and demand of TGCs, and in the level of compliance price, certainty is lost and therefore developers/investors are exposed to market risk.

A typical TGC scheme is best described by the following scenario. Governments set an increasing quota for renewable energy supply. Either the producers, wholesalers, retailers or consumers are obliged to supply or consume a certain percentage from renewable electricity sources. For each unit of renewable electricity (kWh or MWh), a certificate is generated and issued to the producer. This certificate serves as proof that renewable electricity was delivered into the grid.

Certificates can be obtained by the following paths:

- A supplier owns generation plants.
- Certificates can be bought from other generation plants.
- Certificates can be bought from a broker who acts as an intermediary.

In order to enforce the scheme, penalties are implemented to ensure compliance to the level quotas mandated. Penalties need to be considerably higher than the expected value of certificates in order to motivate quota compliance. If penalties are set too low, they might have a price controlling factor which limits the economic driver for decarbonisation. By setting a quota which increases over time, the demand for certificates also increases over time. It is left to the open market to deliver the certificates. The value of certificates will determine if it is profitable for generators to set up a generation plant or not. In case demand exceeds supply (meaning less renewable electricity is produced than set in the quota), the value of certificates will rise until further investors set up generating assets. The value of the certificates increases until a sufficient number of investors see an optimised return on investment.

An underlying aim of this support scheme is that the target should be fulfilled at the lowest possible cost. Technologies with the lowest generation costs will be able to operate under a TGC scheme. Ultimately, this will lead to a homogenous energy portfolio of technologies and therefore TGC schemes are not deemed to be supportive of novel and emerging technologies.

By setting a quota, there is no incentive to produce more than the quota stipulates. A quota therefore acts like a cap mechanism which avoids additional production of renewable electricity. The cost of operating in a TGC is relatively expensive and therefore does not favour individuals and local empowerment. In order to include emerging technologies in a TGC scheme, technology specific quotas would need to be set. However, this would increase the cost and complexity of the scheme further with the potential for illiquidity for these special certificates.

3.2.6 Indirect Mechanisms

There are a number of indirect financial support mechanisms potentially available to tidal stream developers. The most influential mechanism for driving de-carbonisation of the global economy will be through the recently signed Paris Agreement. At the heart of the agreement are Nationally Defined Contribution (NDCs) where signatories to the agreement provide emission pathway reductions to meet the objective of keeping country allocated carbon budgets below a 2-degree warming scenario. The compliance period begins in 2020 on a rolling 5 years basis.

The consequences of this mechanism should see the acceleration of energy consumers moving from fossil fed system towards renewable based electrical systems covering transport, heat and industrial processes. Consequently, the cost of carbon-based fuel will increase, raising electricity pricing and by doing so providing the opportunity for higher cost renewable technologies to gain market share.

3.3 Power Purchase Agreement

The presence of a PPA effectively de-risks projects[3] by ensuring availability of a secure revenue stream. Currently, grid-connected renewable energy projects are largely dependent on policy support initiatives such as those highlighted in Section 3.2. These incentive mechanisms can be equivalent to a Power Purchase Agreement (PPA), such as a FiT or CfD agreement, or they can be an additional element which complements a PPA in supporting the business case for a project (as is the case with carbon credits, or a capital grant).

Wind and solar cost reduction has enabled grid parity to be reached in many markets (e.g. Chile, Spain, Italy, offshore wind in the North Sea). As a consequence, these projects no longer require any direct government regulatory mechanism to stimulate investment. However, owners and financiers have a preference to take a PPA mechanism to avoid the volatility of market-based wholesale pricing. Developers may also arrange a PPA structure due to regulatory barriers and costs associated with selling power in the wholesale markets.

3.4 Optimal Policy Mechanism for Tidal Energy

For the tidal energy sector to flourish the optimal regulatory mechanism could be a carved-out policy specifically for technologies which are capable of reducing supply side imbalances. Despite the success of FiT based mechanisms to actively reduce LCOE in wind and solar, it is unlikely governments will

[3] Subject to the credit worthiness of the power off-taker

pursue this route due to the popular mis-conception that consumer utility bills will be negatively impacted. However, if the FiT mechanism included corporation tax-based capital or power off take allowance, this could allow large profitable business entities to decarbonise their power requirements while increasing their socially responsible investment practices.

4 Tidal Stream Market Entry and Benefits

The bulk of the current tidal industry is represented by tidal turbine original equipment manufacturers (OEMs) developing own projects (rather than third party supply) to demonstrate viability. All tidal OEMs are currently at the pre-commercial demonstration phase. However, planning consent has been granted for multi-MW projects in Europe and Canada. A limited number of technology developers have tested devices at multi-MW scale generated significant amounts of electricity. These include Orbital Marine Power, SIMEC Atlantis Energy (with their own and Andritz Hydro Hammerfest and Marine Current Turbines devices) and Nova Innovation (with smaller scale devices). Each of these companies has demonstrated the potential for tidal energy to be reliably generated. However, based on the quoted capital costs of the first arrays implementing these technologies, none of these companies is yet able to offer turbines at an LCoE that offers a sufficient return on investment without significant levels of government support.

The level of global or regional theoretical resource uncertainty[4] combined with the pace of technology innovation provides a wide range of addressable market estimates. The following assessments provide the global extractable resource potential for tidal stream:

- IEA Energy Technology Perspectives (2012) - 101 GW
- Ocean Energy Systems Implementing Agreement (2017) – 300 GW (Combined wave and tidal stream)[5]
- Crown Estate (2012) - UK tidal stream resource 32 GW (error band -30% and +45%)
- Pulse Tidal - 50 GW
- Blue Energy - 50 GW to 100 GW
- Atlantis Resources - 90 GW (near term addressable 25 GW)
- UK Department of Trade and Industry (2005) - 90 GW
- Andritz Hydro Hammerfest - 90 GW
- MCT Siemens – 120 GW
- Minesto – 600 GW

[4] Further details of resource assessment: https://www.energy.gov/eere/water/marine-and-hydrokinetic-resource-assessment-and-characterization
[5] Source: https://www.ocean-energy-systems.org/publications/vision-and-strategy/document/oes-vision-for-international-deployment-of-ocean-energy-2017-/

The International Energy Agency (IEA) Energy Perspectives paper[6] predicts up to 337 GW of marine global capacity with 30% (101 GW) derived from tidal sources and 70% (236 GW) from wave by 2050. Key countries with high resource include island communities such as Indonesia and the Philippines and those with remote, populated areas such as parts of Canada. The cost of generation in isolated areas can be in excess of €500MWh[7] and there is a clear commercial and environmental logic to utilising marine energy to displace diesel generation. This presents a significant opportunity for technology and project developers to address these markets and generate learning rates for entry into the lower priced merchant power markets. On the basis that tidal energy can reduce costs through learning and innovation, the greatest commercial opportunity for tidal stream will be large scale arrays linked to urban population centres which are ordinarily located along major coastal lines. As a result, cost benefits will also be derived from reduced grid infrastructure costs and minimising the need for expensive thermal based peaking plants.

The total extractable resource estimates provided above should be revised to consider the technically and practically extractable tidal stream resource. A number of constraints are likely to impact the ability to fully exploit predicated tidal resources. These include the following non-exhaustive elements:

- Environmental impact
- Competing users (e.g. offshore wind, shipping)
- Geochemical constraints (oil and gas deposits)
- Grid constraints
- Bathymetry
- Wake propagation
- Increased turbulence intensity

Table 2 provides Wood estimates for total, technical and practicably extractable tidal stream resource in the UK, the Rest of Europe and the Rest of the World. These – relatively conservative estimates have been derived from a combination of reports from the Carbon Trust (2011 report) and Black and Veatch (2005 and 2011 reports). We have assumed load factors of 35% (from 32.5% - 45% evidenced from prototypes). We assume that the addressable global tidal stream market could theoretically supply up to 166 TWh per year equal to a net practicably extractable generating capacity of 41.2 GW with a corresponding equipment market value of €117 billion (assuming average selling price of €2.9m/MW). The potential for service-based contracts would be equal to around €17 billion in annual revenues to OEMs and third-party providers on the basis the market becomes fully addressed. Our assumption on service revenues reflect

[6] Source: http://www.powerprojects.co.nz/files/pictures/International%20Vision%20Brochure%20V2.pdf

[7] Source: NREL - http://www.islandedgrid.org/wp-content/uploads/2015/03/Brian_Hirsch_IGRC-Indonesiamarketupdate-FINAL.pdf

the mix of equipment and service revenues currently being achieved in the wind turbine sector (e.g. Vestas MHI).

Table 2: Tidal Stream Addressable Market

Area	Total tidal resource (TWh/yr)	Technically extractable resource (TWh/yr)	Practicably extractable resource (TWh/yr)	Practicable installed capacity (GW)
UK	95	29	20.6	7.2
Rest of Europe	71	17	12.1	4.2
Rest of World	600	120	85.2	29.8
Total	766	166	117.9	41.2
Market Value				€117 billion
	Wood Clean Energy assumptions			
	Black & Veatch – 'Tidal Stream Resource and Technology Summary' report' 2005			
	Carbon Trust - 'Accelerating Marine Energy' report 2011			

4.1 Gross Value-Added Benefits from Tidal Stream

Since the EnFAIT project was originally commissioned, substantial work has been undertaken separately by the UK's Offshore Renewable Energy (ORE) Catapult in understanding the potential economic impacts associated with tidal stream energy[8]. While their report is primarily focused on the benefits of tidal stream to the UK, it provides a comprehensive and useful example of the national economic benefits of this new form of energy, and we summarise some of its key findings here.

The UK is the current market leader in the development of tidal stream energy with 23 technology developers currently active in the UK. Data supplied from UK regional government agencies and reviewed by ORE Catapult estimate circa 1,700 directly employed in the wave and tidal sectors, with approximately £445 million expended to date in the UK supply chain. Subject to a supportive policy environment, the UK is likely to retain competitive advantages from the transferable skills nurtured since the discovery of offshore oil and gas, and from its significant tidal stream resource.

With the benefit of a favourable legislative environment we assess the potential for tidal industry to make a meaningful contribution to the wider economy through the Gross Value Added (GVA) created in a UK manufacturing base, including sales both domestically and internationally.

International revenue opportunities are expected to be concentrated around the export of the following types of products and services:

- Blade design and tidal turbine design for manufacture locally
- Small high value components
- Design and detailed engineering expertise
- Project development and management

8 https://s3-eu-west-1.amazonaws.com/media.newore.catapult/app/uploads/2018/05/04120736/Tidal-Stream-and-Wave-Energy-Cost-Reduction-and-Ind-Benefit-FINAL-v03.02.pdf

- Environmental impact studies
- Geotechnical surveys
- Resource estimates
- Array design
- Foundation design and installation techniques
- Health and safety best practice
- Technical third-party consultancy
- O&M strategies

The following GVA estimates incorporate the tidal stream growth and cost reduction profiles predicted in the May 2018 ORE Catapult report[8], which assumes the UK market growing at an average of 100MW per annum deployment from 2021/22, and up to 3GW deployed in the rest of the world by 2030. Over this period the tidal stream sector is projected to generate a net cumulative benefit to the UK of €1.6 billion[9], consisting of €1.8 billion GVA from the domestic UK market plus €1.3 billion GVA from exports, offset by €1.5 billion of revenue support. **Error! Reference source not found.** provides a 2030 projection of cumulative GVA for the UK from tidal stream with the corresponding level of government support required.

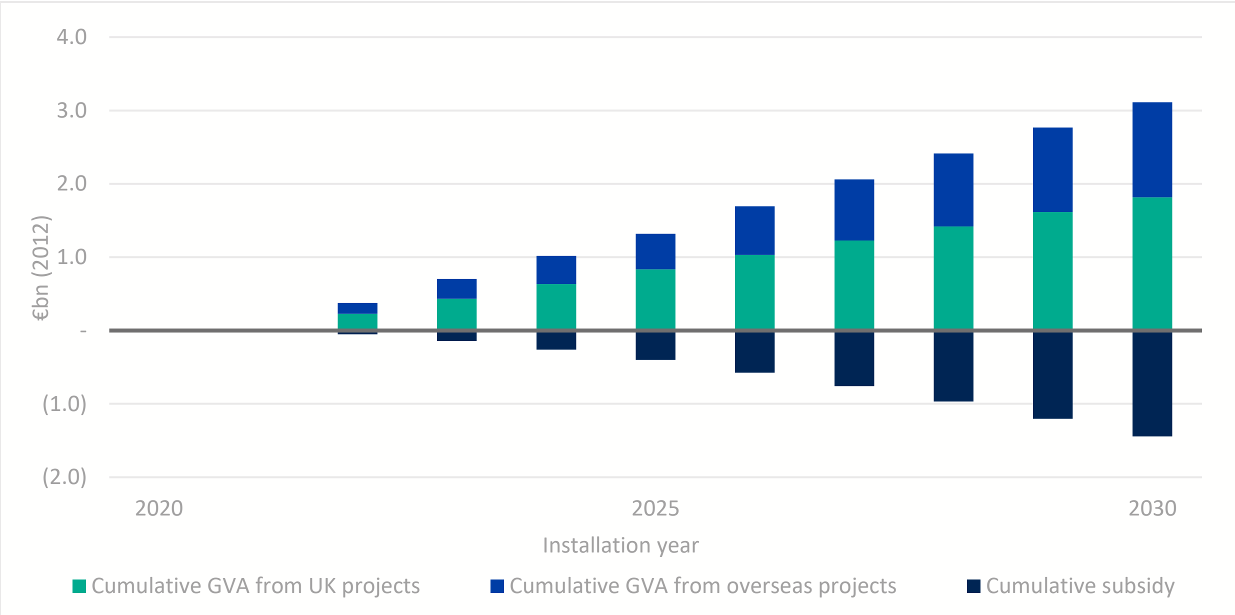

Figure 1: Projected Cumulative GVA for the UK, from Tidal Stream Energy

4.1.1 Employment Creation

New jobs are expected to be supported and sustained through the development of tidal stream energy and will likely be concentrated in distinct regions where there is existing capacity, especially from offshore wind, oil and gas, steel, and maritime businesses looking to diversify their business models.

[9] ORE Catapult's GVA estimates have been converted to Euros at an exchange rate of £1=€1.14

ORE Catapult analysis shows that tidal stream employment in the UK could grow to 4,000 by 2030 and to 14,500 by 2040. Table 3 provides ORE Catapult's estimates for annual GVA (converted to Euros) and job creation associated with the UK's tidal stream energy sector by 2030.

Table 3: Tidal Stream Annual UK GVA, Spend and Job Creation by 2030

Component	UK Projects UK Content	UK Projects 2030 spend €m	UK GVA from UK projects in 2030 €m	Non UK Projects 2030 spend €m	UK GVA from Exports €m	Total UK GVA creation in 2030 €m	FTE supported by 2030
Tidal Platform	65%	127	60	459	67	128	1,210
Foundations/Moorings	80%	26	13	97	6	18	160
Electrical	70%	48	26	174	17	43	460
Installation	60%	24	14	89	8	22	450
Other Capex	72%	24	17	88	23	40	330
O&M[22]	75%	91	64	282	15	79	1,240
Development	75%	8	6	27	11	17	130
Total	70%	350	200	1,215	147	347	3,980

Contact

HEAD OFFICE

Nova Innovation
45 Timber Bush
Edinburgh
EH6 6QH

Tel: +44 (0)131 241 2000
Email: info@enfait.eu

www.enfait.eu

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement number 745862.