



HAL
open science

Chapter 5 - Marine Renewable Energy in France: An opportunity for real change in France

Franck Schoefs

► **To cite this version:**

Franck Schoefs. Chapter 5 - Marine Renewable Energy in France: An opportunity for real change in France. Patrick Chaumette. Economic challenge and new maritime risks management: What blue growth? Challenge économique et maîtrise des nouveaux risques maritimes : Quelle croissance bleue? , GOMILEX, 2017. hal-01792168

HAL Id: hal-01792168

<https://hal.science/hal-01792168>

Submitted on 28 May 2018

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



CHAPTER 5

Marine Renewable Energy in France: An opportunity for real change in France

Franck SCHOEFS

Professor at the Université de Nantes, MRE advisor to the president of the University of Nantes, France
Director of the research federation CNRS "Sea and Litoral research Institute"

Résumé : *De nos jours, nos sociétés affrontent des défis majeurs qui prendront une place croissante durant le siècle, parmi lesquels l'alimentation et l'énergie. Cette dernière affecte largement des sujets connexes comme : les espaces disponibles pour l'agriculture, les émissions de gaz à effet de serre. La mer couvre 70 % de la surface terrestre et jouera un rôle majeur pour répondre à ces questions. Nous portons ici notre attention sur le sujet de l'énergie en analysant l'intérêt et les limites des Énergies Marines Renouvelables. Nous introduisons des questions clés comme l'évaluation globale des risques, la gouvernance et la sécurité dans un contexte multi-usages, le bénéfice de la combinaison avec d'autres composantes de l'économie bleue comme les Plates-Formes Multi-Usages, la formation et les enjeux liés aux compétences et aux carrières, la réduction des coûts et les enjeux d'assurance de maintenance et démantèlement. La complexité et les enjeux croisés dans un environnement incertain mettent clairement en évidence l'intérêt de co-constructions multi-acteurs et le point de vue multidisciplinaire durant les différents stades du projet qui incluent des étapes très différentes. Il met également en relief l'intérêt croissant de structures telles que la fédération de recherche CNRS 'Institut Universitaire Mer et littoral'.*



FRANK SCHOEFS

Abstract: *Our societies currently face major challenges that are becoming more and more prominent in our lives this century, including food and energy. The latter affects related broader issues such as available land for agriculture and greenhouse gas emissions. The sea covers more than 70% of the earth's surface and will play a major role in addressing these challenges. We focus here on the topic of energy by analysing the interest and limits of Marine Renewable Energy. We introduce some key issues such as the global evaluation of risks, governance and safety in a multi-use context, the benefits of combination with other fields of the blue economy through Multi-Use Offshore Platforms, teaching, skills and career development, the reduction of cost and insurance challenges and maintenance and decommissioning. This chapter focuses on the interest of multi-stakeholder co-construction and on multi-disciplinary approaches throughout the whole life of a project with multiple steps. It also highlights the role of research organisations such as the CNRS Research Federation, "Sea and Littoral Research Institute".*

A comprehensive risk assessment is needed to demonstrate France's commitment

Energy and food shortages are among the most significant challenges societies face in the first half of the 21st century. These challenges will force societies into significantly constrictive situations as a result of population growth and climate change. It was clearly forecasted in the 1990s that the first half of the 21st century would be marked by oil shortages, and the relationship between energy sources and climate change has only become more obvious in the last decade. We have also witnessed how this raw material can cause a domino effect with serious consequences: this includes the Piper Alpha disaster, the first and second Gulf Wars in Iraq and Kuwait, migration, piracy, financing of terrorism and the pollution caused by petrol extraction and transportation operations (e.g. the Deepwater Ocean oil spill, which was made into a motion picture and is currently in theatres, and the Prestige oil spill). We will also witness the consequences of uranium mining operations which include supplying and upholding dictatorships, the widespread environmental impact (e.g. the Chernobyl and Fukushima accidents), underestimation of the risks of decommissioning sites and the challenges of long-term radioactive waste management and storage, among others.

Oceans and seas lie at the heart of these issues: deepwater oil and gas exploration (over 1000m), hydrocarbon transportation, migration, among others.

Renewable energies can only be fully understood if they are studied through a holistic approach and not from short-term financial points of view. Furthermore, creditor bodies in hydrocarbon-producing countries, such as Norway, have the insight to analyse oil price volatility because of local micro-economies and circumstances – notably political circumstances (e.g. elections and nationalisations) – but also as a result of geopolitical strategies involving unpredictable alliances. This poses an even more significant risk to investments than to energy itself. As a result, margins are lower but more predictable.

Let us return to this holistic approach and analyse the means by which we can tackle the challenges posed by energy and food shortages that seem unrelated. We know that the most financially attractive renewable energies come in the form of hydroelectric plants and solar farms. These types of energy also require substantial amounts of land in order to operate. For instance, large areas of land need to be flooded to build hydroelectric plants and solar farms require vast amounts of land to accommodate the panels. However, they do impact the environment because they leave a footprint on natural habitats. This interdependent relationship needs to be studied and requires the most apt solutions (e.g. panel-driven production that supply communities by covering surfaces, administrative and commercial buildings, roads, etc.). It also requires other territories to be explored with the same holistic approach because more than 50% of the world's current population lives in coastal areas.



FRANK SCHOEFS

Marine renewable energies provide an opportunity because they sit on an extraordinary blue territory that covers more than 70% of the world's surface. We now know that renewable energy can be a major player in the production of the world's energy; I would even go as far to say between 10 and 50% because a) we already know that it represented 20% in Denmark in 2016, b) major consumers such as China and Japan have made significant developments, and c) the first sites were built in the USA under the Obama administration despite oil lobbying, shale gas scandals and other scandals prior to the last elections. It also includes both offshore wind energy, which first appeared in Denmark in 1991, and ocean energy. The main ocean energies are currently produced via wave, tidal stream, tidal and ocean thermal energies. It should be mentioned that innovating concepts such as tidal energy (e.g. the Swansea Bay Tidal Lagoon Project) present an interesting prospect in terms of a comprehensive review by pinning coastal protection against the risks of flooding or erosion and energy production. We must implement the same surveillance mechanisms that are used on land even if marine life seems foreign and elicits less interest. These mechanisms should include environmental impact studies to see how these types of energy generators cohabit with other sea activities such as fishing, maritime transport and even defence. With regard to the last points, we must bear in mind that France and its ports are leading contributors to the European Union's marine energy production. Furthermore, 80% of merchandise transport is conducted via oceans. Submarine reliefs and marine wildlife diversity need to be accounted for when conducting impact studies. However, these variables are not fully integrated, especially in regards to climate change. Thus, how can a framework that evolves over time be established? And, that doesn't include the direct involvement of humankind? Or, that doesn't integrate variables and risks? Countries such as Colombia see centralising production as an alternative (even if vulnerable to climatic variations and/or terrorism) and an opportunity to implement a circular economy in coastal and isolated areas; what role does France have?

We have to use the conditional tense or even the future tense when speaking about offshore marine renewable energy development in France because the only existing endeavour dates back to the 60's: the Rance tidal power plant. It is obvious that France has quite a lot of catching up to do in comparison with countries such as Denmark who started developing this technology 25 years ago. Other countries, such as the United Kingdom and Germany, also took proactive initiatives 10 years ago. However, France, which has the second largest maritime sector after the United States, needs to be more ambitious. If we look at the Grenelle Environment Forum and determine the absence of an ambitious 10-year+ strategic plan, the lack of commitment is evident. The reason for this type of culture is because of France's relationship with nuclear energy in recent decades. Comprehensive analysis (decommissioning and product treatment) was ignored and experts were served up mono-cultural training (the Mines Inspectorate). It also stems from the lack of a risk culture among the elite and political class. Proof of this lies with how the use of the precautionary principle was perverted in the treatment of the H1N1 virus during



pregnancies. This outlines the importance of performing the abovementioned comprehensive risk evaluations.

Based on this analysis and because France has the following proven capabilities: research (the CNRS Research Federation 'Sea and Litoral Research Institute' in the Pays de la Loire performs 1/3 of the maritime research conducted by Denmark), training (University of Nantes, École Centrale de Nantes, ENSAM [Faculty of Engineering] and ENSM [the national maritime college]), transferring from academic institutions employment in the industry (Capacités, a subsidiary of the University of Nantes). France can also count on institutions such as ADWEN, STX, DNCS and a panel of SMEs from within the framework of Neopolia. Furthermore, Human Sea-MARISK has placed this subject matter at the forefront of its programme during its fifth edition in 2016. Nevertheless, we must not see this as a promising source of employment and fail to invest in the saving power of this industry. The following overview shall also address this issue and remains faithful to the exchanges that took place during the conference. This reporting is proposed under the responsibility of the author of this paper.

Marine renewable energy development and maritime security

Sylvain Traversa, Head of the Marine Renewable Energy Office of the maritime prefecture of the Channel and the North Sea (France), presented the above: the sea is a shared space in a broad sense. It includes preserving the environment and is a shared space with other uses. In fact, the maritime territory referred to previously, the Channel and the North Sea, is certainly the busiest area within the metropolitan territory, and he emphasised three major issues that were identified across all forty-five missions assigned to the maritime prefecture. This includes safeguarding people and goods at sea, maritime security (including malicious acts) and protecting the maritime environment. These actions are conducted by the governing emergency body that also ensures coordination efforts among different units such as the national coast guard, maritime affairs, customs, police, civil protection and the SNSM (the French Sea Rescue). The Channel and the North Sea require the presence of two RCC's (one in Jobourg and the other in Gris Nez). These centres manage the search and rescue region and are necessary to cover the geographical area. Two traffic separation schemes (TSS) were put into place to manage the flux of tens of thousands of ships that pass through the area per year. The most important TSS in the world is located at Pas de Calais and monitors the 35,000 ships that travel both upstream and downstream. The following facts demonstrate the variety of risks: 30% of the area lies within marine protected areas, fishing areas and recreational diving and granulate extraction areas; 600 ships/day travel the channel; 80 ships/day travel cross-channel with 45,000 passengers/day; 800 fishing vessels and 134,000 pleasure boats. Furthermore, 1,400 explosive devices (45 eq. TNT) were identified, 41 cases of pollution were detected in 2015. There are also 4 nuclear power plants located on the coast. It is in this shared and tightened space where 5 marine renewable energy projects will



FRANK SCHOEFS

come to life. This includes a tidal plant at Raz Blanchard and 4 wind farms at Courseulles sur Mer, Fécamp, Dieppe le Tréport and Dunkerque, with a total of 2 GW installed over time.

Security is a top priority that needs to be addressed, especially because of the threats posed by terrorism and the transport of hazardous goods. 462 million tons of hazardous goods are transported per year on every-growing vessels: 500 crates was equivalent to 20 feet in 1960 but is now equivalent to 20,000 feet. Catastrophes are narrowly averted on a monthly basis. There is a significant increase in the number of damaged ships since 2014. 230 damaged-vessel reports were filed in 2015 alone. Furthermore, the number of lost containers at sea is also on the rise. Floating refrigerated containers pose an even larger threat. 15 containers of this type were lost at sea in 2015 and 517 conventional containers were lost by one single ship in 2014. The safety of people is also at risk because it impacted 3,435 people in 2015, 27 of whom died.

Focusing on Marine Renewable Energy, PREMAR shall be involved in the following phases: design (definition of zones), installation, production and decommissioning. Common regulations are in place to enforce co-construction practices but we understand the need for site-specific regulations. This includes taking into account sea conditions during installations and their evolution in relation to new technological developments. The aim is to regulate the use of the area under concession. The state's strong willingness to maintain pre-existing uses would also be regulated in the spirit of co-construction. This would ensure regulations are accepted and respected which ultimately ensure their effectiveness. We must also emphasise the limitations of some of the state's actions because they do not ensure site surveillance and security during construction.

We also question the operating experience obtained from other European sites, especially those located in the North Sea (Denmark, the Netherlands, Belgium, Germany and the United Kingdom). There are limitations to the operating experience because provisions are not identical. For example, Germany decided to prioritise the sector and forbid fishing activities in those sites. France, as it was previously mentioned, holds a different position on the matter.

The development of marine renewable energies on multi-purpose platforms

Let us fast forward 10 to 15 years into the future and study the issues outlined in the introduction. These issues can be solved by adopting a comprehensive approach that involves offshore multi-purpose platforms. This approach – Project Offshore – was proposed by Pierre Leonidas, an independent legal advisor on the issues tied to the legal framework. It is interesting to note that firms such as DCNS and Bouygues are closely studying this subject. So, what are multi-purpose offshore platforms? Multi-



V. Marine Renewable Energy in France: An opportunity for real change in ...

purpose offshore platforms are industrial facilities that accommodate ongoing sea activities such as marine renewable energies, recreational activities, durable living-resource production, marine bio-technology, defence and offshore services. The latter include vessel berthing, procurement, loading/unloading. An example of these types of platforms are floating wind turbines that coexist with mollusc farms, desalination plants, passenger terminals, hotels and port hubs (such as in Guyana). They are comprised of modular and scalable platform systems with floaters anchored to the seabed. The European project TROPOS – and specifically the following three projects: wind energy and aquiculture in Crete, durable service hub (logistics and wind) in the North Sea and the Recreational Island in the Canaries (solar and leisure) – have outlined the industry by integrating specific legal issues with the understanding that these platforms are not vessels nor oil production platforms. Multi-purpose offshore platforms do not move and do not have any propulsion capacity. They also occupy more space than floaters because they occupy space both vertically and horizontally. Concrete is the main material used to build these types of platforms. This provides France with an interesting opportunity because France has world leading civil engineering firms such as Bouygues, Eiffage and Vinci. It also has laboratories that have spent the last 20 years developing the necessary experience and skill in this field such as IFSTTAR, the Civil Engineering Research Centre of the University of Nantes and the projects DéCoF-Ré, MAREO and IMARECO2.

What is the international legal framework? The United Nations set forth the first legal framework in the convention on the Law of the Sea signed in Montego Bay in 1982. It came into force in 1994 to target offshore oil production which surged in the 1970s and 80s. The law does not explicitly address multi-purpose offshore platform systems but it does recognise the notion of the facility based on geographical locations: in territorial seas, in Exclusive Economic Zones (EEZ), on the continental shelf of coastal states and at high sea. For further information, refer to Articles 11, 561.B, 60 and 87.1.d. In national law, as previously mentioned, multi-purpose offshore platform systems are not comparable to vessels and are subject to temporary occupation permits in territorial seas for a maximum of 30 years. Regulations are also needed to regulate activities that take place on multi-purpose offshore platforms. This includes stipulating regulations within labour law and environmental law that would apply to complex operations such as those of an aquiculture farm and marine renewable energy facilities. We see that marine renewable energy pilot projects could contribute to consolidating the framework.

We can also see that people other than "seafarers" are referred to in the transportation code (Law of 16 July 2013, article L. 5541-1). The presence of non-residents and/or industrial activities will also give rise to new regulations in the fields of social law and competition rules (Decree No. 2015-454 of 21 April 2015).¹ Operating experience

1) CHAUMETTE P., "Gens de mer marins, gens de mer non marins et autres. Décret n° 2015-454 du 21 avril 2015", *Droit Maritime Français*, DMF 2016, No. 781, pp. 483-494.

from marine private facilities such as disused offshore storage installations, and hotels used to maintain British offshore wind farms should be studied, too.

What position should financiers and underwriters occupy in this environment of risk?

We have identified the need to define, create awareness and assess the breadth of risks associated with renewable marine energies in regards to the type and phase in which they exist: design, implementation, production and decommissioning. This is how François Renelier, head of the marine renewable energy cell Bessé Insurance Broker Firm (Nantes, France) addresses the subject of insurance by responding to the question, "How do we get insurance companies on board with renewable marine energy projects?" and explaining that insurable risks, which are accidental, are only those outlined in the presentation and not reinsurance after an accident. Operating experience from wind, floating and tidal current projects indicates project demonstrations are especially instructive. Firms, which are often start-ups, must be able to refinance themselves in order to stay afloat in the event of major damages. This is particularly true for cutting-edge projects which are most often undertaken by smaller firms who rely on public funds or European grants. This is the case of the firm IDEOL and their project FLOATGEN. Prototype projects are especially necessary when referring to French wind farms which require a two billion euro investment. Full Scale projects remain close enough to their demonstrator projects because they are undertaken by wholly-owned firms (special-purpose entities or Special Purpose Vehicles) and taken on by several firms (turbine manufactures, operators, among others) and financed not by their own funds but by the debt held by lenders who waive using parent companies. Banks require guarantors as insurance. It is becoming more and more common for government authorities to provide financing through the ADEME (the French Environment and Energy Management Agency) by issuing reimbursable advances. These aspects apart, and especially for innovative projects, insuring new concepts by conducting insurance feasibility studies (e.g. Insurability Notes) has become a trade passport which allows not only proof that risk assessment has been thoroughly conducted but also proof that risks are insurable and the project credible.

Why would it be beneficial for underwriters to be on board? They may see a return on premiums but they are exposing themselves to significant risks. To gain a better understanding of the reasons behind such a choice, one must become familiarised with the world of underwriters and understand how they view see marine renewable energy as a new insurable product. This does not happen often as the average is once every decade. Another example of such an event is when cyber risks became insurable; this is also addressed within the framework of Human Sea - Marisk international symposium (Nantes, 3 and 4 October 2016). This new market is even more necessary than any other because the number of insurable goods goes down



(e.g. projects are halted). This is the case of marine underwriters who work on offshore hydrocarbon extraction projects.

The amounts are quite substantial because the rate applied to the value of the project is between twice and five times higher than that applied to onshore wind projects. This leads to orders of magnitude worth tens of millions of euros. These types of quotes are based on leveraging operating experience to predict future risks – it's actuarial science. Why are we speaking about an actuarial nightmare? Because operating experience is drawn from diverse populations and weak samples (technologies evolve too quickly, few projects per technology, specific environmental conditions per site). It is the opposite of what is necessary in order to provide an accurate risk prediction. Furthermore, the risk is volatile because frequencies are very weak and have polar-opposite effects. Danois, the principle insurance company, says, "there is no single major project without a single major disaster." Two major risks are terrorism and climate events such as squalls. They alone represent 30% of the premiums. We may believe the costs associated to floating wind farms are lower than those associated to fixed wind farms because they are movable and damages are not as frequent. However, this is not the case. When floating wind farms lose their anchors, these objects pose a danger to third parties.

To comprehend the costs incurred during these interventions at sea, we can compare it to a manufacturing defect that requires a jackup which is not readily available because there are very few in the world. Its location necessitates that a weather window be accurately identified and forecasted because the cost of immobilising a jackup is between \$150,000 to \$200,000 USD per day. If the weather conditions were erroneously calculated, it could drive up the cost dramatically in addition to operating losses. This is why the cost of an incident could rise to tens of millions of euros and should be compared to the order of magnitude mentioned above.

These elements demonstrate that insurance policies need to be individually tailored to projects. Are operating losses included? Is the defective part covered? On the latter point, it would be different if it was a key bolt of a propeller or a generalised corrosion. We can see how the business of insurance and engineering are closely linked (e.g. Via Sofimar at the Bessé firm) when writing clauses that are precise and logical. If these elements are key and we want underwriters to get on board, it is important to raise their awareness by introducing them to projects and technologies and provide specific details so that they may become familiar with this new sector. There exists a specialised profession, "the Marine Surveyor", and this individual is responsible for ensuring sites are designed in accordance with best practices, that operations are conducted during designated weather conditions and that safety distances are respected.

Lastly, legal topics also interfere in the insurance of marine renewable energy. Is it terrestrial or marine insurance for an object that will be placed on the ground? What is the status of a floating wind farm in comparison to a vessel, since it is not equipped



FRANK SCHOEFS

with a propulsion system? These answers can be found in Law No. 2016-816 of 20 June 2016 for a blue economy thanks to the joint work conducted by underwriters and the RSE.² The current trend is to insure floating wind farms as if they were vessels because they present similar risks to third parties. This practice is still experimental and only the future will tell if this is the correct practice.

Marine renewable energies: Good for the environment, but for employment?

Since the first call-to-tenders was launched, several figures attributed to job creation were put forth without being proven. It created the perception that marine renewable energies were the El Dorado of job creation. The current group of actors resulting from buyouts and the risk of specific sites being saturated by other activities (STX with the construction of ocean liners) will not deny that the exercise of extreme caution is required. It is important to emphasise that the few existing sites, all of which will be completed in 2013, are not sufficient to create an industrial sector and sustainable job opportunities. Should we plan for job transformations in our country to accompany technological developments? The CEREQ (Centre for Study and Research of Qualifications of France) in association with the Faculty of Economic Science of Rennes (France) under the leadership of the researcher Gérard PODEVIN, PhD in Economy and Demography, has provided avenues to answer the question, "Do marine renewable energies generate new employment opportunities?"³

These questions can only be supported by tangible socio-economic studies such as those provided by the CEREQ in 2014 to the CGDD (the French Commission on Sustainable Development). The results of their research was also published in the CEREQ editions in 2015. This study was conducted in parallel with that of onshore wind power. The following information was extracted from the report issued by the CEREQ. It is important to remember that this is still an emerging field even if research

2) *Insurance schemes specific to renewable marine energies.* The lack of insurance schemes specific to renewable marine energies was seen as an impediment that thwarted its development. The law for a blue economy completes the law on insurance by stipulating that renewable marine energy facilities belong to the significant hazard category. It exempts marine renewable energy projects from contributions due because of natural disasters and terrorism. The objective is to ensure offshore wind projects can be in fact insured. French insurance schemes prove to be insufficient. Therefore, the participation of foreign insurers is required. Since there were no specific regulations in place, offshore wind power insurance schemes were based on those applicable to terrestrial wind power.

3) PODEVIN G., "Quand l'éolien prend la mer: un vent nouveau sur des métiers existants", Céreq Bref No. 336, June 2015, 4p. – *L'émergence d'une filière EMR en France: quelles perspectives pour l'emploi et la formation? Le cas de l'éolien offshore posé*, Net.Doc No. 136, May 2015, p. 136.
<http://www.cereq.fr/articles/Focus/Energies-marines-renouvelables-nouveaux-metiers-ou-competences-nouvelles>.



is being conducted and the GE plant (e.g. Alstom) in Saint-Nazaire manufactures turbines for the USA. It is also important to remember that the six scheduled fields correspond to only 50% of what was announced following the Grenelle Environment Forum, i.e. 6 GW and only 3 GW would be made available in 2020-2022. One of these erroneous figures was provided by Senator Gisèle Gautier. In December 2010, she said in a report that 50,000 jobs would be created in France, although France was one of many international competitors, especially in the sector of installation vessels where France has very little presence. Four years later, in 2014, the European Wind Energy Association reported that a total of 74,000 jobs had been created in all of Europe. We now forecast the creation of 6,000 to 10,000 direct and indirect jobs (top-tier contractors) in 2022 for the entire value chain. These figures are quite far from the abovementioned quixotic figures. Maintenance job creation numbers were also re-evaluated and it was determined that it would be 80 per site (compared to the initial 120). It represents a total of 500 workers once the sites are completed. This is the only case of sustainable employment because sites have an operational life of at least 25 years. The RSE issued a report that indicated that people usually occupied a position for 5 years and skill recycling should be prioritised. There is a lack of visibility which results in the range mentioned above. It is accentuated by tier 2 and 3 contractors, especially in regards to the sustainability of the sector because it conditions the participation of some SMEs who invest in very specific training certifications. We thus return to the need to position actors in export markets since they cannot justify references to the national market. Prototypes and pilot farms are an opportunity to improve skill development but this requires firms to have a proactive approach, as it is difficult to ask people to take on supplementary risks with new actors on a pilot project in a very competitive industry. Park surveillance and security are among the niche jobs emerging from this industry. It also has created tourism-related employment, as seen in the Netherlands, and health and safety-related employment to monitor transitory transport phases of goods and people (QHSE policy). The CEREQ report concludes that no new jobs will emerge and current skills will evolve into professional certifications (RNCP in France) operated by the University of Nantes and the École Centrale de Nantes with the participation of ENSM and several companies who constitute the cluster WEAMEC (West Atlantic Marine Energy Centre). Yves Guignot, professor of maritime education at ENSM in Nantes (France) has stated that ENSM contributes to the nation's strength in maritime operations by training senior deck and engineering officers. The other important fact is the current trend of transdisciplinarity where engineers in mechatronics require additional skills in the field of maritime environment. Lastly, robotisation, as seen in other sectors, will bring about the elimination of certain jobs such as deep-sea diving. France can benefit from the great synergy that exists between the industries of naval construction and aeronautics.

The CEREQ report indicates that there are few training programmes available which is positive because it does not limit candidates to a specific skillset and facilitates employment recycling. The trend in France is to link career paths to existing degrees and renew certifications such as welding and boilermakers (additional terms) by putting a spotlight on professions that are not well-known or as attractive. This also includes



FRANK SCHOEFS

TUTB naval construction or professional bachelor's degrees such as offshore operations management at the University of Nantes. Job representation can be achieved via the organisation of visits which would allow to showcase potential career paths and their associated salaries. The CEREQ recommends innovating marine renewable energy career paths by including on-the-job learning at principal and sub-contractor firms. It also notes that the region of Nantes presents many opportunities for such endeavours. It also highlights the importance of reflecting upon the "maritimisation" of terrestrial technicians or marine training or even how offshore oil and gas jobs can be reconverted.

Marine renewable energies: What maintenance issues could arise once set up?

Maintenance issues are accounted for in the initial design phase because, based on a 25-year life cycle, they represent a significant part of the total cost at 20% of the initial cost. Significant gains can only be obtained by implementing optimal design, limiting failures by installing warning devices which allow for preventive maintenance. Current projects include R&D SURFFEOL and HYPERWIND. Aurélie Klein, project manager for marine renewable energy and wind projects in VALEMO (France) indicates that French worker skill sets are improved via the onshore to offshore path in her work "Offshore wind farm operation and maintenance challenges". Márcio Rigueti de Alencar, electrical engineer, M.Sc., M.B.A., and CEO of Brasca Ltd. (Norway), addresses the end of production with "the challenges posed by the decommissioning of oil fields and the maintenance of oil wind turbines." Klein briefly outlines the limitations of transitioning from onshore to offshore, even if they have issues in common. Sea operation costs are considerably higher and require special attention to details that have little impact on onshore operations. It is especially important to dispose of sufficient warning devices so as to not have to resort to onsite human verifications. It would prevent exposing workers to high-risk operations such as helicopter hoisting operations and reduce the costs of mobilising equipment for at-sea operations. Several innovating industry actors are present in France. Prototypes and simulators provide the chance to build on skills by exposing workers to marine technologies and methods.

Rigueti de Alencar, on the other hand, addresses the very serious issue of decommissioning. Greenpeace organised a high-profile campaign against the decommissioning of Brent Spar in 1995 and how it would have meant disposing of 14,500 tons of concrete and would have forced Shell to spend between 60 to 100 million pounds to recycle or reuse 95% of said concrete. In fact, some years later, the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) came into effect on 25 March 1998. It stipulates how international cooperation should be conducted in regards to marine environment protection of the North-East Atlantic. Operating experience from the North Sea demonstrates that marine facilities have an active impact on the environment because they cannot accommodate

marine wildlife. The creation of sanctuaries such as those in the Gulf of Santa Barbara in the U.S.A. or in the Gulf of Guinea would need to be considered. In some cases, reefs, although artificial, act as true reefs and provide such a biological richness that any act of dismantling would have a significant impact on the affected eco-system. It would also involve significant human and environmental risks linked to any sea operation and would biologically pollute the ocean floor because of detaching parts of a bio-colony. The latter is negligible in regards to isolated structures such as offshore gas and oil rigs but it is significant when decommissioning parks made up of several dozens of units. It is thus necessary to ask the only question possible with the most comprehensive approach possible: is it best to decommission units entirely or partially and leave components on site because they do not harm the environment and limit the risk of an accident occurring, even if it has a positive impact on the environment? We can now see why this subject is more complex than it seems. Let us return to the abovementioned point regarding risk management. Decommissioning operations generally present more risks than start-up operations because they deal with aged and used, and not new, structures. Corroded bolt connections are more difficult, if not impossible, to unscrew. Materials are more degraded (e.g. cracks and corrosions) than expected. Operations that were initially planned are no longer possible and procedures have to be adapted. It is during unprogrammed operations that human and economic risks are higher.

As a result of these complexities and the presence of uncertainty, it is necessary to identify potential scenarios and conduct risk assessments. It also involves allowing the co-construction of decisions.

