Chapter 42
Offshore Windfarms

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Abstract The Earth is endowed with a bounty of natural energy sources. So far, fossil fuels have simply proven the simplest to exploit on a large scale. But we have reached a point where the governments of most developed countries have recognised the perils of fossil fuel reliance—for both energy security and environmental reasons—and responded by (to varying extents) consciously diversifying national energy portfolios. Globally, wind generation is a small but growing source of electricity, and offshore wind is making great strides. This chapter considers offshore wind energy specifically, the management and regulatory challenges it poses, and emerging best practice in this relatively new area. It concludes that strategic marine spatial planning, an ecosystem approach to environmental impact assessment, and the precautionary approach are becoming three vital tools in striking an appropriate balance between the need to deploy offshore wind generation on the one hand, and the need to safeguard the marine environment on the other.

Keywords Offshore wind farms • Marine regulation • Marine management • Marine spatial planning • Environmental impact • Environmental effects • Precaution

42.1 Introduction

The Earth is endowed with a bounty of natural energy sources. So far, fossil fuels have simply proven the simplest to exploit on a large scale. But we have reached a point where the governments of most developed countries have recognised the perils of fossil fuel reliance—for both energy security and environmental reasons—and responded by (to varying extents) consciously diversifying national energy portfolios. New Zealand is a prime example, where renewables account for over 70 percent of total electricity generation (Ministry of Economic Development 2011). Globally,

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wind generation is a small but growing source of electricity, and offshore wind is making great strides (International Energy Agency 2013). This chapter considers offshore wind energy specifically, the management and regulatory challenges it poses, and emerging best practice in this relatively new area.

42.2 Opportunities and Challenges for Offshore Wind Farm Deployment

Offshore wind generation, simply put, involves the harnessing of energy from natural movements in the air in offshore areas. The technology involved is basically the same as in onshore projects, but the naturally strong and less turbulent winds occurring in some offshore locations present an attractive prospect; although often hard to predict, they can offset the substantially higher costs involved in operating in the marine environment (Scott 2006: 89–118; Ministry for the Environment 2005). The wind turns the blades of a turbine, and the energy generated from this movement is converted into electrical energy and fed into the grid.

The last decade has seen a proliferation of wind farm developments offshore, which currently comprise the leading form of offshore energy (Appiott et al. 2014: 58–64). This has been especially noticeable in the northern part of Europe (Long 2013: 15–52; Kaplan 2004: 177–219), with concerns over nuclear generation, climate change and energy security at the foundations of policies that are driving development (Scott 2006: 89–118; Long 2014: 690–715; see also Dir 2009/28/EC; Barton et al. 2004; Barnes 2014: 573–599). The United Kingdom now possesses a number of offshore projects, including the large “London Array” at the approaches of the Thames, and many exist also in the low countries, Germany and Sweden (Scott 2006: 89–118; International Energy Agency 2013). Chinese developments are expected to increase significantly (Long 2014: 690–715). The United States is also taking the first (albeit somewhat faltering) steps down the road to deployment, with an approved project in Nantucket Sound.

Offshore wind farms represent a significant opportunity for sustainable global energy. However, they also present substantial challenges. If it were simple to do, many more projects would exist. Such challenges are of several kinds: operational, commercial, legal and policy. Operational and commercial hurdles to the deployment of offshore wind farms are substantial, but appear to be steadily reducing. Technical innovation has played a large role here. Historically, offshore wind generation has been confined to shallow coastal waters (of up to 40–50 m) (Scott 2006: 89–118; Ministry for the Environment 2005). However, recent technological advancements have enabled the construction of turbines in deeper waters, and “floating” turbines, although perhaps not yet commercially viable, are capable of operation many miles from shore (International Energy Agency 2013; Long 2014: 690–715). Scaling of turbines has been significant in achieving efficiencies, and alternative foundation designs to the traditional “monopile” show promise (International Energy Agency 2013). While offshore projects remain expensive compared to terrestrial projects, construction and operating costs have fallen in recent years (International Energy Agency 2013; Scott 2006: 89–118). A focus has been on increasing competition in supply, improving farm design, increasing economies of scale, promoting mass production, and reducing commercial risk (International Energy Agency 2013). Predictable yet flexible public subsidies or tax credits are seen as one way forward to enhance the competitiveness of wind generation and accelerate its deployment, while not dis-incentivising the private innovation that is essential to long-term cost reduction and technological improvement (International Energy Agency 2013; Long 2014: 690–715; Kaplan 2004: 177–219; Gibbons 2013). Encouraging international collaboration on research and development is another (International Energy Agency 2013).

Yet technical and commercial challenges remain (International Energy Agency 2014); in particular, turbines must operate in an environment that is usually less hospitable than on land, contending with adverse weather conditions and withstanding extreme ocean forces. Access for maintenance and repairs is also challenging, leading to a focus on developing preventative maintenance and an ability to control operations remotely (International Energy Agency 2013). Investors also require early assurances that electricity generated will have access to and be purchased at market (International Energy Agency 2013; Long 2014: 690–715).

42.3 Blowing Hot Then Cold: Legal and Policy Challenges for Offshore Wind

Legal and policy challenges are, in some ways, more difficult. While technical and commercial developments are driven by clear goals (basically, efficiency and feasibility), the legal and policy space is characterised by different goals that may conflict. It would be naïve to think that the overriding goal of marine environmental law and policy is to enable the exploitation of offshore wind at *any* cost. The benefits of doing so must be weighed against interests of the marine environment and those who use it (or wish to use it in the future) for other purposes (Caine 2014: 89–127). Close management is therefore needed to ensure that while the benefits of wind are exploited, it does not come at an unacceptable cost to people or the environment with which they exist in what has been called a "dynamic tension" (New Zealand Parliamentary Commissioner for the Environment 2006). At the risk of stating the obvious, the overriding legal and policy challenge facing offshore wind farm deployment seems to be striking an appropriate balance between these interests in a way that is stable, predictable and participatory (Long 2014: 690–715; Sustainable Development Commission 2005; Leitch 2010: 182–199). Many more specific management issues can be understood in this light. Perhaps resolving the "messy reality" of weighing so many interests requires an interdisciplinary approach; for example, one author has sought to apply an "economic sociology of law" to the issues posed by wind farms (Perry-Kessaris 2013: 68–91; see also Aitken 2010: 1834–1841). Yet at the same time we cannot ignore the particularly important role that policy and regulation play in enabling and restricting projects. A balance needs to be sensitive both to the needs of people, and the needs of the environment.

42.3.1 Recognising and Balancing Effects on People

Direct effects on people are a key consideration for regulators. In particular, it is important that decision-makers recognise the *benefits* of offshore wind generation for people. It is all too easy to be drawn into the negative rhetoric surrounding the risks posed by individual projects, without seeing the bigger picture. Incorporating wind into broader energy strategies, roadmaps and coastal planning mechanisms in a clear and transparent way is essential to provide signals for future investment and to reduce costs associated with policy risk (International Energy Agency 2013), thereby realising the substantial energy security benefits that wind farms have for people (see e.g., New Zealand Coastal Policy Statement 2010; policy 6(1)(g)). Although the main policy driver of wind farms is not economic benefit per se, projects can also have substantial economic and social value; they generate employment and can provide a stable price for electricity not dependent on volatile international prices (like fossil fuels are) (International Energy Agency 2013).

Active planning for renewable generation more generally can be seen in the European Union, where robust targets are imposed on member states (International Energy Agency 2013; Dir 2009/28/EC), and in New Zealand, where the Government's energy strategy specifically aims for 90 percent of electricity to be generated from renewable sources by 2025 (Ministry of Economic Development 2011). Offshore wind does not have a specific mention in those documents, but it offers an attractive policy option for meeting such targets; one reason is that offshore wind farms can avoid to a large extent the "not in my backyard" (NIMBY) concerns that often plague terrestrial projects (Ministry for the Environment 2005; Ewea 2010). Further offshore a wind farm is located, the lower such concerns are likely to become (Long 2014: 690–715). Opposition is often strongly linked to a sense of place (Manzo and Devine-Wright 2014), and visual or amenity impacts are most likely to give rise to NIMBYism. This has certainly proved the case in the United Kingdom, the United States, other parts of Europe and New Zealand (Scott 2006: 89–118; New Zealand Parliamentary Commissioner for the Environment 2006), despite broad public support for wind power as an industry (New Zealand Parliamentary Commissioner for the Environment 2006; Giddings 2011: 75–86; Marinakos 2012: 82–117). People want it, but not near them.

In the exclusive economic zone, such problems are likely to be minimal. Yet projects closer to shore and visible from the coast may arouse similar negative feeling (Scott 2006: 89–118; International Energy Agency 2013; Long 2014: 690–715; Marinakos 2012: 82–117). To be effective, large numbers of turbines must be dispersed along a relatively wide coastal area, and while proximity to the coast may reduce costs (International Energy Agency 2013), it may increase objections. There is no silver bullet management solution to such tensions. An individual coastal landowner, for example, should not be accorded a right to veto a proposal in which the wider public has a substantial interest. However, genuine objections to amenity impacts should not be dismissed; this is particularly so if they are culturally-based, an issue that has arisen in the United States and also in New Zealand in relation to terrestrial wind farms (Unison Networks Ltd. v. Hastings District Council, NZEnvC Auckland 2009; O'Brien 2013–2014: 411–434). Consultation and real consideration of local views are important in a participatory system of environmental law, although not necessarily determinative of an outcome. International experience shows that the best route may be extra-legal; public education concerning the benefits of wind, early consultation on specific projects, and direct community benefits are valuable to allay NIMBY concerns and smooth a path for deployment (International Energy Agency 2013; Devine-Wright 2005: 125–239). If terrestrial learnings are transferable, it may be that incentives for substantial local ownership and management of farms could accelerate public acceptance (New Zealand Parliamentary Commissioner for the Environment 2006). In this light, some commentators have applied a Danish proverb: “your own pigs don’t stink” (Thomson 2008). One’s own windmills may not look all that bad.

One can even hope that public acceptance of turbines, if strategically sited, may develop over time and evolve into an overt sense of pride that symbols of sustainable energy generation are on prominent display (New Zealand Parliamentary Commissioner for the Environment 2006). While natural coastal beauty is important, and should be safeguarded in places, it is also essential not to take a dogmatic or static view of amenity. After all, in contrast to (e.g.,) physical effects on marine life, the visual value of our environment is ultimately a subjective human construct (New Zealand Parliamentary Commissioner for the Environment 2006; Good 2006: 76–89). We can shape what we consider beautiful through our attitudes towards it. Turbines may, just as the early skyscrapers of the modernist architects, come to be seen as sculptural symbols of a progressive, enlightened and sustainable age (Maniototo Environmental Society Inc. v. Central Otago District Council, NZEnvC Christchurch 2009). In that sense, it is to be hoped that conceptual opposition to early projects may prove the most vehement, and decline as public acceptance of wind generation grows. Again, education and practical examples of deployment may allay many fears.

However, not all the effects of offshore wind farms can be overcome by the changing of attitudes over time. We cannot simply stride ahead on the assumption that *all* wind power is a good thing for people (New Zealand Parliamentary Commissioner for the Environment 2006). For one, construction and turbines can produce a great deal of noise. Here, offshore projects have policy advantages over their terrestrial counterparts. This is because, to some extent, noise amenity is an anthropocentric concept (determined by its effect on humans). It recalls the old adage "if a tree falls in a forest, and no one is around to hear it, does it make a sound?" In terms of environmental management, the answer is generally that is makes a less *important* noise if *people* cannot hear it. Far fewer people spend time offshore than on land, and generally no one lives there. Where sites are proposed close to land, the challenge of noise can be overcome to some extent by sensible spatial planning; objections are likely to be less pronounced and effects less marked where noise is already produced near pre-existing industrial zones such as ports.

Of course not all those affected by offshore wind farms would be land-based. The large areas required for turbines may require substantial exclusion zones and restrict the navigation of vessels, or pose navigational hazards (Scott 2006: 89–118). They may also impact on aircraft, military uses, and prevent the utilisation of fisheries in areas where cables and other infrastructure need to be protected (Scott 2006: 89–118). A process is needed whereby legitimate interests are considered and not unduly affected, particularly where they are reflected in legally conferred rights. While specific solutions to this challenge will vary according to a country's development priorities (should a new wind farm override existing interests in other, less publicly important resources?), equity and environmental justice are broadly important considerations in assigning rights to use areas or resources (International Energy Agency 2013; see generally Marinakos 2012: 82–117).

42.3.2 Environmental Effects

Offshore wind farms do not only affect people directly. They also have impacts on the broader notion of the "environment." Such impacts are equally significant, but substantially different, to those experienced as a result of wind generation on land, and can arise in the exploration, construction, operation and decommissioning stages. They form important considerations in striking an appropriate balance between various interests. The impacts of offshore energy have been discussed generally in Chap. 9 (see also Pelc and Fujita 2002: 471–479; OSPAR Commission 2008a).

Of course many environmental effects of offshore wind farms are context-specific, and some (such as the destruction of particularly vulnerable ecosystems) can be avoided through the protection of specific areas. Others are of more general concern. Seismic surveying, construction and operation present a substantial amount of noise and vibration, potentially excluding fish from important habitats and harming marine mammals (Scott 2006: 89–118; Caine 2014: 89–127). Other impacts on biodiversity may stem from increased turbidity from construction (Caine 2014: 89–127), and electrical cables, which could affect sharks and rays (Scott 2006: 89–118; Adair et al. 1998: 576–587). There is also a risk of bird strike by turbines (Scott 2006: 89–118; Adair et al. 1998: 576–587). Area-specific assessments performed in the United Kingdom concluded that bird strike posed a significant risk, as did exclusion from important habitats (Scott 2006: 89–118. This problem can to some extent be mitigated through the configuration of farms (including spacing between turbines), turbine design and dimensions, and blade speed (Powlesland 2009). Above all, site selection remains key (OSPAR Commission 2008b). Some discharge of contaminants into the water column is also inevitable as part of the construction process, and the abandonment of infrastructure once a project had been decommissioned can be seen as a form of dumping, which is subject to strict controls under international law and most domestic laws (OSPAR Commission 2008b; United Nations Convention on the Law of the Sea 1833; Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1996). That said, the actual physical destruction of seafloor ecosystems is generally limited; the overall area required is large, but the footprint of turbines and cables is small. Overall, some have concluded that adverse environmental effects tend to be no more than moderate (Giddings 2011: 75–86). As with effects on people, it is important to recall that some impacts are positive. The reduction of greenhouse gas emissions is an obvious example; wind energy has been projected to account for a significant proportion of the global CO_2 reductions necessary in the electricity sector, and forms a key part of modelling in scenarios designed to limit global temperature increases to 2°C (International Energy Agency 2013). But offshore wind farms may also lessen the wider environmental impacts of electricity generation when compared to alternatives such as hydro or onshore wind farms.

42.4 A Positive Spin? Legal and Policy Frameworks for Addressing Challenges

The discussion above has identified some challenges faced by marine wind generation. The key problem is striking a balance between various interests, both human and environmental. Yet it is important to remember that, in management terms, these challenges arise and must be addressed within coherent legal and policy frameworks. At its most basic, the law provides a transparent and consistent way for regulators to determine whether a proposal should proceed—if the balance between interests is acceptable. International law has comparatively little to say about offshore wind farms specifically, although it impacts upon aspects of their regulation. International climate law encourages deployment indirectly (United Nations Framework Convention on Climate Change 1992), while various marine treaties require environmental protections and for the interests of other states to be safeguarded. For the most part, international law enables coastal wind projects as long as certain matters are considered and addressed. The general global regime concerning the protection of the marine environment, found in UNCLOS, does not impose hard and fast environmental rules on wind farms—only general obligations in relation to pollution reduction and management (United Nations Convention on the Law of the Sea, arts. 192–195). But although it may be difficult to claim that the authorisation of any particular project infringed UNCLOS obligations, most states are parties to other more specific agreements which elaborate on these general provisions. Exact obligations will vary according to the conventions to which a state is party, but many exist concerning the protection of the marine environment from dumping (Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1996; Convention for the Protection of the Marine Environment of the North East Atlantic), the protection of cetaceans (Agreement on the Conservation of Small Cetaceans in the Baltic, North East Atlantic, Irish and North

Seas) and the protection of biodiversity and particular species of animals (Convention of the Conservation of Migratory Species of Wild Animals; Convention on Wetlands of International Importance; Convention on the Conservation of European Wildlife and Natural Habitats). Members of the European Union must also comply with a number of directives concerning wildlife (Dir 79/409/EEC; Dir 92/43/EEC). In siting farms, states must also take care to comply with international law concerning ships' freedom of navigation in the exclusive economic zone and right of innocent passage through the territorial sea (United Nations Convention on the Law of the Sea). Authorisation could not be granted to projects resulting in interference with the use of recognised sea lanes essential to international navigation (Scott 2006: 89–118).

Perhaps more importantly, one observes that national environmental laws in most countries are capable of providing for decisions to be made concerning wind farms. But they may not always do so in a way that strikes an appropriate balance over the long-term. Rather than providing a detailed account of specific instruments, this section introduces some general ideas and strategies that can be seen as underpinning effective decision-making frameworks.

First, fragmented regimes involving multiple statutory authorisations and agencies are generally undesirable and inefficient (International Energy Agency 2013; Young 2015: 148–174; International Energy Agency 2014). In this vein, the United Kingdom, Germany, and Denmark have implemented processes by which a single agency co-ordinates the permissions needed for a project (International Energy Agency 2013; Young 2015: 148–174). The hurdles that a fragmented regulatory environment in the European Union can pose for the offshore wind industry is well-attested (Long 2014: 690–715). In many jurisdictions, permitting frameworks continue to be divided along resource-specific lines (such as fisheries, navigation, pollution, petroleum) rather than integrated according to coherent areas of geographical space.

Secondly, particular projects should not necessarily be authorised simply because a general energy strategy demands it. Local concerns and effects must also be weighed. Some protective considerations may be considered to be "bottom lines" that must not be infringed, while others may more appropriately be weighed against the benefits a project would offer at a decision maker's discretion. For example, it may legitimately be decided that wind generation is an inappropriate (and therefore entirely prohibited) activity in protected marine areas (see generally Caine 2014: 89–127). In areas already proximate to industrial activities, considerations in favour of development may outweigh the benefits of absolute protection. In others, there may be more room for discretion and compromise.

Thirdly, although the need for some discretion is unavoidable, there should be a degree of certainty as to what legally relevant considerations will mean for applicants, decision makers, and the public. Regulatory uncertainty can be a significant hurdle to deployment. As well as a clear process, substantively the law should provide a fairly good idea as to what kinds of effects are acceptable and whether an application could be successful.

Fourthly, within a decision-maker's set of legally relevant considerations, it is important that the law accords appropriate weight to *benefits*. This includes strong guidance to the effect that discretion is to be exercised in a way that recognises the potential for the technology to provide for long-term energy security (Scott 2006: 89–118; McCormick and Vats 2012: 12–13). But it must also emphasise the *global* benefits of offshore wind farms. If deployed widely, they have potential to contribute significantly to climate change mitigation. Yet because decision making is the preserve of states, it may often be tempting for national or local concerns to override those of the global climate, particularly if a state has untapped fossil fuel reserves. This is the tragedy of the commons in action, and is a temptation that must be resisted. To some extent it can be overcome by placing a robust and stable price on carbon under an emissions trading scheme or tax, thereby attracting private finance for alternatives to fossil fuels, like wind (International Energy Agency 2013). In the long-term, this is likely to be dependent on an effective global agreement on carbon emissions, which may or may not be provided by the recent climate agreement reached in Paris. But the global benefits of wind farms also need to be built into national regulatory provisions as a counter-consideration to a project's adverse effects. Financial incentives under a carbon tax or ETS to submit an application mean very little in practice if commercially viable projects are then defeated through the regulatory process. Again, this does not presuppose that any particular project should be authorised, but at a strategic national level it *does* mean that the global and national benefits of offshore wind farms should be accorded substantial weight when compared to local adverse impacts.

Fifthly, it is important that *adverse* effects are also recognised in national legal frameworks, and weighed against benefits (Caine 2014: 89–127). In doing so, the law should clarify the relative weight to be given to local and national effects. The benefits of wind farms are usually disproportionately national and global (long-term energy security and climate mitigation), while adverse impacts are disproportionately local (e.g., impacts on marine ecosystems or amenity concerns) (New Zealand Parliamentary Commissioner for the Environment 2006). A decision maker, which may often (depending on the legal system) be local, should not be invited to decline authorisation for nationally beneficial projects simply because it chooses to focus on avoiding local impacts (Genesis Power Ltd. v. Franklin District Council, NZ EnvC Auckland 2005). If this occurred, nationally important projects could seldom come to fruition. This tendency can be exacerbated if local decision makers are comprised of elected officials, being concerned more with placating local NIMBY concerns than acting in the national interest (Giddings 2011: 75–86). Offshore wind farms will often reflect a national community of interest, and may need to be decided either by national level agencies or by local decision makers guided firmly by policies reflecting the national interest.

42.5 Charging Ahead: Emerging Best Practice in Regulating Marine Wind Farms

Several aspects of best practice have developed over the last decade or so concerning offshore wind farm regulation. This section briefly considers three of them.

First, an appropriate balance between various interests should be struck pro-actively at a strategic level, not only reactively at a project level. This means that law and policy-makers should be active in identifying particular areas where wind farms may and may not be appropriate *before* applications are made. Key to this is preventing development in areas identified in advance as protected. For example, guidelines produced under the OSPAR Convention (designed to protect the environment of the north-west Atlantic) recommend that the construction of installations should not occur in conservation sites or ecologically valuable areas (OSPAR Commission 2008b). That said, some have lamented the fact that states have been reticent to implement such recommendations in practice (Scott 2006: 89–118). Substantial work remains to be done in this space; in New Zealand, for example, legislation governing marine reserves has progressed only slowly.

A strategic approach to authorisation also involves the identification of areas where development would be *most* appropriate. We do not only want to prevent and mitigate environmental harm; we also want to ensure positive effects are actually achieved for social and environmental reasons. Whether this means a structured tendering process where only limited areas are opened up for wind development (see Caine 2014: 89–127), or whether it simply means the implementation of policies incentivising development in some areas over others, authorities should begin to take an active rather than passive role in shaping activities in offshore areas within their jurisdiction. This is particularly important where demand for offshore space is high, and where activities like wind farms require a great deal of space and room to expand. One may learn from experience in the oil and gas sector, where the strategic release of acreage is now the norm. In the United Kingdom, strategic environmental assessments (SEAs) have been undertaken to identify zones suitable for wind farms, while guidelines under the OSPAR and Bonn Conventions expressly recognise the importance of SEAs (Scott 2006: 89–118). These are, in essence, a process for predicting and evaluating the environmental implications of a policy, plan or programme (Ministry for the Environment 2005). Such pro-active assessment may be costly, but it is more likely than a system relying on ad hoc applications to nurture important activities while providing protection to more sensitive areas of the environment (Scott 2006: 89–118).

The more sophisticated concept of marine spatial planning (MSP) has also received much attention over the last few years (see Azzellino et al. 2013: e11–e25). This has been utilised in the European Union and elsewhere to mitigate what has been described as a "haphazard" approach to offshore wind deployment in what are increasingly congested areas (Dir 2014/89/EU; Long 2014: 690–715; Young 2015: 148–174; Douvere and Ehler 2009: 77–88). The concept is described in more detail in Chap. 54. In short, MSP involves a highly integrated strategic assessment of how different spaces should be developed for environmental, social, cultural and economic reasons, and how different activities and concerns can interact and conflict (Douvere and Ehler 2012: 111–133; Douvere 2010). It provides a degree of certainty as to how offshore space is to be developed in a way that is efficient and likely to maximise the benefits of development, and is particularly important where space is congested, in high demand, or crosses jurisdictional boundaries. Central to spatial planning is the idea that the specific use of limited space is important not only for reasons of environmental protection (although this is often an important part of it), but also to achieve strategic development aims, promote the equitable distribution of public resources, and to mitigate conflict (Young 2015: 148–174). It is a pro-active, rather than reactive, management approach, based on a "clearly articulated vision" (Young 2015: 148–174; International Energy Agency 2014). For example, it may be considered inappropriate to authorise the exclusive use of offshore geological formations for petroleum extraction where social and environmental aims would be better served by using it for carbon geo-sequestration (or both together). Marine areas with high wind and lower natural amenity value may be better reserved for wind farms.

Conflict management is extremely important in a spatial planning approach to offshore wind generation. All stakeholders, including those in potentially affected industries, like shipping, and recreational users, should have a voice in the strategic planning process (Scott 2006: 89–118; OSPAR Commission 2008b). Of course, this includes those with an interest in developing wind farms. Strategic areas for wind farm development should be identified in advance in order to minimise risks to navigation and other existing or future activities (spatial separation), and it is important that remaining risks be managed on an ongoing basis. But MSP also recognises that some activities can co-exist if managed carefully. Strict separation is a blunt instrument, and exclusive rights are not always necessary for viable development (or a particularly efficient use of finite space). One can picture the substantial space between offshore turbines that could be used for other socially and economically valuable purposes. Some have identified "unexpected synergies" that may exist between, for example, power generation and petroleum mining or fishing (Young 2015: 148–174; Diffen 2008: 240). Yet others have pointed out that MSP does not itself ensure sustainability; much depends on the substantive priorities that are determined at the political and practical levels and the weight that is placed on protecting the environment (Santos et al. 2014: 59–65). MSP could be used, for example, to prioritise oil and gas extraction. Yet it is a useful tool if used responsibly.

Secondly, it remains important for a detailed assessment of a wind farm at the *project* level. It is not enough to identify an area generally suitable for development and then allow it to proceed; close scrutiny of individual proposals and their adverse effects is needed. This should generally involve the provision of a detailed environmental impact assessment (EIA), which provides authorities with a sound information base on which to consider potential effects. In general terms, these are required under several international agreements concerning the marine environment and European law (see Scott 2006: 89–118; OSPAR Commission 2008b). EIAs should also be developed and assessed using an ecosystem approach. This involves a focus on environmental impacts as they affect entire ecosystems, including cumulative effects from different or existing activities, including where they cut across different laws, policies, and responsible agencies. It encourages a holistic, rather than sectoral, approach to managing different kinds of environmental impacts, and has been emphasised in OSPAR, among other international instruments (Convention for the Protection of the Marine Environment of the North East Atlantic). It is particularly important that permitting regimes and environmental assessments are harmonised across jurisdictional boundaries, such as that between the territorial sea and exclusive economic zone (Long 2014: 690–715; Young 2015: 148–174). After all, this is an artificial legal line that does not reflect the reality of natural systems, and separate regimes can introduce regulatory uncertainty and duplication of processes for applicants. (Indeed, given the work being done on floating turbines, it is timely to ensure that appropriate permitting structures are in place in the EEZ; this was addressed, e.g., by New Zealand in 2012 in new environmental legislation concerning the EEZ). An ecosystem approach to EIAs does not itself determine substantive outcomes, but is an important example of procedural good practice. As a project-level tool, it complements well the strategic-level tool of MSP.

Thirdly, in striking a balance both at the strategic and project levels, weight should be given not only to *known* adverse effects on the environment, but also to *potential* effects. In other words, offshore wind farms should be assessed according to a relatively strong version of the precautionary principle. This is a legal version of the old maxim "it is better to be safe than sorry," and provides most commonly that a lack of scientific certainty as to the adverse effects of an activity should not be used as reason to take no measures to address them. While considerable debate continues as to the status of this principle in customary international law (see Freestone 1999: 135–164; Cameron and Abouchar 1991: 1–27), it makes its presence strongly felt in a number of conventions touching upon the marine environment specifically, often in stronger language than its most well-known general formulation in the Rio Declaration (Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1996; Convention for the Protection of the Marine Environment of the North East Atlantic).

Yet even a robust precautionary approach does not require the elimination of *all* risk. The response taken to risk should be proportionate to the likelihood, magnitude, irreversibility and significance of potential effects, and authorisation should not be refused where risks can be effectively and safely managed (see generally Gillespie 2011: 264–385; Iorns Magallanes and Severinsen 2015: 201–234). Not all wind farm proposals can be treated alike. Moreover, comparative risk assessment is important. While the risks to the local environment of implementing a particular wind farm may be substantial, at a strategic level the environmental risks of inaction (reliance on fossil fuel generation) may be *greater*. Wind farms may *themselves* be conceived of as a precautionary response to the problems of climate change and energy security. Risk may also be *managed* rather than eliminated, and precautionary approaches may sometimes be implemented through adaptive management. This is where a proposal occurs at a reduced intensity or scale, which may be gradually increased as effects prove to be acceptable. In practice, this may see a wind farm begin by constructing and operating fewer turbines or restricting the area or times in which they operate, while undertaking extensive monitoring and review that feeds back into management decisions.

Precaution also suggests that decisions authorising offshore wind farms should not signal the end of the regulatory process. It is important for authorities to retain oversight over a project, not only to monitor and enforce conditions but also to review them if unexpected effects arise. This includes being satisfied, before authorisation is granted, that appropriate safeguards are in place for decommissioning. While UNCLOS itself does not prohibit the abandonment of turbines, nevertheless best practice suggests removal is necessary. A resolution of the IMO has strongly recommended that infrastructure be removed in almost all situations likely to apply to offshore windfarms (IMO Resolution 1989, A.672(16)). Moreover, while abandonment or toppling may not technically be a prohibited form of disposal under general international dumping law, it is not allowed under the more specific dumping regime applicable to those states parties to the OSPAR Convention where much development is occurring (Scott 2006: 89–118).

42.6 A Revolution Per Minute: Striding Bravely into a Low Carbon Energy Future

The last decade has witnessed a proliferation of offshore wind energy projects, notably in northern Europe. To some extent many challenges presented by the technology have been or are in the process of being overcome, and technological refinements are increasing its potential. The dual issues of climate change and energy security demand that renewable energy sources are exploited, and offshore wind generation presents an exciting opportunity to do so. However, as with any industrial scale activity in the oceans, we must take care. Exploration, construction, operation and decommissioning present numerous potential adverse effects on people and the environment, and these challenges do not look likely to go away. Environmental law must provide a framework within which numerous competing interests can be resolved.

In many areas of national law, best practice has emerged or is emerging. This chapter has considered a few of them. Most fundamentally, frameworks for decision making must provide a mechanism that expressly recognises both the benefits and risks of wind farms, and a matrix within which they can be weighed consistently and transparently. This should occur both at a strategic level, through the use of spatial planning and wide consultation, and at a project level, through the use of robust EIAs and a holistic focus on ecosystems. Decision makers should hold the precautionary principle or approach at the forefront of their minds when considering projects; however, this should involve comparative risk analysis and risk may be managed rather than eliminated. Consistent with this "look before you leap" ethos ingrained in the precautionary principle is a need for consenting mechanisms to look well into the future, and to plan for the decommissioning process from the outset.

The local risks of offshore wind farms should certainly not be ignored. But the focus needs to be on the avoidance, mitigation and management of adverse local effects and a recognition of substantial potential for positive effects at a national and global level, rather than relying wholly on arbitrary bottom line standards concerning the local environment to determine when a project should proceed. The success of an offshore wind farm industry relies on a balanced, yet receptive, legal and policy landscape. Looking to the future, and the advent of floating wind farms capable of being sited in deeper water, some may even wish to tackle the more difficult (but presently theoretical) issues associated with management on the high seas. Although not explored here, it is worth noting that international law (UNCLOS) presents much more substantial barriers to projects on the high seas and their regulation by coastal states (see Young 2015: 148–174).

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