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EDITED BY
Maria Vittoria Struglia,
Energy and Sustainable Economic Development (ENEA), Italy

REVIEWED BY
Giuseppe Giorgi,
Politecnico di Torino, Italy

*CORRESPONDENCE
Gabriele Paolinelli,
gabriele.paolinelli@unifi.it

†These authors have contributed equally to this work

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On marine wind power expressiveness: Not just an issue of visual impact

Gabriele Paolinelli[1*†], Lorenza Fortuna[2†], Ludovica Marinaro[3†] and Antonella Valentini[1†]

[1]Department of Architecture - Landscape Design Lab, University of Florence, Florence, Italy, [2]Ph.D. Programme in Landscape Architecture, University of Florence, Florence, Italy, [3]School of Architecture, University of Florence, Florence, Italy

Technological research for the exploitation of marine energy has produced significant advances which promise to expedite the process of transitioning to renewable resources. However, many issues hinder the effective exploitation of marine energy: among these are cultural concerns regarding the visual impacts of these technologies used. Assuming that "protecting" means preserving without banning evolutive changes, seascape protection and ecological transition are not alternatives because both converge toward sustainability. Even so, scientific concepts, technical practices, social perceptions, and the decisions and actions associated with them raise contradictions and conflicts. Within the complex challenge of ecological transition, clean energy availability arises as a necessary and imperative condition. This article proposes a critical landscape design perspective which focuses on the importance of understanding and expressing contemporaneity through the changes it brings to habitats and life. A focus on the visual impact of marine wind turbine is proposed as an example for a general discussion on technical and social perceptions in a context of both cultural and spatial transition. Site-specific critical visions have to be imagined and discussed to produce not business as usual transformations. This article aims to show that decisions predominantly influenced by issues of visual impact do not adequately express the cultural dimension of ecological transition.

KEYWORDS

ecological transition, blue energy, visual impact, expressiveness, seascape, Mediterranean Sea

Introduction: Ecological transition, today's challenge is one of a long series

Over 60 years ago Sylvia Crowe wrote "Tomorrow's Landscape" (Crowe, 1956), "The Landscape of Power," (Crowe, 1958) and "The Landscape of Roads" (Crowe, 1960). Something was changing in economies and societies, and landscapes were recording the ongoing transitions. Human beings have been using wood for over 120.000 years and coal for more than 800 years; over the last three centuries massive quantities of coal have been burnt to produce energy, and oil and gas have been used for the same purpose since the

early nineteenth century. Surface water, underground heat and nuclear reactivity have been in use for half a century or thereabouts, and (and) solar and wind power for a decade or so. Human societies have always been in transition, but in the last three centuries they have multiplied emissions and waste. In the 20th century the increasing demand for energy caused the electrification of countries and the expression of this in their landscapes. Nowadays we need technologies that will transform natural energies without producing greenhouse gases or generating radioactive waste. "Electrification of the Landscape," a research project the University of Florence is currently undertaking, explores the issue of expressing of contemporaneity, which is also the focus of this paper.

The processes that Crowe envisaged in her seminal books are today widely implemented. In Italy, electricity consumption has increased nearly 40 times from about 8 TWh in 1931 to about 314 TWh in 2011 (ISTAT, 2022). Since the end of the 1980s, internal production, although greatly increased, has not covered national consumption.

The impacts of marine technologies upon ecosystems, fishing, navigation, tourism and recreational activities, vary considerably and productivity levels depend on the available energy: these two factors, therefore will define specific potentials and limits of use. This makes the assessment of the environmental and economic-financial feasibility of such transformations is a priority. The visibility of marine technologies is mostly seen as an issue of visual impact, but landscapes and seascapes are expressions of societies and economies within environments, rather than just panoramas or images. So the ecological transition paradigm is challenging the aesthetics of contemporary cultures and the visibility of changes is affecting its social acceptance. To this general approach to landscape protection, the specific Italian context adds the controversial positions of the landscape authorities, mostly still focused on the 20th century concepts of the preeminence of aesthetic and panoramic values. Planning ecological transition in the Mediterranean region requires a systemic understanding of landscapes and how best to protect them. The care of natural richness and cultural heritage makes it possible to "achieve sustainable development based on a balanced and harmonious relationship between social needs, economic activity, and the environment" (CE, 2000). But we also have to consider that "public understanding of marine cultural landscapes and seascapes is limited yet" (Pungetti, 2012). Because cultural perceptions matter, a vision of the sea is not only just as the environment or territory but also as a special kind of space, with water-covered land and a meaningful liquid surface. This sensitive attention that the English (and German) word "seascape" denotes is missing in the Italian language (and culture); therefore, the commitment is that the word "paesaggio" should be fully inclusive of the dimension of the sea.

Seascape and blue energy

From a formal point of view, the use of certain words is indicative. The Convention on the Law of the Sea (UN General Assembly, 1982) does not use the terms "landscape" or "seascape," but "territory," "environment" and their derivatives do recur several times. With regard to the environment, a regional convention for the Mediterranean Sea was signed in 1976 and then amended to become the Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (UNEP/MAP, 1995). The Marine Strategy Framework Directive (EC, 2008) has the same profile. Although the Landscape Convention approved by the Council of Europe makes no reference to "sea" or "seascape," the text is explicit and demanding when it "includes land, inland water and marine areas" (CE, 2000). The scientific literature identifies seascape with regard to specific features. "(...) the concept of seascape, initially meaning a picture or view to the sea, or a view of an expanse of sea (Oxford English Dictionary), has been broadened to mean the coastal landscape and adjoining areas of open water, including views from land to sea, from sea to land and along the coastline. As it can describe the effect on landscape at the confluence of sea and land, seascape becomes an area of intervisibility between land and sea, with three defined components: sea, coastline, and land" (Pungetti, 2012). So with regard to the sea it is evident that there are not only territorial, environmental and blue energy issues, that beyond environmental and economical issues, there is not only the social issue of visual impact.

According to European Commission communications on Blue Energy (EC, 2012; EC, 2014), offshore wind and marine technologies can generate electricity and contribute towards sustainable development. In fact, technological developments can positively impact the supply of sustainable electricity, even though average potentials in the Mediterranean Sea are lower than those found in the North Sea and the oceans (Golfetti et al., 2018; Nikolaidis et al., 2019). Research into the exploitation of marine energy has produced significant advances which have the potential to expedite the process of ecological transition (Pisacane et al., 2018) but there are still issues that need to be explored (Golfetti et al., 2018).

Regarding the visibility of energetic changes, we consider the development of offshore wind plants as a key to understanding landscape relationships brought into existence by the visibility of sustainable energy generating infrastructure. With regard to the impact of this type of infrastructure on visual resources and the stewardship required, the literature makes it clear that a dominat issue is how the impact is classified (Golfetti et al., 2018). Some researches (Haggett, 2010; Jones and Eiser, 2010; Walker et al., 2014) highlight how sensitivities towards visible changes along coastal landscapes and seascapes are not only caused by exterior attachments to their images but also depend on people's sense of places, be they insiders or outsiders, tourists or workers, and

independently of their ages and social ranks. Technocratic approaches are characterised by a lack of public participation and unfortunately this is widespread in the decision-making and design processes for offshore wind plants (Breukers and Wolsink, 2007; Wolsink, 2007). Effective engagement with local stakeholders is likely to result in a fuller, and more meaningfullikely to result in a fuller, and more meaningful understanding of the issues involved (Van Hooijdonk et al., 2007). Wind turbines can easily seem contradictory and unrelated to the consolidated image of marine landscape: they provide new perceptions and change the relationship between the landscape and the observer (Pasqualetti, 2011; Sullivan et al., 2012a; Donaldson, 2018; Colafranceschi and Manfredi, 2021). Most studies are about to move away from what is identified as a visual problem (O'Keeffe and Haggett, 2012), or at least from the solution of making that which is impossible to hide seem smaller. This prevailing perspective makes the need for mitigation arise as a key point if there is to be a general acceptance of wind farm implementation (Sullivan et al., 2012b; Walker et al., 2014; Donaldson, 2018), bringing into play several aspects of the design process.

By only evaluating the visual impact of a wind farm with a view to pushing it further offshore, its expressive potential is denied before it has been critically investigated. The visibility of marine wind turbines needs to be discussed in a context that does not only seek to mitigate the effect of their presence but also identifies what they can add to seascapes in terms of aesthetic meaning and scenic value. In such conceptual framework the transitioning of the landscape emerges as a sensitive matter, to be evaluated and framed taking into account people's attachment to places and their sense of landscape's identity loss (Jones and Eiser, 2009; Gee, 2010; Haggett, 2010; Pasqualetti, 2011; Walker et al., 2014; DeWan, 2018). Social perceptions, though, depend on cultures and attitudes which change over time: turbines could become inherent to seascapes. Moving energy generating plants offshore for tens of kilometers requires the laying of submarine cables which increases their environmental impacts and makes their construction and management less economically viable (Green and Vasilakos, 2011). If the intention of hiding wind farms is replaced with a willingness to consider their expressive potential the point of view could shift towards an understanding of sustainable aesthetics (Nohl, 2001; Meyer, 2008; Paolinelli, 2018).

Position: Expressing versus hiding

While most contributions focus on how to hide or reduce disturbance and visual disamenity of marine wind farms (Ladenburg and Dubgaard, 2009; Krueger et al., 2011; Donaldson, 2018), it is worth trying to change this perspective and consider energy transition as an opportunity to design something which will have an effect on aesthetics. In fact hiding anthropic changes is a strange, non-evolutionary way of expressing their meanings.

With regard to Blue Energy, some features of the sea matter. It is a wide-open surface, for the most part uniform and flat, which hosts few anthropic structures, mostly perceived from on-shore points of view and less frequently from off-shore, and it has a straight continuous horizon that distinguishes its surface from the sky. Seascapes express unique scale factors in terms of objects-background and object-surface relations.

Thus, we could argue that the width of the sea surface probably makes large turbines more suitable than smaller ones, and that the almost total absence of human structures could significantly reduce scale concerns for such huge technological devices (Scottish Natural Heritage, 2014). Visual perceptions also depend upon distances. A short distance produces an imbalance of scale between the observer and the power plants. These dominate the scene, making it seem disharmonious and disturbing the comprehensibility of the seascape's new connotation. If the power plants are too far from any potential point of view their connoting capacity decreases, and the low comprehensibility of the images generates disturbance. Thus, it is worth evaluating distances as key factors when designing wind farms, in order to balance environmental and visual impacts, and construction and management costs. Some authors (Ladenburg and Dubgaard, 2007; Haggett, 2010) however argue that it is worth moving the power plants as far away as possible to reduce their visual impact, despite the higher cost. Power plant planning must provide congruous coastal marine corridors to safeguard the many human activities which depend on seascapes; it must also allow for large marine fields, in order to alternate the visibility of smaller areas of changed seascape with larger ones that maintain the horizon intact.

According to Sullivan et al. (2012a) and Colafranceschi and Manfredi (2021), rotational motion is sometimes perceived as a factor of visual disturbance, unrelated, and detached from the seascape scenery, because it contrasts with backgrounds' stillness. This perspective recalls the notion of panorama: a view to be observed as a canvas with fixed images whereas in seascapes everything is actually in constant movement, both in the sea and in the sky, with natural changing speeds and rhythms. Seascape reveals the power of nature and our ability to exploit it: wind turbines are just human inventions that highlight natural forces.

For engineering reasons wind farms are generally designed in regular patterns with clusters prevailing over one-line patterns. We suggest that, independently of their orientation, extended lines of turbines should also be avoided for visual reasons because they could adversely affect the view of the horizon making it uniform and continuously disturbed by structures.

Looking for a seascape planning position on the issue of offshore wind plant visibility, here we propose a preliminar focus on distances from the shore, the main focus in the literature on visual impact and social acceptance. This literature clearly

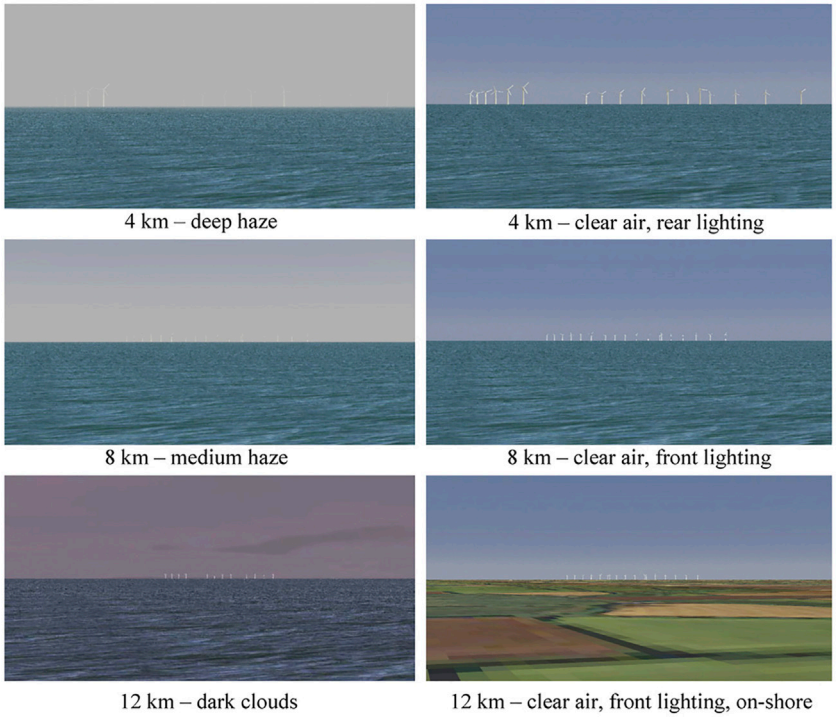

FIGURE 1
Simulation of visibility as a variable of distance: the visual recognition of turbines appears weak at around 8 km and compromised at around 12. Source of image: Bishop and Miller (2007, page 819).

demonstrates that opinions on these issue depend primarily on social perceptions and indicates the need to identify basic topics that can be culturally shared. Here, we are not defining visual dimensional planning standards but just posing a concept: expressing versus hiding. So we have consulted available visual data to reflect on the topic, but parametric digital simulations will need to be elaborated to test the hypothesis.

Some simulations carried out by Bishop and Miller (2007) about turbines of a 2.0 MW commercial facility with a 100 m tower and 40 m blades show that at 4 km from the coast both the turbine formations and the marine horizon which they interfere with are legible. Around 8 km, the legibility weakens and at around 12 km it appears compromised (Figure 1). This fits in with the findings of Sullivan et al. (2012b) as we can also see in Figure 2: at about 12 km from the coast turbines are still visible, but at such a distance it is no longer possible to perceive the composition of the clusters or to enjoy the alternation of seascape with intact horizon. So, we can hypothesize the need for a distance at least 20 km to avoid visual interference with the horizon. Conversely, close to the shoreline wind plants not only interfere with many activities but also produce heavy scale imbalances of the scenery. Regarding turbines for commercial plants with heights of between 100 and 200 m approx., a distance of 2 km is just a dimension with a 10 factor for heights till up to 200 m and a 20 factor for heights up to 100 m. Here, the hypothesis regards the visual inadequacy of the strip lying between the shoreline and 2–5 km out to sea, with the exception of small wind farms with only a few turbines that can become landscape identity factors expressing the ecological energy transition.

Between the distances of 2–5 km from the coast and 20 km from it, the visual effects of inserting wind farms change. In the area closest to the coast, clusters and their compositions may be legible both compared with the spatial fields without turbines and with the horizon visibility within the clusters, while in the furthest area there are the conditions of visibility and illegibility mentioned earlier. A distinction of the two bands may be assumed as from 2–5 km from the shore up to 5–10 km, and 5–10 km up from the shore to 20 km.

These topics should be investigated with regard to the dynamics of social perceptions by submitting simulations as photorealistic images (rendering) or as immersive experiences (augmented reality) and by holding discussions within participatory processes, which also enhance cultural awareness of ecological transition in the same context as care of seascapes. In a general hypothesis about the changes in seascape expressivity the suitable plant options for large 2 MW industrial turbines from 100 to 200 m high are probably two of the four possible:

– Far away from the shore (d > 20 Km approx.) - a recommended alternative: the turbines are far enough to away eliminate visibility

FIGURE 2
A sample of low visual impact with lack of expressiveness of changes. In such a situation, the infrastructures are not far enough away to eliminate their visibility on the horizon and not close enough to be perceived from the coast. Source of image: Sullivan et al., 2012b, page 6 of the conference paper.

on the horizon but offer a comprehensible and expressive visual of sustainable energy generation to passing ships;
– A medium distance from the shore (5–10 Km approx. < d < 20 Km approx.) - an inadvisable alternative: the turbines are not far enough away to eliminate their visibility on the horizon and are not close enough to be comprehended from the coast line therefore thereby denying expression to the energy transformation process;
– Not far from the shore (2–5 Km approx. < d < 5–10 Km approx.) - a recommended alternative: the turbines are far enough to avoid scale imbalances but close enough for comprehensibility from the coast and therefore for giving expression to the energy transformation process;
– Close to the shoreline (d < 2–5 Km approx.) - an inadvisable alternative: the distance is insufficient to avoid scale imbalances.

Discussion: Ecological transition in seascapes

Protecting a seascape means preserving its essence without preventing changes. This means that seascape protection and ecological transition are complementary to achieving the goal of sustainability. Scientific concepts, technical practices, social perceptions, and the consequent evaluations, decisions, and actions can help prevent contradictions and conflicts.

In every age and geographical area, landscapes and seascapes express the relationships between nature and culture in space and time: the present was once a future and it is going to become a past. The sustainability balances of energy transition interventions need to consider cultural as well as environmental and economic–financial issues. Visual impact is not the only issue if we seek to "express" changes rather than "hiding" them. It is not feasible to reduce these issues to a binary form: yes vs. no, close vs. far, and very visible vs. barely visible. Rather, there is a need to calibrate certain quantities, which are essential quality factors. Visual impact assessments are not enough, we need to design comparisons of expressible scenic properties. Nor are purely technical comparisons sufficient: we need iterative participatory processes to produce more meaningful results.

Because environmental issues are essential for sustainability, they must be *a priori* considered and satisfied, with increasing

recourse to multi-scale balances which also take into account the ecological impacts of non-transition scenarios. With regard to the three linked goals of the New European Bauhaus promoted by the European Commission, it is essential to build not only more sustainable but also more beautiful and inclusive landscapes. Moreover aesthetics are included among the non-material cultural services in the Millennium Ecosystem Assessment (Swaffield and McWilliam, 2013). So we need to constantly bear in mind that sustainability is the comprehensive key of contemporaneity and to understand that beauty cannot exist without it. Ecological transition is stressing our societies with essential challenges that have to be dealt with by thinking together about ecology, economy, ethics, and aesthetics.

In Italy, 64 projects for floating offshore wind farms have recently been proposed and 40 of those have been examined (MiTE, 2021). At least 20 of the expressions of interest have proposed detailed projects, which in many cases include floating plants located over 12 miles from the coast. Of the 40 floating offshore wind farm projects that have been examined, many are located off the coast of Sicily and Sardinia (more than 20), others are located along the Adriatic coast (more than 10) and the remainder are distributed between the Ionian and Tyrrhenian (MiTE, 2021). If the reason for this propensity to float the wind farms offshore lies in the search for the best environmental and economic cost-benefit ratios, this is the right way to proceed. If, on the other hand, the predominant reason is to move the wind farms as far away as possible so they are seen as little as possible, then the choice is inspired by an obsolete concept of landscape and it will limit the development of the essential cultural dimension of ecological transition and compromise the expression of natural energies through human imagination and action. In the official communication of the Ministry of Ecological Transition, we read that it is continuing its work aimed at encouraging the development of a new generation of floating offshore plants, located off the Italian coast and therefore devoid of any impact on the landscape (MiTE, 2021). Once again, visual-impact based positions seem to prevail. As considering landscapes and seascapes as panoramas is simplistic, there need to be changes to this banal approach. Critical scenarios need to be developed and compared using expert design processes and then discussed and selected through participation processes in which the local communities involved are actively engaged. The more ecological transition remains unexpressed or poorly expressed, the less it will be understood both by living and future generations.

A century after the Mumford proposal, we again need utopia to look for "a reconstituted environment, which is better adapted to the nature and aims of the human beings who dwell within it than the actual one; and not merely better adapted to their actual nature, but better fitted to their possible development" (Mumford, 1922). Such planning, mostly intended as a "strong forward looking action" (CE, 2000), can bring forth the beauty inherent in sustainability and stimulate the understanding of its meaning (Paolinelli, 2018). "The intrinsic beauty of landscape resides in its change over time. Landscape architecture's medium (...) is material and tactile; it is spatial. But more than its related fields, the landscape medium is temporal" (Meyer, 2008).

Transition means change and we cannot expect landscapes to defy evolution and not express this change. Landscapes sediment the effects of what we do and represent who we are, our participation in life on Earth. Removing the things we make from our backyards and hiding them far away and out of sight or coloring them green, does not erase them, but it does erase our will to express ourselves. Another problem that this transition poses is therefore to avoid hiding and to express the human intervention in the landscape well.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material; further inquiries can be directed to the corresponding author.

Author contributions

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