Mare Incognitum, Part I: Do We Now Need (to at Least Discuss) a Mobile Offshore Renewables Unit Convention?

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见风转舵—See the wind, turn the helm.

—Chinese Proverb

The sea with its winds, its storms and its dangers never changes and this demands a necessary uniformity of juridical regime.

—Pasquale Stanislao Mancini in his inaugural address to the University of Turin, 1860[1]

1. *See* Patrick Griggs, *Obstacles to Uniformity of Maritime Law—The Nicolas J. Healy Lecture*, 34 J. MAR. L. & COM. 191, 192 (2003); Stuart Hetherington, *The Elusive Panacea of Uniformity: Is it Worth Pursuing?*, COMITÉ MAR. INT'L (CMI) 4 (Sept. 18, 2013), http://amtac.org.au/wp-content/uploads/2016/07/AMTAC-Address-2013-The-Elusive-Panacea-of-Uniformity.pdf.

I. INTRODUCTION

Around the world, states are producing or planning to produce electrical power in their respective territorial seas and exclusive economic zones (EEZs) from a variety of offshore renewable energy resources. So far, the majority of this has been delivered by offshore wind. By the end of 2019, there were 29,136 MWs of installed offshore wind capacity worldwide,[2] and by mid-2019, almost 5,500 offshore wind turbine generators (WTGs) were connected to onshore grids.[3] Almost all of this offshore wind capacity consists of individual WTGs mounted on a permanent fixed-bottom monopile, multi-pile, jacket, gravity, or suction bucket foundation (a "fixed-bottom foundation" and the WTG and fixed-bottom foundation together, a "fixed-bottom WTG") in shallower waters (<60m) typically nearer to shore. These fixed-bottom offshore renewables facilities are subject to their own legal regimes and issues which are not the focus of this Article or its sequels.[4]

However, a variety of new non-fixed, floating offshore renewable energy technologies are also now being developed and deployed around the world. Some of these floating facilities ("Floating Generation Units") generate electrical power from the winds, waves, tides, sun, or differences in ocean water temperatures. Other floating facilities ("Floating Auxiliary Units") provide auxiliary services to those Floating Generation Units. Hybrid facilities ("Floating Hybrid Units"), incorporating multiple

2. *Global Wind Report 2019*, GLOBAL WIND ENERGY COUNCIL 44 (Mar. 2020), https://gwec.net/global-wind-report-2019/.

3. *Offshore Wind Outlook 2019*, INTER. ENERGY AGENCY 15 (2019), https://webstore.iea.org/offshore-wind-outlook-2019-world-energy-outlook-special-report. Compare this to an estimated 1,500 offshore oil and gas installations worldwide in 2013. *See* Steven Rares, *An International Convention on Offshore Hydrocarbon Leaks?*, CMI YEARBOOK 2013 340, 340 (2013).

4. The author is anecdotally aware of fixed-base installations legal treatment as fixtures to real estate, and alternatively, is aware of the non-floating mobile equipment capable of detachment from the foundation.

technologies in a single floating unit, also are being developed. These Floating Generating Units, Floating Auxiliary Units, and Floating Hybrid Units (each a "Mobile Offshore Renewables Unit" or MORU) might be deployed as a standalone unit or in larger arrays consisting of multiple MORUs (each such array, a "MORU Array"). Each of these technologies are described in greater detail in Part II below.

MORUs possess a number of potential territorial, technological, economic, and legal advantages over comparable fixed-bottom and onshore renewable energy technologies for coastal states seeking to exploit offshore renewable energy resources in the superjacent waters of their respective territorial sea and EEZ for the production of energy (each such coastal state, a "Producing Coastal State"). Because they float, MORUs have inherent territorial advantages over competing fixed-bottom renewables technologies—they can be deployed in waters not currently economically viable for comparable fixed-bottom facilities, whether shallower waters with subsea geology inappropriate for fixed-bottom foundations, or deeper waters.[5] This can significantly expand the usable portion of a Producing Coastal State's EEZ. For reasons described in Part II, some MORUs may have technological advantages over fixed-bottom or onshore renewable installations—whether that is an increase in power production relative to fixed-bottom or onshore equivalents found with some MORUs, or in the case of floating tidal energy converters, the ability to combine a predictable production cycle with energy storage to provide a renewable energy baseload power station.[6]

Not surprisingly, the anticipated gross revenue from MORUs might materially differ from that of onshore or fixed-bottom equivalents. Conversely, anticipated MORU costs can also materially differ. As is expected with developing technologies, the capital and operational expenditures ("capex" and "opex," respectively) of research and pre-commercial MORUs are currently higher than equivalent onshore or fixed-bottom commercial offshore technologies on a per MW installed basis. However, capex and opex for serially-produced MORUs could soon

5. *See Floating Offshore Wind Energy: A Policy Blueprint for Europe*, WINDEUROPE § 1.2 (Oct. 2018), https://windeurope.org/wp-content/uploads/files/policy/position-papers/Floating-offshore-wind-energy-a-policy-blueprint-for-Europe.pdf.

6. *See Shetland Tidal Array goes 'Baseload' with Tesla Battery*, MARINE ENERGY (Oct. 30, 2018), https://marineenergy.biz/2018/10/30/shetland-tidal-array-goes-baseload-with-tesla-battery (describing a fixed-bottom tidal energy array combined with a Tesla battery system used as a baseload power plant, which offsets inherent storage losses with the advantage of constant power delivered throughout the day).

be less than those costs for equivalent fixed-bottom facilities, particularly at deep water sites.[7]

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7. *See Going Global: Expanding Offshore Wind to Emerging Markets*, WORLD BANK 4 (2019), http://documents.worldbank.org/curated/en/716891572457609829/pdf/Going-Global-Expanding-Offshore-Wind-To-Emerging-Markets.pdf ("While floating turbine capital costs are [currently] more than double that of fixed foundations, they are expected to drop substantially over the next decade. Since 2009, the cost of floating turbines has fallen 86 percent as projects move from single to multiple turbine demonstrations."); WINDEUROPE, *supra* note 5, at § 1.2 ("[Floating Offshore Wind] has some specific cost advantages compared to [fixed-bottom WTGs]. It requires less operations taking place at sea compared to [fixed-bottom WTGs]. The installation process is less dependent on weather, soil, and sea conditions . . . . Developers can assemble and pre-commission [WTGs] onshore and tow the entire [FWT] to the site offshore . . . . [a]ssembly takes place in a much safer and more controlled environment. Once at sea operators have the option to tow back the [FWT] to port when large operations are required (e.g. blade replacement), thus facilitating the operation & maintenance of [Floating Offshore Wind] farms."); *Floating Wind: The UK Industry Ambition*, SCOTTISH RENEWABLES 4 (Oct. 2019), https://www.scottishrenewables.com/publications/floating-wind-uk-industry-ambition/ (". . . .we expect floating wind to be cost-competitive with other energy technologies by 2030"); Christopher Hopson, *Offshore Wind 'A Must' for Spain as Iberdrola Renewables Chief Tips Floating*, RECHARGE (Jan. 8, 2020), https://www.rechargenews.com/wind/offshore-wind-a-must-for-spain-as-iberdrola-renewables-chief-tips-floating/2-1-733718; Darius Snieckus, *Floating Wind Could Best Bottom-fixed by 2026 in Market 'in Flux'*, RECHARGE (July 25, 2019), https://www.rechargenews.com/wind/1828537/floating-wind-could-best-bottom-fixed-by-2026-in-market-in-flux ("Floating wind power . . . . could be competitive with conventional offshore wind as early as 2026, ... but hinge on a global build-out rate that remains uncertain. . ."); Neil Ford, *Floating Wind Built in Series Could Be Cheaper than Fixed-Bottom*, REUTERS (June 12, 2019), https://analysis.newenergyupdate.com/wind-energy-update/floating-wind-built-series-could-be-cheaper-fixed-bottom ("Floating wind costs are set to plummet in the coming years as developers move from pilot projects to wider commercial deployment. With appropriate support, ... costs could drop to 80 to 100 euros per MWh ($90-$113/MWh) for projects financed by 2025, and fall to €40 to 60 euros/MWh by 2030, WindEurope said in a recent report"); *Equinor Eyes Floating Feast*, RENEWS (June 26, 2019), https://renews.biz/53975/equinor-eyes-floating-feast/ (citing Equinor's Sebastian Bringværd for the proposition that floating wind projects can deliver power at between €40-60/MWh by the end of the next decade); *What's Floatin': Big Push for Floating Wind*, QUEST FLOATING WIND ENERGY (Oct. 30, 2019), https://questfwe.com/big-push-for-floating-wind/ (estimating an LCoE of US$ 100.2/MWh on a planned 504 MW Korean Array); *Equinor Cuts Floating Wind Costs by 40% in Design Revamp*, REUTERS (Dec. 4, 2019), https://analysis.newenergyupdate.com/wind-energy-update/equinor-cuts-floating-wind-costs-40-design-revamp; Darius Snieckus, *Wave Power Targets 'Being Competitive with Gas' After EU Technology Breakthrough*, RECHARGE (Apr. 7, 2020), https://www.rechargenews.com/transition/wave-power-targets-being-competitive-with-gas-after-eu-technology-breakthrough/2-1-789813; Darius Snieckus, *Scottish Floating Wind Power Could be Brought to Market 'at $66/MWh'*, RECHARGE (June 24, 2020), https://www.rechargenews.com/wind/scottish-floating-wind-power-could-be-brought-to-market-at-66-mwh/2-1-832500; Darius Snieckus, *New-age Mooring Could Cut 'Many Tens of Millions of Dollars' from Floating Wind Projects*, RECHARGE (Apr. 24, 2020), https://www.rechargenews.com/markets/new-age-mooring-could-cut-many-tens-of-millions-of-dollars-from-floating-wind-projects/2-1-797254.

Finally, MORUs also have potential legal advantages over equivalent onshore or fixed-bottom facilities as well. MORUs are a form of moveable property—and therefore unlike other forms of renewable energy assets permanently fixed to the soil (or the seabed). This mobility allows fundamentally different legal and business models than those currently used for onshore and fixed-bottom offshore renewables energy projects, some of which are described herein. Given the ease with which a MORU might be redeployed to other sites, different finance and ownership structures to facilitate MORU procurement could become more feasible with the right legal framework.

MORUs lie at the technological intersection of the maritime, oil and gas, and renewables sectors. Because they may be deployed in and moved through multiple coastal states' waters during their lifetimes, MORUs also sit at the legal intersections of public law (including maritime and non-maritime aspects of international and domestic public law), private law, energy and environmental law, sustainable finance, and the fight against climate change. However, there are a number of potential legal obstacles to broader deployment of MORUs, particularly where there are international considerations.

Historically, unusual watercraft without means of mechanical propulsion are a source of domestic and international legal uncertainty, arising from many disputes[8] and frequent academic debate[9] about the

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8. *See, e.g.*, Wells v. Owners of the Gas Float Whitton No. 2 (The Gas Float Whitton No. 2), [1897] A.C. 337 (HL) 337 (appeal taken from Eng.); Regina v. Goodwin, [2006] 1 Lloyd's Rep. 432, (C.A.); The "Von Rocks," [1998] 2 Lloyd's Rep. 198 (Ir.); Stewart v. Dutra Constr. Co., 543 U.S. 481, 489-90, 2005 AMC 609, 614 (2005); Lozman v. City of Riviera Beach, Fla., 568 U.S. 115, 2013 AMC 1 (2013).

9. *See, e.g.*, Michael White, *Offshore Craft and Structures: A Proposed International Convention*, 18 AUSTL. MINING & PETROLEUM L.J. 21, 22 (1999) ("The development of offshore techniques and practices since 1977 has produced a wider range of new craft which have made the legal position more confused."); Richard Shaw, *The FPSO—Is It a Ship? The Proposed CMI Offshore Mobile Craft Convention—An Update*, AMPLA YEARBOOK 81 (2000), http://www.austlii.edu.au/au/journals/AUMPLawAYbk/2000/7.pdf ("The absence of consistent rules governing the application of well-established maritime concepts developed for ships to the unfamiliar looking craft developed by the offshore industry creates legal uncertainty . . . . [and] is a matter of grave concern."); Bruce Grant, *What Is a "Ship": R v. Goodwin in the Court of Appeal*, 2 WEB J.C.L.I (2006), http://www.bailii.org/uk/other/journals/webJCLI/2006/issue2/grant2.html; Zuzanna Peplowska, *What Is a Ship? The Policy of the International Fund for Compensation for Oil Pollution Damage: The Effect of the Greek Supreme Court Judgment in the Slops Case*, 1 AEGEAN REV. L. SEA 157 (2010); Stewart Peck & David Sharpe, *What Is a Vessel?: Implications for Marine Finance, Marine Insurance, and Admiralty Jurisdiction*, 89 TUL. L. REV. 1103, 1104, 1132 (2015); Henning Jessen, *Was Ist ein "Schiff"? — Eine Aktuelle Definitionsfrage mit Versicherungsrechtlicher Relevanz für Offshore-Anlagen*, VERSICHERUNGSRECHT 670-80 (2014);

meaning of the terms "ship" and "vessel," and similarly there has been no international consensus on whether they would be registerable as such.[10] In this way, MORUs resemble the mobile offshore units and floating platforms of the offshore oil and gas industry (each such oil and gas mobile offshore unit or floating platform, an "O&G MOU"), some of which have been recognized as vessels in their own right[11] and some of which have not.[12] Similarly, offshore watercraft which are unmanned during operation are potentially problematic.[13] Consequently, it cannot be assumed *ab initio* that MORUs deployed across multiple borders will fit seamlessly within maritime law's patchwork of domestic law and international maritime conventions governing traditional manned merchant vessels endlessly sailing the seas.

Conversely, because of limitations placed on coastal states' sovereignty over their EEZs by the law of the sea (whether customary or codified under the United Nations Convention on the Law of the Sea[14]

Alexander Severance & Martin Sandgren, *Flagging the Floating Turbine Unit: Navigating Towards a Registerable, First-Ranking Security Interest in Floating Wind Turbines*, 39 TUL. MAR. L.J. 1, 4 (2014); Gotthard Mark Gauci, *Is It a Vessel, a Ship or a Boat, Is It Just a Craft, or Is It Merely a Contrivance?*, 47 J. MAR. L. & COM. 479, 486-87 (2016).

10. *See* White, *supra* note 9, at 23. *See generally* Severance & Sandgren, *supra* note 9.

11. *See, e.g.*, In re Oil Spill by The Oil Rig "Deepwater Horizon" in the Gulf of Mexico, 808 F. Supp. 2d 943, 949 (E.D. La. 2011); Rares, *supra* note 3, at 349-350.

12. *See, e.g.*, Mendez v. Anadarko Petroleum Corp., No. H-10-1755, 2010 WL 4644049, at *2, 7-8 (S.D. Tex. Nov. 9, 2010); Riley v. Alexander/Ryan Marine Servs. Co., 983 F. Supp. 2d 884, 888-90 (S.D. Tex. 2013) (finding that the *Red Hawk* cell spar production platform was not a vessel under the Jones Act); Jordan v. Shell Oil Co., No. G-06-265, 2007 WL 2220986, at *1-2 (S.D. Tex. 2007) (finding the *Ursa* tension leg platform production platform not to be a vessel because it was secured by 16 tendons and pilings and 6 pipelines, required massive engineering and up to 2 years to relocate, and therefore was not practically capable of maritime transportation); Moore v. Bis Salamis, 748 F. Supp. 2d 598, 606-08 (E.D. Tex. 2010) (finding the *Thunder Horse* semisubmersible production platform not to be a vessel because it was fastened to the seabed, had a relocation cost of $400-500 million, and therefore was not practically capable of maritime transportation).

13. *See, e.g.*, Brendan Gogarty & Meredith Hagger, *The Laws of Man over Vehicles Unmanned: The Legal Response to Robotic Revolution on Sea, Land and Air*, 19 J.L. INF. & SCI. 73, 73 (2008); Paul W. Pritchett, *Ghost Ships: Why the Law Should Embrace Unmanned Vessel Technology*, 40 TUL. MAR. L.J. 197, 197 (2015); Michal Chwedczuk, *Analysis of the Legal Status of Unmanned Commercial Vessels in U.S. Admiralty and Maritime Law*, 47 J. MAR. L. & COM. 123, 126 (2016).

14. U.N. Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397, 400-03 (entered into force Nov. 16, 1994) [UNCLOS]. *See* United States v. Beyle, 782 F.3d 159, 167, 2015 AMC 1099, 1109 (4th Cir. 2015) ("With nearly 170 signatory nations today, UNCLOS enjoys widespread acceptance in the international community. As noted above, although the United

(UNCLOS)) described below, it cannot be assumed that coastal states, or even Producing Coastal States, are legally entitled to impose their domestic law over any and all matters arising in relation to any MORU in their waters. Almost inevitably, international disputes will arise where the ownership of (and/or a security interest in) a MORU is registered in one state (each such state, a "Flag State") but the MORU is moored and operated in the territorial seas or EEZ of a foreign Producing Coastal State, enters into the ports of another state (each such state, a "Port State"), or is tied to offshore incidents affecting any other non-Flag state (each such affected state, an "Affected State"). In certain circumstances, retention of jurisdiction over specific issues may be (and likely should be) asserted by relevant Flag State, Port State, or other Affected State, and not the Producing Coastal State.

Typically, international legal uncertainty has been reduced and a level of uniformity in maritime law has been achieved, or at least pursued, through the negotiation and conclusion of international maritime conventions, enforced by the parties thereto.[15] However, in the absence of a governing maritime convention resolving the conflicts-of-law issue for those disputes which are arguably outside of the Producing Coastal State's jurisdiction, would the correct state successfully assert jurisdiction? Do we now need a maritime convention to resolve various international legal uncertainties as they relate to MORUs?

Professor Roy Goode, when discussing the UNIDROIT Governing Council's broader efforts to bring uniformity to law, advised that the Governing Council would "not approve a project unless at least three questions receive a satisfactory answer: Is there a problem? Is there a feasible solution? And is the project likely to receive a substantial measure of support not only from governments but from industry and other interested sectors?" [16] Although not specifically addressing maritime conventions, Professor Goode's tripartite formulation of international convention proposal triage provides a very concise methodology for determining whether, in fact, further work should progress on a hypothetical MORU Convention. This Article attempts to provide a framework for a discussion of Professor Goode's first question ("is there

States is not a signatory to UNCLOS, this country recognizes the treaty's place as an accurate reflection of customary international law.").

15. *See* Griggs, *supra* note 1, at 193.

16. Roy Goode, *From Acorn to Oak Tree: The Development of the Cape Town Convention and Protocols*, 17 UNIFORM L. REV. 599, 599 (2012), https://doi.org/10.1093/ulr/17.4.599.

a problem?") in the context of the legal regime in which MORUs currently sit.

Given the context in which Professor Goode's first question "is there a problem?" was asked (i.e. in the context of a discussion of the UNIDROIT Governing Council's broader efforts to bring uniformity to law through international conventions), there is a sound argument that his question might be expanded to read as follows: "Is there a problem that needs to be solved at the international level?" Self-evidently, the author's suggested addendum to Professor Goode's question would exclude both purely theoretical problems and problems that should be resolved at a domestic level. Part II outlines how the need for an international solution (if any) might be defined in relation to a hypothetical MORU Convention.

Part III of this Article describes different MORU concepts, the extent to which those concepts have been deployed, and various publicized development plans for future deployment. It is a high-level overview of both the current status of the MORU sector and the publicly known outlook for its growth and identifies some of the advantages of, and challenges for, different classes of MORUs.

Part IV outlines the more likely forms of international maritime disputes that might arise between various stakeholders in relation to MORUs and the legal uncertainties facing stakeholders that arise from gaps in international maritime convention applicability to MORUs and the uneven levels of convention acceptance.

Part V describes why current international legal uncertainties facing MORU stakeholders are likely to lead to inefficient finance of MORUs, hindering greater MORU deployment.

The final section of this Article, Part VI, summarizes why there are, in fact, problems that need to be solved at the international level.

The second question in Professor Goode's tripartite test (i.e. "Is it feasible?") will be addressed in *Mare Incognitum, Part II: Is Salvaging the Vancouver Draft Mobile Offshore Unit Convention and Converting It into a Mobile Offshore Renewables Unit Convention Feasible?* Professor Goode's third question ("Is the project likely to receive a substantial measure of support . . . from governments but from industry and other interested sectors?") will be addressed in *Mare Incognitum, Part III*.

Four major themes appear throughout the three Articles. As the two quotes at the beginning of this Article suggest, the first theme concerns the inevitable tension between the unquestionable need to adjust course when faced with a sea change on the one hand and the historic quest for legal

uniformity and certainty on the other. In this context, two important sub-themes arise: the international legal uncertainty resulting from the incomplete sovereignty of Producing Coastal States and other coastal states in their own EEZs in relation to floating offshore facilities, and the questionable applicability of existing international maritime conventions to those same facilities.

The second theme is one of relative mobility. MORUs are not traditional merchant ships: a MORU's primary purpose is the generation of electric power at site, not the endless carriage of goods or people from port to port. Conversely, it is misleading to say that MORUs are "permanent" installations in the same way that either fixed-bottom WTGs or even the huge, site-specific floating production platforms of the oil and gas industry are effectively "permanent." Although MORUs might be used at the same site for their entire life, they also could be redeployed to a roughly equivalent offshore site with relative ease. On average, MORUs will visit port more frequently than "permanent" production O&G MOUs but less frequently than either mobile offshore drilling units (MODUs) or traditional ships.

The third, related theme concerns the similarities and differences of MORUs and O&G MOUs and their underlying industries. In many ways, MORUs are smaller, evolutionary descendants of O&G MOUs—similar in many important ways but substantively different in others. The extent to which the wealth of floating facility experience from the offshore oil and gas industry might be applied to MORUs (and the willingness of the oil and gas industry to share this experience) is worth considering, including the decades-long effort in that industry to put an international maritime convention for O&G MOUs in place.

The fourth theme concerns certain legal aspects of bankability in the context of MORUs. As a novel class of moveable maritime asset likely to cross borders during its lifetime, certain international agreements and practices would be needed in order to facilitate efficient MORU finance.

II. A COMPELLING NEED

The International Maritime Organization (IMO) has formulated its methodology for determining "need" for a new maritime convention by instructing its Council and its committees to "entertain proposals for new conventions or amendments to existing conventions only on the basis of clear and well-documented demonstration of compelling need, taking into account the undesirability of modifying conventions not yet in force or of amending existing conventions unless such latter instruments have been

in force for a reasonable period of time and experience has been gained of their operation, and having regard to the costs to the maritime industry and the burden on the legislative and administrative resources of Member States." [17] Similarly, Patrick Griggs, in *Obstacles to Uniformity of Maritime Law—The Nicolas J. Healy Lecture*, cautioned that an absence of need for an international maritime convention was one significant impediment to the Comité Maritime Internationale's (CMI's) goal of harmonization of instruments in the field of private international maritime law.[18] Although he did not explicitly define "need," he did state that the "CMI could not afford. . . to tackle a project where there was no need for uniformity. . ." [19] Mr. Griggs' admonition to conserve the scant legal resources of multilateral institutions for those issues where uniformity is most needed[20] is quite correct.

However, the answer to the question of whether a need for an international solution exists depends largely on how the list of potential stakeholders is constructed. In this context, a "clear and well-documented demonstration of compelling need" for a new MORU Convention might be construed quite narrowly: only demonstrated *ex post facto*, after a number of very similar incidents have occurred, corresponding international disputes arisen, litigation ensued, and the resulting holdings (or lack of harmony therein) are found unacceptable by a sufficient number of those litigants. Logically, this narrow interpretation is predicated on the existence of a large number of MORUs giving rise to a sufficient number of similar international disputes having unacceptable outcomes for a large pool of litigants. It would also imply that the rest of us are blessed with the luxury of time to allow the organic growth of a body of unacceptable outcomes for a sufficient number of litigants before beginning a discussion (possibly measured in decades) of a possible convention to de-risk the industry.

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17. Inter-governmental Mar. Consultative Org. Res. A.500(xii) (Jan. 8, 1982), at 2, https://wwwcdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/AssemblyDocuments/A.500(12).pdf; Int'l Mar. Org., Res. A.777(18) (Nov. 4, 1993), at 2, https://www.cdn.imo.org/localresources/en/KnowledgeCentre/IndexofIMOResolutions/AssemblyDocuments/A.777(18).pdf. *Compare* Richard Shaw, *Regulation of Offshore Activity: Pollution Liability and Other Aspects*, CMI YEARBOOK 2011-2012 302, 308 (2012) (asking whether there is a "compelling need" for a convention for O&G MOUs).

18. *See* Griggs, *supra* note 1, at 198-199.

19. *See id.*

20. *See id.*

For a number of reasons, time is a luxury we may not have.[21] As will be set out in *Mare Incognitum, Part III*, there are far more stakeholders in a discussion of a hypothetical MORU Convention than a list of past and present MORU litigants. Setting aside the broad scientific[22] and growing political[23] consensus that we are now or soon will be in the midst of what has been described as a "climate crisis" or "climate emergency," a growing number of public and private stakeholders are finding themselves

21. *See* Larry Elliott, *Tackling Climate Crisis Is What We Should Be Doing, Says New IMF Boss*, GUARDIAN (Nov. 30, 2019), https://www.theguardian.com/business/2019/nov/30/imf-boss-kristalina-georgiva-climate-crisis-financial-crash-economics; Mark Hertsgaard, *'We're Losing the Race': UN Secretary General Calls Climate Change an 'Emergency'*, GUARDIAN (Sept. 18, 2019), https://www.theguardian.com/environment/2019/sep/18/un-secretary-general-climate-crisis-trump; Roger Harrabin, *Bank of England Chief Mark Carney Issues Climate Change Warning*, BBC NEWS (Dec. 30, 2019), https://www.bbc.com/news/business-50868717.

22. *See, e.g.*, William J. Ripple et al., *World's Scientists' Warning of a Climate Emergency*, 70 BIOSCIENCE 8 (Nov. 5, 2019), https://doi.org/10.1093/biosci/biz088 (declaration of climate emergency signed by over 11,000 scientists from 153 countries); Jillian Ambrose, *Climate Change: Do More Now or Risk Catastrophe, Warns Energy Agency*, GUARDIAN (Nov. 12, 2019), https://www.theguardian.com/environment/2019/nov/13/climate-change-do-more-now-or-risk-catastrophe-warns-energy-agency.

23. UN Secretary-General Antonio Guterres referred to the situation as a climate emergency. *See Far More Needed to 'Confront the World's Climate Emergency', Guterres Tells ASEAN-UN Summit*, UN NEWS (Nov. 3, 2019), https://news.un.org/en/story/2019/11/1050501. Many African nations have requested a declaration of a global climate emergency at a UN summit. *See* Sophie Mbugua, *Africa to Seek Declaration of Global Climate Emergency at UN Summit*, REUTERS (Sept. 22, 2019), https://www.reuters.com/article/us-climate-change-un-africa/africa-to-seek-declaration-of-global-climate-emergency-at-un-summit-idUSKBN1W70T1. The EU Parliament has declared a climate and environment emergency. *See Resolution on the Climate and Environment Emergency*, EUR. PARLIAMENT, art. 1 2019/2930(RSP) (Nov. 28, 2019), http://www.europarl.europa.eu/doceo/document/TA-9-2019-0078_EN.html. 1,767 jurisdictions and local governments in 30 nations representing over 820 million people have declared a climate emergency, and national declarations by the Welsh Parliament, the Scottish government, the Republic of Ireland, the Canadian House of Commons, and the Portuguese Parliament. *See Climate Emergency Declarations in 1,767 Jurisdictions and Local Governments Cover 820 Million Citizens*, CLIMATEEMERGENCY DECLARATION.ORG (Nov. 4, 2019), https://climateemergencydeclaration.org/climate-emergency-declarations-cover-15-million-citizens/; *UK Parliament Declares Climate Emergency*, BBC NEWS (May 1, 2019), https://www.bbc.com/news/uk-politics-48126677 (reporting that following Welsh and Scottish government declarations, the UK Parliament declared a climate emergency, although it did not compel the government to act); *Climate Change: Ireland Declares Climate Emergency*, BBC NEWS (May 9, 2019), https://www.bbc.com/news/world-europe-48221080; Hannah Jackson, *National Climate Emergency Declared by House of Commons*, GLOBAL NEWS (June 17, 2019), https://globalnews.ca/news/5401586/canada-national-climate-emergency/ (Canadian House of Commons declares climate emergency); *Austrian Parliament Declares 'Climate Emergency' Four Days from Elections*, BRUSSELS TIMES (Sept. 26, 2019), https://www.brusselstimes.com/all-news/belgium-all-news/70094/austrian-parliament-declares-climate-emergency-four-days-from-elections/ (Austrian Parliament declares climate emergency).

pushed, if not obliged, to change past behaviors and investment patterns.[24] As the former head of the Bank of England so delicately put it, "Companies that don't adapt—including companies in the financial system—will go bankrupt without question. [But] there will be great fortunes made along this path aligned with what society wants."[25]

This broader and more inclusive understanding of stakeholders allows an alternative interpretation of a "clear and well-documented demonstration of compelling need" in which the *ex-ante* need for uniformity and greater international legal certainty in relation to MORUs is itself the maritime legal problem that must be solved at the international level.[26] This broader interpretation of stakeholders and *ex-ante* compelling need would allow consideration of the likely negative impact of a lack of uniformity and international legal uncertainty on this emerging sector's growth, the potential consequences of the MORU sector's failure to quickly grow on a broader group of direct and indirect stakeholders, and the incorporation of lessons learned by litigants in comparable sectors that are readily transferable to MORUs.

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24. *See, e.g.*, Atif Ansar et al., *Stranded Assets and the Fossil Fuel Divestment Campaign: What Does Divestment Mean for the Valuation of Fossil Fuel Assets?*, UNIV. OF OXFORD (2013), https://www.smithschool.ox.ac.uk/publications/reports/SAP-divestment-report-final.pdf; *Carbon Avoidance? Accounting for the Emissions Hidden in Reserves*; ASS. OF CHARTERED CERTIFIED ACCT. (2013), https://www.accaglobal.com/content/dam/acca/global/PDF-technical/sustainability-reporting/tech-tp-ca.pdf; Rob West & Bassam Fattouh, *The Energy Transition and Oil Companies' Hard Choices*, UNIV. OF OXFORD (2019), https://www.oxfordenergy.org/wpcms/wp-content/uploads/2019/07/The-Energy-Transition-and-Oil-Companies-Hard-Choices-Energy-Insight-51.pdf?v=3a52f3c22ed6; *UK Becomes First Major Economy to Pass Net Zero Emissions Law*, GOV.UK (June 27, 2019), https://www.gov.uk/government/news/uk-becomes-first-major-economy-to-pass-net-zero-emissions-law; Niclas Rolander, *Sweden's Central Bank Ditches Bonds Issued by Major Polluters*, BLOOMBERG (Nov. 13, 2019), https://www.bloomberg.com/news/articles/2019-11-13/sweden-s-central-bank-ditches-bonds-issued-by-major-polluters; *EU Bank Launches Ambitious New Climate Strategy and Energy Lending Policy*, EUR. INV. BANK (Nov. 14, 2019), https://www.eib.org/en/press/all/2019-313-eu-bank-launches-ambitious-new-climate-strategy-and-energy-lending-policy; Julia Kollewe, *Coal Power Becoming 'Uninsurable' as Firms Refuse Cover*, GUARDIAN (Dec. 2, 2019), https://www.theguardian.com/environment/2019/dec/02/coal-power-becoming-uninsurable-as-firms-refuse-cover; *During the COP, Denmark Passes Climate Act with a 70 Percent Reduction Target*, DANISH MINISTRY OF CLIMATE, ENERGY & UTIL. (Dec. 9, 2019), https://en.kefm.dk/news/news-archive/2019/dec/during-the-cop-denmark-passes-climate-act-with-a-70-percent-reduction-targetws-page-eng/.

25. *See* Mattha Busby, *Capitalism Is Part of Solution to Climate Crisis, Says Mark Carney*, GUARDIAN (July 31, 2019), https://www.theguardian.com/business/2019/jul/31/capitalism-is-part-of-solution-to-climate-crisis-says-mark-carney; *see also* Lynn Doan et al., *What's Behind the World's Biggest Climate Victory? Capitalism*, BLOOMBERG (Sept. 15, 2019), https://www.bloomberg.com/graphics/2019-can-renewable-energy-power-the-world/.

26. *See* Souichirou Kozuka, *The Economic Implications of Uniformity in Law*, 12 UNIF. L. REV. 683, 686 (2007).

Demonstrating *ex ante* need is inherently more difficult than demonstrating a need *ex post facto*. However, in principle Professor Goode's tripartite test provides a reliable map for clearly demonstrating even *ex ante* compelling needs, assuming one can show that there is a problem (i.e. there are a number of international legal uncertainties that hinder greater deployment of MORUs), there is a feasible solution (i.e. an international maritime convention could resolve these legal uncertainties in a uniform manner), and there is, or would be, a substantial measure of support from a number of governments, industries, and other interested sectors. The remainder of this Article argues that there are problems facing MORUs and a compelling need for an international solution to those problems, positing that:

a) MORUs offer potential territorial, technical, commercial, and legal advantages over competing technologies and have the potential to deliver renewable energy at a lower levelized cost of energy (LCoE) than competing technologies in the near term;
b) standalone MORUs and small MORU Arrays already exist as pilot and pre-commercial projects;
c) assuming projected decreases in capex and opex costs are accurate and reasonably priced finance available, MORU numbers are projected to rapidly increase in the near- to mid-term as developers deploy individual MORUs and utility-scale[27] MORU Arrays globally, multiplying the number of public and private stakeholders in this industry;
d) these MORUs will be subject to many common types of international maritime disputes, and in particular many of the same types of disputes previously encountered with O&G MOUs, and to a lesser degree, traditional merchant ships and aircraft;
e) like O&G MOUs and other non-propelled watercraft moved only occasionally, many existing international maritime conventions regulating international maritime disputes relating to traditional merchant ships either do not apply to MORUs or their application is ambiguous, creating international regulatory gaps and legal uncertainties;
f) even where the provisions of existing international maritime conventions might apply to MORUs, the general level of

27. For purposes of this Article only, at least 100 MW in nominal capacity.

acceptance of some conventions by relevant states may be so low as to render that convention's coverage ineffective and uniformity low;

g) although the gaps and legal uncertainties for existing and currently planned MORU projects may have been accepted by their stakeholders, those same legal uncertainties are likely to act as a deterrent to other potential stakeholders contemplating future utility-scale MORU deployment, particularly where there are more cross-border considerations and/or a greater likelihood of international disputes;

h) the fight against climate change will require the efficient global mobilization of many different technologies and very large amounts of (primarily private) capital, but the capital being set aside globally for sustainable investments will only flow efficiently to those sustainable and bankable investments offering an acceptable return; and

i) axiomatically, the deterrent effect of legal uncertainty is particularly relevant in the context of internationally financed projects, where international legal uncertainties could result in higher borrowing costs and an inefficient flow of capital across borders to otherwise deserving projects, if not a denial of credit for un-bankable projects,

and that many of these legal uncertainties should be solved at an international level. As a consequence, it is respectfully submitted that we do have a problem, particularly if we consider the potential territorial, technical, commercial, and legal advantages of MORUs over-competing technologies, the amount of investment required in the global fight against climate change, and the negative consequences of international legal uncertainty in relation to a number of issues facing MORUs, not the least of which is their efficient cross-border finance.

III. MOBILE OFFSHORE RENEWABLES UNITS AND ARRAYS: A PRIMER

Before assessing the need (if any) for either new or amended regulation of MORUs, a common understanding of the technologies and their basic functions, operation, and limitations, is necessary. Although it is the author's intent to use a technology-neutral approach when presenting various types of MORUs, attention should be paid to the common features and peculiarities of different MORUs, and the similarities of and differences between MORUs, O&G MOUs, and, to a

lesser extent, both traditional merchant vessels and fixed-bottom offshore renewables installations.

The author accepts that an *ex-ante* need for an international maritime convention would only be demonstrated if MORUs are, or are likely to be, prevalent in a number of jurisdictions and in sufficient quantities to justify international regulation. In that context, this Part also provides a brief description of different MORU technologies and the extent to which they already have been deployed, or are planned to be deployed, in different Producing Coastal States' waters in the coming years.

MORUs are at a relatively early stage of technical development and very different concepts are being explored. The current pace of research and development makes definitive general statements about any MORU technology challenging.[28] However, to simplify legal analysis in this Article only, and without offering any opinion on the ultimate viability of any particular MORU concept, the author has assumed that each type of MORU has the characteristics described below.

As floating structures, MORUs depend on the buoyancy of a hull (as opposed to structural support from a fixed-bottom base) consisting of one or more hollow vessels displacing water to physically support its generation or auxiliary equipment. MORU hull designs are quite diverse. Many MORUs use smaller versions of the hull types frequently used to support O&G MOUs (e.g. tension leg platforms (TLPs),[29] spar platforms,[30] or semi-submersible platforms[31]) (each such hull on a MORU,

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28. *See* Darius Snieckus, *Floating Wind Power Plays the Generation Game*, RECHARGE (Apr. 15, 2019), https://www.rechargenews.com/wind/1754437/floating-wind-power-plays-the-generation-game ("Even by the precocious standards of the fast-maturing floating wind power sector the last fortnight has been an extraordinary one, as no fewer than four next-generation designs made meaningful progress towards commercialization.").

29. For purposes of this Article, TLPs consist of topsides mounted on a floating structure that is moored to the seafloor with tensioned steel cables (vs. traditional catenary or taut mooring). *See Guide for Building and Classing: Floating Offshore Wind Turbine Installations*, AM. BUREAU OF SHIPPING ch. 1, § 1.15.1.1, at 11 (July 2014), https://ww2.eagle.org/content/dam/eagle/rules-and-guides/archives/offshore/195_floatingoffshorewindturbineinstallations/FOWTI_Guide_e-July14.pdf; *DNVGL-ST-0119: Floating Wind Turbine Structures*, DNV GL, §§ 8.2.1, 8.3 (July 2018), https://rules.dnvgl.com/docs/pdf/DNVGL/ST/2018-07/DNVGL-ST-0119.pdf.

30. For purposes of this Article, spar platforms consist of a deep draft vertical hull supporting the topsides above the waterline. *See* AM. BUREAU OF SHIPPING, *supra* note 29, at 11; DNV GL, *supra* note 29, at 16, 23 ("Deep Draught Floater" includes classic, truss & cell spar, deep draught semi, and buoy FWTs. "Deep Draught Floater" is a "spar or similar type platform with a relatively large draught compared to barges and semisubmersibles").

31. For purposes of this Article, semisubmersible platforms consist of topsides resting on vertical support columns providing ballast and buoyancy, connected to each other by bracings. *See* AM. BUREAU OF SHIPPING, *supra* note 2929, at 11 (referring to semisubmersibles as "column-

a "modified O&G hull"). However, other MORU concepts include traditional ship-shaped hulls, multi-hulls (i.e. catamaran or trimaran concepts), barges, pontoons, buoys, or more exotic designs like the snake-like *Pelamis* or asymmetric Wello *Penguin* floating wave energy converters. Hybrid hulls combining the characteristics of two or more hull concepts are also being developed.[32]

MORUs are assumed to have no mechanical self-propulsion but are designed to be towed in a controlled manner on open water.[33] MORUs also are assumed to be moored in place for extended operational periods, but designed to be (relatively) easily detached from cables, other umbilicals, and mooring lines and moved by ocean-going tug,[34] whether occasionally to a service point or permanently to another production site.[35] This is in

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stabilized Floating Support Structure[s]"); NV GL, *supra* note 2930, at 25 (defining "semi-submersible" as a "buoyancy and free-surface stabilized structure with a relatively shallow draught. A number of large columns are linked to each other by bracings. The columns provide the ballast and flotation stability (column-stabilized)").

32. *See, e.g.*, *04. Starfloat™ Technology,* OCEANFLOWENERGY, http://www.oceanflowenergy.com/Starfloat-Technology.html (combining spar and semi-submersible technology to support a FWT); *Brochure*, STIESDAL A/S, https://www.stiesdal.com/offshore-windpower/, Slides 19 & 20, https://www.stiesdal.com/material/2019/02/Stiesdal-Tetra-01.02.19.pdf (describing Stiesdal's TetraSpar floating concept—a FWT which behaves as a semi-submersible in transit, but converts to a spar or TLP configuration on arrival at site); *Floating Wind Power Plays the Generation Game*, *supra* note 28 (describing a concept combining TLP and single point mooring (SPM) and another combining semi-submersible and SPM technologies); Nadja Skopljak, *Wison Unveils New Tower Concept for Deepwater Turbines*, OFFSHOREWIND.BIZ (Aug. 12, 2019), https://www.offshorewind.biz/2019/08/12/wison-unveils-new-tower-concept-for-deepwater-turbines (modifying the "truss buoyant tower" concept from the oil and gas industry and a self-elevating tower).

33. *See Australian Ship Registration Act 1981*, S 3 (Austl.) ("Ship' means any kind of vessel capable of navigating the high seas and includes: . . . . (b) any structure that is able to float or be floated and is able to move or be moved as an entity from one place to another").

34. *See Offshore Standard DNV-OS-J10: Design of Offshore Wind Turbine Structures*, DNV GL, §§ 1.6.9.2, 1.6.10.1, at 27 (May 2014), https://rules.dnvgl.com/docs/pdf/DNV/codes/docs/2014-05/Os-J101.pdf ("The installation is simple since the structure can be towed to the site and then be connected to the anchors."). In the case of TLP MORUs (which would by definition be connected to the seabed with a number of tensioned steel tendons that likely provide vertical—and potentially horizontal—stability to the MORU), this exercise could be more complex. *But see id.* at 27 ("The entire structure can be disconnected from the tension legs and floated to shore in case of major maintenance or repair of the wind turbine."); *Evopod™ Technology*, OCEANFLOWENERGY, http://www.oceanflowenergy.com/Evopod-Technology.html ("Floating solutions are more accessible for first line maintenance and, with the *Evopod*™ patented disconnectable mooring and power export solution, easily recoverable to sheltered water for servicing or repair activities.").

35. The author acknowledges that the ease with which a MORU could be towed on open water depends to some degree on, *inter alia*, the hull shape chosen, but for the sake of simplicity, it has been assumed (for purposes of legal analysis only) that any MORU hull design would be capable

contrast to the offshore oil and gas industry's more frequent use of individual site-specific "permanent" floating oil and gas production facilities, which can be much more challenging to detach from their umbilicals and mooring systems, modify for use elsewhere, and relocate to other sites.[36] Finally, Multi-Unit MORU Arrays are assumed to consist of a number of serially-produced Floating Generation Units capable of use at any roughly similar offshore site and potentially a few supporting Floating Auxiliary Units.

A. Floating Ocean Thermal Energy Converters

Floating ocean thermal energy converters (or FOTECs) use differences in shallow and deeper water temperatures to generate electricity.[37] FOTEC generating equipment has been mounted on modified O&G hulls and traditional ship-shaped hulls. They can be manned or unmanned in operation. They could have a bespoke design or a serially-produced design usable at other comparable sites.

As early as 1930, an onshore ocean thermal energy converter system was tested.[38] In 1933, the first FOTEC was built by retrofitting a 10,000-ton cargo ship for ocean thermal energy conversion.[39] Unfortunately, it sank in rough seas,[40] which could be considered the first loss at sea of a MORU.

Research and development later resumed, and the state of Hawai'i, Lockheed, and Dillingham Corporation tested a barge-based FOTEC called *Mini-OTEC* in 1979.[41] A converted oil tanker, *OTEC-1*, was then

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of at least being towed in a controlled manner between sites without much modification, while acknowledging certain designs might be more challenging to relocate than others.

36. *See* Mendez v. Anadarko Petroleum Corp., No. H-10-1755, 2010 WL 4644049, at *2, 7-8 (S.D. Tex. Nov. 9, 2010); Riley v. Alexander/Ryan Marine Servs. Co., 983 F. Supp. 2d 884, 888-90 (S.D. Tex. 2013); Jordan v. Shell Oil Co., No. G-06-265, 2007 WL 2220986, at *1-2 (S.D. Tex. 2007); Moore v. Bis Salamis, 748 F. Supp. 2d 598, 606-08 (E.D. Tex. 2010).

37. *See* Ruud Kempener & Fank Neumann, *Ocean Thermal Energy Conversion Technology Brief*, INT'L RENEWABLE ENERGY ASS'N (2014), https://www.irena.org/publications/2014/Jun/Ocean-Thermal-Energy-Conversion.

38. *See Power from the Sea*, 54(6) POPULAR MECHS. MAG. 881, 881-82 (Dec. 1930), https://books.google.de/books?id=qOIDAAAAMBAJ&lpg=PA881&dq=Popular%20Science%201930%20plane%20%22Popular%20Mechanics%22&pg=PA881#v=onepage&q&f=true.

39. *See* Mayasuki Mac Takahashi, *Ocean Water and Its Wonderful Potential*, DEEP OCEAN WATER AS OUR NEXT NAT. RES. 9, 18 (2000), http://www.terrapub.co.jp/e-library/dow/pdf/chap2.pdf.

40. *See id.* at 18.

41. *See id.* at 27.

used for further tests in 1980-81.[42] Lockheed and a Japanese consortium separately developed spar designs, and TRW Company developed a dynamically positioned semi-submersible design.[43] Lockheed also explored a 100MW semi-submersible concept.[44] Currently, DCNS/Naval Energies and Akuo Energy are working on *NEMO*, a 10MW barge-based FOTEC to be placed in Martinique in 2020.[45] Other groups are working on FOTEC concepts as well.[46]

B. Floating Solar Energy Converters

Floating Solar Energy Converters convert sunlight into electrical power, typically using photovoltaic panels. By using seawater as a cooling system, the efficiency of Floating Solar Energy Converter modules can be increased by 10-15% relative to onshore modules.[47] Unlike other Floating Generation Units, Floating Solar Energy Converters tend to be modular in design. Typically, multiple photovoltaic panels are mounted on a single displacement hull (effectively a small barge), forming a single Floating Solar Module. Several identical Floating Solar Modules are then physically attached to each other to form a larger floating raft ("Floating Solar Raft"). A solar MORU Array could consist of multiple Floating Solar Rafts (each of which consists of multiple Floating Solar Modules) and several other auxiliary MORUs. Floating Solar Energy Converters would typically be unmanned in normal operation. They are likely to have a non-site-specific, serially-produced design capable of use at other comparable offshore sites.

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42. *See id.* at 28.

43. *See id.*

44. *See* Lockheed Martin, *Ocean Thermal Energy Conversion*, YOUTUBE (Mar. 9, 2017), https://www.youtube.com/watch?v=zjzgcHngQFM.

45. *See Ocean Thermal Energy Conversion*, NAVAL ENERGIES (Oct. 16, 2014), https://www.naval-energies.com/en/produit/ocean-thermal-energy-conversion; *NEMO—10.7 MW Martinique in Development*, AKUO ENERGY, http://www.akuoenergy.com/en/nemo.

46. *See Ocean Thermal Energy Conversion*, MAKAI OCEAN ENG'G (Oct. 16, 2014), https://www.makai.com/ocean-thermal-energy-conversion.

47. *See* Sung-Min Kim et al., *Analysis and Prioritization of the Floating Photovoltaic System Potential for Reservoirs in Korea*, 9 APPL. SCI. (2019), https://doi.org/10.3390/app9030395 ("In addition to being able to utilize the reflected light from the water surface, ... floating PV is known to be about 11% more efficient than the terrestrial solar panel due to the temperature reduction effect in water"); Anthony Deutsch, *Dutch Plan to Build Giant Offshore Solar Power Farm*, REUTERS (Feb. 14, 2018), https://www.reuters.com/article/netherlands-solar-offshore/dutch-plan-to-build-giant-offshore-solar-power-farm-idUSL8N1Q46M0.

The first small-scale, research floating PV system was built in 2007 in Aichi, Japan. It was followed by projects in several other countries, including France, Italy, the Republic of Korea, Spain, and the United States.[48] The first commercial floating solar array was a 175 kWp (kilowatt-peak) system built in California in 2008.[49] Floating solar arrays larger than 1 MWp began to emerge in 2013.[50] The first floating solar array larger than 10 MWp was installed in 2016, and in 2018 several utility-scale floating solar arrays were installed, the largest of which is 150 MWp.[51] In mid-2018, the global floating solar array installed capacity was approaching 1.1 gigawatt-peak, the same milestone that ground-mounted PV reached in 2000.[52]

To date, most Floating Solar Energy Converters have been placed on inland waters.[53] However, Korea is now planning a 2.7 GW Floating Solar Energy Converter and 300 MW offshore wind complex behind the Saemangeum sea wall.[54] True offshore solar MORU Arrays are also in development, including existing installations off the Netherlands[55] and planned installations in the Straits of Johor between Singapore and Malaysia[56] and potentially in the Persian Gulf off Dubai.[57]

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48. *See Where Sun Meets Water: Floating Solar Market Report—Executive Summary*, WORLD BANK GRP. 1, 2 (2018), http://documents.worldbank.org/curated/en/579941540407455831/pdf/131291-WP-REVISED-P161277-PUBLIC.pdf.

49. *See id.* at 2.

50. *See id.* at 3.

51. *See id.* at 4.

52. *See id.*

53. *See* Sue-Ann Tan, *Singapore's Largest Offshore Floating Solar Panel System to be Built Along Straits of Johor*, STRAITS TIMES (Nov. 9, 2018), https://www.straitstimes.com/business/singapores-largest-offshore-floating-solar-panel-system-to-be-built-along-straits-of-johor.

54. Bernd Radowitz, *South Korea Plans World's Largest Floating PV Plant with 2.7GW*, RECHARGE (Dec. 6, 2019), https://www.rechargenews.com/transition/south-korea-plans-world-s-largest-floating-pv-plant-with-2-7gw/2-1-719765.

55. *See a World's First: Offshore Floating Solar Farm Installed at the Dutch North Sea*, OCEANS OF ENERGY (Dec. 11, 2019), https://oceansofenergy.blue/2019/12/11/a-worlds-first-offshore-floating-solar-farm-installed-at-the-dutch-north-sea.

56. *See* Deutsch, *supra* note 47; Tan, *supra* note 53; *Bright Future for Floating Solar Panels in South-east Asia*, STRAITS TIMES (Feb. 9, 2019), https://www.straitstimes.com/business/bright-future-for-floating-solar-panels-in-s-e-asia.

57. *See* Dominic Dudley, *Dubai Joins the Race to Develop Offshore Solar Plants*, FORBES (June 12, 2019), https://www.forbes.com/sites/dominicdudley/2019/06/12/dubai-offshore-solar-power/#7d3b08ee79db.

C. *Floating Tidal Energy Converters*

Floating tidal energy converters ("FTECs") convert tidal kinetic energy (or potentially other non-tidal ocean currents like the Gulf Stream[58]) into electrical power. Current FTEC designs typically suspend generating turbines beneath traditional ship-shaped hulls,[59] pontoon barges, or multi-hulls.[60] Variable depth, fully submersible platform designs exist.[61] Modified O&G Hulls are also possible.[62] FTECs typically would be unmanned in normal operation. They are likely to be non-site-specific designs in serial production.

Fixed-bottom, submerged tidal stream turbines have been deployed for some time, but several FTECs have also been deployed. A trimaran-hulled FTEC, *Plat-I*, was installed in Scotland for testing,[63] before being relocated to Canadian waters.[64] In 2015, a ship-shaped 200kW, single-turbined FTEC, *BlueTEC*, was installed off the Netherlands.[65] In 2019, a

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58. *See* Darius Snieckus, *Gulf Stream on Tap for 'World's Largest' Ocean Energy Project*, RECHARGE (May 28, 2019), https://www.rechargenews.com/technology/1793142/gulf-stream-on-tap-for-worlds-largest-ocean-clean-energy-project.

59. *See Orbital 02 2MW*, ORBITAL MARINE POWER, https://orbitalmarine.com/technology-development/orbital-o2 (last visited Dec. 20, 2020); *Plat-I Tidal Energy Platform*, SUSTAINABLE MARINE ENERGY, https://sustainablemarine.com/plat-i (last visited Dec. 20, 2020); *BlueTEC Texel Prototype*, BLUEWATER, https://www.bluewater.com/new-energy/texel-project/ (last visited Dec. 20, 2020).

60. *See Current Catcher Pontoon Barge®*, MARINE ENERGY CORP., http://www.marineenergycorp.com/marine-energy/current-catcher-pontoon-barge.shtml (last visited Dec. 20, 2020).

61. *See Plat-I*, SUSTAINABLE MARINE ENERGY, https://sustainablemarine.com/plat-i (last visited Dec. 20, 2020) (describing a fully submersible tidal energy converter); *The Future of Renewable Energy*, MINESTRO, https://minesto.com/our-technology [last visited] (describing a submersible kite tidal energy converter); *Gulf Stream on Tap for 'World's Largest' Ocean Energy Project*, *supra* note 58 (describing submersible Gulf Stream energy converters).

62. *See* OCEANFLOWENERGY, *supra* note 34 (showing semisubmersible *Evopod*™ systems).

63. *See* Chris Green, *Giant Tidal Turbine Hailed as 'Phenomenal' Success*, THE SCOTSMAN (Aug. 22, 2018), https://www.scotsman.com/news/giant-tidal-turbine-hailed-as-a-phenomenal-success-1-4787694; *Scotland's Floating Turbine Smashes Tidal Renewable Energy Records*, INDEPENDENT (Aug. 22, 2018), https://www.independent.co.uk/environment/scotland-floating-turbine-tidal-power-record-sr2000-scotrenewables-ofgem-a8503221.html;

64. *See Canada Tidal Makes Waves*, RENEWS (Feb. 28, 2019), https://renews.biz/51756/canada-tidal-makes-waves; Alexandra Pope, *Testing the Future of Tidal Energy in Nova Scotia*, CANADIAN GEOGRAPHIC (Aug. 29, 2019), https://www.canadiangeographic.ca/article/testing-future-tidal-energy-nova-scotia.

65. *See BlueTEC Platform Set to Receive Tocardo's T2 Turbine*, MARINE ENERGY (Nov. 12, 2015), https://marineenergy.biz/2015/11/12/bluetec-platform-set-to-receive-tocardos-t2-turbine.

2MW ship-shaped FTEC with twin 19m rotors called *Atir* was installed off Orkney.[66] A 9 MW project in Canada using the *Plat-I* is now being developed.[67] As of 2018, the global nominal capacity of installed fixed-bottom and FTEC power was 33.5MW, predominantly in Europe.[68]

D. Floating Wave Energy Converters

Floating wave energy converters ("FWECs") convert the kinetic energy of waves into electrical power. FWECs designs include traditional ship-shaped hulls,[69] modified O&G hulls, smaller buoy concepts,[70] barges,[71] or non-traditional hull shapes such as the multi-segmented *Pelamis*,[72] the asymmetric-hulled Wello *Penguin*,[73] or the donut-shaped *BOLT Lifesaver*.[74] Floating, fully submersible designs also exist.[75]

The first multi-Unit FWEC MORU Array was the 2.25MW Aguaçadoura Wave Farm, consisting of three *Pelamis* FWECs.[76] Wello's

66. *See Spanish Tidal Floater Shipshape off Orkney*, RENEWS (Feb. 18, 2019), https://renews.biz/51551/spanish-tidal-floater-shipshape-off-orkney.

67. *See* Elisa Obermann, *'Right Pieces of Puzzle in Place to Make Tidal a Reality for Canada'*, RECHARGE (Oct. 14, 2019), https://www.rechargenews.com/transition/right-pieces-of-puzzle-in-place-to-make-tidal-a-reality-for-canada/2-1-687900.

68. *See Ocean Energy Statistics: Europe Holds Strong as World-Leader in 2018, but Revenue Support Needed*, OCEAN ENERGY EUR. (Apr. 25, 2019), https://www.oceanenergy-europe.eu/ocean-energy-statistics-europe-holds-strong-as-world-leader-in-2018-but-revenue-support-needed/.

69. *See* Kim Nielsen & Jonas Bjerg Thomsen, *KNSwing—On the Mooring Loads of a Ship-Like Wave Energy Converter*, 7 J. MAR. SCI. ENG. 1, 2 (2019), https://doi.org/10.3390/jmse7020029.

70. *See PB3*, OPT OCEAN POWER TECHNOLOGIES, https://oceanpowertechnologies.com/pb3-powerbuoy/ (describing a buoy-based hybrid FWEC/FESS unit).

71. *See Super Watt Wave Catcher Barges®*, MARINE ENERGY CORP., http://www.marineenergycorp.com/marine-energy/super-watt-wave-catcher-barges.shtml (last visited Dec. 20, 2020).

72. *See Pelamis Wave Power*, EMEC: THE EUR. MARINE ENERGY CTR. LTD., http://www.emec.org.uk/about-us/wave-clients/pelamis-wave-power/ (last visited Dec. 20, 2020).

73. *See Product*, WELLO, https://wello.eu/product/.

74. *See BOLT Lifesaver Technical Introduction*, BOLT SEA POWER, https://boltseapower.com/bolt-lifesaver-technical-introduction/ (last visited Dec. 20, 2020).

75. *See Marine Power Systems: The Future of Energy*, MARINE POWER SYS., http://marinepowersystems.co.uk/ (last visited Dec. 20, 2020).

76. *See* Alok Jha, *Making Waves: UK Firm Harnesses Power of the Sea . . . in Portugal*, GUARDIAN (Sept. 25, 2008), https://www.theguardian.com/technology/2008/sep/25/greentech.alternativeenergy.

1MW *Penguin* was installed in 2017,[77] but subsequently sank in 2019.[78] A 826-ton FWEC barge called *Ocean Energy Buoy* is being built in Oregon for use in Hawaii,[79] where a smaller FWEC barge, *Triton C*, also will be tested.[80] Enel Green Power has purchased two hybrid wave/energy storage power buoys to place off Chile.[81] Many other FWEC concepts exist. As of 2018, the nominal capacity of fixed-bottom and FWEC deployed in Europe was 11.3MW.[82] However, ENI is now looking to build utility-scale FWEC MORU Arrays.[83]

E. Floating Wind Turbines

Floating wind turbines (FWTs) convert the kinetic energy of offshore wind into electrical power using one or more[84] hull-mounted vertical or horizontal axis turbines (or in at least one instance, multiple small wind turbines mounted on a moving kite tethered to a spar[85]). FWTs typically

77. *See Green Marine Deploys Wello Wave*, RENEWS (Mar. 6, 2017), https://renews.biz/38428/green-marine-deploys-wello-wave/.

78. *See Wello Wave Device Sinks off Scotland*, RENEWS (Mar. 23, 2019), https://renews.biz/52195/wello-wave-device-sinks-off-scotland/.

79. *See 826-ton Ocean Energy Buoy Nearing Completion in Portland*, KPTV FOX 12 OR. (Sept. 26, 2019), https://www.youtube.com/watch?v=SLJxPNuCGqI.

80. *See Project Profile: Demonstration of an Advanced Multi-Mode Point Absorber for Wave Energy Conversion*, OFF. OF ENERGY EFFICIENCY & RENEWABLE ENERGY, https://www.energy.gov/eere/water/project-profile-demonstration-advanced-multi-mode-point-absorber-wave-energy-conversion (last visited Dec. 20, 2020).

81. *See* Alexandre Spatuzza, *EGP Buys Wave Power Buoys to Scope Out Chilean Marine Energy*, RECHARGE (Sept. 19, 2019), https://www.rechargenews.com/transition/1853010/egp-buys-wave-power-buoys-to-scope-chiles-marine-energy.

82. *See* OCEAN ENERGY EUROPE, *supra* note 68.

83. *See* Darius Snieckus, *Eni-led Industrial Group Launches Utility-Scale Wave Power Plans*, RECHARGE (Oct. 28, 2019), https://www.rechargenews.com/transition/1869853/eni-led-industrial-group-launches-utility-scale-wave-power-plans.

84. *See* Darius Snieckus, *World's First Twin-Headed Floating Wind Unit Raises Sails*, RECHARGE (Apr. 10, 2019), https://www.rechargenews.com/wind/world-s-first-twin-headed-floating-wind-unit-raises-sails/2-1-585279.

85. *See* Will Mathis, *Flying Wind Turbines Make Their First Trip Offshore in Norway*, BLOOMBERG (Aug. 15, 2019), https://www.bloomberg.com/news/articles/2019-08-15/flying-wind-power-turbine-makes-first-trip-offshore-in-norway; Mark Anderson, *Alphabet's Makani Tests Wind Energy Kites in the North Sea*, IEEE SPECTRUM (Oct. 25, 2019), https://spectrum-ieee-org.cdn.ampproject.org/c/s/spectrum.ieee.org/energywise/energy/renewables/alphabets-makani-tests-wind-energy-kites-in-the-north-sea.amp.html; *see also World Intellectual Property Org. Pub. No. WO/2017/218118*, https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2017218118 [last visited or date before https] (describing a Patent Cooperation Treaty application by ExxonMobil in relation to a spar-based, tethered kite concept).

are based on modified O&G hulls, but barges[86] and multi-hull shapes[87] also exist. There are also FWTs designs that use detachable pontoons during transit/tow but are sunk at site and operated as gravity-based, fixed-foundation WTGs in operation.[88] FWTs are unmanned in normal operation[89] and are likely to have non-site-specific, serially-produced designs usable at other comparable sites.[90]

As discussed, fixed-bottom WTGs currently dominate offshore renewables. FWTs made up just 73 MW[91] —0.25%—of the 29,136 MWs of installed offshore wind capacity worldwide at the end of 2019.[92] Nonetheless, like other MORUs, FWTs offer a number of potential territorial, technical, economic, and legal advantages over fixed-bottom WTGs and utility-scale FWT deployments are predicted by a number of sources.

Because fixed-bottom WTG foundation costs increase significantly with water depth, 40m-60m roughly represents the current economic limit for fixed-bottom WTGs.[93] The proportion of a Producing Coastal State's EEZ suitable for economic use of fixed-bottom WTGs may be severely

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86. *See An Industry-Transforming Innovation Technology*, IDEOL, https://www.ideol-offshore.com/en/technology (last visited Dec. 20, 2020); Nadja Skopljak, *Hibiki Takes Center Stage*, OFFSHOREWIND.BIZ (May 21, 2019), https://www.offshorewind.biz/2019/05/21/hibiki-takes-center-stage-video/?sfns=mo.

87. *See The P-37*, FLOATING POWER PLANT, http://www.floatingpowerplant.com/products/?_sm_au_=iVVPZjMT4D4fDqqNTRKNjKHWR8RV1 (last visited Dec. 20, 2020); *SATH Technology*, https://www.saitec-offshore.com/sath/ (last visited Dec. 20, 2020).

88. *See TUV SUD Backs Elisa in Spain*, RENEWS (July 5, 2018), http://renews.biz/111724/tuv-sud-backs-elisa-in-spain; *Elisa Technology by Esteyco*, YOUTUBE (Sept. 12, 2018), https://youtu.be/QewinCGGg1g; *The Potential of Offshore Windpower is Enormous*, STIESDAL A/S, https://www.stiesdal.com/offshore-windpower (describing the temporary attachment of pontoons to Stiesdal's TetraBase fixed-bottom concept to tow it to and from site).

89. *See* DNV GL, *supra* note 29, at §§ 2.2.1.2, 2.2.1.3, 7.3.1.11, 10.1.1.4, 10.3.1.1, 10.3.1.3; AM. BUREAU OF SHIPPING, *supra* note 29, at Ch. 3, § 3.

90. *See* DNV GL, *supra* note 29, at §§ 1.1 ("The standard is in principle written for site-specific design; however, it may be suitable with a view to an expectation of mass production to design a FWT structure not for a specific site but rather for a class of environmental conditions and then, for each application, qualify the structure for the specific location in accordance with this standard.").

91. *See Phase II Summary Report: Floating Wind Joint Industry Project 1*, CARBON TR. (June 2020), https://www.carbontrust.com/resources/floating-wind-joint-industry-project-phase-2-summary-report [Carbon Trust, Phase II Summary Report].

92. GLOBAL WIND ENERGY COUNCIL, *supra* note 2, at 44.

93. *See Floating Offshore Wind: Market and Technology Review*, CARBON TR. 43-48 (2015), https://prod-drupal-files.storage.googleapis.com/documents/resource/public/Floating%20Offshore%20Wind%20Market%20Technology%20Review%20-%20REPORT.pdf. Admittedly, this economic limit is also dependent on the site's wind resource, distance to shore, seabed conditions, etc.

limited by, *inter alia*, the extent to which the EEZ consists of waters deeper than 60m.[94] Approximately 80% of Europe's offshore wind resources are located in waters greater than 60m deep.[95] In Japan, the number is also approximately 80%.[96] In the United States, it is approximately 60%[97] and off the Pacific coast and Hawaii it can be up to 95%.[98] Because better wind resources are frequently found over deeper waters, FWTs can deliver lower hourly variability[99] and higher average capacity factors (e.g. in some instances approaching 60%,[100] versus approximately 40-50% for new offshore fixed-bottom WTG projects[101]). Globally, the IEA estimates that the theoretical technical potential of offshore wind in waters less than 60m is approximately 1.5 times the current global electricity demand, while FWTs could unlock enough technical potential to meet 11 times the current global electricity demand in 2040.[102] Finally, the replacement of specialized WTG installation and jack-up service vessels[103] needed for

94. *Floating Wind Joint Industry Project: Policy & Regulatory Appraisal*, CATAPULT OFFSHORE RENEWABLE ENERGY & CARBON TR. (2017), https://www.carbontrust.com/resources/floating-wind-joint-industry-project-policy-regulatory-appraisal. *See also* David McPhee, *UK Offshore Wind Will 'Likely Remain' in Shallow Waters Without Floating Investment, Report Claims*, ENERGY VOICE (Oct. 17, 2019), https://www.energyvoice.com/otherenergy/210018/uk-offshore-wind-will-likely-remain-in-shallow-waters-without-floating-investment-report-claims.

95. CARBON TRUST, *supra* note 93, at 11.

96. *Id.* at 11.

97. *Id.*

98. *See New Energy Update, Floating Wind Turbines: The Road to Commercialisation*, US OFFSHORE WIND (2016), http://1.newenergyupdate.com/LP=20409?extsource=resources.

99. *See* INTER. ENERGY AGENCY, *supra* note 3, at 12, 22.

100. *See Going Global: Expanding Offshore Wind to Emerging Markets*, *supra* note 7, at 4 (recognizing *Hywind Scotland* for achieving "an impressive 57 percent capacity factor in its first full year of operation"); *Hywind Prospers in Winter Winds*, RENEWS (Feb. 15, 2018), https://renews.biz/33247/hywind-prospers-in-winter-winds/ (reporting that *Hywind Scotland* had an average capacity factor of 65% in its first three months of operation, significantly exceeding expectations); Keith Findlay, *'Be Bolder' in Going for Contracts, Firms Urged*, THE PRESS & J. (Nov. 2, 2018), https://www.pressandjournal.co.uk/fp/business/north-of-scotland/1600522/be-bolder-in-going-for-contracts-firms-urged/ (citing Equinor's Halvor Hoen Hersleth for the statement that *Hywind Scotland* achieved an "annual capacity factor of 56%, which . . . beats the bottom-fixed average of 40%"); Nadja Skopljak, *Floatgen Breaks Record in February*, OFFSHOREWIND.BIZ (Mar. 12, 2020), https://www.offshorewind.biz/2020/03/12/floatgen-breaks-record-in-february/ (Floatgen FWT had average capacity factor of 66% in Feb. 2020).

101. *See* INTER. ENERGY AGENCY, *supra* note 3, at 12, 21, 39-40, 49; *but see* Darius Snieckus, *Bigger Turbines Powering Offshore Wind to Capacity Factors of 'Over 70%'*, RECHARGE (Feb. 19, 2020), https://www.rechargenews.com/wind/bigger-turbines-powering-offshore-wind-to-capacity-factors-of-over-70-/2-1-759150.

102. *See* INTER. ENERGY AGENCY, *supra* note 3, at 11.

103. *See* Lars Paulsson et al., *Offshore Wind Will Need Bigger Boats. Much Bigger Boats.*, BLOOMBERG (May 13, 2019), https://www.bloomberg.com/news/features/2019-05-13/offshore-

fixed-bottom WTGs with cheaper tugs can also contribute to significant installation and O&M cost improvements, further reducing FWTs' LCoE relative to fixed-bottom equivalents.[104]

In 2009, Equinor mounted a Siemens Gamesa 2.3 MW WTG on a Technip-designed spar, creating the first full-sized FWT, the 5,300-tonne *Hywind Demo*.[105] It was moored 10 km off Norway in 220m of water,[106] where it remains. Subsequently, individual multi-megawatt FWTs were installed in Portugal,[107] France,[108] and Japan.[109] From 2013 to 2015, *Fukushima FORWARD*, a research and development MORU Array consisting of three different FWTs and a Floating Grid Integration System (i.e. a floating substation), was installed 20 km off the coast of Fukushima, Japan.[110] The first commercial MORU Array consisting of multiple identical FWTs, *Hywind Scotland*, was an Equinor-led 30 MW project consisting of five 11,500-ton spar-based FWTs,[111] installed in 2017 in

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wind-will-need-bigger-boats-much-bigger-boats ("While there are enough [installation] ships to serve the [bottom-fixed offshore wind] industry now, BNEF analyst Tom Harries in London sees a crunch in about four to five years.").

104. *See* CARBON TRUST, *supra* note 93, at 5; Ford, *supra* note 7 (costs of serially produced FWTs could be less than fixed-bottom WTGs); Aldo Chircop & Peter L'Esperance, *Functional Interactions and Maritime Regulation: The Mutual Accommodation of Offshore Wind Farms and International Navigation and Shipping*, 30 OCEAN YEARBOOK 1, 7 (2016), https://ssrn.com/abstract=2757060 ("Floating substructures have the potential to facilitate the mass production and deployment of offshore wind turbines, reducing reliance on costly offshore installation operations").

105. *See StatoilHydro Inaugurates Floating Wind Turbine*, EQUINOR (Sept. 8, 2009), https://www.equinor.com/en/news/archive/2009/09/08/InnovativePowerPlantOpened.html. *Hywind Demo* was voluntarily registered as a floating facility in the Norwegian Ordinary Ship Register in 2020. *See Spennende registrering i NOR*, NORWEGIAN MAR. AUTH. (May 13, 2020), https://www.sdir.no/aktuelt/nyheter/spennende-registrering-i-nor/.

106. *See Spennende registrering i NOR*, NORWEGIAN MAR. AUTH. (May 13, 2020), https://www.sdir.no/aktuelt/nyheter/spennende-registrering-i-nor/.

107. *See WindFloat: Pilot Project Phase*, EDP, https://www.edp.com/en/windfloat (last visited Dec. 20, 2020).

108. *See France's First Offshore Wind Turbine and Ideol's First Demonstrator: Floatgen Demonstrator*, IDEOL, https://www.ideol-offshore.com/en/floatgen-demonstrator (last visited Dec. 20, 2020).

109. *See Ideol's Second Demonstrator: Hibiki*, IDEOL, https://www.ideol-offshore.com/en/japanese-demonstrator.

110. *See Fukushima Floating Offshore Wind Farm Demonstration Project*, FUKUSHIMA OFFSHORE WIND CONSORTIUM, http://www.fukushima-forward.jp/english/movie03.html (last visited Dec. 20, 2020).

111. *See* RenewableUK, *An Introduction to Floating Offshore Wind*, YOUTUBE (Oct. 29, 2018), https://www.youtube.com/watch?v=okOojvNwaHs.

105m of water, 24 km off Scotland.[112] This will be followed in 2020 by the 50 MW, six FWT *Kincardine Array* floating 15 km off Scotland, combining MHI Vestas WTGs with Principle Power semi-submersible hulls.[113] The first operational commercial FWT MORU Array in the Atlantic Ocean, the 25 MW *WindFloat Atlantic*, consists of three similar FWTs, moored 20 km off Portugal.[114] *Hywind Tampen*, a planned 88 MW MORU Array with eleven FWTs consisting of Aker Solutions spars with Siemens Gamesa WTGs, 140 km off Norway in 260-300m of water, is scheduled to export power to Equinor-operated offshore oil and gas platforms at the end of 2022.[115] More than 50 FWT projects are in different stages of development,[116] including MORU Arrays off China,[117] France,[118]

112. *See* Michael J. Coren, *Floating Wind Farms Just Became a Serious Business*, QUARTZ (June 22, 2019), https://qz.com/1650433/hywind-scotland-makes-floating-wind-farms-a-serious-business.

113. *See Kincardine Floating Offshore Wind Farm, Scotland*, NS ENERGY, https://www.nsenergybusiness.com/projects/kincardine-floating-offshore-wind-farm-scotland/ (last visited Dec. 20, 2020).

114. *See* Craig Richard, *WindFloat Atlantic Fully Operational*, WIND POWER MONTHLY (July 27, 2020), https://www.windpowermonthly.com/article/1690362/windfloat-atlantic-fully-operational.

115. *See Equinor Awarding Hywind Tampen Contracts Worth NOK 3.3 Billion*, EQUINOR (Oct. 31, 2019), https://www.equinor.com/en/news/2019-10-31-hywind-tampen.html.

116. *See* Ilaria Valtimora, *What's Happening in Floating Wind in Europe?*, A WORD ABOUT WIND (July 3, 2019), http://membership.awordaboutwind.com/blog/whats-happening-in-floating-wind-in-europe?utm_medium=social&utm_source=email.

117. *See* Yuki Yu, *China Poised for Floating Wind Leap with Trio of Pilots*, RECHARGE (July 5, 2019), https://www.rechargenews.com/wind/china-poised-for-floating-wind-leap-with-three-projects/2-1-633670; Yuki Yu, *China's First Floating Wind Tender Wants Turbine in Water by Next Summer,* RECHARGE (May 27, 2020), https://www.rechargenews.com/wind/chinas-first-floating-wind-tender-wants-turbine-in-water-by-next-summer/2-1-815542.

118. Adnan Durakovic, *EU Nods to Four French Floating Wind Farms*, OFFSHOREWIND.BIZ (Feb. 25, 2019), https://www.offshorewind.biz/2019/02/25/eu-nods-to-four-french-floating-wind-farms.

Greece,[119] Ireland,[120] Italy,[121] Japan,[122] Korea,[123] Norway,[124] Saudi Arabia,[125] the Spanish Canary Islands,[126] Taiwan,[127] and the United States.[128]

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119. Tasos Kokkinidis, *Energy Giant Proposes Massive Floating Wind Farm in the Aegean*, GREEK REP. (Mar. 22, 2019), https://greece.greekreporter.com/2019/03/22/energy-giant-proposes-massive-floating-wind-farm-in-the-aegean/.

120. *See Inis Ealga Marine Energy Park*, DP ENERGY, http://dpenergy.info/inisealga/ (last visited Dec. 20, 2020); *Emerald*, SIMPLY BLUE ENERGY, https://simplyblueenergy.com/emerald/ (last visited Dec. 20, 2020).

121. *See* Darius Snieckus, *First Floating Wind Farm off Italy 'in Four to Five Years' as Sicily Project Raises Sails,* RECHARGE (June 22, 2020), https://www.rechargenews.com/wind/first-floating-wind-farm-off-italy-in-four-to-five-years-as-sicily-project-raises-sails/2-1-830005.

122. Joshua Hill, *Macquarie Signs up to Co-develop Japanese Floating Wind Farm*, RENEW ECON. (May 1, 2018), https://reneweconomy.com.au/macquarie-signs-co-develop-japanese-floating-wind-farm-70385/; Darius Snieckus, *Hitachi Zosen Joins up with Naval Energies for Floating Wind off Japan*, RECHARGE (July 8, 2019), https://www.rechargenews.com/wind/hitachi-zozen-and-naval-energies-tie-up-for-japanese-floating-wind/2-1-634858; Darius Snieckus, *Japanese Industrial Giant Taisei Ties up for Floating Wind Build-out*, RECHARGE (Oct. 10, 2019), https://www.rechargenews.com/wind/japanese-industrial-giant-taisei-ties-up-for-floating-wind-build-out/2-1-685022; Andrew Lee, *Floating Project on Pole to be First Japan Offshore Wind Auction: Law Firm*, RECHARGE (June 10, 2020), https://www.rechargenews.com/wind/floating-project-on-pole-to-be-first-japan-offshore-wind-auction-law-firm/2-1-823109; Darius Snieckus, *International Industrial Group Launches Massive Fast-Track Floating Wind Plan*, RECHARGE (June 22, 2020), https://www.rechargenews.com/wind/international-industrial-group-launches-massive-fast-track-floating-wind-plan/2-1-830030.

123. *Equinor Lines up Floating Wind Power Development in South Korea*, REUTERS (Feb. 15, 2019), https://www.reuters.com/article/us-equinor-southkorea-windpower/equinor-lines-up-floating-wind-power-development-in-south-korea-idUSKCN1Q41DW; *Macquarie Floats 1GW Korea Plan*, RENEWS (June 4, 2018), https://renews.biz/46821/macquarie-floats-1gw-korea-plan/; Darius Snieckus, *Offshore Heavyweights Launch Giant Floating Wind Project off Korea*, RECHARGE (Oct. 18, 2019), https://www.rechargenews.com/wind/offshore-heavyweights-launch-giant-floating-wind-project-off-korea/2-1-691046.

124. Bernd Radowitz, *Floating Wind Power 'Could Be Worth $13bn' to Norway*, RECHARGE (Sept. 17, 2019), https://www.rechargenews.com/wind/1851589/norway-could-see-usd-13bn-in-value-creation-through-floating-wind. *See Norway Proposes Areas for Floating Offshore Wind*, MAR. EXEC. (June 19, 2019), https://www.maritime-executive.com/article/norway-proposes-areas-for-floating-offshore-wind (describing Norway's 500-1500MW Utsira Nord project).

125. *See* Darius Snieckus, *First Full-Scale Floating Wind Plant in Asia Lifts Off*, RECHARGE (June 27, 2019), https://www.rechargenews.com/wind/first-full-scale-floating-wind-plant-off-asia-lifts-off/2-1-628699; *Saipem to Build a Floating Offshore Wind Farm in Saudi Arabia*, SAIPEM (July 17, 2019), https://www.saipem.com/en/media/news/2019-07-17/saipem-build-floating-offshore-wind-farm-saudi-arabia.

126. Bernd Radowitz & Darius Snieckus, *Spain Grants Equinor Ok for World's Biggest Floating Wind Farm*, RECHARGE (June 4, 2019), https://www.rechargenews.com/wind/spain-grants-equinor-ok-for-worlds-biggest-floating-wind-farm/2-1-615375.

127. *See* Darius Snieckus, *Eolfi and Cobra Join Forces for 2.5GW of Taiwan Floating Wind*, RECHARGE (Dec. 22, 2017), https://www.rechargenews.com/wind/1403287/eolfi-and-cobra-join-forces-for-25gw-of-taiwan-floating-wind. With the acquisition of Eolfi by Shell, this is now also a Shell project. *See* Darius Snieckus, *Oil Supermajor Shell Buys French Floating*

Although market predictions should be taken with a grain of salt, installed FWT capacity has been predicted to grow to 73.8MW by the end of 2019,[129] an annual market of 175 MW by 2020,[130] and in Europe over 300 MW in installed capacity by 2022.[131] The first GW of installed FWT capacity might be reached as early as 2025.[132] A consultancy has estimated that U.S. $32 billion are being set aside for FWT projects proposed or under development between 2020 and 2025, including fifteen U.S. $1 billion projects.[133] While one study estimates up to 4.3 GW of installed FWT capacity globally by 2030,[134] another study estimates up to 12 GW.[135] The UK's Carbon Trust has estimated 70 GW's of FWTs by 2040 (a thousand-fold increase valued at £195 billion) and DNV GL has predicted 250 GW's of FWTs by 2050.[136]

Wind Pioneer Eolfi, RECHARGE (Nov. 5, 2019), https://www.rechargenews.com/wind/1873416/oil-supermajor-shell-buys-french-floating-wind-pioneer-eolfi.

128. *See Maine Floater Secures PPA Approval*, RENEWS (Nov. 6, 2019), https://renews.biz/56244/maine-floater-secures-ppa-approval/; Nadja Skopljak, *14 Answer California Offshore Wind Call*, OFFSHOREWIND.BIZ (Apr. 26, 2019), https://www.offshorewind.biz/2019/04/26/14-answer-california-offshore-wind-call/; Nadja Skopljak, *New California Offshore Wind Coalition Calls for 10GW by 2040 Goal*, OFFSHOREWIND.BIZ (Oct. 2, 2019), https://www.offshorewind.biz/2019/10/02/new-california-offshore-wind-coalition-calls-for-10gw-by-2040-goal/ (a coalition which includes Equinor, Ørsted, Northland Power, Principle Power, Aker Solutions, Magellan Wind, and Mainstream Renewable Power); Richard A. Kessler, *Hawaii Offshore Wind Opportunities Draw Another Developer*, RECHARGE (Sept. 28, 2017), https://www.rechargenews.com/wind/hawaii-offshore-wind-opportunities-draw-another-developer/2-1-175885.

129. *See* Daniel Fraile, *How Can We Move Beyond Shallow Waters? Floating Wind Turbines*, EUR. COMM'N (June 17, 2019), https://webgate.ec.europa.eu/maritimeforum/en/system/files/2_windeurope_fraile.pdf.

130. *See Global Trends in Renewable Energy Investment 2018*, FRANKFURT SCHOOL, UNEP CTR. & BLOOMBERG NEW ENERGY FIN., 75 (2018), http://www.fs-unep-centre.org.

131. *See* Ford, *supra* note 7; WINDEUROPE, *supra* note 5, Table 1.

132. *See Global Offshore Wind Report 2019*, WORLD F. OFFSHORE WIND 1, 8 (Feb. 2020), https://wfo-news.de/wp-content/uploads/2020/02/WFO_Global-Offshore-Wind-Report-2019.pdf.

133. *See* Neil Ford, *Floating Wind Groups Lure Heavyweight Backers in Race for Scale*, NEWENERGYUPDATE BY REUTERS EVENTS (Sept. 25, 2019), https://analysis.newenergyupdate.com/wind-energy-update/floating-wind-groups-lure-heavyweight-backers-race-scale.

134. *See* Darius Snieckus, *Floating Wind Growth Could Be 'Far Slower' than Hoped: Study*, RECHARGE (Oct. 17, 2019), https://www.rechargenews.com/wind/1865313/floating-wind-growth-could-be-far-slower-than-hoped-study.

135. *See* Darius Snieckus, *Powering Floating Wind into the Future*, RECHARGE (Mar. 15, 2018), http://www.rechargenews.com/wind/1453789/powering-floating-wind-into-the-future; RENEWS, *supra* note 7.

136. *See Phase II Summary Report*, *supra* note 91, at 1; *Floating Wind: The Power to Commercialize*, DNV GL 4 (DEC. 2020), https://www.dnvgl.com/focus-areas/floating-offshore-wind/commercialize-floating-wind-report.html.

Assuming a future average nameplate capacity of 10 MW-20 MW[137] per FWT, this represents hundreds if not thousands[138] of large, multi-million-dollar FWTs and Floating Auxiliary Units in coastal states' waters over the next two decades.

Although these numbers might seem high, they also could be low. The IEA has predicted that, under current investment plans and policies, offshore wind power capacity added per year will reach 20 GW by 2030, increase 15-fold by 2040 (expanding by 13% per year), and will require investments of U.S. $840 billion to do so.[139] It also estimates that actual achievement of global climate and sustainability goals would require offshore wind capacity added per year to reach 40 GW by 2030 and cumulative investments of U.S. $1.2 trillion over two decades.[140] If, as predicted, FWTs achieve a lower LCoE than equivalent fixed-bottom WTGs at some point in the late 2020s, FWTs' share of the roughly U.S. $1 trillion prize is likely to be much larger.[141]

F. Floating Energy Storage Systems

A floating energy storage system (FESS) would temporarily store generated power, providing baseload power backup to balance renewables' intermittency or power services such as load-leveling and frequency regulation. FESS concepts are diverse, including traditional ships and barges packed with electrochemical batteries,[142] floating platforms storing

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137. Andrew Lee, *Floating Wind Joins 10MW-Turbine Era with MHI Vestas French Win*, RECHARGE (Nov. 18, 2019), https://www.rechargenews.com/wind/1878188/floating-wind-joins-10mw-turbine-era-with-mhi-vestas-french-win; Adnan Durakovic, *GE Global Research to Develop Controls for 12MW Floating Wind Turbine*, OFFSHOREWIND.BIZ (Sept. 30, 2019), https://www.offshorewind.biz/2019/09/30/ge-global-research-to-develop-controls-for-12mw-floating-wind-turbine/?sfns=mo; Darius Snieckus, *Offshore Wind Turbine 20MW Generator Ready 'Within Three Years'*, RECHARGE (Nov. 22, 2019), https://www.rechargenews.com/wind/offshore-wind-turbine-20mw-generator-ready-within-three-years/2-1-711845.

138. *See* GustoMSC, *Unlocking Massive Energy Potential*, 31 INSIDE 11 (May 2019), https://www.gustomsc.com/sites/default/files/Downloads/Inside/GustoMSC-InSide31-web%5B1%5D.pdf?utm_source=offshorewind.biz&utm_medium=OffshoreWindBiz%20728x90&utm_campaign=Inside%2031&utm_term=Inside%2031.

139. *See* INTERNATIONAL ENERGY AGENCY, *supra* note 3, at 13.

140. *See id.*

141. *See* CARBON TRUST, *supra* note 91, at 1; Darius Snieckus, *Floating Wind Power Will be 'Gigawatts and Billions of Dollars' Play for Iberdrola,* RECHARGE (Apr. 9, 2020), https://www.rechargenews.com/wind/floating-wind-power-will-be-gigawatts-and-billions-of-dollars-play-for-iberdrola/2-1-790561.

142. *See* Daniel Liang, *Floating Energy Storage for Grid and Maritime Applications*, DNV GL (Apr. 21, 2015), https://blogs.dnvgl.com/energy/floating-energy-storage-for-grid-and-maritime-applications.

electrical power as gravitational potential energy in lifted and lowered weights,[143] and floating platforms using pressurized water and compressed air to store energy.[144] Conversion of renewable electric power into chemically stored energy (e.g. hydrogen or ammonia) is also being explored,[145] including potential deployment of such technology on offshore floating platforms (functionally resembling FPSOs in some senses).[146] FESSs might be manned or unmanned. Each might be a site-specific design requiring modification before re-use or a serially-produced design usable at comparable offshore sites.

At least one FWT MORU Array already has a dedicated onshore energy storage system.[147] Glosten has presented a hybrid energy storage concept combining a floating substation with compressed air and rock heat-bed thermal technologies.[148] HydroWing has developed a floating tidal energy and hydrogen production, storage, and offtake concept called THyPSO.[149] The author is unaware of any current FESS deployment within MORU Arrays.

G. Floating Grid Integration Systems

Like other power plants, most MORU Arrays will require some form of dedicated grid integration system to convert produced power into a more easily transmitted form and stabilize the grid by *inter alia* collecting

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143. *See MGH—Stockage D'Énergie en Mer*, MGH ENERGY, http://www.mgh-energy.com/#mgh-stockage-d-energie-en-mer; *Our Technology*, SINKFLOATSOLUTIONS, http://sinkfloatsolutions.com/?page_id=1005 (last visited Dec. 20, 2020).

144. *The Technology*, FLASC, https://www.offshoreenergystorage.com/ (last visited Dec. 20, 2020); *Maltese Start-up Developing Floating Energy Storage*, OFFSHOREWIND.BIZ (Feb. 5, 2018), https://www.offshorewind.biz/2018/02/05/maltese-start-up-developing-floating-energy-storage/.

145. *'Green' Ammonia Is the Key to Meeting the Twin Challenges of the 21st Century*, SIEMENS, https://new.siemens.com/uk/en/company/topic-areas/sustainable-energy/green-ammonia.html; Andrew Lee, *Floating Wind-to-Hydrogen Plan to Heat Millions of UK Homes*, RECHARGE (Sept. 13, 2019), https://www.offshorewind.biz/2019/10/02/tractebel-unveils-hydrogen-producing-offshore-platform/.

146. *See* Lee, *supra* note 145.

147. *See Equinor has Installed Batwind—the World's First Battery for Offshore Wind*, EQUINOR (June 27, 2018), https://www.equinor.com/en/news/26june2018-equinor-has-installed-batwind.html.

148. *See* Darius Snieckus, *Glosten Launches Floating Wind Hybrid Energy Storage Concept*, RECHARGE (July 31, 2019), https://www.rechargenews.com/wind/1830631/glosten-launches-floating-wind-hybrid-energy-storage-concept.

149. *See HydroWing Unveils Tidal Power-Hydrogen Platform,* RENEWS (May 6, 2020), https://renews.biz/60118/hydrowing-unveils-tidal-hydrogen-platform/.

power from multiple Units, transforming the voltage of the power to be transmitted, changing the frequency of current, converting alternating and direct current, switching current to alternate cables or paralyzing a line following a failure, or compensating for reactive power.[150] Floating Grid Integration Systems would provide one or more of those services. Floating Grid Integration Systems concepts could include modified O&G hulls,[151] traditional ship-shaped hulls, and barges.[152] They might be manned or unmanned in normal operation. Floating Grid Integration Systems might include site-specific or serially-produced designs.

At least one Floating Grid Integration System has been installed: the floating substation spar, *Fukushima KIZUNA*, which connects the *Fukushima FORWARD* FWTs to shore.[153] A number of fixed-bottom WTG wind farms already use submersible Floating Grid Integration System concepts, which are floated to site and submerged until they rest on the seabed[154] or mounted on a floating and self-installing system before being mounted on a pre-installed jacket foundation.[155] Other groups are working on other offshore Floating Grid Integration Systems concepts as well.[156]

150. *See Hornsea Project One Welcomes World's First Offshore RCS*, OFFSHOREWIND.BIZ (June 29, 2018), https://www.offshorewind.biz/2018/06/29/hornsea-project-one-welcomes-worlds-first-offshore-rcs/ (describing a fixed-bottom offshore reactive power compensation station).

151. *See Ideol and STX Bringing Substations to Floating Realm*, OFFSHOREWIND.BIZ (May 22, 2018), https://www.offshorewind.biz/2018/05/22/ideol-and-stx-bringing-substations-to-floating-realm.

152. *A Floating Barge for Offshore Substations*, IDEOL, https://www.ideol-offshore.com/en/technology (last visited Dec. 20, 2020).

153. *See Fukushima Floating Offshore Wind Farm*, POWER TECHNOLOGY, https://www.power-technology.com/projects/fukushima-floating-offshore-wind-farm/ (last visited Dec. 20, 2020).

154. *See Dolwin Beta on the Move*, ABB (Aug. 3, 2015), http://www.abb.com/cawp/seitp202/7334a312604850a7c1257e960034063c.aspx.

155. *See* Michelle Froese, *Making of the Modern Offshore Substation*, WINDPOWER (Oct. 16, 2016), https://www.windpowerengineering.com/making-modern-offshore-substation/.

156. *See French Duo Unveil Floating Substation*, RENEWS (June 4, 2019), https://renews.biz/53544/french-duo-unveil-floating-substation/; OFFSHOREWIND.BIZ, *supra* note 151; Froese, *supra* note 155.

H. Floating Measurement Units

Floating measurement units (FMUs) are used to detect and measure various meta-ocean conditions. Floating meteorological masts[157] and light imaging, detection, and ranging (i.e. floating LIDAR) technology has been used for several years in the offshore wind industry to measure wind speeds and estimate wind resources at site.[158] Other FMUs measure the height, periods, and direction of waves, currents, air temperatures and pressure, water depths, water temperatures, and other relevant metocean data.[159] Typically, FMUs are deployed for shorter periods than other MORUs (e.g., for pre-investment resource analysis), but as costs decline, FMUs might be deployed for longer periods. FMU hulls include buoys,[160] smaller modified O&G hulls, or traditional ship-shaped hulls.[161] FMUs are typically unmanned and have a non-site-specific design capable of use at other offshore sites.

I. Floating Offshore Maintenance and Accommodation Facilities

Shore-based maintenance crews become less affordable the further MORUs are from shore, due to weather risks, costs of transit, and increased unproductive time. Fixed-bottom offshore operations and maintenance and accommodation facilities supporting fixed-bottom wind farms have already been built[162] but may not be practical for MORUs in deeper waters. Depending on the site, distance from shore, and other factors, floating offshore maintenance and accommodation facilities

157. Adnan Durakovic, *Floating Met Mast Starts Operating Offshore Greece*, OFFSHOREWIND.BIZ (July 26, 2019), https://www.offshorewind.biz/2019/07/26/floating-met-mast-starts-operating-offshore-greece/.

158. *See* Equinor, *Equinor Launches High-Tech Buoy in New York Bight*, YOUTUBE (Feb. 7, 2019), https://www.youtube.com/watch?v=a9pP9LIibg8&app=desktop; *Seawatch Metocean Buoys and Sensors*, FUGRO, https://www.fugro.com/about-fugro/our-expertise/technology/seawatch-metocean-buoys-and-sensors.

159. *See Products*, AXYS TECHNOLOGIES, http://axystechnologies.com/ (last visited Dec. 21, 2020).

160. *See FLiDAR WindSentinel*, AXYS TECHNOLOGIES, http://axystechnologies.com/products/flidar-windsentinel/ (last visited Dec. 21, 2020).

161. *Id.*

162. *See Fred Olsen Unveils 'Gamechanger'*, RENEWS (Nov. 19, 2015), https://renews.biz/45203/fred-olsen-unveils-gamechanger/; *Fred Olsen Plans Offshore Heliport*, RENEWS (June 18, 2016), https://renews.biz/42328/fred-olsen-plans-offshore-heliport/.

("FOMA Facilities") might make economic sense for MORU Arrays as well.[163]

FOMA Facilities would likely use modified O&G hulls, but traditional ship-shaped hulls are also possible. Unlike most other MORUs, FOMA Facilities would be manned for extended periods, including normal operation. FOMA Facilities might, or might not, have a non-site-specific design or be capable of use at other offshore sites with roughly equivalent needs. FOMA Facilities have been used for offshore oil and gas development,[164] but the author is unaware of existing FOMA Facilities at a MORU Array.

J. Hybrids

Floating Hybrid Unit concepts are only limited by the designer's creativity. MORUs combining multiple generation technologies exist.[165] Combining generation technology and auxiliary equipment (e.g., generation with energy storage) in one MORU is possible.[166] Similarly, combining auxiliary activities (e.g., grid integration systems, energy storage, and measurement technologies) is possible. As vessel technology evolves, hull types which combine the characteristics of more than one existing hull type also could be created.[167] A floating hybrid wind and tidal current generation unit, *SKWID*, was deployed off Japan, but in 2014 it sank,[168] resulting in another MORU loss.

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163. *See Is the Market Ready for–and Willing to Invest–In a Floating O&M Platform?*, RIVIERA (Jan. 18, 2018), https://www.rivieramm.com/opinion/is-the-market-ready-for--and-willing-to-invest--in-a-floating-om-platform-25980.

164. *See Our Fleet*, PROSAFE, https://www.prosafe.com/fleet/ (last visited Mar. 1, 2021); *Offshore Floatels for Harsh Environments*, FLOATEL INT'L, http://www.floatel.se/offshore-floatels-harsh-environments (last visited Mar. 1, 2021).

165. *Id.; See* Nadja Skopljak, *UK Marine Energy Developer Enters Floating Wind Market*, OFFSHOREWIND.BIZ (Apr. 4, 2019),https://www.offshorewind.biz/2019/04/04/uk-marine-energy-developer-enters-floating-wind-market/?sfns=mo (describing FWT/FWEC hybrid unit); Darius Snieckus, *Excipio Floats Hybrid Offshore Energy Design*, RECHARGE (Jan. 17, 2019), https://www.rechargenews.com/wind/1677863/excipio-floats-hybrid-offshore-energy-design (combining wind power and other generation technologies on a multi-spar platform); RECHARGE, *supra* note 148; *Floating Power Plant*, FLOATING POWER PLANT A/S, http://www.floatingpowerplant.com/ (last visited Dec. 21, 2020); *Orpheo*, ENEROCEAN, http://enerocean.com/orpheo/ (last visited Dec. 21, 2020).

166. *See* OPT OCEAN POWER TECHNOLOGIES, *supra* note 70 (a hybrid FWEC/FESS unit).

167. *See* STIESDAL A/S, *supra* note 88. *HydroWing Unveils Tidal Power-Hydrogen Platform*, *supra* note **Error! Bookmark not defined.**.

168. *See SKWID Sinks Off Japan*, OFFSHOREWIND.BIZ (Dec. 18, 2014), https://www.offshorewind.biz/2014/12/18/skwid-sinks-off-japan/.

K. Mooring, Umbilicals, and Cables

Like some O&G MOUs, MORUs depend on permanently installed subsurface mooring systems to remain on location. Various subsurface umbilical lines, including cables for the export of electrical power and transmission of data will hang from MORUs. However, MORUs' mooring systems and umbilicals tend to be smaller and less complex than O&G MOUs', allowing for easier detachment of MORUs for offsite maintenance or permanent relocation. Mooring systems and umbilicals raise legal issues of their own, described briefly in Part III.B.k below.

III. LIKELY MORU-RELATED DISPUTES, AND THE LEGAL STATUS QUO

Any affirmative answer to Professor Goode's first question ("Is there a problem?") should identify likely sources of MORU-related disputes and identify those that are not likely to be effectively addressed under existing international conventions and agreements.

A. Sources of Mobile Offshore Renewables Unit Disputes

Any *ab initio* effort to identify any and all international disputes that might arise in relation to a developing sector is perilous at best, but there are obvious places to look. A few MORU-related incidents have already occurred. The experiences of the offshore oil and gas industry with O&G MOUs provide useful reference points for identifying potential MORU legal issues. In certain circumstances, lessons also might be learned from industries reliant on other movable assets such as traditional ships or aircraft.

Lenders to MORU owner/operators might move away from the corporate or project finance contractual structures used for fixed-bottom offshore renewables projects to ship or moveable asset-based finance structures addressing lender concerns specific to mobile maritime assets. A shift from an offshore renewable energy owner/operator paradigm in which the asset owner and the operator are the same or related entities to a model where the owner/lessor and operator/lessee are separate, unrelated entities also might be possible.[169] In some circumstances, this could

169. *See Eni Signs Up OPT Wave*, RENEWS (Mar. 19, 2018), https://renews.biz/32707/eni-signs-up-opt-wave/ (Eni intends to lease for 18 months, with an option to extend or buy, an FWEC to power Adriatic subsea installations).

include a shift from an owner's capex driven economic model to an operating lessee's opex driven model, potentially changing the operator's accounting or tax treatment.[170] Lessors might include owner/operators leasing underutilized MORUs to another owner/operator, or, as has happened with traditional ships and aircraft, large dedicated financing companies owning and leasing a fleet of MORUs on short- or long-term contract to lessee/operators as a business.[171] Such leasing structures might allow developers/operators to finance the entirety of the MORU's cost, conserve credit lines, and respond quickly to fluctuations in demand. Different forms of offtake contracts might be possible as well.[172]

With this flexibility comes new issues. MORUs' relative mobility (e.g. the ease with which they can be detached and removed from site) when compared to fixed-bottom or onshore facilities could impact the representations and warranties demanded by lenders from debtors and lessors from lessees, particularly in the absence of binding international conventions providing legal certainty in relation to specific topics.[173] Conversely, MORU mobility gives lessors and lenders more potential levers against a lessee or borrower in default—lessors and lenders would not be forced to renegotiate with a MORU counterparty in default in the same way they could be when assets are permanently affixed to the seabed and dependent on revenue from a particular Producing Coastal State offshore lease or concession (hereinafter "concession").[174] Instead, lessors or lenders taking possession of MORUs from a counterparty in default could re-lease or sell them to third parties for use elsewhere,[175] creating a

170. This depends on, inter alia, the accounting standards of the jurisdiction (e.g. FAS 13 or IFRS 16), the term of the lease, the size of the loan relative to value, and the existence of a purchase option.

171. *Compare* Francis X. Nolan, III, *The Last Half Century of Financing Vessels*, 91 TUL. L. REV. 927, 928 ("Many traditional vessel operators have withdrawn from vessel ownership, and vessel ownership has experienced consolidation").

172. One could look at the commercial offerings of existing fossil-fueled powership and powerbarge fleets like Karpower for inspiration. *See Powership in 10 Questions*, KARPOWERSHIP, http://www.karpowership.com/en/powership-in-10-questions (last visited Dec. 21, 2020) ("6- What are the contract types? . . . . Electricity Generation Services Contracts, Power Rental Contracts, Energy Conversion Works Contracts or Power Purchase Agreements").

173. *See* Juan Pablo Rodriguez Delgado, *Security Interests over Ships: From the Current Conventions to a Possible Shipping Protocol to the UNIDROIT Convention-Lege Data and Lege Ferenda*, 49 (2) J. MAR. L. & COM. 239, 260 (2018) [hereinafter Delgado, *Security Interests over Ships*] (mentioning explicit trading limitations on charter parties prohibiting a ship from entering ports where the law of the flag would not be respected).

174. *See* Severance & Sandgren, *supra* note 9, at 4.

175. *See id.*

secondary market for MORUs. This might justify a reduction of contingencies set aside for counterparty default, local market, and political risks when compared to equivalent fixed-bottom facilities. These contracts might resemble the wet and dry leasing arrangements of the aircraft leasing industry, the bareboat and time charters of the shipping industry,[176] or something else.[177]

Self-evidently, MORU owners will seek to prevent competing ownership claims and clouds on title by public registration of their MORU ownership. Borrowers will seek to secure loans with MORUs offered as collateral, and lenders will demand priority against other creditors through public registration of their security interest. Equipment manufacturers and shipyards might go bankrupt[178] during construction, resulting in multiple creditors seeking to take possession of, and enforce any security interests over, incomplete MORUs and hulls.

Borrowers will default on loans or enter bankruptcy. MORU lessors will seek to take possession from lessees in breach. Labor disputes and injuries in relation to MORUs will result in claims.[179] Inevitably, disputes over criminal and civil jurisdiction over the MORU itself or the people thereon will arise from events occurring in coastal states' waters, and regulatory authority will be asserted and contested. Various parties will assert the existence of maritime liens. Arrests of MORUs will be attempted in Port States.

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176. *See* John Gallagher, *FTUs Float into Deeper Legal Issues*, IHS MARITIME FAIRPLAY (Apr. 23, 2015), https://www.akd.nl/Downloads/PublicatiesPDF-EN/1780686_2015-04-24_cvlynden_fairplay.pdf (citing a partner of a Dutch maritime firm for the proposition that the Dutch ship registry would register an FWT as a ship and allow a bareboat charter of the same).

177. *See generally* Nolan, *supra* note 171, at 928, 954-61 (outlining the evolution of alternative sources of capital financing of traditional vessels, including public equity and debt markets, specialized shipping banks, private equity, finance leasing, and fintech, each of which could also play a role in future MORU finance).

178. *See, e.g.*, *Where's the Money Coming From?: Financing Offshore Wind Farms*, EWEA 1, 43 (Nov. 2013), http://www.ewea.org/fileadmin/files/library/publications/reports/Financing_Offshore_Wind_Farms.pdf ("Up to 2011, no [fixed-bottom] offshore wind project was fully completed without a contractor going bankrupt"); *Jobs Lost as Wave Energy Firm Aquamarine Power Folds*, BBC (Nov. 23, 2015), https://www.bbc.com/news/uk-scotland-scotland-business-34901133; *Wave Power Firm Pelamis Calls in Administrators*, BBC NEWS (Nov. 21, 2014), https://www.bbc.com/news/uk-scotland-scotland-business-30151276; *Tocardo Tidal Power declared Bankrupt*, RENEWS (Oct. 11, 2019), https://renews.biz/55791/tocardo-tidal-power-declared-bankrupt/.

179. *See* Adnan Durakovic, *Three Injured after CTV Hits Wind Turbine at German Offshore Wind Farm*, OFFSHOREWIND.BIZ (Apr. 24, 2020), https://www.offshorewind.biz/2020/04/24/three-injured-after-ctv-hits-wind-turbine-at-german-offshore-wind-farm/.

MORU tow lines will snap during transit through Affected State waters. Mooring will be lost during operation in Producing Coastal State waters.[180] Uncontrolled contact[181] between MORUs and between MORUs and other vessels flying various flags will occur in Producing Coastal States', Port States', and Affected States' waters,[182] resulting in a multitude of possible international collision or allision claims.[183] Given that several MORUs have already been lost,[184] salvage and wreck removal claims seem inevitable. Unfortunately, in the future liabilities related to abandoned MORUs might need to be allocated.

Competing ocean and coastal users might seek to restrain the deployment of MORUs. Environmental incidents might occur. Self-evidently, increasing numbers of MORUs at sea will increase the number of MORU-related international maritime disputes.

B. Legal Status Quo: Maritime Conventions and Mobile Units

1. Sailing into *Mare Incognitum*: The Question of Applicable Law

Is the legal *status quo* sufficient to address international maritime disputes when they relate to MORUs? Clearly, allowing large numbers of MORUs to operate offshore without some juridical connection to a state

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180. *See DNV GL Algorithm Could Prevent FPSOs from Floating Away*, OFFSHORE ENERGY (May 10, 2019), https://www.offshoreenergytoday.com/dnv-gl-algorithm-could-prevent-fpsos-from-floating-away/ ("Over the past two decades, more than 20 incidents have been reported globally involving failure of permanent mooring systems on floating structures. In the most severe cases, vessels drifted, ... causing extended field shutdown and risk to life, property, and the environment, DNV GL said.").

181. *See* Mike Schuler, *Standby Vessel Damaged in Collision with Wind Turbine Pile Off England*, GCAPTAIN.COM (Aug. 14, 2014), https://gcaptain.com/standy-vessel-damaged-in-collision-with-wind-turbine-pile-off-england/; *Ship Collides with Wind Farm Due to Master's Poor Judgement*, SAFETY4SEA (July 29, 2018), https://safety4sea.com/ship-collides-with-wind-farm-due-to-masters-poor-judgement/ (describing a vessel collision with a fixed-bottom transition piece); *Real Life Accident: Wind Farm Vessel Collides with Turbine Tower*, MARINE INSIGHT (Aug. 13, 2020), https://www.marineinsight.com/case-studies/wind-farm-vessel-collides-with-turbine-tower/.

182. The Norwegian Petroleum Safety Authority counted 26 collisions between vessels and offshore platforms from 2000-2010. *See* Zhang Pengfei et al., *Research on Prevention of Ship Collisions with Oil Rigs*, 6 J. SHIPPING & OCEAN ENG'G 279, 281 (2016), http://ssudl.solent.ac.uk/3452/1/3-JSOE-E%200600710-2-Research%20on%20Prevention%20of%20Ship%20Collisions%20with%20Oil%20Rigs.pdf.

183. *See* Chircop & L'Esperance, *supra* note 104, at 9.

184. *See* Takahashi, *supra* note 39, at 18 (loss of a FOTEC); RENEWS, *supra* note 78 (loss of a FWEC); OFFSHOREWIND.BIZ, *supra* note 168 (loss of a Hybrid FWT/FTEC); Martin Foster, *Floating Platform Keels Over in Japan—Updated*, WIND POWER MONTHLY (May 12, 2016), https://www.windpoweroffshore.com/article/1394760/floating-platform-keels-japan-updated.

and its legal system would be undesirable.[185] Both MORUs and people thereon should be under a settled system of law.[186] The stakeholders in current smaller pilot and pre-commercial MORU projects have deployed MORUs in a few Producing Coastal States' waters and have entered other coastal states' waters infrequently, limiting stakeholders' actual exposure to international legal uncertainties to an acceptable level. Smaller Array size, balance-sheet financing, and a limited number of parties and coastal states involved act as natural hedges against broader international legal uncertainty and risks. For such projects, domestic law solutions have been found sufficient.

However, global deployment of internationally financed, utility-scale MORU Arrays dependent on a global supply chain will change that. Like traditional merchant ships and O&G MOUs, such MORUs will be inherently cosmopolitan things. In its lifetime, a MORU might be: (i) built of globally sourced materials and components[187] in the shipyards of one state and its hull registered therein;[188] (ii) upon completion, re-registered in a second, open-register Flag State open to MORUs; (iii) towed through the territorial sea and EEZ of a third state;[189] (iv) moored and operated by its owner in a fourth state's EEZ;[190] (v) serviced by offshore workers from fifth and sixth states; (vi) towed to a seventh state's port for repairs before

185. *See* White, *supra* note 9, at 23 (in relation to O&G MOUs).

186. *See id.*

187. *See* Cees Verburg & Jaap Waverijn, *Liberalizing the Global Supply Chain of Renewable Energy Technology: The Role of International Investment Law in Facilitating Flows of Direct Investment and Trade*, 2 BRILL OPEN L., 101 (2019), https://doi.org/10.1163/23527072-00201001 (describing wind and photovoltaic global supply chains).

188. *See Convention Relating to Registration of Rights in Respect of Vessels Under Construction*, art. 1, (May 27, 1967), *reprinted in* TRANSPORT LAWS OF THE WORLD, SEA I/E/14 (Malcolm Evans & Martin Stanford eds., 1983) (not in force) [hereinafter Vessel Construction Rights Convention], https://www.jus.uio.no/english/services/library/treaties/07/7-04/vessels-construction.xml.

189. *See* RENEWS, *supra* note 64 (FTEC towed from Scotland to Canada); Adam Vaughan, *World's First Floating Windfarm to Take Shape off Coast of Scotland*, GUARDIAN (June 27, 2017), https://www.theguardian.com/business/2017/jun/27/hywind-project-scotland-worlds-first-floating-windfarm-norway (five FWTs towed from Norway to Scotland); *see also Penguin Primed for Tallinn Departure*, RENEWS (Apr. 24, 2019), https://renews.biz/52772/penguin-primed-for-tallinn-departure/ (describing an Estonian-built FWEC, to be towed through multiple Baltic states' waters, and the North Sea, before deployment off Scotland).

190. Some Producing States presumably will allow or encourage foreign-registered MORUs to be deployed in their waters. This is particularly true where the Producing State's primary focus is obtaining a sustainable source of energy or reducing reliance on imported energy, and foreign Flag State registration of ownership and mortgages offers a viable and bankable alternative to domestic solutions. Self-evidently, other Producing States will not.

being returning to the fourth state's EEZ to resume operation;[191] (vi) sold to a new owner,[192] who repowers the MORU with updated generating equipment,[193] prior to reflagging it in an eighth state; (vii) leased by that owner to an offshore developer/lessee, who deploys and operates the MORU in a ninth state's waters for the remainder of its operational life; and (viii) decommissioned and broken up in a tenth state.[194] Conversely, MORUs will likely remain moored in place for extended periods (i.e. years) during normal operation. In short, the relative mobility of MORUs within the world of floating maritime assets sits somewhere between that of traditional merchant ships endlessly traversing the seas and MODUs moving from drilling job to job on one hand, and de facto permanent hydrocarbon-producing O&G MOUs spending their entire operational lifetime tied by their bespoke design and complex mélange of umbilicals to specific oil or gas reservoirs on the other. With financing from international banks in an eleventh state and credit support provided by the government of a twelfth state, potential international issues and stakeholders only increase.

Unfortunately, but almost axiomatically, technological innovation precedes well-conceived and tailored international regulation.[195] Once they leave the safety of home waters, MORUs sail into a legal *mare incognitum*: in relation to a particular international dispute involving a MORU, what is the applicable law? To the extent that two sophisticated private parties engaged in MORU-related transactions have the legal

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191. *See* Jan Dodd, *Devising O&M strategies for floating offshore*, WIND POWER MONTHLY (May 31, 2019), https://www.windpowermonthly.com/article/1585415/devising-o-m-strategies-floating-offshore.

192. *See World's First Floating Wind Turbine Finds New Calling*, OFFSHOREWIND.BIZ (Jan. 8, 2019), https://www.offshorewind.biz/2019/01/08/worlds-first-floating-wind-turbine-finds-new-calling/.

193. *See Opera Poised for Re-tune*, RENEWS (June 14, 2018), https://renews.biz/46669/opera-poised-for-re-tune/; WINDEUROPE, *supra* note 5, at § 1.1 (after decommissioning, the WindFloat Atlantic FWT semi-submersible hull was prepared for reuse at a pre-commercial project off Scotland); MARINE ENERGY, *supra* note 65 (describing a repowering of a FTEC).

194. *See* Severance & Sandgren, *supra* note 9, at 5 n.6. The first FWT was decommissioned in 2016. *See Floating Offshore Wind Energy: A Policy Blueprint for Europe*, *supra* at § 1.1 n.5.

195. *See* Maria Gavouneli, *Energy Installations in the Marine Environment*, ENERGY AT SEA, 1-2, 4, 9, 14 (2015), http://www.energyatsea.law.uoa.gr/uploads/media/Gavouneli_BIICL.pdf ("As a result, offshore structures erected for the generation of energy from renewable sources remain virtually unregulated by international law"); Darius Snieckus, *Renewable Energy Boom 'Not Closing Gap' on Climate Change*, RECHARGE (Sept. 11, 2019), https://www.rechargenews.com/transition/1848959/renewable-energy-boom-not-closing-gap-on-climate-change ("It is important to differentiate between the progress we are making on technology and the progress we are making on regulation").

autonomy to do so, their contractually agreed choice of law and forum generally should be respected.[196] However, this choice of law between two private parties, even if respected, is limited in scope to certain topics where this is possible. It still leaves unanswered MORU-related questions of public international law, particularly where a state seeks to impose a mandatory legal regime on MORUs. It also leaves unanswered questions of private international law when claims arise from and against third parties who have agreed to neither a choice of law nor a forum.

The law of the sea presents a natural starting point. Ambassador Tommy Koh of Singapore, at that time president of the Third U.N. Conference on the Law of the Sea, described UNCLOS as "a Constitution for the Oceans."[197] UNCLOS distinguishes between "ships" on one hand and "artificial islands, installations, and structures" on the other (albeit without defining any of those terms).[198] Article 60 grants the Producing Coastal State the exclusive right to construct and to authorize and regulate the construction, operation, and use of "installations and structures" for the purposes of the production of energy from the water, currents, and winds,[199] and, furthermore, grants the Coastal State exclusive jurisdiction over such installations and structures, including jurisdiction over customs, fiscal, health, safety, and immigration laws and regulations. Given that, a Producing Coastal State would likely consider MORUs installations or structures subject to its exclusive jurisdiction. Furthermore, Producing Coastal States will exercise a *de jure* monopoly on offshore concessions, and, unless energy storage or transnational subsea grids allow MORUs to export energy produced to other states, a de facto monopoly on the purchases of energy produced, giving MORU developers and operators a

196. *Convention on Offshore Units, Artificial Islands and Related Structures Used in the Exploration for and Exploitation of Petroleum and Seabed Mineral Resources*, COMITÉ MAR. INT'L (CMI) 3 (2004) https://comitemaritime.org/wp-content/uploads/2018/06/2004-1.pdf [hereinafter Vancouver Draft].

197. Tommy Koh, *A Constitution for the Oceans*, UNITED NATIONS (Dec. 1982), https://www.un.org/depts/los/convention_agreements/texts/koh_english.pdf (Remarks of the President of the Third United Nations Conference on the Law of the Sea at the Conference at Montego Bay). *See also* Elisabeth Mann Borgese, *A Constitution for the Oceans: Comments and Suggestions Regarding Part XI of the Informal Composite Negotiating Text*, 15 SAN DIEGO L. REV. 371 (1977-1978); John R. Stevenson, *Lawmaking for the Seas*, 61 A.B.A. J. 185 (1975).

198. *Compare* UNCLOS, *supra* note 14, at art. 17-28 (which apply to "ships") *with id.* at art. 56(1)(b)(i), 60 (regulation of "artificial islands, installations, and structures").

199. *See id.* at art. 56(1). Query whether offshore production from solar energy is also covered by UNCLOS.

strong commercial incentive to tacitly consent to (or at least not challenge) broader assertions of jurisdiction or authority by a monopolistic Producing Coastal State in its EEZs, even if such Producing Coastal State assertions exceed the bounds of commonly accepted public international law.

However, while Article 60 gives Producing Coastal States a general right of regulation of activities within their EEZ in relation to "installations and structures" for the production of energy from the water, currents, and winds, Article 56 states that these rights must be exercised with regard to the rights of other states and UNCLOS.[200] Under Article 91, each state has the right to determine the conditions for registration of "ships" under its flag.[201] As indicated previously, it seems quite possible that some Flag States would be willing to register MORUs as "ships" or "vessels"[202] or as an "installation" (as contemplated under Articles 109(3)(b) and 209(2)), even if that MORU is ultimately meant for use in the waters of a foreign Producing Coastal State. Under Article 94, Flag States (to the extent MORUs are "ships" under UNCLOS) would be obliged to exercise jurisdiction over administrative, technical, and social matters onboard those MORUs/"ships," including jurisdiction under its internal law over the MORU/"ship" (and, if manned, its master, officers, and crew).

Clearly, a potential jurisdictional conflict could arise under different provisions of UNCLOS where the mobility of the object is somewhere between a traditional "ship" and a permanent "installation," and the determination of whether a MORU legally is considered either a "ship" or an "installation" sits in the hands of multiple states (i.e. a Producing Coastal State and a Flag State or under UNCLOS). When a MORU registered as a "ship," "vessel," or "installation" by a foreign Flag State is then used in a Producing Coastal State's EEZ, does the Flag State or the Producing Coastal State have jurisdiction over, e.g., the internal law concerning administrative, technical and social matters on that MORU (and, if manned, its master, officers and crew) under UNCLOS?[203] More broadly, under UNCLOS Article 56, what rights do non-producing states (whether Flag States, Port States, or Affected States) retain and when can

200. White, *supra* note 9, at 24; UNLCOS, *supra* note 14, at art. 58(3); Vancouver Draft, *supra* note 196, at 6.

201. M/V Saiga (No. 2) (St. Vincent v. Guinea), Case No. 2, Judgment of July 1, 1999, 2 ITLOS.

202. *See* Gallagher, *supra* note 176; NORWEGIAN MAR. AUTH., *supra* note 105.

203. *See* Fair Work Ombudsman v. Pocomwell Ltd. (No. 2) [2013] FCA 1139, ¶¶ 10-11, 15-16, 30-33, 35-36, 48, 43-53, 57-60, 63-64, 66, 68, 70-77, 79-82, 86-105, 107, 155, 188-89, 246, 249, 258-62, 280. http://www6.austlii.edu.au/cgi-bin/viewdoc/au/cases/cth/FCA/2013/1139.html.

those states exert jurisdiction in relation to MORUs, or the people thereon, for events occurring in Producing Coastal State waters? Separately, which state has jurisdiction, and when, if a claim arises when a MORU is in the waters of a coastal state that is not a Producing Coastal State? Is it the Flag State, the Port State, or the Affected State? Two parties in dispute might resort to the dispute resolution process described in UNCLOS Part XV. Alternatively, in the absence of clear answers under UNCLOS, international maritime conventions may provide some guidance in relation to the interpretation of portions of UNCLOS and specific areas of the law, and the relevant jurisdictional competence to issue binding decisions in relation to any disputes thereunder.[204]

2. Topical International Maritime Conventions, Generally

Over several centuries, a mixture of topical international maritime conventions have been developed to bring uniformity to specific questions of maritime law.[205] Under some maritime conventions, a new, uniform substantive supranational law in relation to a particular issue is imposed, to be enforced domestically by the party states.[206] In others, procedural uniformity (but not necessarily substantive uniformity) is achieved by allocating exclusive jurisdiction to a particular category of state (e.g. the Flag State) for the settlement of specific types of maritime disputes. The latter is a private international law approach that provides certainty in terms of exclusive jurisdiction but not uniformity in terms of substance,[207] creating a multitude of possible (but hopefully predictable) outcomes for the same type of event depending on, *inter alia*, the nature and circumstances of the incident and the particular domestic laws of the relevant Producing Coastal State, Flag State, Port State, Affected State, etc., to which jurisdiction has been allocated.[208]

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204. *See* UNCLOS, *supra* note 14, at art. 282.

205. *See* Griggs, *supra* note 1, at 193.

206. *Id.*

207. *See* Juan Pablo Rodriguez Delgado, *Is the Preparation of a Future Protocol to the Convention on International Interests in Mobile Equipment Concerning Ships and Maritime Affairs a Good Idea?*, 24 J. INT'L MAR. L. 213, 217 (2018) (contrasting the Cape Town Convention's substantive law approach to security interests with the conflict-of-laws approach taken in existing maritime conventions governing ship mortgages and liens).

208. *See* Ole Böger, *The Case for a New Protocol to the Cape Town Convention Covering Security Over Ships*, 5 CAPE TOWN CONVENTION J. 73, 94-95 (2016), https://doi.org/10.1080/2049761X.2016.1256432 ("Under the conflicts-of-law approach, secured creditors may rely on the

Unfortunately, even where the subject matter of a dispute is of the type nominally covered by a topical international maritime convention, there are two potential obstacles to the application of that convention to a MORU-related dispute. The first obstacle is uneven acceptance: Is the convention accepted by a sufficient number of relevant states to conclude (for purposes of this discussion) that a respectable level of international uniformity within the maritime community on the procedural or substantive solution to the particular problem exists? The second obstacle is one of scope: Are MORUs objects to which the convention even applies?[209]

Self-evidently, the relevant states must be parties to an international convention for it to apply. Unfortunately, acceptance of international maritime conventions is anything but uniform.[210] Some maritime conventions, such as the Convention for the Unification of Certain Rules of Law with Respect to Collisions Between Vessels (Collision Convention 1910);[211] the Convention on the International Regulations for Preventing Collisions at Sea, 1972, as amended (COLREG 1972);[212] International Convention for the Prevention of Pollution from Ships (as amended by the Protocol of 1978);[213] the International Convention on Load Lines, 1966 (LL 1966);[214] the International Convention for the Safety of Life at Sea 1974 (SOLAS);[215] and the International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, as amended

application of the law of the flag, but . . . the substantive content . . . will vary as between the legal systems of the various flag States").

209. *Compare* Shaw, *supra* note 9, at 83.

210. *See generally* Griggs, *supra* note 1, at 193-98.

211. International Convention for the Unification of Certain Rules of Law with Respect to Collision Between Vessels, Sept. 23, 1910, 212 Consol. T.S. 178 *reprinted in* 6 BENEDICT ON ADMIRALTY Doc. 3-2, 3-11 to 3-14 (Frank L. Wiswall, Jr. ed., 7th ed. rev. 2007) [hereinafter Collision Convention].

212. Convention on the International Regulations for Preventing Collisions at Sea, *opened for signature* Oct. 20, 1972, 1050 U.N.T.S. 16 [COLREGS 1972].

213. International Convention for the Prevention of Pollution from Ships, Nov. 2, 1973, 12 I.L.M. 1319, *amended by* Protocol of 1978 Relating to the International Convention for the Prevention of Pollution from Ships, Feb. 17, 1978, 1340 U.N.T.S. 61 [MARPOL 1973/1978].

214. International Convention on Load Lines, 1966, Apr. 5, 1966, 640 U.N.T.S. 133 (applying only to ships on international voyages).

215. International Convention for the Safety of Life at Sea, 1974, Nov. 1, 1974, 32 U.S.T. 47, 1184 U.N.T.S. 278 [SOLAS].

in 1995 and 2010,[216] are broadly accepted.[217] Others struggle to even enter into force, let alone become generally accepted. Although the current number of states adopting each of the conventions discussed below has been indicated, this is only intended to illustrate uneven levels of maritime convention acceptance—in relation to any actual dispute, a member state check must be performed to determine whether the litigants are subject to that convention. To the extent they are, a second, fundamental question of scope arises.

Unfortunately, the endless legal and academic debate over whether, when, and in which contexts, non-traditional, non-propelled watercraft are considered "ships" or "vessels" [218] only begs the question of whether, when, and in which contexts a MORU would be a "ship" or "vessel" within the scope of otherwise relevant maritime conventions. [219] The answer to this question can be seen largely, but not exclusively, as a further expansion of the "What is a 'ship'?" debates.

There is no uniform definition of "ship" or "vessel," with considerable variety between the conventions.[220] As detailed below, some maritime conventions leave the terms undefined, others define the terms in different ways, and many conventions then explicitly include or exclude certain categories of floating objects from the generally applicable definition or certain provisions of the convention.[221] As a consequence, the possible applicability of each international maritime convention to MORUs needs to be analyzed in isolation.

If MORU stakeholders, in relation to a particular international maritime dispute, conclude that:

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216. International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978, July 7, 1978, 1361 U.N.T.S. 2 [STCW].

217. *See CMI Yearbook 2016*, COMITÉ MAR. INT'L (CMI) 368-70 (2016), https://comitemaritime.org/wp-content/uploads/2018/05/Status-of-the-Ratifications-of-and-Accessions-to-the-Brussels-International-Maritime-Law-Conventions.pdf (listing the parties as of 2016 to Collision Convention 1910); *Status of IMO Treaties*, INT'L MAR. ORG., 17, 98, 115, 205, 410 (2021), https://wwwcdn.imo.org/localresources/en/About/Conventions/StatusOfConventions/Status%20-%202021.pdf [hereinafter STATUS OF TREATIES] (as of 2021, there were 161 parties to COLREG 1972, 158 parties to MARPOL 1973/1978, 163 parties to LL 1966, 165 parties to SOLAS, and 165 parties to STCW).

218. *See supra* note 9.

219. *See* White, *supra* note 9, at 22 ("The development of offshore techniques and practices since 1977 has produced a wider range of new craft which have made the legal position more confused."); *see also* Shaw, *supra* note 9, at 81 (". . . the CMI…adopted texts which attempted to apply established legal concepts to the strange new craft generated by the offshore oil industry.").

220. *See* Severance & Sandgren, *supra* note 9, at 27.

221. *See id.* at 15-19, 27-28.

a. either:
    1. the relevant states are not party to an otherwise applicable international maritime convention; or
    2. the otherwise applicable convention does not apply to MORUs; and
b. the collective body of domestic law(s) of the relevant Producing Coastal State, Flag State, Port State(s), and/or Affected State(s) do not provide consistent rules in relation to conflict of laws, jurisdiction, and (in a state with jurisdiction) adequate substantive treatment and procedural due process of the particular maritime issue for both foreign and domestic parties.

Those stakeholders enter uncharted waters. As in any age of exploration, there will be those brave souls who dare to enter the *mare incognitum*. However, there will be many, many more who, fearing monsters, wait for fair winds, following seas, and a decent map before venturing beyond the safety of home waters.

3. Applicability of Specific Topical International Maritime Conventions

Together with UNCLOS, various topical international maritime conventions are described below, focusing on levels of convention acceptance and whether the MORU is clearly an object to which those conventions apply. The conventions are grouped by category: (a) freedoms of the high seas and rights of innocent and transit passage (b) default civil jurisdiction in the absence of other regulation; (c) interrelated topics of registered ownership, *in rem* non-possessory collateral rights, and maritime liens; (d) arrests; (e) collisions and allisions; (f) safety at sea; (g) end of life issues, such as salvage, wreck removal, and decommissioning; (h) limitations of liability; (i) environmental impact and pollution; and (j) criminal jurisdiction. In addition, MORUs raise specific legal issues not addressed by existing topical maritime conventions in relation to: (k) allocation of CO_2 reduction obligations; and (l) marine spatial planning.

a. Freedoms of the High Seas and Rights of Innocent and Transit Passage

Do MORUs in transit have internationally recognized freedoms of the high seas and right to innocent or transit passage in the superjacent waters of a coastal state? Before UNCLOS's effective date, a similar question arose in the *Great Belt* case in the International Court of Justice in relation to an assertion of a right of innocent passage for Finnish-built MODUs intending to pass through Danish waters,[222] but was not resolved by the ICJ as the parties reached a settlement prior to any decision.[223] UNCLOS Articles 17, 21-28, 38-45, 52-54, and 211 largely frame rights of innocent passage or transit passage and coastal state limitations on those rights either directly or, in the case of Articles 18-19, 44-45, and 54, indirectly, in the context of a "ship." Articles 90-92, 94, and 97-98 do the same in relation to the freedom of the high seas and the right to sail "ships" flying a nation's flag on the high seas. This again begs the question of whether a MORU (particularly if the MORU is not registered as a ship under domestic law) would be recognized as a "ship," if only for purposes of freedom of the high seas, or rights of innocent or transit passage under the law of the sea.

b. Default Civil Jurisdiction

While UNCLOS acknowledges Producing Coastal States' sovereign right to produce energy from water, currents and winds and jurisdiction in relation to, *inter alia*, the establishment and use of artificial islands, installations, and structures to do so in their EEZs, it is also clear that these rights must be exercised with regard to the rights of *other* States and the remaining provisions of UNCLOS.[224] As noted above, under UNCLOS Art. 91 each state has the right to determine the conditions for registration of "ships" under its flag, and a Flag State might be willing to register

222. *See* Passage through the Great Belt (Fin. v. Den.), Provisional Measures, 1991 I.C.J. 12 (July 29, 1991), https://www.icj-cij.org/public/files/case-related/86/086-19910729-ORD-02-00-EN.pdf.

223. *See* Passage through the Great Belt (Fin. v. Den.), Discontinuance Order, 1992 I.C.J. 348, 348-49 (Sept. 10, 1992), https://www.icj-cij.org/public/files/case-related/86/086-19920910-ORD-01-00-EN.pdf.

224. White, *supra* note 9, at 24; UNCLOS, *supra* note 14, art. 56 & 58.3; Vancouver Draft, *supra* note 196, Commentary 6.1.

MORUs destined for foreign Producing Coastal State waters as Flag State "ships" or, under UNCLOS Art. 109(3) and 209(2), as "installations."

In contrast to constantly moving traditional merchant ships,[225] MORUs resemble O&G MOUs insofar as both might remain in stationary operation within Producing Coastal States' waters for extended periods[226] and be serviced or manned by a multinational workforce. As has happened with O&G MOUs, some will assert that foreign-flagged MORUs should be considered jurisdictional enclaves within Producing Coastal State's waters.[227] If a Producing Coastal State licenses a foreign-registered or serviced MORU to operate within its EEZ, there may be a conflict of the laws of the Producing Coastal State and the Flag State[228] or an Affected State providing offshore workers. Which state has jurisdiction over civil claims arising from events that are not directly related to either the production of energy from the water, current, or winds or the establishment and use of the MORU: for example, a civil claim by an Affected State offshore worker against the operator of a foreign-flagged MORU operator for back pay or wrongful dismissal related to work performed in a Producing Coastal State EEZ?

When a MORU is not moored and operating in a Producing Coastal State's EEZ, the waters are even murkier. UNCLOS Art. 28 limits coastal states' exercise of civil jurisdiction over a foreign "ship" or the people thereon when the "ship" is simply moving through a state's EEZ.[229] Is a foreign-flagged MORU moving through an EEZ a "ship" for purposes of innocent passage under UNCLOS Art. 28?

Under UNCLOS Art. 59, in the event that UNCLOS "does not attribute rights or jurisdiction to the [Producing] [c]oastal State or to other States within the [EEZ] and a conflict arises between the interests of the [Producing] [c]oastal State and any other State or States, the conflict should be resolved on the basis of equity and in the light of all the relevant circumstances, taking into account the respective importance of the interests involved to the parties as well as to the international community as a whole." However, states may settle disputes concerning UNCLOS interpretation or application in several forums,[230] if they are unable to

225. *See* UNCLOS, *supra* note 14, at art. 28.

226. White, *supra* note 9, at 24.

227. *Id.*

228. *Id.*

229. *See* UNCLOS, *supra* note 14, at art. 28 (limiting a coastal State's exercise of civil jurisdiction over foreign *ships* passing through its EEZ to certain circumstances).

230. *See* UNCLOS, *supra* note 14, art. 286 & 287.

settle the dispute by peaceful means of their own choice.[231] Article 59's formulation offers little certainty as to probable outcome where there are competing claims of jurisdiction. Given the uncertainty with regard to the rights retained by other states under UNCLOS Art. 56 and the uncertainty of whether a MORU would be a "ship" under UNCLOS Art. 28, some mechanism is needed to clarify which state has jurisdiction in a number of circumstances.

Assuming the relevant states are parties, UNCLOS acknowledges that jurisdiction for particular types of civil claims might already be agreed in an applicable topical international maritime convention (discussed below).[232] In the absence of such, the limitations on each coastal state's sovereignty in its EEZ and the ambiguity of rights retained by other states under UNCLOS suggest the need for international agreement on allocation of default jurisdiction for resolution of civil claims, particularly in relation to third party civil claims (in tort or negligence) not otherwise addressed.[233]

c. Registered Ownership, *In rem* Collateral Rights, and Maritime Liens

Clear international rules in relation to ownership, use of movable assets as collateral under non-possessory *in rem* security interests, registration of various security interests, priority of claims, and remedies in the event of a default can significantly improve international banks' willingness to finance movable assets and increase the level of capital available for cross-border finance.[234] Unfortunately, that is not yet the case for MORUs. Finally, some mechanism of providing an internationally recognized clean title to the purchaser in the event of a judicial sale is needed.

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231. *See id.* at art. 281-283; *see also* The M/T "San Pedro Pio" Case (Switz. v. Nig.), Case No. 27, Order of July 6, 2019, https://www.itlos.org/fileadmin/itlos/documents/cases/case_no_27/Orders/C27_Order_06.07.2019_rev.pdf.

232. *See* UNCLOS, *supra* note 14, at art. 282, 288(2).

233. Vancouver Draft, *supra* note196, Commentary 6.5-8.

234. *See* Rainer F.H. Haselmann et al., *How Law Affects Lending*, 23 REV. FIN. STUD. 549 (2010) ("Results show that collateral law seems to have a statistically significant effect on bank lending, while improvements in bankruptcy do not . . . . we find a strong positive effect of Collateral on multinational banks' lending decisions, and . . . . in particular foreign banks, benefit more from legal change [to collateral law] by expanding their lending volume to a greater extent than incumbent domestic banks.").

i. Recognition of Flag State Registration of Ownership

Efficient secured finance of any maritime asset capable of cross-border relocation requires, *inter alia*, international recognition of ownership and title registered by the Flag State.[235] Unfortunately, there is no broad international or domestic legal consensus with regard to the treatment of MORUs as a particular form of registerable, moveable floating property, whether as a "ship," "vessel," "installation," or otherwise, an uncertain position not unlike that of O&G MOUs and other non-traditional watercraft.[236]

Under the law of the sea, every state has the right to a merchant fleet under its flag and is entitled to use the high seas.[237] As noted above, UNCLOS Art. 91 gives states the right to fix the conditions for granting nationality to ships, registering ships in its territory, and flying its flag.[238] UNCLOS takes no position as to what is registerable as a ship, leaving it to the Flag State to determine whether a MORU should be registered as such, and thereby both accepting responsibility for it and acquiring authority over it.[239]

Neither the United Nations Convention on Conditions for Registration of Ships, [240] (Ship Registration Convention) nor the Convention Relating to Registration of Rights in Respect of Vessels under Construction, 1967 (Vessel Construction Rights Convention, 1967) have entered into force.[241] Even if the Ship Registration Convention enters into force, it would not apply to MORUs: it defines a "ship" as "any self-propelled sea-going vessel used in international seaborne trade for the transport of goods, passengers, or both, with the exception of vessels of less than 500 gross registered tons."[242] If the Vessel Construction Rights Convention, 1967 entered into force, it is unclear whether it would apply

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235. *See* Souichirou Kozuka & Naoe Fujisawa, *Old Ideas Die Hard?: An Analysis of the 2004 Reformation of Secured Transactions Law in Japan and its Impact on Banking Practices*, 31 T. JEFFERSON L. REV. 294, 299-01 (2009) (discussing efficiency and inefficiency issues facing secured commercial finance of movables).

236. *See* White, *supra* note 9, at 23; *see also* NORWEGIAN MAR. AUTH., *supra* note 105.

237. *See* UNCLOS, *supra* note 14, at art. 90; Severance & Sandgren, *supra* note 9, at 15.

238. *See* Severance & Sandgren, *supra* note 9, at 15.

239. *See* Alexander P. Higgens & Constantine J. Colombos, THE INTERNATIONAL LAW OF THE SEA 201 (2d ed. 1951).

240. United Nations Convention on Conditions for Registration of Ships, Feb. 7, 1986, 26 I.L.M. 1229, https://unctad.org/en/PublicationsLibrary/tdrsconf23_en.pdf [hereinafter Ship Registration Convention].

241. *See* COMITÉ MAR. INT'L (CMI), *supra* note 217, at 411, 490.

242. *See* Ship Registration Convention, *supra* note 240, at art. 2.

to MORUs, as that convention limits its application to the registration of constructions which, when completed, would be registerable as "sea-going vessels" in the relevant contracting state.[243]

Given the right of each state to determine what it registers as a "ship" and the absence of any other international convention on point, many Flag States might conclude that MORUs are generally considered "ships" or "vessels" under their domestic law and register them as such.[244] Some Flag States might conclude that MORUs are "ships" or "vessels" for purposes of registration of ownership, but not for other purposes.[245] However, other Flag States might conclude that MORUs are not registerable "ships" or "vessels" under their domestic law. For example, it is not inconceivable that the Japanese government concludes that MORUs are not "ships" under Japanese law but are movable equipment under the Japanese Construction Machinery Mortgage Law, and any true transfer of ownership should be registered as a transfer of movable equipment[246] with the Nakano Ward Legal Assistance Bureau in Tokyo.[247] This potential diversity of domestic law asset characterization in the context of ownership presents a legal problem for maritime assets likely to cross borders in their lifetime.[248]

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243. *See* Construction Rights Convention, *supra* note 188, art. 1.

244. *See* Gallagher, *supra* note 176; Severance & Sandgren, *supra* note 9, at 71-73; *see also* Merchant Shipping Act 1973, § 2(1) (U.K.); Merchant Shipping Act 1995, § 311 (U.K.) (stating that in the United Kingdom, the Secretary of State could use his authority under section 311 of the MSA 1995 to decide that an object designed or adapted for use at sea is or is not to be treated as a "ship" for purposes of the Act).

245. *See* Norwegian Mar. Code of 24 June 1994, No. 39, LOV OM SJØFARTEN § 33(2), https://lovdata.no/dokument/NL/lov/1994-06-24-39/KAPITTEL_1-2#KAPITTEL_1-2 (allowing the registration under section 33 of "such other floating constructions as the King shall decide"); 42 U.S.C. § 9118(e)(3) (deeming ocean thermal energy conversion facilities and plantships (i.e. FOTECs) to be vessels—notwithstanding the fact that ocean thermal energy conversion facilities may be standing, fixed, or moored in place—and, if documented, vessels of the United States specifically for the purposes of the Ship Mortgage Act); *see also* 42 U.S.C. § 9141(a) (deeming ocean thermal energy conversion facilities and plantships (i.e. FOTEC) to be vessels operated in the foreign commerce of the United States for purposes of Chapter 535 (Capital Construction Funds) of Title 46 of the U.S. Code); Severance & Sandgren, *supra* note 9, at 73-75.

246. *See* Kozuka & Fujisawa, *supra* note 235, at 304 (indicating ships are exempt from the Law on Special Rules to the Civil Code Concerning the Perfection of the Transfer of Movables and Assignment of Receivables).

247. *See* Taro Awataguchi & Yuki Kohmaru, *Ch. 3.3(3) Machinery and Equipment*, LENDING & SECURED FIN. 2019: JAPAN (2020), https://iclg.com/practice-areas/lending-and-secured-finance-laws-and-regulations/japan.

248. *See generally* Nolan, *supra* note 171, at 971-74.

MORU owners seeking to prevent competing ownership claims and possible clouds on title will seek Flag States that are able to achieve international recognition of the Flag State's public registration of MORU ownership. However, in the absence of legally binding agreements to do so, Producing Coastal States, Port States, and Affected States are not bound to recognize that foreign Flag State's registration of MORU ownership.[249] Indeed, a Producing Coastal State, Port State, or Affected State might determine (under its own domestic law) that MORUs whose ownership is registered as something other than a "ship" by the foreign Flag State (e.g., registered as movable equipment by Japan in the hypothetical above) should be treated as unregistered, stateless, or flagless "ships" or "vessels" under its own domestic law.[250] Conversely, a Producing Coastal State, Port State, or Affected State might determine (under its domestic law) that MORUs whose ownership is registered as a "ship" or "vessel" by a foreign Flag State nonetheless should be treated as something other than a flagged "ship" or "vessel" (e.g., an "installation"). From a Flag State perspective, to the extent that its flagged MORUs will move through the waters of any foreign coastal state (be it a Producing Coastal State, Port State, or Affected State), some acknowledgement by those states of the Flag State's registration of MORU ownership (whatever its form) would be highly desirable.[251]

A publicly accessible Flag State MORU register would also be of great benefit to creditors of any other coastal state in the waters of which a foreign flagged MORU of unknown provenance might appear.

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249. *See id.* at 972 (raising the inverse corollary of this proposition: "There is also a divergence among [responding NMLAs] as to whether their national courts would allow seizure and foreclosure proceedings against property which their courts do not recognize as 'vessels' or 'ships' when such property is registered as a vessel in another flag jurisdiction"); Böger, *supra* note 208, at 81-82 (describing the heavily criticized decision in The Ship 'Betty Ott' v. General Billsin where a New Zealand Court gave priority over an previously registered Australian ship mortgage to a later security interest arising under New Zealand law, and the remedy of that error with the enactment of Section 70 of New Zealand's Ship Registration Act 1992. The Sao Paulo Court of Appeal's failure to recognize a Liberian ship mortgage issued in favor of a Norwegian mortgagee on an FPSO, the OSX-3, used in Brazil's EEZ, on the basis that there was no international agreement between Brazil and Liberia providing for the mutual recognition of ship mortgages); Delgado, *Security Interests over Ships*, *supra* note 173, at 260-64 (discussing similar problems in Thailand, Turkey, Venezuela, South Africa, Argentina and Brazil).

250. *See* White, *supra* note 9, at 23; Naim Molvan v. Attorney General of Palestine (The "Asya") [1948] Lloyd's List LR 277 (UK); United States v. Marino-Garcia, 679 F.2d 1373 (11th Cir. 1982); United States v. Trinidad, 839 F.3d 112 (1st Cir. 2016); Allyson Bennet, *That Sinking Feeling: Stateless Ships, Universal Jurisdiction, and the Drug Trafficking Vessel Interdiction Act*, 37 YALE J. INT'L L. 433 (2012).

251. *See* White, *supra* note 9, at 23 (in relation to O&G MOUs).

Consequently, Port States and Affected States have an incentive to require Flag States' agreement to provide a publicly accessible register of ownership of Flag State MORUs. However, any such acknowledgement of Flag State ownership by other states might depend in part on that Flag State's commitment to a competent maritime administration enforcing international safety and pollution prevention standards on its MORUs.[252] An international agreement requiring both public registration of MORU ownership by all contracting states and contracting state recognition of all other contracting states' public registration of MORU ownership is needed.

ii. *In Rem* Non-Possessory Collateral Rights

In addition to clear title, secured finance of any movable asset also requires international recognition of security interests over that asset and a clear first-ranking priority over other claims (albeit potentially subject to specific exceptions like maritime liens) established by its public registration.[253] In that context, other states' acknowledgement of a Flag State's registration and ranking of security interests over a MORU would be highly desirable prior to the MORU entering that state's waters.[254] This is even more important if the lender, the borrower/owner/lessor, and the operator/lessee are not the same entities. Lenders would presumably require unambiguous recognition of their registered, *in rem* security interests over a MORU by any coastal state into whose waters the MORU might be taken, before they would consent to the borrower/lessor transferring possession of the MORU to an operator/lessee.[255] Without

252. *See id.* at 23 (in relation to O&G MOUs); *see also* UNCLOS, *supra* note 14, at art. 94.

253. *See* Kozuka & Fujisawa, *supra* note 235, at 299-301 (discussing efficiency and inefficiency issues facing secured commercial finance of movables); Haselmann et al., *supra* note 234, at 1 ("[w]e find that law does in fact promote lending. The overall level of formal creditor rights protection is positively associated with the lending volume, and so is legal change with increases in lending volume over time."), 4, 5-6, 13; Anthony Saunders et al., *Innovation in International Law and Global Finance: Estimating the Financial Impact of the Cape Town Convention,* NYU Working Paper No. FIN-06-001, 3-6 (2008), https://ssrn.com/abstract=1300774.

254. *See* White, *supra* note 9, at 23 (in relation to O&G MOUs).

255. *See* Nolan, *supra* note 1711, at 971 ("the lender must have certainty under the laws of the registry state that the pledged property collateral will be eligible for registration and mortgaging during the entire term of the loan. The lender must also be comfortable in its belief that wherever the collateral travels in the world it will be recognized as a proper subject of such a mortgage and that the mortgage will thus be enforceable in foreign courts."); Delgado, *Security Interests over Ships*, *supra* note 173, at 246, 258 (a satisfactory security must be enforceable wherever the asset is found).

unambiguous recognition by those states of registered security interests (whatever their forms) and applicability of Flag State law governing them, MORU financial structures could become unnecessarily complex and uncertain.[256]

Two internationally recognized forms of registered security interests over movable assets are potentially relevant to MORUs: (i) the international security interest created by the Convention on International Interests in Mobile Equipment [257] (Cape Town Convention) and its Protocols; and (ii) a registered ship mortgage, hypothecation, or the like (hereinafter, a "ship mortgage") arising under the domestic law of a Flag State.[258] Both forms are potentially problematic in the context of MORUs.

There are currently eighty parties to the Cape Town Convention,[259] but there is no shipping or maritime protocol to it, let alone one that unambiguously includes MORUs.[260] In principle, a new maritime protocol to the Cape Town Convention could create a uniform international security interest (as opposed to a security interest under the domestic law of the Flag State) covering MORUs that would be broadly recognized by many other states. However, prior discussions of a shipping/maritime protocol to the Cape Town Convention were scuttled by IMO resistance, primarily in relation to maritime liens (discussed below) and the IMO's desire to give MLM 1993 a chance.[261]

The venerable ship's mortgage is also a possibility.[262] In relation to traditional ships, almost all legal systems have replaced the application of *lex situs* with the application of Flag State law in relation to the perfection of security rights over ships and their recognition and effectiveness vis-à-vis third party foreign security rights, providing cross-border certainty in

256. *See* White, *supra* note 9, at 23 (in relation to O&G MOUs).

257. Convention on International Interests in Mobile Equipment, Nov. 16, 2001, 118 Stat. 1095, 2307 U.N.T.S. 285 (entered into force Apr. 1, 2004).

258. *See generally* Severance & Sandgren, *supra* note 9.

259. *See Current Lists of Parties to Multilateral Air Law Treaties*, INT'L CIVIL AVIATION ORG., https://www.icao.int/secretariat/legal/lists/current%20lists%20of%20parties/allitems.aspx (last visited Feb. 6, 2021).

260. *See* Delgado, *Security Interests over Ships*, *supra* note 173, at 300, 302 (mentioning the possible inclusion of "maritime mobile equipment," "maritime equipment," and "offshore platforms" in a future Shipping Protocol).

261. Delgado, *supra* note 207, at 223.

262. *See generally* Severance & Sandgren, *supra* note 9.

relation to priority.[263] However, this might not always be true, particularly for unusual vessels like MORUs.[264]

As a general rule, the *sine qua non* of a domestic law ship mortgage would be an object recognized as a registerable "ship" or "vessel" under Flag State law.[265] As with ownership, Flag States might conclude that MORUs are "ships" or "vessels" under their domestic law for purposes of ship mortgages over them.[266] At the same time, it cannot be assumed that traditional ship mortgages would be available under every Flag State's domestic law to provide lenders with a registerable, first-ranking security interest on MORUs.[267] As with ownership, a diversity of domestic law approaches and forms of security interests over MORUs might be possible. As above, it is not inconceivable that the Japanese government concludes that "ship mortgages" on its MORU fleet are not permitted under Japanese law but a corporate transfer by way of security of a MORU could be registered[268] in the Nakano Ward Legal Assistance Bureau office in Tokyo.[269] A diversity of domestic law approaches to security interest characterization is problematic for lenders financing assets likely to cross borders,[270] given that one of the essential features of an effective security interest is the possibility of enforcement wherever the asset might be found.[271]

Other states could voluntarily elect to recognize foreign Flag State ship mortgages on MORUs. However, this cannot be taken for granted. Even if the characterization of the MORU as a "ship" is respected, in the

263. *See* Delgado, *supra* note 207, at 216; Böger, *supra* note 208, at 81.

264. *See* Nolan, *supra* note 171, at 972; *see also* Böger, *supra* note 208, at 81-83; Delgado, *Security Interests over Ships*, *supra* note 171, at 260-64.

265. *See* Severance & Sandgren, *supra* note 9, at 5.

266. Gallagher, *supra* note 176; *see* Severance & Sandgren, *supra* note 9, at 72-73; *see* Merchant Shipping Act 1973, § 2(1) (U.K.); Merchant Shipping Act 1995, § 311 (U.K.) (stating that in the United Kingdom, the Secretary of State could use his authority under section 311 of the MSA 1995 to decide that an object designed or adapted for use at sea is or is not to be treated as a "ship" for purposes of the Act).

267. *See generally* Severance & Sandgren, *supra* note 9, at 78.

268. *See* Kozuka & Fujisawa, *supra* note 235, at 304 (indicating ships are exempt from the Law on Special Rules to the Civil Code Concerning the Perfection of the Transfer of Movables and Assignment of Receivables).

269. *See* Awataguchi & Kohmaru, *supra* note 247.

270. *See generally* Nolan, *supra* note 171, at 971-74.

271. *See* Delgado, *Security Interests over Ships*, *supra* note 173, at 245-46 (referring to comments by Prof. Francesco Berlingieri to that effect in *The 1993 Convention on Maritime Liens and Mortgages*, LLOYD'S MAR. COM. L. Q. 57–77 (1995)).

absence of an applicable international convention, domestic law limitations on recognition of other states' ship mortgages or their priority may exist or come into existence.[272]

Following denunciations, by 2016 there were only twenty-one parties to the International Convention for the Unification of Certain Rules of Law relating to Maritime Liens and Mortgages*, 1926* (MLM 1926).[273] For those parties, MLM 1926 provides mutual recognition of domestic law mortgages, hypothecations, and other similar charges upon "vessels" that are duly effected in accordance of the law of a contracting State to which the "vessel" belongs and publicly registered at the port of registry or a central office.[274] The term "vessels" is undefined in MLM 1926, and it is unclear whether MORUs would qualify as "vessels."

MLM 1926's first proposed replacement, the International Convention for the Unification of Certain Rules of Law relating to Maritime Liens and Mortgages, 1967, never entered into force, having only been signed by six parties.[275] All six subsequently joined the second effort to replace MLM 1926, the *International Convention on Maritime Liens and Mortgages, 1993* (MLM 1993).[276] Unfortunately, there are currently only nineteen parties to MLM 1993, illustrating limited international acceptance of MLM 1993 as well.[277] It provides mutual recognition of mortgages, hypothecations, and other similar charges upon "sea-going vessels" that are effected in accordance of the law of a party state where the "sea-going vessel" is registered, the register or instruments are open to public inspections and abstracts obtainable, and the register or instruments deposited specify the name and address of the beneficiary, or that it has been issued to bearer, (if required) the maximum amount secured and the date and other particulars necessary to determine

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272. *See* Böger, *supra* note 208, at 85 (describing Flag State exemptions from registration of smaller ships and security interests over them).

273. CMI YEARBOOK 2016, *supra* note 217, at 384.

274. International Convention for the Unification of Certain Rules of Law relating to Maritime Liens and Mortgages, 1926, art. 1, reprinted at 27 AM. J. INT'L L. 28-38 (Supp. 1933), in 6E BENEDICT ON ADMIRALTY, as Doc. No. 15-6 [MLM 1926].

275. *Id.* at 411.

276. International Convention on Maritime Liens and Mortgages, art. 1, May 6, 1993, 2276 U.N.T.S. 39 [MLM 1993].

277. *See Chapter XI (Transport and Communications), D. Water Transport, 4 (International Convention on Maritime Liens and Mortgages, 1993)*, UNITED NATIONS TREATY COLLECTIONS, https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XI-D-4&chapter=11&clang=_en (last visited Feb. 6, 2021).

ranking.[278] Whether a MORU would be considered a "seagoing vessel" under MLM 1993 is apparently untested.

iii. *In rem* Maritime Liens

Because MORUs are movable maritime assets, stakeholders from Port States and Affected States supplying offshore workers to MORUs will likely assert *in rem* maritime liens against MORUs and their priority over ship mortgages. Although their acceptance is limited and applicability to MORUs questionable, both MLM 1926 and MLM 1993 recognize *in rem* maritime liens and establish a system of priorities for maritime liens and ship mortgages.[279]

Conversely, stakeholders from Flag States and Producing Coastal States will have a clear interest in obtaining the prompt release of an arrested MORU sitting in a Port State upon posting of a bond against maritime liens. This is discussed in sub-part (c) below.

iv. Ownership, Security Interests, and Liens for Floating Solar Energy Converters

In the context of registration of ownership, security interests, and maritime liens, Floating Solar Energy Converters present an interesting legal question peculiar to the technology. Assuming a Floating Solar Raft consists of multiple interlinked, identical Floating Solar Modules, what is the "Unit" for purposes of registration of Floating Solar Energy Converter ownership, security interests, or maritime liens claim? Should registration of ownership, security interests, and assertion of maritime liens on modular Floating Solar Energy Converters be implemented at the Floating Solar Module or the Floating Solar Raft level? Neither approach is entirely satisfactory.

v. Recognition of Judicial Sales

UNCITRAL is currently working on a draft instrument (the "Beijing Draft") providing for international recognition of the judicial sale of

278. MLM 1993, *supra* note 276, at art. 1, 5.

279. *See* White, *supra* note 9, at 24 (in relation to O&G MOUs); *see also* MLM 1993, *supra* note 276, at art. 4.1; MLM 1926, *supra* note 274, at art. 2 (enumerating a slightly different list of *in rem* maritime liens against "vessels").

ships.[280] As a draft instrument, it has by definition not been accepted by any state. The Beijing Draft would define a "ship" as "any ship or other vessel [capable of being subject of a judicial sale under the law of the State of judicial sale]."[281] The initial section of that definition would seem to be broad enough to include MORUs, but the acceptance of the bracketed text would make coverage of MORUs a matter of domestic law, muddying the waters.

d. Arrests

Given MORUs' cross-border mobility, a creditor (whether a lender or otherwise) might seek to detain a MORU from leaving port until its claim is satisfied or security for the claim provided. If MORUs are to be subject to the existing maritime practice of vessel arrest, the consent of Flag States to arrest of their MORUs for certain claims following a determination by Coastal or Port State courts[282] would be desirable. Conversely, an agreed mechanism mandating the release of arrested MORUs upon delivery of sufficient security covering such claims (thereby allowing them to return to productive use and earn income to pay the claim) is also desirable.[283]

The International Convention for the Unification of Certain Rules relating to Arrest of Sea-going Ships, 1952 ("Arrest Convention 1952") is widely adopted.[284] It allows for the arrest ships flying the flag of Party States in the jurisdiction of a party state for certain maritime claims, and their release on bail in certain circumstances.[285] It applies to "ships" without defining that term,[286] again begging the question of whether it extends to the arrest of MORUs.

280. *See* U.N. Com. on Int'l Trade Law Working Group VI (Judicial Sale of Ships), Draft Instrument on the Judicial Sale of Ships: Annotated First Revision of the Beijing Draft (Sept. 10, 2019), U.N. Doc. A/CN.9/WG.VI/WP.84, https://undocs.org/en/A/CN.9/WG.VI/WP.84

281. *See id.* at 8.

282. International Convention Relating to the Arrest of Seagoing Ships art. 2, 4, May 10, 1952, 439 U.N.T.S. 193 [hereinafter Arrest Convention 1952]; International Convention on Arrest of Ships art. 2, U.N. Doc. A/CONF.188/L.2 (Mar. 12, 1999) [hereinafter Arrest Convention 1999].

283. Arrest Convention 1952, *supra* note 282, art. 5; Arrest Convention 1999, *supra* note 282, art. 4; *see* White, *supra* note 9, at 24 (in relation to O&G MOUs).

284. CMI YEARBOOK 2016, *supra* note 217, at 397-98.

285. Arrest Convention 1952, *supra* note 282, at art. 2, 5.

286. *Id.*

The International Convention on Arrests of Ships, 1999 ("Arrest Convention 1999") currently has only twelve parties.[287] It also allows for the arrest of ships for certain maritime claims, and their release on bail, in certain circumstances.[288] It applies to "ships" but leaves the term "ship" undefined, again leaving it uncertain whether that convention would apply to MORUs.[289]

During their lifetimes, MORUs are likely to visit ports more often than "permanent" production O&G MOUs but considerably less often than MODUs, let alone traditional merchant ships. The arrest of a specific MORU may be impracticable if it is rarely in a port where it can be arrested.[290] However, unlike stand-alone O&G MOUs, MORUs are much more likely to be part of a multi-Unit MORU Array in common ownership. One approach could be to allow the arrest of "sister ship" MORUs with common ownership, as provided under Arrest Convention 1952[291] and Arrest Convention 1999.[292] It could be debated whether a right of arrest should be extended to MORUs not in common ownership, but in common operation as part of a single MORU Array.[293]

e. Collisions and Allisions

Uncontrolled contact between a MORU and another MORU or a traditional merchant ship might occur when the MORU is in transit (i.e. under tow), properly moored and in normal operation, or is adrift. The *Collision Convention 1910* remains broadly accepted by many nations.[294] It refers to "sea-going vessels" and "vessels of inland navigation," without defining those terms.[295] This again begs the question of whether MORUs

287. *See Chapter XII (Navigation), 8 (International Convention on Arrest of Ships, 1999)*, UNITED NATIONS TREATY COLLECTIONS, https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XII-8&chapter=12&clang=_en (last visited Feb. 6, 2021).

288. Arrest Convention 1999, *supra* note 282, at art. 2, 4.

289. *See* Arrest Convention 1999, *supra* note 282.

290. *See* White, *supra* note 9, at 24 (in relation to O&G MOUs).

291. Arrest Convention 1952, *supra* note 282, at art. 3(1).

292. Arrest Convention 1999, *supra* note 282, at art. 3(2), 3(3).

293. If MORUs were owned by different owners but chartered by a common MORU Array developer/operator, query whether each MORU should be subject to arrest for claims against the common developer/operator. *See id.*; Arrest Convention 1952, *supra* note 282, at art. 3(2).

294. *See* CMI YEARBOOK 2016, *supra* note 217, at 368-70.

295. *See* Collision Convention, *supra* note 211, at art. 1 ("Where a collision occurs between sea-going vessels or between sea-going vessels and vessels of inland navigation . . . ."); Severance & Sandgren, *supra* note 9, at 17.

are "seagoing vessels" for purposes of *Collision Convention 1910*, whether in transit, moored, or adrift.

The International Convention for the Unification of Certain Rules Relating to Civil Jurisdiction in Matters of Collision (May 10, 1952) also has been adopted by a large number of countries.[296] It gives a collision-action plaintiff a choice of forum of the place of the defendant's habitual residence or business, the place of the collision, or a place at which the ship or a "sister ship" may be arrested.[297] Under its own terms it applies only to "seagoing vessels," without defining that term. This begs the question whether MORUs are "seagoing vessels" for purposes of the convention.

One of the most important and widely adopted[298] regulatory maritime conventions,[299] COLREG 1972, interprets "vessel" broadly: "the word 'vessel' includes every description of water craft, including non-displacement craft and seaplanes, used or capable of being used as a means of transportation on water."[300] Under Rule 1(a), COLREG 1972 applies to all seagoing vessels, but there are various defined[301] subcategories of "vessel" (e.g. "vessel not under command," "vessel restricted in her ability to manoeuvre," and "vessel constrained by her draught") that are subject to special provisions and are particularly relevant to MORUs. Conversely, there are other defined[302] subcategories of "vessel" (e.g. "power-driven vessel," "sailing vessel," "vessel engaged in fishing," "vessel engaged in laying, servicing or picking up a navigation mark, submarine cable or pipeline") subject to special provisions, which would not apply to MORUs. As a consequence, some elements of COLREG 1972 likely apply to MORUs while others clearly do not.[303]

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296. *See* CMI YEARBOOK 2016, *supra* note 217, at 387-89.
297. White, *supra* note 9, at 24.
298. STATUS OF TREATIES, *supra* note 217 (161 parties to COLREG 1972).
299. *See* Gauci, *supra* note 9, at 479.
300. COLREG 1972, *supra* note 212, art. 3(a).
301. *Id.*
302. *Id.*
303. *See, e.g.*, COLREG 1972, *supra* note 212, Rule 10(k)-(l) (concerning vessels restricted in their ability to maneuver in traffic separation schemes), Rule 27 (concerning vessels not under command or restricted in their ability to maneuver), Rule 28 (concerning vessels constrained by their draught), Rule 35(c) (concerning sounds to be signaled in restricted visibility by vessels not under command, vessels restricted in their ability to maneuver, vessels constrained by their draught). *Compare id.*, Rule 3(e) (describing circumstances of less than full compliance by "vessels of special construction or purpose").

f. Safety at Sea

SOLAS applies to ships entitled to fly the flag of member states.[304] The term "ship" is not defined under SOLAS,[305] leaving it to the relevant states to determine what is a "ship." However, unless expressly stated otherwise, the provisions of SOLAS do not apply to ships not on "international voyages," which might exclude MORUs towed to offshore sites and moored indefinitely[306] or be subject to a Flag State exemption to the extent that such MORUs are not regularly engaged in "international voyages."[307] Further, unless expressly stated otherwise, ships without mechanical propulsion are excluded from the application of SOLAS.[308] This would seem to exclude or exempt MORUs from most, if not all, of SOLAS.

However, Chapter V (Safety of Navigation) applies to all ships (including non-propelled vessels) on any voyage (international or not) unless otherwise provided in that chapter[309] or granted a Flag State exemption. This implies a number of obligations that include informing other ships of severe weather, icebergs, or other dangers,[310] and responding to distress messages (to the extent able).[311] The question remains: how and to what extent SOLAS Chapter V would (or could) be applied to non-propelled manned, and unmanned, MORUs?

Likewise, Chapter IX of SOLAS, implementing the International Safety Management Code (the "ISM Code"), is limited in scope to passenger ships, oil tankers, chemical tankers, gas carriers, bulk carriers, various high-speed crafts, cargo ships, and mobile offshore *drilling* units.[312] The ISM Code itself does not define the term "vessel," but strongly urges parties to implement the ISM Code, giving priority to vessels that were passenger ships, tankers, gas carriers, bulk carriers, and mobile offshore *drilling* units that are flying an adopting party's flag.[313]

304. SOLAS, *supra* note 215, at art. 1.
305. *See* Severance & Sandgren, *supra* note 9, at 16.
306. *See* SOLAS, *supra* note 215, annex, ch. I, pt. A, reg. 5(a).
307. *See id.* at ch. I, reg. 1(a).
308. *See id.* at ch. I, reg. 3(a)(iii).
309. *See id.* at annex, ch. V, reg. 1.
310. *See id.* at ch. V, reg. 2, 3.
311. *See id.* ch. V, reg. 10.
312. *See id.* at annex, ch. IX, reg. 2(1) and 3(1).
313. *See* Int'l Mar. Org. [IMO], A. 741(18), *International Management Code for the Safe Operation of Ships and for Pollution Prevention* (Nov. 4, 1993); Severance & Sandgren, *supra* note 9, at 19.

Similarly, the adoption in 1979 of the MODU Code,[314] and subsequent amendments on the application of LL 1966 and SOLAS to mobile offshore *drilling* units,[315] are not applicable to MORUs.[316] However, the existence of the MODU Code begs the question of whether and to what extent LL 1966 and SOLAS should be extended to MORUs.

Similarly, the International Ship and Port Facility Security Code (ISPS Code)[317] forming part of Chapter XI-2 of SOLAS includes MODUs within the meaning of the term "ship," but does not mention MORUs.[318] Query whether ISPS Code coverage should not be explicitly extended to MORUs.

g. End of Life Issues: Salvage, Wreck Removal, and Decommissioning

Much like O&G MOUs, a major MORU incident might require salvage skills.[319] However, O&G MOUs have traditionally been excluded from the class of recognized subjects of salvage.[320] This practice was continued in the widely accepted[321] International Convention on Salvage, 1989 (Salvage Convention 1989).[322] Its broad definition of "vessel" extends to any "craft, or structure capable of navigation" which arguably would include MORUs (if it covers any other non-propelled vessels).[323] Salvage Convention 1989 expressly excludes its application to "fixed or floating platforms or to [MODUs] when such platforms or units are on location engaged in the exploration, exploitation, or production of sea-bed

314. Int'l Mar. Org. [IMO], A. 1023(26), *Code for the Construction and Equipment of Mobile Offshore Drilling Units* (Dec. 2, 2009) [MODU Code 2009].

315. *See* White, *supra* note 9, at 22.

316. *See* MODU Code 2009, *supra* note 314, at §§ 1.2.1, 1.3.40.

317. Int'l Mar. Org. [IMO], *Resolutions of the Conference of Contracting Governments to the International Convention for the Safety of Life at Sea 1974*, (Dec. 12, 2002), https://www.classnk.or.jp/hp/pdf/activities/statutory/isps/IMO/SOLAS-CONF.5-32.pdf [hereinafter ISPS Code].

318. *See id.* at art. 2.2.

319. White, *supra* note 9, at 25; *See* OFFSHOREWIND.BIZ, *supra* note 168 (outlining salvage of a sunk Hybrid FWT/FTEC); Foster, *supra* note 184 (near loss of FWT hull).

320. White, *supra* note 9, at 25.

321. STATUS OF TREATIES, *supra* note 217, at 476.

322. International Convention on Salvage, 1989, (Apr. 28, 1989), 1953 U.N.T.S. 165 [hereinafter Salvage Convention 1989].

323. *Id.* at art. 1(c).

mineral resources,"[324] but the exclusion would not cover MORUs as they are not "engaged in the exploration, exploitation, or production of sea-bed mineral resources." Unlike O&G MOUs on location, it would seem that *Salvage Convention 1989* would apply to MORUs.

Several MORUs were recently decommissioned.[325] Removal of disused or abandoned MORUs could become a problem with time,[326] becoming navigation or environmental hazards.[327] Given that MORUs are easily towed across boundaries, international rules governing abandonment and decommissioning of MORUs are warranted.

As of 2019, there were fifty-five parties[328] to the *Nairobi International Convention on the Removal of Wrecks, 2007* ("Wreck Removal Convention").[329] The Wreck Removal Convention's definition of "ship" includes any "floating platform, except when such platforms are on location engaged in the exploration, exploitation, or production of sea-bed mineral resources."[330] Given that MORUs are not "engaged in the exploration, exploitation, or production of sea-bed mineral resources," it seems that the Wreck Removal Convention also applies to MORUs, whether in transit or operation.

As of 2019, the Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships, 2009 (Hong Kong

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324. *Id.* at art. 3; White, *supra* note 9, at 25; Violeta S. Radovich, *Offshore Activity-New Regulations,* CMI YEARBOOK 2013, COMITÉ MAR. INT'L 539, 546 (2013), https://comitemaritime.org/publications-documents/cmi-yearbook/.

325. *See Principle Power Announces the Successful Completion of Its Windfloat 1 Pilot*, PRINCIPLE POWER (Sept. 28, 2016), http://www.principlepowerinc.com/en/news-press/press-archive/2016/09/28/principle-power-announces-the-successful-completion-of-its-windfloat-1-pilot; *OceanTec Wave Energy Device Decommissioning*, COREMARINE (June 25, 2019), https://www.core-marine.com/news/2019/6/25/oceantec-wave-energy-device-decommissioning; Nadja Skopljak, *7 MW Fukushima Turbine Starts Final Voyage*, OFFSHOREWIND.BIZ (June 24, 2020), https://www.offshorewind.biz/2020/06/24/7-mw-fukushima-turbine-starts-final-voyage/.

326. *See* UNCLOS, *supra* note 14, at art. 194.3(a), 210, 216; White, *supra* note 9, at 26 (in relation to O&G MOUs); Emma Davie, *Idle Turbine to Stay Put This Winter, No Word on Who Will Pay to Retrieve It*, CBC NEWS (Dec. 13, 2018), https://www.cbc.ca/news/canada/nova-scotia/minas-passage-idle-turbine-to-stay-put-this-winter-1.4943339 (describing a fixed-bottom tidal turbine abandoned in Canada following developer bankruptcy).

327. *See* White, *supra* note 9, at 26 (in relation to O&G MOUs).

328. STATUS OF TREATIES, *supra* note 217, at 532.

329. Int'l Mar. Org. [IMO], IMO No. 55565, *Nairobi International Convention on the Removal of Wrecks* (May 23, 2007), http://folk.uio.no/erikro/WWW/Wreck%20Removal%20Convention.pdf [hereinafter Wreck Removal Convention].

330. *Id.* at art. 1.2.

Convention)[331] had only been accepted by fifteen parties, had not entered into force, and cannot yet be considered generally accepted.[332] The Hong Kong Convention term "ship" means "a vessel of any type whatsoever operating or having operated in the marine environment and includes submersibles, floating craft, floating platforms, self-elevating platforms, . . . , including a vessel stripped of equipment or being towed."[333] It would seem that the Hong Kong Convention, if it enters into force, would also apply to MORUs above 500 GWT, provided their operational life was not spent exclusively in their Flag State's waters.[334]

h. Limitations of Liability and Financial Responsibility

Traditional ship owners have long had the ability to limit their liability.[335] Underpinning the modern understanding of this limitation of liability has been a compromise: shipowners had to accept that their liability would be calculated on a pre-casualty tonnage basis, and in exchange received a limit of liability which has become "virtually unbreakable."[336] This has allowed insurers and P&I clubs to provide commercially workable and affordable insurance and indemnity protection on the basis of a known maximum risk.[337] Indeed, it would make little sense to not provide for a limitation of liability for MORUs: unlimited liability for an owner/operator whose only asset is the MORU destroyed by the casualty would be a hollow victory, and unlimited liability would likely make the MORU un-bankable to the extent that financiers require the asset to be fully insured against these liabilities on a commercially reasonable basis.[338] It would seem that MORU Flag States and Producing Coastal States would likely seek recognition of ship-like limitations of liability for their flagged MORUs by Port States and Affected States, in part to facilitate the availability of commercially

331. Int'l Mar. Org. [IMO], *Hong Kong International Convention for the Safe and Environmentally Sound Recycling of Ships* (May 15, 2009), https://ec.europa.eu/environment/waste/ships/pdf/Convention.pdf [hereinafter Hong Kong Convention].

332. STATUS OF TREATIES, *supra* note 217, at 536, 539.

333. Hong Kong Convention, *supra* note 331, at art. 2.7.

334. *See id.* at art. 3.3.

335. Rares, *supra* note 3, at 357.

336. *See id.* at 357.

337. *See id.*

338. *See id.*

workable and affordable insurance and indemnity protection for their MORUs (and, indirectly, MORU bankability).[339]

The modern law of limitations of liability is set out in the *1976 Convention on Limitation of Liability for Maritime Claims* (LLMC 1976),[340] as amended by the 1996 Protocol and the 2012 amendment thereto. LLMC 1976 expanded the definition of "shipowner," and, by doing so, the parties, which can limit their liability, to include charterers, managers, and operators of a seagoing ship.[341] Following a number of denunciations, as of 2021 there were fifty-six parties to LLMC 1976 and sixty-one parties to the 1996 Protocol.[342] LLMC 1976 expressly excludes "floating platforms constructed for the purpose of exploring or exploiting the natural resources of the sea-bed or the subsoil thereof" (e.g., O&G MOUs) from its application.[343] Unfortunately, the exclusion of O&G MOUs from application of LLMC 1976 only begs the question of whether that Convention would (or should) apply to MORUs, which were almost *res nulla* when those documents were drafted (but were not when the 2012 amendment entered into force).[344] One might argue that, in light of the uncertainty and importance of insurability to commercial MORU deployment across borders, explicit international agreement to limit the liability of MORU owners, charterers, managers, and operators is needed.

As with ownership, security interests, and maritime liens, modular Floating Solar Energy Converters again present an interesting legal question: What would be the proper "Unit" for purposes of determining any Floating Solar Energy Convert limitations of liability? Should it be determined at a Floating Solar Module or Floating Solar Raft level? Again, neither approach is entirely satisfactory.

i. Environmental Conventions

Under UNCLOS, a Producing Coastal State is generally entitled to regulate under its own domestic law the environmental impact of, and

339. *See id.*

340. International Convention on Limitations of Liability for Maritime Claims (Nov. 19, 1976) *reprinted in* 8 J. MAR. L. & COM. 533 (1976) [hereinafter LLMC 1976]; Richard Shaw, *Offshore Craft and Structures*, CMI YEARBOOK 1998 145, 158 (1998) (noting the same *in re* O&G MOUs in 1998).

341. LLMC, *supra* note 340, at art. 1(2).

342. *See* STATUS OF TREATIES, *supra* note 217, at 381, 394.

343. White, *supra* note 9, at 25; *see* LLMC, *supra* note 340, at art. 15.5(b).

344. *Id.*

environmental damages originating from, any MORU licensed to operate in that state's waters.[345] However, environmental damage originating from MORUs also could occur in the waters of a non-producing coastal state. From the 1970s, the general approach to offshore pollution damage has been one of strict liability for the vessel owner (and, under LLMC 1976, a charterer, manager, or operator), with direct action against his insurer, but (as mentioned above) a finite limit of liability calculation by reference to tonnage of the vessel and the availability of insurance for such liabilities.[346]

Although MORUs do not carry petroleum in bulk as cargo,[347] almost all will hold some amount of petroleum products, whether lubricants,[348] oil in transformers, or, in manned MORUs, bunker oil for diesel generators. The International Convention on Civil Liability for Bunker Oil[349] (the "Bunker Oil Convention") defines "bunker oil" as "any hydrocarbon mineral oil, including lubricating oil, used or intended to be used for the operation or propulsion of the ship, and any residues of such oil"[350] and defines a "ship" as "any seagoing vessel and seaborn craft, of any type whatsoever."[351] MORUs would seem to fall within the meaning of "seaborn craft," if not "seagoing vessel" and therefore potentially within the scope of the Bunker Oil Convention. The Bunker Oil Convention imposes strict liability[352] on the "shipowner" (including registered owners, bareboat charterers, managers, and operators of the ship[353]) for pollution damage caused by any bunker oil on board or originating from the ship. The Bunker Oil Convention does not have its own limitations of liability, but Art. 6 refers to limitations of liability "under any applicable national

345. *See* UNCLOS, *supra* note 14, at art. 193, 208, 209, 214. Query whether art. 211 should also be included in this list in relation to MORUs.

346. Shaw, *supra* note 340, at 157 (noting the same *in re* O&G MOUs in 1998).

347. *See* International Convention on Civil Liability for Oil Pollution Damage (Nov. 29, 1969) *reprinted in* 1 J. MAR. L. & COM. 373 (1969); International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, Dec. 18, 1971, 110 U.N.T.S. 57, *reprinted in* 3 J. MAR. L. & COM. 624 (1971).

348. *See* OFFSHOREWIND.BIZ, *supra* note 168 (highlighting governmental concern in relation to potential spillage of lubricating oils from a sunk Hybrid FWT/FTEC).

349. International Convention on Civil Liability for Bunker Oil Pollution Damage, Mar. 27, 2001, 40 I.L.M. 1493 (entered into force Nov. 21, 2008) [hereinafter Bunker Oil Convention].

350. *Id.* at art. 1(5).

351. *Id.* at art. 1(1).

352. *See id.* art. 3(1); *but see id.* at art. 3(3)-(5) (providing various defences and rights of recourse against other parties at fault).

353. *Id.* at art. 1(3).

or international regime, such as the [LLMC 1976, as amended]."[354] Given that the Bunker Oil Convention likely applies to many MORUs, but the application of LLMC 1976 to those MORUs is at least questionable,[355] it is possible that MORUs are subject to unlimited strict liability under the Bunker Oil Convention,[356] which would seem to be contrary to that Convention's preamble, which links shipowner strict liability to appropriate limitations of liability.[357] In that context, explicit international agreement on limitations of liability for bunker oil pollution originating from MORUs seems warranted.

Non-petroleum hazardous materials might also be present,[358] including chemicals used to produce and store energy in some FOTEC and FESS concepts. Reasonable limitations of liability for environmental damage proportionate to the volumes of the chemicals carried might be warranted. Although not yet in force, the *International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea 1996* and the 2010 Protocol thereto defines "ship" as "any seagoing vessel and seaborne craft, of any type whatsoever."[359] Such a broad definition would include MORUs once the convention enters into force, but the definition of "hazardous and noxious substances" is limited to a specified list of materials "carried on board ship *as cargo* [emphasis added]."[360] This cargo limitation would seem to exclude the chemicals used in, e.g., FOTECs to convert thermal differences into electrical power. Although some future FESS concepts converting electrical power into chemical potential energy might create, store, and export covered chemicals, query whether those substances

354. *See id.* at art. 6; Konstaninos Bachxevanis, *Bunker Pollution Convention 2001*, REED SMITH LLP 2, 15 (2009), https://www.reedsmith.com/-/media/files/perspectives/2009/09/the-bunker-pollution-convention-2001/files/the-bunker-pollution-convention-2001/fileattachment/the-bunker-pollution-convention-2001--k-bachxevani.pdf; *but see* Patrick Griggs, *International Convention on Civil Liability for Bunker Oil Pollution Damage*, BRIT. MAR. L. ASSOC. (2001), https://www.bmla.org.uk/documents/imo-bunker-convention.htm (describing possible limitations of this approach).

355. *See* para 0 *infra*.

356. *See* BACHXEVANIS, *supra* note 354, at 2.

357. *See id.* at 2, 3.2, 3; LLMC 1976, *supra* note 340, at art. 15(5).

358. *See* Shaw, *supra* note 340, at 160 (noting in section 8.9-8.11 the same *in re* O&G MOUs in 1998).

359. International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea 1996, 35 I.L.M. 1415, *superseded* by the 2010 Protocol art. 1(1) [hereinafter HNS Convention].

360. *See id.* at art. 1(5)(a).

would be considered a stationary FESS's *cargo* (as opposed to a FESS's *product* to be exported via pipeline or transport vessel).

It would appear that, with the possible exception of bunker oil leaks, there is no legal regime in force to impose on the owner, charterer, manager, or operator of a MORU liability for environmental damages incurred by a non-producing coastal Affected State.[361] If a strict liability regime with direct action against insurers for pollution damages were to be imposed on MORUs, query whether LLMC 1976 would provide adequate comfort to insurers. In the context of O&G MOUs, insurers have previously expressed a reluctance to offer cover with direct action by claimants without some realistic limitation of liability for damages.[362] Although it might be argued that a ship-like, tonnage-based limitation of liability is inappropriate for O&G MOUs,[363] such a limitation might very well be a feasible and appropriate measure in relation to MORUs (given the different risk profiles of the two classes of Units), and a prerequisite for financiers looking to fully insure the asset against this risk on a commercially acceptable basis.[364]

j. Criminal Jurisdiction

UNCLOS limits coastal state criminal jurisdiction on a foreign "ship" transiting the coastal state's territorial sea to certain categories.[365] However, while the bulk of criminal jurisdiction would generally be left to the Flag State,[366] the positioning of MORUs (as with O&G MOUs) for long

361. *See* Shaw, *supra* note 340, at 157 (noting the same *in re* O&G MOUs in 1998); Rares, *supra* note 3, at 352 (noting the same). *Compare* Shaw, *supra* note 17, at 305 (questioning the legal basis for such transboundary claims filed in U.S. Federal Courts in relation to the Deepwater Horizon incident); *see also* Radovich, *supra* note 324, at 539 (describing the Protocol for the Protection of the Mediterranean Sea against Pollution from the Exploration and Exploitation of the Continental Shelf and the Seabed and its Subsoil, the first international legal instrument devoted entirely to O&G MOUs, which did not itself establish cross-border liability, but required state parties to impose liability for pollution emanating from covered activities under art. 27 thereto).

362. Shaw, *supra* note 340, at 157-58 (noting the same *in re* O&G MOUs in 1998).

363. White, *supra* note 9, at 25.

364. *Compare* Rares, *supra* note 3, at 352-56 (describing the challenges in insuring the same in re O&G MOUs in 2013).

365. *See* UNCLOS, *supra* note 14, at art. 27; *see also* Mariya Anton Vijay v. State, (2015) 9 SCC 294 (India) (holding UNCLOS art. 27 recognized the 'floating island theory' and provided that the criminal jurisdiction of the coastal state should not be exercised on board a foreign ship passing through the territorial sea save in specified circumstances); UNCLOS, *supra* note 14, at art. 97 (which further limits the jurisdiction of any state (other than the Flag State for events on the high seas)).

366. *See* UNCLOS, *supra* note 14, at art. 27, 97.

periods in the waters of a Producing Coastal State gives rise to important public interests of that state.[367] This is partially reflected in UNCLOS, which provides an exception for violations of laws adopted by a coastal state in relation to its EEZ under UNCLOS Part V.[368] Unfortunately, UNCLOS leaves open questions of criminal jurisdiction for events in the territorial sea, which are not included in the exclusive list under Article 27 or in a coastal state EEZ, which are not covered by the exception in Article 27(5).[369] Whether a foreign MORU would be considered a "ship" for purposes of Article 27 is unclear.

Extended operation at site was not contemplated in earlier international maritime conventions, such as the 1952 International Convention for the Unification of Certain Rules Relating to Penal Jurisdiction in Matters of Collision or Other Incidents of Navigation.[370] Any allocation of penal jurisdiction should address multinational work forces operating and servicing manned and unmanned MORUs and the different interests of Flag States, Producing Coastal States, Port States, and Affected States (including MORU workers' state of domicile).[371] Given the potential for conflicts of law, States' interests must be prioritized in some way, an accused's exposure to double jeopardy eliminated, and the accused's right to the defense of compulsory compliance preserved.[372] At the same time, most MORUs are unmanned during normal operation, reducing the risk (or frequency) of many personal criminal offences more likely to occur between workers or occupants onboard manned MORUs and O&G MOUs.

Although vessels permanently attached to the sea-bed are specifically excluded from its application, piracy and politically motivated offences are regulated under the Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation, 1988 (SUA

367. White, *supra* note 9, at 24.

368. *See* UNCLOS, *supra* note 14, at art. 27(5); *but see id.* at art. 73(3) (prohibiting-unless otherwise agreed-imprisonment, or corporal punishment in relation to violations of a Producing State's regulations).

369. *See* United States v. Beyle, 782 F.3d 159, 165-66, 2015 AMC 1099, 1109 (4th Cir. 2015).

370. White, *supra* note 9, at 24.

371. *Id.*

372. *See* Vancouver Draft, *supra* note 196, at 7.1-7.8 (in relation to O&G MOUs).

1988).[373] At the same time, fixed platforms already come under the Protocol for the Suppression of Unlawful Acts against the Safety of Fixed Platforms located on the Continental Shelf, 1988 (SUA PROT 1988).[374] Depending on whether MORU attachment to the seabed is "permanent" or "fixed," it seems that MORUs would fall under either SUA 1988 or SUA PROT 1988, or could be regulated consistent with those agreements.[375]

k. CO_2 Reduction Obligations

In 2015, the UN General Assembly set out seventeen Sustainable Development Goals (SDGs),[376] of which four are most relevant to MORU discussions: SDG 7 (ensuring access to affordable, reliable, sustainable, and modern energy for all);[377] SDG 9 (building resilient infrastructure, promoting sustainable industrialization, and fostering innovation);[378] SDG 13 (taking urgent action to combat climate change and its impacts);[379] and SDG 14 (conserving and sustainably using the oceans, seas, and marine resources for sustainable development).[380] *The United Nations Framework Convention on Climate Change* (UNFCCC)[381] is the primary international and intergovernmental forum for negotiating the global response to climate change and achieving SDG 13.[382] Under Article 3 of the *Paris Agreement* adopted by the Twenty-first Conference of Parties to the UNFCCC (the "Paris Agreement"), almost all nations[383]

373. White, *supra* note 9, at 25; *see also* Convention for the Suppression of Unlawful Acts against the Safety of Maritime Navigation, art. 1, Mar. 10, 1998, 1678 U.N.T.S. 201 [hereinafter SUA 1988] (excluding vessels "permanently" attached to the sea-bed from the definition of "ship").

374. Protocol for the Suppression of Unlawful Acts against the Safety of Fixed Platforms located on the Continental Shelf, Mar. 10, 1998, 1678 U.N.T.S. 201 [hereinafter SUA PROT 1988]; *see* White, *supra* note 9, at 25.

375. White, *supra* note 9, at 25.

376. *Transforming Our World: The 2030 Agenda for Sustainable Development*, SUSTAINABLE DEVELOPMENT UNITED NATIONS, G.A. Res. 70/1, A/RES/70/1, 14 (Sept. 25, 2015) [hereinafter 2030 Agenda for Sustainable Development].

377. *See id.* at 14, 19 (SDG 7, and Targets 7.2, 7.a, and 7.b).

378. *See id.* at 14, 20 (SDG 9, and Targets 9.1 and 9.a).

379. *See id.* at 14, 23 (SDG 13, and Targets 13.2 and 13.a).

380. *See id.* at 13, 23-24.

381. United Nations Framework Convention on Climate Change, May 9, 1992, 1771 U.N.T.S. 107 [hereinafter UNFCCC].

382. *2030 Agenda for Sustainable Development*, *supra* note 376, at 14.

383. *Chapter XXVII (Environment), 7.d (Paris Agreement)*, UNITED NATIONS TREATY COLLECTIONS (Nov. 4, 2016), https://treaties.un.org/pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-7-d&chapter=27&clang=_en (making almost every nation a stakeholder in the discussion) [hereinafter UNITED NATIONS TREATY COLLECTIONS]; *see also* U.N. Secretary-General,

have self-determined, mandatory greenhouse gas emissions reduction targets called nationally determined contributions (or NDCs).

As previously indicated, it is entirely possible that MORU ownership might be registered in a Flag State other than the Producing Coastal State. It also seems entirely possible that MORUs might be leased from a third-party owner by the developer. Paris Agreement parties may enter into cooperative agreements to achieve their respective NDCs,[384] including international transfers of mitigation outcomes (e.g. between a Flag State and a Producing Coastal State).[385] However, in the absence of such an agreement, should MORU-based CO_2 reductions be included in Producing Coastal States' or Flag States' NDCs? What is the impact on NDCs if MORUs are relocated to another Producing Coastal State earlier than anticipated?

l. Marine Spatial Planning

Hugo Grotius's statement in *Mare Liberum* that "the navigation of rivers is easily lessened and impeded by constructions placed therein, but this is not true of the sea"[386] may no longer be as true as it was in 1608. The surface footprint of each MORU includes the MORU itself and all associated safety zone belts, which are typically allocated on an exclusive and long-term basis.[387] The surface footprint of fixed-bottom offshore renewables sites can be quite large: Hornsea Project One, a British 1.2 GW plant consisting of 174 fixed-bottom WTGs and, as of 2019, the world's largest offshore wind farm, is spread over approximately 407 km^2.[388] Presumably, gigawatt-scale FWT-based MORU Arrays[389] would require a

Depositary Notification (Nov. 4, 2019), https://treaties.un.org/doc/Publication/CN/2019/CN.575.2019-Eng.pdf (U/N. Secretary General's acknowledgment of U.S. withdrawal from the Paris Agreement); U.N. Secretary-General, Depositary Notification (Jan. 20, 2021) (U.N. Secretary General's acknowledgment of U.S. subsequent reentry into the Paris Agreement).

384. *Id.* at art. 6(1).

385. *Id.* at art. 6(3).

386. HUGO GROTIUS, THE FREEDOM OF THE SEAS, 58 (Oxford Univ. Press 1916).

387. Chircop & L'Esperance, *supra* note 104, at 1.

388. *See The World's Biggest Offshore Wind Farm, Hornsea 1, Generates First Power*, ORSTED (Feb. 15, 2019), https://orsted.com/en/Media/Newsroom/News/2019/02/The-worlds-biggest-offshore-wind-farm-Hornsea-one-generates-first-power.

389. *See* Darius Snieckus, *South Korea Plans for Flagship 1 GW Floating Wind Complex*, RECHARGE (Jan. 25, 2019), https://www.rechargenews.com/wind/1684755/south-korea-in-plans-for-flagship-1gw-floating-wind-complex.

comparable number of FWTs (±100) occupying a comparable surface footprint.

Traditional merchant vessel navigation can be impacted by such large exclusionary zones. MORU Arrays might encroach on existing deep-water sea lanes, increasing the risk of collisions/allisions between MORUs and traditional vessels within MORU Arrays,[390] traditional vessels forced into more confined spaces by Array safety zones,[391] and vessels restricted in their ability to maneuver.[392]

Below the surface, the sub-surface vertical and sea-bed footprints of MORUs qualitatively and quantitatively differ from those of other offshore facilities. Individual fixed-bottom foundations (whether for renewables or oil and gas installations) tend to be relatively compact, rigid vertical structures with correspondingly small sea-bed and sub-surface vertical spatial footprints. Although some MORU mooring concepts (e.g. TLP or tower mooring systems) would also create almost vertical sub-surface obstacles with a small sea-bed footprint, other mooring concepts (e.g. single point-, turret-, spread-, or taut leg-mooring systems) would create a pyramidal or cone-shaped sub-surface obstacle. MORU sub-surface and subsea cables and data transmission lines create additional conflicts.[393] MORU Array submarine inter-array and export cables are likely to run for longer distances than nearshore fixed-bottom facilities. Cables might not be buried in the subsoil immediately beneath a MORU. The scale and complexity of the aggregate sub-surface vertical and sea-bed footprints increases with MORU Array size, quantitatively

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390. *See* Jeremy Firestone & Willet Kempton, *Regulating Offshore Windpower and Aquaculture: Messages from Land and Sea*, 14(1) CORNELL J.L. & PUB. POL. 71, 92 (Jan. 2004), https://www.researchgate.net/publication/265101201_Regulating_Offshore_Wind_Power_and_Aquaculture_Messages_from_Land_and_Sea (". . . the potential for navigational hazards exists anytime a facility or structure is erected in the open ocean, whether it arises from an oil and gas platform, a wind turbine support structure, or an aquaculture net pen); *DNVGL-ST-0119: Floating Wind Turbine Structures*, *supra* note 29, § 4.5.2.7 (describing boat load impact considerations for FWTs).

391. Chircop & L'Esperance, *supra* note 104, at 9. Conversely, the navigational impact of MORU Arrays far from shore might be less than comparable fixed-bottom WTG arrays closer to port shipping lanes.

392. *Id.*

393. *See id.* at 11 ("The development of floating wind turbines displaying umbilical electrical cables which span the water column creates an increased potential for conflict with other marine users."); *see also* UNCLOS, *supra* note 14, art. 79 ("Nothing in this Part affects the right of the coastal State to establish conditions for cables or pipelines entering its territory or territorial sea, or its jurisdiction over cables and pipelines constructed or used in connection with the exploration of its continental shelf or exploitation of its resources or the operations of artificial islands, installations and structures under its jurisdiction.").

distinguishing them from those of standalone MORUs and O&G MOUs: the 11 FWT *Hywind Tampen* Array (including mooring systems) will have a total surface footprint of 11 km^2 and a seabed footprint of 22.5 km^2.[394]

More MORUs and MORU Arrays are likely a source of future disputes with other ocean users.[395] Where its concession, its cables, umbilicals, and mooring lines preclude fishing within a MORU Array, it acts as a de facto marine protected area for some species and a source of conflict with local and foreign fishermen.[396] Its cables and umbilicals could be a source of conflict with users of other subsea cables and pipelines as well.[397] Conversely, Producing Coastal States might issue overlapping, concurrent concessions for non-conflicting sustainable activities[398] (e.g. combining MORU Arrays with sustainable

394. *See Hywind Tampen PL050-PL057-PL089 PUD del II-Konsekvensutredning Mars*, EQUINOR, 9 (2019), https://www.equinor.com/no/how-and-why/impact-assessments.html.

395. *See* Chircop & L'Esperance, *supra* note 104, at 1, 9-12.

396. *See* Olivia Langhamer, *Artificial Reef Effect in Relation to Offshore Renewable Energy Conversion: State of the Art*, 2012 SCI. WORLD J. 1, 2-3 (2012) http://dx.doi.org/10.1100/2012/386713.

397. *See* UNCLOS, *supra* note 14, at art. 79(1), (2), (5); *but see id.* at art. 79(4).

398. *See generally* Ian Boisvert, *Lifting the Looking Glass: Tradable Occupation Could Facilitate Ocean Renewable Energy*, 15 N.Z. J. ENV'T L. 1 (2011); Robin Kundis Craig, *It's Not Just an Offshore Wind Farm: Combining Multiple Uses and Multiple Values on the Outer Continental Shelf*, 39 PUB. LAND & RES. L. REV. 59 (2018); *Bombora and ORE Catapult Collaborate to Develop Co-Located Floating Wave and Wind Technology*, CATAPULT (May 12, 2020), https://ore.catapult.org.uk/press-releases/bombora-ore-catapult-collaborate-to-develop-co-located-floating-wave-and-wind-technology/.

aquaculture,[399] artificial oyster bed installations,[400] coral reef restoration,[401] or transnational subsea grids in one site).[402]

To a large degree, these issues require an international solution balancing the rights of the Producing Coastal States, Flag States, and other Affected States.

IV. THE FINANCIAL IMPACT OF LEGAL UNCERTAINTY AND THE OPPORTUNITY

A. The Funding Required

Article 2.1 of the *Paris Agreement* declares that one of the objectives of the 190 parties thereof is "to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty, including by: (a) [h]olding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change."[403] There is general consensus that the consequences of future climate-related risks are even greater if global warming exceeds 1.5°C before returning to that level by 2100, especially if the peak temperature is high (i.e. about 2°C).[404]

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399. *See generally* Firestone & Kempton, *supra* note 390; Bela Hieronymus Buck et al., *Extensive Open Ocean Aquaculture Development within Wind Farms in Germany: The Prospect of Offshore Co-management and Legal Constraints*, 47 OCEANS & COASTAL MGMT. 95, 97 (2004), https://www.researchgate.net/publication/235938669_Extensive_open_ocean_aquaculture_development_within_wind_farms_in_Germany_The_prospect_of_offshore_co-management_and_legal_constraints; Langhamer, *supra* note 396, § 6 (Aquaculture and Offshore Energy Installations); Wylie Spicer & Melanie Gillis, *Go Deep: How International Legal Reform Can Prevent Legal Uncertainty from Hindering Offshore Wind & Aquaculture Growth*, MCINNES COOPER, https://www.mcinnescooper.com/publications/go-deep-how-international-legal-reform-can-prevent-legal-uncertainty-from-hindering-offshore-wind-aquaculture-growth/.

400. *See Artificial Reef Installed at Eneco Luchterduinen OWF*, WIND ENERGY MAG. (Nov. 6, 2018), https://www.windenergie-magazine.nl/artificial-reef-installed-at-eneco-luchterduinen-owf/.

401. *See* Langhamer, *supra* note 396, at § 5.3 (Alternative Designs to Enhance Biomass and Diversity).

402. *See generally* Hannah Katharina Müller, *A Legal Framework for a Transnational Offshore Grid in the North Sea*, University of Groningen (2015), https://www.rug.nl/research/portal/files/23245539/Complete_thesis.pdf.

403. *See* UNITED NATIONS TREATY COLLECTIONS, *supra* note 383 (showing the number of signatories and Parties as of 2019).

404. *Global Warming of 1.5°C*, INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE 1, 7, 9-12, 20 (2018), https://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf.

The International Energy Agency (IEA) and the International Renewable Energy Agency (IRENA) have prepared an analysis of the investment needs for a low-carbon energy system which would have a 66% chance of keeping global warming below 2°C above pre-industrial levels (the "REmap scenario").[405] IEA and IRENA have stated that even this risk-tolerant scenario[406] requires a "fundamental reorientation of energy-supply investments and a rapid escalation in low-carbon demand side investments . . ."[407] The IEA estimates that it would require around on average U.S. $3.5 trillion of combined demand-side and supply-side investments in the energy sector each year between 2016 and 2050, compared to an annual U.S. $1.8 trillion investment in 2015.[408] Although natural gas continues to play an important role in this scenario, fossil fuel investments would decline overall, largely offset by a 150% increase in renewable energy supply-side investments between 2015 and 2050.[409] IRENA found that the share of renewable energy in this scenario would need to rise from 15% of the primary energy supply in 2015 to 65% by 2050.[410] To achieve this, IRENA estimates that an additional investment of U.S. $16 trillion in the aggregate on and offshore renewable energy supply (beyond those already included in existing Paris Agreement parties' NDCs) would be required in that period.[411]

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405. *See Perspectives for the Energy Transition—Investment Needs for a Low-Carbon Energy System*, OECD/IEA & IRENA, 5-6, 124 (2017), https://www.iea.org/publications/insights/insightpublications/PerspectivesfortheEnergyTransition.pdf.

406. This scenario allows a one in three chance that society would fail to achieve the goals of the Paris Agreement and global warming would exceed 2°C above pre-industrial levels, with all the consequences that such warming implies.

407. *See* OECD/IEA & IRENA, *supra* note 406, at 8; *Perspectives for the Energy Transition*, INT'L ENERGY AGENCY 1, 51 (2017), https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Mar/Perspectives_for_the_Energy_Transition_2017.pdf.

408. *See* OECD/IEA & IRENA, *supra* note 405, at 8.

409. *See id.* at 8, 9; *see also* Andrew Lee, *Renewables to Grow 50% by 2024—But It's Still Not Enough: IEA*, RECHARGE (Oct. 21, 2019), https://www.rechargenews.com/transition/1866219/renewables-to-grow-50-percent-by-2024-but-its-still-not-enough-iea.

410. *See* OECD/IEA & IRENA, *supra* note 405, at 10.

411. *See Chapter 3: Global Energy Transition Prospects and the Role of Renewables*, *Perspectives for the Energy Transition—Investment Needs for a Low-Carbon Energy System*, IRENA, 125, 141 (2017), https://www.iea.org/publications/insights/insightpublications/PerspectivesfortheEnergyTransition.pdf; *Compare Global Energy Transformation: A Roadmap to 2050*, IRENA, 8 (2019), https://irena.org/-/media/Files/IRENA/Agency/Publication/2019/Apr/IRENA_Global_Energy_Transformation_2019.pdf (setting the additional investment required at U.S. $15 trillion).

Offshore wind power, making up the vast majority of the world's current installed offshore renewable energy capacity, currently provides only 0.3% of global electricity generation.[412] In 2018, the most commercially advanced MORUs, FWTs, made up less than 0.3% of that. Nonetheless, the IEA sees fixed-bottom and floating offshore wind as increasingly important and predicts that current investment plans and policies would result in offshore wind capacity expanding at least 15-fold worldwide by 2040,[413] requiring estimated capital investments of U.S. $840 billion over the next two decades.[414] In order to achieve global climate and sustainability goals, the IEA's "Sustainable Development Scenario" estimates that cumulative investment in offshore wind would need to increase to over U.S. $1.2 trillion during that period.[415]

Admittedly, MORUs currently play a very small role in renewables investment and will continue to do so in the immediate future. However, if and when the LCOE of MORUs falls below that of fixed-bottom and onshore facilities, the share of MORUs relative to competing renewable energy technologies will rapidly increase.[416] IRENA estimates that FWTs alone could capture a 5-15% share of an almost 1,000 GW global offshore wind market by 2050.[417]

This will require a tremendous amount of capital. Financing just 1% of IRENA's estimated U.S. $16 trillion *additional* investment in on- and offshore renewable energy required in the next three decades to achieve the REmap scenario requires U.S. $160 billion. Shifting 10% of the IEA's estimated two-decade capital spend of U.S. $840 billion under current offshore wind investment plans and policies from fixed-bottom WTGs to MORUs represents a reallocation of U.S. $84 billion. Similarly, each 10% of the estimated U.S. $1.2 trillion in offshore wind investments over the next 20 years required to achieve IEA's Sustainable Development Scenario represents U.S. $120 billion in potential investment in MORUs.

As discussed, current research and pre-commercial MORUs and MORU Arrays tend to be smaller, low-leverage, or self-financed projects structurally exposed to an acceptable amount of international legal uncertainty. However, this will not always be the case—the number and

412. *See* INTER. ENERGY AGENCY, *supra* note 3, at 11.
413. *See id.* at 13.
414. *See id.*
415. *See id.*
416. *See* QUEST FLOATING WIND ENERGY, *supra* note 7.
417. *See* FUTURE OF WIND: DEPLOYMENT, INVESTMENT, TECHNOLOGY, GRID INTEGRATION AND SOCIO-ECONOMIC ASPECTS, IRENA, 11 (2019), https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Oct/IRENA_Future_of_wind_2019.pdf

size of MORUs and MORU Arrays, global supply chain complexity, international finance, and movement of MORUs between jurisdictions are all likely to increase over time. Most offshore developers will simply not be able to consistently deliver large numbers of utility-scale MORU Arrays in multiple developed and developing jurisdictions without reliable sources of outside capital.

In the right legal regime, MORUs might permit the use of different business, debt, and ownership models, and different accounting and tax treatments than those traditionally used in renewables finance. Moveable asset-based finance structures might replace fixed-facility project finance. Both short-term and long-term leasing by owner/operators with underutilized MORU capacity and by dedicated financing companies owning and leasing a fleet of MORUs to a variety of lessee/operators seem possible. Like financing for traditional ships, necessary capital will likely come from many sources, including long-term commercial debt,[418] public equity and debt markets, specialist green investment or shipping banks, private equity, finance leasing, and fintech.[419] This could be supported by export credit agencies.[420] Climate change is a global problem requiring global solutions, in which the whole financial sector has a crucial role to play,[421] and in the end the majority of the massive amount of capital required in the next few decades will need to come from the private sector.[422]

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418. *But see* Nolan, *supra* note 171, at 928 ("[t]he classic marriage of closely held equity with traditional long-term bank debt has faded. Demand for capital has grown enormously to fuel the shipping industry growth . . . .").

419. *See id.* at 954-61. This Article's author, however, is of the belief that some categories of fintech have a decent chance of rendering Plutarch's characterization of bottomry as "the most disreputable form of money lending" obsolete.

420. *See id.* at 969.

421. Mark Carney et al., *The Financial Sector Must be at the Heart of Tackling Climate Change*, GUARDIAN (Apr. 17, 2019), https://www.theguardian.com/commentisfree/2019/apr/17/the-financial-sector-must-be-at-the-heart-of-tackling-climate-change.

422. *See UN Chief Urges Action to Avert Climate Change 'Catastrophe'*, RFI (June 30, 2019), http://www.rfi.fr/en/contenu/20190630-un-chief-urges-action-avert-climate-change-catastrophe-0 ("What we have to do is mobilise more private capital and instead of having private money invested in coal projects . . . . it should be invested in renewable energy"); *Corporate, Investment Leaders Review SDG Impact Plans*, UNITED NATIONS DEVELOPMENT PLAN (July 1, 2019), https://www.undp.org/content/undp/en/home/stories/corporate--investment-leaders-review-sdg-impact-plans-.html ("Achieving the SDGs will require investment on an unprecedented scale—which we cannot afford not to make. That means unlocking private capital by helping enterprises and investors identify and report on SDG-aligned business opportunities."). However, this does not mean that state funds have no role in MORU finance.

B. The Negative Impact on Lending of Legal Uncertainty and the Opportunity

Self-evidently, an efficient capital market supported by a clear legal regime is a prerequisite to mobilization of these volumes of capital,[423] particularly when moving foreign capital into countries with uncertain or inadequate domestic legal regimes. Conversely, legal uncertainty *per se* is weak evidence of a compelling need for a new international maritime convention. Concrete evidence that removal of such legal uncertainties and their deterrent effects would have (or is very likely to have) a material, positive impact on stakeholder participation, which is needed.

With so little data to establish a baseline, determining *a priori* the precise long-term magnitude of the global negative impact of international legal uncertainties on MORU finance in the absence of a convention would be difficult, if not impossible. However, an understanding of why legal uncertainty impacts decisions to provide finance, combined with indicative *ex post facto* data of an international convention's positive impact on lending in an analogous industry, would provide anecdotal evidence of how international legal uncertainties facing MORUs are likely to have a material, negative *ex ante* impact on their efficient financing, and conversely, the material, positive impact that a convention removing certain international legal uncertainties could create.

1. The Impact on Lending of Legal Uncertainty

In a well-developed and efficient legal environment for investment, each risk is clearly allocated to one party or another, and that party able to set aside acceptable contingencies or purchase insurance to cover that risk.[424] Conversely, in an inefficient legal environment, multiple parties are potentially exposed to the same risk(s), with each incentivized to set aside its own contingencies or purchase insurance against that unallocated risk,

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See McPhee, *supra* note 94 ("in order for the UK to meet its highly ambitious 2050 net-zero carbon target, it is essential its offshore wind sector continues to expand over the next 30 years . . . . Our report highlights how UK and Scottish government must act now to safeguard their market lead. Actions include reinstating government funds to de-risk floating wind projects and retaining strong trade links with Europe post-Brexit."); Delgado, *Security Interests over Ships*, *supra* note 173, at 244-46.

423. *See* Verburg & Waverijn, *supra* note 187**Error! Bookmark not defined.**, at 1-2.

424. *See id.* at 7 ("Roughly speaking, identified risks can be dealt with in three ways: they can be obtained by the investor, transferred to counterparties or transferred to insurers."); *see also EDF Seeks Floating Insurance in France*, RENEWS (May 27, 2019), https://renews.biz/53390/edf-seeks-floating-insurance-in-france.

or avoid an otherwise profitable activity altogether, resulting in inefficient risk mitigation and/or project selection. Not surprisingly, all exposed parties contemplating the activity will demand a higher rate of return from that activity to reflect the (inefficiently) higher capital they employ to cover the unallocated risk,[425] resulting in lower project viability[426] and, in the context of this Article, fewer MORUs deployed.

Conversely, when a legal change removes legal uncertainty, there can be a positive impact on lending.[427] Not surprisingly, some changes in law will have a greater impact on lending than others: strengthening legal rules protecting individual creditors' claims outside bankruptcy (i.e. the ability to pledge assets as non-possessory collateral) have been found to be more important (and statistically significant) for credit supply decisions of banks in emerging and transition economies than the collective enforcement regime bankruptcy establishes.[428] Lending market entrants, in particular foreign banks, respond strongly to such legal changes by increasing their lending volume.[429] Taking the issue of international recognition of registerable non-possessory security interests and priority of claims in isolation, the potential for the provisions of a broadly accepted international convention to lower the costs of borrowing and increase the funds available for different classes of borrowers by providing greater international legal certainty can be seen.

2. The Cape Town Convention and Aircraft Finance

The Cape Town Convention and its Aircraft Protocol address international legal uncertainties in relation to collateral rights in two specific types of high-value movable assets (airframes and aircraft engines) by establishing a non-possessory international security interest

425. *See* Verburg & Waverijn, *supra* note 187, at 7.

426. *Financing and Investment Trends: The European Wind Industry in 2018*, WIND EUR. 1, 18 (2019), https://windeurope.org/wp-content/uploads/files/about-wind/reports/Financing-and-Investment-Trends-2018.pdf ("National energy policies and lack of a stable regulatory environment have affected both the level of investment and financial commitments in half of EU Member states. Closely tied to policy and regulatory stability is the cost of capital. Future political uncertainty is factored in as a risk premium. Higher risks lead to a higher cost of capital and negative impacts on the economic viability of wind projects.").

427. *See* Haselmann et al., *supra* note 234 at 1 ("[w]e find that law does in fact promote lending. The overall level of formal creditor rights protection is positively associated with the lending volume, and so is legal change with increases in lending volume over time").

428. *See id.* at 2, 5-6, 12.

429. *See id.* at 2.

over them. They give creditors access to an international registry establishing priority of claims,[430] and in the event of default, rights to deregister and export the aircraft, take possession or control of the aircraft, sell or grant a lease in the aircraft, and collect and receive income arising from the management or use of the aircraft.[431] It also gives designated courts of contracting states, and courts where the aircraft is situated, jurisdiction to grant orders to preserve, immobilize, regulate use in the interim, or take possession, control and custody of the aircraft.[432] The Protocol extends the Convention to outright sales and insolvency and specifies remedies in default or insolvency.[433] The objective was to reduce the barriers arising from a variety of local legal systems' approaches to security interests over aircraft and thereby reduce creditors' uncertainty by providing an internationally recognized and readily enforceable collateral right in aircraft and related equipment.[434]

In less developed legal systems, the absence of, or legal uncertainty in relation to the application of, such broad non-possessory collateral rights can result in international lenders treating such debt as unsecured.[435] The Cape Town Convention and Protocol gives airlines in markets with uncertain collateral rights over aircraft, access to global secured debt markets on a commercial basis, avoiding some of the conventional country-risk premium associated with that legal uncertainty.[436] One analysis has estimated the difference in such secured and de facto unsecured lending for aircraft to be as high as 250 basis points.[437] Based on assumptions about the Convention's impact on airlines' credit ratings and their secured and unsecured interest costs,[438] loan tenors of 12 years (with and without a final bullet payment),[439] average discount rate before and after Convention ratification,[440] and the calculation method chosen,[441]

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430. *See* Saunders et al., *supra* note 253, at 3-4.
431. *See id.* at 4.
432. *See id.*
433. *See id.*
434. *See id.* at 3.
435. *See id.* at 9.
436. *See id.* at 7, 9.
437. *See id.* at 13, 18, 31; Delgado, *Security Interests over Ships*, *supra* note 173, at 288 ("the airlines of States that adopt the Convention and Protocol may receive a . . . 10% discount on export credit premiums").
438. *See* Saunders, *supra* note 253, at 8-9.
439. *See id.* at 10.
440. *See id.*
441. *See id.* at 10-12.

that analysis indicated that Convention accession yielded an interest savings of between 13% and 20% per principal dollar borrowed for aircraft financings in jurisdictions which were not already covered by domestic collateral right protection comparable in strength to those provided by the Cape Town Convention and Protocol.[442] This reduction in debt costs was then linked to an increase in the stock market valuation of publicly traded airlines of approximately 10%.[443] It estimated a 20-year global cost savings attributable to Cape Town Convention and Protocol at between U.S. $267 billion and U.S. $299 billion for the airline industry or 10-15% of Boeing's 2003 forecasted U.S. $2 trillion 20-year global demand for aircraft.[444]

In short, accession gave member states' airlines greater legal certainty and better credit ratings, and consequently greater access to international capital at more competitive rates,[445] resulting in a huge reduction in the cost of debt for that industry. Importantly, the Cape Town Convention's positive impact on aircraft lending costs and availability of funds was greatest in countries where the previously applicable domestic collateral right protections were weakest when compared to the Cape Town Convention and the Protocol.[446] By inverse reasoning, the absence of a convention eliminating previous legal uncertainties in relation to collateral rights in aircraft and aircraft engines had a material, negative *ex ante* impact on lending, profits, and shareholder value for that same industry.

3. The Risk of Extrapolation

Would a MORU Convention resolving international uncertainties in relation to non-possessory security interests (and other legal uncertainties for good measure) have the same positive impact on MORU lending as the analysis indicated that the Cape Town Convention had on aircraft finance? Can we now safely assume a MORU Convention would yield an estimated interest savings of between 13-20% per principal dollar borrowed, stock market valuation bumps of 10% for publicly traded

442. *See id.* at 31.
443. *See* Saunders, *supra* note 253, at 32.
444. *See id.* at 19.
445. *See id.* at 30; Delgado, *Security Interests over Ships*, *supra* note 173, at 289.
446. *See* Saunders, *supra* note 253, at 14, 19, 31; Delgado, *Security Interests over Ships*, *supra* note 173, at 288.

MORU owner/operators, and a 20-year global cost savings approaching of 10-15% of estimated global MORU demand?[447]

Although back-of-the-envelope calculations can be extremely entertaining, a simple pro rata extrapolation of these results to MORUs would be crude at best. Estimates of the values of the 20-year global demand for MORUs vary. MORUs are not aircrafts and both have legal and economic risks particular to their sector. Loan tenors, political risk premiums, and commercial terms and conditions demanded by lenders, and the underlying creditworthiness of borrowers in each industry, might vary significantly. Baseline domestic collateral rights existing for aircraft in some countries pre-Cape Town and the same for MORUs now differ. For better or worse, a MORU Convention might not offer the same collateral rights protections as the Cape Town Convention.[448] As a consequence, the economic values of legal protections pre- and post-convention will differ for MORUs relative to aircraft. These factors suggest simple extrapolation is unwise.[449]

In short, the Cape Town Convention's success offers no guarantee that a MORU Convention would have an identical impact on MORU finance. However, it would not be unreasonable to conclude that the absence of a MORU Convention covering comparable non-possessory security interests (and other international legal uncertainties as well) will have a long-term material and negative impact on MORU finance costs (whatever the precise magnitude), with a larger impact in countries where existing legal uncertainties are greatest.

V. CONCLUSION

MORUs offer potential spatial, technical, commercial, and legal advantages over competing technologies and the potential to supply renewable energy at lower LCOEs than competing offshore technologies in the mid-term. The pilot and pre-commercial MORUs and small MORU Arrays that exist today are likely to be joined globally by hundreds, and potentially thousands, of MORUs in utility-scale MORU Arrays in the next two decades.

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447. Delgado, *Security Interests over Ships*, *supra* note 173, at 243.

448. For example, a hypothetical MORU Convention might provide collateral rights protections more akin to those under MLM 1926 or MLM 1993 than under the Cape Town Convention.

449. A robust, retrospective analysis of the estimated global financial impact of a MORU Convention is best left to future practitioners of the dismal science.

MORUs will be subject to various types of international maritime disputes, many of which have already been raised in relation to traditional merchant ships, O&G MOUs, other non-traditional watercraft, and to a lesser degree aircraft. Unfortunately, existing international maritime conventions designed to govern international maritime disputes related to manned merchant ships often either do not apply to unusual watercraft like MORUs or their application is ambiguous. Compounding the problem, the level of acceptance of some conventions may be so low as to render the convention's coverage ineffective.

To some degree, the resulting international legal uncertainty for existing and currently planned pilot projects has been accepted or mitigated by their stakeholders, but that same legal uncertainty is likely to act as a global deterrent to many potential future stakeholders in the deployment of utility-scale MORU Arrays, particularly if there are international aspects to the project. Given the estimated capital investments required to remain within the Paris Agreement objectives, even small legal uncertainties could have a material negative impact on the aggregate cost of the capital required. Specifically, some uncertainties are likely to have a material negative impact on future MORU finance with the greatest negative impact in jurisdictions where the domestic legal regime provides inadequate redress for a dispute. Removal of these uncertainties could materially lower the LCOE of MORUs by reducing project contingencies and the cost of debt, while simultaneously increasing the availability of international funds for MORU finance. Conversely, even small improvements could have a material positive impact.[450] A failure to address these uncertainties would result in capital otherwise destined to finance MORUs drifting towards less deserving projects and technologies.

In 2000, the late Richard Shaw said the following of FPSOs: "What is clear, however, is that the present state of international maritime law on this subject is uncertain and unsatisfactory . . . a solution may be found in a carefully worded international convention on offshore craft. Those who argue against such an initiative on the ground that there is no real problem are, in the author's respectful view, incorrect."[451] On the basis of the

450. *See* Saunders, *supra* note 253, at 2 ("Small changes in the legal and regulatory overlay of the market can create dramatic shifts in financial flows"); *see also id.* at 14 ("Given the size of capital investment required for aircraft, even small percentages savings add up to significant absolute savings in dollar terms").

451. Shaw, *supra* note 9, at 89.

arguments presented herein, it is respectfully submitted that Mr. Shaw's quote is as true for MORUs now as it was for FPSOs then and the first question in Professor Goode's tripartite test may be answered in the affirmative: There are several problems identified above that need to be solved at an international level.

As mentioned above, Professor Goode's second question ("Is it feasible?") will be addressed in *Mare Incognitum, Part II*. It explores the potential scope of a multi-topic international maritime convention for MORUs and two existing documents that might provide inspiration for such a convention (i.e. the Vancouver Draft and the Cape Town Convention). As stimulus for further debate, *Mare Incognitum, Part II* will include an annexed straw-man draft MORU Convention (based on the Vancouver Draft). Professor Goode's third question ("Is the project likely to receive a substantial measure of support . . . from governments but from industry and other interested sectors?") will be addressed in *Mare Incognitum, Part III*.