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ARTICLE

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This article provides a review of the existing laws and conventions that might be applied to the development of offshore methane hydrates. Offshore methane hydrates are an exciting emerging new energy resource; one with great potential to provide vast energy supplies, and also one with substantially novel risks and hazards to the environment, marine flora and fauna, and adjacent human communities. Some of these new risks include cataclysmic levels of greenhouse gas emissions, subsea landslides, and tsunamis. As such, it is important to take a survey of the existing laws and conventions that could be applied to such risks, examine them for their ability to efficiently govern those risks, and take account of where risks from offshore methane hydrates are insufficiently addressed by current laws and conventions. This article undertakes that task in order to compare and contrast existing rules against recommended legal policies, and to offer potential solutions to existing shortfalls.

The first section of this article provides an introduction and review of the potential impacts from the development of offshore methane hydrates. It will discuss the potential economic and public welfare improvements to be gained from the development of offshore methane hydrates. It will also provide an exposition of the risks posed by that same development.

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The second section of this article will demonstrate the application of law and economics theory to the choice of risk governance mechanisms. Within the rules of civil liability, a rule of strict liability is found to better fit the facts and circumstances of offshore methane hydrates, and would thus be more robust in the efficient governance of its risks compared against a rule of negligence. Arguments for the application of both public and private regulations will be provided. The resultant risk governance strategy is a mechanism of complementary implementation of strict liability, public regulations, and private regulations.

The third section provides a review of the major international laws and conventions that have a nexus to the development of offshore methane hydrates as well as the federal laws of the United States and the legal instruments of the European Union. Because so many laws or conventions might have some minimal application to the governance of offshore methane hydrates, only those with the greatest *a priori* expected nexus are reviewed. For each law or convention, two levels of analysis are provided: an examination of the nexus and potential applicability of the law, and an examination of the law's risk governance mechanisms. Thus, each law is examined for both applicability and for alignment with the recommended three-prong risk governance strategy.

Conclusions are provided on the state of the existing laws and conventions to address the potential risks and harms from the development of offshore methane hydrates. Potential improvements to the existing laws and conventions and efficient means to that end are discussed.

Finally, looking at the whole article: are the world's laws and conventions ready for the development of offshore methane hydrates? No, not quite yet, but they could readily be amended and extended to better provide for the efficient protection of the environment, marine biota, and impacted human communities.

I. THE POTENTIAL IMPACT OF OFFSHORE METHANE HYDRATES

The most important facts about methane hydrates can be summarized quickly.[1] Offshore methane hydrates offer abundant energy and fresh water supplies to practically every coastal state in the world, and the commercial development of offshore methane hydrates could substantially impact both developed and developing economies. Offshore methane hydrates offer the means to provide those benefits, while also serving as substantial sinks for climate change policy makers. It is a policy trio of substantial benefits: water policy, energy policy, and climate change policy. But, the downside is that the commercial development of offshore methane hydrates could unleash both cataclysmic and non-cataclysmic risks and harms.

A. Benefits of Offshore Methane Hydrates

Methane hydrates are a potential source of both methane and fresh water.[2] After the methane volumes are extracted, the methane can be converted expeditiously into routine natural gas for use in both industrial and residential energy supplies.[3] Extracted water can be used for both consumer and agricultural purposes. As the methane volumes are extracted from the hydrate deposits, streams of carbon dioxide can be injected into the same hydrate structures to provide carbon capture and storage (CCS).[4] It also appears that the costs of extracting and producing offshore methane hydrates are dropping, and may become price competitive with other energy sources in the near

1. For a detailed exposition of the scientific and engineering circumstances of offshore methane hydrates, of the potential benefits from the commercial development of offshore methane hydrates, and of the potential risks and hazards from that development, see Roy Andrew Partain, *Primer on Methane Hydrates, in* MECHANISM DESIGN FOR THE FIERY ICE: CIVIL LIABILITY AND REGULATIONS FOR THE EFFICIENT GOVERNANCE OF THE ENVIRONMENTAL HAZARDS FROM OFFSHORE METHANE HYDRATE OPERATIONS (forthcoming 2015), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2465612 [hereinafter MECHANISM DESIGN FOR THE FIERY ICE].

2. *Id.* at ch. 2, § 2, n.18.

3. *Id.* at ch. 3, § 3.

4. *See id.* at ch.3, § 5.1, n.141.

future, and it may already be price competitive with certain liquid natural gas (LNG) prices.[5]

In the alternative, the methane can be combusted on-site to generate electricity, and the exhaust therefrom can be re-injected into the hydrate deposits for CCS storage. Or, the methane can be reformed with steam (created with extracted fresh water and heated with methane) to create hydrogen fuel.[6] From methane fuels, to carbon-neutral electricity, to hydrogen fuel options, the commercial development of offshore methane hydrates could enable a wide array of green and greener energy options.[7] In an era concerned with anthropogenic climate change, these are potentially exciting options.

Methane hydrates exist abundantly in many locations, including locations found onshore in arctic permafrost. Almost every coastal country is expected to possess methane hydrate reserves,[8] and those countries with onshore methane hydrates also possess offshore methane hydrates.[9] Developed countries, such as Japan and South Korea, that do not currently possess strategic volumes of domestic energy supplies, do possess substantial offshore methane hydrate supplies.[10] Many developing countries with no domestic energy supply are expected to possess substantial offshore methane hydrate reserves; many of those countries might also be interested in the freshwater co-produced with methane hydrates to assist in their agricultural development and consumer freshwater needs.

The world has faced critical energy supply shortages since the dawn of the fossil fuel era of industrialization. While not a perfect cure to that problem, the commercial development of offshore methane hydrates could enable local access to energy supplies, and level the geo-political playing field of energy markets. The potential benefit of both lowering energy costs and

5. *See id.* at ch.3, § 2, n.16. The LNG comparison here is to spot prices seen in the recent decade in northeast Asia.

6. *See id.* at ch.3, § 5.2, nn.150-52.

7. *See* MECHANISM DESIGN FOR THE FIERY ICE*, supra* note 1, at ch. 3, § 1.

8. *Id.* at ch. 2, § 1.

9. *See id.* at ch. 2, § 3, nn. 78-79.

10. *Id.* at ch. 3, §§ 4.1, 4.2.

the potential stability of supplies could assist in global economic development.

B. Hazards of Offshore Methane Hydrates

The extraction and production of offshore methane hydrates is a "new thing under the sun."[11] Innovative technologies and new risks heretofore untouched in offshore energy extraction are required to extract energy supplies from under subsea mud layers.[12] Previously, offshore operators feared methane hydrates as one of the most dangerous aspects of offshore drilling and in gas pipeline transportation. A lot of unlearning must be accomplished, as methane hydrates are increasingly seen as valuable energy resources.

Methane hydrates collect under mud layers in the ocean.[13] The icy crystals are endothermically stable, as they need extra energy to be added to their reservoir system before they will begin to disassociate and release methane volumes from the hydrate structures.[14] Left alone, they are, and have been, stable for geologically long time frames.[15]

But, scientists have found evidence that ancient earthquakes or landslides have added that necessary energy to ancient hydrate deposits.[16] When that happened, earthquakes and tsunamis occurred, which resulted in massive impacts on coastal flora and fauna.[17] For example, the Mesolithic-era Storegga event sent tsunami waves forty meters high directly into the coasts of Iceland and Norway; such an event in modern times might kill millions of coastal dwellers and severely impact a broader radius of coastal communities. [18]

Without tsunamis, major disruptions of the mud layer and of the underlying hydrate deposits could enable massive and sudden

11. With apologies to the author of Ecclesiastes 1:9. Ecclesiastes 1:9.
12. MECHANISM DESIGN FOR THE FIERY ICE*, supra* note 1, at ch. 3, § 3.
13. MECHANISM DESIGN FOR THE FIERY ICE*, supra* note 1, at ch. 2, § 1.
14. *See id.* at ch. 2, § 6.
15. *Id.* § 6.
16. *Id.* at ch. 4, § 4.2.
17. *See id.*
18. *Id.* at ch. 4.

disassociation of methane.[19] If a sufficient amount of methane is released, a funnel or chimney can be created, which can enable the methane to be directly released into the atmosphere without first transmitting through the water column.[20] Such a large emission of methane into the atmosphere could cause several problems. Methane itself is combustible and explosive; such an event would create a radius of danger preventing emergency crews from gaining immediate access to the damage area. Such volumes could also potentially asphyxiate first responders. Finally, the emission of methane into the atmosphere would be a grave accident in climate change consequences, as methane is considered substantially more dangerous than carbon dioxide for inducing climate change.

Are cataclysmic events likely? Probably not; however, until more information is acquired from completely developed offshore extraction projects, the risk might remain difficult to ascertain. However, given that methane hydrates are endothermic, and given the potential to measure the amounts of energy injected or placed into the hydrate deposits, it should be feasible to substantially limit black swan type events by setting standards to ensure that cautious energy budgets are enforced to prevent overstimulation of the hydrate deposits. Yet, given the complexity of the hydrate structures, the limits of sub-mud-line surveillance, and the complex marine interactions that will continue to exist from natural processes, it would likely remain impossible to prevent all likelihood of cataclysmic events at offshore methane hydrate installations. Thus, whatever resulting standards emerge to address the risks and hazards of offshore hydrate accidents, there will remain a need to ensure that those standards contemplate how to address cataclysmic accidents.

Gentler events also could make substantial impacts to the adjacent coastal communities and to the flora and fauna of the oceans wherein the offshore methane hydrate projects enable methane venting or seepage to occur.[21] The preparation of fields

19. *Id.* at ch. 4, § 6.

20. MECHANISM DESIGN FOR THE FIERY ICE, *supra* note 1, at ch. 4, § 4.1.

21. MECHANISM DESIGN FOR THE FIERY ICE, *supra* note 1, at ch. 4, § 4.1.

for production involves a variety of drilling and vibration inducing activities. Extraction may well include various heating injections and flooding techniques.[22] The depletion of the methane or water volumes could cause hydrate bed collapses that in turn could lead to structural problems. [23] Both the development and on-going operation of offshore methane hydrates could lead to non-cataclysmic methane accidents. Given the many modes in which the hydrate deposit could become disturbed and begin to emit methane, the chance of non-cataclysmic venting and seepage would not be expected to be slight; rather, one might reasonably conclude that minor events could reasonably occur in most fields. But, it would also be more likely than not, that such events would lose their energy source or be detected and addressed, and thus be events of limited duration and of limited impact.

Methane itself is a greenhouse gas, and its constant seepage and emission could enable additional anthropogenic climate change to occur. Methane is also interactive with the biota of the ocean, both as a food stock for certain micro-biota and as a displacer of oxygen.[24] Methane can be digested and converted metabolically into carbon dioxide, which is another critical greenhouse gas. [25] The nuisance of emitted methane and carbon dioxide gas volumes, the potential interference into marine economies, such as fishing and tourism, and the general anxiety of living near a field of risk, could all be considered part of the harms and hazards of living near offshore methane hydrate projects. [26]

The commercial development of offshore methane hydrate technologies would offer both risks and rewards. The needs of certain countries to achieve domestic energy supplies, to sustain economic development, and to potentially address parallel issues

22. *See id.* at ch. 4, § 4.2.

23. *See id*.

24. *See* MECHANISM DESIGN FOR THE FIERY ICE*, supra* note 1, at ch. 4, § 6.

25. Some marine biota can metabolize methane. There are also non-biotic chemical processes in the water column that can enable the decomposition of methane into carbon dioxide. *See id.* at ch. 4, § 6.

26. *See id*.

of freshwater supplies and of effective climate change policies could encourage an earlier timeframe for development. On the other hand, there are substantial risks and hazards that endanger both the local communities to methane hydrate accidents and global communities impacted by climate change events. The risks and benefits need to be balanced, and an efficient means of obtaining the optimal levels of safety and extraction activity are needed.

II. MODEL GOVERNANCE OF THE RISKS FROM OFFSHORE METHANE HYDRATES

The primary tools available for the governance of accidental risk are both the public and private rules of civil liability and regulations.

This section will summarize the overall circumstances of offshore methane hydrates. Literature from law and economics support an argument that it would be best governed under the rule of strict liability.[27] However, there are certain circumstances that frustrate a rule of strict liability; in those cases public regulations were found to be an efficient means of risk governance for offshore methane hydrates.[28] Additionally, private regulation can be integrated into a regulatory mechanism with public regulation.[29]

27. For a detailed, yet non-mathematical, discussion on the models and arguments supporting the application of a rule of strict liability to the risks and hazards of offshore methane hydrates, see Roy Andrew Partain, *The Application of Civil Liability for the Risks of Offshore Methane Hydrates*, 26(2) FORDHAM ENVTL. L. REV. 225 (2015). For a summary of the mathematical models presented in the aforementioned article, *see* MECHANISM DESIGN FOR THE FIERY ICE, *supra* note 1 (mathematical appendices).

28. For a detailed, yet non-mathematical, discussion on the models and arguments supporting the application of public and private regulations to the risks and hazards of offshore methane hydrates, *see* Roy Andrew Partain, *Governing the Risks of Offshore Methane Hydrates: Part II – Public and Private Regulations* (Rotterdam Inst. of Law & Econ., Working Paper), *available at* http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2466079 [hereinafter *Governing the Risks of Offshore Methane Hydrates: Part II*]. For a summary of the mathematical models on regulatory mechanisms presented in the aforementioned article, *see* MECHANISM DESIGN FOR THE FIERY ICE, *supra* note 1 (mathematical appendices).

29. *See Governing the Risks of Offshore Methane Hydrates: Part II, supra* note 27, § 5.

Ergo, the recommendation of this article is a rule of strict liability, employed alongside public and private regulations. This will produce the optimal set of incentives to efficiently set the correct standards for safety and precaution and the correct levels of operational activity when offshore methane hydrates are installed.[30]

A. A Rule of Strict Liability Should Apply

In the last fifty-plus years since Calabresi's first foray in the law and economics of accident law,[31] much advancement has been made. There is now a substantial body of literature to draw from, and a strong consensus has emerged on when certain rules of civil liability could be efficiently applied, and under what circumstances other rules might be efficiently applied.[32] Of course much theoretical activity remains, and not all models agree, but there is a workable standard model that can be utilized for the present article.

When accidents are primarily or exclusively under the control of a single actor, theory suggests that a rule of strict liability would be more efficient than a rule of negligence.[33] When accidents are a result of both the tortfeasor's and the victim's actions, but the tortfeasor's acts are more critical to containing the risk of harm, again, theory suggests that a rule of strict liability would be more efficient.[34] When the underlying activity creating the harm is abnormally hazardous, theory suggests that a rule of strict liability would be more efficient.[35] When particular uncertainties are to be encountered, theory suggests that a rule of strict liability would be more efficient.[36] And when it is important to prevent stress to a judicial system,

30. *See* Partain, *supra* note 27, at 316-18; *see Governing the Risks of Offshore Methane Hydrates: Part II, supra* note 28, § 6.

31. *See* Guido Calabresi, *Some Thoughts on Risk Distribution and the Law of Torts*, 70 YALE L.J. 499 (1961).

32. *See* Partain, *supra* note 27, at 252-57.

33. *See id.* at 257.

34. *See id.* at 258.

35. *See id.* at 266.

36. *See id.* at 270.

theory suggests that a rule of strict liability would present fewer transaction costs on the path to justice.[37]

The development of offshore methane hydrates contains the circumstances that advocate for a rule of strict liability.[38] Offshore methane hydrates projects would primarily be of a unilateral nature of activity and risk and the operator would be the primary, if not sole, determiner of which risky acts would be undertaken, when they would be undertaken, and how they would be undertaken, and thus a rule of strict liability would be the efficient policy choice.[39] Even if there were a nexus between the operator and local community members in the acts leading to methane hydrate accidents, i.e., a bilateral accident model, the determinants of risk would still primarily sit with the operator, and thus a rule of strict liability would be the efficient policy choice.[40] When the potential risks of cataclysmic events are considered, the development of offshore methane hydrates could reasonably be characterized as abnormally hazardous.[41] But, one need not rely on the risks of tsunamis and earthquakes, as the damages from non-cataclysmic accidents could also be characterized as abnormally hazardous in that the combined risks, both local and global, are neither normal nor safe, and thus a rule of strict liability would be the efficient policy choice.[42] Given the novelty of the nascent industry, many uncertainties are to be encountered, such as indeterminate *ex ante* duty of care, uncertainty of future harms, and complex interactions of precaution and activity levels.[43] Therefore, a rule of strict liability would be the efficient policy choice. And given that many of the countries wherein methane hydrate deposits lay have developing legal institutions and may not be able to bear the full brunt of transaction costs from a major methane hydrate

37. *See id.* at 273.
38. *See* Partain, *supra* note 27, at 275-82.
39. *See id.* at 275.
40. *See* Partain, *supra* note 27, at 275.
41. *See id.* at 276-78.
42. *See id.*
43. *See id.* at 278-79.

accident, a rule of strict liability would again be the efficient policy choice.[44]

A rule of negligence cannot be excluded from consideration,[45] but the circumstances of offshore methane hydrates strongly fall on the side of those favoring a rule of strict liability.[46] However, if only a rule of strict liability were employed, a number of circumstances that would fail to provide the correct incentives to optimally set precautionary and activity levels would likely arise. To correct for these potential events, public regulations should complement strict liability.[47]

B. Public and Private Regulations Should be Engaged

Public regulations can directly set standards *ex ante* of a tortfeasor's engagement in a risky activity; as such, public regulations can enable the tortfeasor to make strategic decisions on activity levels and on care levels in alignment with the standards set by the regulatory body. This could facilitate the development of offshore methane hydrates by setting optimal standards before financial investment decisions would need to be made. Clear *ex ante* regulations could also communicate to the engineers and developers of the offshore hydrate installation, what standards and tolerances for safety their designs and plans should achieve. The establishment of optimal standards, under the deliberative process requirements as set out under the Environmental Impact Analysis (EIA) and Strategic Environmental Assessment (SEA) Directives, and under the National Environmental Policy Act (NEPA),[48] would also disclose to the public critical information about the risky activities undertaken at the installations, and enable many groups to engage in the development of those standards.

44. *See id.* at 282.

45. *See id.* at 281-82.

46. *See* Partain, *supra* note 27, at 275-82.

47. *See Governing the Risks of Offshore Methane Hydrates: Part II, supra* note 28, §§ 5-6.

48. *See* discussions of the EIA, SEA, and NEPA deliberative procedures to develop correct institutional responses to novel harms and hazards, *infra* Parts III(D)(1), III(D)(2), and III(E)(1), respectively.

Public regulations can be usefully applied to cure certain circumstances so that routine economic decisions can be properly performed, as these regulations can cure or at least ameliorate missing markets or market failures.[49] The consensus view holds that regulations could be efficient at achieving optimal levels of precaution and activity levels when civil liability rules are stymied by: (i) informational asymmetries, (ii) insolvency, (iii) problems of underdeterrence, and (iv) of institutional juridical capacity.[50]

The development of offshore methane hydrates demonstrates aspects from each of the above concerns. Informational symmetries would likely be a concern as offshore methane hydrates projects are developed and operated.[51] For example, while the development of the technologies and science related to offshore methane hydrate operations has been greatly fostered by public investments, the ability to continually monitor on-going events would be dangerous and prohibitive if extended to all of the potential victims. Thus, there is an efficient role for a regulatory body to play to enable both a quality collection of data to be obtained and made publicly available while limiting the overall impact to the safe operations of the hydrate fields. Public regulations could be the efficient policy choice for methane hydrates to address these informational asymmetries.

While one would hope that the revenues from the sales associated with commercially operated offshore methane hydrates projects would ensure solvency, there are a variety of reasons that policy vigilance should be maintained to ensure that the potential insolvency of operators does not diminish the effectiveness of public safety planning.[52] Whereas a strict liability rule begins to falter when the operator becomes insulated from the informational incentives of potential damages, regulations can provide policy tools to incentivize the operator to both stay solvent and to provide non-monetary behavioral incentives.

49. *See Governing the Risks of Offshore Methane Hydrates: Part II, supra* note 28, § 2.

50. *See id.* §§ 3.2.1-3.2.4.

51. *See id.* § 3.2.1.

52. *See Governing the Risks of Offshore Methane Hydrates: Part II, supra* note 28, § 3.2.2.

Public regulations could be the efficient policy choice for methane hydrates to address insolvency.

Underdeterrence can result when various plaintiffs fail to plead their injuries and receive judicially determined damages. In the event of offshore methane hydrate accidents, there are a variety of means in which victims might fail to plead their injuries.[53] For example, in non-cataclysmic methane leakages and venting, plaintiffs might not have sufficient evidence of the leakage events, or they might not be able to directly connect their injury to the leakage event, or their incidental harm might not cost-justify litigation on an individual basis. In such scenarios, a regulatory body might be able to collect a superior set of evidence, be able to connect more points of causation, and be able to integrate many injury claims into a cost-justifiable set. In other considerations, potential victims may be missing; it might be due to the long timeframes of some injuries or the results of a cataclysmic accident that swept victims away. Public regulations could be the efficient policy choice for methane hydrates to address underdeterrence.

Private regulations enable those closest to the activity and its risks to develop the optimal standards.[54] Because the technology of developing and operating offshore methane hydrate fields is likely to continue to advance, and because the risks and hazards will become better understood as more experience is gained, it would be advantageous to have those parties closest to those learning engaged in setting the optimal standards.[55] Additionally, it has been demonstrated that private regulations can be developed to function alongside of public regulation; such a mechanism is called an integrated regulatory mechanism.[56] This article recommends that regulation should be developed in harmony with public regulation to ensure that all of the advantageously informed parties could participate in standards setting efforts.[57]

53. *See id.* § 3.2.3.

54. *See id.* § 4.1.

55. *See Governing the Risks of Offshore Methane Hydrates: Part II, supra* note 28, § 4.4.

56. *See id.* § 4.4.

57. *See id.* § 6.

Finally, in consideration of certain legal systems, not all jurisdictions have court systems that can support the litigious demands that a major methane hydrate accident event might entail.[58] A regulatory or administrative body might be better equipped to gather and handle legal claims than a singular litigant with a rule of strict liability. The presence of private regulations could also assist with these concerns.

C. Application of Civil Liability, Public Regulations, and Private Regulations

Thus, public regulations and private regulations would be efficient in certain circumstances. But, so was the rule of strict liability. Might they well be implemented in a complementary fashion? Yes, they would.[59]

Rules of civil liability can help to protect the effectiveness of public regulations when such regulations or regulatory bodies would be affected by agency costs and lobby capture.[60] Regulations can help to provide critical information to lower transaction costs and to better ensure the function of a strict liability rule in court.[61] When it is difficult to determine *ex ante* safety standards, regulations can serve as a floor beneath which potential tortfeasors are incentivized to stay above.[62] In this article, other reasons for complementary implementation were reviewed, and few reasons were found to support a contrary result.[63]

Thus, this article supports the combined approach of both public regulation and rules of civil liability. This article further supports the choice of a rule of strict liability for the civil liability system.

58. *See id.* § 5.8.
59. *See id.* §§ 5-6.
60. *See id.* § 5.1.
61. *See id.* § 5.8.
62. *See Governing the Risks of Offshore Methane Hydrates: Part II, supra* note 28, § 5.2.
63. *See id.* §§ 5.4-5.7.

III. STATE OF EXISTING GOVERNANCE FOR OFFSHORE METHANE HYDRATE RISKS

There is a wide array of international, regional, and national legal frameworks that address situations analogous to offshore methane hydrate operations. Some of the governance directly addresses oil spills and related emissions into the ocean; others address various environmental liabilities or climate change concerns. Some of these legal systems appear to apply as currently enacted to offshore methane hydrates, but few properly provide sufficient attention to the particular needs of offshore methane hydrate accidents. It would appear that the lack of historical examples has prevented a more complete drafting of the existing laws; this is not a critique, as laws need not regulate what is not yet in existence.

A. Laws of the United Nations

The international legal community has taken dramatic steps in the last several decades towards clarifying a common perspective on international environmental law.

Within the United Nations' (UN) umbra, there are three major conventions that would likely govern or coordinate with the domestic governance of offshore methane hydrates. Other conventions might have limited nexus or applicability.

First, the UN Convention on the Law of the Sea (UNCLOS) would provide jurisdiction over the waters and subsea lands that contain methane hydrates.[64] While UNCLOS does not apply to every country in the world, its paradigm of Exclusive Economic Zones (EEZ) does appear globally recognized, either by ratification of the Convention, by functioning *opinio juris*, or, as with the U.S., by presidential declaration. UNCLOS calls for comprehensive "rules, regulations and procedures" to protect the ocean and its environment.[65] Also, to the extent that methane hydrates were found further offshore than the EEZ, UNCLOS provides that the International Seabed Authority (ISA) would

64. *See infra* Part III(A)(1).

65. United Nations Convention on the Law of the Sea, art. 151, Dec. 10, 1982, 1833 U.N.T.S. 397 [hereinafter UNCLOS].

become the regulatory body to both establish the relevant regulations, and to provide for the leasing of such methane hydrates.[66]

Second, the UN Convention on the Transboundary Effects of Industrial Accidents (UNCTEIA) provides a *per se* exclusion to offshore hydrocarbon accidents with the understanding that oil pollution has been dealt with by separate international efforts;[67] many conventions make similar provisions and assumptions. However, UNCTEIA does establish what is likely an expectation for ratifying states to adopt strict liability type rules in their civil liability or regulatory systems. When states do develop those regulations, they are "to protect human beings and the environment against industrial accidents by preventing such accidents *as far as possible*," by reducing the frequency and severity of those accidents that do occur, and by mitigating the effects of the accidents that do occur. [68] Further, UNCTEIA does list methane and hydrogen as hazardous substances that might be within its ambit of regulation were it not otherwise specifically excluded for offshore oil and gas operations. So while UNCTEIA would not directly apply to the development of offshore methane hydrates, it does strongly suggest an approach to take in governing such risks.

Third, the UN Framework Convention on Climate Change (UNFCCC), and its Kyoto Protocol do not provide a liability framework for accidental greenhouse gas emissions, but they do set absolute limits on emissions for a certain sub-class of signatories.[69] Those countries that have assumed obligation emission limits are required to enforce those obligations with domestic law; the EU, its Member States, and Japan are such parties, but the U.S. and Canada are not. The EU has a sophisticated mechanism to ensure compliance, *see infra* at Section 3.3, but many other countries with methane hydrate assets have not assumed emissions obligations. As such, the

66. *Id.* at art. 156.

67. *See infra* Part III(A)(2).

68. United Nations Convention on the Transboundary Effects of Industrial Accidents, art. 3.1, Mar. 17, 1992, 2105 U.N.T.S. 457 [hereinafter UNCTEIA] (emphasis added); *see infra* Part III(A)(2).

69. *See infra* Part III(A)(3).

UNFCCC will be challenged by the development of offshore methane hydrates, and further developments would be needed.

Thereafter, both the Espoo EIA Convention and the Rio Declaration should be examined, as they guide the development of other future conventions and domestic governance systems. While much work remains in order to develop complete and comprehensive international regulations, a set of Kelsian norms have been established.

1. UNCLOS

The 1982 UNCLOS[70] is one of the most comprehensive international law conventions functioning in environmental law.[71] UNCLOS governs many aspects of activities that occur within coastal, marine, and oceanic locations.

a. Rules on Mineral Exploitation

UNCLOS establishes the oceanic boundary lines for coastal states. The "Zone" is defined as that area of the oceans and seas that is beyond national jurisdiction.[72] The territorial limits of coastal states are set at twelve miles offshore, as measured against the baseline of its coastal geography.[73] For the twelve miles beyond the territorial waters, coastal states are given rights to their contiguous zones, which are intended to enable them to enforce their territorial waters.[74] Within these areas, the coastal states retain comprehensive sovereignty.

For the exploitation of minerals, coastal states' EEZs extend far beyond their territorial waters. EEZs are limited to stretch no further than 200 nautical miles beyond the baseline that determines their territorial waters.[75] Additional details are provided on the definition of the continental shelf, which is

70. UNCLOS, *supra* note 65.

71. Craig H. Allen, *Protecting the Oceanic Gardens of Eden: International Law Issues in Deep-Sea Vent Resource Conservation and Management*, 13 GEO. INT'L ENVTL. L. REV. 563, 586 (2001).

72. UNCLOS, *supra* note 65, at art. 55.

73. *Id.* at art. 3.

74. UNCLOS, *supra* note 65, at art. 33.

75. *Id.* at art. 57.

similarly defined at 200 nautical miles beyond the baseline, in the base case, but there are more concerns about the actual underlying geography and geology, which may enable a coastal country to claim up to 350 nautical miles beyond its baseline.[76]

Coastal states enjoy full sovereignty over the minerals contained in the sea, seabed, and its subsoil in both the EEZ and the continental shelf areas. Coastal states retain their:

> sovereign rights for the purpose of exploring and exploiting, conserving and managing the natural resources, whether living or non-living, of the waters superjacent to the sea-bed and of the sea-bed and its subsoil, and with regard to other activities for the economic exploitation and exploration of the zone, such as the production of energy from the water, currents and winds.[77]

And coastal states exercise:

> over the continental shelf sovereign rights for the purpose of exploring it and exploiting its natural resources. . . . The natural resources referred to in this Part consist of the mineral and other non-living resources of the sea-bed and subsoil together."[78] Coastal states "have the exclusive right to authorize and regulate drilling on the continental shelf[,]" and thus within their EEZs, "for all purposes.[79]

There are economic differences for minerals further out offshore. For minerals extracted from within the EEZs' 200 nautical mile limits, the coastal states retain all of the economic benefits of produced minerals. The coastal states are required to make payments, or payments in kind, to the ISA against the net value of minerals with mineral extraction that occurs beyond the 200 nautical miles.[80] The ISA is to redistribute those funds "to States Parties to this Convention, on the basis of equitable

76. *Id.* at art. 76.
77. *Id.* at art. 56(1)(a).
78. *Id.* at art. 77.
79. *Id.* at art. 81.
80. The first five years are free of payments; then in year six, a one percent payment is required; every year thereafter increases the toll by one percent until the toll rate equals seven percent. All subsequent years pay a toll rate of seven percent. UNCLOS, *supra* note 65, at art. 82(2).

sharing criteria, taking into account the interests and needs of developing States, particularly the least developed and the land-locked among them."[81]

b. Protection of the Environment

In addition, the coastal states retain the jurisdiction and duty to handle "protection and preservation of the marine environment."[82]

UNCLOS provides guidance as to where coastal states retain certain aspects of sovereignty at different points in the ocean to define and delimit the Zone, which is the area of the ocean beyond any national jurisdiction. Within the Zone, all minerals and resources, living and non-living, as said to belong to "the common heritage of mankind."[83] Resources include methane hydrates, as resources are defined as "all solid, liquid or gaseous mineral resources in situ in the Area at or beneath the sea-bed."[84] So, within the Area, all methane hydrates belong to all of mankind, and therefore, their development and exploitation would be administered by the ISA.[85]

UNCLOS takes a very clear line that environmental concerns should remain front and center with all activities taking place in the Area. The operation behavior of the Member States in the Area are controlled by UNCLOS. State parties are liable for the damages, including environmental damages, caused on their behalf within the Area.[86]

Within all three locations, the EEZ, the continental shelf, and within the Area, "States have the obligation to protect and preserve the marine environment."[87] Within the areas under their sovereignty, States have the "right to exploit their natural resources," but only if "pursuant to their environmental policies

81. *Id.* at art. 82(4).
82. *Id.* at art. 56(1)(b)(iii).
83. *Id.* at art. 136.
84. *Id.*at art. 133(a).
85. *Id.* at art. 151(1)(a).
86. UNCLOS, *supra* note 65, at art. 139.
87. UNCLOS, *supra* note 65, at art. 192.

and in accordance with their duty to protect and preserve the marine environment."[88]

There are several requirements set out to establish the manner in which the ocean and its associated ecologies must be protected.[89] Those subsections most relevant to the commercial development of methane hydrates are listed hereunder:

i. "States shall take . . . all measures consistent with this Convention that are necessary to prevent, reduce and control pollution of the marine environment from any source, using for this purpose the best practicable means at their disposal."[90]

ii. "States shall take all measures necessary to ensure that activities under their jurisdiction or control are so conducted as not to cause damage by pollution to other States and their environment, and that pollution arising from incidents or activities under their jurisdiction or control does not spread beyond the areas where they exercise sovereign rights."[91]

iii. "These measures shall include, *inter alia*, those designed to minimize to the fullest possible extent: (c) pollution from installations and devices used in exploration or exploitation of the natural resources of the sea-bed and subsoil, in particular measures for preventing accidents and dealing with emergencies, ensuring the safety of operations at sea, and regulating the design, construction, equipment, operation and manning of such installations or devices."[92]

Within the Area wherein states lack sovereignty or jurisdiction, State Parties are liable for their own behavior, as well as "state enterprises or natural or juridical persons which possess the nationality of States Parties or are effectively controlled by them or their nationals."[93]

88. *Id.* at art. 193.
89. *Id.* at art. 194.
90. *Id.* at art. 194(1).
91. *Id.* at art. 194(2).
92. *Id.* at art. 194(3)(c).
93. UNCLOS, *supra* note 65, at art. 139(1).

The Area shall only be used for the "benefit of mankind as a whole."[94]

> (a) the prevention, reduction and control of pollution and other hazards to the marine environment, including the coastline, and of interference with the ecological balance of the marine environment, particular attention being paid to the need for protection from harmful effects of such activities as drilling, dredging, excavation, disposal of waste, construction and operation or maintenance of installations, pipelines and other devices related to such activities.[95]

Article 145 further clarifies the environmental duty of care: "(b) the protection and conservation of the natural resources of the Area and the prevention of damage to the flora and fauna of the marine environment."[96]

Similar to how UNCLOS provides operational details of how environmental safety should be guarded and preserved with precautionary behaviors,[97] Annex III of UNCLOS also provides a full set of operation guidelines for the ISA to manage the exploitation of minerals within the Area. Key among the concerns enumerated are:

> (i) Given that the extraction and production of methane hydrates are regulated by UNCLOS, the selection of qualified operators is to be determined by the rules, regulations, and procedures of the ISA.[98]
> (ii) To be qualified, the Annex requires both *financial* and *technical* competence to be established.[99]
> (iii) Additionally, the applicant operator must be sponsored by a Member State and the Member State must be able to demonstrate that they have the capacity to "ensure, within their legal system" that the applicant operator will be required to operate to the environmental protection standards of the ISA.

94. *Id.* at art. 140(1).
95. *Id.* at art. 145(a) (emphasis added).
96. *Id.* at art. 145(b).
97. *Id.* at art. 147.
98. *Id.* at Annex III, art. 4(1).
99. UNCLOS, *supra* note 65, at art. 4(2) (emphasis added).

That said, if the Member State has sufficient regulations and institutions to "reasonably appropriate for securing compliance" from the applicant operator, and that operator later fails its duties under the Member State's laws, then the Member State itself will not be liable for any harms caused by the sponsored operator.[100] Thus, in the event that extraction from methane hydrates becomes operationally commercial in nature, then Member States have a strong incentive to provide sound regulatory regimes and institutions to better defend themselves under UNCLOS.

c. Risk Governance Under UNCLOS

UNCLOS requires the development of regulatory systems prior to the commercial development of methane hydrates. "Rules, regulations and procedures shall be drawn up in order to secure effective protection of the marine environment from harmful effects directly resulting from activities in the Area" if undertaken with regards to the exploitation of minerals, such as methane hydrates.[101]

Should an operator cause harm, they will be liable for the actual amount of damage; on the other hand, if the damage was caused by a failure of the ISA to operate correctly under UNCLOS, then it shall be liable for the actual amount of damages.[102] It does not appear that there is any provision for a prescriptive level of care or prevention that would exclude the "cautious tortfeasor" from damages; thus it appears that UNCLOS contemplates a strict liability rule if civil liability rules were to be employed by the coastal state.

While there are requirements for the operators to demonstrate their financial capacity to respond to the harms they might create, nowhere in UNCLOS is it explained where the ISA or the UN more broadly might receive sufficient revenues to handle the burdens of a major methane hydrate catastrophe. But, the requirement for a regulatory body to address insolvency is

100. *Id.* at Annex III, art. 4(4).
101. *Id.* at Annex III, art. 17(2)(f).
102. UNCLOS, *supra* note 65, at Annex III, art. 22.

reassuringly close to the model of governance suggested in this article, *supra*, at Section II.

Also intriguing under UNCLOS is the idea that all technology developed to operate within the Area should be shared and distributed as part of the "common heritage" paradigm of UNCLOS.[103] The data from activities in the Area is required to be shared and transferred inter-members.[104] This type of arrangement would normally assume a regulatory body is involved; perhaps the ISA would coordinate, but it is not clear if other regulatory bodies could lead, or if the ISA and the UN could coordinate a "methane hydrate data clearinghouse registry."

In conclusion, UNCLOS has a sufficient ambit to regulate the development of methane hydrates. If the extraction of methane hydrates happened within the Area, the environmental regulations would apply and there would need to be a new set of regulations and rules to establish proper safety practices and methods of handling environmental damages. Such rules and regulations do not currently exist.

2. UNCTEIA

UNCTEIA would not likely apply to the development of offshore methane hydrate projects.[105] But, the Convention might apply to the onshore facilities related to the processing and marketing of natural gas and hydrogen.

a. Exclusion of Certain Hydrocarbon Accidents

UNCTEIA applies to "the prevention of, preparedness for and response to industrial accidents capable of causing transboundary effects, including the effects of such accidents caused by natural disasters."[106] However, UNCTEIA provides a seven-point list of exceptions to the Convention.[107] Within that list, accidents that

103. *See generally* UNCLOS, *supra* note 65, at Annex III, art. 5.
104. *Id.* at Annex III, art. 14.
105. UNCTEIA, *supra* note 68.
106. *Id.* at art. 2(1).
107. *Id.* at art. 2(2)(a)-(g).

occur in the marine environment, including seabed exploration and exploitation, are excluded from UNCTEIA.[108] Similarly, leakages into the sea, such as oil or other harmful substances, are excluded from UNCTEIA coverage.[109] Thus, any accidents related to the seeping, leakage, or venting of methane from an offshore methane hydrate project is excluded from the coverage of UNCTEIA.

b. Application to Onshore Facilities of Offshore Installations

If a project had onshore facilities that were otherwise related to the offshore activities, but an accident arose onshore from those onshore facilities, without direct causation to the offshore activities, then UNCTEIA might apply. Such events might be the leakage of a gas transportation pipeline or the rupture and conflagration of an onshore methane storage facility.

UNCTEIA provides that industrial accidents result from the loss of control during hazardous activities over hazardous substances either during the processing or storing within an installation, or when such hazardous substances are in transport.[110] Hazardous activities are those activities that use hazardous substances and are capable of transboundary effects.[111]

Transboundary effects are those serious effects that occur within one jurisdiction as a result of industrial accidents in other jurisdictions, as long as both jurisdictions are under the sovereignty of signatories to UNCTEIA.[112] Also, the industrial accident needs to qualify as such and also not be listed as an exception to UNCTEIA; *e.g.*, onshore methane processing, storage, and transportation are not per se excluded.[113]

Methane and hydrogen gases are reasonably characterized as hazardous substances under UNCTEIA. A substance is a

108. UNCTEIA, *supra* note 68, at art. 2(2)(f).
109. *Id.* at art. 2(2)(g).
110. *Id.* at art. 1(a)(i), (ii).
111. *Id.* at art. 1(b).
112. *Id.* at art. 1(d)-(f).
113. *Id.* at art. 2(1)-(2).

hazardous substance if it is listed under Annex I, either as a named substance or as a chemical that meets certain minimum quantities.[114] Methane, as natural gas, is included under Annex I, either as regular gaseous methane or as a cryogenic liquid, such as LNG.[115] To the extent that hydrogen is extracted,[116] or otherwise associated with the onshore activities, it would also be a named substance under Annex I.[117]

c. Risk Governance Under UNCTEIA

Once the character of a hazardous activity has been identified, such as an onshore methane processing facility or a hydrogen generation facility, then the obligations of UNCTEIA are binding upon the parties.[118] Foremost among the obligations is "to protect human beings and the environment against industrial accidents by preventing accidents *as far as possible*," by reducing the frequency and severity of those accidents that do occur, and by mitigating the effects of the accidents that do occur.[119]

UNCTEIA establishes a very high duty of care to prevent accidents "as far as possible;"[120] but it does not appear to be an unlimited demand, but rather the highest reasonable level of due care, which implies a balancing of social benefits and costs. The Parties are to "take appropriate measures for the prevention of industrial accidents."[121] In addition, the Parties are to "take appropriate measures to establish and maintain adequate emergency preparedness"[122] and "the Parties shall support

114. UNCTEIA, *supra* note 68, Annex I, pts. I, II.

115. *Id.* at Annex I, pt. II, § 11 (minimum quantity of 200 metric tons, a functionally tiny amount of methane for a methane producing facility).

116. For a more complete discussion on producing hydrogen from methane hydrates, see MECHANISM DESIGN FOR THE FIERY ICE, *supra* note 1, at ch. 3, § 5.2.

117. UNCTEIA, *supra* note 68, at Annex I, pt. II, § 5. The minimum amount required is fifty metric tons. If the daily production of hydrogen were assumed, to provide a green fuel stock, then this volume would be readily met. *Id.*

118. *Id.* at art. 3.

119. *Id.* at art. 3(1) (emphasis added).

120. *Id.*

121. *Id.* at art. 6, § 1.

122. *Id.* at art. 8, § 1.

appropriate international efforts to elaborate rules, criteria, and procedures in the field of responsibility and liability."[123]

Does the requirement for "as far as possible" require a strict liability rule, or a rule of negligence? It is likely that the drafters had a strict liability rule in mind, but left sufficient flexibility to the Parties to determine the details.[124] The overall semantic character of the UNCTEIA reasonably appears to support and suggest the development of a rule of strict liability, or a unique form of a negligence rule with the duties of care set at the highest feasible levels.

Indeed, one might be able to comply with a combination of regulations and civil liability rules. For example, UNCTEIA takes care to highlight the type of minimal goals of safety that should be addressed by the implementing state; Annex IV provides a non-binding, non-obligatory listing of methods to prevent industrial accidents.[125] Yet, precisely because of this non-binding, non-obligatory character of these rules, no particular duty level is prescribed therein. Thus, there is little evidence for the duty of care needed for a rule of negligence; yet, the means to attain decentralization under a rule of strict liability has been left unblocked by the regulatory suggestions. Thus, a combined regulatory and strict liability framework would coordinate with UNCTEIA.

UNCTEIA engages in such discussions with regard to sufficient or fitting levels of precaution, and the drafters expectations suggest that a regulatory approach would be taken by many, and therefore, parties would benefit from some sort of template to facilitate later coordination intra-parties.

3. UN Framework Convention on Climate Change

The UNFCCC[126] addresses the problems posed by anthropogenic climate change; it is particularly focused on the

123. UNCTEIA, *supra* note 68, at art. 13.

124. UNCTEIA, *supra* note 68, at art. 13.

125. *See id.* at art. 6(1) ("[s]uch measures may include, but are not limited to"); *id.* at Annex IV, pmbl. ("the following measures may be carried out").

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

issues related to the emissions of greenhouse gases.[127] Additional details necessary for the effective administration of the UNFCCC were developed and adopted as the Kyoto Protocol to the UNFCC (Kyoto Protocol).[128]

a. Governance of Anthropogenic Climate Change

The UNFCCC defines greenhouse gases in a scientific frame, "gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation."[129] The Kyoto Protocol provides an enumerated list of greenhouse gases: carbon dioxide, methane, nitrous oxide, hydrofluorcarbons, perfluorocarbons, and sulfur hexafluoride.[130] Thus, methane and methane hydrates are potentially regulated by the UNFCCC.

The UNFCCC recognizes two determinants of anthropogenic greenhouse gases, emissions, and sinks. Emissions are the release of greenhouse gases "into the atmosphere over a specified area and period of time."[131] Emissions arise from a source of greenhouse gases; a source is any process or activity that releases greenhouse gases or their precursors to the atmosphere.[132] Sinks are those processes, activities, or methods that remove greenhouse gases or their precursors from the atmosphere.[133]

The anthropogenic venting and seeping of methane to the atmosphere from offshore methane hydrate installations qualify as emissions under the UNFCCC because methane is a listed greenhouse gas, and the transmission to the atmosphere would qualify as an emission. Likewise, there is a reasonable argument to be made that the release of carbon dioxide from interactions of vented or seeped methane volumes could also qualify as emissions; however, there is an intermediate role played by

127. *Id.* at pmbl.

128. Kyoto Protocol to the United Nations Framework Convention on Climate Change, *opened for signature* Mar. 16, 1998, 2303 U.N.T.S. 148 [hereinafter Kyoto Protocol] (entered into force Feb. 16, 2005).

129. UNFCCC, *supra* note 126, at art. 1, § 5.

130. Kyoto Protocol, *supra* note 128, at Annex A (greenhouse gases).

131. UNFCCC, *supra* note 126, at art. 1(4).

132. *Id.* at art. 1(9).

133. *Id.* at art. 1(8).

nature in converting that methane into carbon dioxide, and thus the emission is indirectly anthropogenic in character.

The absorption of carbon dioxide back into the hydrate beds in replacement of the extracted methane volumes would likely qualify as a sink under the UNFCCC.[134] Many of the promoted means of developing offshore methane hydrate installations have included the option of CCS alongside methane production in part to facilitate minimizing the net impact of offshore methane hydrate installations under the UNFCCC. Thus, offshore methane hydrate installations might qualify as both emitters and sinks, and therefore, need netting under the UNFCCC accounting procedures.

b. Governance of Regulatory Character

The UNFCCC requires its Contracting Parties to employ the *precautionary principle,* which states that they should "take precautionary measures to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects."[135] However, the UNFCCC takes a measured approach to which strategies should be undertaken, in that it requires the "measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost."[136]

Additionally, the UNFCCC is sensitive to the fact that each country or culture may face different determinants of cost-effectiveness and that each country is enabled to take its unique circumstances into account.[137] Thus, the potential for methane hydrate projects to both emit and sink greenhouse gases needs to be integrated within the framework of the precautionary principle. However, the UNFCCC does not particularly determine

134. *E.g.,* Japan has expressed interest in a plan that would extract the methane in order to fuel offshore electrical generation coordinated with re-injection of the exhaust carbon dioxide volumes back into the hydrate reservoirs. Also, Germany has a research interest in offshore CCS that coordinates with methane hydrate reservoirs. Projekt SUGAR and Eco_2 lead those efforts. See MECHANISM DESIGN FOR THE FIERY ICE, *supra* note 1, ch. 3, § 5.1, for a more complete discussion.

135. UNFCCC, *supra* note 126, at art. 3(3).

136. *Id.*

137. *Id.*

how a particular country might utilize its methane hydrate resources, this depends on the unique "socio-economic contexts" of each Contracting Party. Thus, the UNFCCC has preserved to its Contracting Parties the decisions of regulations or rules of civil liability. These burdens are imposed at the state-level and not lower.

While all of the Contracting Parties are obligated to undertake broad responsibilities to ameliorate and reduce the threat of anthropogenic climate change,[138] the UNFCCC distinguishes between Annex I Parties and Annex II Parties. Annex I Parties are developed countries, and are expected to lead the UNFCCC's Parties by establishing national policies and measures to limit anthropogenic emissions of greenhouse gases and to protect and enhance greenhouse gas sinks and reservoirs.[139] The Annex I Parties are obligated to provide measurements and metrics on their progress in achieving those goals.[140] The Kyoto Protocol took the next step to make those requirements functional.[141] The Protocol set an aspirational goal to limit anthropogenic emissions of greenhouse gases.[142] There is a new list of Parties so committed at Annex B to the Protocol. [143] The goals, as drafted within the Protocol, are percentage targets against an estimated level of emissions from the year 1990; *e.g.* the United States committed to reduce its emissions to ninety-three percent of its 1990 emission levels.[144] The overall changes to emissions are reduced by increases to sinks and reservoirs;[145] thus the use of methane hydrate deposits as both an energy resource and as a CCS facility could be tallied on both sides of the emissions target.

Groupings of Annex I Parties can agree to achieve their targets as an aggregate;[146] this could assist methane hydrate

138. UNFCCC, *supra* note 126, at art. 4(1)(a)-(j).
139. *Id.* at art. 4(2)(a).
140. *Id.* at art. 4(2)(b), (c).
141. *See* Kyoto Protocol, *supra* note 128, at art. 2(1)(a) (list of specific obligations).
142. *Id.* at art. 3(1).
143. *Id.* at art. 3(1); *id.* at Annex B.
144. *Id.* at art. 3(1)-(3); *id.* at Annex B.
145. *Id.* at art. 3(3); *id.* at Annex A.
146. *Id.* at art. 4(1).

projects by including a transboundary perspective on the combined emissions and sink planning related to the project. Additionally, Parties may volitionally transfer or acquire emission reduction units by engaging in projects that reduce anthropogenic emissions or enhance their removal by sinks.[147] The Protocol also provides for a Clean Development Mechanism (CDM), which enables Parties outside of Annex I to engage in sustainable development in line with the UNFCCC.[148] The CDM enables developed countries to sponsor efforts within the developing countries that would assist the attainment of UNFCCC targets by enabling the Annex I Parties to receive some emission reduction units for their own accounts.[149] Also, more broadly the Annex II Parties and other developed Parties are obligated to provide new financing mechanisms to support the attainment of the UNFCCC targets by assisting in the financing of projects that would limit emissions and enhance sinks.[150] Thus, there are several means for the financing and development of methane hydrate projects if they are characterized as green energy projects that reduce emissions and enhance sinks.

Annex II countries undertook additional financial, technological, and burden-sharing obligations to assist developing countries to reduce and mitigate their own anthropogenic emissions.[151] The developed parties have special obligations to assist those countries particularly vulnerable to the impacts of the effects of climate change due to anthropogenic emissions.[152] There are particular concerns raised for a limited number of critical situations:

(a) Small island countries;
(b) Countries with low-lying coastal areas;
(c) Countries with arid and semi-arid areas, forested areas and areas liable to forest decay;
(d) Countries with areas prone to natural disasters;
(e) Countries with areas liable to drought and desertification;

147. Kyoto Protocol, *supra* note 128, at art. 6.
148. *Id.* at art. 12(2).
149. *Id.* at art. 12(3)(a), (b).
150. *Id.* at art. 11.
151. UNFCCC, *supra* note 126, art. 4(3).
152. *Id.* at art. 4(4).

> (f) Countries with areas of high urban atmospheric pollution;
> (g) Countries with areas with fragile ecosystems, including mountainous ecosystems;
> (h) Countries whose economies are highly dependent on income generated from the production, processing and export, and/or on consumption of fossil fuels and associated energy-intensive products.[153]

Subsections (a), (b), (d), and (g) could be adversely affected by the potential harms and hazards of methane hydrate projects. Subsections (c), (e), and (f) might benefit from the potential freshwater reserves associated with methane hydrates or the pollution abatement that methane hydrates might offer over existing energy resources. Finally, subsection (h) raises a query on the potential impact on those countries highly dependent on other non-methane hydrate, fossil fuel industries from the development of methane hydrate technologies. For if methane hydrates are developed as a form of green energy under the UNFCCC, this surely would affect the revenues of those countries previously benefiting from coal and crude oil industries.

c. Risk Governance Under the UNFCCC

The approach to risk governance taken under the UNFCCC is best described as regulatory in nature. What discipline that exists is to coordinate at the state level of international law and not below to lesser actors, thus rules of civil liability are not engaged in directly by the UNFCCC. The previous paragraphs, *supra* section III(A)(3)(b), demonstrated a variety of requirements that could only be properly undertaken by regulatory bodies at both the UNFCCC level and within its Party States.

To the extent that ratifying states opt to facilitate their own domestic obligations under the UNFCCC by enacting domestic regulation or civil liabilities to limit the risks of unplanned emission accidents is not explicitly addressed within the UNFCCC or the Kyoto Protocol. Some countries have taken

153. UNFCCC, *supra* note 126, art. 4(8)(a)-(h).

stricter discipline into account,[154] but others countries have not.[155]

In conclusion, the UNFCCC does support a regulatory body's oversight of the data and operations of offshore methane hydrate installations. To the extent that a Contracting Party needs to monitor its overall levels of emissions and sinks, the offshore installations could fit within that regulatory rubric. To the extent that such observation data overlaps with similar data needs for accident awareness and prevention, that regulatory framework could both directly improve precautionary efforts and could also provide secondary support to reducing the various transaction costs of implementing a strict liability regime.

4. Espoo EIA Convention

The Convention on Environmental Impact Assessment in a Transboundary Context functions as the UN's equivalent to the EU's EIA Directive.[156] When a proposed activity emerges that would be likely to cause a significant adverse transboundary impact, then the Contracting Parties have a duty to notify those other Contracting Parties that would be affected by the activity.[157]

Appendix I provides a list of activities that are likely to have transboundary effects.[158] Offshore hydrocarbon production is a listed activity under the Appendix; it is defined to include the extraction of natural gas if the installation extracts more than 500,000 cubic meters (m^3) of methane a day.[159] However, as of

154. *See infra* Part III(D)(7) (discussing the EU efforts to limit greenhouse gases, which established fiscal discipline for Member States falling short of their greenhouse gas emissions-reduction commitments).

155. Several key developed countries, including the United States, who are significant emitters, have not ratified the Kyoto Protocol despite their ratification of the underlying UNFCCC.

156. The Convention on Environmental Impact Assessment in a Transboundary Context, *adopted* Feb. 25, 1991, 1989 U.N.T.S. 309 [hereinafter Espoo EIA Convention] (entered into force Sept. 10, 1997).

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

158. *Id.* at Appendix I. *See id.* at art. 3(1).

159. *Id.* at Appendix I, § 15. "Offshore hydrocarbon production. Extraction of petroleum and natural gas for commercial purposes where the amount extracted exceeds 500 metric tons/day in the case of petroleum and 500,000 cubic

January 2014, Appendix I was not in effect as an insufficient number of Contracting Parties had ratified the Appendix.[160]

Because the commercial development of a methane hydrate project would have the potential to make an impact "on the environment including human health and safety, flora, fauna, soil, air, water, climate, landscape and historical monuments or other physical structures or the interaction among these factors" there is no requirement for adverse effects.[161] To the extent that such impacts could cross from one jurisdiction to another jurisdiction, such an impact would qualify as a transboundary impact.[162] In that sense, the awareness of an impending methane hydrate project that would have a transboundary impact would raise the requirement to provide notification to the other impacted Contracting Parties.

This system of notifications would be primarily a regulatory action that collects information but provides for no judicial damages, and thus the Convention provides no explicit form of *ex ante* anticipation of *ex post* costs to provide incentives in the manner that civil liability systems provide. But, the Convention would clearly be an information-clearing house that would complement a strict liability system.

5. Rio Declaration on Environment and Development

UN Conference on Environment and Development (UNCED) was held in 1992; it has been described as one of "the most

meters/day in the case of gas." *Decision III/7 Second Amendment to the ESPOO Convention,* UNITED NATIONS ECON. COMM'N FOR EUR., http://www.unece.org/env/eia/about/amendment2.html (last visited Nov. 30, 2014), *archived at* http://perma.cc/GU8K-T6ML.

160. Only twenty-one Parties had ratified the Appendix as part of the second amendments as of January 26, 2014. The underlying Convention has forty-five Parties, so a total of thirty-four Parties need to ratify the Appendix (*i.e.*, thirteen more Parties). *Amendment to the Convention on Environmental Impact Assessment in a Transboundary Context*, UNITED NATIONS TREATY COLLECTION (June 4, 2004), https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXVII-4-c&chapter=27&lang=en, *archived* at https://perma.cc/8Z7A-3EBZ.

161. Espoo EIA Convention, *supra* note 156, art. 1(vii).

162. *Id.* at art. 1(viii).

ambitious international environmental conferences of the twentieth century."[163] Both binding conventions, such as the Convention on Biological Diversity and the UNFCCC, and soft law documents, such as the Rio Declaration on Environment and Development, were accomplished at the UNCED.[164] The Conference effectively shifted international customary law towards a paradigm of precautionary law and a broader notion of protecting whole eco-systems, as contrasted against earlier paradigms of limited numbers of specifically targeted species.

The Rio Declaration is akin to the Universal Declaration of Human Rights, in that it is aspirational in character. Unlike the previous discussed matters, the Rio Declaration is not binding law. It might reflect developing *opinio juris*, but it is a relatively recent source of soft law.

The document lists twenty-seven specific principles and guidelines for future efforts to better coordinate economic growth and ecological conservation.[165] Several of those principles have direct application to the development of methane hydrates.

Principle 2: States maintain their sovereign rights to exploit their own resources, but they have a corresponding duty to ensure that activities within their jurisdiction or control do not cause transboundary damage to the environment.

Principle 4: Requires that planning and actions to mitigate potential environmental harms are included within all developmental efforts.

Principle 10: Calls for all states to engage their citizens in the due and deliberative processes of engagement and decision making on matters that could affect the environment. Information

163. *See* Allen, *supra* note 71, at 599.

164. *Id.* at 599-600.

165. United Nations Conference on Environment and Development, Rio de Janeiro, Braz., June 3-14, 1992, *Rio Declaration on Environment and Development*, U.N. Doc. A/CONF.151/26/Rev.1 (Vol. 1), Annex 1 (Aug. 12, 1992), *available at* http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=78&ArticleID=1163&l=en, *archived at* http://perma.cc/5T3D-U6AF.

sharing and awareness building are also called for.

Principle 11: Calls, amongst other targets, for recognition that different states have different legal institutions and stages of economic development, and as such the regulatory standards applied by some countries may be inappropriate and of unwarranted economic and social cost to other countries.

Principle 13: Calls for the development of national laws regarding liability and compensation for the victims of pollution and other environmental damage. States should also cooperate to develop international law regarding liability and compensation for adverse effects of environmental damage caused by activities within their jurisdiction or control to areas beyond their jurisdiction.

Principle 15: Calls for states to protect the environment by widely adopting the use of the *precautionary approach*, limited only according to their capabilities.

Principle 16: Calls for the international adoption of the *polluter pays* principle into domestic and international laws.

Principle 17: Calls for Environmental impact assessments to become a standard activity for all activities that might endanger or harm the environment.[166]

Thus, the Rio Declaration establishes norms of comportment with regards to prospective acts of commercialization, and the aspirational goals of the international legal community for the prospective protection of the environment.

a. Risk Governance Under Rio Declaration

Perhaps the most important risk governance issues with the Declarations are the recognition of: (i) the necessity to establish

166. *See id.*

liability systems to address environmental protection concerns, (ii) both regulatory and civil liability systems could be engaged, (iii) different countries and cultures might need different manners of liability and regulations implementations, (iv) *precautionary principles* should be applied, and (v) the *polluter pays principle* should be applied.

The general call for liability rules reflects a growing recognition that polluters or tortfeasors need to know *ex ante* that they will be held accountable for their decisions. The Declaration enables the retention of legal flexibility, particularly for jointly and complementarily implementing civil liability rules and regulations as circumstances fit. The *precautionary principle* sets a Coasian right to the general public, that they have a right to retain their current enjoyment of nature and to their way of life; it places the burden on the tortfeasor to prevent harm even if it is unclear that harm would result. The polluter pays principle, without additional clarification, appears to prefer a rule akin to strict liability. Put together, it would appear that the Declaration on the whole is more closely aligned with a strict liability perspective, or a very stringent regulatory system, and not with a rule of negligence or permissive regulatory framework.

B. Regional Marine Conventions

The rise of oceanic transportation of fuel and other potentially hazardous materials gave cause to the development of a group of regional marine pacts and international oil spill pacts. The two groups of conventions are somewhat interwoven, as they both address the potential leakage of hazardous elements into the ocean.

Both of these legal paradigms provide for the development of risk governance schemes with historical perspectives and insights. At large, the international maritime conventions and oil spill conventions are in alignment with strict liability and the coordinated implementation of regulations. They all either explicitly or implicitly call for the implementation of strict liability; not a single convention in the collection below advocates or supports a rule of negligence. None of them disavow the useful

role of regulation, and most provide frameworks of the regulations that they expect to be put into place.[167]

Yet, it will be seen that both sets of conventions are likely to apply only indirectly to the potential risks and hazards of offshore methane hydrates. As will be explored, some of the disconnection stems from the ocean going vessel paradigm underlying the conventions, and some of the disconnection arises from linguistic word choices that leave methane and related concerns out of the domain of the conventions.

The challenges of responding to oil spills resulted in multiple international conventions. The problems of transboundary oil spills, particularly in the waters off of Europe, led to a collection of regional marine pacts. Herein is provided a review of four of the major regional marine conventions:

i. the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) (North East Atlantic Ocean),[168]
ii. the Barcelona Convention (Mediterranean Sea),[169]
iii. the Bonn Agreement (North Sea),[170] and
iv. the Helsinki Convention (Baltic Sea).[171]

The regional marine pacts, taken as a group, call for the adoption of two key legal principles: (i) the *polluter pays principle*, and (ii) the *precautionary principle*.[172] As such, the fundamental tone of the regional marine pacts is to support rules of strict liability.[173] The regional marine pacts also call for the implementation of certain measures to ensure high safety standards are maintained; it is most likely that such measures would be carried out as public regulations.[174] These measures

167. The main goals of those regulations are to both provide a certain standard of sufficient breadth and coverage of contracting states' resultant regulations and to provide for better intercommunication and cooperation on the eventual need to work together to address transboundary problems associated with oil spills and other marine pollutants.

168. *See infra* Part III(B)(1).

169. *See infra* Part III(B)(3).

170. *See infra* Part III(B)(2).

171. *See infra* Part III(B)(4).

172. *See infra* Part III(B)(5).

173. *See infra* Part III(B)(5).

174. *See infra* Part III(B)(5).

should include those measures that could eliminate and remediate pollution from the exploration and exploitation of the continental shelf, the seabed, and its subsoil; such measures would be applicable to offshore methane hydrates and any potential methane venting or seepage. Several of the pacts, such as the Barcelona Convention, have additional protocols to specifically address the risks associated with the operations of offshore facilities, such as would be needed to extract methane hydrates.[175]

However, a fundamental disconnect remains in that most of the aforementioned conventions would barely be applicable to the risks and hazards of offshore methane hydrates. Not that the conventions are in any form structurally opposed to such, but rather, it appears that need for such coverage was not foreseeable at the time the conventions were drafted and implemented. Indeed, much of the language and vocabulary of the conventions could readily be extended to coordinate with the particular circumstances of offshore methane hydrates.

Because the existing international maritime and oil spill conventions do reflect both a history of diplomatic draftings and accumulated practical experiences, it might be wise to build upon their foundations in addressing the risks and hazards of offshore methane hydrates.

The employment of standards, such as requirements to maintain "best available techniques" and "best environmental practices," are clearly relevant in providing the standards for offshore methane hydrates. Many of the functional definitions from these conventions, such as "offshore activities" and "offshore installations" can readily be extended to cover similar or identical concepts related to offshore methane hydrates. Other definitions, *e.g.*, such as "pollution" within OSPAR, already might be interpretable as applicable to methane hydrates, as they include all "substances or energy" that could result in hazard to human health or the marine ecosystem.[176] However, more clear standards could be set by a provision of explicit terms that make

175. *See infra* Part III(B)(3).

176. The Convention for the Protection of the Marine Environment of the North-East Atlantic, art. 1(d), *opened for signature* Sept. 22, 1992, 2354 U.N.T.S. 67 [hereinafter OSPAR] (entered into force Mar. 25, 1998).

clear that emissions, seeps, and ventings from methane hydrates should be included within that definition when introduced by human activities.

The international maritime and oil spill conventions have histories of textual evolution.[177] Thus, it is a reasonable option to consider that the existing international maritime and oil spill conventions might be amendable to include the circumstances related to the events of offshore methane hydrates that could lead to risk and harms of the oceanic domains that those conventions currently protect.

1. OSPAR Convention (North East Atlantic Ocean)

OSPAR stands for Oslo and Paris, and the acronym refers to the documentary history of the Convention in that it conjoined the Convention for the Prevention of Marine Pollution by Dumping from Ships and Aircraft, "Oslo Convention" (1972), against at-sea dumping of wastes with the Convention for the Prevention of Marine Pollution from Land-Based Sources, "Paris Convention" (1974), against land-based sea pollution and oil pollution.[178] OSPAR was founded under Article 197 of UNCLOS for global and regional cooperation.[179]

OSPAR requires the Contacting Parties to take all possible steps to prevent and eliminate pollution to protect the maritime area.[180] OSPAR requires the Contracting States to adopt programs and measures and to cross-harmonize their policies.[181] OSPAR states that nothing in OSPAR is to be taken to prevent Contracting States from undertaking more stringent measures than that required within OSPAR, both substantively and

177. For example, OSPAR's Annex III addresses novel concerns related to CCS events. *Id.* at Annex III. The Barcelona Convention's Offshore Protocol addresses offshore exploitation events more directly. Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean, *adopted* June 10, 1995, 1102 U.N.T.S. 27 [hereinafter Barcelona Convention] (entered into force July 9, 2004).

178. OSPAR *supra* note 176.

179. *Id.* at pmbl. *See* discussion on UNCLOS *supra* Part III(A)(1).

180. OSPAR *supra* note 176, at art. 2(1)(a).

181. *Id.* at art. 2(1)(b).

procedurally, to protect the maritime area.[182] OSPAR requires application of both the *polluter pays principle*[183] and the *precautionary principle*[184] in the design of the program and measures to be adopted by the Contacting Parties.

OSPAR mandates the best available techniques and the best environmental practices.[185] The term "best available techniques" requires the use of the latest stage of development or state of the art processes or methods of operation.[186] Economic feasibility is to be taken in account when determining the best available technique.[187] The best available technique should be based on those recently successful comparable processes or methods of operation and up-to-date technological advances and changes in scientific knowledge and understanding.[188] Given the inputs of economic feasibility, advancing science and newly successful comparable processes and methods, the best available techniques should be expected to change over time.[189]

The phrase of "'best environmental practices' means the application of the most appropriate combination of controls and strategies."[190] In developing the combination of measures, seven key factors are taken into consideration.[191] The environmental hazard of the product and its production is considered.[192] The social and economic implications of the measures should be integrated with the analysis.[193] The potential for substitution and the scale of use should both be considered, as well as the potential environmental benefit or penalty of substitute.[194] Advances in scientific knowledge and understanding should be

182. *Id.* at art. 2(5).
183. *Id.* at art. 2(2)(b).
184. *Id.* at art. 2(2)(a).
185. *Id.* at art. 2(3)(b)(i). *See id.* at Annex III, art. 2 (explicit requirements for offshore sources).
186. OSPAR *supra* note 176, at Appendix I, § 2.
187. *Id.* at Appendix I, § 2(c).
188. OSPAR *supra* note 176, at Appendix I, § 2(a), (b).
189. *Id.* at Appendix I, § 3.
190. *Id.* at Appendix I, § 6.
191. *Id.* at Appendix I, § 7(a)-(g).
192. *Id.* at Appendix I, § 7(a).
193. *Id.* at Appendix I, § 7(g).
194. OSPAR *supra* note 176, at Appendix I, § 7(b)-(d).

taken into account.[195] Finally, the time limits for implementation of the measures should be considered.[196]

The Contracting Parties are required to undertake all possible steps to prevent and eliminate pollution from offshore sources, as guided by the OSPAR's Annex III.[197] "Offshore sources" are defined to include both offshore installations and offshore pipelines.[198] An offshore installation is any "man-made structure, plant or vessel or parts thereof, whether floating or fixed to the seabed, placed within the maritime area for the purpose of offshore activities."[199] Pollution is defined as "introduction by man, directly or indirectly, of substances or energy into the maritime area which results, or is likely to result, in hazards to human health, harm to living resources, and marine ecosystems, damage to amenities or interference with other legitimate uses of the sea."[200] However, vessels and aircrafts, and wastes therefrom, are exempt from inclusion under offshore sources.[201] Vessels include any water-borne crafts, including "air-cushion craft, floating craft whether self-propelled or not, and other man-made structures in the maritime area," but excludes offshore installations.[202] The critical definition is that of offshore activities: those activities undertaken for "exploration, appraisal or exploitation of liquid and gaseous hydrocarbons."[203]

All potential discharges or emissions from the offshore installations and activities must be authorized and regulated by "competent authorities of the Contacting Parties."[204] Accidental venting or seeping of methane is not considered dumping, as dumping requires the deliberate act of disposal.[205] Thus, accidental venting and seeping of methane is not regulated under

195. *Id.* at Appendix I, § 7(e).
196. *Id.* at Appendix I, § 7(f).
197. *Id.* at art. 5.
198. *Id.* at art. 1(k).
199. *Id.* at art. 1(l).
200. OSPAR *supra* note 176, at Appendix I, § 1(d).
201. *Id.* at Annex III, art. 1(a)-(b).
202. *Id.* at art. 1(n).
203. *Id.* at art. 1(j).
204. *Id.* at Annex III, art. 4(1).
205. *Id.* at art. 1(f)(i)-(ii).

Annex III's Article 3.[206] Thus, the exclusion of weather and other cause-based *force majeure* does not apply to accidental venting and seeping, unless so granted under the domestic laws of the Contracting State.[207]

OSPAR Annex III has already addressed the offshore sequestration of carbon dioxide, in that such carbon dioxide is not considered a dumping of waste for OSPAR.[208] So, offshore sources of pollution basically arise from offshore installations, vessels, and pipelines associated with the exploration, appraisal or exploitation of liquid and gaseous hydrocarbons (such as methane from offshore methane hydrate deposits). If the development of methane hydrate projects offers risks of harm and hazards from offshore installations that may potentially emit pollution, then OSPAR's Contracting Parties would be obligated to prevent and eliminate hazards to human health, harm to living resources, and marine ecosystems from those potential methane hydrate projects.

2. Bonn Agreement (North Sea)

The Bonn Agreement covers the North Sea and attempts to protect it from pollution by oil and other harmful substances.[209] The Agreement is fairly brief and leaves out much in the way of detail, as opposed to the details seen in OSPAR or in the Barcelona Convention.[210] The Agreement serves primarily to coordinate national level efforts to respond to specific pollution events.[211] Additionally, the Bonn Agreement coordinates within the OSPAR Convention's shadow.

The Agreement is to be invoked whenever a Contracting Party is presented with either the actual presence or the

206. *Compare* OSPAR *supra* note 176, at Annex III, art. 3(2)., *with id.* at Annex III, art. 4(1).

207. *Id.* at Annex III art. 4(2), (6).

208. *Id.* at Annex III art. 3(3)(a)-(d).

209. Agreement for Cooperation in Dealing with Pollution of the North Sea by Oil and Other Harmful Substances, Sept. 13, 1983, 1984 O.J. (L 188) 9 [hereinafter Bonn Agreement].

210. *See infra* Part III(B)(3).

211. *See* Bonn Agreement, *supra* note 209.

prospective presence of oil or other harmful substances.[212] The phrases "oil" and "harmful substances" are not defined nor detailed within the Agreement.

The Agreement was not intended to alter in any form the underlying laws or civil liability rules that affect the prevention and combat of marine pollution.[213] While the Agreement itself coordinates international action and facilitates cost-recovery between the Contracting Parties,[214] nothing in the Agreement limits further pursuit by the Contracting Parties against third parties.[215]

Where the Bonn Agreement lacks substantive details, its affiliated Manual provides some details.[216] The chapter addressing oil pollution clearly is focused on persistent crude oils and liquid petroleums.[217] Natural gas and methane are addressed as flammable and exploding gases within the chapter on hazardous materials; however the operatic paradigm is vessel-transported gases.[218] Hazardous chemicals are sorted into four classes: evaporators, floaters, dissolvers, and sinkers.[219] Evaporators are sub-sorted into three response modes: toxic gas cloud, toxic and explosive gas cloud, and explosive gas cloud.[220]

Methane is listed as being both a health risk gas, for distances within 200 meters of the gas cloud, and as an explosion risk for distances within 200 meters of the gas cloud.[221]

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

213. *Id.* at art. 8(1).

214. *Id.* at arts. 9-10.

215. *Id.* at art. 11.

216. BONN AGREEMENT SECRETARIAT, BONN AGREEMENT COUNTER POLLUTION MANUAL, *available at* http://www.bonnagreement.org/site/assets/files/3946/bonn_agreement_counter_pollution_manual.pdf, *archived at* http://perma.cc/2KXM-5NN5 [hereinafter COUNTER POLLUTION MANUAL].

217. *See* COUNTER POLLUTION MANUAL, *supra* note 216, at ch. 22 (the frequency and dominant use of the phrase "oil slick" to describe oil pollution).

218. *See id.* at ch. 26 (specifically, the discussion on how harmful substances leak from vessels).

219. *Id.* at ch. 26, § 1.4.

220. *Id.* at ch. 26, § 1.8.

221. *Id.* at Annex I ("Intervention on Gases and Evaporators: Card Number F1.1, F1.2, F1.3"). It is important to recall that the risk stated therein is related to leaks of methane from LNG-type containers at sea, not methane vented or leaked from the ocean at any low or high rate.

It is perhaps noteworthy that the development of offshore windmill farms has been included within the coverage of the Bonn Agreement.[222] The installations associated with offshore windfarms are seen as novel risks for shipping and the installations could also complicate oil pollution recovery and abatement efforts.[223] To the extent that methane hydrate projects are foreseen in the North Seas area, it would probably be reasonable to assume that a similar chapter might be drafted to take the particular harms and hazards of subsea methane extraction into the greater Bonn Agreement framework.

3. Barcelona Convention (Mediterranean Sea)

The Barcelona Convention and its associated documents are designed to provide protection to the Mediterranean both within and without the EU.[224] It applied general concepts of transboundary coordination and of monitoring.[225]

Pollution is defined as "the introduction by man, [both] directly and indirectly, of substances or energy into the marine environment" that could cause a variety of harms to both the marine environment and human use and enjoyment thereof.[226]

The Barcelona Convention implements several key environmental law policies. It requires the application of the *precautionary principle*: a lack of full scientific certainty should not be used as a reason for postponing cost-effective measures.[227] All appropriate means should be undertaken to preserve biological diversity.[228] This implementation of the *precautionary principle* balances the prevention of environmental degradation against the costs-effectiveness of such measures.[229] The best available techniques and the best environmental practices are called for within the Convention;[230] this clarifies the

222. *See id*. at ch 8.
223. *See id.*
224. Barcelona Convention, *supra* note 177.
225. *Id.* at arts. 9-12.
226. Barcelona Convention, *supra* note 177, at art. 2(a).
227. *Id.* at art. 4(3).
228. *Id.* at art. 10.
229. *Id.* at art. 4(3)(a).
230. *Id.* at art. 4(4)(b).

precautionary principle, but also requires data sharing among both competent authorities and operators. Finally, the means to be undertaken are to reflect the reality of the social, economic, and technological conditions of the signatories.[231]

While the Convention calls for early implementation of potentially effective measures, it constrains its call to cost effective socially balanced measures; it does not call for any and all measures at all costs.

The Convention applies the *polluter pays* principle.[232] The costs of pollution are to be borne by those individuals that introduce the pollution to the environment.[233] The Convention calls for the contracting parties to formulate and adopt appropriate rules and procedures for the determination of liability and compensation resulting from harms to the Mediterranean region.[234]

The Convention requires the signatories to take all appropriate measures to eliminate and remediate pollution from the "exploration and exploitation of the continental shelf and the seabed and its subsoil."[235] These requirements make no reference to hydrocarbons, instead they apply to any and all minerals, including hydrocarbons, and potentially methane hydrates.

The Convention expands the concepts from the EU's EIA Directive to the broader Mediterranean region.[236] Functionally, the Convention supports the development and adoption of Protocols to expand, and details the objectives of the Convention.[237] For the purposes of this article, the most important protocol to the Convention is the "Offshore Protocol."[238]

231. *Id.* at art. 4(4)(b).
232. Barcelona Convention, *supra* note 177, at art. 4(3)(b).
233. *Id.*
234. *Id.* at art. 12.
235. Barcelona Convention, *supra* note 177, at art. 7.
236. *Id.* at art. 4(3)(c).
237. *Id.* at arts. 21, 22.
238. Protocol for the Protection of the Mediterranean Sea Against Pollution Resulting from Exploration and Exploitation of the Continental Shelf and the Seabed and Its Subsoil, Oct. 14, 1994, 13 I.L.M. 976 [hereinafter Offshore Protocol].

The stated goal of the Protocol is: "[t]he Parties shall take, individually or through bilateral or multilateral cooperation, all appropriate measures to prevent, abate, combat and control pollution in the Protocol Area resulting from activities, *inter alia*, by ensuring that the best available techniques, environmentally effective and economically appropriate, are used for this purpose."[239]

The Protocol does not designate a rule of civil liability, but requires that such be employed by the signatories to ensure that the polluter pays, *i.e.* the operator, and the polluter pays prompt and adequate compensation.[240] Also, the Protocol requires each signatory to ensure sanctions exist to punish violators; the character of the requirements appear to be more regulatory than civil liability in design: "[e]ach Party shall prescribe sanctions to be imposed for breach of obligations arising out of this Protocol, or for non-observance of the national laws or regulations implementing this Protocol, or for non-fulfillment of the specific conditions attached to the authorization."[241]

Additionally, the Protocol requires the operators to maintain insurance or other financial securities to ensure that the problems of insolvency do not arise at the time of compensation.[242] The Protocol provides for certain limited applications of *force majeure* and certain public welfare justifications.[243] But those exceptions are terminated if "intent to cause damage or recklessly and with knowledge that damage will probably result."[244]

Methane hydrate projects broadly appear to qualify for regulation under the Offshore Protocol. "Activities" are defined to include scientific activities, exploration activities, and exploitation activities that would include the development and production stages of a methane hydrate project, but apparently not the abandonment and sequestration period.[245] Removal of

239. *Id.* at art. 3(1).
240. *Id.* at art. 27(1), (2)(a).
241. *Id.* at art. 7.
242. Offshore Protocol, *supra* note 238, at art. 27(2)(b).
243. *Id.* at art. 14(1)(a).
244. *Id.* at art. 14(2).
245. *Id.* at art. 1(d).

Installations, otherwise known as sequestration and abandonment within oil and gas, are defined and addressed within the Protocol;[246] similar EIA and authorizations requirements are found.[247] Installations are defined as floating, mobile, or fixed; they include drilling units, production units, storage units, and loading and transporting units.[248] Operators include both those authorized or licensed to operate offshore facilities or those in *de facto* control of such facilities.[249] Article 5 of the Protocol essentially requires the performance of an EIA, and strictly does so for EU waters.[250]

The Offshore Protocol does not list methane or natural gas as "oil."[251] Oil is defined as "petroleum in any form including crude oil, fuel oil, oily sludge, oil refuse and refined products."[252] Crude oils, and various refinery products, are listed as harmful or noxious substances.[253] But, the Protocol integrates the definition of pollution from the Convention; methane or natural gas might qualify as a form of a substance that could be deleterious to the environment.[254] Additionally, the venting or seeping of methane into the water column may be seen as adding energy, and thus qualify as pollution in that sense.[255]

The Protocol addresses both the support of developing countries within the region, and the support of transboundary concerns.[256]

246. *Id.* at art. 20.

247. *Id.* at art. 20(1)-(2).

248. Offshore Protocol, *supra* note 238, at art. 1(f)(i)-(v).

249. *Id.* at art. 1(g)(i)-(ii). A literal reading suggests that even non-normal personnel might be included within this scope; *e.g.* a pirate or terrorist of an offshore facility might be classified as a *de facto* operator.

250. *Id.* at art. 5.

251. *Id.* at art. 1(l). *See id.* at Annex V, App. But, the Appendix title carries a footnote that states, "the list of oils should not necessarily be considered as exhaustive." Nevertheless, nothing in the list, or in the nomenclature of oil and refining, suggests that methane should be included within the category of oil under the Protocol.

252. *Id.* at art. 1(l).

253. Offshore Protocol, *supra* note 238, at Annex I., Part A(6).

254. Barcelona Convention, *supra* note 177, at art. 2(a).

255. *See id.*

256. Offshore Protocol, *supra* note 238, at arts. 24, 26.

4. Helsinki Convention (Baltic Sea)

The Helsinki Convention serves a similar role to OSPAR and the Barcelona Convention: to protect a marine region from environmental harms.[257] Overall, the Helsinki Convention is drafted similarly to other regional marine conventions.

The Helenski Convention carries the same definition of pollution as seen in other regional marine documents, the "introduction by man, directly or indirectly, of substances or energy into the sea . . . which are liable to create hazards to human health, to harm living resources and marine ecosystems."[258] The Convention has a similar definition of dumping as OSPAR.[259] Oil is narrowly defined as oils, refinery products, or sludge[260]; definitely exclusive of natural gas or methane. Harmful substance is defined as any substance that could cause marine pollution.[261]

The Helsinki Convention mandates that the Contracting Parties take all appropriate legislative, administrative, or other relevant measures to prevent and eliminate pollution in the region.[262] The Convention requires the application of the *precautionary principle*.[263] It requires the application of the best available technology[264] and of the best environmental practice.[265] Specifically, the Contracting Parties are required to apply the *polluter pays principle*.[266] The Convention requires the prevention of the introduction of harmful substances[267] and

257. Convention on the Protection of the Marine Environment of the Baltic Sea Area, *adopted* Apr. 9, 1992, 1507 U.N.T.S. 167 [hereinafter Helsinki Convention] (entered into force Jan. 17, 2000).

258. *Id*. at art. 2(1).

259. *See id.* at art. 2(4); *compare id.* at art. 2(4)(a), *with* OSPAR, *supra* note 171, at art. 1(f).

260. Helsinki Convention, *supra* note 257, at art. 2(6).

261. *Id.* at art. 2(7). Methane, hydrogen, or even potentially freshwater, or mud might qualify.

262. Helsinki Convention, *supra* note 257, at art. 3(1).

263. *Id.* at art. 3(2).

264. *Id.* at art. 3(3).

265. *Id.* at art. 3(3).

266. *Id.* at art. 3(4).

267. *Id.* at art. 5.

pollution from ships,[268] including waste dumping.[269] The Convention requires the Contracting Parties to take all appropriate action to conserve natural habitats and biological diversity and to protect ecological processes.[270] Broadly speaking, the Helsinki Convention is well aligned with both other regional marine conventions and UN environmental policies.

The exploration and exploitation of the seabed and its subsoil require both the prevention of pollution and the precautionary preparation to ensure adequate preparedness is maintained in order to provide immediate action to respond to accidental pollution when it occurs.[271] Annex VI to the Convention provides additional guidelines for offshore oil and gas activities.[272] Offshore activity is defined to be any exploration or exploitation of oil and gas by either fixed or floating installations.[273] An offshore unit is any particular installation engaged in oil or gas exploration, exploitation or production activities, including transportation.[274] EIAs are required before any licensing can occur within the marine region.[275] A compositional analysis of the deposit zone, its sediments, hydrocarbon content, and potentially hazardous substances or hazards should be among the items investigated during the EIA assessment.[276] On-going and subsequent studies should be made on the deposit zone to ensure the prevention of pollution and the emission of harmful substances.[277] Finally, each offshore unit should have a pollution emergency plan to ensure quick and appropriate responses to accidents.[278]

268. Helsinki Convention, *supra* note 257, at art. 8.
269. *Id.* at art. 11.
270. *Id.* at art. 15.
271. *Id.* at art. 12, § 1.
272. *Id.* at Annex VI.
273. *Id.* at Annex VI, Regulation 1, § 1.
274. Helsinki Convention, *supra* note 257, at Annex VI, Regulation 1, § 2.
275. *Id.* at Annex VI, Regulation 3, § 1.
276. Helsinki Convention, *supra* note 257, at Annex VI, Regulation 3, § 2(d).
277. *Id.* at Annex VI, Regulation 3, §§ 3, 4.
278. *Id.* at Annex VI, Regulation 7.

5. Risk Governance Under the Regional Marine Conventions

The regional marine conventions are very similar in design with regards to risk governance. While they are all high level international agreements that leave specific implementation to the signatory states, the conventions provide clear guidance on the types of governance needed to both attain the policy goals and to enable coordination across parties.

They all call for the contracting states to implement liability rules that function in harmony with the *polluter pays principle*. The *polluter pays principle* does not provide for a duty of care that would indemnify tortfeasors as a rule of negligence would. The *polluter pays principle* at its core would be opposed to the idea that victims of environmental pollution would need to bear the costs of damage simply because the tortfeasor operated reasonably; the quintessence of the polluter pays principle is that the polluter always pays; this is the spirit of the rule of strict liability. The *polluter pays principle* could be implemented in regulations, but the overall spirit that the victims are not to blame and not to pay would remain the same.

There is clearly support within the conventions for the use of regulations to govern risk. There are many items to be achieved and confirmed, and it would be very inefficient to allow private civil liability claims to pursue that level of investigation; additionally, no rule of civil liability would be able to enforce or perform those investigations until an actionable cause arose, thus, the purpose and function to provide on-going safety monitoring would be defeated. A regulatory body would be far better suited to the needs of on-going monitoring and procedural assurances.

Another aspect is that the conventions require an undertaking of active steps to prevent and eliminate pollution; again, a regulatory body could act daily and currently without the need of actionable causes so long as the regulations receive a sufficient delegation of power to act.

Further, the conventions heavily discuss permits and licensing, which remains the exclusive territory of regulatory bodies.

There are also many scientific and other specialized knowledge sets required to implement the obligation of the conventions. It would be more efficient to train and maintain a dedicated pool of experts instead of the stop and start of civil liability lawsuits.

In conclusion, the conventions set high standards and provide a framework for contracting states to base their domestic enactments upon. Both regulations and rules of civil liability are encouraged, but it would appear that more attention has been given to the development of the regulatory framework. If a rule of civil liability were employed by a contracting state, it would likely need to be a rule of strict liability.

C. International Oil Spill Conventions

This section follows the discussion on the history, paradigmatic aims, and risk governance mechanisms as presented in the introduction in Section B, *supra*. The oil spill conventions mirror the regional marine conventions in many ways, key is their common pre-occupation on surface oil spills, but they operate beyond regional limits.

The international oil spill conventions address liability. They call for the implementation of strict liability regimes; limited defences of *force majeure*-type events and limited defences from grossly or recklessly negligent victims are also provided.

The conventions also assume that many procedural aspects of oil pollution prevention, detection, and remediation can be coordinated internationally. It is hard to imagine how that might be coordinated without manifestations tantamount to regulations. Indeed, a common regulatory body, the International Maritime Organization under the UN, oversees several of these conventions.

Thus, the international oil spill conventions are broadly in alignment with the recommendations of Section 2.

1. A Brief History of Marine Oil Spill Conventions

The current oil spill regimes were developed primarily as a reaction to several significant spills, all from seagoing vessels. The paradigm of oil spills as currently understood by existing oil

spill regimes is the broken tanker or leaking crude oil well in shallow waters paradigm.[279] That the laws and conventions responding to catastrophic oil spills respond primarily to this paradigm made practical sense. Historically, this type of oil spillage in shallow waters has been the most common type of offshore-based oil spill, as documented in governmental records.[280] A recent Congressional Research Service report documented that only approximately one percent of all oil spill incidents were from extraction activities.[281]

The original spill of concern was the Torrey Canyon spill of 1967,[282] which contaminated eighty kilometers (km) of French coastlines and 190 km of Cornish shorelines in the United Kingdom. This spill leaked 119,000 tons of crude oil into the

279. The marine oil spill paradigm assumes that crude oil is spilled near or at the ocean surface, for the oil to collect at the surface, or very near the surface, and that the oil is likely to be spilled sufficiently close to shore to quickly threaten the shoreline and coastal areas with persistent crude oil contamination. The paradigm assumes that only certain heavy crudes will yield persistent crude contamination removing lighter fuels, such as gasoline or natural gas, from substantial focus of the damages.

280. This is not to say that offshore well-based leaks were unknown; however, these well-based catastrophes were "the exceptions that proved the rule" until recently. Two well-known examples are the Union Oil event offshore Santa Barbara, CA, and the Ixtoc event offshore the Yucatan Peninsula in Mexico. Both of these events pre-date the 1990 Oil Pollution Act and the International Convention of 1992. The Santa Barbara offshore blowout and seeps began on January 28, 1969. Keith C. Clarke & Jeffrey J. Hemphill, *The Santa Barbara Oil Spill: A Retrospective,* UNIV. OF CAL. SANTA BARBARA (2001), http://www2.bren.ucsb.edu/~dhardy/1969_Santa_Barbara_Oil_Spill/Essays.html, *archived at* http://perma.cc/KX79-NFWZ. It was the third largest oil leak in U.S. history, ranked behind only the BP Macondo explosion and the Exxon Valdez shipwreck. The oil leak occurred in only fifty-seven meters of water, so the effects were largely similar to a vessel leak. The Ixtoc was an offshore drilling catastrophe that began on June 3, 1979. Tim Johnson, *Mexico's Ixtoc 1 Oil Spill a Distant Mirror to BP Disaster*, SEATTLE TIMES (May 22, 2010), http://www.seattletimes.com/nation-world/mexicos-ixtoc-1-oil-spill-a-distant-mirror-to-bp-disaster/, *archived* at http://perma.cc/Y8VW-WU9P. It too was in fifty meters of water, so its leak, while massive and long lasting, functionally resembled a massive vessel leak in many ways.

281. JONATHAN L. RAMSEUR, CONG. RESEARCH SERV., RL33705, OIL SPILLS IN US COASTAL WATERS: BACKGROUND, GOVERNANCE, AND ISSUES FOR CONGRESS 3 (2010).

282. Michael G. Faure & Hui Wang, *The International Regimes for the Compensation of Oil-Pollution Damage: Are They Effective?*, 12 REV. EUR. CMTY. & INT'L ENVTL. L. 242, 242 (2003).

sea.[283] That spill resulted in several legal regimes and conventions: the Civil Liability Convention of 1969,[284] the Fund Convention,[285] the Tanker Owners' Voluntary Agreement concerning Liability for Oil Pollution (TOVALOP),[286] and the Contract Regarding an Interim Supplement to Tanker Liability for Oil Pollution (CRISTAL).[287]

These four conventions were revealed for their weaknesses under the Amoco Cadiz spill of 1978. The Amoco Cadiz spilled 223,000 tons of crude oil onto the shores of Brittany, France, nearly double the amount spilled in the earlier Torrey Canyon spill. That accident led to updates to the Civil Liability Convention of 1969/1992 (CLC) and the Fund Convention.[288] The updates were entitled the "Protocols." The two protocols were the Protocol of 1984 to amend the International Convention on Civil Liability for Oil Pollution Damage, 1969, and the Protocol of 1984 to amend the International Convention on the Establishment of an International Fund for Compensation of Oil Pollution Damage, 1971.[289]

283. *Oil Tanker Spill Statistics 2013,* INT'L TANKER OWNERS POLLUTION FED'N LTD., http://www.itopf.com/information-services/data-and-statistics/statistics (last visited Oct. 9, 2014), *archived at* http://perma.cc/VK2X-Y7FR.

284. International Convention on Civil Liability for Oil Pollution Damage, Nov. 29, 1969, 973 U.N.T.S. 3 [hereinafter CLC], *available at* http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-on-Civil-Liability-for-Oil-Pollution-Damage-(CLC).aspx, *archived at* http://perma.cc/5AGS-EGE3. The CLC was updated in 1992, and is still currently in force. *See also* International Convention for the Prevention of Pollution of the Sea by Oil, 1954, 12 U.S.T. 2989.

285. International Maritime Organization Protocol of 1992 to Amend the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, *adopted* Nov. 27, 1992, 1953 U.N.T.S. 373 [hereinafter Fund Convention] (entered into force May 30, 1996).

286. TOVALOP was originally intended as a stop-gap measure by the owners and operators of oil-transporting vessels until the adoption of the CLC in 1975. Since February 20, 1997, TOVALOP is no longer operational as an industrial convention. *See History of ITOPF*, ITOPF, http://www.itopf.com/fileadmin/data/Documents/Company_Lit/HistoryofITOPF.pdf (last visited Oct. 9, 2014), *archived at* http://perma.cc/Y6P8-J6RR.

287. CRISTAL was originally intended as a stop-gap measure by the producers and refiners of petroleum until the adoption of the Fund Convention in 1975. Since February 20, 1997, CRISTAL is no longer operational. *See id.*

288. *See infra* Part III(C)(2).

289. *See* Faure & Wang, *supra* note 282, at 245.

Despite the public support for the international conventions, the U.S. did not join as a signatory to those conventions. After the Exxon Valdez spill of 1989, again a large sea-going vessel leak,[290] the U.S. finally responded with the enactment of the Oil Pollution Act of 1990 (OPA).[291] In responding to the Exxon Valdez incident, OPA primarily targeted the shipment of oil in tankers and the types of harm caused by those previous spills discussed herein. Global awareness to the Exxon Valdez spill resulted in additional updates to the CLC and Fund Convention; those updates are known as the 1992 Conventions.[292]

The OPA does apply to offshore oil and gas facilities, and thus would now apply in some contexts to offshore methane hydrate facilities; the mineral lessee is the deemed tortfeasor, and the liability for offshore facilities is distinct from other sources of oil pollution. [293] The OPA also provides a "limited liability" version of strict liability due to certain caps placed on the maximum amount of assessable damages.[294] However, OPA is substantively distinguishable from several important sections of the CLC and Fund Convention, so their legal responses to oil spills are significantly different from each other.[295]

There are doubts on the ability of the crude oil spill regimes to address major spills from deep-sea wells, such as the BP Deepwater Horizon, and by extension, methane hydrate extraction projects. An extensive review and critique of the

290. Interestingly, the Exxon Valdez spill only released 37,000 tons of crude oil, significantly less than the earlier volumes, 223,000 tons for the Amoco Cadiz and 119,000 tons at the Torrey Canyon spill, which drove reform efforts in Europe.

291. For more information on OPA, see *infra* Part III(E)(3).

292. *See* discussion on CLC, *infra* Part II(B).

293. *See* 33 U.S.C. § 2701(32)(C) (2012) (defining "responsible party"). *See also id.* § 2704(a)(3) (providing the limitations on liability for "offshore facility").

294. OPA provides for routine strict liability up to certain maximum limits and below those limits there are no "duty of care" protections for the tortfeasor. *See* 33 U.S.C. § 2702(a). The types of damages are limited to certain categories of damages. *See id.* § 2702(b)(2). And there are defenses of *force majeure*, *see id.* § 2703(a), and limited defenses of contributory gross negligence on the part of the victims, *see id*. § 2703(b).

295. *See* relevant discussions, *infra* Part III(C).

overall liability system of U.S. oil spill law has recently been provided by Faure and Wang.[296]

2. Civil Liability Convention of 1969/1992

The CLC derives from an earlier sequence of agreements originally designed to respond to crude oil spills from vessels and boats and was later extended to include other hazardous substances.[297] It would not likely apply to damages resultant from methane hydrate harms, but it is guiding in its approach to liability management.

The CLC defines oil as "any persistent hydrocarbon," and provides examples of crude oil, fuel oil, diesel oil, and lubricating oil.[298] However, nothing in this definition appears to include methane or any of the lighter alkanes that might be found in methane hydrate deposits. Pollution damage is defined as, "loss or damage outside the ship by contamination resulting from the escape or discharge of oil from the ship."[299] While the definition provides extensions of damage to include the environment, it does not appear to include any pollution caused by forces or substances other than oil. Because the CLC provides exclusively for pollution damage within the territories of the Contracting States,[300] it

296. Michael G. Faure & Hui Wang, Civil Liability and Compensation for Marine Pollution - Lessons to Be Learned for Offshore Oil Spills, 8 OIL, GAS & ENERGY L. INTELLIGENCE 1 (2010).

297. CLC, *supra* note 284. The CLC is still in force as updated by the CLC of 1992. *See International Convention on Civil Liability for Oil Pollution Damage (CLC),* INT'L MAR. ORG., http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-on-Civil-Liability-for-Oil-Pollution-Damage-(CLC).aspx (last visited Oct. 9, 2014), *archived at* http://perma.cc/R6VW-MMZS. *See also* International Convention for the Prevention of Pollution of the Sea by Oil, 1954, 12 U.S.T. 2989; International Convention for the Prevention of Pollution from Ships, Nov. 2, 1973, 12 I.L.M. 1319 [hereinafter MARPOL]. The latter, when combined with its 1978 Annex, creates MARPOL.

298. CLC, *supra* note 284, at art. I(5). For the additional language defining crude oil and fuel oil, *see* Fund Convention, *supra* note 285 at art. I(3)(a), (b). Crude oils are defined as liquid hydrocarbons, apparently in distinguishing them from gases, and fuel oils are heavy distillates or residues. Neither definitional refinement appears to include any light alkanes, especially not methane.

299. CLC, *supra* note 284, at art. I(6)(a).

300. *Id.* at art. II(a).

would be difficult to connect the hazards and harms of methane hydrates to the CLC.

The owner of a ship is to be held liable for any pollution damage caused or associated with that ship.[301] Owner's liability is extinguished if: (i) damage resulted from war or hostilities,[302] (ii) damage resulted from exceptional, inevitable, and irresistible natural phenomena,[303] (iii) "wholly caused by" undertaking by a third party's act or omission,[304] (iv) caused by Governmental negligence or wrongful act,[305] (v) and if in partial or whole causation by the victim of the pollution damage.[306] As such, the rule employed is essentially a rule of strict liability.

Liability is limited to a fixed amount determined by the tonnage of the ship.[307] However, that limit to liability is not preserved if the act that resulted in pollution was committed with the intent to cause such damage, or recklessly and with the knowledge that it would probably result in pollution damage.[308] The availability of limited liability is predicated on the establishment of a fund capable of making such payments in presentation to the court before which liabilities are established.[309] Expenses undertaken by the owner to prevent or remediate the pollution damage are equally ranked for

301. *Id.* at art. III(1). *See also id.* at art. IV (describing where that liability is extended to joint and severable liability if multiple ships are involved in joint causation of pollution damage).

302. CLC, *supra* note 284, at art. III(2)(a).

303. *Id.* at art. III(2)(a).

304. *Id.* at art. III(2)(b).

305. *Id.* at art. III(2)(c).

306. *Id.* at art. III(3). If the victim is wholly and solely responsible for the acts that caused the pollution damage, then no liability attaches to the owner; if the victim is partially at cause, then the owner's liability is limited to that extent covered by the victim.

307. The maximum amount of liability was set at 89,770,000 accounting units. *Id.* at art. V(1). The accounting unit is defined to be the Special Drawing Rights unit of the International Monetary Fund. *See id.* at art. V(9)(a).

308. CLC, *supra* note 284, at art. V(2).

309. *Id.* at art. V(3). *See* Fund Convention, *supra* note 285, for the details of the fund and its stewardship. It is because of the advancements in the funding under this Convention that other earlier funds, such as CRISTAL and TOVALOP, have since been abandoned or folded into the International Fund. *See also* WILLIAM TETLEY, INTERNATIONAL MARITIME AND ADMIRALTY LAW 454 (Yvon Blais ed., 2002).

recompense under the fund with other pollution damage claims.[310]

The assignment of liability under the CLC displays liability channeling to the owner, a form of strict liability in that no excuse of reasonable care is provided, multiple defenses to the strict liability rendering it close to a functional negligence rule, and that the idea of strict liability must be tempered with the recognition of limited liability.

As the primary focus of the "Civil Liability Convention" is on civil liability, its text is primarily focused on establishing strict liability as the agreed to rule and the means of coordinating civil liability across affected jurisdictions.[311]

3. International Convention for the Prevention of Pollution from Ships (MARPOL)

MARPOL[312] was designed to address marine pollution and contamination from crude oil and noxious liquids. MARPOL follows the CLC in establishing strict liability for accidental emissions. But, because exploitation of subsea minerals is exempt from MARPOL, because methane is excluded from consideration as an oil, and because methane is not a defined liquid or noxious liquid, MARPOL would not likely apply to methane hydrate projects. However, methane might qualify as a hazardous substance, and if discharged apart from the "exploration, exploitation and associated offshore processing of sea-bed mineral resources," then MARPOL might be applicable.[313]

MARPOL's definition of harmful substances is very broad; if the substance might harm human life, marine life or the local ecology, then it is a harmful substance, and therefore, methane might qualify as a harmful substance.[314]

310. CLC, *supra* note 284, at art. V(8).

311. There is insufficient material to draw conclusions on regulations.

312. MARPOL, *supra* note 297.

313. *Id.* at Annex I, Regulation 21.

314. *Id.* at art. 2(2) ("Harmful substance means any substance which, if introduced into the sea, is liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea, and includes any substance subject to control by the present Convention.") (internal quotations omitted).

MARPOL could apply to offshore facilities. Oil tanker is defined as a ship that primarily carries oil;[315] similarly, a combination carrier is a ship designed to carry a combination of oil and solid freight.[316] Furthermore, the regulation primarily applies to ships;[317] but offshore structures engaged in the "exploration, exploitation and associated offshore processing of sea-bed mineral resources," whether floating or fixed, will be treated as legally equivalent to ships of 400 tons gross tonnage.[318] Additionally, MARPOL's definition of ships includes all sea-going vessels and platforms that might be related to an offshore methane hydrate installation.[319]

MARPOL defines discharge as the release by any cause of harmful substances from a ship into the oceanic environment;[320] however, events arising from the "exploration, exploitation and associated off-shore processing of sea-bed mineral resources," are exempted from the definition of discharge.[321] Thus, to the extent that methane hydrates or methane were held to be harmful substances, if they were released, *e.g.* vented or seeped, from activities associated with a methane hydrate project, then that situation would not be a discharge and not a reportable incident of a discharge of harmful substances.[322]

Annex I of MARPOL 73/78,[323] hereinafter Annex I, provides extensive rules on the handling, disposal, and leaking of oil from ships and platforms. However, it would not apply to methane hydrate accidents. Annex I defines oil as "petroleum in any form including crude oil, fuel oil, sludge, oil refuse and refined products . . . and, without limiting the generality of the foregoing, includes

315. *Id.* at Annex I, Regulation 1, § 4.
316. *Id.* at Annex I, Regulation 1, § 5.
317. *Id.* at Annex I, Regulation 2, § 1.
318. MARPOL, *supra* note 297, at Annex I, Regulation 21.
319. *Id.* at art. 2(4) ("Ship means a vessel of any type whatsoever operating in the marine environment and includes hydrofoil boats, air-cushion vehicles, submersibles, floating craft and fixed or floating platforms." (internal quotations omitted)).
320. *Id.* at art. 2(3)(a).
321. *Id.* at art. 2(3)(b)(ii).
322. *Id.* at art. 2(6).
323. *Id.* at Annex I.

the substances listed in appendix I to this Annex."[324] The listed chemicals at Appendix I include the classes of Asphalt solutions, Gasoline blending stocks, Gasolines, Oils, Jet Fuels, Distillates, Naphthas, and Gas Oils, but nowhere in the listings are light alkanes nor methane products.[325] Thus, Annex I would not apply to the types of harms and hazards contemplated by this article.

Annex II responds to noxious liquids other than oils.[326] Methane will not likely be present as a liquid in Nature, nor is it technically a liquid within hydrate structures;[327] it would also not qualify under the Annex II definition of liquid.[328] Thus, the concerns on noxious liquids do not relate to the harms and hazards of methane hydrate projects.

4. International Convention on Oil Pollution Preparedness, Response, and Cooperation (OPRC)

The 1990 OPRC focuses on the actual events and incidents of oil pollution.[329] The focus, though, is tightly on oil. Oil is defined as "petroleum in any form including crude oil, fuel oil, sludge, oil refuse and refined products;" thus methane hydrates and methane are excluded from the category of oil.[330] Oil pollution incidents are defined as situations wherein oil is discharged,[331] thus methane hydrate events would not normally lead to an oil pollution incident.

324. MARPOL, *supra* note 297, at Annex I, Regulation 1, § 1.

325. *Id.* at Annex I, Appendix I.

326. *Id.* at Annex II.

327. For a more complete discussion on the chemistry of methane hydrates, *see* MECHANISM DESIGN FOR THE FIERY ICE*, supra* note 1, at ch. 2, § 2.

328. "Liquid substances are those having a vapour pressure not exceeding 2.8 kp/cm^2 at a temperature of 37.88C" (internal quotations omitted). MARPOL, *supra* note 297, at Annex II, Reg. 1, § 5.

329. "Parties undertake, individually or jointly, to take all appropriate measures in accordance with the provisions of this Convention and the Annex thereto to prepare for and respond to an oil pollution incident." 1990 International Convention on Oil Pollution Preparedness, Response and Co-operation, Nov. 30, 1990, 1891 U.N.T.S. 51, art. 1 [hereinafter OPRC].

330. *Id.* at art. 2(1).

331. *Id.* at art. 2(2).

However, methane hydrate project installations might qualify as offshore units, which are defined to include offshore natural gas installations.[332] And, the 2000 Protocol[333] adopted the term hazardous and noxious substances, which could include methane and methane hydrates.[334] Thus, it is feasible that the OPRC would apply to pollution incidents from methane hydrate projects under the 2000 Protocol, whereas it would not have found an oil pollution incident under the original OPRC.

Should methane hydrates qualify as hazardous and noxious substances, OPRC would require every nation engaged in methane hydrate activities to establish a national system for responding promptly and effectively to pollution incidents.[335] The 2000 Protocol requires extensive pre-planning and preparation for potential pollution incidents, and strongly encourages the cooperation of the Contracting Parties to coordinate where possible on response capability and research into precautionary technologies and strategies.[336] But, for most countries in Europe and North America, the requirements are parallel to other similar commitments.[337]

D. Laws of the EU

The laws of the EU are more recently drafted, on the whole, than their counterparts in the U.S. As such, many of them reflect more recent trends in legal theory. Generally speaking, the EU directives support the application of strict liability; this is in part

332. "Offshore unit means any fixed or floating offshore installation or structure engaged in gas or oil exploration, exploitation or production activities" (internal quotations omitted). *Id.* at art. 2(4).

333. Protocol on Preparedness, Response and Co-operation to Pollution Incidents by Hazardous and Noxious Substances, Mar. 15, 2000, London [hereinafter 2000 Protocol].

334. *Id.* at art. 2, § 2 ("Hazardous and noxious substances means any substance other than oil which, if introduced into the marine environment is likely to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea.").

335. 2000 Protocol, *supra* note 333, at art. 4(1).

336. *See generally id.*

337. The OPRC does not explicitly discuss liability beyond the recovery of costs to the parties; the assumption is liability is dealt within separate proceedings beyond this convention.

due to the direct enactment of the *polluter pays principle* into the Treaty on the Functioning of the EU (TFEU).

The EU has a wide variety of legal instruments that address environmental protections and related industrial torts. An effort has been made to select those directives or frameworks more likely to be engaged in the governance of risks and hazards from offshore methane hydrate installations. The most relevant directives are the EIA and SEA Directives, the Offshore Directive, the CCS Directive, and the Marine Framework collection of directives.

The EIA Directive and the SEA Directive provide for the cautious and public review of upcoming projects and plans that might substantially impact the environment.[338] They call for exhaustive studies to be completed in advance of the granting of approvals or licenses, so that specific causes of harms or hazards could be addressed in full prior to the acceptance of such risks.[339] While not providing specific requirements on how to implement civil liability or regulatory governance beyond the collection and review of environmental precautionary data, by the very collection of that data they do provide for many cures that would otherwise befall both rules of civil liability and public regulation of offshore methane hydrate projects and of the policies and plans to facilitate their development. As such, they function as meta-rules on the rules applicable to offshore methane hydrates. [340]

Several directives have been selected because they touch on the regulation and liabilities attending to industrial accidents. The ELD was selected due to its role in providing oversight of the legal issues related to environmental damages.[341] The ELD extends legal protection to aspects of nature that might not otherwise be protected under more traditional rules of injury and damages. Seveso provides for the prevention and control of events surrounding industrial accidents.[342]

338. *See infra* Parts III(D)(1), III(D)(2).

339. *See infra* Part III(D)(3).

340. A review of the EU's EIA and SEA Directives also provides some perspective on the U.S.'s NEPA, which is similar, but was drafted earlier. *See infra* Part III(E)(1).

341. *See infra* Part III(D)(3)(a).

342. *See infra* Part III(D)(3)(b).

The Offshore Directive provides for the regulation of offshore oil and gas installations.[343] As such, to the extent that offshore methane hydrate installations would be viewed as a type of unconventional natural gas project, the Offshore Directive would apply to their development and operations. The Offshore Directive provides both broad and deep requirements on precautionary planning related to offshore hydrocarbon operations. But, a review of the Offshore Directive reveals that it is primarily focused on historical modes of offshore accidents and does not yet include provisions that would better address the needs of an offshore methane hydrate industry.

The CCS Directive reflects the other half of the coin from the Offshore Directive, as it could regulate the injection of carbon dioxide into offshore reservoirs.[344] As has been discussed, offshore methane hydrates can be extracted in conjunction with CCS injection activity; in fact, due to the economic uplifts from facilitating methane extraction and Kyoto Protocol concerns, most suggested commercialization studies have included some form of CCS-type injections in the extraction process. Similar ideas have been floated within the EU; for example, Germany's SUGAR Projekt would seek to inject carbon dioxide into offshore methane hydrate reserves.[345] As such, it is likely that within EU waters the CCS Directive would regulate the development of offshore methane hydrates. But, the CCS Directive, even if applicable, would address only a slice of the operations related to the development, production, and abandonment and sequestration of the methane hydrates. The CCS Directive would probably be most important, and most centrally applied, during the abandonment and sequestration phases, as it might govern long-term liability and post-production ownership of the methane hydrate fields.

343. *See infra* Part III(D)(4).

344. *See infra* Part IV. In some ways, it is not unreasonable to imagine that a hypothetical Offshore Methane Hydrate Directive would be an amalgam of the Offshore Directive and the CCS Directive.

345. *See* MECHANISM DESIGN FOR THE FIERY ICE*, supra* note 1, at ch. 3, § 5.1. *See SUGAR Project,* GEOMAR, http://www.geomar.de/en/research/fb2/fb2-mg/projects/sugar-2-phase/ (last updated Jan. 15, 2014), *archived at* http://perma.cc/3296-MQF8.

The Water and Marine Frameworks draw in a large number of marine, coastal, and riparian protecting directives, decisions, and regulations.[346] They function in coordination to protect the biota and human communities that need their ecosystems and environments to continue to be healthy and vibrant.[347] All marine projects, while still in the planning and pre-development stages, need to provide programs of measures to achieve and maintain good environmental status, and when the hydrates overlay transboundary marine ecosystems, plans for regional cooperation must also be provided. The various international regional marine conventions are called on by the Frameworks to extend this planning and cooperation. The Frameworks track a variety of hazardous activities, including chemicals transported through the water columns, to prevent accidental damages to those ecosystems. The Frameworks present a selection of known fragile environmental areas and endangered biota to specifically protect. However, while the presence of methane is known to affect marine biota in several substantial pathways, the marine locations and biota adjacent to those areas do not currently appear to be specifically protected under the Frameworks.

Finally, the EU is fully engaged with the goals and obligations of the UNFCCC. As such, it has developed a Greenhouse Gas Mechanism to enable it and its Member States to set and coordinate greenhouse gas emissions targets.[348] The methane that could directly be emitted and the resultant carbon dioxide from metabolized or combusted methane are both listed as greenhouse gases within the Kyoto Protocol, and are thus governed within the Greenhouse Gas Mechanism.

1. The EIA Directive

Two central directives guide the laws and regulations on environmental harms and hazards: the EIA[349] Directive and the

346. *See infra* Parts III(D)(6), III(D)(6)(C).

347. *See infra* Parts III(D)(6), III(D)(6)(C).

348. *See id.* § 7.

349. Directive 2011/92, of the European Parliament and of the Council of 13 December 2011 on the Assessment of the Effects of Certain Public and Private Projects on the Environment, 2011 O.J. (L 26) 1 [hereinafter EIA Directive]. The EIA Directive reflects the codification of the original Council Directive

SEA[350] Directive. These two directives require the *ex ante* review of projects, programs, and plans that might in some manner have an impact on the environment.

The EIA and SEA Directives are elements that are invoked in a wide array of EU laws; they are used to ensure that consistent review and forethought are applied to environmental issues across the EU and its Member States. In addition to their role as positive law within the EU matrix, the EIA and SEA provide foundational legal norms for similar review efforts within both EU Member States, and for countries and associations beyond the EU. As such, their influence is often guiding on activities at the earliest stage of drafting and development.

The EIA Directive applies to any project, public or private in nature, prior to the issuance of a permit for the onset of the project's development.[351] A project includes the execution of construction projects (including installations) and "other interventions in the natural surroundings and landscape[,]" including extractive efforts such as mineral resources.[352] The developer is the person held responsible for drafting the EIA report, and is the applicant who initiates a project by requesting authorization, or development consent, for the project.[353] Member States may elect to apply the EIA to projects related to their national defense on a case-by-case basis.[354] The EIA Directive allows projects that are designed through legislative processes and adopted by specific acts of national legislation to be exempt

85/337/EEC and its subsequent amendments: Directives 97/11/EC, 2003/35/EC, and 2009/31/EC. The EIA Directive is currently undergoing review for an amendment to streamline the procedures, and to improve cross member state consistency. *See Review of the Environmental Impact Assessment (EIA) Directive*, EUR. COMM'N, http://ec.europa.eu/environment/eia/review.htm (last updated Aug. 22, 2014), *archived at* http://perma.cc/Y6LJ-8ZGA; *see also Proposal for a Directive of the European Parliament and of the Council Amending Directive 2011/92/EU on the Assessment of the Effects of Certain Public and Private Projects on the Environment*, COM (2012) 628 final (Oct. 26, 2012).

350. Directive 2001/42, of the European Parliament and of the Council of 27 June 2001 on the Assessment of the Effects of Certain Plans and Programmes on the Environment, 2001 O.J. (L 197) 30 [hereinafter SEA Directive].

351. EIA Directive, *supra* note 349, at art. 1(1).

352. *Id.* at art. 1(2)(a).

353. *Id.* at art. 1(2)(b)-(c).

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

from the EIA Directive; the Directive holds out that similar due diligence reviews are assumed of the legislatures as guided by the EIA Directive.[355] Member States are required to integrate the designs of the EIA Directive into their national laws to ensure that prior to consent for development, all projects likely to have significant effects are properly assessed.[356]

a. Offshore Methane Hydrates Qualified Under Annex I

Methane hydrates projects would require the completion of an EIA review. The EIA Directive provides two manners of determining when a project should be reviewed under this Directive. There is a specific list of project types that must complete an EIA review at Annex I; these reviews are not optional.[357] There is a secondary list of activities at Annex II that may need review; Member States can either review those projects on a case-by-case basis or provide *ex ante* threshold guidelines.[358]

Annex I has multiple activities that would characterize offshore methane hydrate projects. It is almost certain that a methane hydrate project would qualify as an Annex I project, as it *per se* qualifies under several listed categories and arguably could be included under several other Annex I categories. Or, depending on how the process of project development was managed and how the Member State(s) in question decide how to handle such a review process, there are potentially several different aspects of a methane hydrate project that might need their own EIA review procedures.

So long as the methane hydrate project is designed to produce in excess of 500,000 m^3 of methane daily,[359] then the project would certainly qualify as an Article 4(1) - Annex I project

355. *Id.* at art. 1(4).

356. *Id.* at art. 2(1).

357. EIA Directive, *supra* note 349, at art. 4(1).

358. *Id.* at art. 4(2)(a)-(b).

359. The equivalent of 17,700,000 cf/d (17,700 mcf/d). *See Frequently Asked Questions*, U.S. ENERGY INFO. ADMIN., http://www.eia.gov/tools/faqs/faq.cfm?id=45&t=8 (last visited Dec. 1, 2014), *archived at* http://perma.cc/5QXT-G7CK.

requiring a full EIA process.[360] The methane extracted from methane hydrates is the same chemical as the term natural gas, thus methane extraction is *per se* natural gas extraction.[361] It is fairly unlikely that methane hydrate reservoirs contain substantial quantities of petroleum as distinct from natural gas; to the extent that any hydrocarbon liquids are recovered, it is very reasonable to assume that they would fall below the "500 tonnes/day" minimum requirement.[362]

Several ancillary aspects of methane hydrate projects would also likely qualify under Annex I. To the extent that CCS technologies are engaged to offset the extract volumes of methane with carbon dioxide, the project would be a storage site pursuant to Directive 2009/31 (The CCS Directive).[363] Depending on the location of the methane hydrate project and the gathering and transportation needs to move the methane and relate fluids from the wellsites to the platforms to onshore facilities, the project may qualify as a pipeline.[364] Assuming that methane qualifies as natural gas and if the pipelines involved in its transport were wider than eighty centimeters (cm) and longer than forty km, then the pipelines of the project would qualify.[365] If similar pipelines were utilized to transport carbon dioxide to the wellsites for sequestration, then those pipelines would also qualify under Annex I.[366]

Methane hydrate projects could be characterized as an integrated chemical installation for the production of basic organic chemicals.[367] Methane is an organic chemical; its extraction involves "chemical conversion processes" to convert

360. EIA Directive, *supra* note 349, at Annex I, § 14.

361. For a discussion on the chemistry of methane hydrates and their methane-character, see MECHANISM DESIGN FOR THE FIERY ICE, *supra* note 1, at ch. 2, § 2.

362. EIA Directive, *supra* note 349, at Annex I, § 14. For a discussion on the chemistry of methane hydrates, *see* MECHANISM DESIGN FOR THE FIERY ICE, *supra* note 1, at ch. 2, § 2.

363. EIA Directive, *supra* note 349, at Annex I, § 22. For a discussion on the nexus of CCS and methane hydrates, see MECHANISM DESIGN FOR THE FIERY ICE, *supra* note 1, at ch. 3, § 5.1.

364. EIA Directive, *supra* note 349, at Annex I, § 16.

365. *Id.* at Annex I, § 16(a).

366. *Id.* at Annex I, § 16(b).

367. *Id.* at Annex I, § 6(a).

methane hydrates to methane and other components.[368] One would reasonably assume that the scale of investment required to construct methane hydrate projects presumes chemical product volumes sufficient to qualify as "on an industrial scale."[369] To the extent that the project is engaged in the conversion of the methane and water volumes into steam and hydrogen, the project might qualify as in the "production of basic inorganic chemicals."[370] In that case, the chemical processes to convert methane to hydrogen would better satisfy the "chemical conversion processes" requirement.[371]

Methane hydrate projects might be characterized as groundwater abstraction schemes to the extent that the water volumes associated with the methane in the hydrate formations is produced alongside the methane.[372]

It is possible that methane hydrate projects could be characterized as "trading ports, piers for loading and unloading," if the offshore structures are built in such a manner to facilitate transport of produced methane, water, or hydrogen volumes.[373]

Methane hydrate projects should not be characterized as crude-oil refineries nor as gasification/liquefaction installations of coal or bituminous shales.[374] Methane hydrate projects would lift negligible amounts of crude oil, if at all, and no volumes of coal or shale would be extracted nor processed. To the extent that any hydrocarbon liquids would be produced coincidentally at a methane hydrate project, it would be very unlikely for those chemicals to be processed or refined onsite; more likely they would be relocated to a regular refinery location for disposition.

368. *Id.* at Annex I, §§ 6, 6(a). For details on the chemical processes involved, see MECHANISM DESIGN FOR THE FIERY ICE*, supra* note 1, at chs. 2-3.

369. EIA Directive, *supra* note 349, at Annex I, § 6.

370. *Id.* at Annex I, § 6(b).

371. *Id.* at Annex I, § 6.

372. EIA Directive, *supra* note 349, at Annex I, § 11. For a discussion on the chemistry of methane hydrates, *see* MECHANISM DESIGN FOR THE FIERY ICE*, supra* note 1, at ch. 2, § 2.

373. EIA Directive, *supra* note 349, at Annex I, § 8(b).

374. *Id.* at Annex I, § 1.

b. Offshore Methane Hydrates Qualified Under Annex II

Given that the EIA procedures will almost certainly be invoked by the Annex I analyses, it is still worthy to review the Annex II categories because there are several additional categories of activities that are not present in the Annex I list that might also merit review under a methane hydrate project.

Under the category of "Energy Industry," there are several subcategories that might be involved as support systems to a methane hydrate project. Industrial installations for carrying gas, steam, or water may be involved in both offshore efforts to extract the methane, or as part of onshore support systems.[375] To the extent that the methane hydrate project is producing substantial volumes of natural gas that will need translation into an onshore distribution network, it is likely that the facilities will need storage facilities to provide safe and reliable delivery of the natural gas into the distribution pipelines. As such, the methane hydrate project may include the sub-categories of surface storage of natural gas, underground storage of combustible gases, and surface storage of fossil fuels.[376]

As the methane hydrates are in a solid form prior to removal from the deposit, it would be reasonable to describe their extraction as an extractive industry category. First, the surface industrial installations for the extraction of natural gas that will be associated with a methane hydrate project would likely independently qualify as an Annex II category project.[377] As the hydrates are underground, they potentially involve underground mining.[378] While not immediately foreseeable, it is not impossible to imagine that marine or fluvial dredging may be involved in either the direct extraction of methane hydrates or utilized as a means of facilitating the removal of methane hydrates.[379] While the phrasing of deep drilling is left unclarified in Annex II, it is conceivable that fresh water can be produced

375. *Id.* at Annex II, § 3(b).
376. EIA Directive, *supra* note 349, at Annex II, §§ 3(c)-(e).
377. *Id.* at Annex II, § 2(e).
378. *Id.* at Annex II, § 2(b).
379. *Id.* at Annex II, § 2(c).

from the hydrate deposits and then positioned as potable water for human or livestock consumption.[380]

Certain aspects, or sub-projects, of a methane hydrate project are likely to fit within several of the sub-categories of Infrastructure Projects. Depending on the overall footprint of the project and its associated co-projects, *e.g.* electrical power generation, it might be engaged in the development of an industrial estate project.[381] To the extent that carbon dioxide sequestration is involved in the methane hydrate project, it would likely involve gas pipeline installations and pipelines for the transport of the to-be-injected carbon dioxide.[382] And without regard to the use of hydrate waters as potable waters, if the project plans to remove those waters from the deposit, then the project could be seen as engaged in the abstraction of groundwater.[383]

It is not likely that the products from a methane hydrate project would qualify as petroleum, petrochemicals, or as chemical products.[384] Nor is it likely that a methane hydrate project or its products would be considered as part of a chemical industry category.[385] Nor would the methane hydrate project fit any of the categories under Annex II's Mineral Industry, as the listed items are fairly specific and exclude any of the materials involved in a methane hydrate project.[386]

Qualification under Annex II requires a determination from the relevant Member State on whether the project needs an EIA assessment.[387] The requirements for the determination are detailed in Annex III;[388] they are broad and detailed in scope. Annex III requires the detailing of the project's characteristics; of note are the use of natural resources, the production of waste, the associated pollution and nuisances, and the risk of major

380. *Id.* at Annex II, § 2(d)(iii).
381. *Id.* at Annex II, § 10(a).
382. EIA Directive, *supra* note 349, at Annex II, § 10(i).
383. *Id.* at Annex II, § 10(l).
384. EIA Directive, *supra* note 349, at Annex II, § 6(c).
385. *Id.* at Annex II, § 6.
386. *Id.* at Annex II, § 5.
387. *Id.* at art. 4(2).
388. *Id.* at art. 4(3).

accidents with particular regard to the substances or technologies involved in the project.[389] The location of the project is critical, especially with regards to the existing use of the area, the regenerative capacity of the project's surroundings, and the impacts on wetlands, coastal zones, nature reserves, and parks.[390] Finally the characteristics of the potential impact must be detailed.[391] All of the issues previously addressed in Annex III must also be addressed with regards to the extent of the impact on populations and the geographical area, on the trans-frontier nature of the project, the magnitude and complexity of the impact from the project, the probability of the impact, and of the duration, frequency, and reversibility of the impact.[392]

i. Risk Governance Within the EIA Directive

The collection of data provided at the early stage of pre-development is of focused interest to efficient governance of the risks and harms from methane hydrate projects. The risks of the project need to be clearly enumerated and stated,[393] the probability of the impact needs to be forecast,[394] and the duration and frequency of potential accidents needs to be squarely addressed.[395] The actual nature of the impact, of the potential harms and hazards, needs to be surveyed; the potential for reversibility also needs to be evaluated.[396]

There is value to this Annex II and III process, even if the Member States decide to exempt the project from an EIA review. All of this data is collected prior to the onset of the EIA assessment itself, and then provided to the public.[397] Additionally, the public (which one assumes would include both the impacted communities and specialized public interest groups)

389. *Id.* at Annex III, § 1(c)-(f).
390. EIA Directive, *supra* note 349, at Annex III, § 2(a)-(c)(i), (ii), (iv).
391. *Id.* at Annex III, § 3.
392. *Id.* at Annex III, § 3(a)-(f).
393. EIA Directive, *supra* note 349, at Annex III, § 1(f).
394. *Id.* at Annex III, § 3(e).
395. *Id.* at Annex III, § 3(f).
396. *Id.; see generally id.* Annex III, §§ 2(c), 3(a), (e).
397. *Id.* at art. 4(4), (5).

has an opportunity to engage in the determination process, enabling it to request information and explanations that the competent authorities might not have requested.[398] Thus, from a negligence rule point of view, the awareness of a duty to act with care is made manifest, and the type of information that a judge might need to evaluate the level of care undertaken is made publicly available; even if the Member State decides to not require an EIA, this data would greatly reduce the transaction costs of litigation and enable both regulators and private parties to bring lawsuits if harm does in fact result from the project.

Once a project qualifies for assessment,[399] the EIA Directive requires application of Articles 5 through 10 in the completion of the assessment.[400] Article 5 requires the assessment include all of the information as directed under Annex IV.[401] Additionally, the developer may request clarification on what types of information are to be included in the assessment from the specific competent authority for the relevant member state.[402] At a minimum, the developer should submit to the competent authorities:

> (a) a description of the project comprising information on the site, design and size of the project;
> (b) a description of the main effects which the project is likely to have on the environment;
> (c) a description of the measures envisaged in order to avoid, reduce and, if possible, remedy significant adverse effects;
> (d) an outline of the main alternatives studied by the developer, and an indication of the main reasons for his choice, taking into account the environmental effects;
> (e) a non-technical summary of the information referred to in points (a) to (d).[403]

398. *Id.* at art. 6(1). This form of public interaction is parallel to more discrete means of engagement, such as privately lobbying the competent authorities and other branches of the Member State's regulatory administration.

399. EIA Directive, *supra* note 349, at art. 4(1) (with reference to Annex I). *See also id.* at art. 4(2), (3).

400. *Id.* at art. 4(1), (2) (for Annex I and II projects, respectfully).

401. *Id.* at art. 5(1)(f).

402. EIA Directive, *supra* note 349, at art. 5(2).

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

All five issues should address both their direct and indirect effects on: (i) human beings, fauna and flora, (ii) soil, water, air, climate and the landscape, (iii) material assets and cultural heritage, and (iv) the interaction between all of these factors.[404] The Annex IV requirements are stated simply, but they require both broad and detailed reports. The description of the project would need to explain both the production processes of the methane hydrate project, and estimates of the expected residues and emissions, which includes all forms of pollution.[405] The breadth of the emissions definition, which includes such phenomena as vibrations, light, and heat, might include disturbances such as earthquakes or tsunamis in the case of a methane hydrate project.[406] A review of the alternatives must be submitted; clearly such information provides documentary proof of both the options acknowledged to be known and tacit admissions of technologies unknown to the developer, if they cannot list them as an alternative one assumes that they are unaware.[407] The developers are also responsible for explaining the choices made by the developer while taking into account the effects of those choices on the environment.[408] In Annex IV, section three, there is a repeat of the requirements found within the EIA Directive itself to report on the impacts on life, cultural assets, and the environment.[409] Annex IV also requires a study of the impacts, including potential harms, of the project's simple existence in the environment, of its use of natural resources, and

404. *Id.* at art. 3(1)(a)-(d).

405. *Id.* at Annex IV, § 1. "A description of the project, including in particular: (a) a description of the location of the project; (b) a description of the physical characteristics of the whole project . . . and the land-use requirements during the construction and operational phases; (c) a description of the *main characteristics of the operational phase of the project (in particular production process),* for instance . . . the nature and quantity of the materials . . . used; (d) an estimate, by type and quantity, of *expected residues and emissions* (such as *water, air, soil and subsoil pollution*, noise, *vibration*, light, heat [and] radiation . . . produced during the construction and operation phases." (emphasis added).

406. EIA Directive, *supra* note 349, at Annex IV, § 1(d).

407. *Id.* at art. 5(1)(d).

408. *Id.* at art. 2.

409. *Id*. at art. 3(a)-(d).

of the potential of the project to emit pollution, create nuisances, and to eliminate, meaning discharge, waste products.[410]

Once the various impacts and potential harms and hazards have been itemized, potential means of prevention, reduction, and offsetting measures should be provided in the assessment.[411] To the extent that the developer can identify where shortfalls in knowledge or technology exist that would improve the assessment itself, they should ensure that such is provided in the report.[412] An explanation of the scientific methods and techniques used to develop the above forecasts is to be included in this assessment of potential impacts.[413] Finally, there is a requirement to provide a non-technical version of the above reports within the assessment.[414]

While that assessment is in drafting and undergoing review, there are several opportunities for non-developer parties to engage in the process. Member States are required to ensure that all of the relevant authorities are given opportunities to express their expertise on the assessment.[415] The general public has extensive rights reserved within the EIA Directive.[416] Most importantly, the public is to be informed when and where the information gathered for the assessment will be made public and when the public can participate in the assessment review.[417] The EIA Directive itself does not explicitly provide means of control, approval, or veto to the public, but the Directive would allow each Member State to grant this to its own citizens under its own statutes.[418] However, the public has a right reserved to either, receive a sufficient interest in the review and development of the assessment, or to have access to due process before a court of law or other independent and impartial body to challenge the

410. *Id.* at Annex IV, § 4.
411. *Id.* at art. 5(1)(c).
412. EIA Directive, *supra* note 349, at Annex IV, § 8.
413. *Id.* at Annex IV, § 5.
414. *Id.* at art. 5(5)(e).
415. *Id.* at art. 6(1).
416. EIA Directive, *supra* note 349, art. 6(2)(a)-(g).
417. *Id.* at art. 6(2)(f), (g).
418. *Id.* at art. 2.

decision, acts, or omissions on substantive or procedural grounds.[419]

The EIA Directive requires that the assessment review engage other Member States should they be discovered to be at a transboundary risk.[420] Similarly, the transboundary-affected Member State, once engaged, shall provide to its authorities and the public the same access to the information as was afforded to the parties in the original Member State.[421]

Critically important is the conclusion of the assessment process, at which time the Member State(s) need to release the reasons for the decision (and any attached conditional requirements), an explanation of the impact of the public's participation on the decision process, and a description of the main measures necessary to avoid, reduce, and offset the major adverse effects of the approved project.[422]

Because the rules provide for both the technical and non-technical provision of the information, the public and other parties will face lower transaction costs in reviewing the materials. This would affect both the potential *ex post* litigation decisions made after an impact event, *e.g.,* a harmful accident, or to better facilitate the *ex ante* drafting of necessary regulations.

2. The SEA Directive

Whereas the EIA Directive applied to projects, the SEA Directive is targeted at plans and programs; in short, at legal or political policies.[423]

Plans and programs, broadly speaking, are those plans and programs that are undertaken by authorities within Member States at local, regional, or national levels and are subject to legislative procedure by Parliament or Government.[424] The

419. *Id.* art. 11(1), as limited by art. 11(2), (3).
420. *Id.* art. 7(1)(a).
421. *Id.* at art. 7(2), (3).
422. EIA Directive, *supra* note 349, at art. 9(1).
423. SEA Directive, *supra* note 350, at art. 1.
424. *Id.* at art. 2(a).

overall character of the Directive is procedural in nature, not substantive.[425]

The preamble of the SEA Directive explains that the *precautionary principle* was a central goal of the Directive, to preserve, protect, and improve the quality of the environment, the protection of human health, and the prudent and rational utilization of natural resources.[426]

A SEA is required for every plan or program that is likely to have significant environmental effects.[427] There are specific explicit requirements for SEAs to be drawn for any plan or program prepared for energy, industry, transport, waste management, and water management, among others, if those plans or programs would set the framework for future development of those areas of interest listed within Annex I and II of the EIA Directive.[428]

Additionally, Member States should identify if other plans or projects would have significant environmental effect beyond those identified if review is undertaken, and if a SEA is found unwarranted, then the authorities need to make that analysis public.[429] These SEAs are to be accomplished and completed prior to the submission or adoption of the plans or programs by a legislative process.[430]

Due to the nature of the plans and programs being essentially of a political and legislative nature, there is inherently a certain amount of due process and democratic political process within the EU to support an assumption that the public ultimately does have a say on these plans and programs. The SEA Directive highlights the need and mandates the active participation of the public, and other authorities beyond the drafters of a SEA, to ensure that they have a chance to review the

425. *Id.* pmbl. § 9.

426. *Id.* pmbl. § 1. Plans or programs related to methane hydrate projects would most likely qualify under the categories of energy and industry, and potentially under the waste and water management categories.

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

428. *Id.* at art. 3(2)(a).

429. SEA Directive, *supra* note 350, at art. 3(4), (7).

430. *Id.* at art. 4(1).

findings of the SEA and to consult on the SEA.[431] Furthermore, in the event of transboundary considerations, the SEA Directive has functionally similar mechanisms to the EIA Directive.[432]

The information to be reviewed under a SEA assessment is detailed at Annex I to the SEA Directive.[433] In an effort to be as inclusive as possible of relevant information, the Annex advises to include all information from its immediate implications, as well as its "secondary, cumulative, synergistic, short, medium, and long-term permanent and temporary, positive and negative effects."[434] It is clear that the assessment is to be drafted from as broad and inclusive a perspective as possibly feasible; if there are any harmful effects due to the plans or programs evaluated, however vague, they should identified, quantified, and probabilistically modeled for both benefits and costs.[435]

The notion of plans and programs are not projects, more an art of law or policy building, and as such merit slightly different considerations than those listed under Annex IV of the EIA Directive.[436] It should include an outline of the contents and main objectives of the plans or programs, as well as any interconnection(s) with other plans or programs.[437] It should describe the current state of the target environmental settings and how they might evolve without the plans or programs.[438] The assessment should make clear what characteristics are likely to be impacted by the plans or programs and how the plans or programs are expected to protect those areas or characteristics.[439]

The SEA Directive's Annex I repeats the mantra of life from the EIA directive;[440] it also requests specification of the measures envisaged to prevent, reduce, and offset any significant adverse

431. SEA Directive, *supra* note 350, at art. 6(1), (2). *See id.* art. 6(4) (NGOs); *See also id.* at pmbl., § 15.

432. *Id.* at art. 7.

433. *Id.* at Annex I.

434. *Id.* at Annex I, n.1.

435. *See generally id.* at Annex I.

436. EIA Directive, *supra* note 349, at Annex IV.

437. SEA Directive, *supra* note 350, at Annex I(a).

438. *Id.* at Annex I(b).

439. SEA Directive, *supra* note 350, at Annex I(c), (d).

440. *Id.* at Annex I(f) ("human health, fauna, flora, soil, water, air "). *See* EIA Directive, *supra* note 349, at art. 3; *see also id.* at Annex IV, art. 3.

effects of the plans or programs on such ecological and social concerns; this should include technical descriptions of the various monitoring methods necessary to achieve these goals.[441] It also demands for the reasons why the particular plans or programs were selected, which options were eliminated and the reason for their elimination, and what limits in knowledge frustrated or limited a more complete review of the options.[442] Finally, a non-technical version of the above discussions is required.[443]

3. Environmental Liability and Seveso III Directives

The EU has provided two legal instruments to address the commercial and industrial activities that could result in environmental and social harms, the Environmental Liability Directive (ELD)[444] and the Seveso III Directive (Seveso III).[445] These establish doctrines that then have broader applications in other areas of environmental regulation, such as the Birds and Habitats Directives,[446] the MSF Directive,[447] and the Water Framework Directive (WFD).[448] The ELD is not likely to apply to

441. SEA Directive, *supra* note 350, at Annex I(f), (g), (i).

442. *Id.* at Annex I(h).

443. *Id.* at Annex I(j).

444. Directive 2004/35, of the European Parliament and of the Council of 21 April 2004 on Environmental Liability with Regard to the Prevention and Remedying of Environmental Damage, 2004 O.J. (L 143) 56 [hereinafter ELD].

445. Directive 2012/18, of the European Parliament and of the Council of 4 July 2012 on the Control of Major-accident Hazards Involving Dangerous Substances, Amending and Subsequently Repealing Council Directive 96/82/EC, 2012 O.J. (L 197) 1 [hereinafter Seveso III].

446. Directive 2009/147, of the European Parliament and of the Council of 30 November 2009 on the Conservation of Wild Birds, 2009 O.J. (L 20) 7 [hereinafter Birds Directive]. *See also* Directive 92/43 of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora, 1992 O.J. (L 206) 7 [hereinafter Habitats Directive].

447. Directive 2008/56 of the European Parliament and of the Council of 17 June 2008 on Establishing a Framework for Community Action in the Field of Marine Environmental Policy (Marine Strategy Framework Directive), 2008 O.J. (L 164) 19.

448. *See* Directive 2000/60 of the European Parliament and of the Council of 23 October 2000 on Establishing a Framework for Community Action in the Field of Water Policy, 2000 O.J. (L 327) 1 [hereinafter Water Policy Directive] (example of one of the major directives within that framework).

the development of offshore methane hydrate projects, the Seveso III is *per se* not applicable to the offshore development of hydrocarbons such as methane hydrates.

Beyond those, the Directive on Natural Habitats governs the impacts on special environment ecologies and on certain protected species.[449]

a. Environmental Liability Directive

i. Unsure Applicability to Methane Hydrates

The ELD was intended to address environmental harms and hazards generally. The Offshore Directive and the CCS Directive have also applied the ELD to address the liabilities from environmental harms from offshore activities and carbon sequestration activities.[450] But, there are several reasons that the ELD is not likely to address the events associated with methane hydrate projects: (i) the ELD's limited scope of environmental damages, (ii) the Lack of applicable Annex III activities, (iii) the difficulty of establishing potential non-Annex III activities, and (iv) the exclusion of certain international conventions on civil liability.

The ELD governs environmental damages caused by occupational activities;[451] its focus is squarely on damages to nature.[452] However, the ELD does not apply to all sources of environmental hazards.[453] It declares that it addresses only

449. *See* Habitats Directive, *supra* note 446.

450. It would at first appear that the ELD limits itself to waters closer to the shoreline than where methane hydrates are deposited. However, the adoption of the ELD methods by the Offshore and CCS Directives would extend this zone of application.

451. ELD, *supra* note 444, at art. 3(1)(a).

452. ELD, *supra* note 444, at art. 2(1)(a)-(c). "This Directive should apply, as far as environmental damage is concerned, to occupational activities which present a risk for human health or the environment," *see id.* at art. 2(8). Of course, environmental harm can impact humans and human health in many ways, but the ELD handles the human-related issues indirectly. The extent of land damage is limited to include those contaminations that create a significant risk of human health. *See id.* art. 2(1)(c).

453. *See id.* at art. 4.

those causes of harm that arise from a diffuse character wherein a causal link still functions to connect tortfeasor and accident.[454] There are also exceptions for various acts of God and *force majeure* that result in accidents otherwise covered within the ELD.[455] The damage can be created by nature or pose an imminent threat[456]; an imminent threat requires a sufficient likelihood of the threat in the near future.[457]

Environmental damage is defined as measurable adverse change in a natural resource, which worsens the environment against a baseline, unless permitted by relevant authorities from the Member States[458]:

> damage to protected species and natural habitats, which is any damage that has significant adverse effects on reaching or maintaining the favourable conservation status of such habitats or species. The significance of such effects is to be assessed with reference to the baseline condition, taking account of the criteria set out in Annex I;
>
> Damage to protected species and natural habitats does not include previously identified adverse effects which result from an act by an operator which was expressly authorised by the relevant authorities.[459]

454. *Id.* at art. 4(3).

455. *Id.* at art. 4(1)(a), (b). *See also id.* art. 4(6) (activities related to war or natural disasters).

456. *Id.* at art. 3(1)(a), (b).

457. ELD, *supra* note 444, at art. 2(9).

458. *Id.* at art. 2(2). Clearly this raises an immediate issue of metrics, measurements, observation, and detection. In many cases, these are not necessarily readily reduced to low-cost technologies, and thus might be seen as preventing recognition of certain damages that are less readily reduced to measurement or lack clear *ex ante* base lines against which to draw contrasts over time. Certain damages may have occurred in a location that *ex ante* to detection was not assumed to be a likely site of damage and so went unobserved at the beginning of the operations that ultimately led to the harm. Yet, this might also serve as an incentive to both protect the courts from the nuisance of unserviceable pleas and to encourage the development of baseline metrics by those interested in protecting their surroundings. Those best able to observe suggest the ELD have a duty to themselves to monitor and take measurements.

459. ELD, *supra* note 444, at art. 2(1)(a). *See also id.* art. 2(3)(a)-(b) (definition of protected species and natural habitats). *See generally* Council Directive 79/409, of 2 April 1979 on the Conservation of Wild Birds, art. 4(2), 1979 O.J. (L

Thus, the scope of damages under the ELD is primarily centered on those "parties" that would not otherwise be able to bring their own complaints to trial. This limits the potential applicability of the ELD to the various potential injuries and harms that might result from offshore methane hydrate accidents.

The listed activities under Annex III do not appear to overlap with the general nature of methane hydrate projects. Annex III activities do not include activities that are substantially related to methane hydrate project related activities.[460] Issues of waste management, water disposal management, and water abstraction might be relevant to a methane hydrate project, but it is not clear that the intent of the Annex III listings had such an offshore purpose in mind.[461] It is also not clear that the operations at an offshore methane hydrate project would be seen as in the manufacture, use, storage, etc., of dangerous chemicals.[462]

Given the lack of applicable activities under Annex III and the lack of clearly excludable conventions under Article 4, unless the environmental risks of methane hydrates are included within the scope of Annex III, those harms would likely only be found applicable under the "at fault" rule of Article 3, Section 1(b). Thus, some focus needs to be put on those non-Annex III occupational activities that could damage protected species and natural habitats.

While one might expect to find broad definitions of water damages as provided within the U.S.'s Clean Water Act, such is not available under the ELD. Water damage, another form of environmental damage, includes any damage that "significantly adversely affects the ecological, chemical and/or quantitative status and/or ecological potential" of the waters addressed within the River Basin Water Directive.[463] This is partially due to

103) 1 (idea of protected species and natural habitats); *see also* Habitats Directive, *supra* note 446, at Annexes II, IV.

460. *Id.* at Annex III, arts. 1-12.

461. *Id.* at Annex III, arts. 2, 3, 4, 6.

462. *Id.* at Annex III, art. 7.

463. Habitats Directive, *supra* note 446, at art. 2(1)(b). *See also* Water Policy Directive, *supra* note 448, at art. 2(1) (definition of surface water upon which ELD relied). *See also* ELD, *supra* note 444, at art. 2(5) (nominally limits waters

separate EU actions on the EU related seas and oceans.[464] However, this nuanced definition would appear to prevent the application of the ELD to the waters under which the vast bulk of methane hydrates are expected to lay, as methane hydrates lay offshore the coasts beyond the reach of the River Basin Frameworks.[465]

It is also difficult to connect the onshore harms of cataclysmic methane hydrate accidents to application under the ELD. Land damage is defined in a fairly limited sense to impacts on human health: "significant risk of human health being adversely affected as a result of the direct or indirect introduction, in, on or under land, of substances, preparations, organisms or micro-organisms."[466] Perhaps sudden inundation by water would qualify as an 'introduction of a substance that could adversely affect human health,' but it reads beyond the intent of the ELD.

There is a potential argument to boot-strapping the ELD into regulating the development of methane hydrate projects, in that *arguendo* methane hydrates are *themselves* a natural resource deserving protection under Article 2.[467] The definition of damage includes a reference to adverse change to a natural resource; to the extent that a methane hydrate project damaged the hydrate deposits, and the impairment of use and production for future generations, then the notion of environmental damage might reasonably apply.[468] However, natural resource is a defined term within the ELD and appears to exclude natural resources such as methane hydrates, as they are not generally considered to be a "protected species and natural habitats, water and land," especially as land damage is previously defined as that which causes adverse risks to human health by the introduction of substances, preparations, organisms, or micro-organisms.[469]

to just those of the River Basin Frameworks). *See generally* Water Policy Directive, *supra* note 448.

464. *See* discussion on the various water protection frameworks within the EU. *Infra* Parts III(D)(6)(a), III(D)(6)(c).

465. *See* MECHANISM DESIGN FOR THE FIERY ICE, *supra* note 1, at ch. 2, §§ 4, 5, for discussions on geology and geography of methane hydrates.

466. ELD, *supra* note 444, at art. 2(1)(c).

467. *Id.* at art. 2(12).

468. *Id.* at art. 2(2).

469. ELD, *supra* note 444, at art. 2(1)(c), 2(12).

Finally, there may be some protected species and natural habitats in the vicinity of methane hydrate projects; but it is most likely that if protection of the species and habitats near methane hydrates are to be protected that they will need to be more explicitly detailed as a target under the relevant frameworks. Protected habitats could include methane hydrates, as "1180 Submarine structures made by leaking gas" is a designated habitat under the Habitats Directive,[470] but 1180 is not currently listed as a priority habitat and thus is not protected under the ELD.[471] It is also not clear that the structures itemized at 1180 are methane hydrate deposits versus other sources of subsea methane, such as a volcanic vent.[472] The 1180 is neither a special habitat, nor is it occupied by specially protected species, so it is not an area currently protected by the Habitat's Directive. As a result, it is not likely that the ELD's damage to the natural resources clause would apply to methane hydrates unless amended or clarified.

The ELD excludes a list of pre-existing conventions that are of a more specialized nature, and thus deemed better suited to the particular harms addressed within those conventions.[473] Of the conventions listed at Annex IV, four of the five listed address oil pollution:

i. "International Convention of 27 November 1992 on Civil Liability for Oil Pollution Damage;"[474]

ii. "International Convention of 27 November 1992 on the Establishment of an International Fund for Compensation for Oil Pollution Damage;"[475]

470. Habitats Directive, *supra* note 446, at Annex I.

471. EUR. COMM'N, INTERPRETATION MANUAL OF EUROPEAN UNION HABITATS 16 (2013), *available at* http://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/Int_manual_eu28.pdf, *archived at* http://perma.cc/LU39-BRCK.

472. *Id.* The Manual describes structures of carbonate cement and is less focused on the underlying reservoirs from whence the methane originates; the Manual is focused on the locus of plants and animals near these structures. Usually there are no plants, but a large diversity of invertebrates is found in these areas.

473. ELD, *supra* note 444, at art. 4(2) (with reference to Annex IV). *See also id.* at art. 4(3) (with reference to certain maritime related conventions).

474. *Id.* at Annex IV(a).

475. ELD, *supra* note 444, at Annex IV(b).

iii. "International Convention of 23 March 2001 on Civil Liability for Bunker Oil Pollution Damage;"[476]

iv. "International Convention of 3 May 1996 on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea;"[477]

Given this extensive exclusion of the oil spill paradigm from the ELD, one wonders to what extent events from a methane hydrate project might likewise become excluded from the ELD. A careful reading of the excluded conventions reveal that damages discussed in those conventions are unlikely to be coincident with a methane hydrate accident. Thus, the result is inconclusive.

ii. Governance of Risk Within the ELD

The ELD provides that the prevention and remedying of environmental damages should be developed through the *polluter pays principle*.[478] Thus, operators of activities that create environmental damages should be required to be financially liable for those damages; this is explicitly intended to provide economic incentives to motivate operators to minimize the risks of such accidents so that their exposure to financial liabilities is reduced.[479]

The ELD presents a mixed strategy with regards to liability; the ELD distinguishes between Annex III activities and non-Annex III activities.[480] The ELD applies to environmental damages caused by activities listed at Annex III and to any damage to protected species and natural habitats caused by occupation activities not on Annex III.[481] Annex III activities are

476. *Id.* at Annex IV(c).

477. *Id.* at Annex IV(d).

478. *Id.* Annex IV(d)(2), (18) (explanation of 'polluter-pays' principle). *See also id.* at art. 1.

479. *Id.* at art. 1(2).

480. The ELD explicitly avoids engagement with rights of compensation for traditional damage under international agreements on civil liability. *See id.* at art. 1(11).

481. ELD, *supra* note 444, at art. 3(1)(a)-(b).

to be governed by a rule of strict liability.[482] Non-Annex III activities are to be governed by "at fault" rules.[483]

Should a competent authority find an operator nonresponsive and thus decide to undertake such measures by themselves, the competent authority is able to recover those expenditures from the operators.[484] To avoid a pass-through tax burden to tax payers, competent authorities may charge the operators fees for the transaction costs of addressing the environmental hazards and harms.[485]

The ELD is limited to addressing environmental damage, and *per se*, the ELD is categorically denied application to matters of personal injury, private property damages, and forms of economic loss.[486] It also excludes several international conventions on civil liability.[487] Additionally, the ELD yields no rights to private parties to make economic recoveries for damage to such protected species or habitats; its application remains on the public welfare.[488]

b. Seveso III Directive

Seveso III applies to the prevention and control of major accidents that introduce dangerous substances to the environment; is it further stated *inter alia* that the accidents are generally industrial in nature.[489] In that regard, it is similar to the perspective of the UNCTEIA and indeed Seveso III is the implementation of that Convention within the EU.[490] Seveso III appears to take stronger language than the UNCTEIA. In contrast to the Convention's repeated use of "appropriate," Seveso III repeatedly relies on the phrase "all necessary measures." "Operators should have a general obligation to take all necessary

482. *Id.* at art. 3(1)(a).
483. *Id*. at art. 3(1)(b). *See also id.* at pmbl., § 9.
484. *Id.* at pmbl., § 18.
485. *Id.*
486. *Id.* at pmbl., § 14.
487. ELD, *supra* note 444, at pmbl., § 11.
488. *Id.* at art. 3, § 3.
489. Seveso III, *supra* note 445, at art. 1.
490. *Id.* at pmbl., §§ 1, 2, 3, 5.

measures to prevent major accidents;"[491] "the operator is obliged to take all necessary measures;"[492] the Member States must inspect to ensure that "the operator has taken all necessary measures;"[493] and the discussion of the duties of a Member State after an accident uses the term "necessary" three times throughout Article 17.[494]

i. Inapplicability of Seveso III to Offshore Methane Hydrates

Seveso III provides the rules for the prevention of major accidents involving dangerous substances.[495] And Seveso III does include both hydrogen and natural gas as dangerous substances.[496]

However, Seveso III does not apply to the offshore exploration and exploitation of hydrocarbons such as methane hydrates.[497] Seveso III, also does not apply to the exploration, exploitation, extraction, and processing of minerals from boreholes such as methane hydrates.[498]

Seveso III does not cover underground storage of natural gas in conjunction with the exploration and exploitation of hydrocarbons such as methane hydrates.[499] And finally, Seveso III would not apply to the pipeline transport of methane, hydrogen, or other dangerous substances.[500]

As such, there is very little potential for the development of methane hydrate projects to be regulated by Seveso III.

491. Seveso III, *supra* note 445, at pmbl., § 12.
492. *Id.* at art. 5(1).
493. *Id.* at art 5(2).
494. *Id.* at art. 17(a)-(c).
495. *Id.* at art. 1.
496. *Id.* at Annex I, Part 2, §§ 15 (hydrogen), 18 (liquefied flammable gases).
497. Seveso III, *supra* note 445, at art. 2(2)(f).
498. *Id.* at art. 2(2)(e).
499. *Id.* at art. 2(2)(g).
500. *Id.* at art. 2(2)(d).

ii. Risk Governance Within Seveso III

Seveso III lacks a specific discussion on liability, other than of the obligations of the Member States to ensure that operators undertake all necessary measures.[501] However, the preamble makes clear that operator failed compliance should be met with penalties that should be effective, proportionate, and dissuasive.[502]

Given the mandate to provide for penalties for compliance failures and the repeated phrasings of "all necessary measures," there is a combined semantic sense of a duty that can be failed and that incentives should be provided to ensure that those duties are met. However, there is no discussion of what should occur if that duty is met and accidents still occur.

Is a strict liability rule suggested in the requirement for the operator to undertake all measures necessary to "limit their consequences,"[503] to the mandate that the "operator takes any necessary remedial actions?"[504] It is difficult to ascertain because there is a paucity of financial responsibility clarifications with Seveso III;[505] presumably the details rest within each Member State's individualized implementation. It is perhaps more reasonable that Seveso III expects domestic regulations to be drafted and implemented as part of a command and control regulatory framework.

4. Offshore Directive

As currently enacted, the Safety of Offshore Oil and Gas Operations Amending Directive (Offshore Directive) [506] would likely apply to the exploration, development, and production of

501. *See generally* Seveso III, *supra* note 445.

502. *Id.* at pmbl. § 29.

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

504. *Id.* at art. 17(c).

505. Neither Annex II nor Annex IV provide explicit requirements to detail whence financing is sourced for the remediation and compensation budgets. Annex II, § 5(c) does refer to "mobilizable resources." *Id.* at Annex II.

506. Directive 2013/30, of the European Parliament and of the Council of 12 June 2013 on Safety of Offshore Oil and Gas Operations and Amending Directive 2004/35/EC, 2013 O.J. (L 178) 66 [hereinafter Offshore Directive].

methane hydrates from offshore operations.[507] However, this article will demonstrate that the Offshore Directive remains focused on viscous oil spill damage and could be in need of amending to better address the potential hazards of offshore methane hydrate operations.[508]

a. Applicability to Offshore Methane Hydrates

The subject and scope of the Offshore Directive is to ensure the provision of "minimum requirements for preventing major accidents in offshore oil and gas operations and limiting the consequences of such accidents."[509]

Major accidents are defined as incidents associated with installations that involve "explosion, fire, loss of well control, or release of oil, gas or dangerous substances" and could result in substantial human injuries.[510] Other forms of major accidents include those that involve serious damage to the installation that also involve substantial human injuries,[511] events that lead to the serious injury of five or more humans,[512] or those events that

507. Exploration and production are defined terms of the Offshore Directive. *Id.* at art. 2(15), (16) respectively. The definition of exploration includes "drilling into a prospect and all related offshore oil and gas operations necessary prior to production-related operations." *Id.* at art. 2(15). However, traditional oil and gas parlance distinguishes between "exploration," the project phase focused on finding and identifying producible oil and gas volumes, and "development," the project phase that occurs after the financial investment decision and includes all the construction, drilling, and preparations prior to the onset of production activities.

508. The Offshore Directive was adopted in response to the events of April 20, 2010, when an oil and gas well broke near the production christmas tree valve stack, close to the seabed/ocean interface. The resulting accident brought awareness to the dangers of deep sea oil and gas exploration and production, as contrasted with the hazards of boat-based oil spills such as the Exxon Valdez of 1989. *See* Offshore Directive, *supra* note 506, at pmbl., § 5 ("Accidents relating to offshore oil and gas operations, in particular the accident in the Gulf of Mexico in 2010, have raised public awareness of the risks involved in offshore oil and gas operations and have prompted a review of policies aimed at ensuring the safety of such operations.").

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

510. *Id.* at art. 2(1)(a).

511. *Id.* at art. 2(1)(b).

512. *Id.* at art. 2(1)(c).

could result in major environmental damages.[513] Those major accidents need to occur offshore, which is defined as those areas within the territorial seas, EEZ, or continental shelves of member states.[514] The definition of offshore parallels the zones of "marine waters" for the MSF Directive,[515] thus the applicability of those regulations on the avoidance of environmental damages applies to offshore operations.[516] Finally, offshore oil and gas operations include most regular aspects of oil and gas exploration, development and production, except for trans-coastal transportation of oil and gas.[517]

As methane is natural gas, and assuming methane hydrate operations would require installation or infrastructure, the Offshore Directive applies to the exploration, development, and production of methane hydrates from the offshore waters of the Member States of the EU.[518] Events resulting from the release of methane from methane hydrate fields would be considered major accidents if they also resulted in "significant potential to cause, fatalities or serious personal injury," or if the methane ventings or seepages resulted in "any major environmental incident."[519] The additional cases of major accident also apply to those involving damages to the installation with corresponding human injuries or other incidents that result in substantial injuries to five or more persons.[520]

513. *Id.* at art. 2(1)(d).

514. Offshore Directive, *supra* note 506, at art. 2(2).

515. Directive 2008/56, of the European Parliament and of the Council of 17 June 2008 Establishing a Framework for Community Action in the Field of Marine Environmental Policy (Marine Strategy Framework Directive), art. 3, 2008 O.J. (L 164) 19 [hereinafter Marine Strategy Framework Directive].

516. *Id.* at art. 3(1)(a)-(b). *See also* Offshore Directive, *supra* note 506, at pmbl., § 58, which provides guidance that the "definition of water damage in Directive 2004/35/EC should be amended to ensure that the liability of licensees under that Directive applies to marine waters of Member States as defined in Directive 2008/56/EC."

517. Offshore Directive, *supra* note 506, at art. 2(3).

518. *Id.*

519. *Id.* at art. 2(1)(a), (d).

520. *Id.* at art. 2(1)(b)-(c).

b. Risk Governance Within the Offshore Directive

Member States are required to ensure that operators undertake all "suitable measures" of precaution, to provide that operators remain liable for the acts of their sub-contractors, and that operators undertake all "suitable measures" to limit consequences for human health and the environment.[521] The Directive requires that the Member States ensure that operators and licensees comply with the Directive.[522] The Member States are to provide penalties within their own legal systems for noncompliance.[523] The penalties should be "effective, proportionate, and dissuasive."[524]

Environmental damage and harm caused by offshore activities are to be regulated under the ELD.[525] The definition of environmental damage is inherited from the ELD.[526] Member States do a have an affirmative duty under the Offshore Directive to ensure that licensed operators are financially liable for both prevention and remediation of environmental harms from offshore activities; this is to be accomplished by domestic legislation.[527] The phrasing suggests a rule in comport with the operations of a strict liability rule, but the requirement does not particularly require a rule of civil liability, regulatory guidance would appear to suffice.[528]

While the Preamble to the Offshore Directive refers to a particular standard of care, "where the cost of further risk reduction would be grossly disproportionate to the benefits of such reduction,"[529] it does not appear that a rule of negligence

521. *Id.* at art. 3(1)-(3).

522. Offshore Directive, *supra* note 506, at art. 34.

523. *Id.* at art. 34.

524. *Id.*

525. *Id.* at art. 7.

526. *Id.* For a more complete discussion on the limitations of the ELD with regards to offshore methane hydrates, please see the discussion on the ELD, *see infra* Part III(D)(3)(a).

527. Offshore Directive, *supra* note 506, at art. 7.

528. Under the ELD, Annex III activities are *per se* under a strict liability rule, non-Annex III activities are under a "fault-based" rule. *See* ELD discussion *supra* Part III(D)(3)(a).

529. Offshore Directive, *supra* note 506, at pmbl., § 14.

was suggested. Rather, the whole of the Directive appears to reflect the *polluter pays principle*, and thus the rule of strict liability.[530] The licensee, as determined by Directive 94/22,[531] is to be held financially liable for both the prevention and remediation of major accidents and their consequences.[532]

Additionally, the Offshore Directive is subordinated to the rules under the EIA Directive, SEA Directive, and 94/22.[533]

i. Offshore Directive's Call for a Regulatory Body

Overall, the Offshore Directive provides for a deliberate and cautious review of offshore oil and gas projects prior to their licensing and throughout their operational periods. The Member States are required to allow for public participation during the review process.[534] Prior to the issuance of a license for offshore oil and gas operations, the Member States must ensure that the applicant is technically and financially capable of meeting their responsibilities under the Offshore Directive.[535] The Member States shall also ensure that the there are sustainable financial instruments made available to better provide for the financial needs of major accidents and their risk management.[536]

Competent authorities are to be established by the Member States to be responsible for overseeing the study, evaluation,

530. All EU environmental laws need to be read with the guidance of article 191(2) of TFEU, which states that the polluter pays principle is fundamental to all EU legislation. "Union policy on the environment shall aim at a high level of protection taking into account the diversity of situations in the various regions of the Union. It shall be based on the precautionary principle and on the principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay." Consolidated Version of the Treaty on the Functioning of the European Union, art. 191, Oct. 26, 2012, 2012 O.J. (C 326) 47 [hereinafter TFEU].

531. Offshore Directive, *supra* note 506, at pmbl., §12. *See* Directive 94/22, of the European Parliament and of the Council of 30 May 1994 on the Conditions for Granting and Using Authorizations for the Prospection, Exploration and Production of Hydrocarbons, 1994 O.J. (L 164) 3.

532. Offshore Directive, *supra* note 506, at art. 7.

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

534. *Id.* at art. 5(2)(a)-(f).

535. *Id.* at art. 4(2)(a).

536. *Id.* at art. 4(3).

regulatory compliance, and monitoring of major hazards.[537] Additional requirements are set out at Annex III. The competent authority is to remain independent and objective; it should not be involved in the revenue or economic development discussions related to the offshore projects it oversees.[538]

The European Maritime Safety Agency (EMSA) shall provide technical and scientific expertise to the Member States and the Commission, with special regards to the detection and monitoring of transboundary oil or gas spills.[539] EMSA may also assist in the drafting and development of the Member States' external emergency response plans, and may also develop a catalog of available emergency equipment and services.[540] EMSA may also assist the Commission in reviewing the external emergency response plans of Member States to ensure that the plans are in compliance with the Offshore Directive.[541] EMSA can also run review exercises to test the designed emergency mechanisms for major accidents.[542] EMSA has a potentially major role to play in ensuring consistent safety levels are maintained Union-wide.

ii. Regulatory Actions

Member States have to require that all suitable measures be undertaken to prevent major accidents.[543] Suitable is defined as "right or fully appropriate," in consideration of "proportionate effort and cost, for a given requirement or situation."[544]

The Member States should also require offshore oil and gas operations to be managed on the basis of systematic risk management so that any residual risks or hazards are acceptable.[545] Acceptable is defined as a level of risk that the costs or efforts to further reduce its expected harms would be grossly disproportionate to the benefits received from such

537. *Id.* at art. 8(1)(a)-(f).
538. Offshore Directive, *supra* note 506, at art. 8(2), 8(3); *id.* at art. 9(a).
539. Offshore Directive, *supra* note 506, at art. 10(1), (10)(2)(a).
540. *Id.* at art. 10(2)(b)-(c).
541. *Id.* at art. 10(3)(a).
542. *Id.* at art. 10(3)(b).
543. *Id.* at art. 3(1).
544. *Id.* at art. 2(6).
545. Offshore Directive, *supra* note 506, at art. 3(4).

reduction.[546] This is not a statement to halt efforts at risk reduction once marginal benefits exceed marginal costs, but rather a defense that not all technologically feasible measures need be undertaken if, on the whole, those resources might be put to better purposes for the impacted communities.

In this process of review, the operator/licensee is to submit a variety of plans and procedural documents:

i. a corporate major accident prevention policy,[547]
ii. a safety and environmental management system applicable to the installation,[548]
iii. a design notification for a production installation,[549]
iv. a description of the scheme of independent verification,[550]
v. a report on major hazards for a production or non-production installation,[551]
vi. an amended report on major hazards in the event of a material change or dismantling of an installation,[552]
vii. an internal emergency response plan,[553]
viii. a notification of well operation and information on that well operation,[554]
ix. a notification of combined operations,[555]
x. a relocation notification.[556]

The application of these guidelines to methane hydrates is straightforward. They require the operator to demonstrate that the major hazards and potential accidents are well understood. Each and every potential major hazard resulting from the

546. *Id.* at art. 2(8).
547. *Id.* at art. 11(1)(a). Detailed at *id.* at Annex I, § 8.
548. Offshore Directive, *supra* note 506, at art. 11(1)(b). Detailed at *id.* at Annex I, § 9, Annex IV.
549. *Id.* at art. 11(1)(c). Detailed at *id.* at Annex I, § 1.
550. Offshore Directive, *supra* note 506, at art. 11(1)(d). Detailed at *id.* at Annex I, § 5, Annex V.
551. *Id.* at art. 11(1)(e). Detailed at *id.* at Annex I, §§ 2, 3.
552. *Id.* at art. 11(1)(f). Detailed at *id.* at Annex I, § 6.
553. Offshore Directive, *supra* note 506, at art. 11(1)(g). Detailed at *id.* at Annex I, § 10.
554. *Id.* at art. 11(1)(h). Detailed at *id.* at Annex I, § 4, Annex II.
555. *Id.* at art. 11(1)(i). Detailed at *id.* at Annex I, § 7.
556. *Id.* at art. 11(1)(j). Detailed at *id.* at Annex I, § 1.

exploration and production of methane hydrates needs to be identified and cataloged. Not only surface-related hazards, but also those subsea- and seabed-related should be thus identified. The potential environmental harms from venting or seeping methane and resultant metabolites, such as carbon dioxide, needs to be inventoried. If additional chemicals are involved in the production of methane hydrates, such as injected carbon dioxide or in-situ fuels and oxidizers, then their potential environmental harms also need to be included in that study. The interactive effects of multiple wells into a common deposit, the effects of various production stimulation efforts, the impacts of field deterioration, and all of the combination events that might impact major hazards or major accidents should be analyzed. With regard to methane hydrates, particular attention needs to be placed on subsea and seabed activities. The likelihood and consequences of all of the major hazards of methane hydrate exploration and production need to be determined. Environmental, meteorological and seabed limitations on safe operations need to be evaluated from the perspective of methane hydrate fields and not from traditional oil and gas well stability perspectives. Similarly, the environmental conditions for methane hydrates may need to include consequences from landslides, tsunamis, and oxygen-deprived atmospheres near the major accident sites. A list of operations and expected correlated major hazards will need to be drawn up for methane hydrate exploration and production. While an operator would need to report on the number of persons adjacent to the installation per the Offshore Directive, it might not suffice to stop there. Operators should probably advise on the number of people who, while not involved in the operations of the installation, may still be impacted as a "first wave" of injuries or deaths. Due to the tsunami, landslides, and atmospheric fire risks, those people might be some distance from the installation.

The Member States will need to prepare their own SEAs as they develop their "plans and programs" in response to the Offshore Directive and each prospective operator will be expected to complete their own EIAs as they bring projects forward for

licensing and approvals; licensing authorities are required to consult with competent authorities.[557]

Prior to the onset of well operations and the commencement of offshore exploration and production, the Member States are required to ensure that the operators have in place internal emergency response plans.[558] The Member States are to ensure the operator retains and maintains appropriate expertise and equipment to perform its internal emergency response plans without delay whenever major hazards should emerge.[559] The Member States are also required to bring forward their own external emergency response plans and acts of emergency preparedness.[560] Annex VII and Annex VIII provide guidelines for the drafting of the external emergency response plans together with the operators;[561] once drafted, the plans should be shared with the Commission and the general public for feedback.[562]

Once operations commence, the Member States have the duty to require that the operator is taking all reasonable steps, in light of the definition of suitable, to carry out its functions and duties under the Offshore Directive.[563] If a Member State ascertains that an operator no longer has the capacity to meet the relevant requirements, it should remove that operator and propose a replacement operator to the licensing authority.[564] Amidst all of the EIA and similar risk and hazard studies that need to be presented, reviewed and enforced, the Member States need to enforce a variety of other measures as well. The Member States must ensure that only properly licensed parties are operators of installations within their jurisdictions.[565] Member States are required to enforce safety zones around the approved and

557. Offshore Directive, *supra* note 506, at pmbl., § 16. *See also id*. at art. 4(2), art. 5(1).
558. *Id.* at art. 28(1).
559. *Id.* at art. 28(2).
560. Offshore Directive, *supra* note 506, at art. 29(1).
561. *Id.* at Annex VII, VIII.
562. *Id.* at art. 29(3).
563. *Id.* at art. 6(3).
564. *Id.* at art. 6(4).
565. *Id.* at art. 6(1), (2).

permitted installations.[566] The Member States need to ensure that independent verification of the various risk and hazard studies is performed prior to the completion of design for production installations or prior to the onset of operations for non-production installations; the Member States must provide that the feedback from independent verifiers must be taken into consideration by the operators.[567] The Member States are to ensure that both the plans and the equipment necessary to address major hazards or major accidents is constantly kept ready and in place by the operators.[568] If the operator is also registered within their jurisdiction, Member States are also required to investigate major accidents outside of the EU.[569]

The Offshore Directive provides for extensive research and investigation into the potential causes and concerns related to major hazards and accidents. Note the constellation of required documents focused on safe operation of offshore operations: the report on major hazards, a safety and environmental management system, a corporate major accident prevention policy, and the combination of internal and external emergency response plans.[570] When combined, they present a host of obligations on the part of potential operators of offshore methane hydrate operations.

The report on major hazards, for either production installations or non-production installations, should be developed by the operator in conjunction with its workers' representatives.[571] In addition to data on the companies and employees involved in the proposed installation, the report should include a complete description of the proposed installation.[572]

566. Offshore Directive, *supra* note 506, at art. 6(7).
567. *Id.* at art. 17.
568. *Id.* at art. 19. *See id.* at Annex IV for additional requirements.
569. *Id.* at art. 20.
570. *See* Offshore Directive, *supra* note 506, at art. 11(1).
571. *Id.* at arts. 12, 13.
572. Offshore Directive, *supra* note 506, at Annex I, §§ 2(1), 2(2), 2(4).

5. Carbon Capture and Sequestration Directive

Directive 2009/31, the "CCS Directive,"[573] provides for the regulation of geological storage of carbon dioxide.

a. Applicability to Offshore Methane Hydrates

While the CCS Directive is intended to apply to the sequestration of carbon dioxide, as discussed in Chapter 3, many suggested plans for offshore methane hydrate projects include carbon dioxide injection and sequestration into the depleted methane hydrate reservoirs. In those cases, the CCS Directive would apply directly to those types of offshore methane hydrate projects. Also, the concerns with gas leakage from subsurface reservoirs parallel the risks of the offshore methane hydrate production stage and the abandonment and sequestration stage.

The geological storage of carbon dioxide for the purposes of the CCS Directive is defined to be the injection of carbon dioxide streams into underground geological formations.[574] The CCS Directive applies to all geological storage of carbon dioxide within the territory of the Member States, including within their EEZs and on their continental shelves per UNCLOS.[575] If the methane hydrates from those offshore zones were developed in conjoined re-injection of carbon dioxide into the hydrate deposits, then the CCS Directive would apply to the methane hydrate project. The storage of carbon dioxide within the water column is prohibited.[576]

573. Directive 2009/31, of the European Parliament and of the Council of 23 April 2009 on the Geological Storage of Carbon Dioxide and Amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006, 2009 O.J. (L 140) 114 [hereinafter CCS Directive].

574. Offshore Directive, *supra* note 506, at art. 3(1).

575. *Id.* at art. 2(1). *See also id.* at art. 2(2) (describing exclusions of certain research and testing projects from regulation under the Directive).

576. *Id.* at art. 2(4). This is parallel to the regulations in the Marine Framework, which do regulate the emission of carbon dioxide and methane gases into the water column. *See infra* Part IV. When methane is released at a depth into the water column with insufficient velocity, methane is likely to become metabolized by local biota into carbon dioxide. It is not reasonable that

b. Risk Governance Within the CCS Directive

The preamble to the CCS Directive indicated that the liability matters related to the operations of CCS facilities is to be broken up by the underlying character of the damages. Environmental harms and damages are to be governed by the ELD[577] and climate change harms and damages by the Directive 2003/87.[578]

As was discussed, *supra* at Section 3.4.6, the ELD itself provides little foundation for governing the risks associated with offshore methane hydrates; so to the extent that environmental harms would result, the Offshore Directive would likely not provide sufficient incentives to the operators to employ optimal levels of precaution or activity. It is also unclear, due to the bifurcated liability rules of the ELD, if methane hydrate accidents would be governed under its strict liability rule for Annex III activities or under its article 3.1(b) "at fault" rules.

Directive 2003/87/EC, as amended, provides for penalties in the case of unpermitted or excessive greenhouse gas emissions.[579] Violators are required to purchase and submit sufficient allowances, or to pay an excess emissions penalty.[580] There is no provision for civil liability; the effort to govern greenhouse gases is solely regulatory in nature. This Directive would apply to vented or seeped methane from offshore methane hydrate projects, as methane is one of the listed greenhouse gases under Annex II of the Directive.[581]

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such transport of methane into the water column should be interpreted as water-storage of carbon dioxide.

577. *See supra* Part III(A) for a discussion of risk governance under the ELD.

578. CCS Directive, *supra* note 573, at pmbl., § 30. The directive that established the greenhouse gas emission trading systems within the EU is Directive 2003/87. *See* Directive 2003/87, of the European Parliament and of the Council of 13 October 2003 on Establishing a Scheme for Greenhouse Gas Emission Allowance Trading Within the Community and Amending Council Directive 96/61/EC, 2003 O.J. (L 275) 32 [hereinafter Greenhouse Gas Mechanism].

579. Greenhouse Gas Mechanism, *supra* note 578, at art. 16.

580. *Id.* at art. 16(2), (3).

581. The list of chemicals denoted as greenhouse gases are: carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride. *Id.* at Annex II.

Member states are required to enact penalties for regulatory noncompliance within domestic law that are "effective, proportionate, and dissuasive."[582]

i. Assignments of Liability

In the event of a "significant irregularity," the competent authority must require the operator to take the necessary corrective measures. [583] If the operator fails to do so, then the competent authority is required to assume control and undertake the necessary corrective measures itself, with the operator remaining liable for the costs of such efforts.[584] While the original version of Directive 2003/87/EC provided that greenhouse gas emissions related to *force majeure* events would be potentially excludable from penalty, the current enactment no longer contains that provision.[585]

At the closing of the facility, the operator is to remain liable for the potential accidents from the storage facility until it has been deemed that the carbon dioxide will have been completely and permanently contained.[586] After that point in time, the liabilities for the storage facility would be transferred to a competent authority.[587]

ii. Regulatory Actions

When the CCS Directive is applicable, the operators will be required to complete EIAs. The selection of storage sites,[588] the permitting of exploration permits,[589] and the permitting of storage,[590] are likely to be seen as part of a "private project . . . likely to have significant effects on the environment" and

582. CCS Directive, *supra* note 573, at art. 28. *See also id.* at pmbl., § 42.
583. *Id.* at art. 16(1), (2).
584. *Id.* at art. 16(4), (5).
585. Greenhouse Gas Mechanism, *supra* note 578, at art. 29.
586. CCS Directive, *supra* note 573, at art. 17(2).
587. *Id.* at art. 18(1).
588. CCS Directive, *supra* note 573, at art. 4.
589. *Id.* at art. 5.
590. *Id.* at art. 6.

"involving the extraction of mineral resources," and thus require the completion of an EIA.[591]

If an EIA is required, then the CCS Directive provides clear guidance on safety planning with regards to overall geological stability and risk assessment.[592] These safety regulations are also a strong model for regulating the field safety of methane hydrate projects. In many places, one could replace "storage complex" with "methane hydrate deposit" and have a good first approximation of draft methane hydrate regulations.

Annex I to the CCS Directive provides detailed guidance on what data and analyses should be provided in evaluating the safety of the storage complex of the CCS project and its surrounding area.[593] First, a wide array of scientific and engineering data must be collected. [594] Then, a variety of models must be produced to research potential future risks and hazards. [595]

591. EIA Directive, *supra* note 349, at art. 1(1), (2).

592. CCS Directive, *supra* note 573, at art. 7 (detailing the informational requirements for storage permits). An assessment of the expected reliability of the storage facility is required at article 7(3), the engineering details of expected field operations are required at article 7(4), and a description of the preventative measures on significant irregularities are required at article 7(5). *Id.* at art. 13 requires an extensive monitoring capability prior to permitting. Ongoing comparisons between modeling expectations and observed data are required at article 13(1)(a); the detection of significant irregularities is required at article 13(1)(b); the detection of migrating gas volumes is required at article 13(1)(c), the detection of leaking gas volumes is required at article 13(1)(d); the detection of significant adverse effects to the environment is required at article 13(1)(e); the assessment of the effectiveness of corrective measures is required at article 13(1)(f); and the continual assessment of the overall safety and stability of the storage complex is required at article 13(1)(g).

593. *Id.* at Annex I, Steps 1, 2, 3.

594. *Id.* at Step 1. Steps 1(a) through (g) requires the collection of a wide variety of data types, including geology and geophysics, hydro-geology, reservoir engineering, geochemistry, geo-mechanics, and seismicity and surveillance on natural and man-made pathways that could provide leakage pathways. Steps 1(h) through (l) require the collation of potential interactions with local flora, fauna, and habitats.

595. CCS Directive, *supra* note 573, at Steps 2, 3. Step 2 requires the building of a complicated three-dimensional geological earth model that can be used to forecast and understand likely stability and danger scenarios. Step 3 requires that the model developed in Step 2 be used to perform dynamic behavior models of the CCS activities.

The CCS Directive provides a detailed method for conducing risk assessments. There are three main components of that assessment, the exposure assessment, the effects assessment, and the risk characterization.[596] The exposure assessment focuses on the "environment and the distribution and activities of the human population above the storage complex, and the potential behaviour and fate of leaking CO2 from potential pathways."[597] This assessment demonstrates the nexus of the communities at risk versus the potential location of hazardous ventings and seepages. The effects assessment examines the particular risks and hazards of the venting and seeping gas on the various biota in the impacted communities, including on humans.[598] The risk characterization is a combination of several reports on the short-term and long-term expected safety, or lack thereof, from the proposed conditions of field usage.[599] The risk characterization should also include analysis and modeling of worst-case scenarios.[600]

6. The Marine Framework

a. Marine Strategy Framework Directive

The MSF Directive requires that Member States develop strategies to ensure the present health and future viability of EU marine ecosystems and that such plans are developed and in place by the year 2020.[601]

To the extent that the "programme of measures" called for under the Directive qualify as "plans and programmes'" under the SEA Directive, then they should be coordinated with the requirements of the SEA Directive; as such, there are opportunities for the public to engage in the drafting of the MSF Directive's "programme of measure."[602]

596. *Id.* at Steps 3.3.2-3.3.4.
597. *Id.* at Step 3.3.2.
598. *Id.* at Step 3.3.3.
599. *Id.* at Step 3.3.4.
600. *Id.*
601. Marine Strategy Framework Directive, *supra* note 515, at art. 1(1).
602. *See id.* at art. 5(2)(b). *See also* SEA Directive, *supra* note 350, art. 2(a).

The Member States are obligated under the Directive to implement marine strategies to:

> (a) protect and preserve the marine environment, prevent its deterioration or, where practicable, restore marine ecosystems in areas where they have been adversely affected;"
> "(b) prevent and reduce inputs in the marine environment, with a view to phasing out pollution . . . so as to ensure that there are no significant impacts on or risks to marine biodiversity, marine ecosystems, human health or legitimate uses of the sea.[603]

The reference to "no significant impacts" clearly requires some rationalization of which harms are significant and which impacts are not; ergo, it recognizes that some impacts are indeed tolerable and acceptable. An ecosystem level perspective is an applied marine strategy, which also suggests a net-sum perspective and the legislative permission to make trade-offs for the greater social welfare, as the same section calls for the sustainable use of marine resources for future generations of human beings.[604]

The MSF Directive has a broad definition of marine waters, which are defined as including the "waters, seabed and subsoil on the seaward side of the baseline" extending as far out as its Member States exercise jurisdiction under UNCLOS, to the EEZ or coastal shelf claims.[605] Marine waters also include coastal waters, to the extent not already addressed by other EU Directives or legislation.[606] Major marine areas already covered by separate conventions are also included within the scope of the MSF Directive's purview.[607]

Good environmental status is positively defined with the upbeat markers of ecological diversity, of clean, healthy, and productive oceans, and of sustainability for the future

603. *Id.* at art. 1(2)(a), (b).

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

605. *Id.* at art. 3(1)(a). *See supra* Part III(A)(1) for a discussion on UNCLOS, the EEZ, and other marine jurisdictions.

606. Marine Strategy Framework Directive, *supra* note 515, at art. 3(1)(b).

607. *Id.* at art. 4(1)-(2). For examples of pre-existing conventions, see Barcelona Convention, *supra* note 177, Bonn Agreement, *supra* note 209, and Helsinki Convention, *supra* note 257.

generations.[608] The physiographic, geographic, geologic, climatic, hydro-morphological, physical, and chemical properties and characteristics of the ecosystems must be protected and preserved.[609] Pollution is defined as the direct or indirect introduction into the marine waters of items that could cause harm to those marine water ecosystems.[610] Sources of pollution can include human activity, substances, energy, and anthropogenic noise.[611]

i. Applicability to Offshore Methane Hydrates

The MSF Directive, would likely apply to the development of methane hydrate projects.

The regulation of methane hydrate projects could be effected via the development of specific components of marine strategies applied to areas containing methane hydrate deposits. The MSF Directive requires its implementation in all of the marine areas of the EU and its Member States dependencies,[612] thus it covers the areas that contain methane hydrates.[613]

Each area containing methane hydrate deposits will need to address them within a program of measures to achieve and maintain good environmental status.[614] When the hydrates overlay transboundary marine ecosystems, the Directive calls for a regional cooperative effort.[615] If pre-existing regional

608. Marine Strategy Framework Directive, *supra* note 515, at art. 3(5).

609. *Id.* at art. 3(5)(a)-(b).

610. *Id.* at art. 3(8).

611. *Id.* Thus, the activities of the development and operation of a methane hydrate project would conceivably engage in multiple potential sources of pollution beyond just methane leakages and venting; they could introduce a variety of noises or energy sources into the marine waters. Additionally, there is potentially an argument to be made that the energy released into the ocean by methane hydrate related landslides or tsunamis could be seen as energy releases from the project, and thus be listed as a source of pollution under this Directive.

612. *Id.* at art. 4(1)-(2).

613. *See* MECHANISM DESIGN FOR THE FIERY ICE*, supra* note 1, at ch. 2, §§ 4-5, for a discussion on methane hydrate geography.

614. Marine Strategy Framework Directive, *supra* note 515, at art. 5(2)(b)(i).

615. *Id.* at art. 6(1)-(2).

conventions are already in place, then those conventions are called on to extend to adopt these measures and strategies.[616]

The marine strategies would need to adopt a survey position on the targeted good environmental status, and the strategies are to be developed in alignment with the descriptor elements in the Directive's Annex I, and the scientific factors at Annex III.[617] The programs should itemize what actions need to be undertaken to ensure the achievement or maintenance of good environmental statuses for the targeted marine environments.[618] The programs should establish a set of indicators and tests that can provide on-going metrics for the observation of the programs once in place.[619] It is required that the programs of measures are cost-effective and technically feasible and that cost-benefit analyses are undertaken to affirm those requirements prior to the placement of those measures into service.[620] The costs of the development of the plans and their placement into service are to be supported by EU funding due to the priority of the agenda to sustainably preserve the marine environment.[621]

It is at that pre-activation stage of planning that methane hydrates and the potential for harms and hazards from the development of methane hydrates projects could be included within these marine strategies. Particular attention could be brought to the potential to affect sea-floor integrity,[622] as seen with anthropogenic stressors leading to additional methane venting or seeping with its potential for subsea landslides. Similarly, the various activities and effects of methane hydrate exploration and extraction could lead to various introductions of noise and energy that could adversely affect the marine environment, these potential sources of pollution need to be discussed under the Directive. [623] The potential for the effects of vented or seeped methane to create eutrophication in the waters

616. *Id.* at art. 6.
617. *Id.* at art. 3(5). *See also id.* at art. 8(1)(a).
618. *Id.* at art. 13(1).
619. *Id.* at art. 10(1).
620. Marine Strategy Framework Directive, *supra* note 515, at art. 13(3).
621. *Id.* at art. 22(1)-(2).
622. Marine Strategy Framework Directive, *supra* note 515, at Annex I, § 6.
623. *Id.* at Annex I, § 11.

and its potential adverse effects on marine biota could be another point of concern under the Directive.[624] The observation of metrics on these concerns should be supported under the program of measures; if the above concerns are found covered by the Directive, effective monitoring programs should be put in place.[625]

The Commission issued its Methodological Standards Decision to further implement the MSF Directive.[626] The Decision provided an annex with greater depth on the environmental factors to consider when implementing the MSF Directive.[627] There are substantial concerns raised on the overall chemical effects of emissions into the water columns, such as nutrient levels, nutrient enrichment, and the effects on oxygen levels, all of which could be impacted by the methane venting and seeping.[628] Also, potential physical damages to the seabed and subsurface are detailed. "The main concern for management purposes is the magnitude of impacts of human activities on seafloor substrates structuring the benthic habitats. Among the substrate types, biogenic substrates, which are the most sensitive to physical disturbance, provide a range of functions that support benthic habitats and communities."[629]

Similarly at Descriptor 7, there are concerns on the geological and hydrographical impacts from marine activities: "Permanent alterations of the hydrographical conditions by human activities may consist for instance of changes in the tidal regime, sediment and freshwater transport, current or wave action, leading to modifications of the physical and chemicals characteristics set out

624. *Id.* at Annex I, § 5.

625. *Id.* at Annex V. *See also id.* at arts. 11(1), 24.

626. Commission Decision 2010/477, Commission Decision of 1 September 2010 on Criteria and Methodological Standards on Good Environmental Status of Marine Waters, 2010 O.J. (L 232) 14 [hereinafter Methodological Standards Decision].

627. *See id.* at Annex, pt. A.

628. *Id.* at pt. B, §§ 5.1, 5.2, 5.3. *See also* MECHANISM DESIGN FOR THE FIERY ICE, *supra* note 1, at ch. 4, § 3 (discussing methane in water column).

629. Methodological Standards Decision, *supra* note 626, at Annex, pt. B, § 6.1. *See id.* § 6.2.

in Table 1 of Annex III to Directive 2008/56/EC."[630] "Such changes may be particularly relevant whenever they have the potential to affect marine ecosystems at a broader scale and their assessment may provide an early warning of possible impacts on the ecosystem."[631]

The concerns within Descriptor 7 certainly fit the character of methane hydrate projects.[632] The overall extraction of methane from the hydrate deposits will be substantially an exercise in sediment and freshwater transport. The potential for landslides or tsunamis from cascade events from methane venting or seeping could impact currents and wave action. These issues could certainly have the potential to affect marine ecosystems on a broader scale. Thus, methane hydrate projects would likely be regulated under this Decision, if they were regulated under the MSF Directive.

ii. Risk Governance Within the MSF Directive

Broadly speaking, the MSF Directive is not liability focused, but rather it is focused on the development of regulatory structures to ensure the maintenance of good marine environments; nowhere within the Directive does it provide for liability rules or regulatory punishments.[633] The Directive does not interface with the behavior of private parties, except indirectly through the implementation of the marine strategies.

While not a system of civil liability, it does assign both a duty to Member States to retain and maintain certain good environmental statuses within their marine waters and it clarifies that they are to do so with cost-effective and technically

630. Methodological Standards Decision, *supra* note 626, at Annex pt. B, Descriptor 7.

631. *Id.* at pt. B.

632. *See* MECHANISM DESIGN FOR THE FIERY ICE, *supra* note 1, at ch. 4, §§ 3, 4 (discussing methane hydrate hazards).

633. The only sense of enforcement of the MSF Directive would be in the sense that any Directive is enforceable within general EU mechanisms, but as the MSF Directive is aimed at Member State action and not private parties, civil liability rules would not be applicable for failure to develop policy and plans.

feasible means.[634] A broad sense of cost/benefit analysis is found throughout the Directive.

b. Dangerous Substances Directive

The Dangerous Substances Directive will not apply to the development of methane hydrate projects because it has been phased out and superseded by the MSF Directive.[635] However, much of its guidance will survive within other sources incorporated into the corpus of material surrounding the MSF Directive, so a brief review is warranted.[636]

The Directive provides, Member States are to take the appropriate steps to eliminate pollution.[637] Pollution is defined similarly to the MSF Directive.[638] States are required to develop and implement programs to address discharges into the waters; if the substances are listed in Annex I's List II, then the substances need to be given prior authorization by the competent authorities.[639] Technically, this suggests that such emissions would be permitted, and thus exempted from the ELD as permitted activities.[640]

Of particular interest is the potential lack of methane from the listed substances under Annex I. List I of Annex I presents

634. Marine Strategy Framework Directive, *supra* note 515, at art. 1(2)(a)-(b); *id.* at art. 13(3).

635. Directive 2006/11, of the European Parliament and of the Council of 15 February 2006 on Pollution Caused by Certain Dangerous Substances Discharged into the Aquatic Environment of the Community, 2006 O.J. (L 64) 52 [hereinafter Dangerous Substances Directive].

636. The argument here is that it is reasonable that no lessening of environmental protections was intended by the adoption of the MSF Directive, and to the extent that the Dangerous Substances Directive provides ecological safety standards one could reasonably assume that such guidelines, for the most part, remain persuasive and effective. Directive 67/548, of the European Parliament and of the Council of 27 June 1967 on the Approximation of Laws, Regulations and Administrative Provisions Relating to the Classification, Packaging and Labelling of Dangerous Substances, 1967 O.J. (L 196) 1.

637. Dangerous Substances Directive, *supra* note 635, at art. 3; *see id.* at Annex I-II.

638. *Compare id.* at art. 2(e), *with* Marine Strategy Framework Directive, *supra* note 515, at Annex II, § 8.

639. Dangerous Substances Directive, *supra* note 635, at art. 6(2).

640. *See* discussion on the Environmental Liability Directive, *supra* Part III(D)(3)(a).

"persistent mineral oils and hydrocarbons of petroleum origin,"[641] but methane is not a persistent hydrocarbon as it evaporates and dissipates rapidly if not explosively. List I also provides a listing for those substances that are carcinogenic, but methane is not generally thought to be carcinogenic.[642] List II includes "non-persistent mineral oils and hydrocarbons of petroleum origin," but it is not clear from the combined usage of oils and petroleum, (*i.e.*, literally "oil from rocks"), that gaseous methane would be included, whereas gasoline would surely be included.[643] Also, List II includes substances that could affect the taste or smell of products derived from the waters for human consumption.[644] It is unclear if vented or seeping methane in the water column would affect the taste or smell of seafood or other such products. Ergo, methane hydrate projects might have been regulated under List II of Annex I, but it is uncertain.

c. Water Framework Directive

The WFD is very similar in intent and operations to the MSF Directive.[645] Instead of a focus on marine and oceanic waters, the WFD places its focus on what might be called a river basin perspective because it focuses on inland waters, coastal waters, lakes, and rivers.[646] Where rivers flow into coastal areas and have confluence with saline marine waters, those transitional waters are covered by the WFD.[647] Due to this focus on waters inland and very near the coast, it is unlikely that methane hydrate deposits would be found in those waters, and thus it is

641. Dangerous Substances Directive, *supra* note 635, at Annex I. List I, § 7.

642. *Id.* Annex I, List 1, § 4. *See also* N.J. DEP'T OF HEALTH, HAZARDOUS SUBSTANCE FACT SHEET (2011), *available at* http://nj.gov/health/eoh/rtkweb/documents/fs/1202.pdf, *archived at* http://perma.cc/D6KP-L75X (for non-carcinogenic character of methane, see the health advisory on methane provided by the New Jersey Department of Health).

643. Dangerous Substances Directive, *supra* note 635, at Annex I, List II, § 6.

644. *Id.* at Annex I, List II, § 3.

645. Directive 2000/60, of the European Parliament and of the Council of 23 October 2000 Establishing a Framework for Community Action in the Field of Water Policy, 2000 O.J. (L 327) 1 [hereinafter Water Framework Directive].

646. *Id.* at art. 2(13); *see also id.,* at art. 3(1); *id.* at art. 4(1); *id.* at art. 2(1), (4)-(6).

647. Water Framework Directive, *supra* note 645, at art. 2(1), (6).

unlikely that methane hydrate projects would be directly regulated by the WFD.[648]

The WFD has a very similar definition of pollution to the one found in the MSF Directive.[649] Similar goals of healthy aquatic ecosystems, found within the MSF Directive, can also be found within the WFD's good ecological status, good ecological potential, quantitative status, and good quantitative status terms.[650] The Member States are required to develop programs of measures that can achieve the ecological and environmental goals set out within the WFD.[651] Thus, the SEA Directive also covers these programs, which is similar to the interface found within the MSF Directive.[652] The WFD also requires coordination with other environmental oriented directives, including the EIA Directive.[653]

7. Greenhouse Gas Mechanism

The EU has implemented the UNFCCC and its Kyoto Protocol.[654] Once a year, the Commission compiles a EU greenhouse gas inventory.[655] This inventory accounts for each

648. The caveat here is that the onshore facilities of a methane hydrate project, and those appurtenances in proximity to those installations in coastal waters, might be regulated under the WFD.

649. Marine Strategy Framework Directive, *supra* note 515, at art. 3(8); Water Framework Directive, *supra* note 645, at art. 2(33).

650. Water Framework Directive, *supra* note 645, at art. 2(22), (23), (26), (28).

651. *Id.* at arts. 11, 16, 17 (discussing the requirement to develop programs of measures); *see also id*. at art. 4 (discussing the overall environmental objectives of the Water Frameworks Directive).

652. *See supra* Part III(D)(2).

653. Water Framework Directive, *supra* note 645, at Annex VI, pt. A. *See also id.* at Annex VI, pt. A, § (v) (referencing the EIA Directive).

654. For adoption of the UNFCCC, see Council Decision 94/69, Council Decision of 15 December 1993 Concerning the Conclusion of the United Nations Framework Convention on Climate Change, 1994 O.J. (L 33) 11. For adoption of the Kyoto Protocol, see Council Decision 2002/358, Council Decision of 25 April 2002 Concerning the Approval, on Behalf of the European Community, of the Kyoto Protocol to the United Nations Framework Convention on Climate Change and the Joint Fulfilment of Commitments Thereunder, 2002 O.J. (L 130) 1 [hereinafter Decision 2002/358]. *See also* Decision 280/2004 of the European Parliament and of the Council of 11 February 2004 Concerning a Mechanism for Monitoring Community Greenhouse Gas Emissions and for Implementing the Kyoto Protocol, 2004. O.J. (L 49) 1 [hereinafter Decision 280/2004].

655. Decision 280/2004, *supra* note 654, at art. 4(1).

Member State's greenhouse gas emissions and sinks.[656] To assist in the coordination of the inventory, the Community and its Member States establish registries to ensure accurate accounting, tracking, and accrual of records and credits.[657]

Decision 280/2004 provides for the monitoring mechanisms required under those agreements.[658] The Commission Decision 2010/778 finally set the targeted levels of emissions in 2010.[659] These two greenhouse gas decisions effectively coordinate the EU's compliance efforts under the UNFCCC and the Kyoto Protocol.

a. Applicability to Offshore Methane Hydrates

The development of methane hydrate projects potentially put at risk large reserves of methane, a listed greenhouse gas. [660] Accidents, minor or major, could be considered greenhouse gas emission events.

The Kyoto Protocol called for the monitoring of all anthropogenic greenhouse gases: carbon dioxide, methane, nitrogen oxides, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride.[661]

Decision 280/2004 set a mechanism to monitor all anthropogenic emissions of greenhouse gases by sources and sinks.[662] Decision 280/2004 provides an accounting for both the outward emission of greenhouse gases and an accounting of the capture and/or sequestration of greenhouse gases to provide a net

656. *Id.* at art. 4(2).

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

658. *See* Decision 280/2004, *supra* note 654.

659. Council Decision 2010/778, Commission Decision of 15 December 2010 Amending Decision 2006/944/EC Determining the Respective Emission Levels Allocated to the Community and Each of its Member States Under the Kyoto Protocol Pursuant to Council Decision 2002/358/EC (notified under document C(2010) 9009), 2010 O.J. (L 332) 41 [hereinafter Decision 2010/778].

660. Decision 280/2004, *supra* note 654, at art. 3(1)(a). *See also* discussion on UNFCCC and the Kyoto Protocol, *supra* Part III(A)(3).

661. Decision 280/2004, *supra* note 654, at art. 3(1)(a). *See also* discussion on UNFCCC and the Kyoto Protocol, *supra* Part III(A)(3).

662. Decision 280/2004, *supra* note 654, at art. 1(a).

number emitted.[663] Carbon dioxide and methane are both listed as greenhouse gases to be monitored under the program.[664]

b. Governing Risk Within the Greenhouse Gas Mechanism

The Greenhouse gas mechanism is regulatory in nature and does not contemplate civil liability matters. There are financial mechanisms to dissuade Member States from exceeding their obligatory emission limits. Routine emissions of methane or carbon dioxide would need to be contained within the emission targets; methane hydrate projects would need strategies that balanced emission permits for routine emissions, emission credits for sinking activities on-site, and potential penalties for unpermitted emissions.[665] There does not appear to be a regulatory plan for cataclysmic levels of methane gas emissions.

The EU has committed itself and its Member States to reducing their emissions of greenhouse gases.[666] Member States are committed to specific reductions of their greenhouse gases.[667] Directives 2002/358, 280/2004 and 2010/778 require that each Member State, and the EU as a community, achieve targeted emissions level maximums, as listed and detailed in Directive 2010/778.[668]

The Directive provides that Member State emissions need to remain within a specified range; they can remain within a three-year moving average and they can offset by five percent by borrowing from other year's allotments.[669] Member States can also consume Certified Emission Reductions (CERs) and

663. Decision 280/2004, *supra* note 654, at art. 3(1).

664. *Id.* at art. 3(1)(a). *See also* Decision 406/2009 at art. 2(1), discussed *infra* note 666.

665. With regards to potential penalties, *see supra* Part III(D)(5)(b).

666. Decision 406/2009, of the European Parliament and of the Council of 23 April 2009 on the Effort of Member States to Reduce Their Greenhouse Gas Emissions to Meet the Community's Greenhouse Gas Emission Reduction Commitments up to 2020, 2009 O.J. (L 140) 136 [hereinafter Decision 406/2009].

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

668. *Id.* at art. 7(1). *See generally* Decision 2002/358, *supra* note 654; Decision 280/2004, *supra* note 654; Decision 2010/778, *supra* note 659.

669. Decision 406/2009, *supra* note 666, at art. 3.

Emission Reduction Units (ERUs) to account for reductions in their overall emissions.[670]

The EU provides financial incentives to remain on target for greenhouse gas emissions reductions. First, the EU can sanction a Member State by reducing their next year's allotment by the amount overused in the current year, as multiplied by 1.08.[671] Next, the Member State can be required to develop a corrective action plan within three months of a notification of default.[672] Finally, the Member States ability to plan, trade, and coordinate with other states can be curtailed until the emission targets are met.[673]

E. Federal Laws of the U.S.

The U.S. federal regulatory regime includes several major planks that might address harms from methane hydrate hazards.[674] They include:

i. the National Environmental Protection Act (NEPA)[675]
ii. the Outer Continental Shelf Lands Act (OCSLA),[676]
iii. the Oil Pollution Act (OPA),[677]
iv. the Clean Water Act (CWA),[678]
v. the U.S.'s adoption of the International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties, 1969,[679]

670. Decision 406/2009, *supra* note 666, at art. 5(1). The Certified Emission Reductions (CERs) and Emission Reduction Units (ERUs) are established under Directive 2003/87, *see supra* Part III(D)(5)(b).

671. Decision 406/2009, *supra* note 666, at art. 7(1)(a).

672. *Id.* at art. 7(1)(b), 7(2).

673. *Id.* at art. 7(1)(c).

674. *See* RAMSEUR, *supra* note 281, at 10-12.

675. *See* National Environmental Policy Act of 1969 (NEPA), 42 U.S.C. §§ 4321-70 (2012).

676. *See* Outer Continental Shelf Resource Management Act, 43 U.S.C. §§ 1801-66, *repealed by* Pub. L. No. 101-380, 104 Stat. 507 (1990) (repealing §§ 1813-24, the remainder of the Act is currently still in force).

677. *See* Oil Pollution Act of 1990, 33 U.S.C. §§ 2701-62.

678. *See* Federal Water Pollution Prevention and Control Act of 1972 (Clean Water Act), 33 U.S.C. §§ 1251-1388.

679. 33 U.S.C. §§ 1471-87.

vi. National Oil and Hazardous Substances Pollution Contingency Plan,[680]
vii. the Clean Air Act (CAA),[681] and
viii. the Methane Hydrate Research and Development Act (MHRDA).[682]

The federal laws of the U.S. read like a spoonful of alphabet soup. NEPA, OSCLA, OPA, and the CWA would be the primary federal laws applicable to the development of offshore methane hydrates in American jurisdictional waters.[683]

The NEPA supports the function of the Environmental Protection Agency (EPA), the U.S. *de facto* environmental ministry.[684] All existing and future acts of legislation and substantially related regulations need review by the EPA under NEPA. After enactment, the EPA would steward the overall management and enforcement of those environmental rules.[685] Most importantly, the EPA would likely steward enforcement litigation in the case of environmental damages. Thus, the EPA is granted wide and substantive authority to determine the scope and requirements of future regulatory efforts related to offshore methane hydrates.

The OSCLA provides the underlying access to licensing offshore federally administered minerals.[686] Critically important, OSCLA splits responsibility for specifically mineral-related planning from the EPA to the Commerce Department. To the extent that precautionary regulations or standards relate to offshore methane hydrates themselves, they would need to be developed or approved. This approval would fall to the Secretary of Commerce to approve them. Thus, the environmental damages would be bifurcated into those directly related to offshore methane hydrate operations, and those only indirectly so damaged; one set of regulations would be developed primarily

680. 40 C.F.R. pt. 300 (2014).
681. 42 U.S.C. §§ 7401-671.
682. *See* Methane Hydrate Research and Development Act of 2000, 30 U.S.C. §§ 2001-06.
683. *See infra* the conclusions of Parts III(E)(1)-III(E)(8).
684. *See infra* Part III(E)(1).
685. *See infra* Part III(E)(1).
686. *See infra* Part III(E)(2).

from a commerce perspective, and the other from a primarily environmental perspective. In this result, the U.S. demonstrates that its approach to offshore methane hydrate planning would likely be commercially centered. Once the Commerce Department issues its safety regulations to protect the human, marine, and coastal environments, the Secretary, the Coast Guard, and the U.S. Army are required to enforce those safety and environmental regulations.[687]

The OPA applies to incidents of crude oil spills into the marine environment.[688] It has a very sophisticated strict liability rule alongside a system of liability assignment and of algorithmic liability caps based on tonnages, vessel types, and activities.[689] It also provides two modes of liability caps for those operators acting non-grossly negligent and those acting grossly negligent. Yet, as it primarily addresses crude oil, if a methane hydrates accident does not co-produce oil into the ocean, then the OPA likely would not apply.[690]

The CWA suffers from the same oil-focus as the OPA. As such, it would likely not apply to offshore methane hydrate accidents.[691] However, again like the OPA, it provides a well-developed regulatory system of negative incentives to punitively encourage operators to not spill oil.[692] Daily fees or per-barrels-spilt fees can be imposed, and the powers to bring tortfeasors to court are also provided under the CWA.[693] It was these powers that first brought attention to the question of how many barrels were spilled at the BP Macondo incident, because the disparity in spillage estimates created billions of dollars in penalty differences. But again, while the CWA has a long and useful history of addressing crude oil and other hazardous substances in the ocean and other waterways, it does not currently have the ambit to cover oceanic methane emissions.

687. *See infra* Part II.
688. *See infra* Part III(E)(3).
689. *See id.*
690. *See id.*
691. *See infra* Part III(E)(4).
692. *See id.*
693. 33 U.S.C. § 1321(b)(7).

It is important to note, while the U.S. does not belong to UNCLOS, it does generally recognize similar legal notions developed within UNCLOS, thus the U.S. does claim an EEZ beyond its traditional coastal waters.[694] Also, while some methane hydrates might be found within state jurisdictional waters, the majority of the methane hydrate deposits are expected to be located in federal waters. And finally, while the methane hydrates might lay offshore in federal waters, onshore damages might be spread across multiple state jurisdictions with distinguishable common law traditions on tortious damages and differing state codes on liabilities. Thus, the U.S. model would be more complicated than surveyed herein.

Nevertheless, these federal laws as a whole comport well with the recommendations of Section 2 for a complementary implementation of both strict liability and public regulations. Additionally, the particular semantic structure of the federal laws might facilitate the adaption of those rules more readily than might be the case in other jurisdictions. Given that combination, it could be reasonably argued that the U.S. federal laws might be expanded to include the circumstances of offshore methane hydrates. Additionally, most of the federal laws have been in place for multiple decades and offer a sense of establishment and reliability that could be built upon.

1. National Environmental Protection Act

Broadly stated, NEPA provides a wide base of authority to the EPA to enable deliberative efforts to be made to protect the environment of the U.S.[695]

NEPA contains neither direct provisions to civil liabilities nor regulatory penalties; it resembles the afore-discussed EU EIA Directive in that manner.[696] But its overall impact is to provide public information, which could very much impact both the development of regulations and the implementation of civil liability rules.

694. *See infra* Part III(E)(2).
695. NEPA, 42 U.S.C. §§ 4321-70.
696. *See* discussion on the EU's EIA Directive, *supra* Part III(D)(1).

NEPA directs the EPA to handle a variety of executive and regulatory matters related to environmental legislation. One of its key duties under NEPA is the creation and administration of environmental reviews for bills of legislation.[697] Such bills would include the laws on leasing methane hydrate resources, laws on the regulated operations of federally held methane hydrates, and whatever environmental and tort laws that would be enacted to protect the environment in the wake of methane hydrate development.

Environmental reviews are not generally drafted within the EPA, but rather within the specified department or other governmental body proposing a particular piece of legislation or path of action. NEPA requires that the environmental reviews of the bills begin concurrently with the onset of the bill's drafting, and not after the bill has already been drafted.[698] These prospective reviews are designed to encourage the integration of environmental considerations throughout the drafting process. Environmental reviews can take one of three forms: a categorical exclusion (CE), an environmental assessment (EA), or an environmental impact statement (EIS).[699] A CE is employed when the draft bill is expected to present no calculable environmental impact.[700] An EA is undertaken if the draft bill presents potential environmental concerns; a positive finding under an EA leads to an exhaustive EIS.[701] Finally, an EIS is a comprehensive report to address all of the identified environmental concerns once the EA has identified them.[702] In general, federal agencies have institutionally been encouraged to tilt towards CEs and away from EAs, because they are cheaper to execute, and thus this leaves many environmental aspects of draft bills often unexplored.[703] While the NEPA statute does not overtly require public access or participation to the review

697. KRISTINA ALEXANDER, CONG. RESEARCH SERV., RS20621, OVERVIEW OF NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) REQUIREMENTS 2 (2008).

698. 40 C.F.R. § 1500(b) (2014).

699. *See* ALEXANDER, *supra* note 697, at 3.

700. *Id.*

701. *See id.* at 4.

702. *See id.*

703. *Id.* at 4-5.

process, the associated regulations do provide those rights to the general public.[704]

Should methane hydrates approach commercial development, the NEPA will require both the drafting of rules and regulations to manage the overall impact to the American environment, and NEPA will require a process that is open to the general public. NEPA also clarifies that the drafting of such bills of law will not occur within the EPA, but within the departments or agencies previously appointed to oversee such areas of regulations.

2. Outer Continental Shelf Lands Act (OCSLA)

OCSLA would regulate those methane hydrates within U.S. territorial waters. The OCSLA provides for the recognition of the mineral assets of the U.S. offshore in its territorial and EEZ waters. It also provides the regulatory framework to lease those minerals.

The onset of methane hydrate development is also limited by previous efforts to prevent offshore development of oil and gas within the U.S. A variety of specific statutes banning offshore developments, *e.g.* the North Carolina Outer Banks Protection Act, and presidential executive moratoria have either directly prevented the leasing of areas offshore both the West and East Coasts or have prevented budget allocations from supporting the administrative costs of that licensing. Today, only the areas offshore Alabama, Louisiana, and Texas are active in development activities.[705]

a. Applicability to Offshore Methane Hydrates

OCSLA defines minerals to include both oil and gas,[706] and thus methane hydrates.[707] Likewise, OCSLA includes minerals,

704. *Id.* at 5.

705. *See Areas Under Moratoria*, BUREAU OF OCEAN ENERGY MGMT., http://www.boem.gov/Oil-and-Gas-Energy-Program/Leasing/Areas-Under-Moratoria.aspx (last visited Oct. 20, 2014), *archived at* http://perma.cc/KR8P-DK3Q (maps of some of the moratoria areas).

706. OSCLA provides the legal definitions of oil and gas separately. *See* 30 C.F.R. § 559.002 (2014) ("*Gas* means *natural gas* as defined by the Federal

and thus methane hydrates, within its definitions of "lease,"[708] "exploration,"[709] "development,"[710] "production,"[711] and "fair market value."[712] As such, OCSLA provides the legal foundations for leasing and economically managing methane hydrates within the U.S.'s EEZ.

What might not be expected though, is that OCSLA provides to the Secretary of Commerce, not the Department of the Interior or the EPA, the duties to perform EAs on prospective and on-going methane hydrate leases and operations.[713] Nevertheless, NEPA remains in application, as it applies to all federal agencies.[714]

b. Risk Governance Under OCSLA

OCSLA calls for the implementation of a regulatory framework and an overseeing regulatory body. The Commerce Secretary is required to monitor the human, marine, and coastal

Energy Regulatory Commission.") ("*Oil* means a mixture of hydrocarbons that exists in a liquid or gaseous phase in an underground reservoir and which *remains or becomes* liquid at atmospheric pressure after passing through surface separating facilities, including condensate recovered by means other than a manufacturing process.") (emphasis added).

707. 43 U.S.C. § 1331(q) (2012) ("The term 'minerals' includes oil, gas, sulphur, geopressured-geothermal and associated resources, and all other minerals which are authorized by an Act of Congress to be produced from 'public lands' as defined in [§ 1702] of [this title].").

708. 43 U.S.C. § 1331(c) ("The term 'lease' means any form of authorization which is issued under [§ 1337 of this title] or maintained under [§ 1335 of this title] and which authorizes exploration for, and development and production of, minerals.").

709. *Id.* § 1331(k) ("The term 'exploration' means the process of searching for minerals.").

710. *Id.* § 1331(l) ("The term 'development' means those activities which take place following discovery of minerals in paying quantities, including geophysical activity, drilling, platform construction, and operation of all onshore support facilities, and which are for the purpose of ultimately producing the minerals discovered.").

711. *Id.* § 1331(m) ("The term 'production' means those activities which take place after the successful completion of any means for the removal of minerals, including such removal, field operations, transfer of minerals to shore, operation monitoring, maintenance, and work-over drilling.").

712. *Id.* § 1331(o).

713. *Id.* §§ 1346 (a)(1), (b).

714. *See* discussion on NEPA, *supra* Part III(E)(1).

environments of the outer Continental Shelf, and the coastal areas impacted by the development and production of methane hydrates.[715] The Commerce Secretary, alongside the Coast Guard, "require[s], on all new drilling and production operations and, wherever practicable, on existing operations, the use of the best available and safest technologies which the Secretary determines to be economically feasible, wherever failure of equipment would have a significant effect on safety, health, or the environment."[716]

The Secretary is required to study any area included in an oil and gas lease sale in order to determine what information would be needed for the assessment and management of the environmental impacts on the human, marine, and coastal environments of the outer Continental Shelf and of the coastal areas which may be affected by oil and gas or other mineral development.[717] The collection of that data should lead to regulations to protect the human, marine, and coastal environments; thereafter the Secretary, the Coast Guard, and the U.S. Army are required to enforce those safety and environmental regulations.[718] The Act provides for both civil and criminal penalties and punishments for violations of those regulations.

OCSLA does provide for both civil and criminal penalties,[719] and it allows citizen suits against both private and public parties,[720] but generally under the Chevron doctrine, the Secretary of Commerce is given broad authority to interpret the statute and regulate accordingly. OCSLA provides no specific liability, remedy or punishment for environmental harms caused by the operation of the mineral leases assigned under its authority.

715. 43 U.S.C. § 1346(a)(1).
716. 43 U.S.C. § 1347(b).
717. *Id.* § 1346(a).
718. *Id.* § 1348(a).
719. *Id.* §§ 1350(b), (c).
720. *Id.* § 1349(a)(1).

3. Oil Pollution Act

The OPA is the major federal act for addressing hydrocarbon spills within the jurisdictional waters of the United States;[721] thus it extends beyond state waters into federal jurisdictions offshore.

It was designed to consolidate federal regulatory authority and to clarify the liabilities attending oil spills in the wake of the Exxon Valdez incident in Alaska.[722]

a. Inapplicability to Offshore Methane Hydrates

OPA applies to oil and to hazardous substances that are released in an unpermitted manner into water, but it does not apply to certain hazardous chemicals as defined under other statutes. [723] So while methane emissions might be regulated elsewhere under federal law as a hazardous substance, it is not so for OPA.

721. While the U.S. has taken notice of UNCLOS, it has not ratified it. Its own notions of jurisdictional waters take note of the vocabulary of UNCLOS, but are enacted separately under federal law. Thus, OPA applies to the EEZ of the U.S., but the legal basis is not the international standard, *per se*. *See* 33 U.S.C. § 2701(8) ("'[E]xclusive economic zone' means the zone established by Presidential Proclamation Numbered 5030, dated March 10, 1983, including the ocean waters of the areas referred to as 'eastern special areas' in Article 3(1) of the Agreement between the United States of America and the Union of Soviet Socialist Republics on the Maritime Boundary, signed June 1, 1990."). The U.S. EEZ extends "200 nautical miles from the baseline from which the breadth of the territorial sea is measured." *See* Proclamation No. 5030, 48 Fed. Reg. 10,605 (Mar. 10, 1983).

722. *See* RAMSEUR, *supra* note 281, at 13.

723. *See infra* Part III(E)(4) for discussion of the CWA and the list of hazardous substances that apply to water. Methane is not currently listed under these laws; *e.g.*, methane is sometimes regulated under the CAA, but as an air pollutant and not as a hazardous air pollutant, which is what was carved out under OPA. For the purposes of OPA, oil "does not include any substance which is specifically listed or designated as a hazardous substance under subparagraphs (A) through (F) of § 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act and which is subject to the provisions of that Act[.]" 33 U.S.C. § 2701(23). That subsequent definition refers to listings of hazardous substances under the Clean Water Act, 33 U.S.C. §§ 1317(a), 1321(b)(2)(A), the Solid Waste Disposal Act, 42 U.S.C. § 6921, the Clean Air Act, 42 U.S.C. § 7412, and the Toxic Substances Control Act, 15 U.S.C. § 2606.

While technically methane could be included under petroleum, it would not appear to be so contemplated within OPA.[724] There is not a singular reference to natural gas or methane within OPA. Section 2701(2) provides a standard definition for a volume measure of a barrel of crude oil, but nowhere in OPA is there a comparable definition of volume or mass for natural gas or methane, nor are there any conversion factors provided to convert them into barrels equivalent. On the whole, accidents primarily motivated by natural gas or methane events would appear to fall outside of the scope of OPA's liability scheme.

It is clear that the drafters of OPA were concerned with the particular ecological and community damages of the Exxon Valdez crude oil incident and focused on the impact of crude oil; the exclusion of natural gas and methane may have resulted from a lack of historical accidents that would have enabled popular political action.

b. Risk Governance Under the OPA

OPA provides that the tortfeasor is to be held strictly liable for all public and private cleanup costs.[725] It does not displace state-level jurisdiction, state-level rules of civil liability, or state regulations to the extent that such rules exist and to the extent that certain federalism issues, such as pre-emption, are not in conflict; thus liability for oil spills in general might fall concurrently under both federal and state laws, including OPA.[726]

724. Oil is defined as any kind of oil, but it is not explicitly stated that methane or methane hydrates would be included within that term; a reasonable reading suggests that natural gas and methane would be excluded from the definition of oil. *See* 33 U.S.C. § 2701(23) ("'[O]il' means oil of any kind or in any form, including petroleum, fuel oil, sludge, oil refuse, and oil mixed with wastes other than dredged spoil, but does not include any substance which is specifically listed or designated as a hazardous substance under subparagraphs (A) through (F) of section 101(14) of the Comprehensive Environmental Response, Compensation, and Liability Act (42 U.S.C. § 9601) and which is subject to the provisions of that Act.").

725. James E. NICHOLS, CONG. RESEARCH SERV., R41266, OIL POLLUTION ACT OF 1990 (OPA): LIABILITY OF RESPONSIBLE PARTIES 1 (2010). *See* 33 U.S.C. § 2701(32); *see also* RAMSEUR, *supra* note 281, at 12.

726. 33 U.S.C. §§ 2718(a), (c).

There are limits to the liability imposed by OPA. Liabilities are "capped," or limited by the type of vessel from which the hydrocarbon escaped.[727] The listings include vessels, ports, and rigs;[728] (i) tank vessels,[729] (ii) vessels,[730] generally, (iii) onshore facilities and deepwater ports,[731] (iv) offshore facilities (excluding deepwater ports),[732] and (v) mobile offshore drilling units.[733] These five categories have limits imposed by tonnage, hulling, and character of activity.[734] Those liability limits are set aside when the hydrocarbon spill results from acts of gross negligence or willful misconduct.[735]

While OPA functions with strict liability, it is important to note that the overall liability is determined under a variant of a 'duty of care' rule.[736] The economic incentive is similar to that of routine strict liability for accidents under the scope of liability, but operators are effectively sheltered from more catastrophic liabilities, facilitating investment in the energy sector. All accidents result in liability. Unlike under a rule of negligence, due precaution will not completely shield the operator from damages. An OPA operator retains liability for damages even

727. *See* RAMSEUR, *supra* note 281, at 13.

728. Listings, *infra*, derive from the liability limiting rules found within 33 U.S.C. § 2704.

729. 33 U.S.C. § 2704(a)(1).

730. *Id.* § 2704(a)(2). *See also id.* § 2701(37) ("'[V]essel' means every description of watercraft or other artificial contrivance used, or capable of being used, as a means of transportation on water, other than a public vessel.").

731. *Id.* § 2704(a)(3). *See also id.* § 2701(24) ("'[O]nshore facility' means any facility (including, but not limited to, motor vehicles and rolling stock) of any kind located in, on, or under, any land within the United States other than submerged land."). "'[D]eepwater port' is a facility licensed under the Deepwater Port Act of 1974 (33 U.S.C. §§ 1501-1524)," which includes, for example, the crude oil offloading LOOP facility offshore Louisiana. 33 U.S.C. § 2701(6).

732. *Id.* § 2704(a)(4). *See also id.* § 2701(22) ("'[O]ffshore facility' means any facility of any kind located in, on, or under any of the navigable waters of the United States, and any facility of any kind which is subject to the jurisdiction of the United States and is located in, on, or under any other waters, other than a vessel or a public vessel.").

733. *Id.* §§ 2704(b)(1), (2). *See also id.* § 2701(18) ("'[M]obile offshore drilling unit' means a vessel (other than a self-elevating lift vessel) capable of use as an offshore facility.").

734. *Id.* § 2704.

735. *See* RAMSEUR, *supra* note 281, at 12.

736. 33 U.S.C. § 2702.

under demonstrable (*e.g.*, non-reckless or grossly negligent behavior) precaution.[737]

Additionally, it should be noted that OPA provides liability in complement to liabilities and penalty fines provided by other sources of law within the U.S. It would thus be misleading to suggest that the complete set of damages to be faced by a tortfeasant operator would be strictly limited to these particular limits; they are merely the liability limits under OPA.

The statute refers to both "removal costs" and "damages," reflecting that the statute pursues both the immediate and indirect notions of damages.[738] Those costs may include injury to natural resources, loss of personal property and resultant economic losses, loss of subsistence use of resources, lost revenues resulting from injuries to property or natural resources, lost profits and earnings from injuries to property or natural resources, and the costs of providing additional public services during or after the hydrocarbon spill incident.[739]

Certain damages are only recoverable by units of the federal or state government,[740] in particular, certain environmental damages and wasting acts that impact governmental revenues.[741]

4. Clean Water Act

The CWA would likely govern neither methane hydrates, nor their potential association with environmental harms. Methane

737. *Id.* § 2704.

738. For an example of such phrasing, see *id.* § 2702(a). *See also id.* § 2701(5) ("'[D]amages' means damages specified in § 1002(b) of this Act [33 U.S.C. § 2702(b)], and includes the cost of assessing these damages."). *See also id.* § 2701(30) ("'[R]emove' or 'removal' means containment and removal of oil or a hazardous substance from water and shorelines or the taking of other actions as may be necessary to minimize or mitigate damage to the public health or welfare, including, but not limited to, fish, shellfish, wildlife, and public and private property, shorelines, and beaches."). *See also* 33 U.S.C. § 2701(31) ("'[R]emoval costs' means the costs of removal that are incurred after a discharge of oil has occurred or, in any case in which there is a substantial threat of a discharge of oil, the costs to prevent, minimize, or mitigate oil pollution from such an incident.").

739. *See* RAMSEUR, *supra* note 281, at 11-12.

740. 33 U.S.C. § 2702(b)(2)(D).

741. *Id.*

has not been included within the more general oil spill and hazardous substances discharge rules.

a. Inapplicability to Offshore Methane Hydrates

Oil is defined as a viscous liquid and not as a gaseous substance.[742] As such, methane and other natural gases would not qualify as oil. Similarly, crude oil, is volumetrically measured in "barrels," but no such legal definition is provided for emitted gas within the CWA.[743]

Methane from methane hydrates is not likely to qualify as chemical wastes, nor is it likely to fit any of the other enumerated items. It could be defined to be included under the term hazardous substances, but such would require explicit listing within the associated regulations.[744] The current listing of hazardous substances includes no mention of natural gas, methane, ethane, or butane.[745] Thus, as methane is neither oil nor a listed hazardous substance, its emission into water *sans* co-produced oil is not covered by the CWA.

Furthermore, oil and gas operations are specifically written about within this section; it excludes certain materials associated with oil and gas production.[746] The CWA excludes "water, gas, or

742. *Id.* § 1321(a)(1) ("'[O]il' means oil of any kind or in any form, including, but not limited to, petroleum, fuel oil, sludge, oil refuse, and oil mixed with wastes other than dredged spoil[.]").

743. *Id.* § 1321(a)(13) ("'[B]arrel' means 42 United States gallons at 60 degrees Fahrenheit.").

744. *See* 33 U.S.C. § 1321(a)(14) (directing the definition of hazardous substances to the rule of (b)(2)). *See also id.* § 1321(b)(2)(A) ("The Administrator shall develop, promulgate, and revise as may be appropriate, regulations designating as hazardous substances, other than oil as defined in this section, such elements and compounds which, when discharged in any quantity into or upon the navigable waters of the United States or adjoining shorelines or the waters of the contiguous zone or in connection with activities under the Outer Continental Shelf Lands Act or the Deepwater Port Act of 1974, or which may affect natural resources belonging to, appertaining to, or under the exclusive management authority of the United States (including resources under the Magnuson-Stevens Fishery Conservation and Management Act of 1976), present an imminent and substantial danger to the public health or welfare, including, but not limited to, fish, shellfish, wildlife, shorelines, and beaches.").

745. 40 C.F.R. § 117.3 (2014).

746. 33 U.S.C. § 1362(6)(B).

other material which is injected into a well to facilitate production of oil or gas, or water derived in association with oil or gas production" from inclusion within the definition of pollutants.[747] Thus, potential injectants into the hydrate deposits, such as carbon dioxide, would be exempt from the CWA (*caveat*: such injectants would need their own permitting as part of the operator's licensing arrangement).

b. Risk Governance Under the CWA

The CWA is a very broad grant of regulatory power that supports much of the EPA's activity base. As such, it supports a regulatory body.

The CWA does provide for both regulatory penalties and civil liabilities for oil spills and hazardous substances discharges. The regulatory penalties provide for an administrative hearing process and are limited to $125,000.[748]

Should the Secretary opt to forego the administrative route for judicially enforced civil liabilities, the judgment can get much larger.[749] The civil liabilities are based on both the volumes of oil spill and a determination of the character of causations. Polluters of spilt volumes are to be held liable under a rule of strict liability.[750]

Spilling events not derivative of grossly negligent behavior face liabilities *cum* civil penalties in an amount up to $25,000 per day of violation, or an amount up to $1,000 per barrel of oil or unit of reportable quantity.[751] If the accident follows from grossly negligent behavior, then the liabilities *cum* civil penalties increase to not less than $100,000, and not more than $3,000 per barrel of oil or unit of reportable quantity.[752]

747. *Id.*
748. 33 U.S.C. § 1321(b)(6)(B)(ii).
749. *Id.* § 1321(b)(7)(F).
750. *Id.* § 1321(b)(7).
751. *Id.* § 1321(b)(7)(A).
752. *Id.* § 1321(b)(7)(D).

5. Intervention on the High Seas in Cases of Oil Pollution Casualties

Under the U.S.'s adoption of the International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties, 1969, [753] offshore methane hydrates operations would not likely be regulated

Oil is defined as "convention oil," *i.e*., "crude oil, fuel oil, diesel oil, and lubricating oil."[754] Non-liquid gaseous volumes, such natural gas or methane, would not be seen as included within convention oil. Similarly, "a substance other than convention oil" is defined to mean "those oils, noxious substances, liquefied gases, and radioactive substances" specifically listed within the protocol or determined to be a hazard to human health, to harm living resources, to damage amenities, or to interfere with other legitimate uses of the sea.[755]

Natural gas or methane is only listed if included within "liquified gases" or as an interference with legitimate usages of the sea that harms living resources.[756] Methane as extracted from offshore deposits would not manifest as a liquefied gas until substantially downstream of the extraction process. Methane is rendered into LNG only when prepared for oceanic transport via boat; should the methane be transported onshore for processing and marketing no LNG would likely be produced.

Similarly, methane does not generally find itself included within noxious gases, and it generally has no affinity with radioactivity. Thus, it would likely fail to be included under the listings of those "oils, noxious substances, liquefied gases, and radioactive substances" determined to be a hazard to human health, as methane would likely be qualified as one of the four categories.[757]

753. *Id.* §§ 1471-87.

754. 33 U.S.C. § 1471(3).

755. *Id.* § 1471(1). *See* 33 U.S.C. § 1471(1)(B), in reference to 33 U.S.C. § 1473(a).

756. 33 U.S.C. § 1473.

757. *Id.* § 1471(a). *See id.* § 1473(a).

6. National Oil and Hazardous Substances Pollution Contingency Plan

For similar reasons, as seen in the U.S.'s Intervention on the High Seas in Cases of Oil Pollution Casualties, the National Oil and Hazardous Substances Pollution Contingency Plan has not been applied to methane environmental hazard planning. Natural gas is usually not considered to be either oil or a hazardous substance. Also, most emergency response planners have not foreseen a need for "methane clean-up" in the same way that they need to plan for crude oil clean up operations.

7. Clean Air Act

The CAA could regulate methane emissions from crude oil and natural gas production operations, but so far methane has not been included. In a letter sent by New York Attorney General Eric T. Schneiderman to Lisa P. Jackson, the Administrator of the EPA, Schneiderman announced that the State of New York intended to sue the EPA to bring about changes in the CAA to include the regulation of methane emissions from oil and gas operations.[758] New York was joined in the letter by the states of Connecticut, Delaware, Maryland, Massachusetts, Rhode Island, and Vermont. The letter explains that while the EPA issued preliminary regulations on methane emissions from oil and gas operations in 1985, those regulations were never made effective, contrary to the requirements of 42 U.S.C. §7411(b)(1)(B).[759] The states argue that the EPA needs to regulate methane emissions from existing sources of methane emissions, as well as from new and modified facilities, under 42 U.S.C. §7411(d)(1)(A).[760] This case has not yet been brought to court, and it will be several years at least before a final decision is rendered. But, it is clear from

758. Letter from Eric T. Schneiderman, N.Y. Att'y Gen., George Jepsen, Conn. Att'y Gen., Joseph R. Biden II, Del. Att'y Gen., Douglas F. Gansler, Md. Att'y Gen., Martha Coakley, Mass. Att'y Gen., Peter Kilmartin, R.I. Att'y Gen., & William H. Sorrell, Vt. Att'y Gen., to Lisa P. Jackson, EPA Adm'r (Dec. 11, 2012), *available at* http://www.ag.ny.gov/pdfs/ltr_NSPS_Methane_Notice.pdf, *archived at* http://perma.cc/W6J5-MDPH.

759. *Id.*

760. *Id.*

the substantial efforts of these many states that the CAA is not currently regulating methane emissions, and thus the CAA is not currently applicable to potential methane hydrate events or accidents.

8. Methane Hydrate Research and Development Act

The MHRDA[761] provided for the financing of research to develop technologies that could reduce the incidence and impact of damages from methane hydrate development, from methane "degassing" and from events related to drilling into methane hydrate deposits. But, the MHRDA makes no provisions for the development or use of regulations on environmental hazards from methane hydrate development.

The MHRDA was originally passed in 2000, and was amended in 2005. Its design is to support the funding for research and development in methane hydrates; all of the research and development activities are to be coordinated by the Department of Energy.[762] It provides for no civil liabilities and provides for little in the way of regulations beyond standard NEPA requirements. It does provide a research budget to ascertain if those items might become necessary.

Intriguingly, nowhere in the Act are methane hydrates or gas hydrates defined; the only functional reference to their character is a statement that methane hydrates can offset the decline in America's domestic natural gas assets.[763]

a. Risk Governance Under the MHRDA

There is a requirement for the investment in projects that:

> (D) assist in developing technologies required for efficient and environmentally sound development of methane hydrate resources;

761. 30 U.S.C. §§ 2001-06.

762. *Id.* § 2003(a)(3).

763. 33 U.S.C. § 2001(5) ("[M]ethane hydrate may have the potential to alleviate the projected shortfall in the natural gas supply[.]").

> (F) conduct basic and applied research to assess and mitigate the environmental impact of hydrate degassing (including both natural degassing and degassing associated with commercial development);
> (G) develop technologies to reduce the risks of drilling through methane hydrates.[764]

However, there is no regulatory language requiring the drafting or planning for the use of those technologies, nor for the drafting or development of regulations that would respond to the incident of environmental damages from methane hydrate development.

But, at least there is official recognition that there is a technological problem that certain environmental harms could result, and technologies to mitigate those harms should be invested in. The listed hazards to the environment are: (i) the development of methane hydrates generally, (ii) methane hydrate venting (therein referenced as "degassing"), and (iii) the risks associated with drilling into methane hydrate deposits.[765]

MHRDA does require the assembly of a "Methane Hydrates Advisory Committee" that should include members from environmental organizations alongside other members from "industrial enterprises, institutions of higher education, oceanographic institutions, [and] state agencies."[766] However, none of the listed reports from that committee and the associated research has focused on the environmental hazards and their mitigating technologies.[767]

The Secretary of the Department of Energy is also directed to ensure that the "data and information developed through the

764. *Id.* § 2003(b)(1)(D)-(G).

765. *Id.* § 2003(b)(1).

766. 33 U.S.C. § 2003(c)(1).

767. *See Methane Hydrates*, U.S. DEP'T OF ENERGY, http://www.netl.doe.gov/technologies/oil-gas/FutureSupply/MethaneHydrates/MH_ReferenceShelf/RefShelf.html (last visited Oct. 23, 2014), *archived at* http://perma.cc/LV6T-D6JB. For a list of reports, see also *Publications and Presentations of DOE Supported Methane Hydrate R&D 1999-2014*, U.S. DEP'T OF ENERGY (Oct. 2014), http://www.netl.doe.gov/file%20library/research/oil-gas/methane%20hydrates/MHBibliography.pdf, *archived at* http://perma.cc/M4DY-938M.

program are accessible and widely disseminated as needed and appropriate."[768]

Perhaps most interestingly, the MHRDA requires the Secretary to "ensure, to the maximum extent practicable, greater participation by the Department of Energy in international cooperative efforts."[769] It is unclear to what extent that request is aimed strictly at research and technology or to what extent it can be responsive to the aspirations of the Methane Hydrates Advisory Committee.

IV. RECOMMENDATIONS

A. Emergent Need for Standards

There is an emergent need to provide rules of civil liability and regulations for the development of offshore methane hydrates. Tremendous economic benefits are challenged by substantial accidental risks and hazards. The time to begin the studies for those rules and regulations should be soon, as the industry is likely to develop within the coming decade. The argument is that it is more likely than not that some investors or nations might begin the development of offshore methane hydrates in the very near future. As such, it would be advisable to develop the necessary norms and standards in advance of those programs and projects.[770]

Offshore methane hydrates could provide new sources of natural gas and fresh water supplies. Importantly for the timing of its development, many countries that currently lack access to domestic energy supplies are expected to possess reserves of offshore methane hydrates. For some countries, that access to

768. 30 U.S.C. § 2003(e)(3).

769. *Id.* § 2003(e)(6).

770. To be clear, the argument presented is not an argument to stimulate investment to ensure earlier adoption of offshore methane hydrates. The argument is predicated on the recognition of several nations' stated national agendas to begin the extraction of offshore methane hydrates and in recognition of the imminent technological feasibility of those agendas. Should any of those or other actors actually move forward with plans to develop offshore methane hydrates, it would be constructive to have the necessary standards in place ahead of those development efforts.

local energy supplies within their political control could provide strategic stability and continuity of energy supplies critical for economic growth and development. Such policy concerns could motivate some countries to begin offshore methane hydrate production before it is commercially competitive with more conventional energy supplies.

However, the commercial feasibility of developing offshore methane hydrates might arrive sooner than previously expected. The engineering technology of offshore methane hydrates is rapidly advancing, and the costs of methane hydrate extraction and production are dropping. It is a common view of methane hydrate researchers that offshore methane hydrates may become commercially viable within the next ten years.[771] Japan and South Korea have both established national research programs to obtain that commercial capability by 2015.[772]

If it becomes the case that the technologies and cost structures of offshore methane hydrates reach commercial or politically sufficient levels of advancement, it would be beneficial for both energy investors and for the general public to have already determined optimal standards. Once the economic motives of methane hydrate projects become more evident, it might become more difficult to negotiate the development of the necessary standards.

At the present moment, the development of offshore methane hydrates finds a fairly united community of researchers supported by both private investment and government support.[773] Once projects become commercial in nature, one might expect certain adversarial positions to be taken; public versus private, corporate versus academic.[774] It might be best to attempt to find common ground on standards and on optimal precautions and optimal levels of offshore hydrate development before that competitive aspect of eventual development opens up.

771. *See* MECHANISM DESIGN FOR THE FIERY ICE, *supra* note 1, at ch. 3, §§ 2, 3.

772. *See id.* §§ 4.1, 4.2.

773. *See* MECHANISM DESIGN FOR THE FIERY ICE, *supra* note 1, at ch. 3, § 4.

774. For example, different energy corporations might try to gain proprietary advantages in technology by hiring key researchers. Also, governments might have alternative goals for national resources than commercial operators might have.

B. General Recommendations

What the future of offshore methane hydrates needs is a clear and operational set of guidelines and incentives to ensure, both for the private operators and the general public, that such offshore operations will achieve the socially optimal safety level, so that both private profits and general welfare can be best obtained. The recommendations of this article are that a combined rule of strict liability for the resulting damages and the development of effective public regulations would best provide for the optimal level of safety.[775]

In summary of section 3, *supra*, there are various laws that would be applicable as written, but many would need adjusting to better accommodate the circumstances of offshore methane hydrates.

Those laws, such as the EIA and SEA Directives and the NEPA, but also those like OSCLA, that require EAs to be completed prior to the licensing and permitting of offshore activities, are most complete and less in need of revision or updating. Those specific laws focused on hydrocarbon accidents and similar industrial accidents are generally poorly suited to the specific circumstances of offshore methane hydrates as currently enacted.

The EU has two directives, the Offshore Directive and the CCS Directive, that are so close to the nature and character of offshore methane hydrate operations that one wonders if it might be feasible to adjust those existing directives.

First, the Offshore Directive reflects careful drafting to be inclusive of both known historical oil spill accidents and other potential types of offshore accidents; the generic phrases "major accident," "major hazard," and "environmental impact" are oft used in lieu of more specific forms of accidents. However, the historical bias of well-known oil spill events does lurk within the legal paradigm of the Offshore Directive. The Preamble connects the Offshore Directive to oil spills caused by ships.[776] Additional language could be added to emphasize the potential for both

775. *Supra* Part II(C). For additional depth in those arguments, see *supra* notes 26, 27.

776. Offshore Directive, *supra* note 506, at pmbl. 49.

crude oil and natural gas accidents within offshore extraction operations. Specific mention of the unique circumstances of methane hydrate accidents could buttress the application of the Offshore Directive to such events.

In discussing the importance of the preservation of the Arctic's environment, focus is put on Arctic marine oil pollution with no discussion of the harms of natural gas emissions, venting, or seepage.[777] The definitions section of the Offshore Directive includes an "oil spill response effectiveness" term, but no analog for methane hazards.[778] Such could be readily remedied by either providing parallel definitions and concerns for methane related events, or by expanding the current terms to be more inclusive and more clear. For example, the EMSA is charged with the duty to monitor to the extent of an "oil or gas spill," but gases do not spill as such.[779] The word choice reflects historical expectations of an "oil and gas spill" event, alike the 2010 Gulf of Mexico incident, wherein crude oil has been the dominant semantic concern.[780] Consider the discussion on "[i]nternal emergency response plans," in which there is a requirement for an analysis of the oil spill response effectiveness of the proposed plans.[781] The internal emergency response plan is required to include a list of necessary equipment including those for capping a spill; no requirement or analog terms are made for dealing with gaseous venting or seepages.[782] There is a requirement for environmental factors to be considered in the estimate of the oil spill response effectiveness metric, but no symmetrical analysis is suggested for gaseous accident response plans.[783]

Further, reference is made to dispersants, which only find use against crude oils.[784] The external emergency response plan is required to address "oiled animals" that might reach the coast

777. *Id.* at pmbl. 52.
778. *Id.* at art. 2(32).
779. *Id.* at art. 10.
780. *Id.* at art. 10(2)(a).
781. *Id.* at art. 14(1).
782. Offshore Directive, *supra* note 506, at Annex I, § 10(5).
783. *Id.* at Annex I, § 10(8).
784. *Id.* at Annex I, § 10(12).

in advance of the "actual spill."[785] Similarly, when well operations are to be undertaken, a similar requirement exists for an analysis of the oil spill response effectiveness of the proposed plans.[786] Neither requires an analysis for response effectiveness to methane accidents. The same asymmetry is found in the requirements for the report on major hazards for operation of a production installation[787] and for the report on major hazards for a non-production installation.[788]

So, while the Offshore Directive can be read to include planning for major accidents and major hazards of the exploration and production of methane hydrates, the Offshore Directive retains a semantic bias for crude oil spills. By broadening its existing terms or by providing parallel details for events related to both conventional and methane hydrate related accidents, the Offshore Directive could be extended to better cover the circumstances of offshore methane hydrates.

As discussed earlier, the CCS Directive is a perfect fit for those aspects of offshore methane hydrate projects that do elect to engage in co-productive carbon dioxide injections back into the hydrate deposits. To that extent, the CCS Directive is well drafted for application to offshore methane hydrate projects. However, because of certain similarities between the CCS technologies and hydrate extraction technologies, they can be viewed as the reverse of each other. Some of the terms developed within the CCS Directive might be employable within a future Offshore Methane Hydrate Directive or as terms to assist in the redrafting of the current Offshore Directive. "Leakage" is defined in article 3.5 to include any release of carbon dioxide from the storage complex, and "storage complex" is defined in article 3.6 to include the storage site and the surrounding geological domain.[789] The definition of "significant irregularity" in article 3.17 parallels the concerns of deteriorating stability of methane hydrate fields; "'significant irregularity' means any irregularity in the injection or storage operations or in the condition of the

785. *Id.* at Annex VII (h).
786. *Id.* at art. 15(1).
787. *Id.* at Annex I, § 2(5).
788. Offshore Directive, *supra* note 506, at Annex I, § 3(5).
789. CCS Directive, *supra* note 573, at art. 3(5)-(6).

storage complex itself, which implies the risk of a leakage or risk to the environment or human health."[790] Any efforts undertaken to correct significant irregularities or leakages are defined as "corrective measures" in article 3.19.[791]

If these types of suggestions were implemented, then the conjoint application of strict liability with sophisticated public regulations could be readily affected within the EU and its Member States.

The general trend of U.S. federal laws related to oil spills has focused on the assignment of liability based on rules of strict liability, liability caps, and penalties for lost volumes. As such, the American federal laws could also be readily amended if its current character were to be retained. Once that were accomplished, existing safety regulations could be updated; as the American Petroleum Industry (API) provides the bulk of such regulation privately within the API, one assumes that those materials could and would be updated as offshore methane hydrate projects approached early development.

OCSLA primarily addresses the leasing of minerals, and was found to be effectively applicable to offshore methane hydrates in its current form. OCSLA could be expanded with substantially minor edits to bring attention to the need to provide oversight for methane safety in addition to the existing language on crude oil and on minerals in general. OCSLA already provides a grant of administrative powers to the Commerce Secretary to provide regulatory guidance to ensure the best available practices and safest technologies; these regulatory powers could be used to support development of the appropriate standards and rules for the development of offshore methane hydrates.

OPA at large has a strict liability rule that could be readily adjusted to include methane hydrate accidents. OPA could have accidents and operators redefined to include the circumstances related to offshore methane hydrate accidents. Specifically, OPA could be amended to explicitly provide for the inclusion of marine-based methane emission accidents to parallel its current definition for oil spills. OPA could also include volumetric

790. *Id.* at art. 3(17).
791. *Id.* at art. 3(19).

standards for methane to parallel with its crude oil barrel standards. OPA currently provides a taxonomy of vessel and facilities in defining the liability caps for oil spills; methane hydrates operations might deserve a similar, but separate listing of facility types if liability caps were to be retained for methane hydrate operations.[792] To better address particular concerns related uniquely to offshore methane hydrate accidents, there might be several enumerations of particular acts or omissions that would substantiate gross negligence for offshore methane hydrate operators.

The CWA enables fines and penalties for marine pollution. The CWA could be amended more simply than OPA by including methane as a marine pollutant for the purposes of the CWA. Once included as a marine pollutant, volumetric standards for emitted, seeped, or vented methane should also be developed and included in measures parallel to the existing volumetric provided for barrels of crude oil. Finally, the penalty areas of the CWA could be amended to include both barrels of crude oil leaked or volumes of methane emitted.

There are existing organizations in place that could assist with the development of private regulations for offshore methane hydrates. For example, the API provides over 600 standards for the oil and gas industry.[793] Additionally, there are other research groups and environmental groups that maintain research related to the development of offshore methane hydrates. These groups could be encouraged to begin drafting suggested private regulations. Those draft regulations could also serve to inform public regulatory bodies in the development of their own regulations, or in the coordinated development of integrated regulatory mechanisms.

792. For example, offshore methane hydrate extraction facilities might be onboard a drilling and producing vessel or they might attached to a moored or connected structure.

793. For example, the American Petroleum Institute (API) maintains an "inventory of over 600 standards and recommended practices." *See Publications, Standards, and Statistics Overview*, AM. PETROLEUM INST., *available at* http://www.api.org/publications-standards-and-statistics (last visited Nov. 30, 2014), *archived at* http://perma.cc/GP3P-RUCD.

V. FINAL CONCLUSIONS

Offshore methane hydrates provide a cornucopia of potential benefits and hazards. Because the effects of these benefits and hazards would engage far beyond a private cluster of individuals, a public law response is needed.

This article has also found that the technological hurdles are being reduced, that the costs of extracting and producing offshore methane hydrate are dropping, and that several nations have explicitly stated that they intend to produce offshore methane hydrates within this decade. As such, the timing to develop the necessary rules of civil liability and regulations is pressing.

The theory of law and economics has provided a means of evaluating alternative rules of civil liabilities and of alternate public regulations. It is the result of this article that a rule of strict liability should be implemented in a complementary fashion with public and private regulations. That combination would provide a more complete set of precautionary incentives to the relevant actors, a more complete set of information to all parties, and the combination would reinforce the effectiveness of both systems of risk governance.

There are existing and functional rules to address hydrocarbon accidents. The basic paradigm for spilt crude oil is broadly in alignment with the recommendations of this article. The rules generally display a preference for the rule of strict liability. The rules often call for extensive amounts of public regulations in parallel to the assignment of strict liability.

Where problems were found it was found that they were usually a result of the simple problem that accidents predicated upon methane leakages were not explicitly included in the drafting of oil spill laws and conventions. Even when broader terms of hazardous substances were included within such frameworks, it appeared that water-borne methane was not included. Thus, water-born methane has fallen between the cracks, so to speak, of otherwise sound and useful laws and regulations.

This article concludes that such oversight could and should be readily remedied. The fundamental frameworks that already exist could and should be extended to include the potential for the

commercial development of offshore methane hydrates. Such efforts could be dove-tailed into existing regulatory frameworks and case law histories by amending the existing laws to be more inclusive.

Such a process, although perhaps the efficient choice from a transaction cost perspective, would still require extensive discussion and commentary. Changes to EU Directives would likely engage mechanisms under the EIA and SEA Directives. Changes to U.S. federal laws would require both administrative and public processes under NEPA. These procedural reviews would not be quick and should not be unsafely expedited. To provide sufficient time to ensure safety and public support, these reviews should be started sooner rather than later.