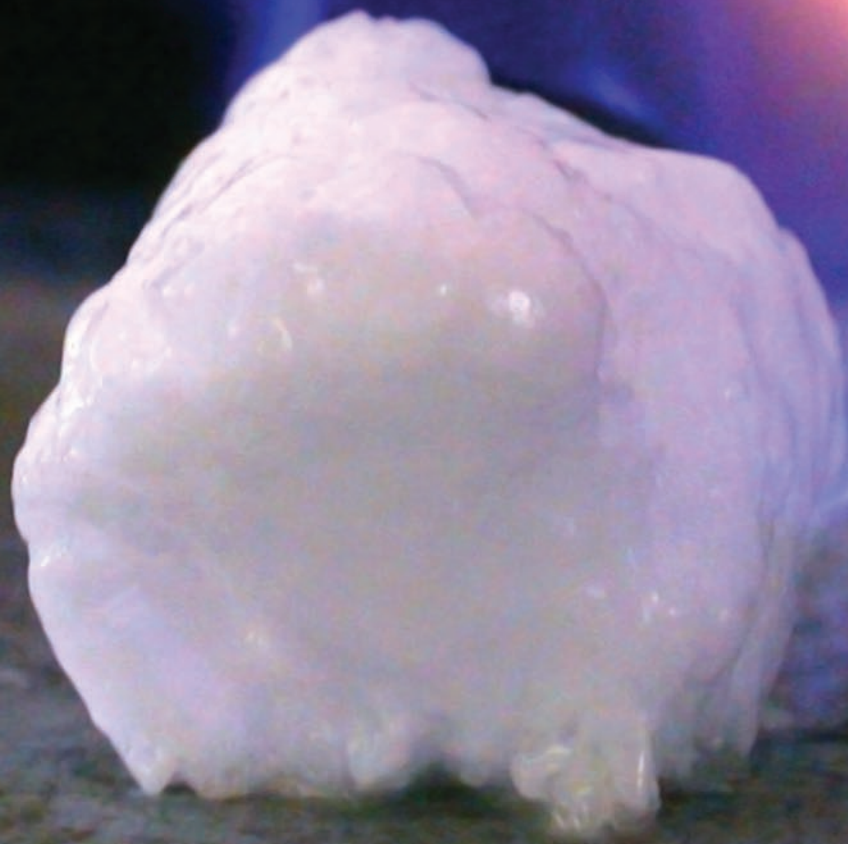


# **GAS HYDRATES**

A DANGEROUSLY  
LARGE SOURCE OF  
UNCONVENTIONAL  
HYDROCARBONS

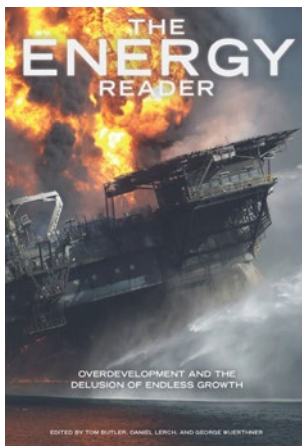
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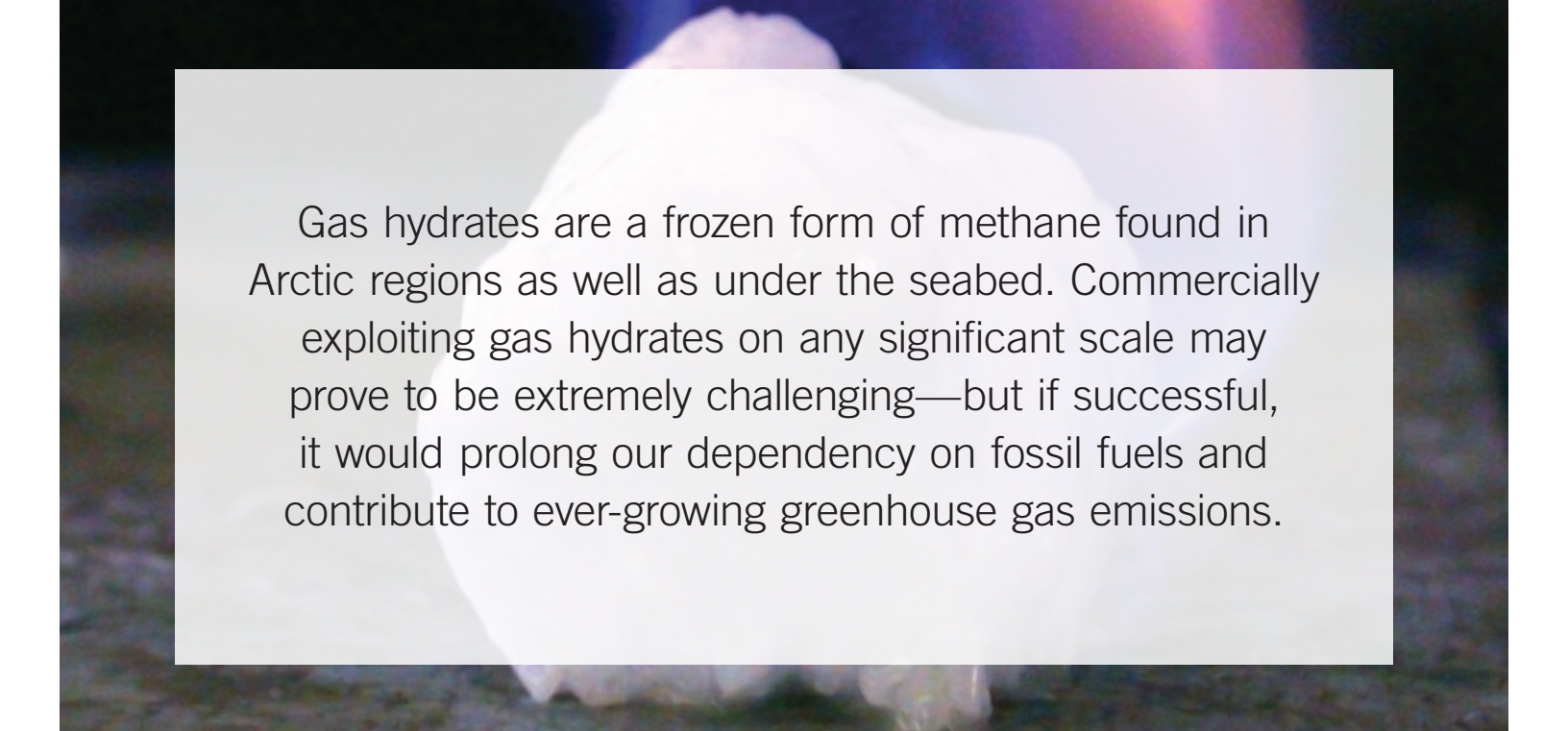
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Photo: Hawaii Natural Energy Institute/University of Hawaii. *Methane hydrates—the ice that burns—are a massive source of hydrocarbons (and greenhouse gas) widely distributed around the globe.*



Gas hydrates are a frozen form of methane found in Arctic regions as well as under the seabed. Commercially exploiting gas hydrates on any significant scale may prove to be extremely challenging—but if successful, it would prolong our dependency on fossil fuels and contribute to ever-growing greenhouse gas emissions.

Under scrutiny as one of the newest energy sources that could help satisfy global energy demand, gas hydrates represent an immense source of methane (the main component of what we call “natural gas”). Gas hydrates are frozen, water-based crystalline solids that trap methane inside; they form at high pressures and low temperatures. Although these deposits look like ice, they turn to water and gas when pressure is relieved or temperatures increase. Massive amounts of gas hydrates exist in deep-sea sediments, on land associated with Arctic permafrost, and sometimes in deep-lake sediments, such as under Lake Baikal in Russia. The majority of ocean-floor gas hydrates are found at depths of more than 1,500 feet (500 meters).

Under hydrate conditions, gas is extremely concentrated. One unit volume of methane hydrate at a pressure of one atmosphere produces about 160 unit volumes of methane gas—thus gas hydrates are very energy-dense reservoirs of fossil fuel. The quantity of methane in gas hydrates worldwide is poorly known, but has been estimated by the U.S. Geological Service (USGS) to be equal to twice the amount of carbon held in all other fossil fuels—all the oil, gas, and coal combined—on Earth.<sup>1</sup> While highly speculative for a fossil energy resource that has essentially zero commercial production at present, interest in hydrates has increased in some parts of the world where other sources of energy are less available or more expensive.

The U.S. Geological Survey estimates that the United States alone holds potentially 200,000 trillion cubic feet (Tcf) of natural gas in gas hydrate deposits.<sup>2</sup> To put that in perspective, in 2010 the United States consumed around 24 trillion cubic feet of natural gas. However, only a small proportion of global hydrate resources may ever be developed due to the technological challenges involving temperature, pressure, environmental protection, and other factors—all of which add to the costs (and energy) required to produce the gas.

The largest known deposit of gas hydrates lies on the continental shelf of the United States between New Jersey and Georgia. The Blake Ridge gas hydrate deposit occurs off the coasts of North and South Carolina, where the USGS estimates there may be 1,300 trillion cubic feet of methane gas.<sup>3</sup> Another promising location for U.S. gas hydrate development lies in the Gulf of Mexico, where the Department of the Interior has estimated the region contains 21,000 trillion cubic feet of methane.<sup>4</sup>

In the near term, the most accessible hydrate deposits occur in the Arctic. Recent drilling on Alaska’s North Slope suggests there may be a minimum of 85 trillion cubic feet of undiscovered, “technically recoverable” (i.e., recoverable with current technologies, but without regard to economics) gas resources within gas hydrates in northern Alaska<sup>5</sup>; meanwhile, a USGS



estimate puts the possible total in-place gas hydrates for northern Alaska at more than 590 trillion cubic feet.<sup>6</sup> Thus these coastal areas and the Alaska North Slope potentially possess enough gas to meet U.S. needs for decades or centuries—if economical means of extraction can be developed. Other large concentrations occur in the Mackenzie River Delta in Canada's Northwest Territory, and in China, India, Japan, and Siberia, among other areas.

Gas hydrates are stable only within a narrow range of temperature and pressure. Under ideal conditions gas hydrates can form a cemented impervious layer that further traps more gas, creating a significant accumulation zone for methane. There is some evidence that changes in pressure and temperature over gas hydrate sediments can precipitate releases of great quantities of methane. Although controversial, some scientists believe that ancient fluctuating global temperatures may have precipitated numerous huge releases of methane into the atmosphere—leading to global warming that could have possibly contributed to past extinctions.<sup>7</sup> The timing of a massive release of methane is speculated to have been at least one factor in the Permian–Triassic extinction event that caused the greatest mass die-off of species ever recorded. It has been called the “Mother of all Extinctions,” with 96 percent of all marine species and 70 percent of terrestrial vertebrate species becoming extinct. Even without causing major extinctions, methane releases are implicated in global climate change. Another global warming event about 55 million years ago is also suspected to be a consequence of the sudden release of massive amounts of methane that had been trapped under the seafloor as gas hydrates.<sup>8</sup>

According to the National Energy Technology Laboratory, the total amount of carbon stored in gas hydrate deposits amounts to many thousands of gigatons, greatly exceeding the quantity of carbon that currently resides in the atmosphere. Such figures give credence to concerns that current global temperature rise may start a chain reaction whereby additional methane, presently frozen beneath the sea and Arctic permafrost or activated from northern wetlands, could be liberated. Since methane is 20 times more effective

(over a hundred years) at trapping heat than is carbon dioxide, even a small amount of additional methane could lead to rapid temperature rise, which in turn may trigger even further releases of methane.

Besides the phenomenon of methane release as unintentional geohazard, there is a real interest in gas hydrates as an energy resource. Recent experimental exploration drilling has demonstrated that certain gas hydrates may be exploitable using existing drilling technology and equipment—suggesting potential for commercial viability, albeit at low net energy returns.<sup>9</sup> One promising technique being tested on Alaska's North Slope involves injecting carbon dioxide into hydrate structures, resulting in the swapping of carbon dioxide molecules for methane molecules in the solid-water hydrate lattice, the release of methane gas, and the permanent storage of carbon dioxide in the formation.<sup>10</sup> The gas hydrate deposits that hold the most potential for commercial viability are located in the Gulf of Mexico and in the Alaska North Slope, where existing oil development technology and equipment make them attractive for future exploitation.<sup>11</sup>

New combinations of drilling technology (i.e., hydraulic fracturing with horizontal drilling) have, at least for the short term, precipitated a natural gas production boom in shale formations around North America that has reduced gas prices, likely pushing off the day when offshore gas hydrates are viewed as commercially viable—at least in the United States. In other parts of the world less endowed with fossil fuels, gas hydrates are being more actively explored as a potential source of energy. Given the fact that huge quantities of gas hydrates are possibly available to be tapped, and that methane burns cleaner than coal, oil, and other potential fuels, it is likely that there will be a major push to find economic means of utilizing gas hydrates sooner or later.

Gas hydrates offer an enormous tempting target for future energy production, but it's an open question how much of the gas can ultimately be extracted given the major technological and environmental (and ultimately economic) challenges involved. Moreover, a gas hydrates drilling rush could be dangerous in that the

perceived abundance of another hydrocarbon resource may undermine the urgent need to develop renewable energy sources. And if such a drilling boom comes to pass in reality, it may exacerbate climate chaos, degrade marine and terrestrial habitats, and contribute to the delusion that perpetual growth is possible on a finite planet.

## ENDNOTES

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