Proposal for a Treaty on Rational Use of Methane Hydrate Reserves

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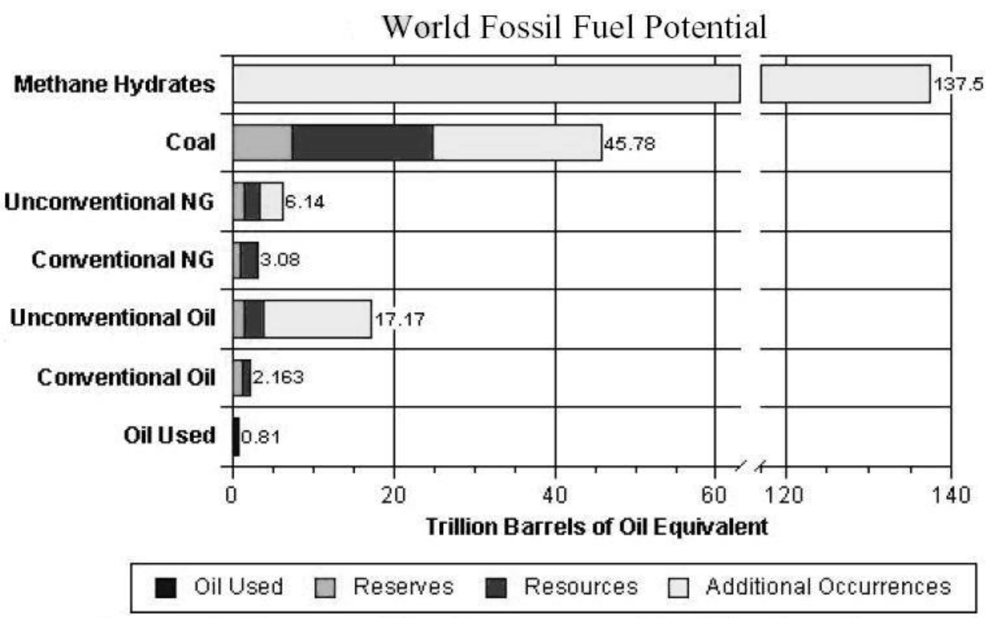
Research done over the last two decades has shown that the oceans and polar terrestrial masses around the world hold immense amounts of methane (the primary component of natural gas) concentrated in cage-like ice structures known as methane hydrates. Occurring naturally both in permafrost regions where cold temperatures persist in shallow sediments, and at ocean depths of 500 meters or more where high pressures dominate, these unique structures encase methane at very high concentrations. In fact, a single unit of hydrate can release as much as 160 times its volume in gas when heated and depressurized.

Hydrates are typically found a few meters below the ocean floor in layers a few hundred meters thick. The majority of methane hydrates were formed from accumulations of biogenic methane excreted by deep-sea bacteria over thousands of years. The sheer magnitude of methane hydrate deposits has drawn the interest of oil companies to explore this potential energy source. It is estimated that methane hydrates reserves approach 400 million trillion cubic feet (Tcf), which is several orders of magnitude greater than the 5,000 Tcf that make up the world's known gas reserves. (See Figure 1.) Hundreds of deposit sites have been identified off the coasts of the United States, Canada, Russia, Japan, India, Mexico, and Costa Rica, among others; countries such as Japan have invested millions of dollars researching extraction methods.

Figure 1. World fossil fuel potential showing the potential amount of methane hydrate deposits compared to deposits of conventional fossil fuels

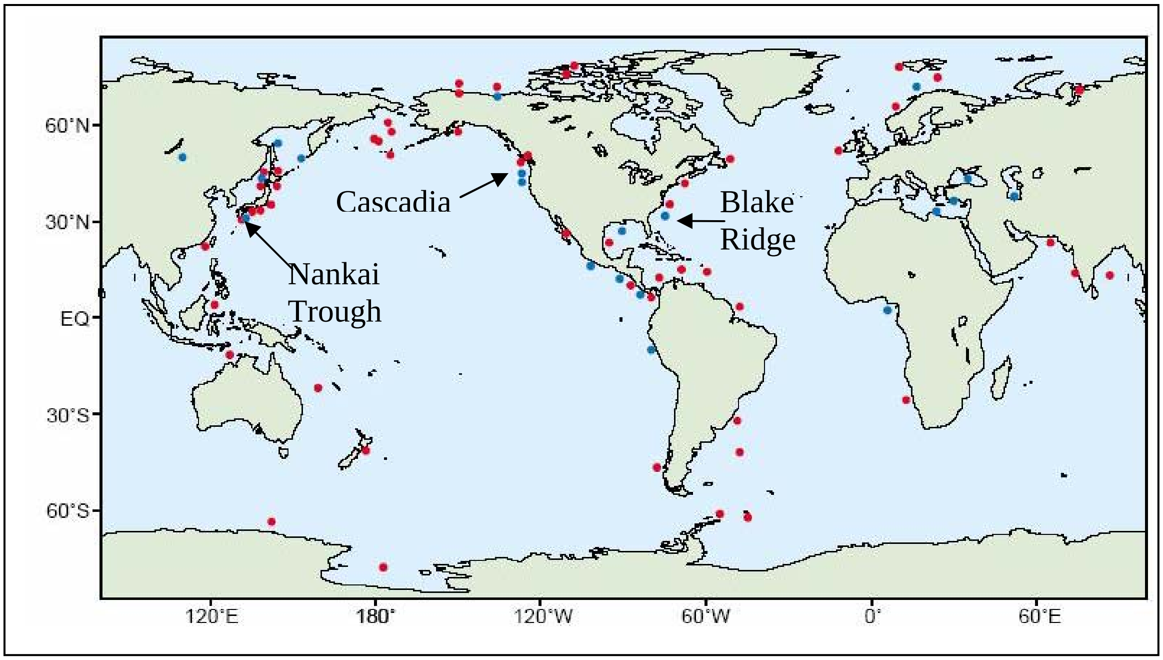


Source: H. H. Rogner, "An Assessment of World Hydrocarbon Resources," Annual Review of Energy and Environment, 1997.

Recovering methane gas from beneath the ocean floor presents several safety and environmental challenges. First, methane gas is very unstable and can be dangerous to work with. Second, melting the crystals could destabilize regions of the ocean floor, thus triggering major submarine landslides that could induce tsunamis that could wipe out coastal areas. Third, the natural venting of unburned methane, a potent greenhouse gas, to the atmosphere will contribute to catastrophic global warming, given that the capacity of methane to trap infrared radiation is 21 times greater per kilogram than the capacity of carbon dioxide. Finally, the combustion of methane hydrates will contribute to the emission of fossil carbon dioxide to the atmosphere, thus contributing to the steady increase in carbon dioxide levels in the atmosphere that is the main cause of the green house effect that induces global-warming phenomenon.

The following map (Figure 2) shows the locations of the known methane hydrate deposits around the world. Most of the methane hydrate deposits are located in continental submarine shelves relatively near the coastlines (20-200 miles) where territorial conflicts among countries would be rare. However, some of the Arctic and Antarctic deposits are in international waters, where disputes about its possession could arise in the mid-term future.

Figure 2. World map showing the location of the main known methane hydrate deposits. The blue dots (which can be differentiated from the red dots in the on-line version of this paper) indicate locations where samples of hydrates have been recovered and the red dots indicate the locations where the presence of hydrates has been inferred by using seismic geological analyses.



Advances in energy generation systems design include the development of hydrogen-fueled power cells and thermophotovoltaic generators. Methane hydrates could be used to obtain large quantities of cheap hydrogen through chemical reformation. Thermophotovoltaic generators can use methane directly to fuel infrared radiation emitters. Expanded use of these energy-generating systems will induce additional political pressure for methane hydrate exploitation if renewable sources of hydrogen and methane are not developed by the year 2020.

To predict these developments it is important to consider how technology development corporations work. Once a technological paradigm is chosen and widely used for power-generating applications, peripheral economic interests build up around the new paradigm (for example, fuel-providing companies, service stations, financing corporations, manufacturing facilities, personnel training, etc.). It is very difficult to suddenly change a power-generating paradigm without damaging a nation's economic health. For this reason, major technological changes occur by steps and usually every 25 years. An example of this is the replacement of carburetors with electronic fuel injection systems to dispense fuel to internal combustion engines in automobiles. The levels of localized air pollution in metropolitan areas is compelling the automotive and power generation corporations to implement the most important technological paradigm change in 100 years: the replacement of internal combustion engines and power generation boiler-turbine systems with fuel cells and thermophotovoltaic generators.

If this major change occurs and energy technology becomes dependent on methane hydrates for hydrogen and methane and if methane mining produces geologic seafloor instability and global warming, we will be trapped in the same addictive, self-destructive dependent relation that we suffer today with the automobile-petroleum relationship. Interest groups would work hard to maintain high levels of methane hydrate extraction using the same arguments used by oil companies today, and a change in power-generating technology could be delayed for another 50-100 years. By that time the effects of seafloor instability and global warming could be so far advanced that they could permanently maim humanity's ability to develop and survive in a sustainable way.

As of this writing (spring 2005), commercial exploitation of methane hydrate deposits does not exist, so few interest groups are advocating for the extraction of methane hydrate. However, this could change in the next 10 years as the demand for cheap hydrogen and methane for power systems increases. Some politicians seeking to develop programs in developed and developing countries would find potential revenues from methane hydrate extraction irresistible. Even worse, corrupt politicians in developing countries could use the revenues from methane hydrate extraction to finance themselves in ways comparable to the situation in Angola, where the amount of revenues the government derives from oil extraction is kept secret from the Angolan public.

Political and economic interest groups would argue that it is a waste not to use methane hydrates when the exploitation of this resource will aid development. They may use simplistic, populist demagogy to encourage public acceptance of methane hydrate extraction without complete understanding of the long-term consequences.

For these reasons, it is necessary to establish a mechanism to (1) promote research on the possible effects of extracting methane hydrates from the ocean floor; (2) provide clear property rights for methane hydrate deposits located in international waters; and (3) regulate the inducement of methane hydrate use in future power systems design.

The World Methane Hydrate Advisory Board

Under this mechanism a World Methane Hydrate Advisory Board (WMHAB) would be created as a branch of the World Trade Organization (WTO). The main functions of this advisory board will be to gather information about the possible good or bad consequences of methane hydrate usage; convert this information into policy-making terms; and reach semiformal consensus about legislation that will be proposed to WTO member countries. Any legislation proposed by WMHAB will be sent to the member countries for approval.

The WMHAB will be composed of chief design engineers of the automotive and power system corporations of WTO member countries in which any products are dependent on any gaseous-phase fuel; scientists appointed by IPCC; and former heads of state and representatives of nongovernmental organizations (NGOs). Corporate membership in the WMHAB will be on a voluntary basis; members would gain the right to use the WMHAB membership seal on their official documents. WMHAB membership would also make a firm eligible to receive the "Annual Corporate Citizen Award" in the energy category.

The award would be given to the company that in the estimation of the IPCC has done the most to assure the sustainable development of energy generation and power-train systems. It would be presented during the opening ceremony of the United Nations General Assembly each fall. The corporation to which the Corporate Citizen Award is given would be permitted to use this title in its publicity during the period of one year. The political rationale for joining such a diverse group is based in the joint-fact finding technique of reaching consensus on complex agreements. This joint-fact-finding technique enables users to avoid what happens when scientists prescribe solutions with socioeconomic implications that may be incompatible with the idiosyncrasies—called by social scientists "local knowledge"-- of those affected by such measures. Sensitivity to local conditions and terminology can greatly increase the success of a policy. Local knowledge provides an empirical assessment of the situation explained in terms of local context and plain language that anyone could understand and interpret.

Joint fact finding uses local knowledge to overcome problems by enabling the affected community, government officials, private corporations, and scientists to learn from each other. This research approach works when there is a balance of power (in terms of resources among the parties. Joint fact finding is useful for resolving disputes in which parties interpret data and information differently (either by education level or side in the conflict), or in the presence of great scientific uncertainty. Joint fact finding allows the partners to learn aspects of the problem that would otherwise escape them; creates a consensus that produce credible agreements; and enables parties to construct strong relationships and implement more creative solutions.

In the joint fact-finding process decision making is divided among three branches with equal powers and faculties to check the activities of the other branches. This is done in order to prevent private corporations located mainly in the North from imposing their economic power over methane hydrate regulations. Their influence is balanced against the opinions of scientists, NGOs, and governments world wide. The balance among the branches would also prevent stagnation of any regulation proposal while providing an implementation mechanism that will assure that credible methane hydrate regulations will be followed by the signing parties.

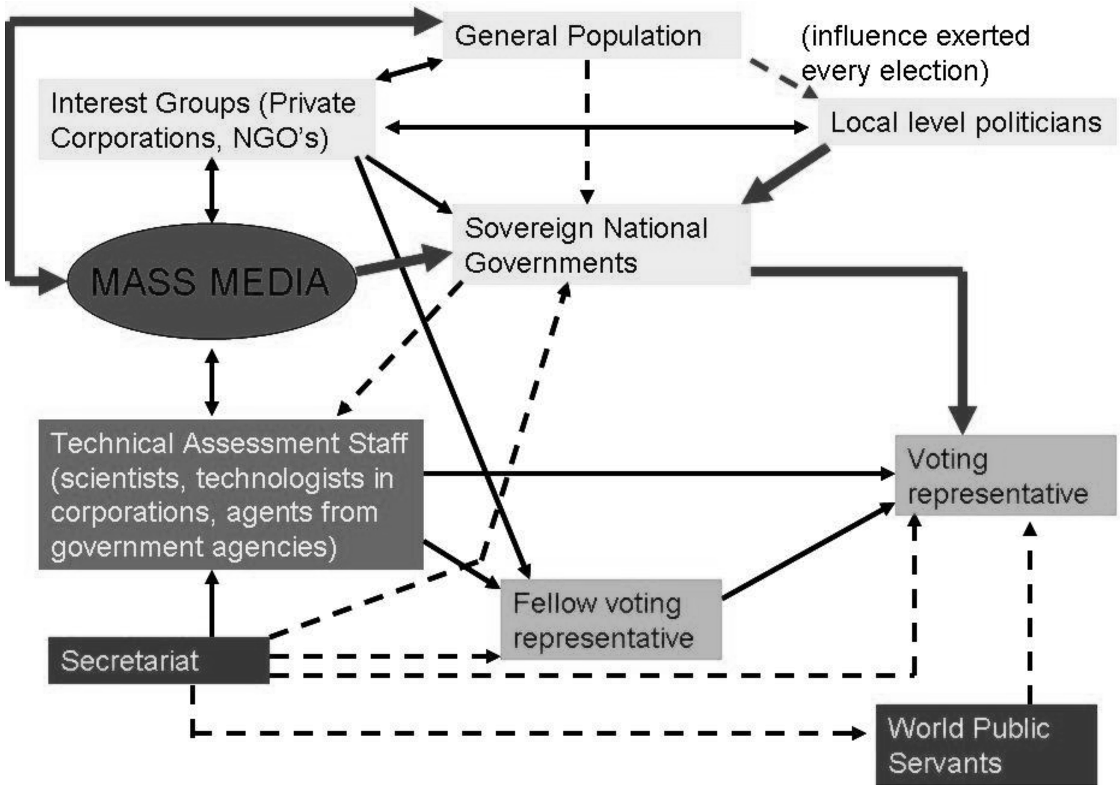
The executive branch of WMHAB will coordinate the implementation of the board's operations. Its head would be proposed by IPCC scientists and voted on by the chief design engineers of technology firms. The technological branch would review the technological demands of the member countries and create legislation related to methane hydrates that would be recommended among its member countries. The technological branch will be divided into two councils: first, a corporate council integrated by the chief design engineers of power systems design technological firms regardless of their number. (These are now located mainly in the North.) and second, a human improvement council including one former head of state (or official of high national moral stature) and one NGO member from each of the countries who would sign the treaty (members from the developing countries in the South could have a majority in this group).

Employees of any fossil energy corporation would be ineligible for membership on either of these councils. Technological firms would not be allowed to send administrative or financial staff employees to the corporate council; only product design staff with proven technological credentials would be eligible. The scientific branch would determine whether the actions of the executive and technological branches follow the spirit of WMHAB objectives. Its judgments over the validity of any regulation could be only appealed before the general assembly of the UN. The member countries in the general assembly of the UN would vote by majority to uphold or change the judgments of the scientific branch.

The scientific branch will be composed of scientists appointed by IPCC and ratified by majority votes by the Human Improvement Council of the Technological Branch. Any regulation related to methane hydrates could be presented by the members of the Corporate Council, the Human Improvement Council, or the Executive and should be approved by the majority of the members of the Corporate and Human Improvement Councils. The head of the Executive Branch would have a veto power over any regulation proposal, which could be exerted only three times for any given regulation passed by the Technological Branch.

The balance of power required for an effective joint-fact-finding endeavor also promotes accountability on the part of the main actors provided that corporations are accountable to stakeholders, former heads of state are attentive to political actors; NGO members are accountable to their constituencies; and scientists remain accountable to peers and politicians. Citizens will participate in the methane hydrate policy-making process if it follows the pattern described in the following figure:

Figure 3. Paths of information flow in the international policy-making process; the thick solid lines denote "imperative" information influence; the thin solid lines denote "nominal" information influence; and the dotted lines denote "indirect" information influence.



The general population will influence the process either by investing in the stock of the corporations, buying their products, voting for local authorities, expressing opinion through the media, or by joining an NGO. These entities directly or indirectly influence the will of national governments which have the main influence their representatives participating and voting in an international agreement process. Joint fact finding "lubricates" the flow of information and clarifies it for all the actors, increasing the possibility of reaching a clear agreement.

WMHAB Main Objectives

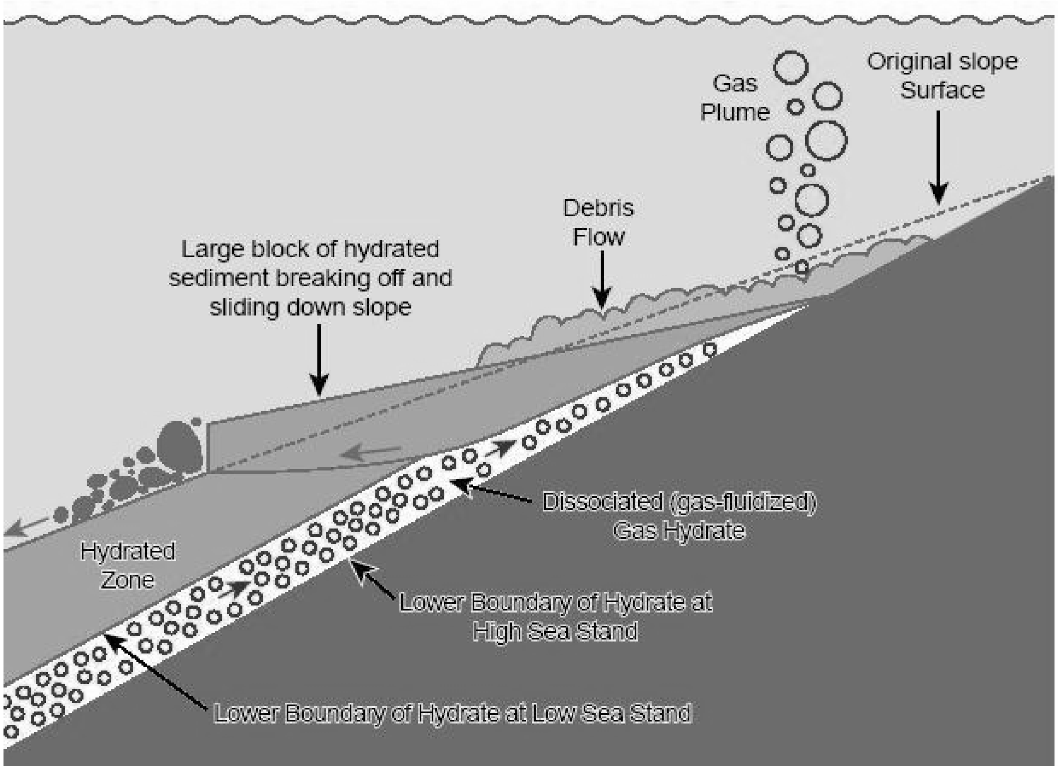
All regulations made by the WMHAB should be based in the precautionary principle of "lowest feasible risk" rather than the standard of "elimination of significant risk." This is important because "lowest feasible risk" means that the possible risks of methane hydrate extraction will be maintained at the lowest possible level with current available technology. "Elimination of significant risk" calls for the reduction of risk only to the point at which further action would "destroy the competitiveness" of an entire industry (for example, the profits of fossil energy companies or unscrupulous energy-generating or automotive companies).

To be proposed and passed by the WMHAB a regulation should have been analyzed from three research perspectives:

<u>1. Possible effects of extracting methane hydrates from the terrestrial or marine subsoil</u>
Research on methane hydrate extraction from the subsoil should address two main issues: ocean floor geological stability and global warming.

Mark Maslin's *Gas Hydrates a Hazard for the 21st Century* (2003) reports that when enclosed in sediment pore space, gas hydrate acts like cement, compacting and stabilizing the seafloor. If it forms in deposits that are still unconsolidated, however, gas hydrate hinders normal compaction processes. If exposed to lower pressure and/or increased temperature, the decomposition of such gas hydrate can disrupt its poorly compacted host sediment triggering a submarine sediment slide. Seismic, bathymetric, and side-scan sonar mapping of the seafloor has shown that slides on a variety of scales characterize all continental slopes. Sediment slides are more likely to be promoted by gas hydrate breakdown on slopes of more than four degrees. One important triggering factor seems to be the expansion of the released gas, which increases with decreasing water depth. For example, at 650 m water depth, the volume of released gas and water is almost three times the original gas hydrate volume. Gas hydrate decomposition at the upper edge of the continental shelf can thus promote enormous pore pressure in the sediment, leading to a massive loss of compactness and the formation of large pore spaces that make the sediment highly unstable.

Figure 4. Mechanism of seafloor landslide induced by melting methane hydrate

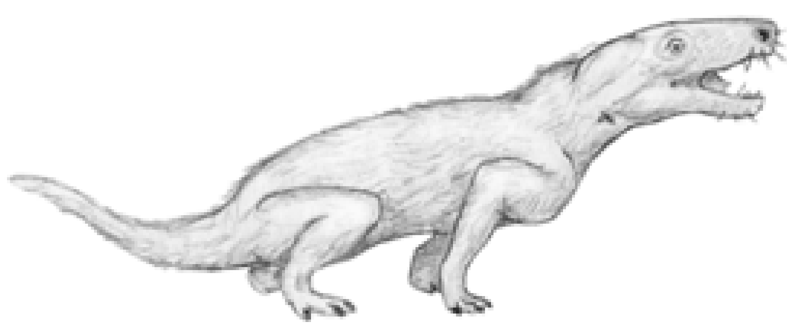


For these reasons, it should be proven with 99 percent certainty that any methane hydrate extraction endeavor will not induce a landslide on the ocean floor on the continental and transcontinental shelves that could induce tsunamis. Every geological assessment of methane hydrate extraction should be performed by licensed geological exploration professionals with at least ten years experience in the field. If a tsunami is induced by a landslide in the terrestrial or oceanic floor in the zone where the geological assessment was performed, the methane hydrate extraction corporation and the geological survey company should be compelled to share equally the costs of economic and environmental damage. If these corporations are unable to pay such damages, they should be paid by the country that granted them the extraction permits. Methane hydrate deposits located in terrestrial subsoil should be subject to these regulations if they are located within a distance of 30 miles from the nearest coastal point.

Known methane hydrates reserves hold ten times the amount of carbon currently present in Earth's atmosphere. If released, this carbon could induce a climatic change disaster similar to the one experienced during the Permian-Triassic extinction which occurred 250 million years ago and killed 95 percent of all the species of that time. It is believed that in the Permian-Triasic threshold, large volcanic eruptions in Siberia emitted massive amounts of sulfur particles and CO_2 into the atmosphere. The particles partially blocked the sunlight for a period of less than 1000 years during which the average atmospheric temperature decreased three degrees Celsius.

Once the particles settled in the soil, sunlight fully penetrated the atmosphere. Massive amounts of volcanic greenhouse gases increased Earth's temperature five degrees Celsius above its initial temperature. This temperature increase was enough to melt the methane hydrates in the primitive ocean floor releasing huge amounts of methane into the atmosphere and inducing further heating by another five to eight degrees Celsius. The resulting two sets of sudden climatic change induced two massive extinctions, one in the oceans and another on land. Among the animal families most affected by this extinction were most of the Therapsids, mammal-like reptiles which are the ancestors of all the mammals.

Figure 5. The Thrinaxodon was a mammal-like reptile of the Therapsid family that dominated the late Permian Era 280-250 million years ago. The Permian Extinction almost wiped out this family. From one of its few surviving species descend all the mammal species, including humans.



Lest we go the way of the Therapsides, it should be proven with 99 percent certainty that any methane hydrate extraction endeavor will not induce raw methane hydrate eruptions into the atmosphere. Any geological assessment of methane hydrate eruptions should be performed by licensed geological exploration professionals with at least ten years experience. Should a raw methane eruption occur, the methane hydrate extraction corporation and the geological survey company would be fined for all the economic and environmental damages caused by such phenomena. The methane hydrate eruption damages will be assessed in terms of the amount of methane expelled on the basis of a monetary value assigned by unit of volume. This money should be paid to the WMHAB which will be responsible for administering these funds to alleviate the problems caused by the eruption. If the responsible corporations are not able to pay such damages, they should be paid by the country that issued the extraction permits. Methane hydrate eruptions would be monitored world wide by satellites in Earth orbit.

<u>2. Clarification of property rights over methane hydrate deposits located in national waters, international waters, and within terrestrial borders</u>

Property rights over methane hydrate deposits should follow a four-point hierarchy:

A. Offshore methane hydrate deposits should belong to the sovereign nations in whose clearly established territorial waters the deposits are found.
B. Should a controversy over territorial waters occur, the WMHAB will invite countries in the relevant regional zone to confer and negotiate property rights following the principles of international law.
C. Methane hydrate deposits found in international waters will be assigned to a sponsor country that will assure the compliance to the regulations outlined above. If a controversy ensues, the location of the deposit will be barred from exploitation for ten years or until an agreement is signed before the UN Security Council.
D. Should methane hydrate deposits be discovered in a terrestrial location, they will belong to the country owning the surface under which the deposits are located. Any deposits found in the Antarctic continent will not be exploited, following the regulations of the Antarctic Treaty of Mineral Exploitation.

Regulation for promoting methane hydrate use in future power systems design

Power-generating systems designed to be explicitly or implicitly used with fuel in any gas form should be reviewed and documented by the technology design companies who have a seat in the Corporate Council. They will specifiy which power systems should use methane hydrates fuel instead of designing power systems based in renewable sources of energy. If a product is a secret or in the patenting process, a special commission of the Human Improvement Council will be appointed to receive the design review documentation in the presence of officials of the office where the patent is being processed. These appointed members will sign a confidentiality agreement with the corporation that requested this special process. If confidentiality is broken the offender will be penalized with the restraint of voting rights (for the former heads of State) or in the case of NGO members, expulsion of the NGO they represent from the Human Improvement Council.

The technology design companies who have a seat in the Corporate Council will be responsible for generating an internal Bill of Design that will establish design parameter guidelines for any power-generating system that uses fuel in gaseous form. This Bill of

Design will be explicit about the conditions under which the use of methane hydrates may not be substituted for renewable sources of energy and should be used internally as a base for the development of future products that could use any fuel in gas form.

Implementation of WMHAB Objectives

The objectives sought by WMHAB will be financed by fees provided by the corporations holding seats in the Corporate Council. These fees would range from 0.5 to one percent of the research and development budget from the previous fiscal year from each member corporation. A precedent for this type of specialized organization for corporations is that of the National Biodiesel Board. It is mandatory to belong to this board in order to get the TIER-2 certification to commercialize biodiesel in the US.

Any failure by a corporation to pay its WMHAB fees or implement the regulations stated by the treaty will be investigated by commissions of the Human Improvement Council which can recommend the expulsion of the corporation from the Corporate Council. Any corporation outside the treaty sanctioned by WMHAB would not be able to use the WMHAB seal (certification) in any of the products they produce, market, service, or provide warranty for. Corporations from WTO member countries should not be allowed to buy individual components or equipment with the WMHAB certification in order to certify their own complete systems or marketing brands. Such regulations will be enforced by the member countries of the WTO following the procedures of Commercial Law as they see fit.

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