Report for Investment to
Build and Install the C.A.R.,

Clean Air Rig
Carbon Absorption Rig
Cities Architecture Rudiment.

The offshore engineering
structure for giant-algae
growth and harvesting in

Giant Algae System Corporation
(G A S Corp),

a subsidiary of the Ocean Earth
Development Corporation
(OEDC), New York, New York.

GIANT ALGAE SYSTEM

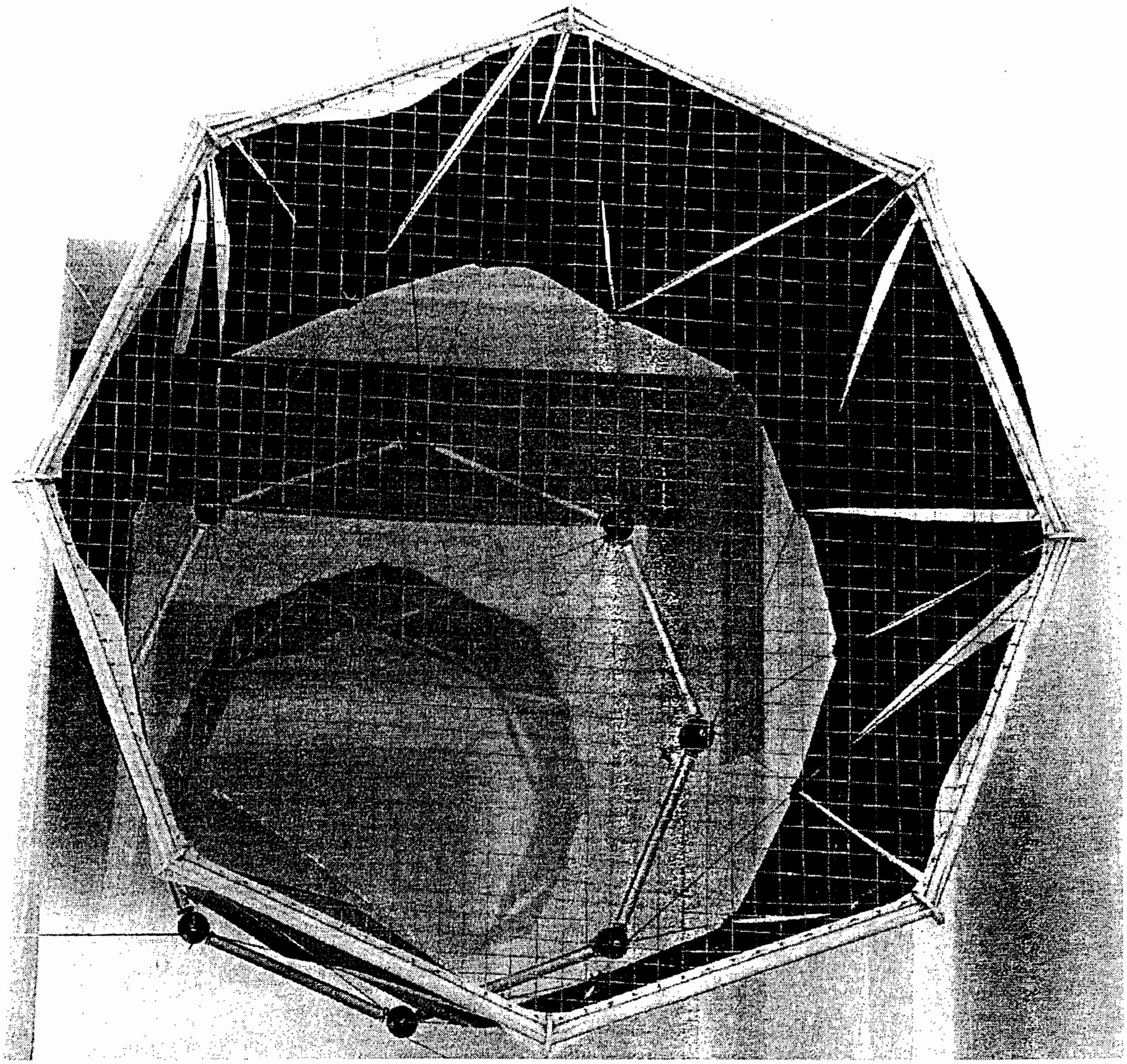
G.A.S.

IDEAS AND MODES OF MATERIAL THOUGHT ORIGINATED IN RECENT ART INCORPORATED BY ARCHITECTS, SCIENTISTS AND ENGINEERS INTO NEW STRUCTURES AND TECHNOLOGIES THAT SERVE CITIES, IN PRACTICAL URBANISM.

HERE, A SUBMERSIBLE FLOATING CAGE, OR OFF-SHORE RIG, FOR PRODUCTION AND HARVESTING OF GIANT BROWN ALGAE, FOR PRIMARY-SECTOR EXTRACTION OF NUTRIENTS ACCUMULATING IN COASTAL WATERS, WITH POTENTIAL TO YIELD LARGE QUANTITIES OF METHANE OR HYDROGEN GAS, FOR A REPLENISHABLE URBAN SUPPLY THAT ASSURES CLEAN AIR. HENCE THE TERM "CLEAN AIR RIG", C.A.R., MEETING THE FIRST CONDITION FOR THE ARCHITECTURE OF CITIES: CLEAN AIR.

OUR PROJECT: TO COMPLETE BUILDING TEST VERSIONS OF THE C.A.R., THEN TEST IT IN A SPECIFICALLY PERMITTED SITE IN NEW ZEALAND, WINTER 1998, USING GIANT BROWN ALGAE—CHIEFLY RAPID-GROWTH MACROCYSTIS.

ALL RESULTS OF THE TESTS TO BE OWNED BY GIANT ALGAE SYSTEM CORPORATION (GAS CORP), THE INVESTMENT VEHICLE, TO BE APPLIED IN SITES AROUND THE TEMPERATE SOUTHERN HEMISPHERE AND PACIFIC NORTH AMERICA—WHERE THE RAPID-GROWTH MACROCYSTIS IS NOW PRESENT.



Scale model of offshore rig , 1:15 scale, exhibited at and sponsored by the FRAC Poitou-Charentes, Angouleme, France. Designed by Ocean Earth with Marc Lombard, La Rochelle.

Towards Ocean Trials of Clean Air Rigs, or Carbon Absorption Rigs, or Cities Architecture Rudiment (C.A.R.)

In the course of queries on how the City shall be supplied with fuel, or how Industry shall be supplied with the rawstuff for production of steel, plastics and numerous chemical goods, the Ocean Earth Development Corporation has reasoned that Algae would be a reliable source.

There can be freshwater algae, such as the Botryoccocus braunii that can grow aviation fuel grade hydrocarbons in its own cells, and there can be saltwater algae such as Gracilaria, which has successfully been grown in the Mediterranean for the absorption of urban run-off with a final yield as methane gas, but Ocean Earth has focused its attention on giant brown algae, to be grown in the open sea in what are recognized to be the world's fastest rates of carbon absorption and solar-energy conversion, or growth. Attention is focused on the open sea, further, only because this is a vast, uninhabited area which, particularly at upwellings (artificial or natural) and near coasts, can be a non-depletable receptacle for nutrients. Crops grown upland deplete the nutrients upland; crops grown at upwellings or coastal waters offshore, if managed well, can never deplete the nutrients offshore.

Taking a large-cycle view of the movement of soil and water, Ocean Earth has focused on developing what can be called the Offshore Soil Rig. Any harvest offshore is a return to upland sites of soil nutrients accumulated offshore or upwelled from sea bottoms offshore. For the public, the term is C.A.R., or Clean Air Rig (as an urban product), also Carbon Absorption Rig (as block against Greenhouse Effect), or still, following Cities Service, the Cities Architecture Rudiment (as an initial act, not sufficient but necessary, for architectural development of a city).

The yield can be an entirely non-polluting fuel: either methane or hydrogen.

The chief dangers to such an industry are:

(1) pollution, which retards the growth of crops and fish;
(2) dams which block the flow of soil nutrients to the sea.

Both dangers are well known. Yet both dangers have not been successfully addressed. There has been some progress on reducing pollution in certain rivers, but overall the oceans of the world, and particularly the regional seas like the North Sea, Baltic and Mediterranean, become more polluted, not less. There is no progress regarding dams: time and again, in country after country, river after river, the building of hydroelectric projects continues, and sometimes accelerates, becoming what is arguably the main cause for the sharp decline in numbers (and size) of fish in the oceans and rivers of the world. One cannot attribute the declines in ocean fertility or fish numbers, and size, in waters off Newfoundland or Iceland to pollution (nearly none), marsh filling (none, either) or overfishing (little change after sharp reductions in fishing quotas), particularly after fishing efforts are cut back. One can attribute these declines to the one industrial phenomenon common to both regions: the damming of rivers.

If there is an adequate supply of nutrients in the sea, and if there is not much pollution, then one can conduct ocean trials in waters naturally conducive to giant brown algae. For now, we focus on the fastest-growth algae, of the genera Macrocystis.

Offshore Soil Rig, or Clean Air Rig

The Rig is submersible, and it is to be built in a shipyard familiar with submersibles. We have discussed this with Australian Submarine Industries, in Adelaide, Australia. They say they can build a submersible rig, which can fall from or return to the ocean surface quickly as wave action increases or declines, for about half the cost—and with more technical expertise—of a conventional shipyard. The time required for production of the first ocean-trials rig, according to this and other firms, has been estimated at 1-2 months. We are aware, further, of Norwegian work with submersible cage systems.

The Rig, which could measure as little as 10 meters in diameter and 10 meters in depth, should be submersible at least an additional 10 meters. It should be set in waters no less than 30-40 meters deep.

First tests should be in relatively calm, sheltered waters, so the depth there can be just about 30 meters.

But more demanding tests, in more exposed, tempestuous seas, where one might need to submerge twice as deep during storms, up to 20 meters, should be in waters with a depth of at least 40 meters.
In any case, the deeper the waters for testing, the better.

Duration of the Ocean Trials need not be long, at least in testing the main points:

- submersibility
- re-emergibility
- survival of the Rig during storms
- survival of the Algae during deep submersion

survival of the Algae during periods of growth
harvestability of the Algae.

Assuming that the Algae fronds are mature when attached to the holdfasts of the Rig, then the Trials can be conducted within several months.

Fronds would be attached to the holdfasts until after initial growth in a nursery, so there is no need to deal with the full life-cycle of the Algae.

As soon as the Algae have achieved a mature growth rate, of up to two meters per week, then harvesting tests can begin. We propose:

cropping the Algae from below and re-attaching
thinning the Algae from above, at the same time
cropping the entire frond, then attaching new fronds.

A full growing season, of about six months, would be best.

The structural tests, of the Rig and of the Algae behavior as the Rig is submerged and re-emerges, are the most critical.

Harvestability, and various techniques of harvesting, are not as critical. Somehow or other optimal solutions can be found; there has been much experience in this.

There seems to have been no successful experience with a large submersible structure to accommodate artificial beds of giant algae, such as Macrocystis. But we will confirm this with a Chinese source who claims to have grown Macrocystis on artificial structures.

Given the importance of the Ocean Trials, it seems that monitoring should be done continuously. There should be close observation of what occurs, particularly during storms. A sheltered site close to shore is best. The people in charge of the project should be able to get to the site quickly, even from a house or boat nearby, in case of dynamic events.

For monitoring, we recommend:

(1) several monitoring buoys;
(2) an overhead camera, suspended by tethered balloon;
(3) an underwater camera with remote switch-on capacity;
(4) an anchored boat with at least one person, ready to enter the water with scuba gear.

The near-land tests allow for the entire staff to stay near the site. We had been interested in Middle Harbor, Sydney, or in the outfall area near Bondi or North Head, Sydney, or the deepwater trough just south of Somes Island, in Wellington Harbor. It is vital to be able to see what is happening during storms. One considers a crew of scuba divers, much as had been offered to us in our proposal for sheltered Ocean Trials in Tivat Bay, Montenegro. We have a list of persons ready to undertake scuba-equipped monitoring, involving also cameras and buoys.

The attachment of Algae to the holdfasts of the Rig can be supervised by experienced scientists, such as Drs. Rene Perez and Raymond Kaas of IFREMER, the French Government applied-oceanography research institute. We expect trials to begin at the start of 1998, during the height of summer in New Zealand. They may try the attachment of nursery grown Algae rather than plants from natural beds nearby. The scientists have suggested to Ocean Earth that they would take responsibility for the biology of Ocean Trials, in assuring that attachment is done successfully, while leaving to Ocean Earth the responsibility for the engineering.

Altogether, we envision two stages of Ocean Trials, first of the engineering of the Rig, which could be as short as one month, and second of the overall growth-harvesting, which should be one season, at least six months.

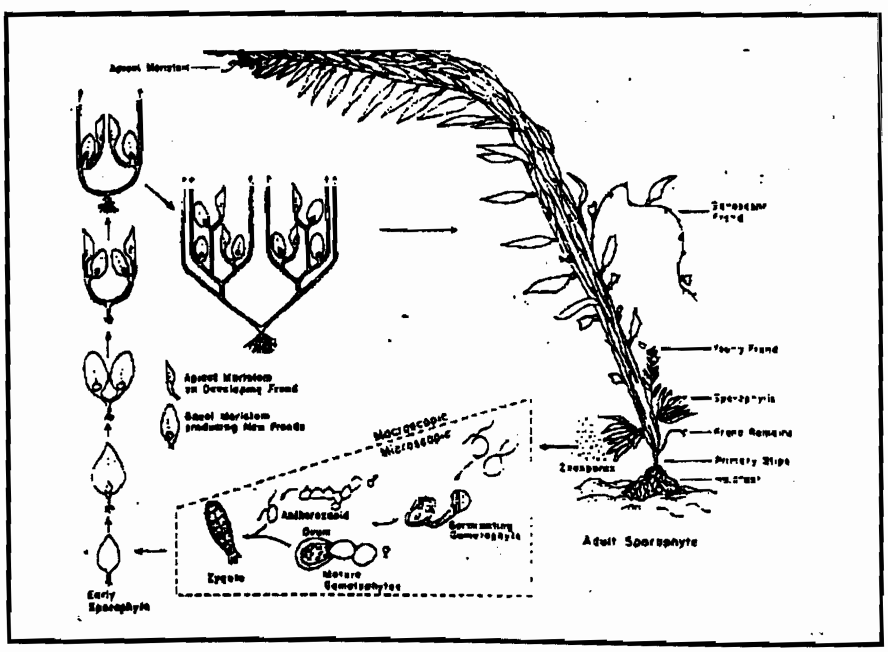
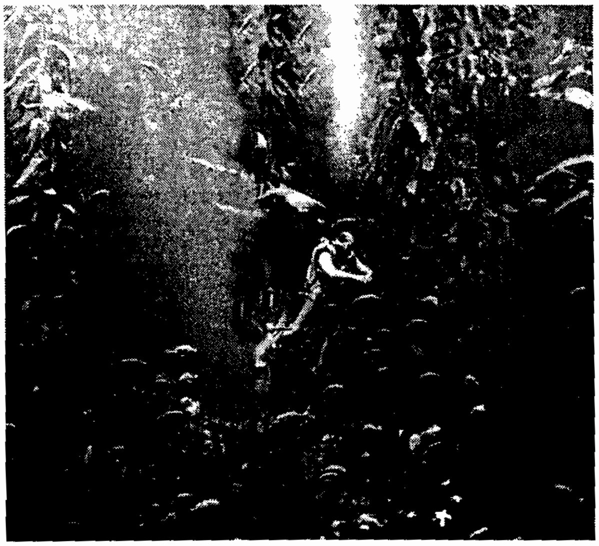


Diagram of Macrocystis live—development: the diploid sporophyte increases its frond numbers through production of blades at both ends of the plant.



Diver descends into kelp forest

Diver examining kelp plant

The Boalch Dictum

Scientists at an American research institute emphasize that at this time the only research efforts with Macrocystis for industrial development are in China. Such apparently violates a rule being enforced by British scientist Gerald Boalch that no Macrocystis work be conducted where the plant does not now occur, even if it used to occur there before. Success in China, even if it violates a Boalch ruling, would almost certainly be preferable to what could foreclose a large offshore industry in China: giant dam projects on primary influence rivers like the Yangtze, e.g., the Three Gorges Dam. The Boalch dictum, enforced now through the International Council for Exploration of the Seas, in Copenhagen, is endorsed by scientists pleading for no interference whatsoever in the oceans. The dictum is of course undermined by our colossal impacts already, such as marsh clearing, river polluting, soil and fertilizer runoff and acid-rain. The regional seas are sick or dying, due to us. One cannot simply do nothing. Also, one cannot—and here's the rub in China—expect vigorous ecology if hydroelectric projects cut off nutrient flows to the sea.

Summary Report for Investment

A review has been conducted of all documents and files accumulated over nearly two decades regarding the development of a giant algae industry for primary fuel and materials production.

This includes a review of the final reports filed in the mid-1980s for the Institute of Gas Technology, of Chicago, and the US Department of Energy.

The consensus is that a primary-energy system based on marine biomass will be fully developed sometime during the 21st century. The questions are: When will this happen, Who will do it, and With What technology?

Our view, that of a company chartered to produce architecture components and media services, is that such renewable energy possibilities should be dealt with as questions of Architecture and Urbanism.

Producing energy is not difficult. But assuring that the supply of energy does not pollute the City and its surroundings, its supporting hinterland, is another matter. One must deal with the City as a physical system, a single phenomenon.

This accords with a growing tendency in the United States, for example. The main academic centers for archiving and research on renewable energy systems, including from the Sea, are two schools of urbanism.

In our view, given the urgent world-wide need for cities with clean air and clean water, and for a planet without acid rain or the Greenhouse Effect, the time for development of the new marine ecology is here, and a venture suited to start is not an energy company dealing in fuel as a commodity, such as the oil companies, but an architecture and planning company dealing with fuel as part of the city-hinterland cycle.

We conclude:

1. The natural successor to the fossil hydrocarbon industry will be a renewable hydrocarbon and hydrogen industry.

2. This successor will emerge in the course of competition between entities like the German Zentrum fuer Sonnenenergie und Wasserstoff Forschung, the Japanese Global Infrastructure Fund and certain Japanese companies already engaged in marine-algae development for fuel, and US companies like ours, a pan-geographic firm based in the US but slated to operate in sites around the world.

3. Technical questions regarding chemistry and biology have been solved; the scientists who have dealt with them are ready to join any serious, multi-site effort.

4. Questions regarding ecological impact, particularly if a marine-algae industry occupies a large tract of sea, or species are introduced from elsewhere, have not been fully answered. However, results of introductions of rapid-growth plants in France and China have not shown any difficulty, and the plants we are focusing on now (Macrocystis or Ecklonia) are highly reputed for their beneficial effect on fisheries and habitat.

5. The chief questions that have not been resolved, and now pose serious difficulties, are ones of structural engineering. How does one build large structures to hold large, commercial numbers of rapid-growth plants in open-ocean sites which would not break up in storms, and would not make the plants break? We believe that these questions can be solved. We believe that we can solve them. This project constitutes a probe into dynamic systems.

In any effort, there is a team of naval architects, physicists, engineers, submarine engineers, scuba divers, marine biologists and both ocean and structural engineers, all of whom are familiar with the long-term project of Ocean Earth, and all of whom are prepared to embark on the proposed, budgeted venture, called GAS CAR, for Giant Algae System, Clean Air Rig.

Testing would begin in oceanic sites which are nonetheless sheltered from extreme storms or turbulence.

A first such site has been selected, applied for and government approved for testing, in Wellington Harbor, near the capital of New Zealand. Other sites recommended to us are: for Ecklonia, the Middle Harbor, Sydney; for Laminaria, the fjords of Norway.

If the tests are successful, Giant Algae System could expand into other sites rich in Macrocystis such as: islands in the Southern Ocean, like Kergeulan (France), Bouvet (Norway) and the Falklands (UK), Chile, South Africa, Argentina, southern Australia and the West Coast of North America from Alaska to the Tropic of Cancer.

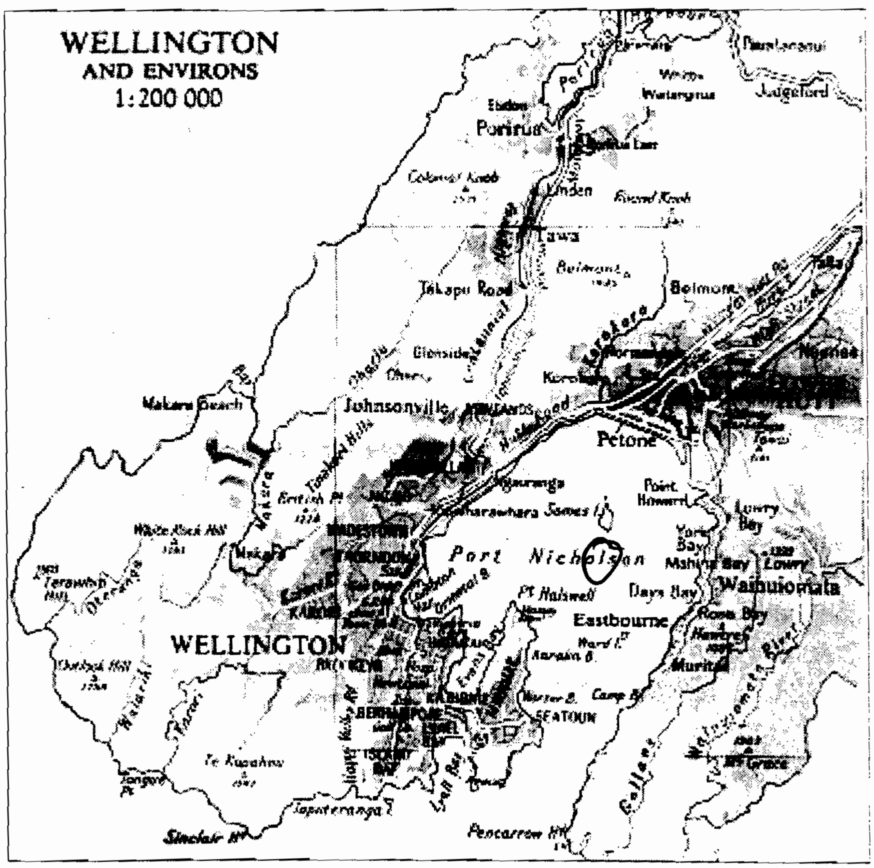
First Test Site

C.A.R. Rig and Site, as a Real-Estate Investment Property

The initial financing of a C.A.R. begins as a research and development project—to be transformed into an industrial production project.
If trials succeed, the equipment and know-how are sold to the local utility, in line with the mandate to furnish "clean air" and meet basic habit architecture needs of the city:

- To produce marketable yields of methane gas or hydrogen, and certain chemicals.
- To provide more habitat for wild fish and plants.

The proposed first site is in New Zealand, south of Somes Island in Wellington Harbor. We have government approval and a team of scientists, architects, engineers and divers ready to start in a 50/50 contract structure.



The technical design for the *C.A.R.* has been prepared in collaboration with Naval Architect Marc Lombard of La Rochelle, France. Mr. Lombard would be on-site, along with French scientists, to oversee installation and submersion trials.

SITE-SPECIFIC PROJECT BUDGET

3 YEARS

Rig Manufacture (2 rigs)	$ 32,000
Naval Architecture Fee, given changes and testing	5,000
Shipping	4,000
IFREMER French government biologists, requiring airfare and certain expenses only	5,000
Site-based biologist(s), on consulting basis $3,000/year plus $1,000 for materials	10,000
<u>Installation and On-site Maintenance</u>	
Scuba Divers,	90,000
Servicing boats, including dock fees $5,000/year	15,000
Anchors, Cables, Buoy Replacements, Lights	6,000
Insurance for Onsite Operations	10,000
<u>Telecommunications and Data Processing</u>	
Computers and Secure Computer Facility, near Site	5,000
Telecommunications and Post	18,000
Office Overhead, over three years ($1000/month)	36,000
General Liability and Property Insurance	24,000
Travel, two roundtrip voyages per year plus local travel	15,000
Environmental Impact Assessments and related filings	4,000
Algae Harvesting Operations (hauling, shore delivery)	15,000
Liaison with Fermentation Facilities, for tests of yield	6,000
Total for Project for Rig On-Site	**$300,000**

C.A.R.

Clean Air Rig (CAR) Underwriting, Ocean Earth

As in the oil industry so with this ocean industry, investment can be structured around a Rig.

A Rig has a Site. It has its Structure. The Site plus Structure constitutes the investable Property.

With each Property, we undertake a Project. This Project can initially be considered as an R & D project, but if successful it can be transformed into an industrial production project. We seek to produce marketable yields of methane or hydrogen, and other industrial products like fine chemicals, as soon as possible, and we seek to simultaneously prove that whatever we do generates more habitat for wild fish.

Each Project, particularly any early R & D Project, is closely monitored. We have much experience with satellites. We aim to develop a methodology of biofeedback and rapid response to (1) keep the Rig moving among ideal positions within the Site, which can be several kilometers in diameter, (2) avoid buildup of mollusks or barnacles on the Rig, (3) avoid catastrophes, particularly biological ones, (4) obtain the highest yields at sustainable, non-depletive rates.

A technical design for the Rig has been prepared, in collaboration with Naval Architect Marc Lombard, of La Rochelle, France. We will test this designed structure with the first Rig(s), and are ready to modify, change or even abandon the design as soon as better engineering ideas are found. We expect that each Rig built will be different, and only after perhaps a score of attempts would we settle down to three or four basic structural forms.

For example, the first requirement, for a Site, has been met in New Zealand. We are officially permitted to start testing a Rig for production of Macrocystis —the world's fastest growing algae, also well suited to commercial harvesting because it is buoyant—in a Site just south of Somes Island in Wellington Harbor. The person heading this site is Heidi Mardon, architect, based in Auckland. Ms. Mardon has found algae specialists and other biologists, also from New Zealand, to work on the Rig and Site.

Giant algae specialists at the French Institute for Research on Exploitation of the Sea (IFREMER) have told us that they are ready to act as biological science advisors. They will also be responsible for ecological security.

Ocean Earth would perform a role, not yet manifest in ocean-biomass projects, of linking the scientific research with structural and ocean engineering work. Until now, there has often been a communication gap between engineers and research biologists. What the biologists do not yet know about giant algae and its behavior in the world usually leaves engineers unsure of how to proceed. We bring the disciplines together.

As an incentive to site discovery and development, and as a means to preventing objections from local fishermen or industries, all Projects, each with a specific Site, are developed on a 50/50 revenue sharing basis with a local company or partner.

Each Project can proceed when there is a Site with legally permitted access. Ideally, the waters at this site should also have an indigenous population of a desirable giant algae genera, e.g., Macrocystis.

Fast-growing alternatives such as some Laminaria or Gracilaria can be used where Macrocystis is not present. Due to current regulations,the use of Macrocystis requires sitting in temperate waters of the Southern Hemisphere, e.g., Australia, South Africa, Argentina or Chile/Peru, or along the California Current to the end of the Baja Peninsula.

The Rig can be manufactured in Scandinavia. For now, this means Denmark, at two firms which already quoted the production cost of 83,000 Dkr, or $16,000. The quoted air freight or sea freight costs are less than $4,000, so we could well proceed with basing all production in Denmark, or at widest range Scandinavia. There is much know-how, for example, in Norway. Centralizing all production in one zone helps secure intellectual property and industrial expertise.

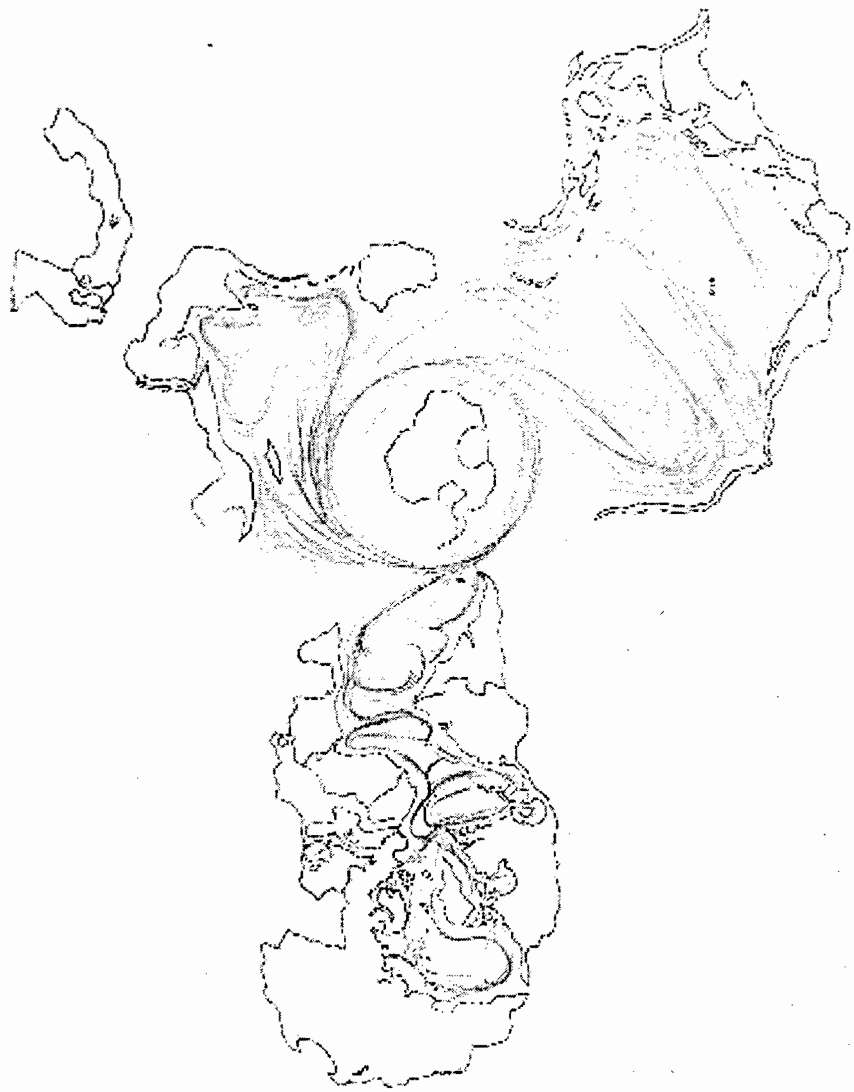
Each Project has a duration of Three Years.

However, a shorter Project, could start this winter in New Zealand, with a duration of just one year. The aim would be structural tests only. These are most vital; the other phases of technology and production are already known.

Throughout, we emphasize that we would be producing not Energy but assuring Clean Air/Clean Water Regions. The technology yields energy at no ecological cost and with some ecological gains. How much, in the overall community budget of an area, is that worth?

Circulatory System

ANOTHER, CONCENTRIC WAY TO VIEW THE EXPANSION OF MARKETS. START WITH NATURAL MACROCYSTIS SITES, WITHIN THE RING, THEN EXPAND OUTWARD.

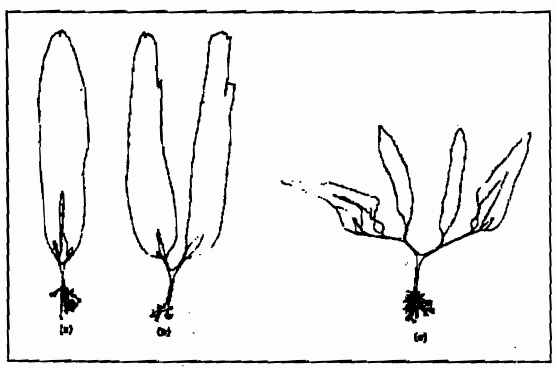


Charting the world according to its ocean basins, separated into Atlantic/Arctic, Pacific and Indian, with all joined around Antarctica in the circumpolar Southern Ocean, one sees a very large expanse where Macrocystis is indigenous, temperatures are well-suited and pollution is nil. A world industry can be centered here, south of the tropics, as well as along the west coast of North America, with no objections from those—like the International Council for Exploration of the Seas or Dr. Boalch—who oppose any introduction of new types of algae to sites where they to not grow now.

GIANT ALGAE, UNLIKE OTHERS, HAVE DISTINCT ADVANTAGES

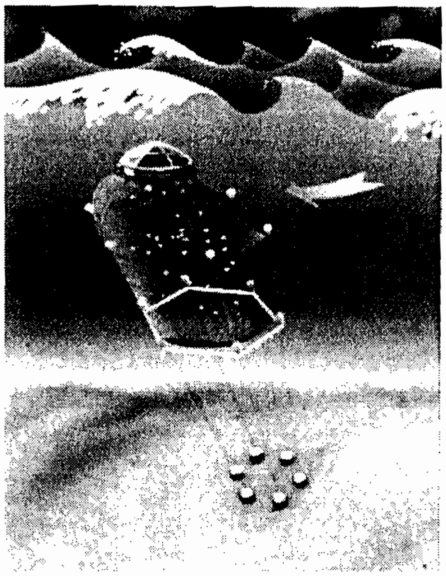
BUT MACROCYSTIS, BEING BUOYANT, HAS THE MOST. IT FLOATS AND HAS LARGE FRONDS, MAKING FOR EASY HARVEST AND EXPOSURE TO THE SEA SURFACE, I.E., THE SUN. IT ABSORBS CARBON AND GROWS AT PHENOMENAL RATES, WITH THE HIGHEST RATE OF ANY PLANT CONVERSION TO METHANE THROUGH FERMENTATION. GROWTH IS ALSO DOWNWARD, BY SEXUAL PROCESSES; IT EXPANDS IN TWO DIRECTIONS AT ONCE.

IN ORDER TO ABSORB NUTRIENTS AND GROW, MACROCYSTIS MUST BE ANCHORED TO A SEA FLOOR OR OTHER SUBMERGED PLATFORM. THE ANCHORING IS BY HOLDFAST. HERE, A MAGNIFIED SECTION OF THE HOLDFAST. THE SITING OF SUCH AN ANCHORING AGGLOMERATION ON ARTIFICIAL SEA FLOORS, OR FLOATING CAGES JUST BELOW SEA SURFACE, IS OUR SIMPLE AIM.

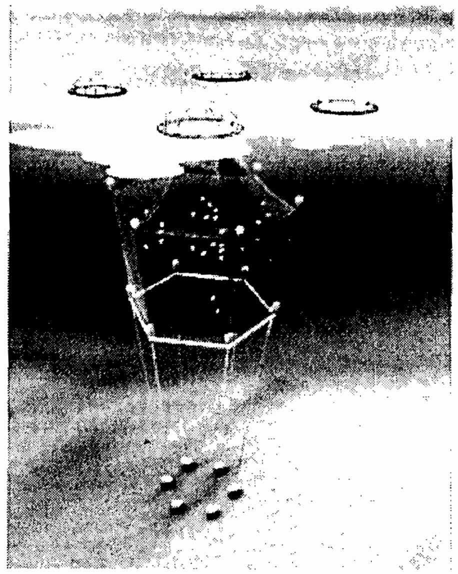


Macrocystis pyrifera. Photograph, left: magnified, of holdfast section. and Drawings, right: sequence a-c shows how through time a single blade splits into two, and again into four, with two lateral series of blades and two central series of eventually fertile blades.

STRUCTURAL STUDIES
CONCEPT: SUBMERSIBLE OPEN SEA CAGES



Cage-rig submerged under rough current weather conditions



Cage-rig under normal conditions, at the surface

Norway's salmon industry is actively conducting research in submersibility of buoyed, floating cages. They use a hexagon structure, much as we have developed. This seems to be more stable than a ring. While submergence may be solved technically, it might still pose problems biologically: would the algae, particularly bladder Macrocystis, survive a rapid drop of 10-15 meters, with consequent rapid change in pressure? We seek to adapt this Norwegian technology to giant algae production. Curiously, since these brown algae promote fish populations and make excellent fish habitat, one could construe the engineered structure to be classifiable as a fishing-industry submersible.

The first C.A.R. tests, for a rig which can fall from or return to the ocean surface, are for responsiveness to changes in wave action. As wave action increases, the rig submerges. As wave action decreases, the rig rises again to the surface. The rise will tend to coincide with the return of clear skies, hence sunlight, for greater rates of photosynthesis. A submergence will tend to coincide with cloudiness, so what growth there might be occurs at the lower end of the plants, by their own unique reproductive processes. We must also find ways to allow for efficient harvesting. Finally, while the behavior and survival of giant algae "kelp" in natural beds is well known, we have not learned how they behave or how long they survive if they are held-fast to an artificial netting. A submersible cage for fish may be different than one for attached plants.

There are questions of physics, particularly about waves, and of biophysics, particularly of plant tissue elasticity. To show the caliber of research, we quote a scientific analysis by a physicist in house, "The effects of wave action in deep water can be suppressed by interfering with water's vertical movement. Can we [do this] by creating a turbulent zone of water?"

REASONING FOR G.A.S.

GIANT ALGAE SYSTEM

As everyone knows, and is already being reported in the financial news, supplies of mineral fuels—particularly oil, coal and gas—will become tighter.

Pressure builds up to find replacements.

Although the World Energy Council says the replacements—mostly renewable energy—should be developed after investments in the mineral industry have been amortized, around 2025, we would like to start now, before 2000, with a biomass industry using large marine algae.

We have many reasons for beginning now.

1. Start the buildup of an inevitable future industry.

2. Be able to learn from mistakes, early, before full-scale competition allows little room for setbacks.

3. Make sure that mineral fuel reserves are not depleted but can be relied on as just that, reserves.

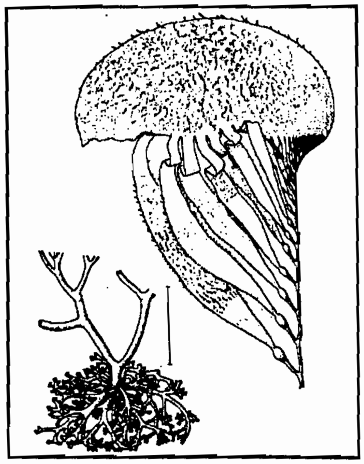
4. Make sure that mineral fuel reserves can be available for certain unique industrial functions, as with lubricants or petrochemical processes.

5. Discover what truly are the costs and benefits, now little calculated, of renewable energy production, and keep that knowledge up to date.

6. Effect the biodiversity that is vital to fisheries, by growing stands of brown algae, yielding oxygen rather than consuming it, and fostering wild populations of fish and other plants.

In our efforts with large algae, always brown algae, ideally of the genus Macrocystis, we are selecting a type of vegetation with the fastest, most economic growth rates—or solar energy conversion rates—of any plant in the world. The rate can reach two meters per week. We are also selecting a type of algae which, unlike the red or green varieties, fosters not less but more oxygen in the water, with benefits to fish. One could even classify the ocean rigs we propose as structures for the fishing industry, with algae and methane or hydrogen produced upon fermentation seen as by-products. For we are harvesting in the ocean—seeking a comprehensive strategy for returning the soil accumulating in the Sea back onto Land, for our use.

Macro-Economic Reasoning for Giant Algae System



Holdfast photograph — **Macrocystis Pyrifera** Diagrams — In the Ocean

We take an overall look at the world energy situation. We note the advent of fuel-cell technology, which—as widely reported in the press—will sharply increase demand for hydrogen or methanol derived from biomass. We recall that other sources of energy in this century are losing their appeal. Hydroelectric energy is seen increasingly as destructive of the world's rivers and oceans. Fossil fuels are seen increasingly as vulnerable to geopolitical risk, let alone causing global warming and acid rain. Nuclear energy has steadily been discredited, and rapid-fission systems, now being researched in China, Libya and Germany, are seen to be politically dangerous. Nowadays, biomass is seen as the next reliable source.

As recognized for decades by institutes like MIT and Caltech, the most sustainable source for biomass will not be vegetation from upland, where nutrients deplete, but offshore. We nominate as a primary energy and raw-materials source a biological and replenishable successor to the global petroleum industry: marine algae industry. As new fuel technologies are developed, we expect to meet a global need for large quantities of non-polluting but portable fuel. Although the end product for combustion may be hydrogen, most likely the intermediate product will be methane or methanol: in all cases, we can look to algae as the main rawstuff. We can look to this as what Hermann Scheer, a German SPD politician and head of Eurosolar, calls "Energiepflanzen." or energy crops. The question now is: how to engineer access to those crops—for easy harvest.

Brown algae, led by the genus Macrocystis, has the fastest and most economic growth rates, or solar energy conversion rates, of any plant in the world.. They are, among the sources of biomass, generally said to be renewable successors to fossil fuels. And the genera with the fastest carbon conversion rates, highest growth rates, and among the highest conversion to methane rates upon fermentation, is Macrocystis. Other crops include, for example, sugar cane or water hyacinths. But those who argue for land crops, which are certainly already available with regular harvests, must contend with the knotty fact that when such biomass is converted into fuel the soil which made it goes away: the soil has been proportionately depleted. In coastal waters and marshes, however, soil regularly accumulates. Extraction is no loss, but a cycle possibly beneficial even to Nature.

Brown algae, unlike red, green or blue-green algae, does not cause eutrophication, or oxygen loss, in the water. It could even be deployed to replace the other algae, sopping up nutrients but without harming fish—or even us. It fosters not less but more oxygen in the water .

The practice can be extended far offshore, wherever there are bottom nutrients which could be upwelled. 70% of the earth's surface is occupied by oceans and salt seas.

While no one can foresee what percentage of total energy supply will come from marine algae, it is reasonable to expect that some level of industry based on marine algae will develop. The levels of risk are relatively low, especially when compared, for example, with those for nuclear fission, or even some of the giant dam projects now underway. There can be ongoing or periodic loss, but there cannot be catastrophe. Brown algae, unlike some other forms, cannot suddenly proliferate and start choking the seas. There is room for error .

Politically, the daunting questions will be: who controls various tracts of ocean water; who can block or punish those who pollute or damage the ocean water as living system; who decides on priority for navigation, fishing, recreation and such industry; whom does one sue if there is damage? For this reason, we, Ocean Earth, have mapped out the watersheds of each body of ocean water. Using the legal rules emerging at the UN Regional Seas Program, part of the UN Environment Program, about "land-based sources of pollution," we can identify what physical and political territory directly impacts on a body of ocean water, and what must therefore be seen as its overall biomass production unit. These legal questions, despite their appearance of challenging current borders, can be subsumed within the framework of respective—and functioning—UN Regional Seas Programs. The "economic zone" concept may be a starting point, working from ocastal waters on outsards, within each sea

In any case, in the Southern Hemisphere and western North America, where there would be no scientific-commission blockage of proceeding, there are almost no border or territorial disputes. Chile drains into its coastal waters;

Argentina into those of the Argentine Current; South Africa into its Macrocystis waters; Australia and New Zealand, respectively, into theirs.

As Ocean Earth is chartered to produce "architectural components" and "media services", the aim is not that "we alone" do it, but that we develop a technology which can be licensed and distributed worldwide for others to do it. The technology to ship out would be the offshore rig engineering, the C.A.R. The technology to develop in-house and to sell directly to clients, as part of a Giant Algae System, would be timely, reliable satellite monitoring and site modeling, particularly towards developing a method of pricing river runoff to the Sea., whether harmful or beneficial.

By good fortune, the areas where, according to the International Council for Exploration of the Seas, any growing of Macrocystis would be ecologically permissible, and where we can start Giant Algae System without blockage, are also areas with few if any territorial disputes. Political crises are unlikely. Further, the questions of "ownership" or jurisdiction are fairly easy to answer. In the temperate Southern Hemisphere, Chile drains into its coastal waters, Argentina into the Argentine Current, South Africa and Namibia into the Benguela Current, and both Australia and New Zealand have unchallenged access to their own giant-algae fields. The chief complications are with the Falklands and the north end of the Argentine Current, where inputs arrive from Brazil and Paraguay perhaps more than from the coastal states of Argentina and Uruguay. In the Macrocystis waters of the Northern Hemisphere, serious political disputes seem remote. There are some fisheries disputes, but all three countries belong now to the NAFTA, a single economic union.

When one begins to introduce Giant Algae System to countries in the rest of the temperate Northern Hemisphere, where Macrocystis is not indigenous (and its culture is not now permitted, but for China, which discounts such rules), one could be entering a diplomatic briar-patch. Who owns the waters of the North Sea? Who controls the nutrients? Who is responsible for any pollution? Or what about the Sea of Japan, or East China Sea influenced by the polluted Yellow and dammed-up Yangtze Rivers. Or what of the Iberian Current as it passes the dammed-up, nutrient-starved rivers of Spain and Portugal?

But even in these cases, entangling further with enclosed seas like the Baltic or Black Seas, the geopolitical tensions would probably be less than those in the oil fields of central, southeast or southwest Asia, or the uranium deposits of Chad and Tibet. The political challenges before an ocean-biomass industry are less daunting—than those for its primary alternatives.

Our Position:

- We approach the conversion from mineral fuels to offshore biomass, and to renewable sources generally, as a problem not of "energy supply", based in commodities and fuel-stocks, but of Regional Development. We approach it as a problem, writ large, of Architecture and Urbanism.
- The provision and combustion of fuel is part of the city-hinterland cycle, which must be continuously in motion.
- There is an urgent world-wide need for cities with clean air and clean water, without acid rain or the Greenhouse Effect.
- The successor to the fossil hydrocarbon industry is a renewable hydrocarbon and hydrogen-based industry, with other forms of renew able energy alongside.
- The time for development of the new marine ecology is at hand.

The advantages of giant Algae System may already outweigh the apparently-lower costs per B.T.U. of fossil fuels. While methane or methanol have less caloric power than petroleum, if directly combusted, they can be readily converted into hydrogen for use in what may become the chief source of power supply and propulsion in the coming century: fuel cells.

Return on Investment

Return on the investment would come from Sale or Lease of the Rig and its Site(s), and of all the Operations Knowledge for the Rig in the Site(s), following the one to three year development period. This Sale or Lease could be made to a local government, or a fisheries cooperative, or a gas or power company, or a company utilizing seaweed industrially.

Methane is by no means the only product. It could also be hydrogen. It could even not be the primary product. Giant algae, or brown algae, can yield potash, fine chemicals, (for pharmaceuticals), carageenan, fertilizer, suitable habitat for fisheries, higher ecosystem structure in the ocean, with consequent high bio-productivity and evapotranspiration

Those who argue that fossil fuels are still cheaper overlook the fact that within the overall energy-fuel budget of a society this may not be true: there are many hidden costs, including diplomatic and military costs, and environmental and public health costs, in the use of mineral fuels. The best markets may well be localities which can factor in all those costs. We notice coastal megalopoli such as: Tokyo, Sao Paulo, New York, LA and Shanghai.

Ocean Earth

Project Staff

Australasia contractors

Mardon, Heidi	NZ	architect
Ribi, Joan	AU	ecologist
Mueller, Allan	AU	ecologist
Arent, Katrine	AU	manager

Ongoing algal scientific supervision, by IFREMER, the French marine biological research institute; the two lead scientists were the pioneers from the early 1970s

Perez, Rene	F	marine biologist
Kaas, Raymond	F	marine biologist

Ocean Earth contract holders

Vaterlaus, Eve	USA	scuba
Waltemath, Joan	USA	scuba/dolphins
Høvo, Jan	N	Norway/strategy
Tekampe, Heike	D	German investments
Donga, Thomas	D	German investments
Erickson, Thor	BR	Portuguese-Atlantic
Chaikin, George	USA	satellite observation
Vieille, Sophie	F	satellite observation
Thorsdottir, Inga Svala	IS	Iceland
Fend, Frederick	USA	physics
Superflex	DK	methanization
Lombard, Marc	F	naval architecture
Trucco, Alberto	I	fish attraction
Scholte, Rob	NL	site search
Onishi, Satoko	J	exhibitions

History of Giant Algae

In the early 70s, as people saw the end of the Oil Era, scientists started up projects to launch giant algae industry. Research was done in China, France, and the United States. Offshore rigs were designed and built. Rates of growth and yields on fermentation were measured

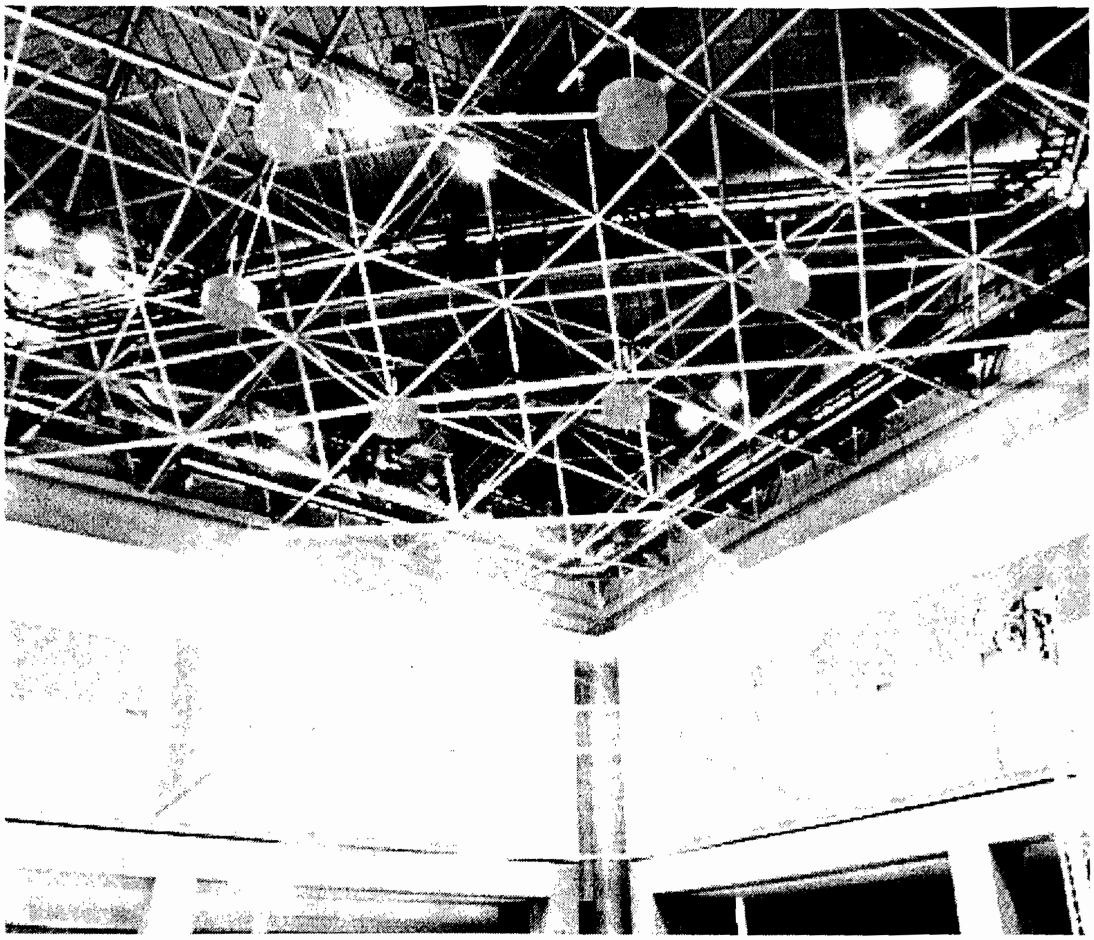
A French team of Drs. Rene Peres and Raymond Kaas achieved astounding rates of growth with Macrocystis introduced into a site in Brittany, a brown algae of the unique genus Macrocystis proven to have the fastest and most economic growth rates—or solar energy conversion rates—of any plant in the world. More, it is unlike the red or green varieties, which foster less and not more oxygen in the water. We would be following up on the pioneers. Our effort is not a raw startup, but a timely recognition of earlier efforts. We note these advantages:

- High rates of methane yield from fermentation
- Fastest rates of carbon absorption and solar-energy conversion or growth
- Crops grown upland deplete the nutrients upland
- Crops grown at upwellings or coastal waters offshore can never deplete the nutrients offshore, unlike the crops grown upland

Research continues in China. We intend to restart it in the West. A prime incentive comes from geopolitical security concerns. In the 21st century, over two-thirds of all natural gas (methane) deposits will be in Russia, Iran, China and contiguous countries such as Azerbaijan. These are all relatively inaccessible to the West. Even though western oil companies may be in there, the political and military situation does not readily assure them staying there, or even getting a fair, complete return on their investment. For the maritime powers ringing the Eurasian land-mass, such as the UK, the US and Japan, the safest access to methane may come from renewable sources. The most prolific of these would be giant algae in the Sea.

Ocean Earth Project Furthered in Tokyo

"Ocean Earth/Tokyo Bay", a project curated by Yukiko Shikata, with Atopic SIte comparison of Tokyo Bay and the Gulf of Genoa, August 1-25, 1996.



All funding from the Tokyo Metropolitan Government.A full-scale maquette, indicating the size., has been displayed at the Tokyo International Exhibition Center and is now ready for exhibition world wide.

The Maquette, computer displays, video and other materials from the Atopic Site project can be obtained for exhibition and promotion through our installation agent, Ms. Satoko Onishi, 135 Plymouth St. (503) Brooklyn, NY 11201, Tel/Fax (718) 246-4438.

OCEAN EARTH DEVELOPMENT CORPORATION

SITE-SPECIFIC PROBLEM SOLVING WITH PREDICTION CAPACITY

With global mapping and monitoring in the context of regional-sea basins, using civil satellites and other visual data, we were able to predict:

Flooding of the Rhine, 1994.

Hydrological instabilities at Chernobyl, 1986.

Israeli routes of attack in Beirut, 1982.

Iraqi incursion on Kuwait, at least to Bubiyan Island, 1985

Capacity for rapid explosions of microalgae in the North Sea, 1988.

Intense activity in Saudi Arabia at Buraida, 1988.

Air attacks on Libya at Benghazi and Tripoli, 1986.

British landing sites in the Falklands, 1983.

Given what has happened and what is to be done, in 1996, we have proposed:

New earthworks at Buraida, Saudi Arabia, and in Kuwait.

Meander-sop reservoirs for Yangtze River, China.

Continuation of multi-channel diversion of Tigris, Iran.

Diamond-grid slope structures for hills in cities like Genoa.

Gantry-crane harvesting rig for freshwater microalgae, chiefly in canals.

Straddle structures, to effect hills, in flat cities, like Tokyo; in any case, off the ground.

Hot-air balloon suspended canopies and light walkways for cities.

Meander-sop control systems for Nile far upstream.

Satellite monitoring of mobile-missile bases.

Meander-sop and bypass-vector development of rivers in the Sahara as divided into watersheds, like Grand Erg Oriental.

Use of counterweights to elevate loft levels.

Use of satellites to effect site-depletion taxation.

Conversion of urban-industrial wastes either at sea, after secondary level treatment, or through methane-unicellular or organism growth cycle, with feathers produced for marshes.

Giant Algae System, with semi-submersible rigs to support the growth and rapid harvest of giant brown algae, to yield methane or hydrogen and other industrial goods, now set for testing in New Zealand.

Background of Artist-Based Ideas

Ideas for technologies to replace mineral fuels with biomass come from:

- Vito Acconci—harvesting from below
- Dennis Oppenheim—inverting the structures
- Newton Harrison—approaching plant production from the ecologi cal standpoint of fish
- Joseph Beuys—Fat Corner: materials cycling between animals and plants passing through a methane phase
- Metabolist architects; Archigram—re-defining industrial systems in the material context of cities
- Paul Sharits; Nam June Paik—rapid color sequences of survey data

The aim is to develop a sustainable practice of urbanistic consequence.

We follow through on the historical fact over the centuries, noted by Kenneth Clark in "Civilisation", that innovations in architecture and planning arise from art, and have often been carried forward by artists themselves as they make a transition from art to architecture.

We recognize, as did the director of the recent Documenta, that art during the late 60s and 70s was enormously fertile. Our endeavor, in line with Kenneth Clark's historical perception, is to convert this fertility of art into more durable practices of building—in architecture and planning. The sources are not what is currently taught in the schools of architecture and planning, but are found directly in the art of recent decades.

To effect this conversion from art into architecture, using as well the contemporaneous discoveries in science (e.g., a correspondence in 1977 of Beuys' Fat Corner with Theodore Woese's scientific analysis of archaebacteria and methane in the carbon dioxide-oxygen cycles), in 1980 was founded the Ocean Earth Construction and Development Corporation .

At the present time, working through the art context, the firm has secured three sites for contracted action: Wellington Harbor, New Zealand, for ocean tests; Kotor and Tivat Bays, Montenegro, for ocean tests together with low-profile, high-density coastal urban development; Limfjord, Denmark, for ocean tests together with the re-entry to marshes of urban wastes after they have been pyrolyzed, reduced to hydrocarbons, then consumed by single-cell proteins, which in turn are keratinized into scales or feathers for easy uptake by higher species in the open, wild environment. The efforts of engineers, architects, scientists and visual artists are converged on each site for what are called "Earth Works."

From such a basis one can serve the biggest growth market in the world today—urban agglomerations—with the means to evolve alongside the other animal and plant species of the planet.