DOCKLANDS SCIENCE PARK P/L
4 Illawarra Road,
ABN 48005 684 113
Hawthorn,
Vic. 3122.
The Chairperson,

AEMC,

Dear Sir,

We have lodged a submission on your form as obtained from your website. However, we continue to receive an error message on pressing the “Submit” button.
As a consequence we submit this letter as a submission on the Reliability Frameworks Review.

Docklands Science Park arose from the combined desire of The University of Melbourne and RMIT University to have an entity doing the “D” of R&D whilst the Universities concentrated on the “R”. Formed in 1991 it is still operating, promoting the use of technology for the common good.

We have the proven technology to burn Yallourn brown coal to produce electricity for some $30 per MWh, WITHOUT any emissions to atmosphere at all. Please read the attachment “APCSEET 2011…” There are choices as to the level of emissions, from 0.583 tonnes of CO2e, per MWh to nil, but it is as economic to have nil. See attachment.

We can produce 5.19 MWh of power per tonne of brown coal, as shown in the attachment. This is twice the average efficiency of the Australian industry. The net result (without taking into account the fuel and/or chemical production profits) is that the Levellised Cost of Electricity (LCOE) ends up being less than at present and does not have to increase, as is the case with other proposed methods of CO_2 removal.
No other technology reduces, or eliminates emissions of CO2e.

The cost of building a pilot plant, in the Latrobe Valley of Victoria, both to prove the technology and obtain the settings for a major plant, is only $3 M, almost nothing in the scheme of things. We seek that $3 M.

Very importantly, as is shown in Fig. 1 of the attachment, the use of this coal burning technology reduces the existing CO2e in the atmosphere by half, or better. Air into the plant is say, 410 ppm of CO2 and air out 200 ppm, down to nil as desired. That should handle all the greenhouse technology requirements and move Australia to the forefront environmentally. This is a huge potential saving to the Federal Government.

Our technology, which we are happy to discuss, can produce cheap gas and electricity, whilst at the same time reduce the carbon dioxide in the atmosphere, as above, by 50% or more. The attachment refers.

In our view the use of the PUTAR system makes substantial contributions to the desired results, as set out in your Reliability Frameworks Review.

The following points are noted:-
PUTAR is reliable and flexible in its operation and in gasifying brown coal is working on a strategic reserve.
The gas produced can be methane or town gas at the will of the operator. The cost of the gas is $1.00 per GJ, given a cost of coal to the gasifier of $6.00 per tonne.

The gas can be sold or turned into electricity costing some $30 per MWh. No water is required in this operation, a big saving in Australia. See attachment.
The gas is burnt in pulse combustion burners which have a high efficiency, some two orders of magnitude above the norm and produce steam with 94% of the energy retained.

Burning Yallourn brown coal the strategic reserves are enormous, estimated at 500 years supply.

We suggest that the gas produced is held in gasometers, for the plant can be throttled up and down to alter dispatchable capacity, to balance demand.

Ramp rates from this type of plant are excellent and well suited to the four types of demand response likely to be required. The equipment required for a high level of automation for this system is available.

Most, if not all of the problems, mentioned in the Reliability Framework Review, are solved by the use of the PUTAR system. One effect should be to reduce the required level of the market price cap, due to a smoother running of the whole system.

The cost estimated for the PUTAR plant is level with a conventional coal fired plant, per MWh. The output is approximately double at 5.19 MWh per tonne of Yallourn coal. The size of the plant is approximately 110% of the conventional plant, including the unit to liquefy the exhaust gases.
Increasingly the exhaust gases have uses and can add value.
Conversion of an existing 1,000 MW coal fired plant is estimated at $100 Million.

We believe that a major PUTAR plant in each of SA, Vic and NSW will do a lot to eliminate disruptions to the power supply at plant level and save enormous sums by eliminating the need for standby units such as Snowy 2, batteries, etc.
The PUTAR plant can be ramped and set at a new level to cope with the level of demand.

Yours sincerely,

John Martin,
CEO,
Docklands Science Park P/L
Ph. 0425 858 567

GENERATION OF ELECTRIC POWER WITH NIL EMISSIONS AND USE THE WATER IF POTABLE

4,700 years ago, use was being made of fresh water springs in the ocean. These springs were called "the eye of the sea" by the Phoenicians. It allowed them to dominate trade around the Mediterranean Sea by providing potable water offshore at many known (mapped) locations. A leather tube connected to a lead funnel was used to cover a "seep" on the ocean floor and water flowed up the tube to an amphora on the vessel. Sails at that time were made of hessian and were unsuitable for collecting rain at sea. Seeking water from landfalls was risky.

This later evolved into a clay piping system that supplied water to a city on an offshore island at Latakia in Syria. The fresh water spring, clay pipes and lead funnel provided enough pressure to "lift" the water to the city's water holding tanks. Running water was provided across the island using gravity flows from those tanks.

The seep off the Syrian coast flows fresh water today.

This is covered in the attachment, “Submarine Hydro Energy - SHE”, see attached.

We believe our application is a desirable technology to modify water shortages:

- Nothing is more important to human life than inexpensive, highly reliable, potable water. This is being demonstrated at many locations..

- This system can also be used to generate low cost, low maintenance, base load, hydro-electric power for hundreds of years.

The impact of ever increasing power and water prices cannot be overstated. This has an enormous effect on government revenues and the sustainability of communities.

We point to the global nature of our solution. We seek assistance in proving the seeps and the ability to generate cheaper electricity and potable water.

There are no CO_2 emissions in its operation.

The process shown is simple and proven over 4,700 years of observation. The modern addition of a generator to harvest the energy from the water flow is known and well used technology.

Slides 15 and 16 show the capture of the flows from hydro seeps.

Key to a seeps usage is the flow rate and water quality. This determines the type of turbine and water use (human or agriculture).
A generator has a long life-cycle and can run remotely controlled. Water authorities have many such units of similar size they run and maintain in such a manner.

There is no other power source that can compete on a life cycle price basis.

Seeps can be located from satellite images and can be seen around the Australian coastline, many well located near centres of high demand, see below.

Our hydro seeps program is technically simple. It provides advantage to all people, including the welfare of the Australian aboriginal people in that it can provide power and potable water around the coastline of Australia and many islands. Most of these locations are supplied water using reverse osmosis and powered by diesel generators. The cost of providing water and power using wind and solar with battery backup is enormous. The cost of maintaining such "renewable" systems can never be profitable.

Hydro-seeps provide base load power. There is no need for an electrical grid connection, synchronizing signal or battery.

The attachment sets out how to find submarine seeps, also called "wonky holes", on the Great Barrier Reef and other places.

Funding is requested to cover, in whole or in part, the following costs:

1. Studying the satellite imagery.
2. Hire of boat and diver to conduct flow rate tests on a selected site. See slide 15.
3. Build, transport and install the capping funnel over the seep.
4. Fabricate the flexible armoured piping, with CSIRO, to conduct the water of the seep to the generator and then from generator to water usage if potable.
5. Wiring for the load on the generator and then to connect to a point of usage, or display.
6. Permit costs, motor vehicle costs, generator, etc.
7. Contribution to Salaries, wages and overheads over 12 months.

Personnel involved include civil engineer Geoff Croker, persons from RMIT University, CSIRO and the writer.

As above, potable water has been collected from seeps around the globe for at least 4,700 years.
Carbon dating shows that some have flows of water exceeding 11,500 years old.

The attachment shows how the seeps are located and tested for flow.

It is simple to locate the most promising seeps from satellite images and then test them for rate of flow, age of flow and water quality.

With CSIRO we have developed a flexible armoured pipeline which costs one sixth to one ninth of a steel pipeline of equal diameter to lay. It is much easier to service and can be moved and used elsewhere if so desired. The flexible pipeline can be laid at sea or on land. It is needed to connect the capping of the seep to the generator, to cope with tidal movements and changeable weather.

The harvesting of water along our Australian coastline will dramatically increase land values and usage possibilities.
The cost of the base load power is between $6.00 and $23 per MWhr.
At $6.00 per MWh, or $23 per MWh, makes a lot of projects possible.

We are very confident that seeps all over the globe can be harvested, including those around Australia.

Revenue as follows:

8,760 hours per operating year @$80 per MWh for this renewable, nil emissions electricity, as defined in the Finkel report as the Clean Energy Target is approximately A$700,000 per annum. Agricultural water can be sold at $100/ML in Australia. A seep would generate typically 70 GL/annum or $7,000,000/annum.

We require $300,000 of risk capital to test a seep along the coast. We will fund the balance above $300,000.

Based on the flows and water data which have been gained from seeps all over the world this is a low risk enterprise. Our technology also captures the flows potential energy. You can see this energy flowing from a water pipe on the attached slides, 15 & 16. Our contribution is to connect this flow to a generator. The flow is important, not the pressure.

We look forward to your prompt and favourable reply.

John Martin,
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Ph. 0425 858 567

How To Remove CO_2, NOx and SOx From Flue Gases and Make A Profit

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Abstract

This paper address 10 of the topics listed for the APCSEET conference. What will be demonstrated is how flue gases can be cleaned up in a manner that is very cost effective for the power generation industry. We approached this problem in a totally different way to those that are currently being tried around the world, in that the greenhouse gases and other unwanted gases are sequentially condensed from the flue gases. The net result is that the combustion air that enters the power generating process at around 400ppm of CO_2, leaves the process at about 200ppm of CO_2, i.e. the ambient air is also being cleaned of CO_2. Thus we can turn a coal (or any other fossil fuel) fired power station into a zero CO_2 emitting power station, fuel and/or chemical producer. The sequential condensation process is based on pulse combustion driven thermoacoustic refrigerators. The system is referred to as a PUTAR, because of the configuration that we have developed for the refrigerator. Although the PUTAR is not quite as efficient as a compressor system, it is cheaper both to operate and build and has no moving parts to wear out. What differentiates the PUTAR process of CO_2 removal from power station flue gases is that it enables the steam generation efficiency to be increased and also the steam turbine efficiency to be increased. The net result is that the increase in the generated electricity more than pays for the PUTAR process of CO_2 removal. The PUTAR process of CO_2 removal can be applied to both post and pre-combustion capture of CO2, but the post-combustion is the better option because it is more cost effective and removes more of the CO_2 than does pre-combustion capture. Although the PUTAR system was originally developed with existing power stations in mind, when applied to a pulse combustion driven coal gasification system and power station we derive the most energy efficient power station. It out-performs a gas turbine/ steam turbine system for power generation at 5.19MW-h / tonne coal. The net result (without taking into account the fuel and/or chemical production profits) is that the Levelised Cost of Electricity (LCOE) ends up being less than at present and does not have to increase, as is the case with other proposed methods of CO_2 removal.

Introduction

Most developing countries are actively pursuing different methods of removing CO_2 from exhaust gases as a result of burning fossil fuels, to mitigate the effects of global warming. Australia is the invidious position of having the largest CO_2 output per head of population because of its dependence on cheap electricity produced from burning its large reserves of both black and brown coal. This paper is mainly about electricity production via fossil fuel fired boilers and CO_2 removal, although the proposed system can be applied to other carbon intensive industries such as aluminium production with similar cost benefits.

There is a large body of opinion that thinks that the cost of capturing CO_2 will result in a doubling of the cost of electricity. There is another group who think that it is unnecessary to worry about CO_2 emissions as global warming is an artifact. Nobody (apart from ourselves) has considered the possibility that a CO_2 removal process can actually lead to reduction in electricity prices. There are other instances where pollution legislation has resulted in the pollutant becoming the main product and the original product a by-product [1] and the same is true in this instance with CO_2 being the pollutant and electricity the original product.

The CO_2 capture process falls into two camps - the pre-combustion capture and the post-combustion capture. The method that is proposed here falls into the latter camp. It has been modeled on both types of systems, with the post-combustion capture coming out in front in terms of electricity produced per unit of fuel.

The Proposed System Of CO_2 Capture

The current method of CO_2 removal that is in vogue is amine scrubbing of the flue gases. There are other methods that also need to be looked at, not only in their effectiveness in removing $CO_{2,}$ but also the knock-on effect that they have on the electricity production. Some other possible routes to are listed in Table 1 below. It is well known in chemical engineering unit operations that gas scrubbing is an energy intensive process, which accounts for the fact that the amine process consumes a large portion of the electricity production and is not likely to be substantially reduced [2] enough to make it even worth considering as a potential solution. In one case of amine scrubbing of flue gases in a power station it was estimated that on a full scale operation half the station power electricity production got consumed [3]. There are two studies on carbon capture [4,5] that have been relied on for the comparisons between the options in this paper. The common figure from these studies is 30% of the produced electricity. According to House *et.al.* [6], the minimum energy penalty is 11% for this process.

Possible Routes to CO_2 Removal	Percentage CO_2 Removed	Electricity Used
Amine scrubbing of the flue gas	85	30%
Oxy-firing of the boiler	85	15%
Feeding the flue gases to growing algae	50	4%
Carbon adsorption filters	90	4%
Chemical looping	100	6%
Condensing out gases from the flue gases	100	can generate up to 45% extra

TABLE 1 Possible Routes to CO_2 Removal

Oxy-firing falls into the pre-combustion capture camp. Its main advantage is is that it markedly reduces the quantity of flue gas to be treated, but it requires an air separation plant to provide the oxygen for the combustion process, which invariably results in the CO_2 production of this process escaping. Proponents of this process claim that it produces a pure stream of CO_2 , but it still has the potential to produce NOx in the flue gas from traces of nitrogen in the oxygen and also from the fuel nitrogen.

The algae route for CO_2 removal percentage depends on (a) the load factor of the power station, (b) the sunshine hours during the day and (c) the quality of the CO_2 in the flue gas, i.e. the presence of other gases and the partial pressure CO_2. A very generous figure has been assumed in this case.
Carbon [7] and zeolite [8] adsorption filters, using nano-technology, and chemical looping [9,10] are still in their infancy and offer better prospects than the previous three process.

The last process involves refrigerating the flue gases. This is not to dissimilar from the LNG process. By paying attention to the heat flows and using plate heat exchangers, we can shuffle the “hot” and “cold” steams and minimise the cooling required. This is not a route that has been examined in detail as far as we know. It has been dismissed as being impractical because of the volumes of flue gases to be handled, a criticism that could equally be applied to the amine capture process. The condensation process can be applied to existing power stations and other industries, such as aluminium, to remove CO_2 , but it is best applied to new power stations.

It is clear from Table 1, that on a technical basis only the condensing process has any merit. The question is - does it have it on an economic basis?

The Consequences

Starting with the current state of most coal fired power stations [11], approximately one third the of the energy going into the power station goes up the stack in the flue gas and one third lost to the cooling towers or cooling pond and the remainder appearing as electricity. The combustion air for the process now contains about 400ppm of CO_2 and the flue gases about 110000ppm of CO_2.

With the condensation process for CO_2 removal, the flue gases have to be cooled down. This is carried out by heat exchanging the flue gases with the incoming combustion air via a plate heat exchanger system. Plate heat exchangers have been chosen because of their compactness, low pressure drop and small temperature difference that they can operate with. This process gives us the first consequence, which is the boiler efficiency is improved and as a result leads to either less fuel being used or more steam generated for the same amount of fuel. Depending on how well the heat transferred to the incoming combustion air is retained by the time the combustion air gets into the boiler will determine how much the efficiency of the boiler is improved. With a new greenfields power station or well insulated and designed pipework, this could result in 46% more steam being available. Half this figure has been taken for the analysis in the next section.

The second consequence of this CO_2 removal process centres on the use of the coolant for the steam turbines. Once the CO_2 is removed from the flue gases, it is in a solid state and has to be changed to a gaseous state at elevated pressures to be dealt with by other storage or conversion processes. This is achieved by heating the cold solid CO_2 in a confined vessel with ethylene as the heat transfer fluid at 0°C and the CO_2 at -100°C. The effect of this is to increase the Carnot efficiency of the steam turbine by 5 percentage points leading to more electricity being capable of being generated from the same amount of steam.

The third consequence and this is of importance in Australia, is that no make-up water is required where wet cooling towers are used.

These three consequences result in extra cash flow being generated, that is enough to pay for this CO_2 removal process and more. There is a fourth consequence and that is that the remnant flue gas that is rejected to the atmosphere only contains at the most about 200ppm of CO_2. Thus not only does this condensation process remove all the CO_2, but it also removes some of the CO_2 that entered the power station in the combustion air. This is summarised in Figure 1.

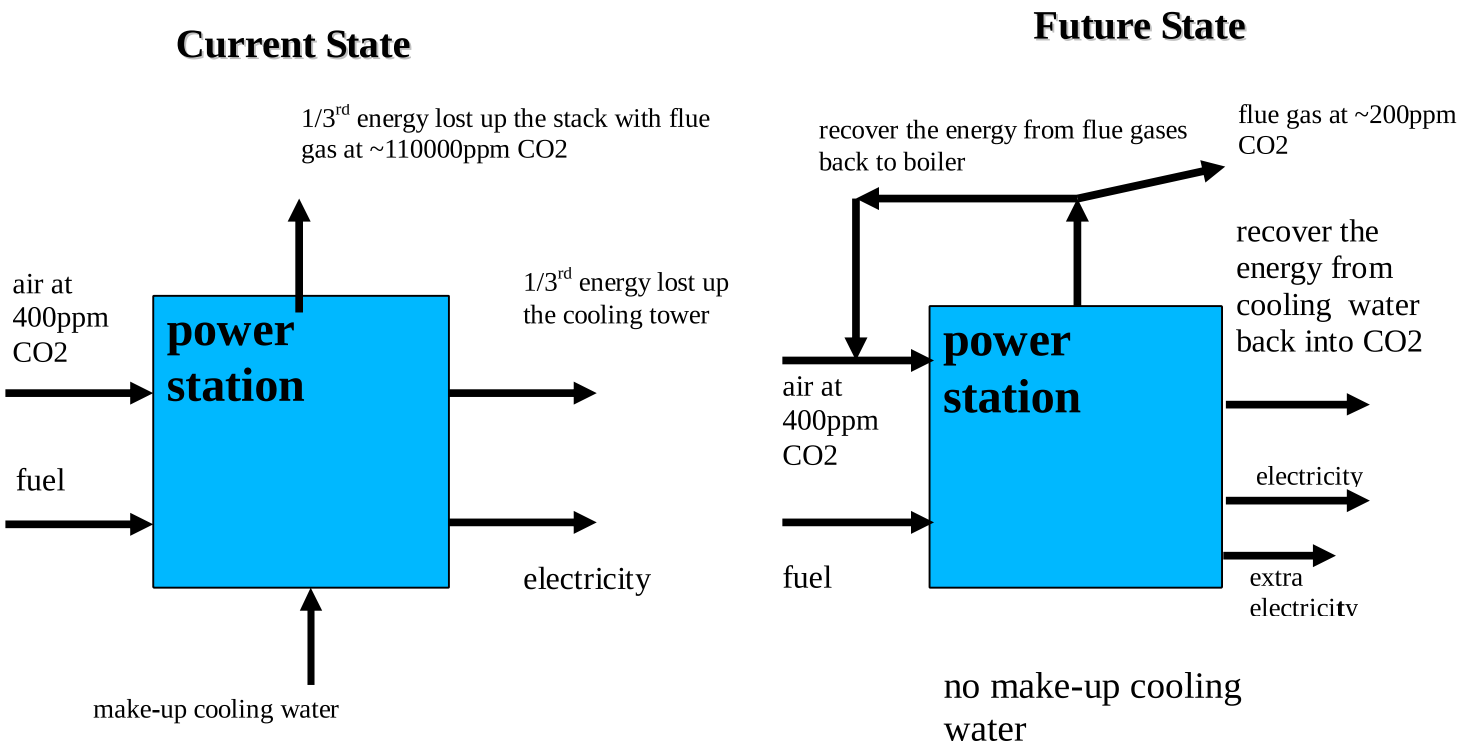

Figure 1. The consequences of using a condensation process for CO_2 removal.

The condensing process is therefore the only process that ends up being able to generate more electricity from the same quantity fuel than before.

What is a PUTAR?
PUTAR stands for **P**ulse-combustion-driven **U**-tube **T**hermo **A**coustic **R**efrigerator. This is a thermo-acoustic refrigerator driven by pulse combustion heaters with no moving parts, unlike compressor driven refrigeration systems. It operates by condensing out of the flue gas all gases condensation below 155°C in a sequential manner, such that the condensed gases are captured separately.

Heat is added at the top end via pulse combustion heaters and heat is also removed at the top end to set up a large temperature difference driving a Stirling engine. The tubes themselves are filled with helium at 3MPa (30atm). The large temperature difference sets up an acoustic wave, which travels up and down the tubes with an amplitude of ± 0.3MPa. At the bottom of the tubes is a Stirling heat pump and an interconnected orifice that throttles the helium flowing through and thus cooling it. Temperatures down to below -200°C are possible to obtain.

There are no moving parts in this refrigerator and hence the operating costs are very low. Because of the simplicity of the design, the capital cost are lower than conventional vapour compression refrigeration systems. The various gases that can be condensed out (this list is by no means complete) are given in Table 2. The gases with an asterisk beside them are produced in negligible quantities from pulse combustion burners and can be ignored. The highest concentration is NO at ~1ppm. An artist's impression of a PUTAR is shown in Fig 2. It is based on the single tube TASHE from Ubas and van Wijngaarden [12] and overcomes the problems that they and others have faced with this unit. We have changed the top end by using pulse combustion heaters, which have 2 orders of magnitude higher heat transfer coefficients. This allows us to reduce the size of the regenerator at the top and also increase the thermal efficiency of the system. The acoustic impedance at the 'cold' end has been changed so that the time phasing always works, no matter what the conditions. Each tube assists the other and in doing so also improves the thermal efficiency of the refrigerator lowering the pressure drop that the helium gas experiences as it moves up and down the tubes.

Gas	Condensing temperature (°C)	Freezing point (°C)
H_2O	100.0	0.0
NO_2*	21.2	-11.2
SO_2*	-10.0	-73.0
H_2S*	-60.2	-86.0
CO_2	-65.0	-78.5
N_2O*	-88.5	-91.0
NO*	-152.0	-160.9

Table 2. Some flue gas properties.

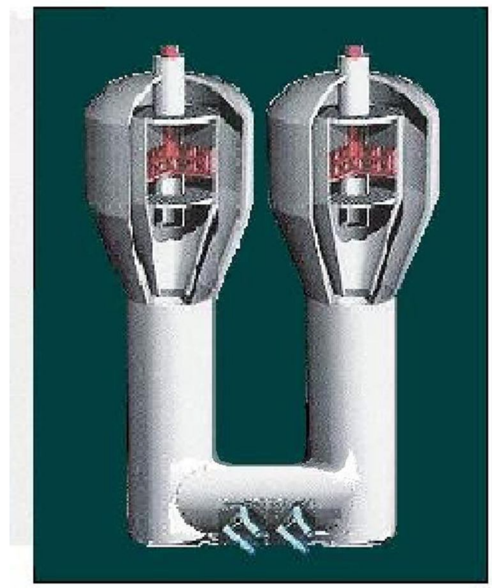

Figure 2. 200tCO_2 /day PUTAR

The Proposed Advanced Power Station

A schematic of the proposed new power station is shown in Fig 3. All the heating in this plant is by pulse combustion as it gives the highest efficiency and lowest emissions. There are three parts to this advanced power station:

1. the pulse combustion driven gasifier,
2. the super critical steam pulse combustion boiler, and
3. the PUTAR.

Variations on each of these parts have been built and operated. The gasifier does not employ an air “blow”, but pulse combustor heaters to attain the desired operating temperature. These units have very high heat transfer coefficients, about two orders of magnitude higher than corresponding conventional heat transfer coefficients [13,14,15], which is why the gasification can be done this way. The pulse combustors are based on Rijke tubes [16] and the gasifier is different from the one shown in Fig 4, which is based on Helmholtz pulse combustors [17,18].

The same version of pulse combustor is used for the PUTAR and also the super critical steam boiler. A 0.5MW version of the boiler is shown in Fig 5. The highest efficiency that has been measured for this boiler is 98% based on the higher calorific value of the fuel. The efficiency figure that has been used in this paper is 95%. Another advantage of this pulse combustion system is the emissions which are very low. NOx is about 1ppm and is mainly NO, SOx is less than 1ppm and similarly with CO.

The heat exchangers that are used to shuffle the “heat” between stream are plate heat exchangers, PHE, [19]. They exist in sizes that are applicable to power station flues. The advantages of PHE are they are low pressure drop devices, they can operate efficiently at low temperature differences and they can be easily opened up if they need to be cleaned.

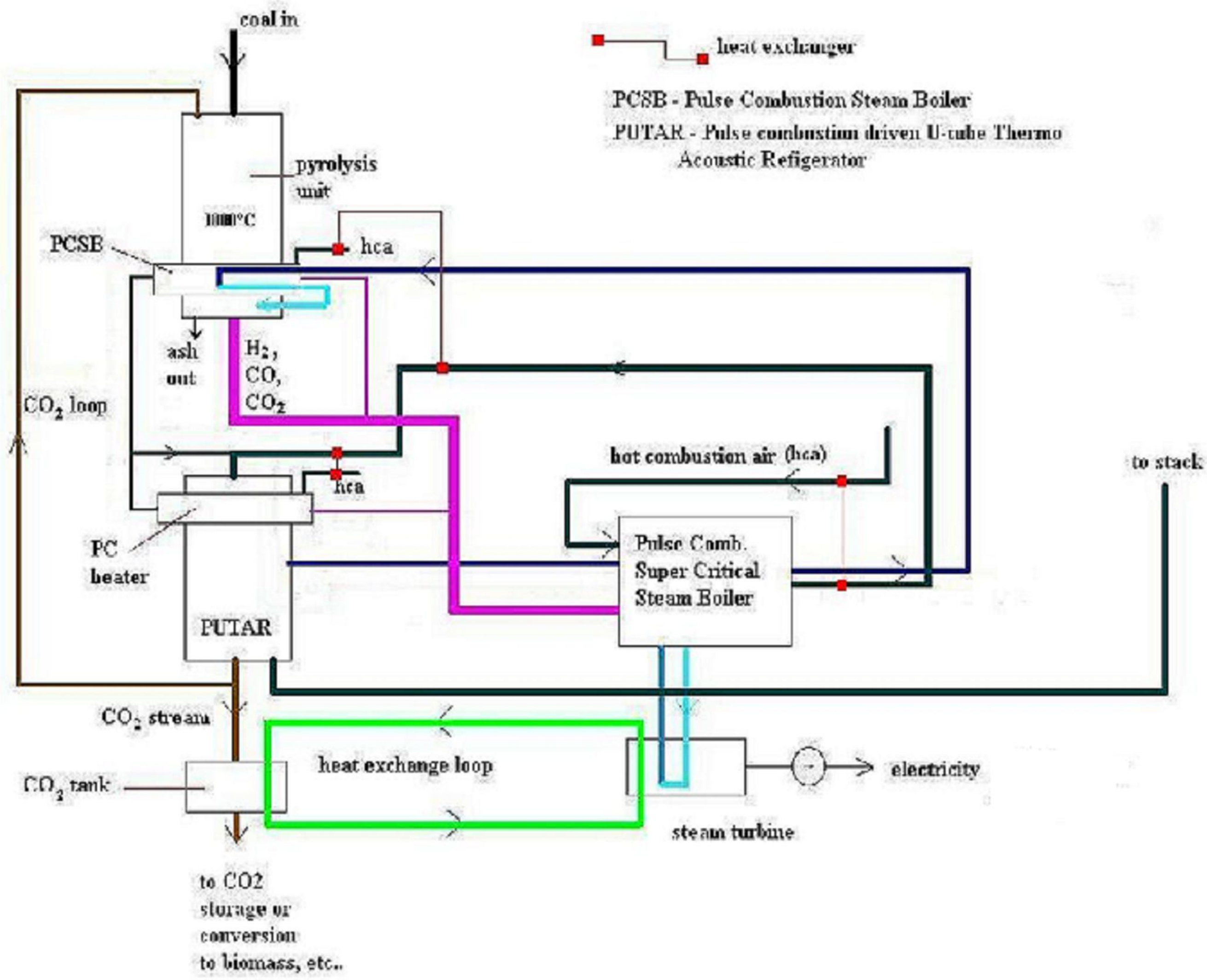

Figure 3. Advanced Power Station

The heat exchange loop between the steam turbine and the CO_2 tank contains ethylene and is used to provide the cold sink for the steam turbine and to condition the CO_2 to a state that is suitable be able to process the CO_2 at the next stage.

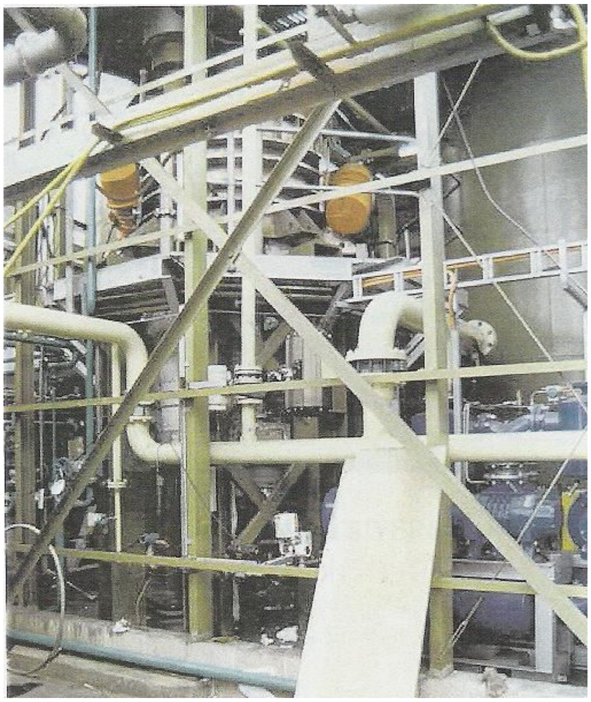

Figure 4. Pulse Combustion Gasifier

Figure 5. 0.5MW Pulse Combustion Steam Boiler

Profit and Loss Statements

The picture changes yet again when the costs of generating electricity with CO_2 removal are included. Here only the amine and condensation PUTAR CO_2 removal process have been considered with different power stations. The cost of selling the electricity from the power stations in Australia is set by AEMO and their figures are available on the web [20]. The average cost for electricity has been taken as $41.40 /MWh based on the last three years and includes the data from NEMMCO [20]. The cost of CO_2 removal has been taken as $80/t CO_2 for the amine scrubbing process [2] and $6/t CO_2 for the PUTAR process, although it is thought that it could drop as low as $3/t CO_2 with mass production of the units. The range of costs for the PUTAR have been calculated at between $3 and $8/t CO_2, the range mainly due to what the maximum size the unit can be made. It has been assumed that AEMO will not change the price of electricity from the power station from the current levels.

The profits and losses are listed in Table 3. It is based on a unit of brown coal producing 1 MWh and 1.44t CO_2 . The same quantity of coal has been used in each of the other electricity generating scenarios. The existing generator is based on Hazelwood Power Station, which is probably among the worst emitters in Australia. The cost of generation has been taken as $30 for the existing power stations and $35 for the new power stations. IGCC has been taken as the most likely candidate for new power station construction [5] because of its “high” thermal efficiency. The advanced power station that is proposed here is based on super critical steam boilers heated by pulse combustors.

In Table 3 it has been assumed that AEMO will not increase the price that the power companies can sell their electricity at to the retailers of electricity. The things that are apparent from Table 2 are:

1. that no matter what the permit price is set at, systems with the PUTAR CO_2 capture will always be profitable
2. systems with the PUTAR CO_2 capture will always be more profitable than the existing brown coal power stations

3. power stations with amine capture will always be in a no win situation because if the costs of amine capture can be reduced the permit cost is going to increase over time and negate any gains that are made.

Electricity Generating System	Relative MWh	Sell at (AU$)	Profit/MWh (AU$)	Profit/MWh with $23/t CO_2 permit(AU$)
existing brown coal	1.00	41.40	11.40	-20.80
existing brown coal with PUTAR CO_2 capture	1.35	55.89	17.49	17.51
existing brown coal with amine CO_2 capture	0.70	28.98	-96.22	-101.05
advanced power station	2.60	107.43	62.03	62.06
IGCC with amine CO_2 capture	1.49	61.48	-70.72	-75.55
IGCC with PUTAR CO_2 capture	2.12	87.56	42.16	42.18

Table 3. Profit/loss for different electricity generating systems.

What To Do With The CO_2?
It is all very well to remove the CO_2 from flue gases, but the big question is what can be done with the captured CO_2? Although the use of the advanced power station for all Australia's electricity could reduce Australia's GHG by about 28%, its still not a total solution to the greenhouse problem. There have been a number of possible solutions put forward:

1. put the CO_2 down into old oil wells or saline aquifers at a cost of just over $10/t CO_2 processed [21],
2. put the CO_2 at below 3000m at the bottom of the ocean under a membrane covered with silt at a cost of $10/t CO_2 processed [22],
3. put the CO_2 encapsulated in a membrane restrained below 1000m in the ocean $10/t CO_2 processed[22],
4. lock the CO_2 in a “carbon sponge” [8] or carbonate at a cost of $20/t CO_2 processed ,
5. convert the CO_2 into formic acid at a cost of $100/t CO_2 processed with the formic acid selling at $1440/t CO_2 processed [23], or
6. convert the CO_2 into bio-fuels via solar energy at a cost of $70/t CO_2 processed with the “crude” oil selling at $230/t CO_2 processed, (the figures for ethanol are $90 and $600), [25, 26].

The first four solutions result in further losses and are only valid options for the PUTAR based processes. The last two make the PUTAR process even more profitable. They may make other removal routes marginally profitable, but as the CO_2 permit to pollute price rises the profits could be wiped out.

Conclusions
There is no need for all the doom and gloom that has said about mitigating the release of CO_2 into the atmosphere. It has been shown here that by looking at things a little differently we can turn the mitigation process to everyone's advantage.

The other point to come out from this CO_2 mitigation process is that even if, and its a big if, global warming turns out not to be due at all from fossil fuels, it makes economic and thermodynamic sense to install PUTAR systems into power stations.

Can we make a profit out of removing CO_2, NOx and SOx from flue gases – YES WE CAN!

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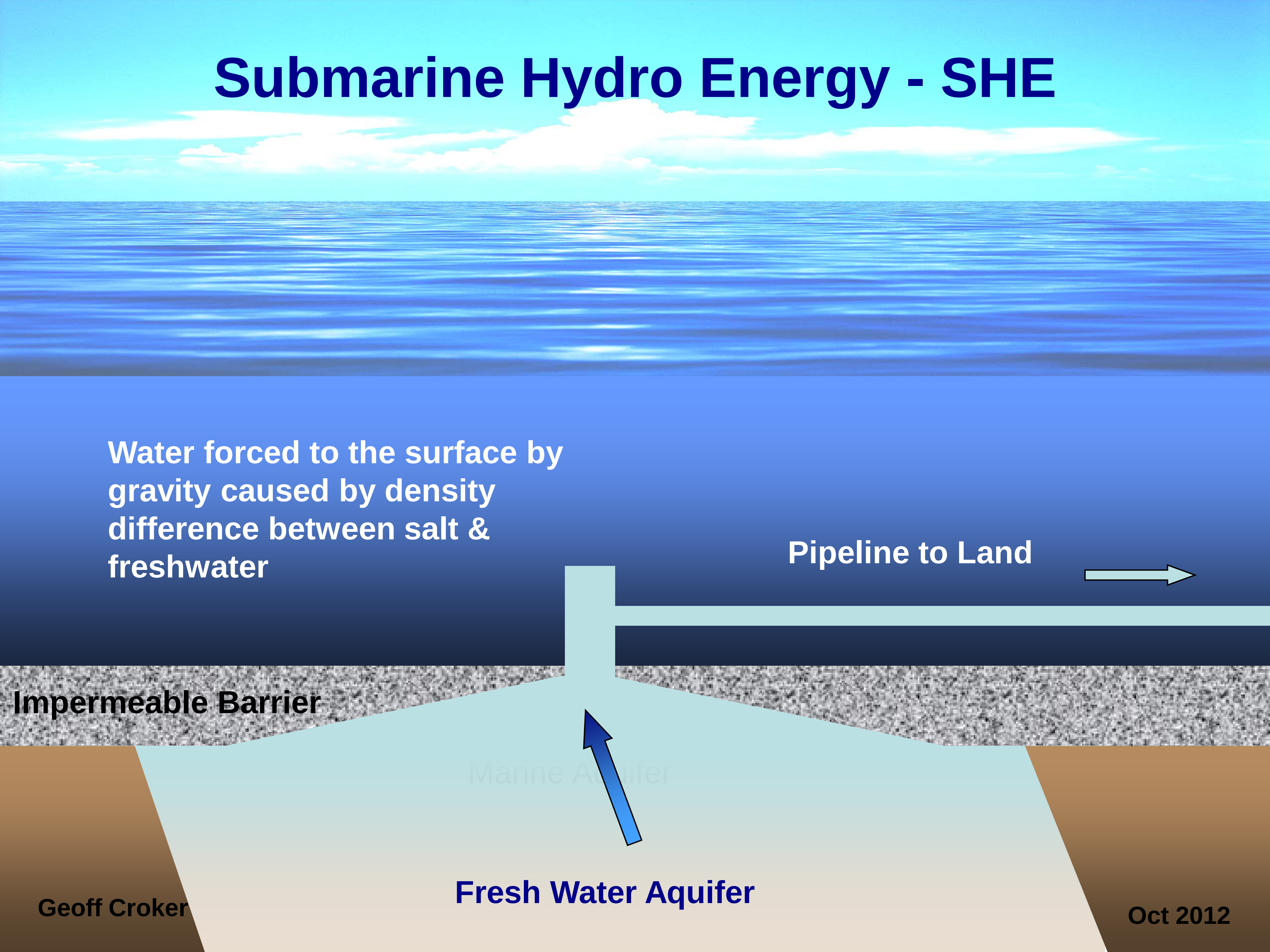

Submarine Hydro Energy - SHE
Water forced to the surface by gravity caused by density difference between salt & freshwater
Pipeline to Land
Impermeable Barrier
Fresh Water Aquifer
Geoff Croker
Oct 2012

Gravity & Water = Potential Energy

- **Freshwater rises in saltwater due to gravity.**
- **Gravity can be converted to electricity using hydro-generators.**
- **For a large known area of seepage (Gulf of Bengal) the area is 1600*700km @ 70m of depth, the potential energy exceeds 600 Million GW assuming a 50% loss.**
- **The world currently generates about 2,500GW of electricity. Now have another look at the Gulf of Bengal figure. 600,000,000 vs 2,500**
- **There are no green house gas emissions other than those created to manufacture, install, maintain and operate simple collection systems, power lines, switches and hydro-generators.**
- **The CO_2 emissions/MWh over 20 years is 0.000285tons/MWh because energy is derived from gravity.**

Australian Households

- Households consumed 223 PJ (61,944 GWh) of electricity in 2010-11.
- New South Wales (and the ACT) used almost as much as Victoria and Queensland homes put together.
- All the other states together barely using more than Queensland.
- Households consumed 148 PJ of gas with Victoria using 100 PJ.
- LPG and solar power – account for 22 PJ, or 5.6%.
- Just 43 square kilometers of seeps would provide all of Australian household's 2010-11 fixed power consumption at a cost of under \$2B/year over 25 years or \$220/household/year excluding connection to the NEM.

Submarine Groundwater Discharge

- The Roman geographer, Strabo, who lived from 63 B.C. to 21 A.D., mentioned a submarine spring (fresh groundwater) four kilometers from Latakia, Syria (Mediterranean) near the island of Aradus.
- Water from this spring was collected from a boat, utilizing a lead funnel and leather tube, and transported to the city as a source of fresh water.
- Water vendors in Bahrain collecting potable water from offshore submarine springs for shipboard and land use.
- Etruscan citizens using coastal springs for 'hot baths' (Pausanius,
- ca. 2nd century A.D.).
- Submarine 'springs bubbling fresh water as if from pipes' along the Black Sea (Pliny the Elder, ca. 1st century A.D.).

Large Global Volume

- **Found in all the world's oceans submarine freshwater discharges were formed thousands of years ago when ocean levels were lower than today.**

- **The subject has been neglected by most water authorities but represents a significant source of freshwater.**

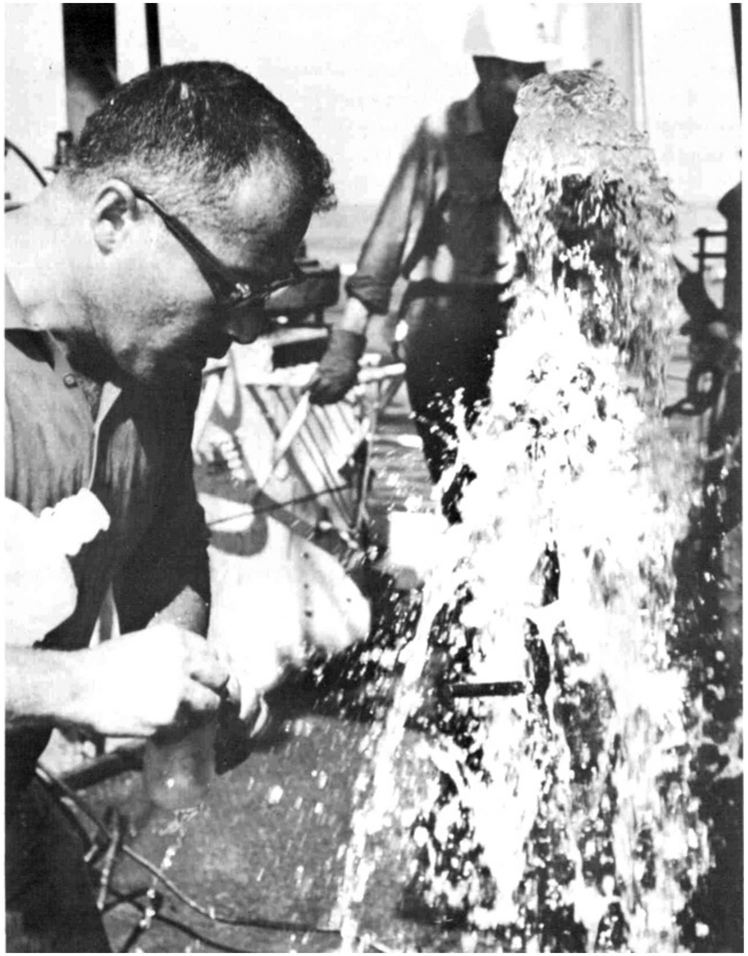
- **Submarine groundwater discharge is more than a mere curiosity. It exists near most Australian coastlines and has been measured by scientists at several locations at flows exceeding 8-10 GL per annum per hectare.**

- **Globally, marine groundwater seepage has been estimated to be about 6% of the total freshwater flux or 2,400 km3 (2.4 Million Gigalitres or 4,800 Sydney Harbours) per annum.**

Submarine artificial spring in the US

A well 43 km offshore from Jacksonville, Florida penetrated an artesian Aquifer in 1966. Chloride content was only ~700 ppm (seawater =19,000 ppm Cl).

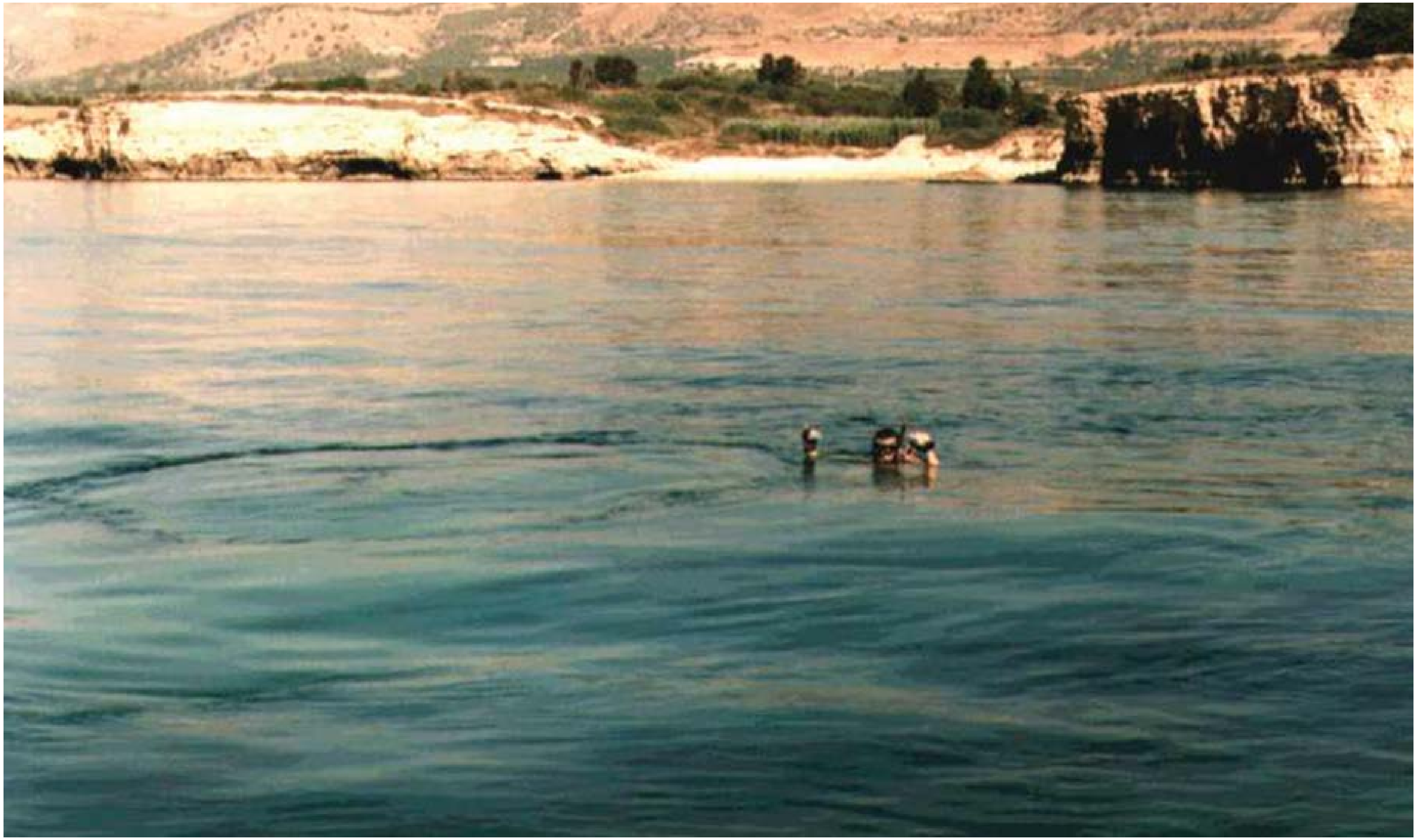
The water came from a depth of 250 m below the ship and had a hydrostatic head of 9 m above sea level.



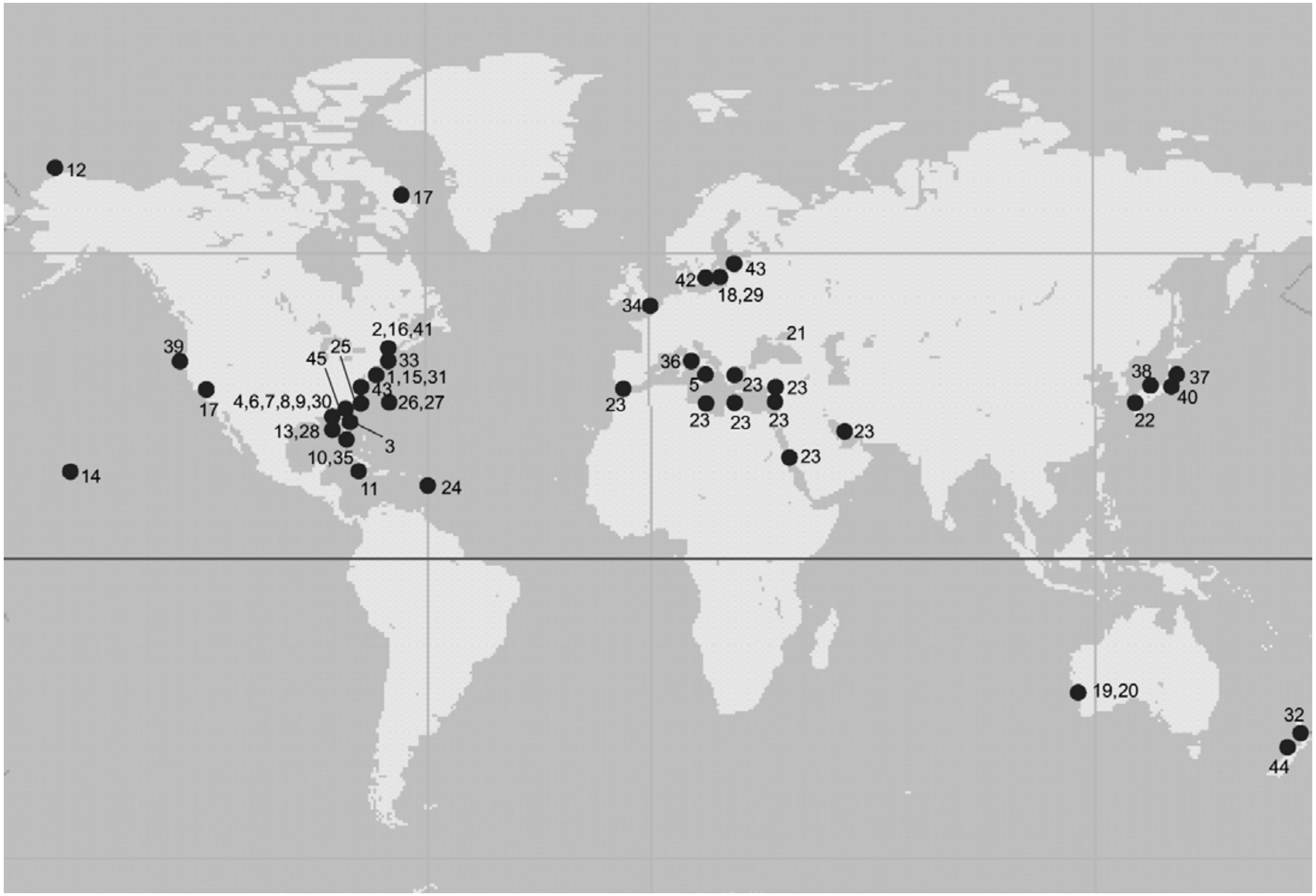
Submarine Discharge Atlantic USA

Crescent Beach Submarine Spring is located in the Atlantic Ocean off the coast of St. Johns County, approx 4 kms east of Crescent Beach at 18m of depth.

Submarine springs off Sicily



Published Studies



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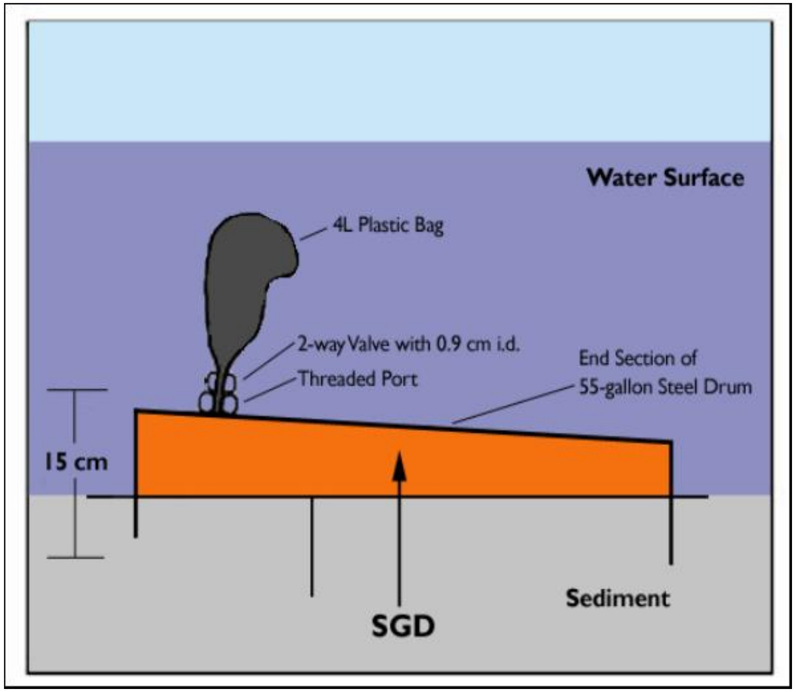
Oct 2012

Flow Measurement Techniques

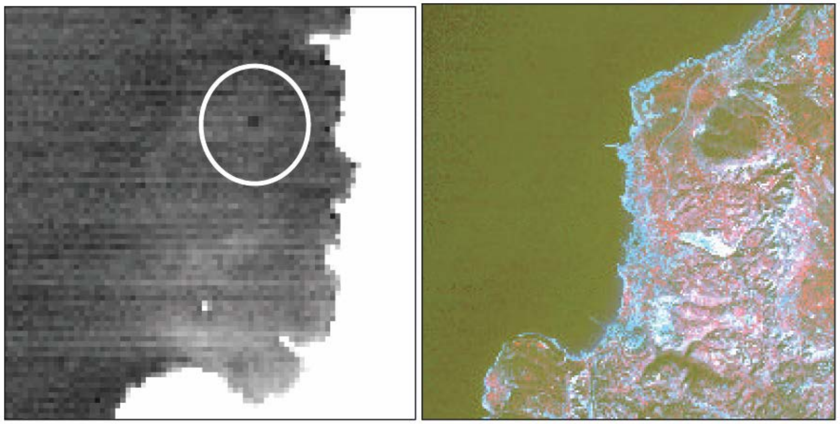
Seepage meters are devices that are positioned on the sea bed and measure fluid fluxes either

- **manually by displacement into a plastic collector bag from a drum;**
- **by measurement of heat transport;**
- **acoustically.**



Submarine Groundwater Detection

- Thermal sensors onboard of satellites such as LANDSAT 7 or ASTER can provide accurate information on ocean temperatures contrasts.



In the circle, dark spot is the cool signature of a major intermittent SGD, detected by its contrast with surrounding sea water, on channel 14 of ASTER. On the right a classical colour composition of the same area with other ASTERS channels.

Infrared aerial survey, Malta

Many Known Submarine Springs

- Mediterranean Sea
- Cannes 165m deep
- San Remo 190m deep
- Saint Martin Gulf 700m deep
- Dinaric 420 kilometres of karst aquifer with 32 seeps
- Rome submarine river
- Gulf of Genoa submarine river
- Port Miu 45m deep
- Bestuan 100m deep

- Adriatic Sea, 700 seeps
- Persian Gulf, Bahrain & Saudi, up to 100km offshore
- Aegian Sea
- Jamaica 43 cubic metres per second, potable, from 256m deep

More Known Seep Locations

- Atlantic West Coast 400m deep
- Entire eastern coast of United States & Mexico
- Florida many seeps up to 120km from shore, 510m deep
- Delaware 37km from coastline
- Savanna Georgia, Blake Plateau, 200km from coast, 510m deep

- Bengal Gulf, 1600km by 700km at 70m deep

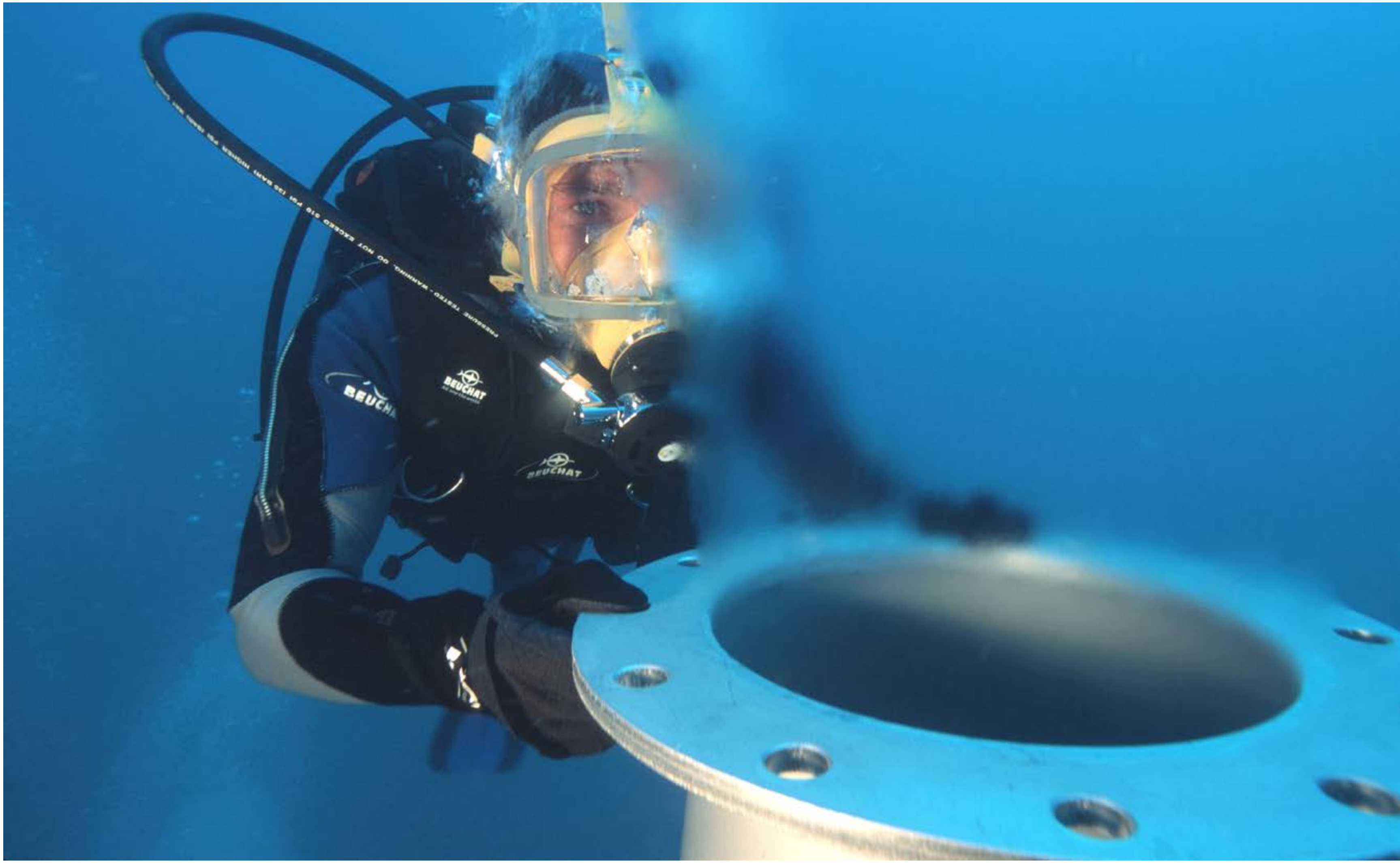
- Greece, Freshwater dams built around submarine springs, 1GL/day flow

- Black Sea

- Caspian Sea

- Coral Sea, 200+ locations

Diver Inspecting Submarine Groundwater Discharge Pipe, Italy



Study of output, Mauritius using small pipe

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Over 2,000 years of flow, Latakia, Syria

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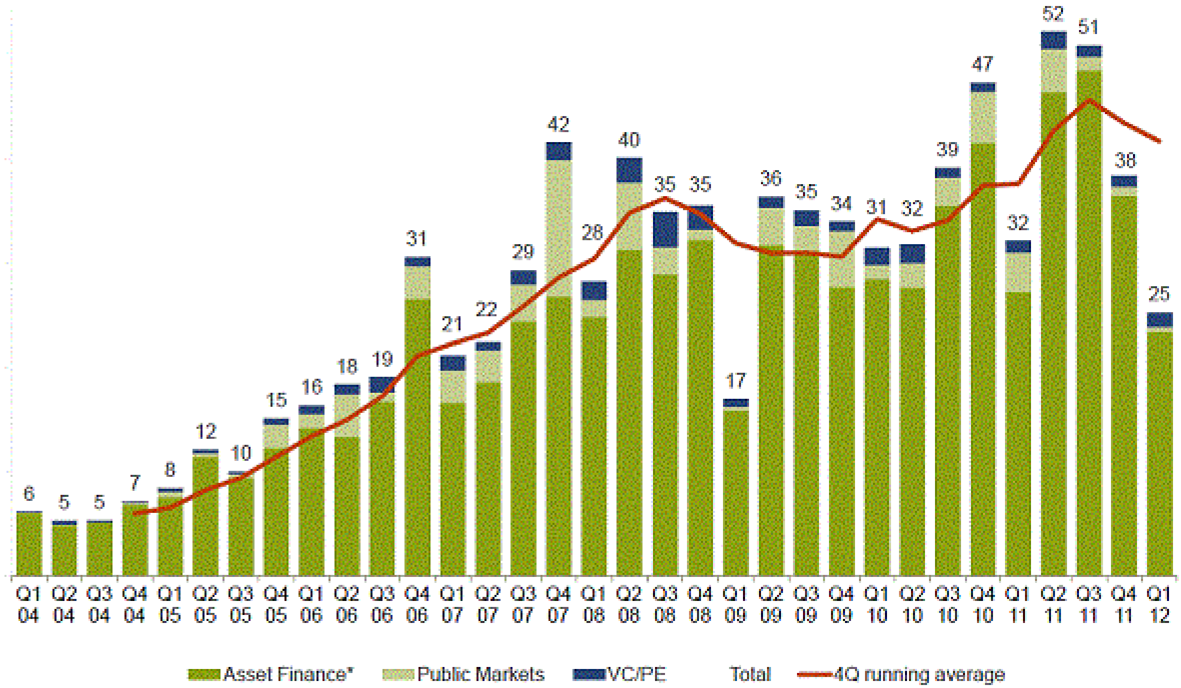
Renewable Energy $250B+ for 3% of World's Energy

FIGURE 10: VC/PE, PUBLIC MARKETS, AND ASSET FINANCE INVESTMENT IN RENEWABLE ENERGY QUARTERLY TREND, Q1 2004-Q1 2012, $BN



*Asset finance volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

Overrated Renewable Capacity

- The UNEP say renewables comprise 25% of the capacity, this capacity is wildly overrated.
- Coal fired stations produce at 75% of capacity.
- Solar produces at 5 - 20% of capacity.
- Capacity is a hypothetical number that is achieved in perfect circumstances.
- Capacity depends on the weather and sunlight.
- A seep depends on the last Ice Age.

FIGURE 3: GLOBAL TRENDS IN RENEWABLE ENERGY INVESTMENT 2011 DATA TABLE, $BN

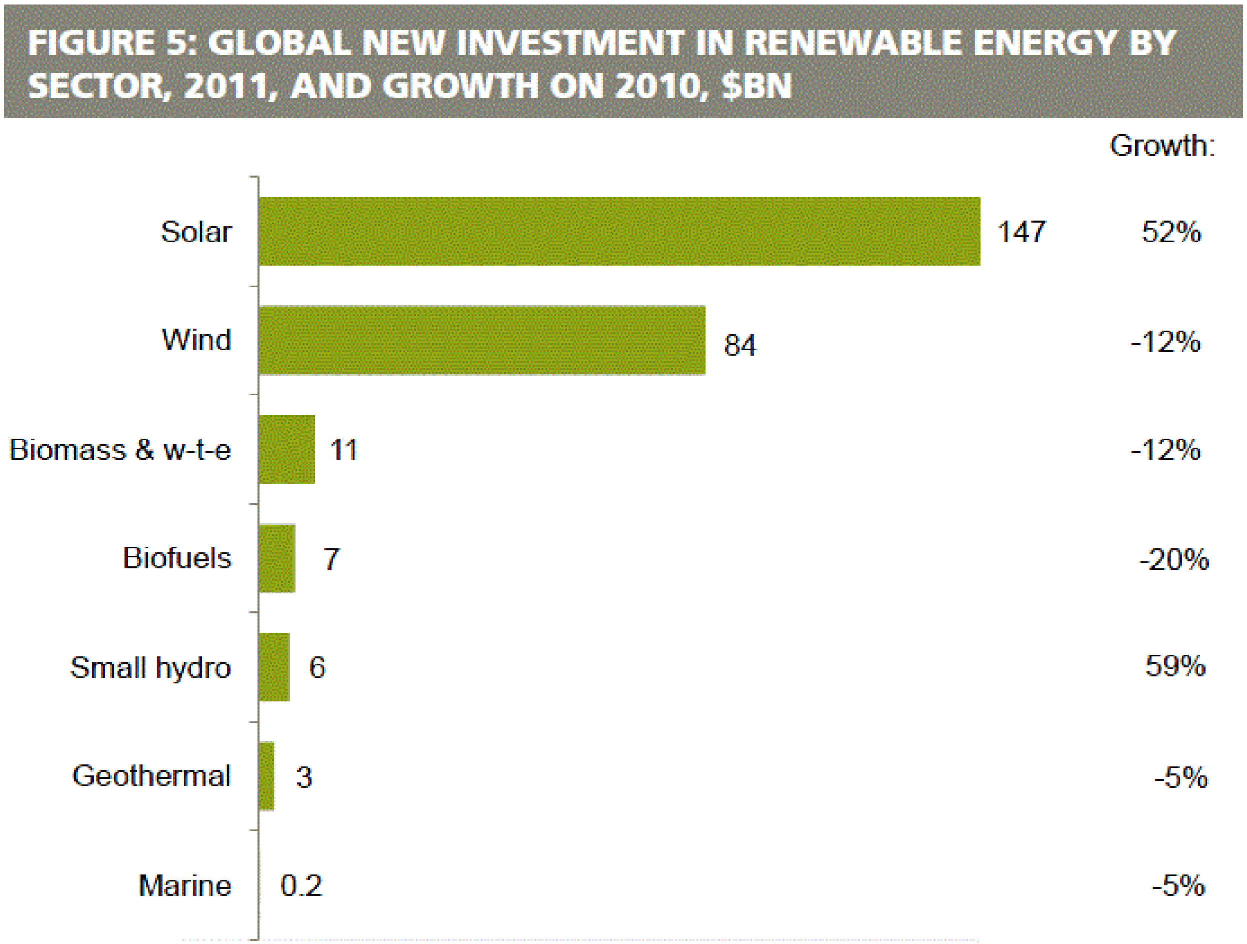
Category (Year / Unit)	2004 $bn	2005 $bn	2006 $bn	2007 $bn	2008 $bn	2009 $bn	2010 $bn	2011 $bn	2010-11 Growth %	2004-11 CAGR %
1 Total Investment										
1.1 New investment	39.5	60.8	96.5	132.8	166.6	160.9	219.8	257.5	17%	31%
1.2 Total transactions	48.6	85.2	132.2	191.9	231.2	226.1	285.1	325.9	14%	31%
2 New Investment by Value Chain										
2.1 Technology development										
2.1.1 Venture capital	0.4	0.6	1.2	2.1	3.0	1.5	2.4	2.5	5%	30%
2.1.2 Government R&D	1.9	2.0	2.2	2.5	2.6	3.5	5.3	4.6	-13%	14%
2.1.3 Corporate RD&D	5.1	2.5	2.9	2.7	3.9	4.0	4.6	3.7	-19%	-5%
2.2 Equipment Manufacturing										
2.2.1 Private equity expansion capital	0.3	1.0	3.0	3.2	6.9	2.8	2.9	2.5	-15%	33%
2.2.2 Public markets	0.3	3.5	9.4	22.7	11.6	11.7	11.3	10.1	-10%	69%
2.3 Projects										
2.3.1 Asset finance	22.8	40.5	71.7	92.0	121.5	108.6	138.8	164.4	18%	33%
Of which re-invested equity	0.0	0.0	1.1	5.7	4.5	2.4	6.0	6.1	3%	-
2.3.3 Small distributed capacity	8.6	10.8	7.2	13.4	21.6	31.2	60.4	75.8	25%	36%
Total Financial Investment	23.8	45.5	84.3	114.2	138.5	122.2	149.5	173.4	16%	33%
Gov't R&D, corporate RD&D, small projects	15.6	15.3	12.2	18.5	28.1	38.7	70.3	84.1	20%	27%
Total New Investment	39.5	60.8	96.5	132.8	166.6	160.9	219.8	257.5	17%	31%
3 M&A Transactions										
3.1 Private equity buy-outs	0.9	3.8	1.7	3.6	5.6	2.6	1.9	3.4	77%	21%
3.2 Public markets investor exits	0.0	1.3	2.7	4.3	1.2	2.6	5.3	0.2	-97%	-
3.3 Corporate M&A	2.6	6.9	12.9	20.2	18.7	21.7	21.1	28.4	34%	40%
3.4 Project acquistion & refinancing	5.5	12.3	18.5	31.0	39.0	38.3	37.0	36.5	-1%	31%
4 New Investment by Sector										
4.1 Wind	13.3	22.9	32.0	51.1	67.7	74.6	95.5	83.8	-12%	30%
4.2 Solar	13.8	16.4	19.5	37.7	57.4	58.0	96.9	147.4	52%	40%
4.3 Biofuels	3.5	8.2	26.6	24.5	19.2	9.1	8.5	6.8	-20%	10%
4.4 Biomass & w-t-e	6.1	7.8	10.8	11.8	13.6	12.2	12.0	10.6	-12%	8%
4.5 Small hydro	1.4	4.4	5.4	5.5	6.6	4.7	3.6	5.8	59%	22%
4.6 Geothermal	1.4	1.0	1.4	1.4	1.9	2.0	3.1	2.9	-5%	12%
4.7 Marine	0.0	0.0	0.9	0.7	0.2	0.3	0.3	0.2	-5%	30%
Total	39.5	60.8	96.5	132.8	166.6	160.9	219.8	257.5	17%	31%
5 New Investment by Geography										
5.1 United States	7.4	11.2	27.2	28.5	37.7	22.5	32.5	50.8	57%	32%
5.2 Brazil	0.4	1.9	4.3	9.3	12.7	7.3	6.9	7.5	8%	51%
5.3 AMER (excl. US & Brazil)	1.3	3.3	3.3	4.7	5.4	6.4	11.0	7.0	-36%	27%
5.4 Europe	18.6	27.7	37.4	57.8	67.1	67.9	92.3	101.0	10%	27%
5.5 Middle East & Africa	0.3	0.4	1.6	1.9	3.7	3.1	6.7	5.5	-18%	50%
5.6 China	2.2	5.4	10.0	14.9	24.3	37.4	44.5	52.2	17%	57%
5.7 India	2.0	2.9	4.7	5.6	4.7	4.2	7.6	12.3	62%	29%
5.8 ASOC excl. (China & India)	7.2	8.0	8.0	10.1	11.0	12.1	18.4	21.1	15%	17%
Total	39.5	60.8	96.5	132.8	166.6	160.9	219.8	257.5	17%	31%

New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.

Source: Bloomberg New Energy Finance, UNEP

Renewable 20.3% of World's Power

- most of that 20.3% (over 90%) comes from large scale hydroelectric generation;
- most of the renewables investment is going into wind power, and especially last year — into solar;
- most renewables contribute next to no power;
- most renewables have no stable income stream;
- hydro-electric generation is well known technology.



New investment volume adjusts for re-invested equity. Total values include estimates for undisclosed deals.

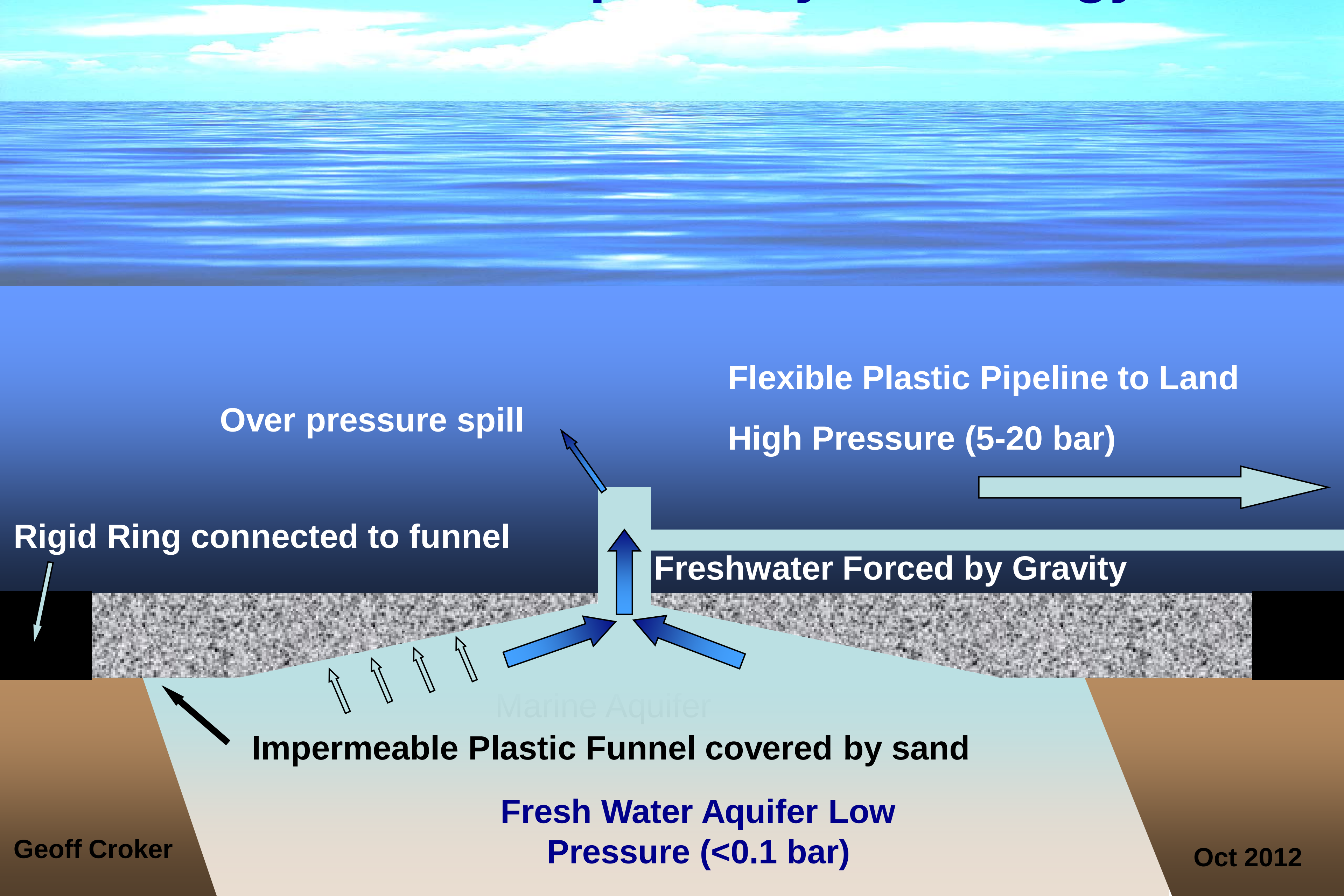
Source: Bloomberg New Energy Finance, UNEP

How Much Power from a Seep?

- The head of a seep at 5m of depth is 0.15m/square metre.
- Head of 100 square metres off a seep funnelled into a 30” pipe is 200+metres.
- This head would drive a turbine and produce about 4 MW allowing for a 50% loss of energy and a 4km pipeline to the turbine on shore.
- This is 400 MW /kilometre for a seep 10 metres wide.
- Submarine Hydro Energy can easily replace nearly all other forms of power as seeps occur worldwide at most shallow limestone aquifers extending from a coastal mountain range under the ocean and/or from trapped water from an Ice Age.
- For a small 10 MW plant costing under $20M this means power at 2.3c/kWh.
- For a medium 100 MW plant costing under $50M, $0.6c/kWh.
- Many of these seeps suitable for power generation will produce potable or Class A water.
- There are so many seeps there is no reason to “manufacture” any.

Typical Generator

Submarine Aquifer Hydro Energy



Power generation

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Applicant	Interlocking Buildings Pty Ltd
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External Links: Patentscope, Espacenet

ABSTRACT

A method of driving an apparatus, comprising, piping water derived from an underwater seep under such conditions that the piped water is arranged to flow under its own pressure to the apparatus to drive the apparatus.

DESCRIPTION (OCR text may contain errors)

Power Generation

Field of the Invention

The present invention relates to an apparatus and method for converting potential energy stored as water under pressure in submarine aquifers and converting that energy to kinetic and/or electrical energy.

Background of the Invention

Submarine aquifer discharge is a common, naturally occurring feature along most coastlines, lakes and rivers. It also occurs in deep ocean waters.

Typically, aquifer discharge comprises freshwater flowing into sea water. If flows are large enough a "pool" of freshwater appears on the sea water surface. Flowing freshwater is not easily mixed with salt water. Aquifers are porous, permeable layers, of sediments such as sandstone, silt or limestone, sandwiched between non-permeable rock and clays. They are fed by rainfall from the land or supplied from a source rock and may be confined or unconfined. Aquifers that occur in sediment under bodies of sea water, can be connected to that sea water, by natural features such as faults, volcanic action, physical or chemical erosion, earthquakes, glacial activity, sea level movement, sedimentation etc. Water is forced by gravity from the aquifer into the lake or ocean above it. The aquifer is "squeezed" by the overburden and water rises where possible.

Aquifers may be connected to a local coastline following an old river bed, seabed or flood plain, or confined within older sediments at great depth. Typically this happens during times of lower ocean depths such as an active glacial period or ice age. As the glaciers recede the freshwater in rivers becomes confined in a sedimentary aquifer under the ocean. This also occurs in very deep water. Trapped water in a confined aquifer can be millions of years old before it finally is naturally exposed and leaks under great pressure. The velocity of escaping leakage is reduced by friction. However, the pressure is generally maintained. What each aquifer type has in common is some naturally occurring discharge area from the ocean or lake floor. This leakage may occur over a small or very large area. Large volume, small area, leakage points are often well known and may appear as "named" features on ocean charts. The potential energy contained in a submarine aquifer is significant. Friction reduces the discharge velocity as it flows through permeable sediments to the sea or lake floor. By diverting the aquifer discharge flow into a specially shaped membrane connected to an exit pipeline, water can be accelerated to a much higher velocity. This potential energy may be harvested with little or no emission of pollutants or carbon dioxide.

Where the discharge water quality is suitable, it can also provide a huge source of untapped irrigation or drinking water.

Large flows can often be seen on the ocean or lake surface with the naked eye. Most often the discharge is of a different temperature and the discharge flow

CLAIMS (OCR text may contain errors)

Claims

1. A method of driving an apparatus, comprising, piping water derived from an underwater seep under such conditions that the piped water is arranged to flow under its own pressure to the apparatus to drive the apparatus.

2. The method according to claim 1 wherein the apparatus is used to generate electricity.

3. The method according to claim 1 or claim 2 wherein the seep is located under saline water having a salt content at least 50% of the average salt content of the earth's oceans.

4. The method according to claim 3 wherein the seep is located at least 15 metres beneath the surface of the saline water.

5. The method according to any one of the preceding claims wherein the broader end^of a collecting member is placed over the seep to collect water from the seep and to pipe it through a join provided at a region of the collecting member which is narrower than the broad end to an offtake pipe.

6. The method according to claim 5 wherein the collecting member comprises a flexible generally cone shaped diaphragm formed of a material resistant to being fouled by marine flora and fauna, and the broader end of the collecting member is secured to ground surrounding the seep so as to substantially prevent communication between water from the seep and the saline water.

7. .The method according to claim 5 or claim 6 wherein the collecting member is suspended beneath the surface of the saline water by a float, such that the join lies at least 7 metres below the surface.

8. The method according to claim 6 wherein the collecting member is reinforced by a plurality of battens and the surface of the collecting member exposed to saline water comprises polymeric material.

flows are usually many thousands of years old, and may even be millions of years old.

The suitability of a seep can be easily assessed by using well known measuring techniques used by hydro-geologists and oceanographers. Such techniques are used to obtain the flow rate, discharge quality and age, ocean or lake depth, location of required piping etc.

Disclosure of the Invention

The invention provides a method of driving an apparatus, comprising, piping water derived from an underwater seep under such conditions that the piped water is arranged to flow under its own pressure to the apparatus to drive the apparatus. By saying that the piped water is arranged to flow under its own pressure, we mean pressure resulting from the difference in density of saline water overlying the seep and the density of the water emanating from the seep, plus pressure if any of water emanating from the underwater seep. Generally speaking, it is expected that the major difference in density will be caused by the difference in salinity of the overlying water and the water from the seep. However, other factors such as temperature differences may also come into play.

Seeps which flow with aged water, are likely to substantially maintain their flow rate even in times of drought, as the water may have been deposited many years before the drought occurred. In choosing seeps, it is preferable to perform the invention in relatio to seeps which are likely to maintain their water flow ie. choosing seeps with water which is aged will generally be preferred. Typically one would prefer to have seeps supplying water which is aged by at least 5 years, more preferably 10 or 20 years.

The apparatus of the invention is most suitably used to generate electricity, although it is to be appreciated that the energy supplied by the piped water can be used to drive mechanical arrangements other than electricity generating apparatus. After water from the seep has been used to drive the apparatus, it may be returned to a marine environment or alternatively, it may be sent to a storage reservoir for purposes such as irrigation or drinking water. The water from the seep may be collected under a flexible diaphragm. The flexible diaphragm may be arranged so that it has a broader end covering the seep. The diaphragm may taper to a narrower opening for an offtake pipe. The offtake pipe may also be formed of a flexible material.

The flexible material used to collect water from the seep to direct it to the offtake pipe may suitably be formed in the shape of a generally conical member with the base of the cone sitting against the floor of an ocean or lake in communication with the seep. The edges of the cone may be covered with material to hold the cone down. Suitable material may comprise aggregate and/or rocks.

A float may be used to hold the top of the cone upright. It may be connected to the top of the cone by a cable and may be arranged to sit below the surface of the overlying water by a distance which is chosen having regard to disturbance by wave action on the surface. The depth of the float may vary between different environments. However, in most circumstances, it is expected that ensuring that the float remains 10 metres below the surface more preferably 12 metres will suffice. In this way it should be possible to reduce disturbance by wave action.

The surface of the diaphragm forming the cone may be treated with a material resistant to being fouled by marine flora and fauna or it may itself be resistant in this regard. It has been found that polymeric materials are generally resistant in such circumstances. The flexible piping material may also be treated in the same fashion.

The cone may be reinforced by a plurality of battens. Battens may also be used to reinforce the flexible pipe.

Electricity may be generated by using conventional means such as a pelton wheel and/or francis turbine driving a generator or alternator. As it is anticipated that the major driving force for the piped water will be the difference in density between the water emanating from the seep and surrounding water, it is preferred that saline content of the surrounding water be at least 50% of the average salt content of the earth's oceans. Of course, the greater the difference in density, the greater pressure exerted per metre of depth on the emanating seep water.

Where the seep is located in an ocean, given the difference in density between fresh water and the saline water, the depth of the seep below the surface of the saline water should preferably be at least 15 metres.

Where there is more than one seep in a region, or where a single seep covers a large area, multiple cones or other collecting members may be used to collect water from the seep. Water from the multiple collecting members may be joined

9. The method according to claim 2 wherein the apparatus comprises at least one of a pelton wheel and a francis turbine.

10. The method according to any one of the preceding claims wherein the piped water is directed to storage after driving the apparatus.

11. The method according to claim 8 wherein at least one of rocks and gravel are used to cover the broader end of the collecting member whereby to hold it down.

12. A construction for generating electricity comprising,

a generally conical member, an offtake pipe from the conical member, and generating apparatus operable by water flow joined to the offtake pipe, wherein the conical member is secured with its broader end in communication with a seep located beneath external overlying water of an ocean, or a saline lake having a salt content at least 50% of the average salt content of the earth's oceans, and the depth of the seep is chosen to provide that the difference in density between seep water emanating from the seep and overlying water is sufficient to cause seep water to flow through the offtake pipe at a sufficient rate and pressure as to drive the electrical generating apparatus.

13. The construction according to claim 12 wherein the conical member and offtake pipe comprise a flexible membrane whose outer surface comprises a polymeric material.

14. The construction according to at least one of claims 12 and 13 wherein the electrical generating apparatus comprises at least one of a pelton wheel and a francis turbine.

15. The construction according to at least one of claims 12 and 13 wherein a plurality of battens are provided to stiffen the flexible membrane of the conical member.

16. The construction according to any one of the preceding claims wherein the conical member is suspended beneath the overlying water by float.

Brief Description of the Drawings

Figure 1 illustrates a schematic view of a construction according to the invention;

Figure 2 shows a schematic view of an arrangement for collecting water from a seep; Figures 3A, 3B and 3G show outlines of typical membrane shapes for collecting water from a seep;

Figure 4 shows a schematic view of more than one collection point for a seep; and

Figure 5 shows schematically steps taken in erecting a seep collection point. The various elements identified by numerals in the drawings are listed in the following integer list.

Integer List

1 Generating system

3 Conical collecting member

4 Base

5 Sea floor

6 Upper portion

7 Sloping floor

9 Shore

11 Float

12 Cable

13 Seep

15 Water flow

17 Surface

19 Relief valve

21 Join

23 Flexible pipe

25 Solid pipe

27 Electrical generator

29 Offtake pipe

31 Aggregate

33 Conical collecting member

35 Circular base

37 Apex

39 Batten

.40 Offtake water

41 Conical member

43 Square base

45 Offtake water 47 Collecting member

49 Offtake water

51 Multiple system

53 Conical member

54 Seep water

55 Flexible pipe

57 Flexible membrane

59 Pole

61 Float

63 Surface

65 Seep water flow

67 Weight

69 Wire

71 Weight

73 Wire

75 Relief valve

77 Cable

79 Offtake pipe

81 Pulley

Detailed Description of the Preferred Embodiments

Referring to Figure 1, there is shown a generating system for generating electricity which is indicated by the reference numeral 1.

The generating system 1 comprises a conical member 3 made of a flexible material such as polyethylene or polypropylene or even carbon fibre. It may be a woven or sheet material. If the flexible material is prone to be fouled by marine organisms, it is preferred that at least the outer surface of the flexible material be covered by an anti- fouling agent or a material which resists fouling such as polyethylene. The base 4 of the conical member 3 sits on the sea floor 5 and will be held down by appropriate means some of which are described hereinafter. The base 4 sits over a seep 13 from which there is a water flow 15. The upper portion 6 of the conical member 3 is provided with a join 21 connecting the narrower end of the conical member to a flexible pipe 23. The flexible pipe may be made of any material which may be sufficiently strong to resist the pressure of water inside the flexible pipe and it may also incorporate or be composed of a material which resists fouling by marine organisms. It may be formed of the same material as the material forming the conical member.

" . .

A float 11 joined by a cable 12 to a relief valve 19 provided at the top of the conical member holds the conical member upright at a level beneath the surface 17 of the sea. In this way, it is possible to maintain the top of the conical member at a depth below which it is not likely to be unduly disturbed by ocean waves.

A solid pipe 25 joined to the end of the flexible pipe 23 at a region where the flexible pipe abuts the sloping floor of the sea floor sits along the sloping floor and directs water flowing through the pipe to the shore 9. An electrical generator 27 sitting on the shore 9 is driven by water from the pipe 25. An offtake pipe 29 takes water exiting the electrical generator and returns it to the sea or pipes it for ongoing use such as irrigation or domestic use.

In Figure 2, it can be seen that the conical member 3 has its edges covered by an aggregate 31 to hold the conical member down on the sea floor in a manner that the water flow 15 from the seep is not in communication with the water of the sea. In such an arrangement, any pressure inherent in the water flow 15 is additive to the pressure derived from the difference in density between the water flow 15 and the sea water.

In Figure 3 A, it can be seen that the conical collecting member having a circular base 35 and an apex 37 is reinforced with battens 39. Offtake water 40 is bled off from near the apex of the conical collecting member 33 as per the description with reference to Figure 1.

In Figure 3B, the conical member 41 has a square base 43. It may also optionally be reinforced with battens and offtake water 45 is again taken near the apex of the conical member.

The collecting member 47 shown with reference to Figure 3C shows that a range of alternative shapes of collecting members may be used provided that offtake water 49 is taken from a high point along the collecting member and provided the cross-sectional area of the connection for taking the offtake water 49 is less than the cross-sectional area of the seep over which the collecting member is placed. This is to ensure that there is sufficient water flow and pressure to drive machinery which is piped from the seep. It is to be appreciated that all types of different shapes and sizes of collecting member may be used depending upon the particular dimensions of the seep, the depth of the water, topography and rate of water flow.

In this regard, referring to Figure 4, which shows a multiple system generally designated 51, it can be seen that two or more collecting members such as the two conical members 53 may be placed over one or more seeps providing seep water 54 and may be joined in series by flexible pipes 55 which can direct water from the seep to one or more locations. Whilst the illustration in Figure 4 shows two collecting members 53 in series, it is to be appreciated that, series, parallel and combination series/parallel systems may also be employed.

Referring to Figure 5, the illustration on the left hand of Figure 5 shows one of the first stages of deployment of a conical member over a seep water flow 65 prior to the conical member being fully erected. Initially, a flexible membrane 57 wrapped on a pole 59 is suspended beneath the ocean surface 63 by a float 61. The pole 59 is held down by a weight 71 and wires 13 secure the bottom of the(flexible membrane to a plurality of weights 67. The wires 73 extend under pulleys 81 and extend upwardly as wires 69 to one or more vessels on the surface 63 of the water during deployment. By pulling on wires 69, the flexible membrane is extended to the conical shape shown on the right side of the drawing of Figure 5. A cable 77 extends into and attaches to the relief valve. The float 61 suspends the top of the flexible membrane 57 at a predetermined depth and maintains it in a conical shape. Subsequently, the offtake pipe 79 may be fitted to the top of the conical member in the region of the pressure relief valve and aggregate may be placed over the edges of the bottom of the conical member to hold it on to the ocean floor. Whilst the above description includes the preferred embodiments of the invention, it is to be understood that many variations, alterations, modifications and/or additions may be introduced into the constructions and arrangements of parts previously described without departing from the essential features or the spirit or ambit of the invention.

It will be also understood that where the word "comprise", and variations such as "comprises" and "comprising", are used in this specification, unless the context requires otherwise such use is intended to imply the inclusion of a stated feature or features but is not to be taken as excluding the presence of other feature or features.

The reference to any prior art in this specification is not, and should not be taken as, an acknowledgment or any form of suggestion that such prior art forms part of the common general knowledge.

PATENT CITATIONS

Cited Patent	Filing date	Publication date	Applicant	Title
WO2012103591A1 *	3 Feb 2012	9 Aug 2012	Weswood Pty Ltd	Differential pressure energy generation
US7615882 *	25 Feb 2008	10 Nov 2009	William Riley	Utilizing aquifer pressure to generate electrical energy
US20110131994 *	4 Dec 2009	9 Jun 2011	General Electric Company	Economical and Sustainable Disposal of Zero Liquid Discharge Salt Byproduct
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* Cited by examiner

CLASSIFICATIONS

International Classification	F03B17/00, F03B13/00
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LEGAL EVENTS

Date	Code	Event	Description
23 Apr 2014	121	Ep: the epo has been informed by wipo that ep was designated in this application	**Ref document number:** 13834127 **Country of ref document:** EP **Kind code of ref document:** A1
25 Feb 2015	WWE	Wipo information: entry into national phase	**Ref document number:** 14423886 **Country of ref document:** US
2 Mar 2015	NENP	Non-entry into the national phase in:	**Ref country code:** DE
5 Mar 2015	ENP	Entry into the national phase in:	**Ref document number:** 2013308374 **Country of ref document:** AU **Date of ref document:** 20130815 **Kind code of ref document:** A
23 Sep 2015	122	Ep: pct application non-entry in european phase	**Ref document number:** 13834127 **Country of ref document:** EP **Kind code of ref document:** A1