NETZEROCHEM - FUTURE RESEARCH - PROGRESS REPORT.

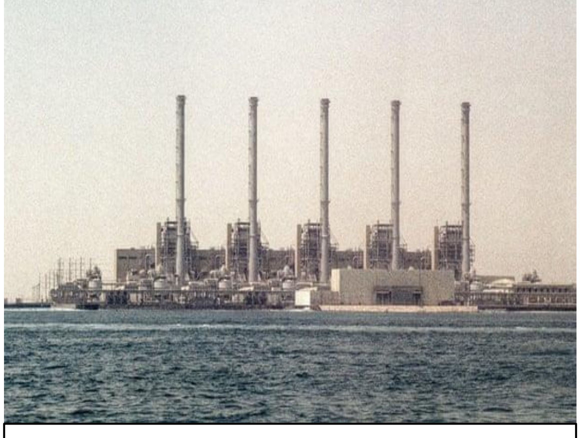
Research and Development labs are no different to any other consumer-facing business. To survive and prosper they must keep an eye on market trends and emerging problems that need to be solved. Since as our brand name suggests we are involved in the effort to transition society and its economy away from a 'no-zeros' one, casually polluting our planet, and move it towards 'net zero' we are always looking for profitable ways to undo the damage new technologies cause.

We have already produced a system for the green and profitable production of hydrogen and important chemicals from the most unloved kinds of scrap metal, and now we are turning our experimental work towards a profitable and practical solution for the problem of 'peak salt', the damage being caused by desalination plants all over the world. Beyond this we are being encouraged by some very well-known physicists to develop some early experiments into what we call 'AF' – accessible (nuclear) fusion, also called LENR or cold fusion. But that is yet to begin, for now we are sticking mostly with 'BC' – benign chemistry to help build a better world.

PROJECT 2.0 - PEAK SALT IS COMING – AND IT'S KILLING THE FISH.

Desalinated seawater accounts for a worldwide fresh water production of 7Bn tonnes/year. The main locus of desalination plants is the Arabian Gulf, but other regions are catching up, for example the Mediterranean coast, Red Sea, California coast, Chile, China, India, Africa and Australia. The Gulf States are the among the world's driest, and are building desalination plants because they have growing populations and an expanding industrial base, all of which puts a huge strain on freshwater resources. The mighty Tigris-Euphrates-Shatt Al-Arab river complex once met this demand, but these rivers pass through many countries who have constructed dams and irrigation projects that reduce flow into the Gulf. This problem is not helped by the fact that the Gulf has little connection to the high seas and suffers very high solar evaporation rates.

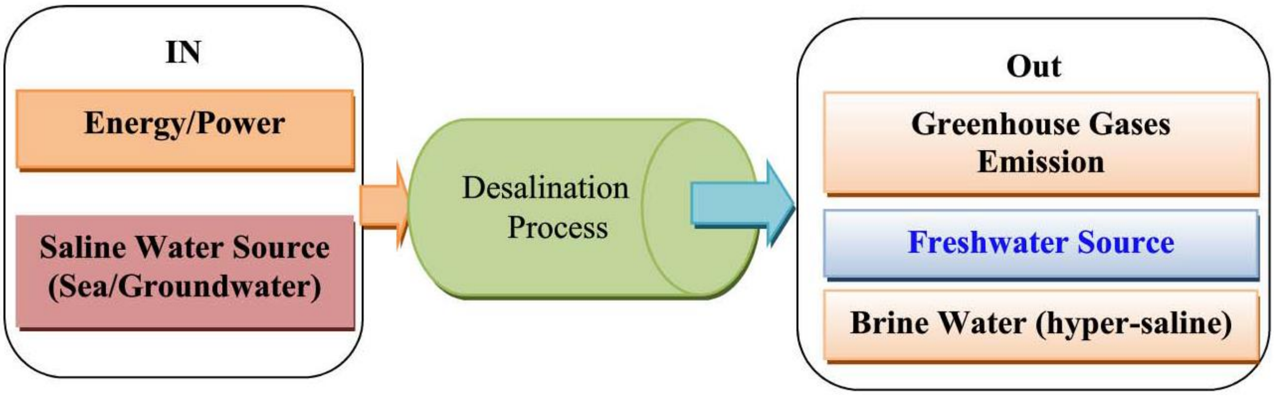
All this has created the 'peak salt' problem, since the more fresh water is extracted by desalination, the more hyper-salty brine is dumped back into the sea. As the Gulf becomes saltier, desalination becomes more difficult and costly until you reach a point where sea-water becomes so saline it is too expensive to desalinate. Adding around 70 million tonnes of super-strength brine from desalination every day has already made Gulf 25% saltier than the Atlantic, a figure which is increases by 1% every year. The discharge of this concentrated brine, containing 40-50 kgs of salt per tonne into coastal waters is causing environmental problems which are particularly noticeable in the Gulf and along the Pacific coast of Chile. The destruction of shellfish beds and loss of once common fish species caused by blanketing the seabed with dense brine are only the first signs of a growing problem as rising demand for water makes desalination a vital part of many economies.

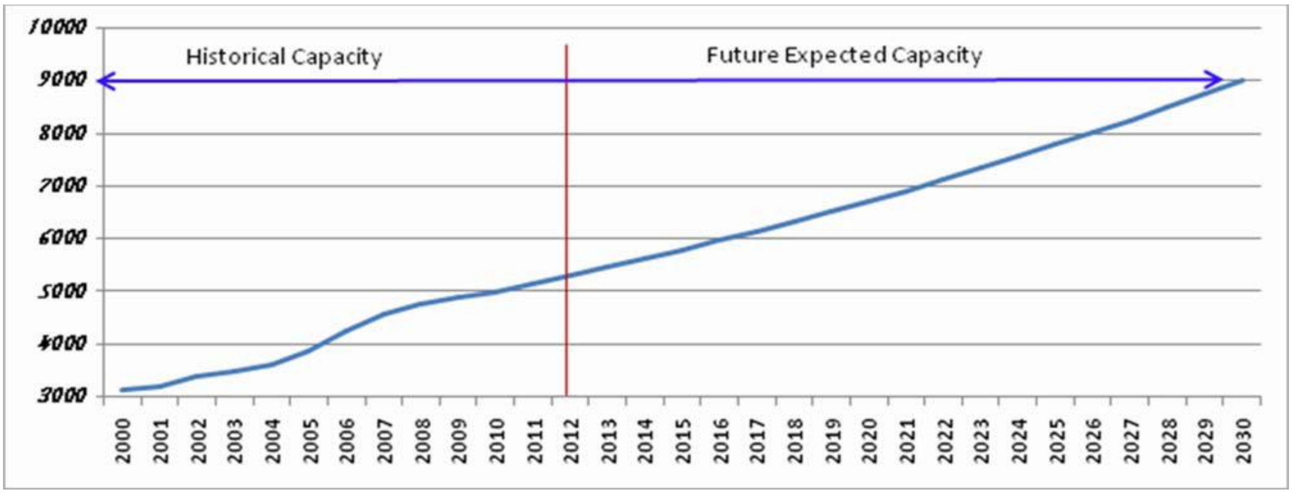


DESALINATION PLANT IN SAUDI ARABIA.

MORE BAD NEWS

The fresh water production industry is the second largest emitter of CO2 and other pollutants (mainly related to energy generation) in the Gulf States according to an paper in the International Journal of Environment and Sustainability | Vol. 1 No. 3, pp. 22-37. Such a 'double-trouble'





With groundwater sources either exhausted or non-existent and climate change bringing higher temperatures and less rainfall, Gulf states plan to nearly double the amount of desalination by 2030 (doc). This is bad news for marine life and for the cost of producing drinking water – unless something can be done about the brine.
Farid Benyahia, a chemical engineer at Qatar University, believes he has a solution. He recently patented a process that could eliminate the need for brine disposal by nearly 100%. The process uses pure carbon dioxide (emitted during the desalination process by burning fossil fuels for power) and ammonia to turn brine into baking soda and calcium chloride. Whether the process is cost-effective remains to be seen but Benyahia believes it could be, especially if markets are found for large volumes of the end products.

Other efforts are also under way to reduce desalination’s country-sized carbon footprint which globally accounts for 76m tonnes of carbon dioxide per year – nearly equivalent to Romania’s emissions in 2014.
The Global Clean Water Desalination Alliance was formed in 2015 to tackle this problem by increasing efficiencies and shifting to renewable energy sources, such as solar-powered desalination. Saudi Arabia expects to have a commercial-scale plant operational by 2017 and in California, a proposed solar-powered desalination plant combines innovation, efficiency and design.
Water pricing, says Günel, is also becoming critical to improving water efficiency in the Gulf.

“Climate change policymakers in the region are pushing for water pricing and awareness campaigns around consumption to explain to governments and citizens that they can’t continue to use water in the same way.”

This novel combination of established chemical processes is designed to solve in particular and in an innovative and profitable way the environmental problems caused by the discharge back into the sea of concentrated brine from desalination systems.

These desalination systems using reverse osmosis systems or evaporation/condensation are coming into widespread use in arid regions of the world. They may be used in coastal areas to process seawater on the spot, or further inland to desalinate ground water, which may be only slightly salty. Modern ocean-side plants are generally what is called ‘double pass’ osmotic desalinators, where the water is passed twice through special membrane systems to separate some of the brine into salt-free and strongly salty fractions, whereas lightly salty water requires only ‘single pass’ systems.

All of these methods share a common problem, which is that the rejected fraction of the intake water needs to be disposed of. In some locations, regrettably few, this concentrated brine may be pumped into salt-pans where the water evaporates allowing salt to be collected and traded on the market, but the usual practice is to return it to the source aquifer or to the sea

expanding economies.

THE METHOD.

There is no alchemy involved in the method we are developing, it is a novel combination of proven electrochemical methods already used in industry, plus some new insights and methods gained from the recent dynamically expanding field of battery technology. The whole process is currently the subject of a patent application.

We use the hyper-saline brine discharged from a desalination system, which may contain as much as 50 kilos of salt per ton of water and load it into a novel form of split-cell reactor with inexpensive electrodes where it is transformed into new commercially useful solid chemicals plus heat, hydrogen and electricity. Apart from the brine other inputs are carbon dioxide from the atmosphere or from generator exhaust and a modest percentage of another waste-derived – thus green- solid material the nature of which is proprietary. Every ton of this solid material input plus the brine and 2 tonnes of CO_2 yields 10 tonnes of saleable chemicals plus over a total output of over 7MW/h of mixed hydrogen energy, direct electrical energy, and process heat. All of this can be used to evaporate water from the chemical products, and this fresh water can be captured and returned to the input of the desalinator to reduce the salinity of the input and thus increase its efficiency . taken together the cost of the inputs for this system are less than 10% of the value of the outputs, plus it offers desalination companies the opportunity of becoming the first suppliers of ‘low to no’ carbon green chemicals to a combined market worth over $20Bn/year. Currently these chemicals are themselves made by polluting and energy-intensive processes, which create CO_2 and habitat destruction.

RELEVANT PAPERS ETC

MIT article paper on their brine treatment system.

https://news.mit.edu/2019/brine-desalianation-waste-sodium-hydroxide-0213

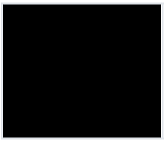
http://eeer.org/upload/eer-1462954096.pdf -relevant paper.

https://uwaterloo.ca/chem13-news-magazine/december-2013-january-2014/feature/chemistry-using-minimum-cost-resources-part-1

Chile seawater desalination to grow 156%

Chile seawater desalination to grow 156%

Peak salt: is the desalination dream over for the Gulf states?



Peak salt: is the desalination dream ov...

ARTICLE...

Scientists have developed a new device that can absorb CO_2 and produce electricity and hydrogen fuelIf we're going to reach the goal of keeping Earth from warming more than 1.5° C (2.7° F) this century, it's not enough to just reduce our carbon dioxide emissions – we need to actively clean it out of the atmosphere too. Inspired by the ocean's role as a natural carbon sink, researchers at Ulsan National Institute of Science and Technology (UNIST) and Georgia Tech have developed a new system that absorbs CO_2 and produces electricity and useable hydrogen fuel.

The new device, which the team calls a Hybrid Na-CO_2 System, is basically a big liquid battery. A sodium metal anode is placed in an organic electrolyte, while the cathode is contained in an aqueous solution. The two liquids are separated by a sodium Super Ionic Conductor (NASICON) membrane.

When CO_2 is injected into the aqueous electrolyte, it reacts with the cathode, turning the solution more acidic, which in turn generates electricity and creates hydrogen. In tests, the team reported a CO_2 conversion efficiency of 50 percent, and the system was stable enough to run for over 1,000 hours without causing any damage to the electrodes. Unlike other designs, it doesn't release any CO_2 as a gas during normal operation – instead, the remaining half of the CO_2 was recovered from the electrolyte as plain old baking soda.

"Carbon capture, utilization, and sequestration (CCUS) technologies have recently received a great deal of attention for providing a pathway in dealing with global climate change," says Professor Guntae Kim, lead researcher on the study. "The key to that technology is the easy conversion of chemically stable CO_2 molecules to other materials. Our new system has solved this problem with CO_2 dissolution mechanism."

This Hybrid Na-CO_2 System is far from the only carbon capture system out there, but it remains to be seen whether these technologies can ever become practical enough at large scales to have much of an impact. Climeworks' direct air capture system is one of the most promising at the moment, but when it only removes 150 tons of CO_2 a year (compared to the 40 billion tons released into the atmosphere annually) it feels like bailing a sinking ship with a plastic cup.

But, the team says, there's still room for improvement with every component of the new design. And the icing on the cake could be the system's ability to also produce renewable electricity and hydrogen fuel, which could be used to power hydrogen cars.

https://www.sciencedirect.com/science/article/pii/S258900421830186X?via%3Dihub

Environmental Impacts of Seawater Desalination:2012
Arabian Gulf Case Study

Mohamed A. Dawoud1* and Mohamed M. Al Mulla2
1 Water Resources Department, Environment Agency, Abu Dhabi, United Arab Emirates
2Ministry of Environment and Water, Dubai, United Arab Emirates