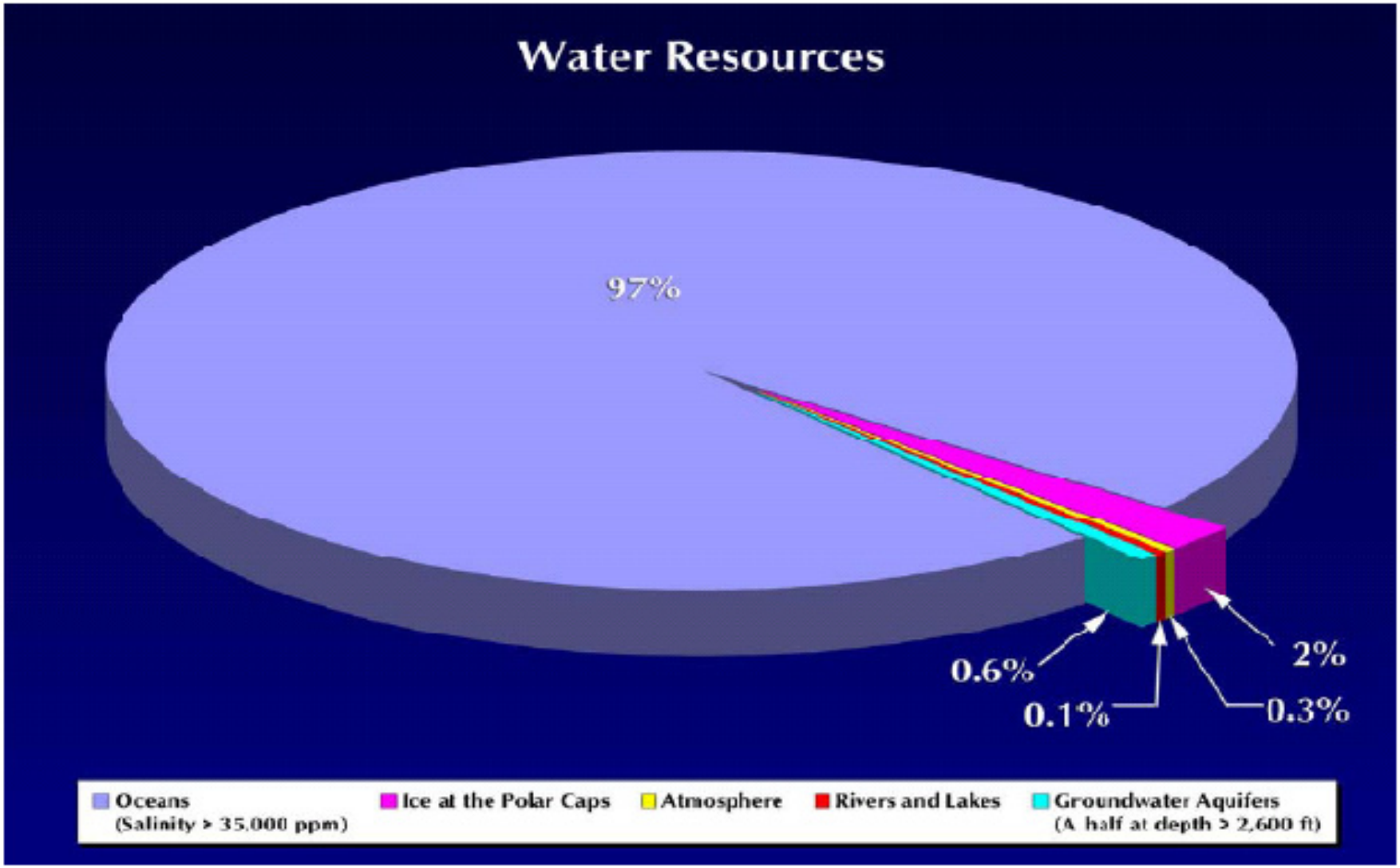
Desalination

New Possibilities With LENR

Disclaimer

- William Donavan and Roger Green are not employed by Andrea Rossi or Leonardo Corporation.
- Independent Investigators and Researchers on Alternative Energies and Propulsion.
- Provide Consulting Services on Energy and Propulsion.
- William Donavan is Chief Technical Advisor for Ecat.tech
- See Roger Green for Contact Information



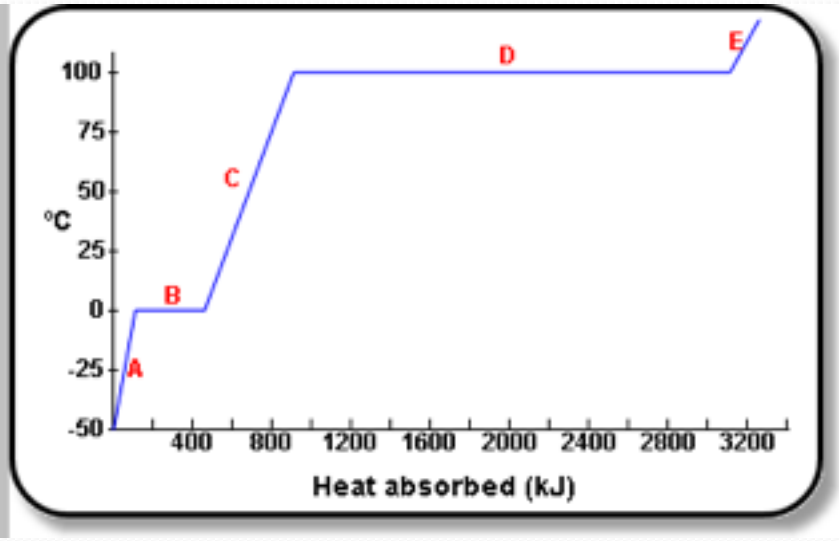
- 97% Of All Available Water is in Earth's Oceans

Problems With Conventional Processes - Distillation

- Energy Intensive
- Essentially Large Boilers

Problems With Conventional Processes – Distillation

- Biggest Problem – Heat of Vaporization
- Next Problem – Heat Loss to Environment
- Usually Uses Petroleum Products for Heating



The diagram on the left shows the uptake of heat by 1 kg of water, as it passes from ice at -50 °C to steam at temperatures above 100 °C, affects the temperature of the sample.

E: Steam absorbs heat and thus increases its temperature.

D: Water boils and absorbs latent heat of vaporization.

C: Rise in temperature as liquid water absorbs heat.

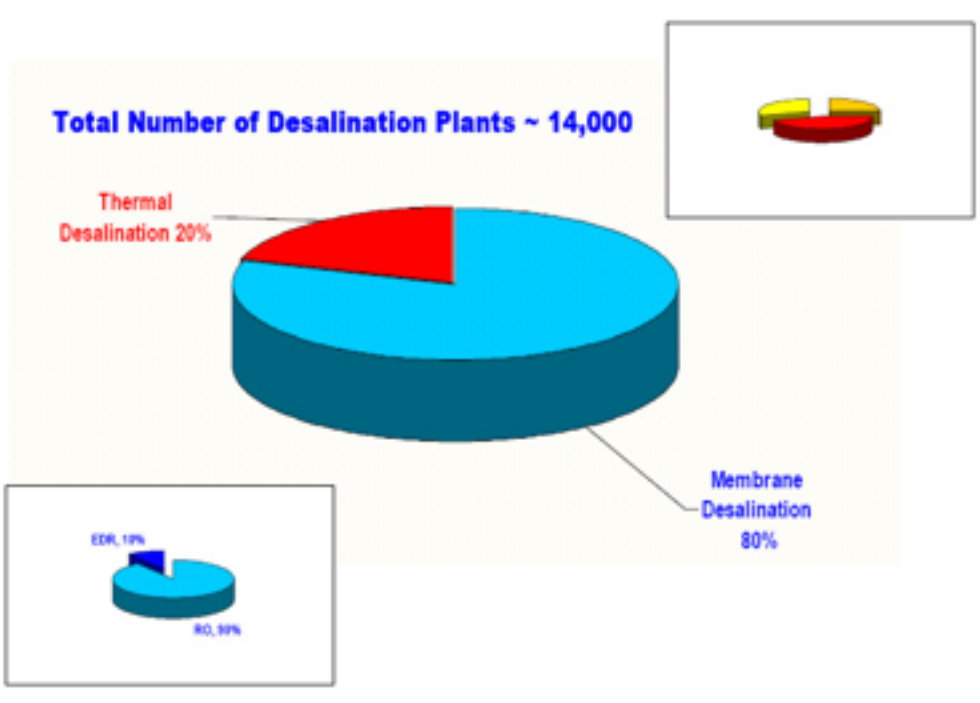
B: Absorption of latent heat of fusion.

A: Rise in temperature as ice absorbs heat.

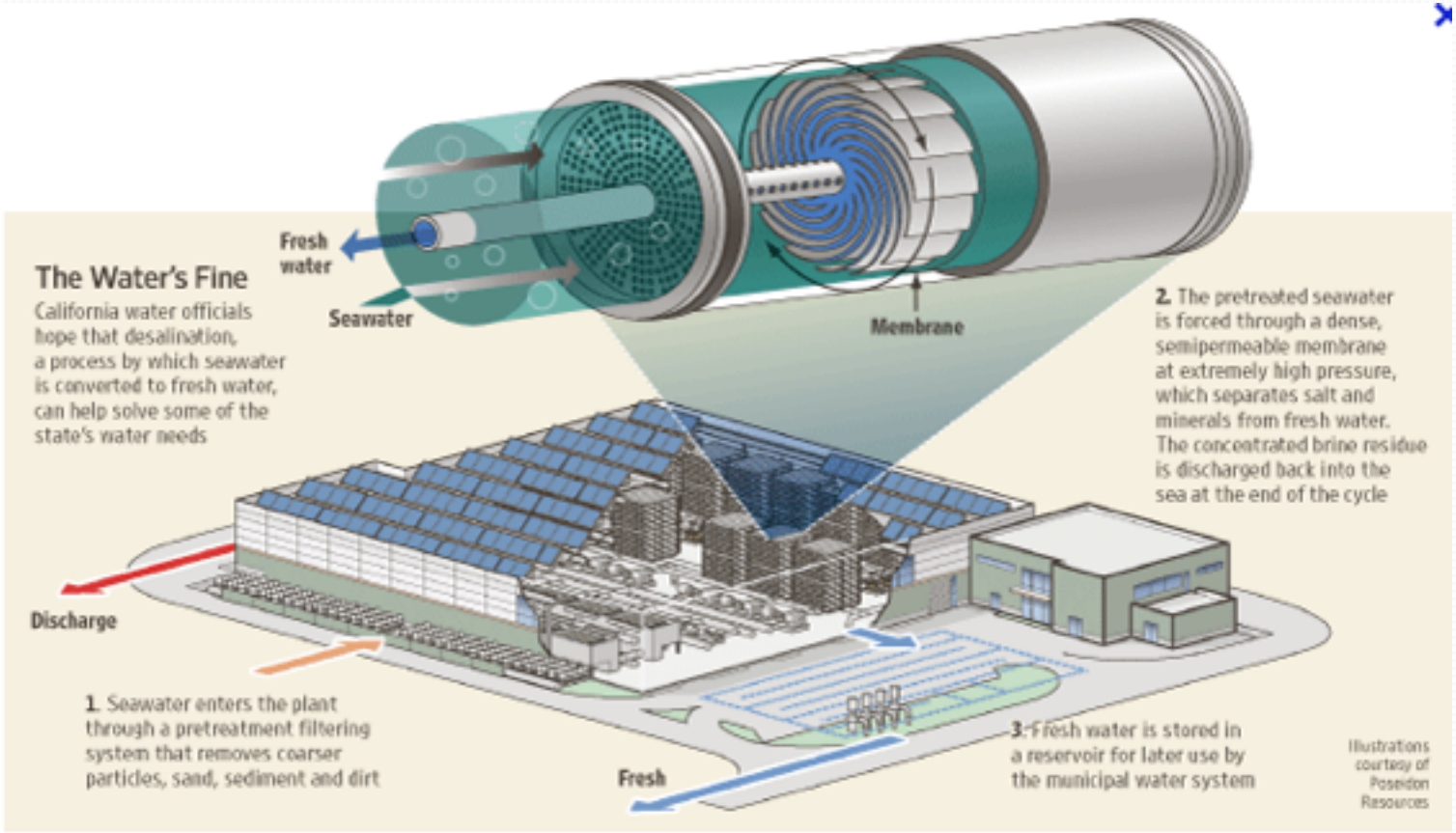
from-http://www.physchem.co.za/Heat/Latent.htm

Problems With Conventional Processes – Reverse Osmosis

- Inefficient – Wastes Substantial Amounts of Water
- Energy Intensive
- Needs Large Pumps
- Maintenance Intensive
- Most Popular Method of Desalination



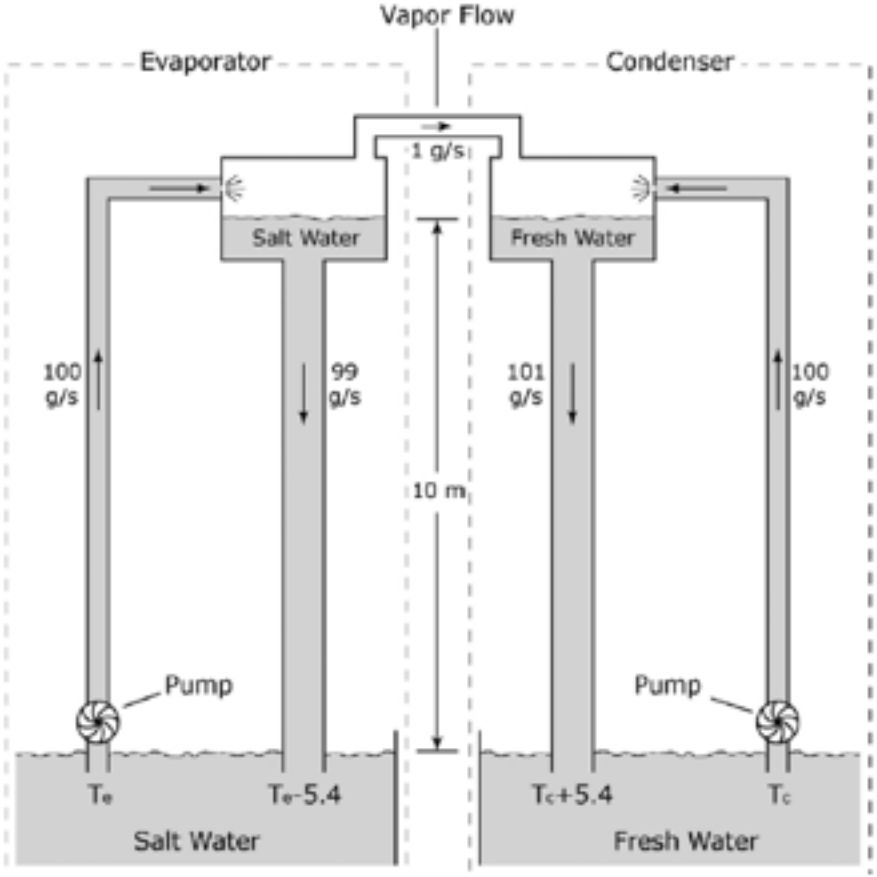
Solutions – Reverse Osmosis With LENR



- Combine Power Plant with Desalination
- Energy Intensive, but also Energy PRODUCER!
- Pumps Coupled to Reactor

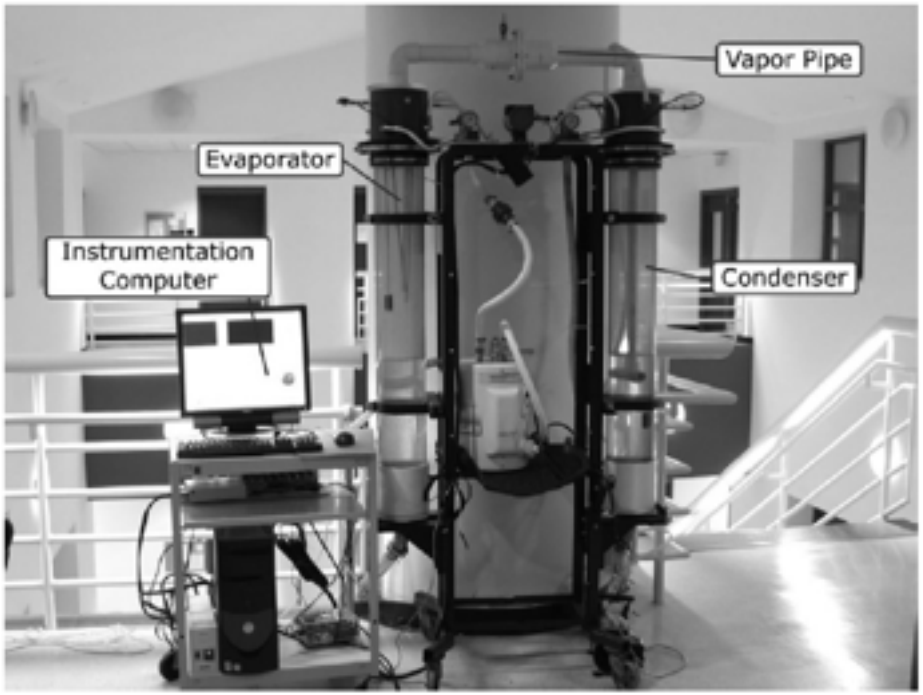
Solutions- Low Pressure Distillation

- Uses Low Boiling Points – 30 Deg. C or Less.
- Not Energy Intensive.
- No Large Pumps.
- Low Tech – No Exotic Materials Needed.
- Several Studies Done Over Years.
- 40% More Efficient Than Reverse Osmosis.



Solutions- Low Pressure Distillation

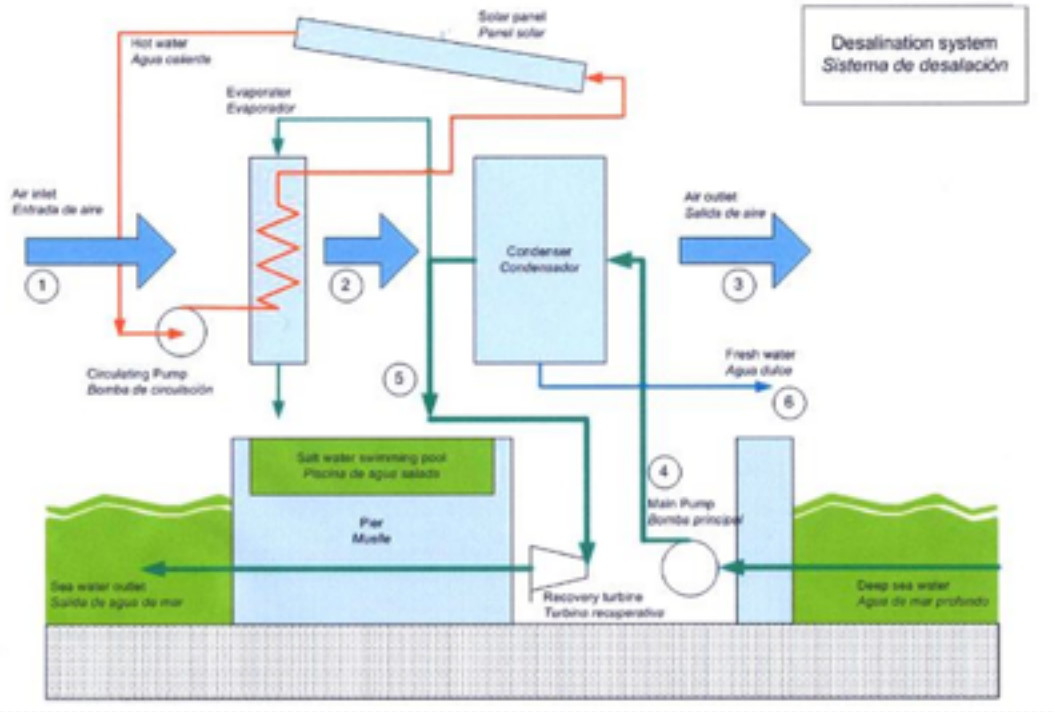
- Solar Energy Only Available During Day.
- Process Heating Required For 24/7 Operation.
- What Type Can Be Used?
- Petroleum Derived?
- Or LENR?



Fourth floor portion of the proof of concept. Hoses extend down 10 m to reservoirs on the 2nd floor. From B.A. Moore et al/ Desalination 220 (2008) 502-505

Solutions- LENR Assisted

- 24/7 Operation
- Co-generation with Small-scale Power Plant.
- Condensate is Potable.
- Both Hot and Cold Water Possible.
- Storage Tank is Allowed to Cool for "Cold" Water.



Solar Desal System. Process Heating Can be Employed For 24/7 Operation

Solutions- LENR Assisted

- Many Third-World Countries Need Power as Well as Fresh Water.
- High-Efficiency Turbines Needed
- Tesla Turbines?
- Tesla Turbines, Due to "Boundary Layer" Effect, Will Not Chemically Interact with Working Fluid.

Image courtesy of Innovation Projects Engineering LLC

Solutions- LENR Assisted

- Open Cycle System.
- Low Maintenance.
- Modular Boiler Design.
- Little Operator Intervention.

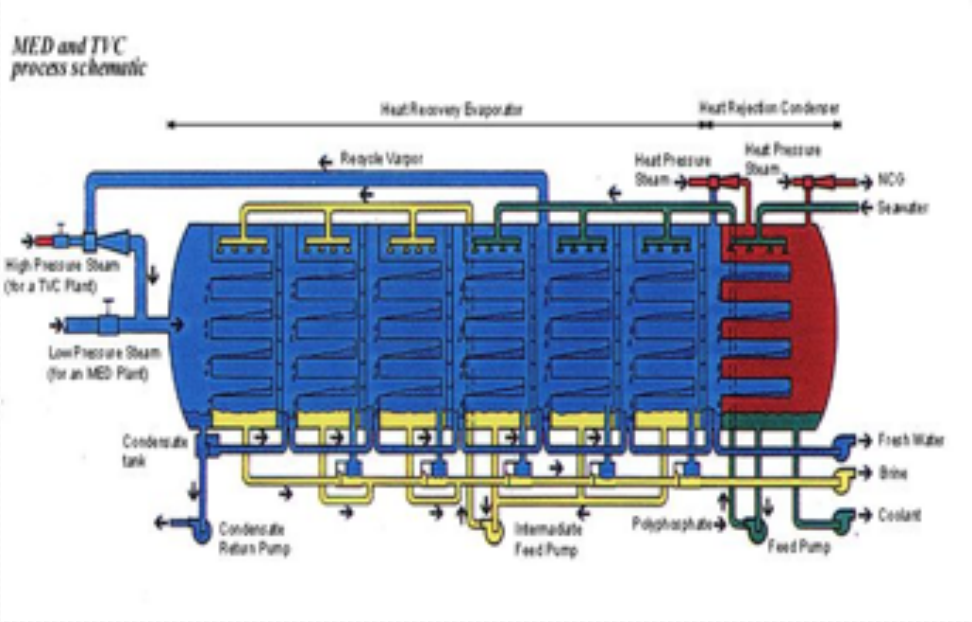
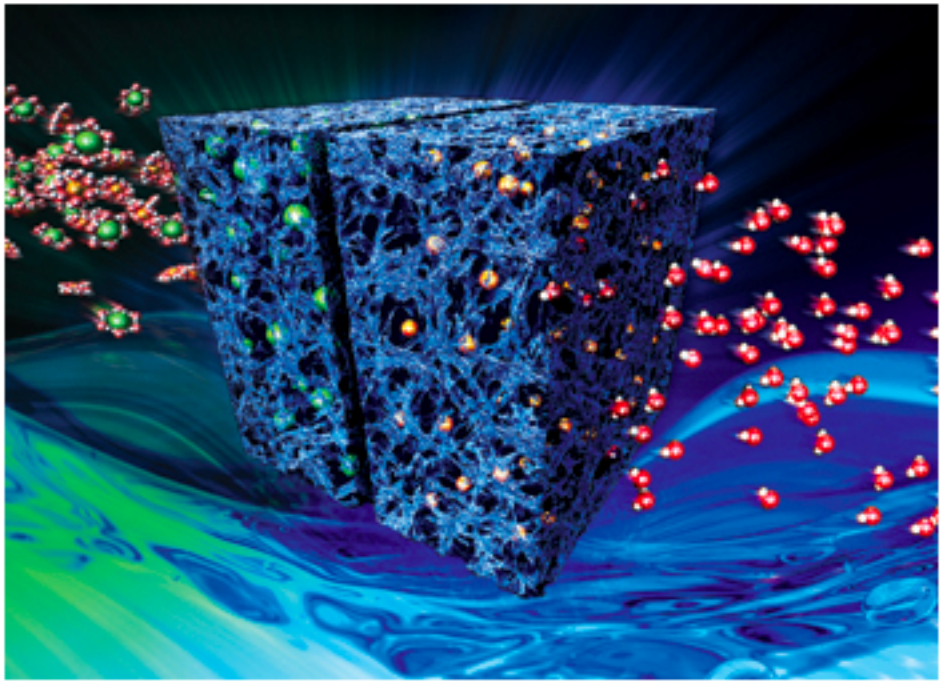


Image courtesy of Innovation Projects Engineering LLC

On The Horizon…

Capacitive Desalination

- Called "Flow-Through Electrode Capacitive Desalination" (FTE CD).
- More Efficient Than Reverse Osmosis.
- Energy Recovery is Through Solid State Circuit.
- Works in Single Pass.
- Operates at Low Pressures and Temperatures (Unlike RO).
- Research Appears in Issue 10 of Energy & Environmental Science.



Flow-through electrode capacitive desalination uses a new hierarchical porous carbon material to create a new device geometry in which the feed stream passes directly through the electrodes, resulting in significant improvements to salt removal and desalination rate.

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On The Horizon…

Water Desalination Via Graphene

- From MIT Researchers Grossman and David Cohen-Tanugi.
- More Efficient Than Reverse Osmosis.
- More Durable Than RO.
- Works in Single Pass.
- Operates at Low Pressures and Temperatures (Unlike RO).
- Pound For Pound, Strongest Material Known.

The key to the new process is very precise control over the size of the holes in the graphene sheet. "There's a sweet spot, but it's very small," Grossman says — between pores so large that salt could pass through and ones so small that water molecules would be blocked. The ideal size is just about one nanometer, or one billionth of a meter, he says. If the holes are just a bit smaller — 0.7 nanometers — the water won't flow through at all.

On The Horizon…

Water Desalination Via Porous Carbon Electrodes

- From Maarten Biesheuvel at Wageningen University in the Netherlands.
- Also More Efficient Than Reverse Osmosis.
- Can Work Continuously or in Batch Mode.
- Low Voltage Needed- 1.2VDC.
- Works With Moderately Brackish Water.
- Low Tech.

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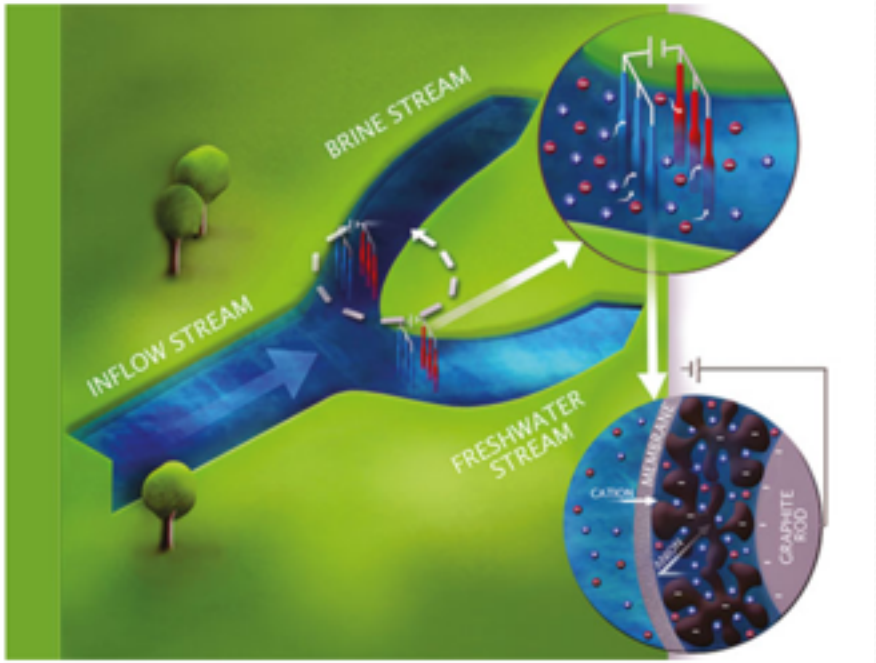
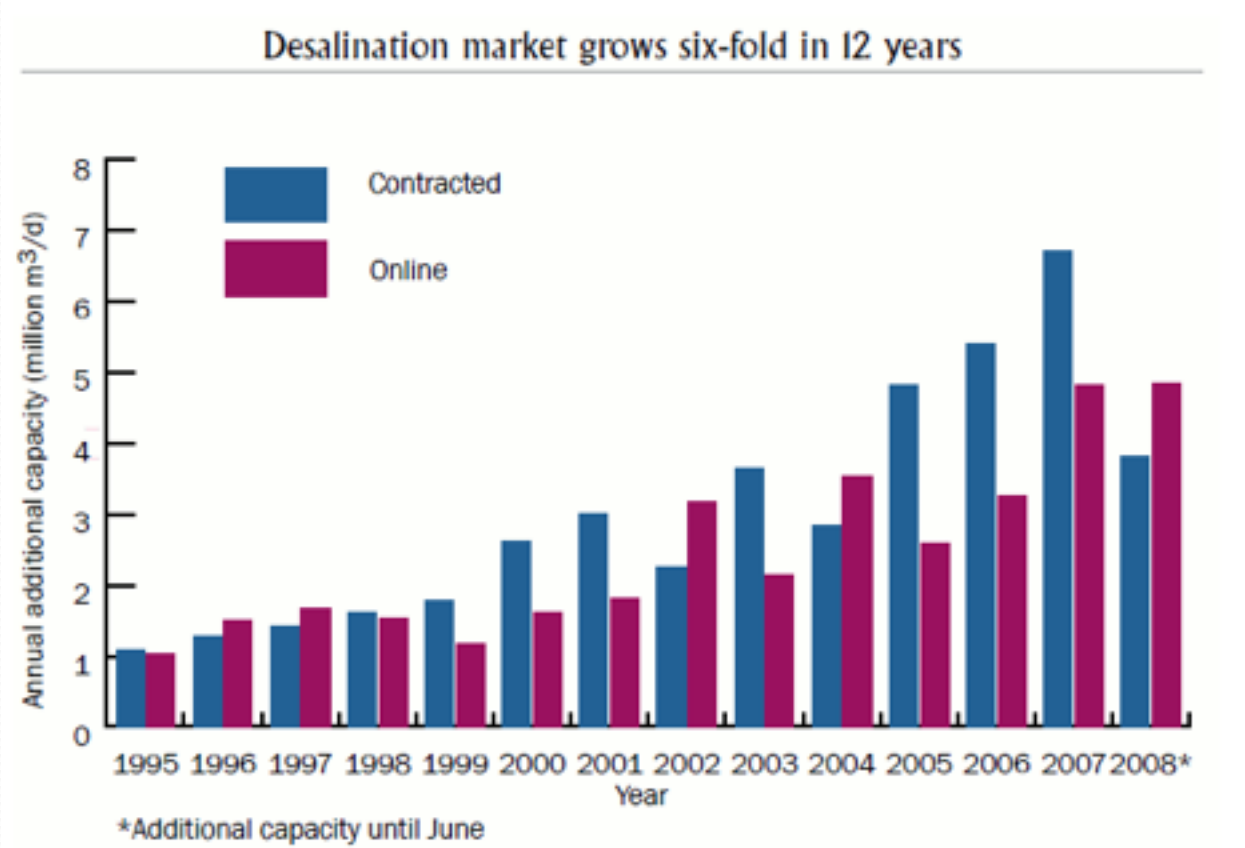


Porous carbon electrodes can be used to desalinate water

REFERENCES

1. S Porada et al, J. Phys. Chem. Lett., 2012, 3, 1613 (DOI: 10.1021/jz3005514)

Markets – LENR Assisted Desal.



This month's chart comes from the new edition of the IDA Desalination Yearbook 2008/9.

Markets – LENR Assisted Desal.

Desal's market Outlook

In a webinar held last week, GWI publisher Christopher Gasson presented a look ahead to, and a look back at, the global desalination market. Based on information gathered for DesalData, GWI's business development and consultancy package, Gasson predicted that the global desal market will add 6.4 million m3/d (1,690 MGD) of contracted capacity, valued at $9 billion, during 2012. These amounts include both brackish and seawater desal.

Markets – LENR Assisted Desal.

However, the desal market appears to be gradually recovering from its double-dip recession. Indicators include:

- GWI has identified 45 projects that should be contracted in 2012
- the Gulf region slowly being revived with oil prices over $100/bbl
- desal's growth in Algeria and Morocco moves ahead
- China's current Five-Year Plan for desal has been revised upward
- the search for unconventional oil requires desal technologies
- new brine management technologies will spur growth
- mining project growth in Australia and South America requires desal
- Texas is set to increase BWRO growth
- oil refining is relocating to upstream countries, BRICs
- industrial reuse growth to increase

Despite the slowdown over the past four years, the next four years look promising. If there are no surprises and the market continues to evolve, equipment sales for 2016 could surpass $18 billion.

GWI Desalination.com
Where everything desal comes together

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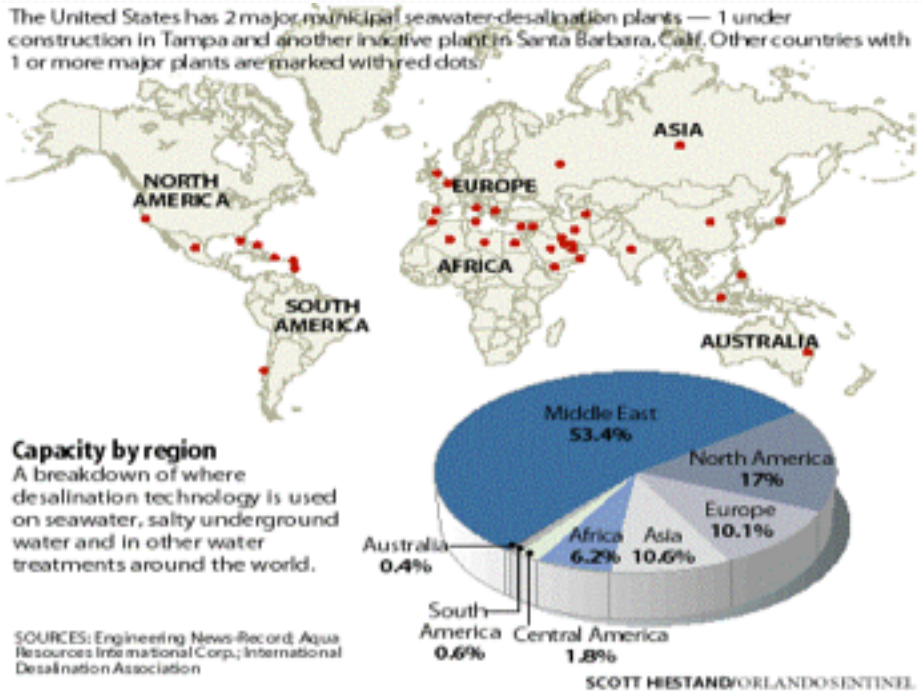
Related countries:
Global

Markets – LENR Assisted Desal.

- 18 Billion Dollars of Equipment by 2016
- Substantial Fraction of This Amount Will be Process Heating Equipment and/or On-Site Power Generation for Desal Plants!
- Oil Industry is Looking for Water Recycling For Remediation on Fracking Operations – Equal Amount of Expenditure!

Major Desalination Plants World Wide



Conclusion

- The Desalination Industry Has a Combination of Mature as Well as Developing Technology that Can Use LENR as a “Good Fit” or Symbiotic Relationship.
- It is a “Green” Technology that is Politically Acceptable to the Environmental Community.
- Co-Generation is Possible For Integration Into Power Plants.
- Billions are to be Made in Future Profits!
- Our R&D Ecat/Desalination project is ready to build