

INTRODUCTION TO TECHNICAL SECTIONS

There is a strong need for fresh water, especially where much of the fresh water supply is being consumed by such vital industries as fracking, mining and agriculture.

The conventional approach is to use Reverse Osmosis (R.O.) wherever possible. However, with the advent of freeze crystallization (F.C.) research and commercialization of F.C. by the Dutch company NIRO, new opportunities have arisen and investigated. For example, the use of R.O. followed by the use of F.C. on the output of the R.O. wastewater stream produced higher purity wastewater at lower capital cost and lower operating cost.

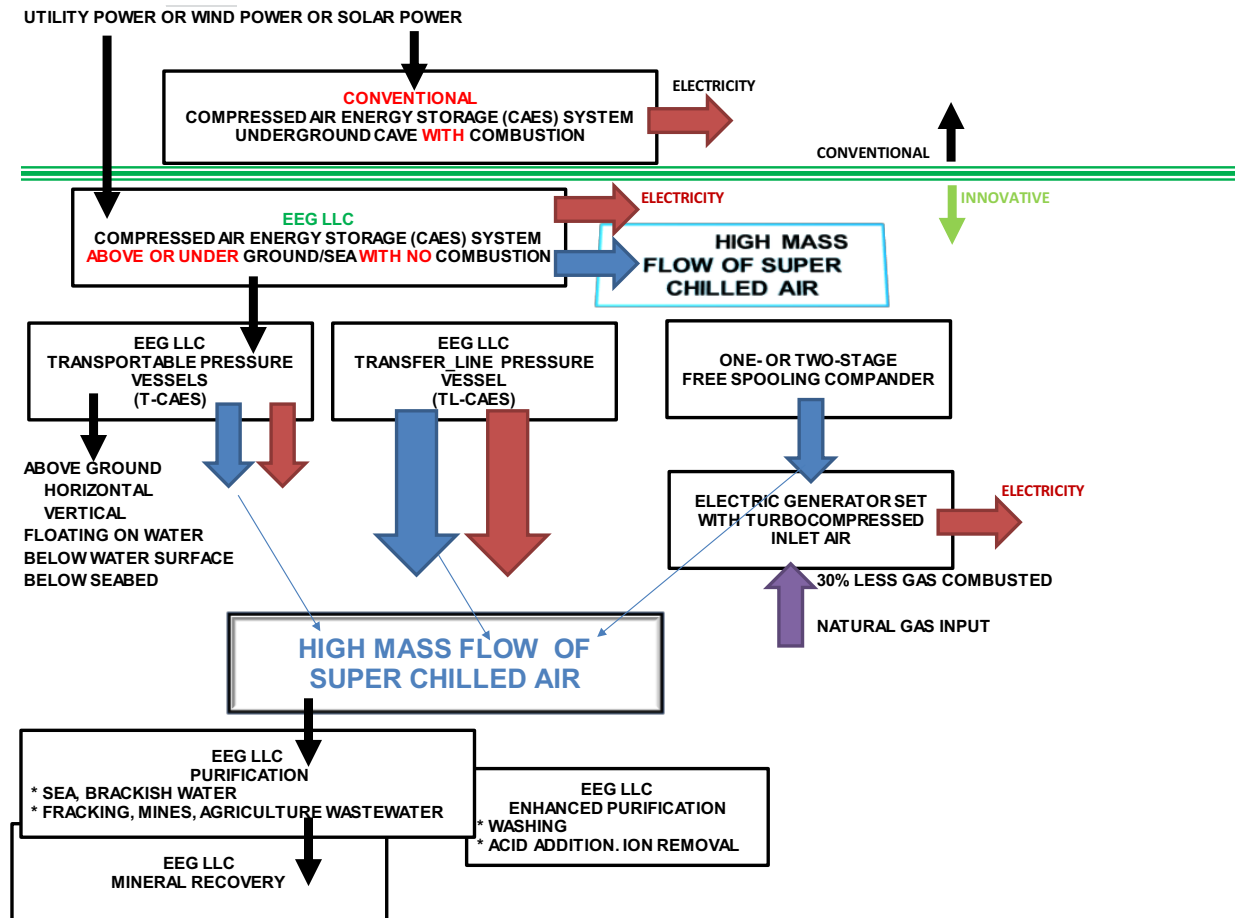
NIRO uses conventional refrigeration systems with all of its precision machined mechanical components to take more than 90 minutes to freeze bulk vats of wastewater and have demonstrated its lower use of electrical power for a given stream of wastewater.

The following diagram shows how the individual EEG LLC water purification systems are inter-related. When you press anyone of the three individual buttons you will be led to a more detailed description.

1. High mass flow of super-chilled air from one-stage, free-spooling compressors to generate a high mass of super-chilled air for small-size flows of wastewater, or
2. High mass flow of super-chilled air from two-stage, free-spooling compressors to generate a high mass of super super-chilled air for medium-size flows of wastewater. Or
3. High mass flow of super-chilled air from two-stage turboexpander/generator set of the EEG LLC TL-CAES system for large-size flows of wastewater...as well as generating electricity from a green energy source (wind farms, solar photovoltaic panel farms, etc)

The above three systems require an additional laboratory capability involving three desk-top size facilities to expand the purification process to treat not only simple solutes but also complex solutes and toxic solutes. This support capability is given as button 4.

The following drawing shows the overview of the EEG LLC water purification systems in abbreviated form.



The compander is a proven commercial system and the EEG LLC T-CAES system (that does not burn fuel) has been demonstrated at the field laboratory of National Technical Systems located in Santa Clarita, CA.

The innovative approach is to replace the huge footprint, tall array and massive hardware associated with bulk freezing with a simple spray of the waste water into a chamber that starts freezing the droplets at -175°F at the top of the chamber. After each room temperature droplet falls vertically down the chamber and is chilled to -6°F at the bottom of the chamber, it accumulates in a porous snow mass at the bottom of the chamber. As the porous snow mass accumulates in height, it drains the high concentration of brine from the surface of each droplet. The thawed porous snow mass is thawed and supplies high purity water. This chamber and sprayer has a small footprint, light weight, portable and has small capital investment.

The investor requires more patience before recovering the initial investment. But once the first system is fielded there will be a large return on investment.

Variations on this design will not only handle saltwater and brackish water but also can be designed to treat wastewater from fracking, mining and agriculture run-off.

The following chart shows that during the initial stages of development of the spray chamber we make use of vaporized liquid nitrogen at -320°F for

- (1) Full Scale Freeze Crystallization Spray Chamber and then
- (2) Three desk-top FCSC chambers... heavily instrumented

Once we have the design parameters studied using liquid nitrogen vapors we switch to the high mass flow of super-chilled air at -175°F . For wastewater with small flows we will use a one-stage compander.

For wastewater with medium flows we will use a two-stage compander.

For wastewater with large flows or with large ponds we will use a two-stage turboexpander/generator set associated with a wind turbine or solar photovoltaic farm driving a TL-CAES system with its available huge volume of super-chilled air.

	IMMEDIATE UNLV	LATER UNLV	FOLLOW-ON FOR UNLV		
SCENARIO	DEVELOPMENT	RESEARCH	COMMERCIAL	COMMERCIAL	COMMERCIAL
WASTEWATER	10 TO 20% NaCl	COMPLEX SOLUTE SMALL CONCENTRATION	SMALL STREAM	MEDIUM STREAM	LARGE STREAM OR POND
COLD GAS	LIQUID NITROGEN	LIQUID NITROGEN	AIR	AIR	AIR
DRIVER (S)	VAPORIZER	VAPORIZER	NATURAL GAS (NG)/GEN_SET	NATURAL GAS (NG)/GEN_SET	WIND TURBINE
HARDWARE			SMALL AIR COMPRESSOR ONE-STAGE , FREE SPOOLING COMPANDER FCSC CHAMBER	MEDIUM AIR COMPRESSOR TWO-STAGE , FREE SPOOLING COMPANDER FCSC CHAMBER	TL-CAES SYSTEM LARGE AIR COMPRESSOR TWO-STAGE , FREE SPOOLING COMPANDER FCSC CHAMBER
SCALE	FULL	DESK TOP	FULL	FULL	FULL
PURIFICATION FACILITY	SPRAY CHAMBER	SINGLE DROP CHAMBER #1 SPRAY CHAMBER #2 DRAINAGE CHAMBER #3	SPRAY CHAMBER	SPRAY CHAMBER	SPRAY CHAMBER
OUTPUT	DEMONSTRATION OF PURIFICATION EFFICIENCY FOR SIMPLE SOLUTE	DEMONSTRATION OF PURIFICATION EFFICIENCY FOR COMPLEX SOLUTE	DEMONSTRATION OF ICE PARTICLE REMOVAL FROM COLD AIR INPUT TO GEN_SET AIR TURBINE COMPRESSOR	DEMONSTRATION OF ICE PARTICLE REMOVAL FROM SUPER-CHILLED AIR INPUT TO GEN_SET AIR TURBINE COMPRESSOR	
END RESULTS	MANUFACTURING AND SALES OF FCSC FACILITIES	DESIGN CHANGES FOR COMMERCIAL SPRAY CHAMBER	PURIFIED WATER 30% REDUCED NG CONSUMPTION	PURIFIED WATER 30% REDUCED NG CONSUMPTION	ELECTRICITY PURIFIED WATER
INNOVATION FOR ENERGY STORAGE COMMUNITY					ELIMINATION OF HIGH VOLTAGE POWER LINES ENERGY STORAGE WITH NO BATTERIES HVAC OR COLD STORAGE FACILITY