



# Turbomachinery-Based Engine: Concurrent Production of Power, Cooling and Desalinated Water

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# Human Being Life Quality Is Influenced by

ELECTRICITY



COOLING



WATER





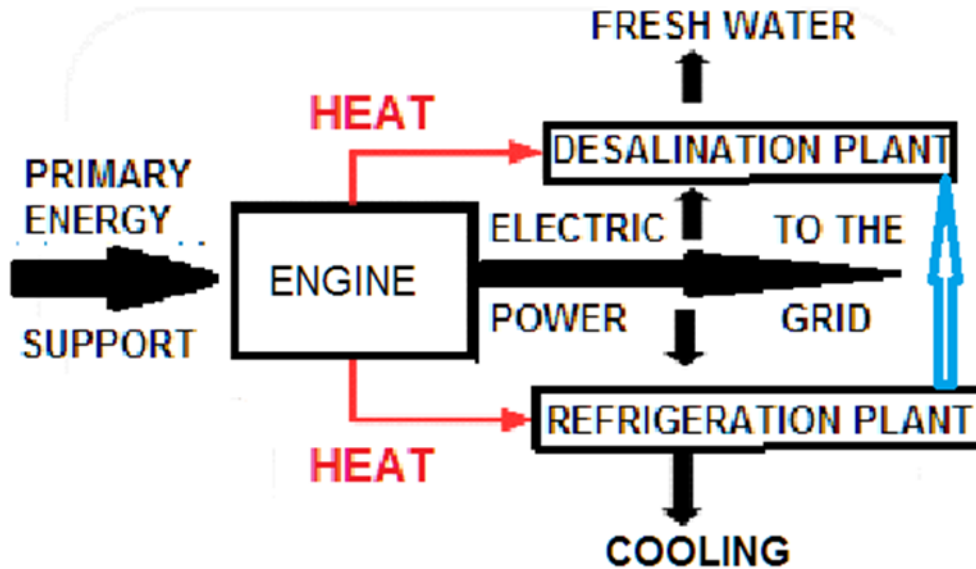
# Human Being always tends to improve

## LIFE QUALITY





## CONVENTIONAL POLYGENERATION OF POWER, WATER AND COOLING (PWC)



PLANTS ARE COMPLEX AND OF HIGH INITIAL AND OPERATION COSTS

JUSTIFIED FOR LARGE PRODUCTIONS

SEAWATER DESALINATION By heat for Distillation

Multi-Stage-Flash (MSF)  
Multi-Effect (MED)

Power for ELECTRODIALYSIS (Membrane)

COOLING for Desalination by Freezing

Power for Distillation  
Vapour Compression (VC)

Power for Reverse Osmosis (RO) (Membrane)

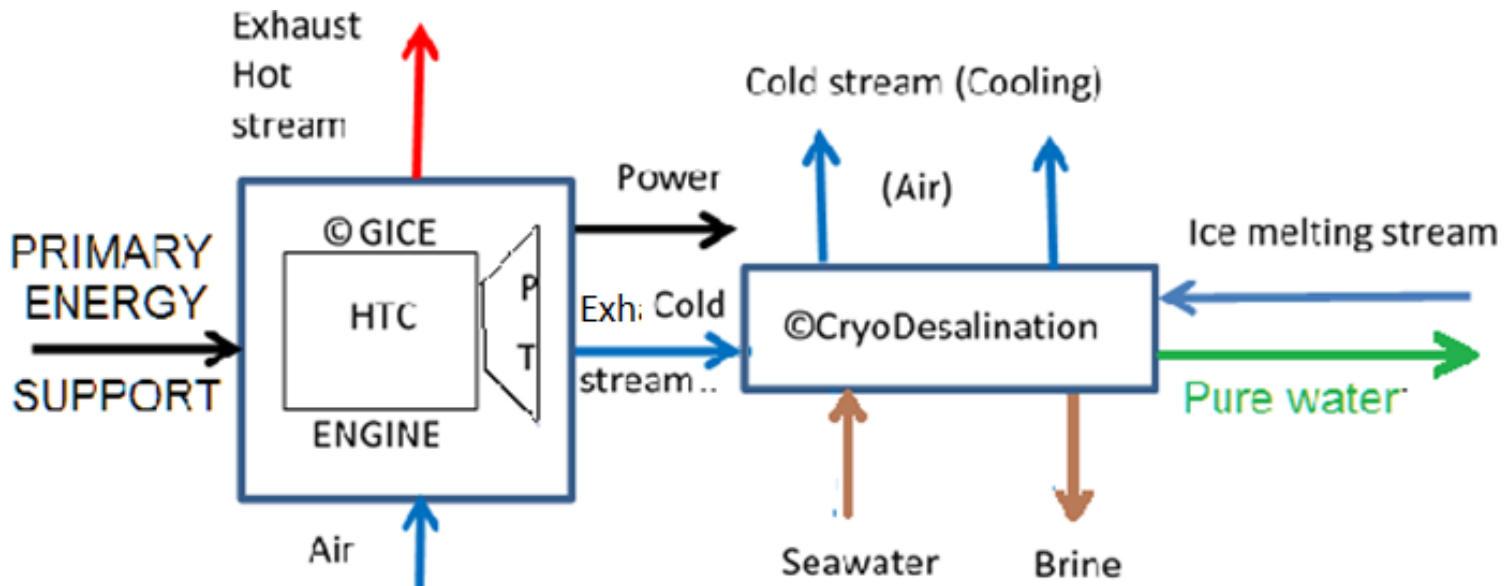


# POLYGENERATION OF POWER, WATER AND COOLING (PWC)

## FOR DISTRIBUTED GENERATION (PRODUCTION)

COSTS CAN BE REDUCED BY

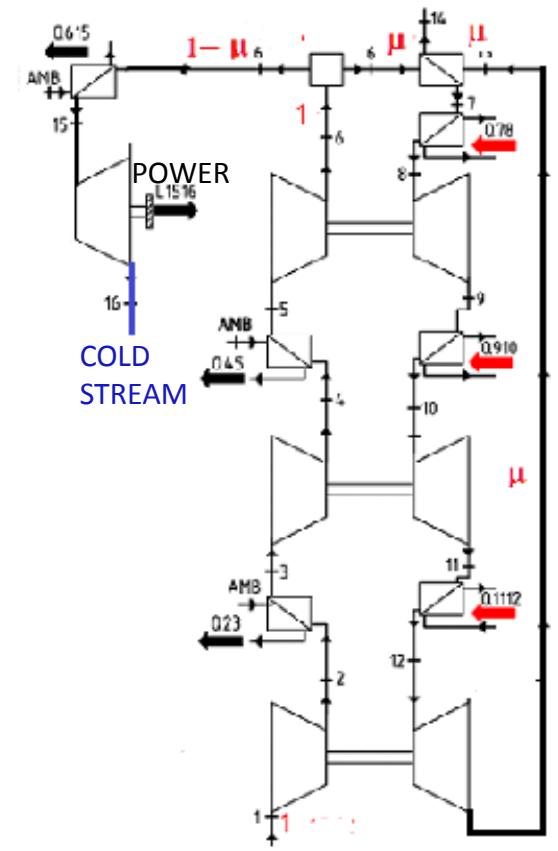
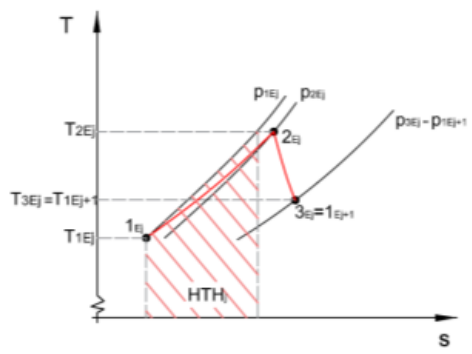
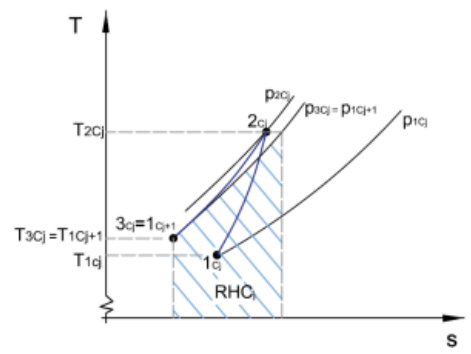
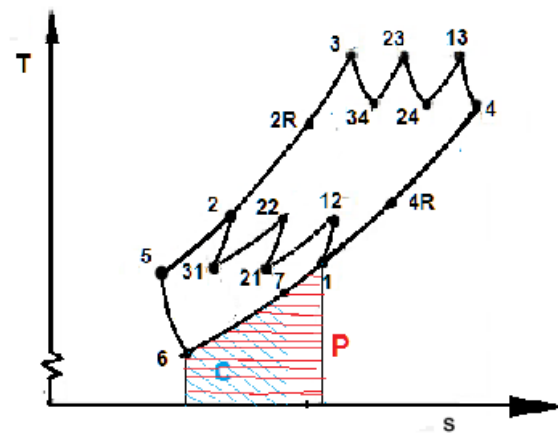
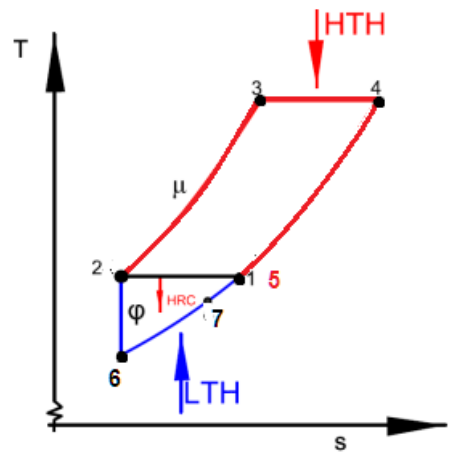
- ✓ SIMPLIFIED ENGINES
- ✓ ADOPTION OF TECHNOLOGIES THAT SUPPLEMENT EACH OTHER





# CONCURRENT PRODUCTION of POWER AND COOLING

## ©GICE Engine Concept





# ©GICE ENGINE for POWER AND COOLING CONCURRENT PRODUCTION

## TECHNOLOGIES

- **COMPRESSOR(S)**
- **EXPANDER(S)**
- **HTDs**
  - **REGEN.**
  - **INTERCOOLER**
  - **RE-HEATER**
- **TURBO**
- **AD HOC MACHINES**

POWER

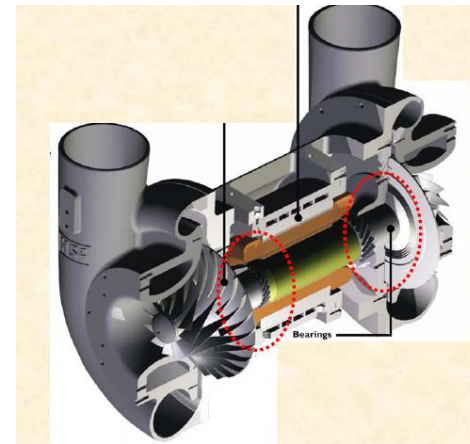
TURBINE



electric generator rotor

## ARRANGEMENTS

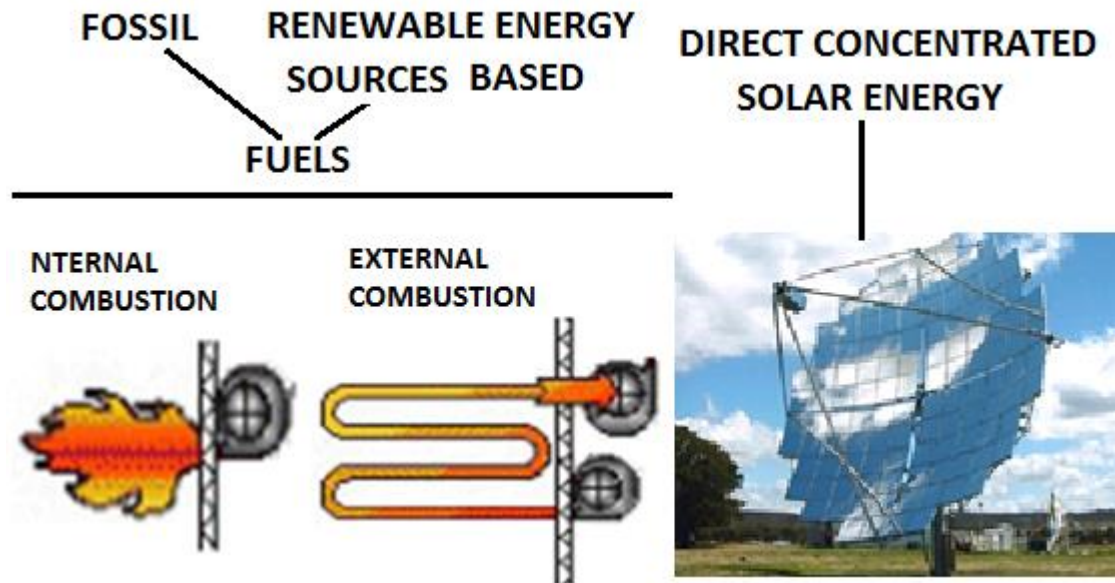
- 1 Single Shaft Recuperated
- 2 Two shafts (Free Standing Spool and Power Turbine) recuperated
- 3 Two shafts (FSS & P T) Double Heating and Recuperated
- 4 Multi Shaft Intercooled, Multi Heating and recuperated
- 5 Closed Cycle or Quasi Closed Cycles
  - A Inlet air cooling
  - B Bottomed cycle





# ©GICE ENGINE for POWER AND COOLING CONCURRENT PRODUCTION

## • THERMAL HEAT SOURCE OPTIONS







# © GICE ENGINE PERFORMANCE

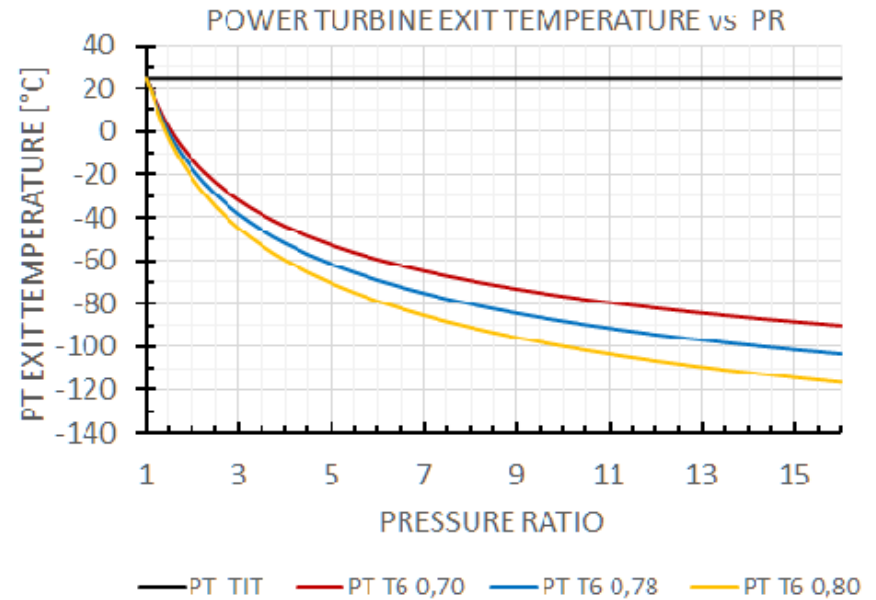
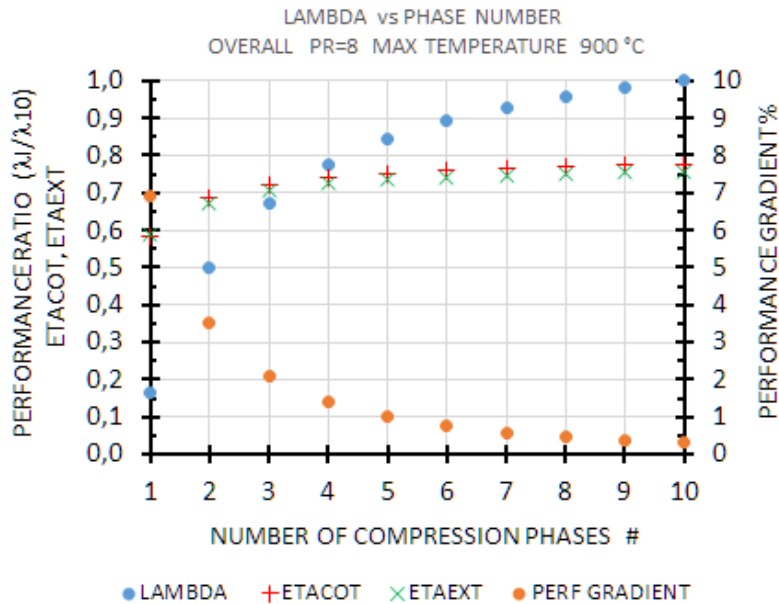
PERFORMANCE RATIO = POWER / POWER $\infty$     DoF    TIT, NC,  $\beta$

OBJECTIVE (ONE)

- POWER
- COMPRESSOR INLET MASS FLOW

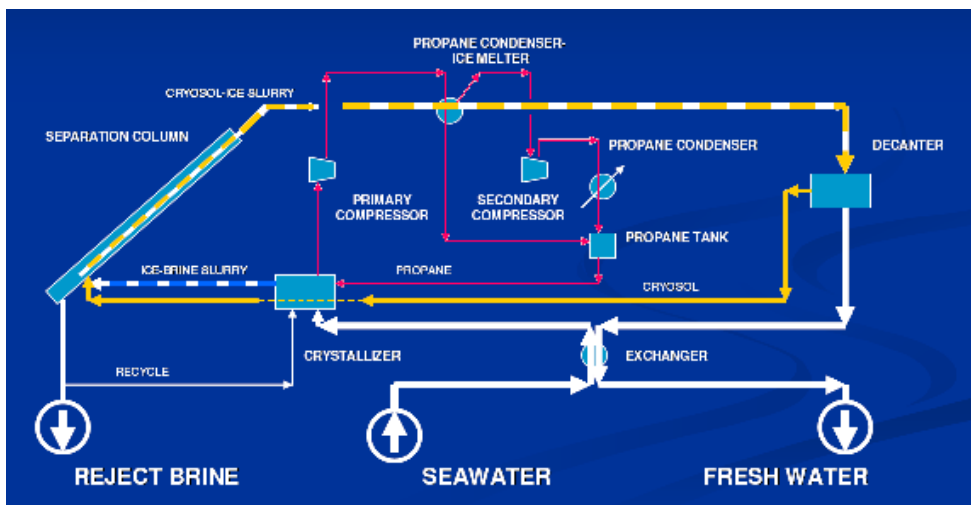
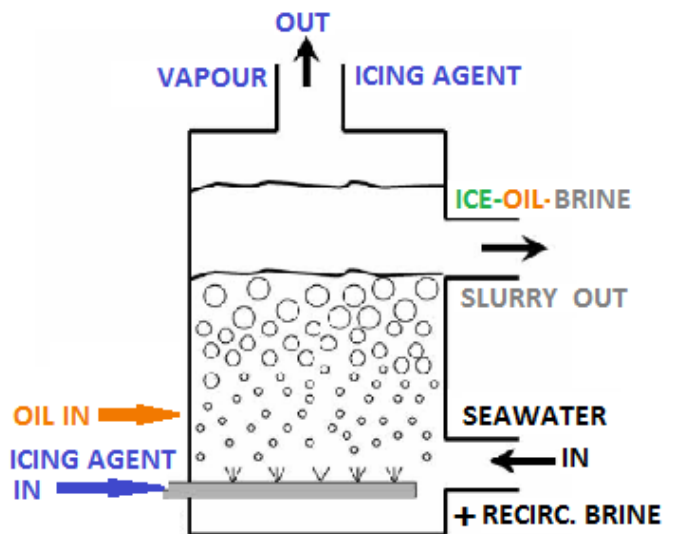
$$\eta_{COT} = \frac{R T_1 \ln \beta}{W_{c \text{ real}}}$$

$$\eta_{EXT} = \frac{W_{e \text{ real}}}{R T_3 \ln \beta}$$



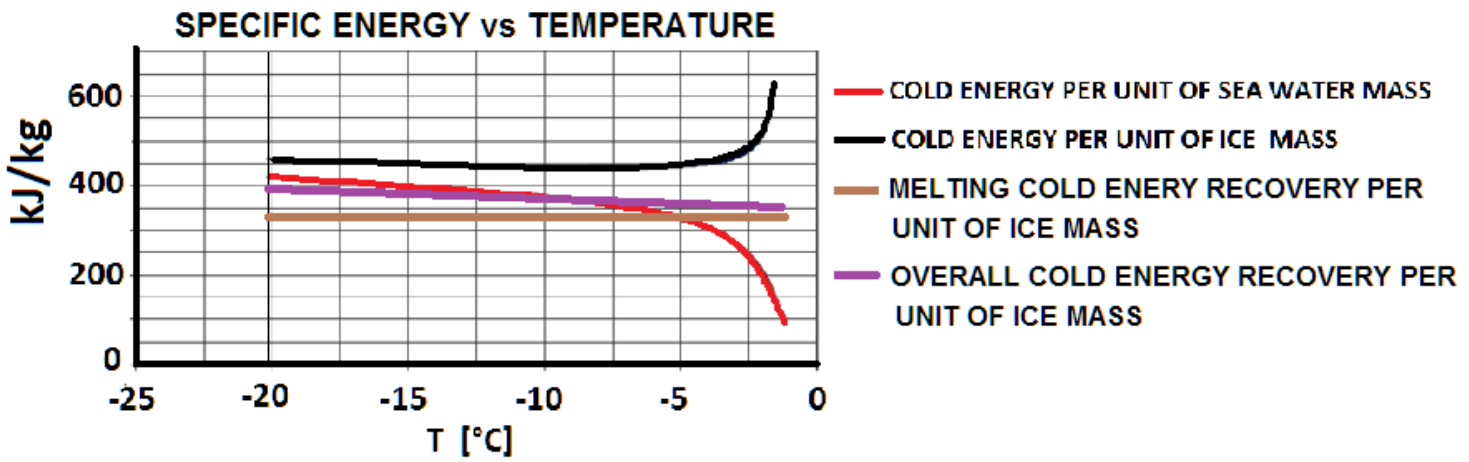
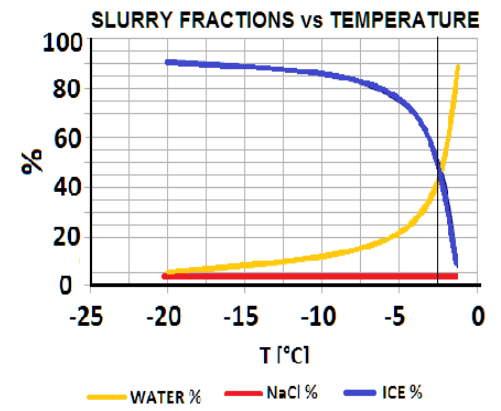
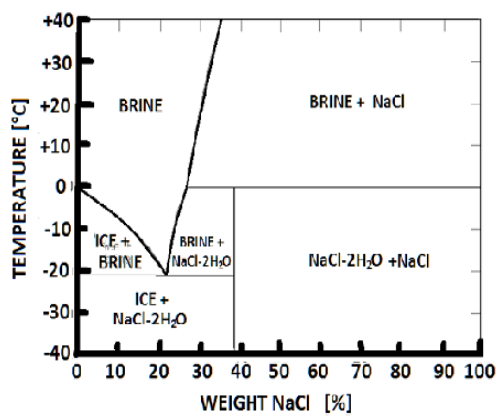
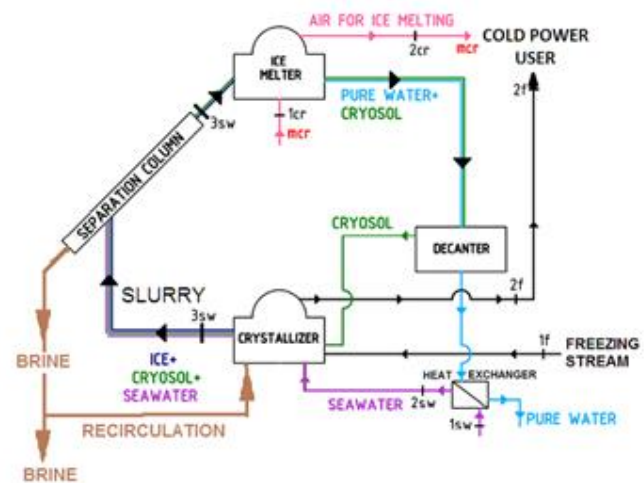


# ©CryoDesalination a NOVEL PROCESS



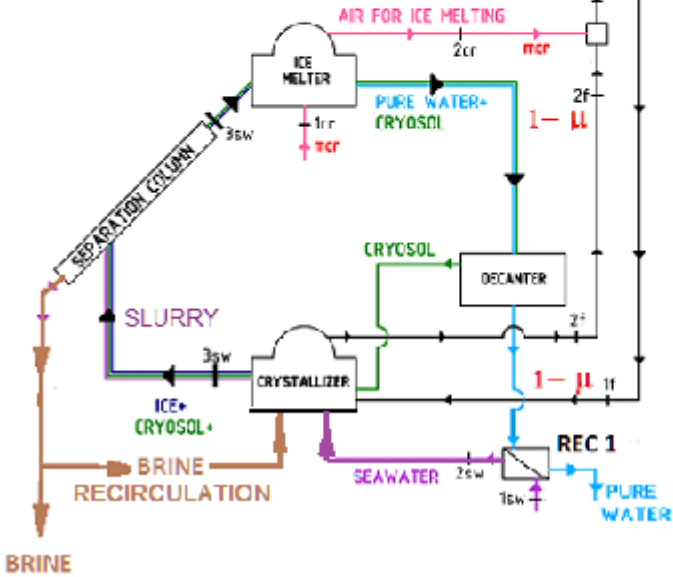
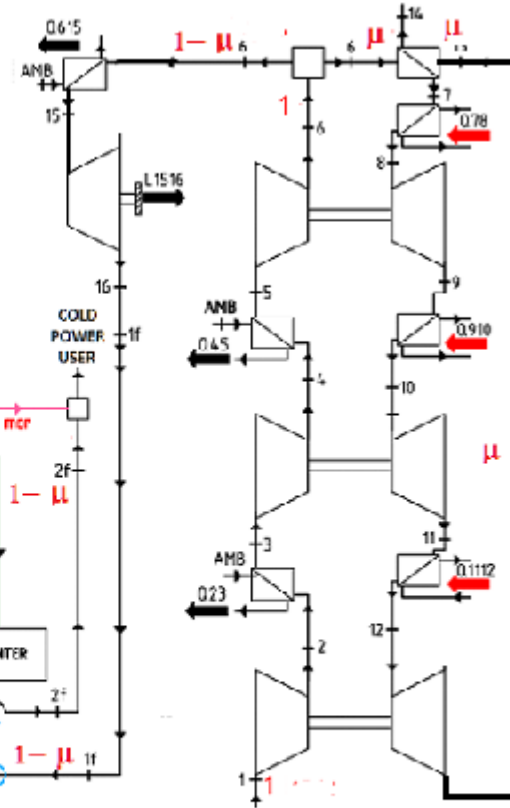


# © CryoDesalination

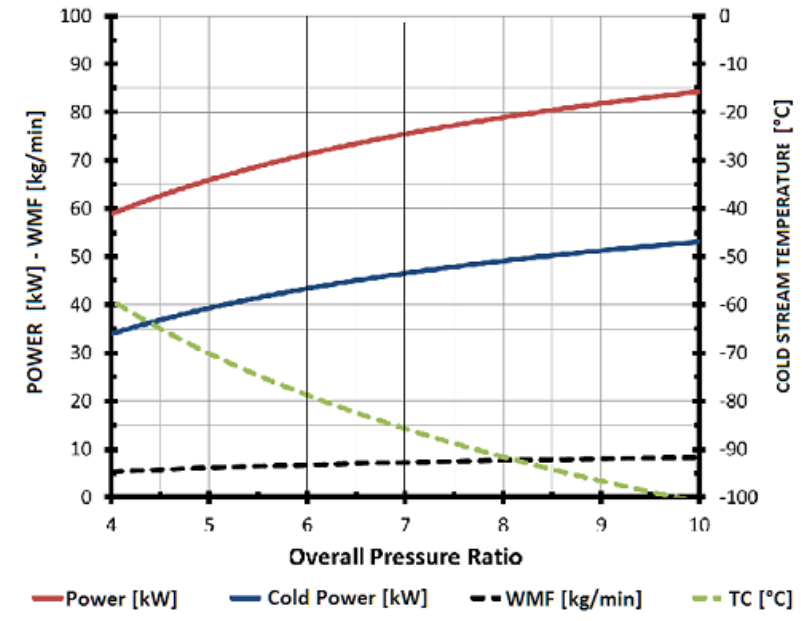




©GICE Engine ©CryoDesalination



OPTION # 1

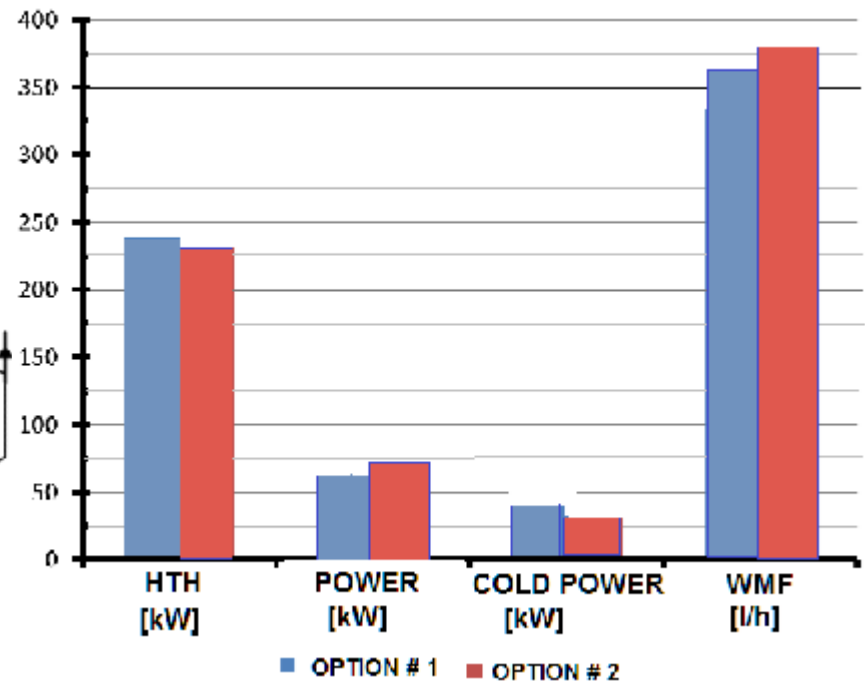
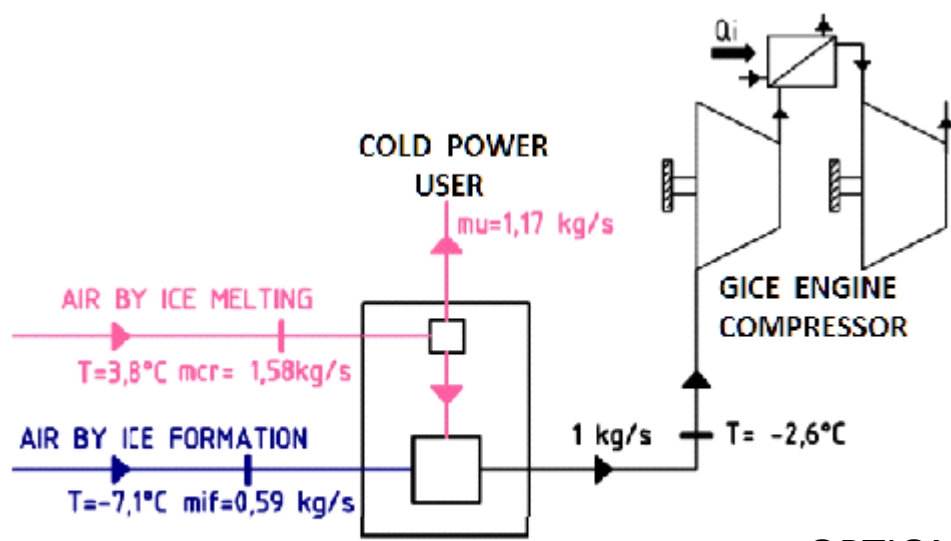


Press. Ratio  $\beta = 5.7$  Power 70 kW  
Water Flow 6 liters/min



# ©GICE Engine ©CryoDesalination

Press. Ratio  $\beta = 5.7$




OPTION # 1 ➔ OPTION # 2

■ OPTION # 2

POWER + 6% PURE WATER + 6% RESIDUAL COOLING -35%



# CONCLUSIONS

- **Innovative ©GICE Engine Arrangements for Concurrent Production**
  - Power, Cooling  Unique Power Plant
- **©GICE Engines can be arranged using reliable existing technologies**
  - Turbocharger Tech, Heat Transfer Devices, etc.
- **Integrating ©GICE Engines with ©CryoDesalination systems**
  - Novel Polygeneration plant configurations for concurrent production of POWER, PURE WATER and COOLING AGENTS



# THE END

*Water is ... a pre-requisite to the realization of all other human rights.”*  
(UN Committee on Economic, Cultural, and Social Rights)

Also POWER and COOLING