



**Rahavard Energy Co.**

[www.rahavard-energy.com](http://www.rahavard-energy.com)

**GAS TURBINE POWER AUGMENTATION**

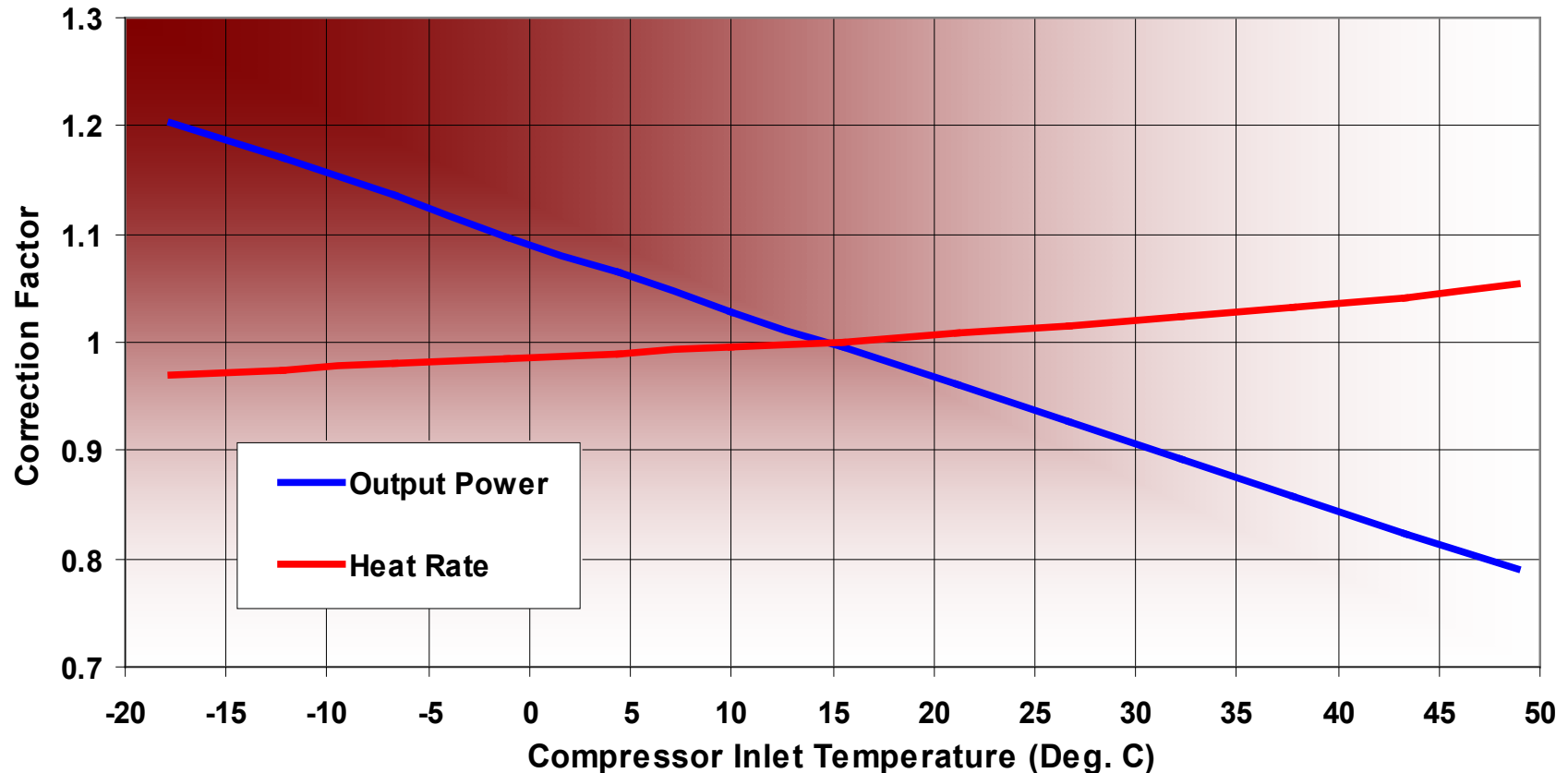
**at**

**HOT SUMMER DAYS**

**by**

**INLET AIR COOLING SYSTEMS**

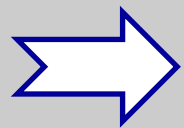
## Typical Gas Turbine Performance Curve



**Every 1.5 °C increase in ambient air temperature, decreases 1% of turbine output power!**

## During Hot Summer Days:

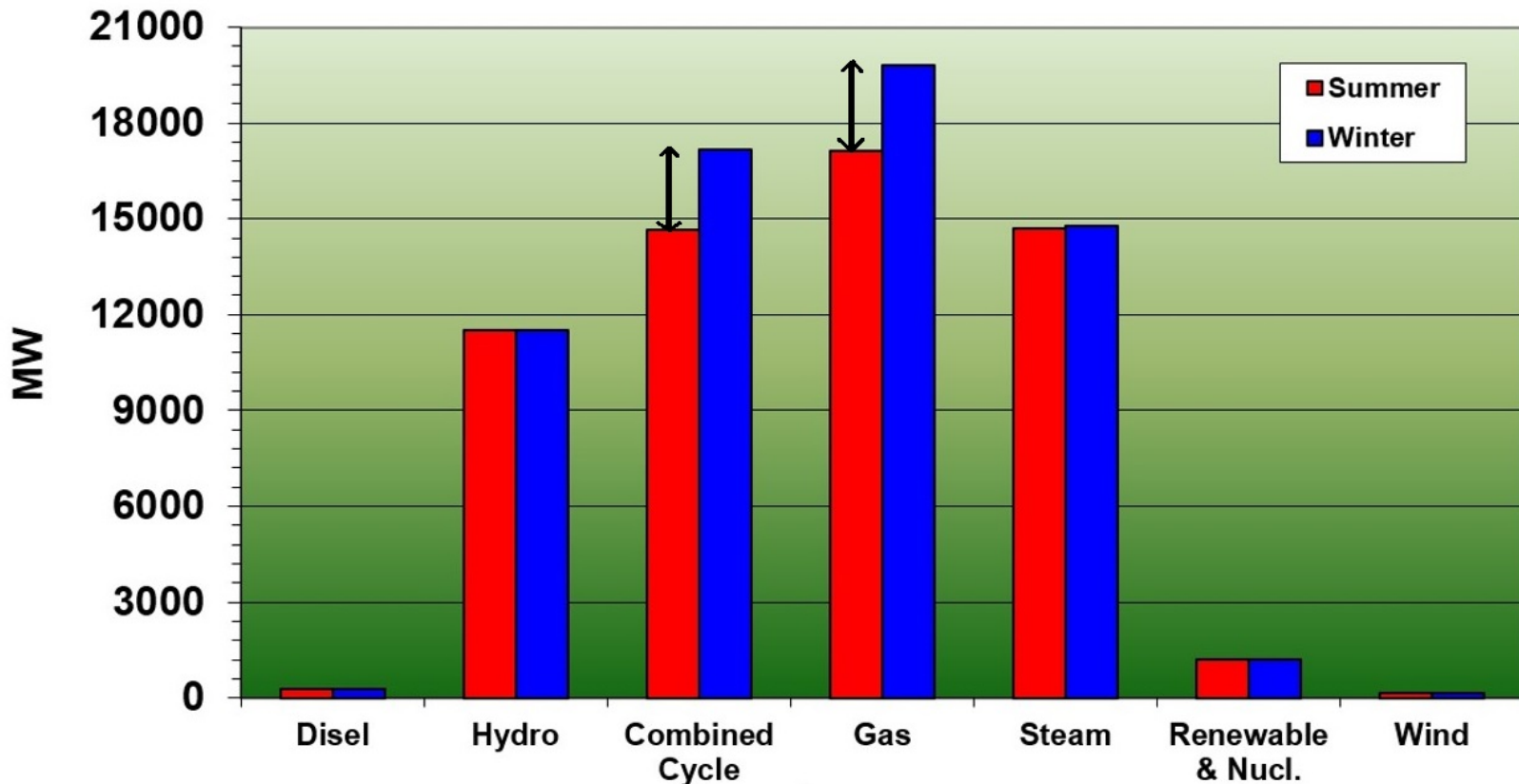
- **Air Mass Flow Rate Decreases**
- **Compressor Power Consumption Increases**



***Gas Turbine Output Power Decreases***

**5000 MW difference between Winter and Summer production capacity, due to Increase of ambient temperature!**

Comparison of Production Capacity of different Iranian Power Plants in Summer & Winter (by March 2017)





# WHAT CAN WE DO ?

To Bring Spring in Summer, with:

**GAS TURBINE  
INLET AIR COOLING TECHNOLOGIES**

## Turbine Inlet Air Cooling Technologies

### Refrigerative Systems

Compression

Absorption

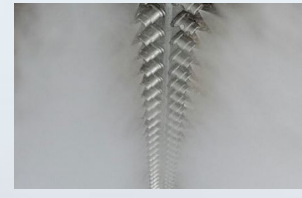
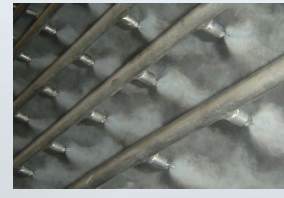
Thermal Storage

### Evaporative Systems

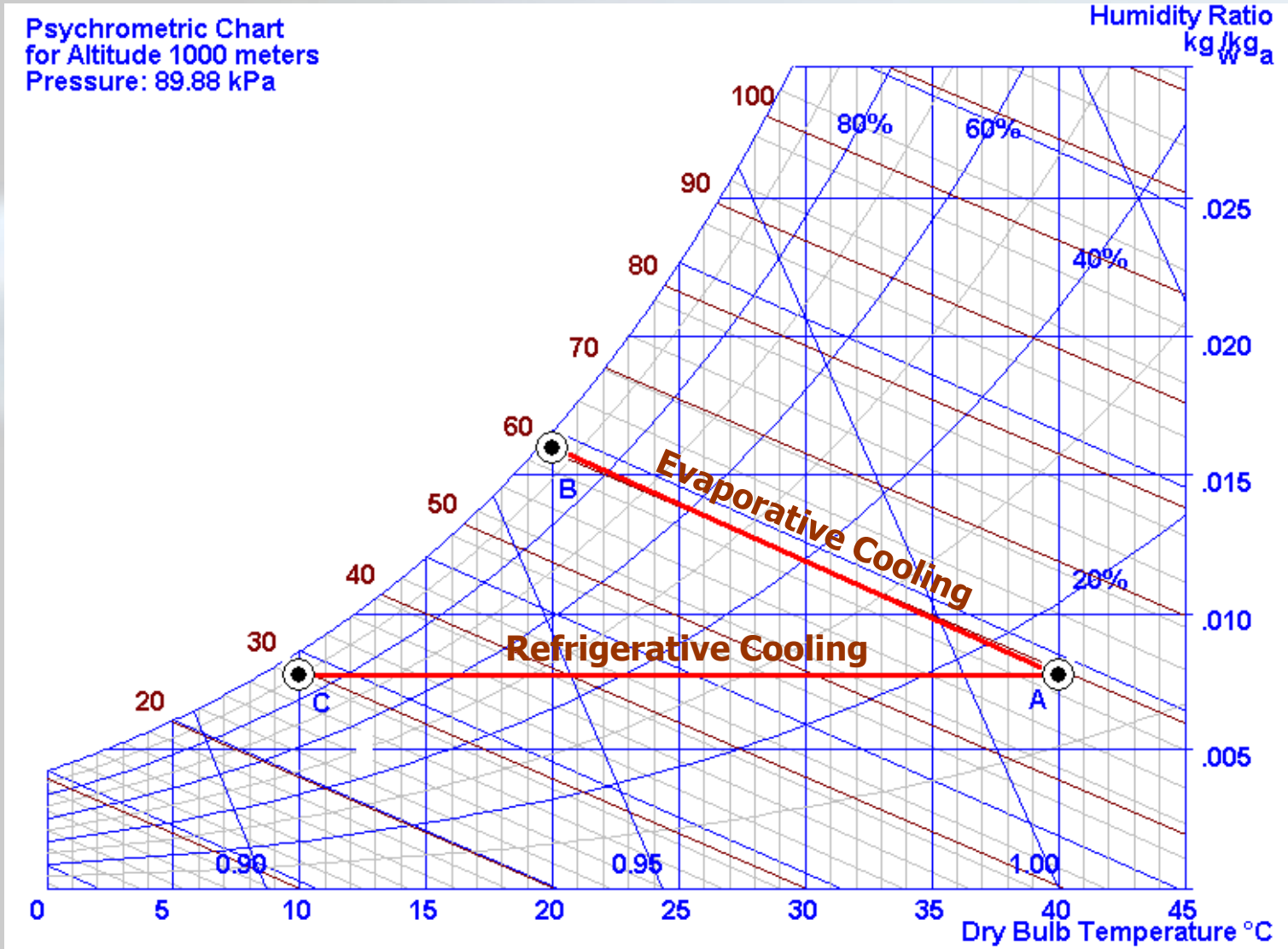
Fog

Media

Wet Compression



## Inlet Cooling Process in Psychrometric Chart



## **GLOBAL EXPERIENCE:**

### **EVAPORATIVE COOLING (MEDIA, FOG & WET COMP.):**

- **MORE THAN 2000 UNITS**

### **COMPRESSION CHILLERS:**

- **AROUND 400 UNITS**

### **ABSORPTION CHILLERS**

- **LESS THAN 30 UNITS**

# TOTAL EXPERIENCE IN *IRAN*

\*AS OF JUNE 2022

**MEDIA: 80 UNITS**

**FOG: 35 UNITS**

**WET COMP.: 7 UNITS**

## TURBINE TYPES EQUIPPED WITH INLET COOLING:

GE F5, F6, F9, HITACHI, MITSUBISHI, ABB, ALSTOM,  
ANSALDO V94.2, ...

## **RESULTS (ACHIEVEMENTS):**

**14-17% POWER INCREASE**

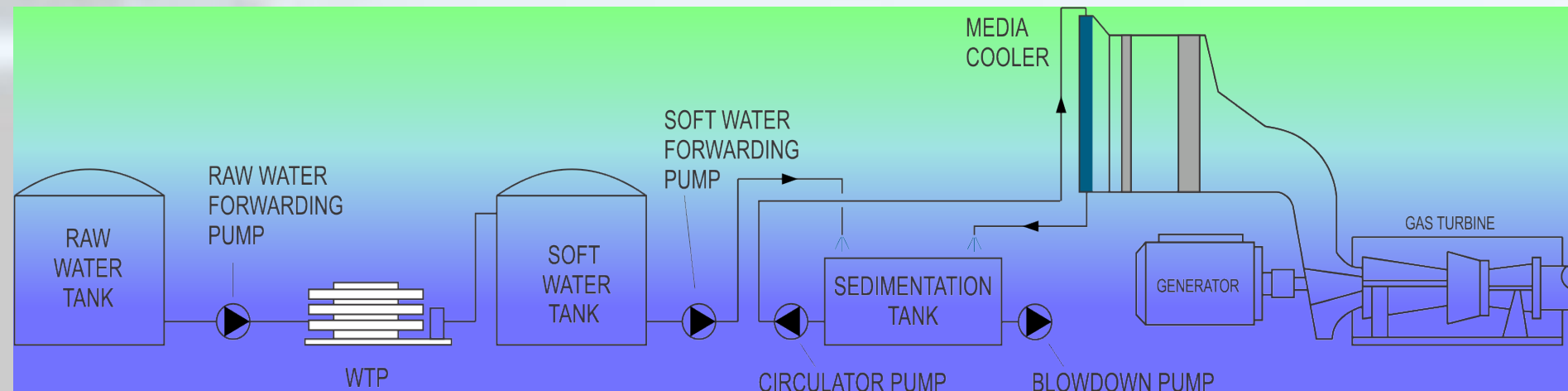
**1- 1.5% EFFICIENCY IMPROVEMENT**

**15-20 °C INLET AIR COOLING**

**10-12% NO<sub>x</sub> REDUCTION**

# MEDIA EVAPORATIVE COOLING

✓ **MOST USED INLET COOLING SYSTEM**



**WHOLE SYSTEM SCHEMATIC DIAGRAM**



## **SAMPLE PHOTOS OF MEDIA COOLING INSTALLED ON DIFFERENT TYPES OF GAS TURBINES, BY **RAHAVARD ENERGY** CO.**





## **SAMPLE PHOTOS OF MEDIA COOLING INSTALLED ON DIFFERENT TYPES OF GAS TURBINES, BY **RAHAVARD ENERGY** CO.**



## **MEDIA COOLING SYSTEMS:**

### ✓ **ADVANTAGES:**

- ***NO NEED TO DEMINERALIZED WATER (POTABLE ENOUGH!)***
- ***QUICK INSTALLATION***
- ***SHORT TURBINE DOWN TIME FOR ERECTION***
- ***LOW MAINTENANCE AND OPERATION COST***
- ***LOW PARASITIC ELECTRICAL CONSUMPTION (<1%)***
- ***LOW PRESSURE DROP (<100Pa)***

### × **DISADVANTAGES:**

- ***REQUIREMENT OF WATER (1 m<sup>3</sup>/h per 1 MW power increase)***



## MAIN WATER TREATMENT SYSTEM FOR PRODUCTION OF POTABLE WATER FOR MEDIA COOLING: RO SYSTEM



**RO SYSTEMS INSTALLED IN DIFFERENT PROJECTS BY RAHAVARD ENERGY CO.**





## WATER STORAGE TANKS FOR MEDIA SYSTEM



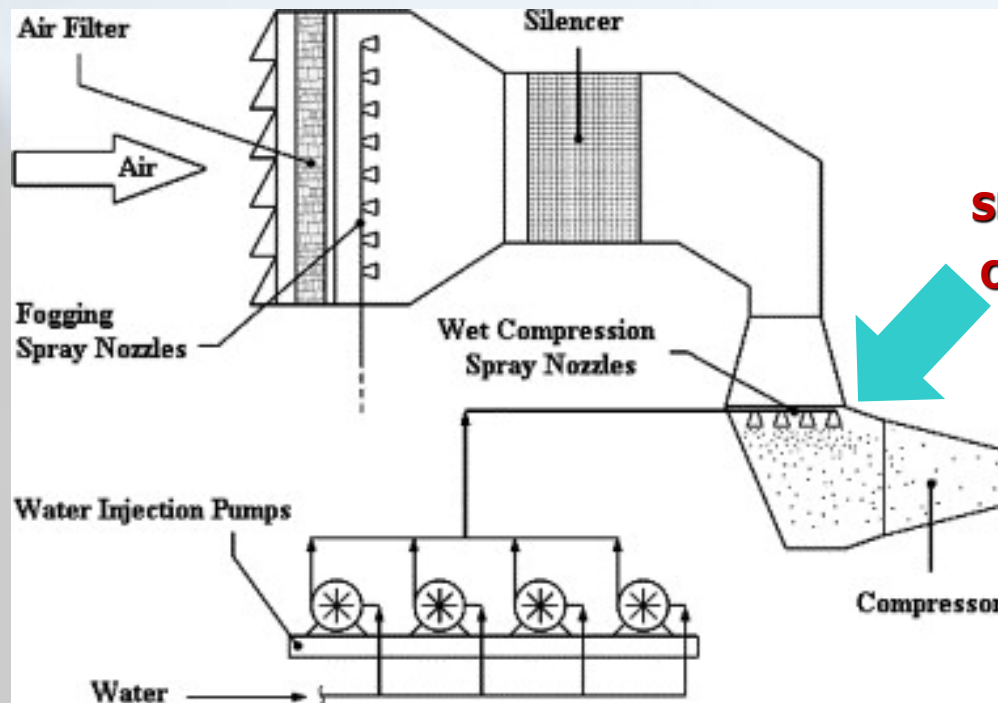
**STORAGE TANKS MANUFACTURED IN DIFFERENT PROJECTS BY RAHAVARD ENERGY CO.**



# WET COMPRESSION SYSTEM,

✓ **THE BEST CHOICE, IF:**

**YOUR TURBINE IS LOCATED IN HUMID REGION (COASTAL AREA)**





# WET COMPRESSION SYSTEM,

FOREIGN PARTNER: **EnergyFog**  
SYSTEMS



**SPRAY AT BELLMOUTH  
OF THE COMPRESSOR**

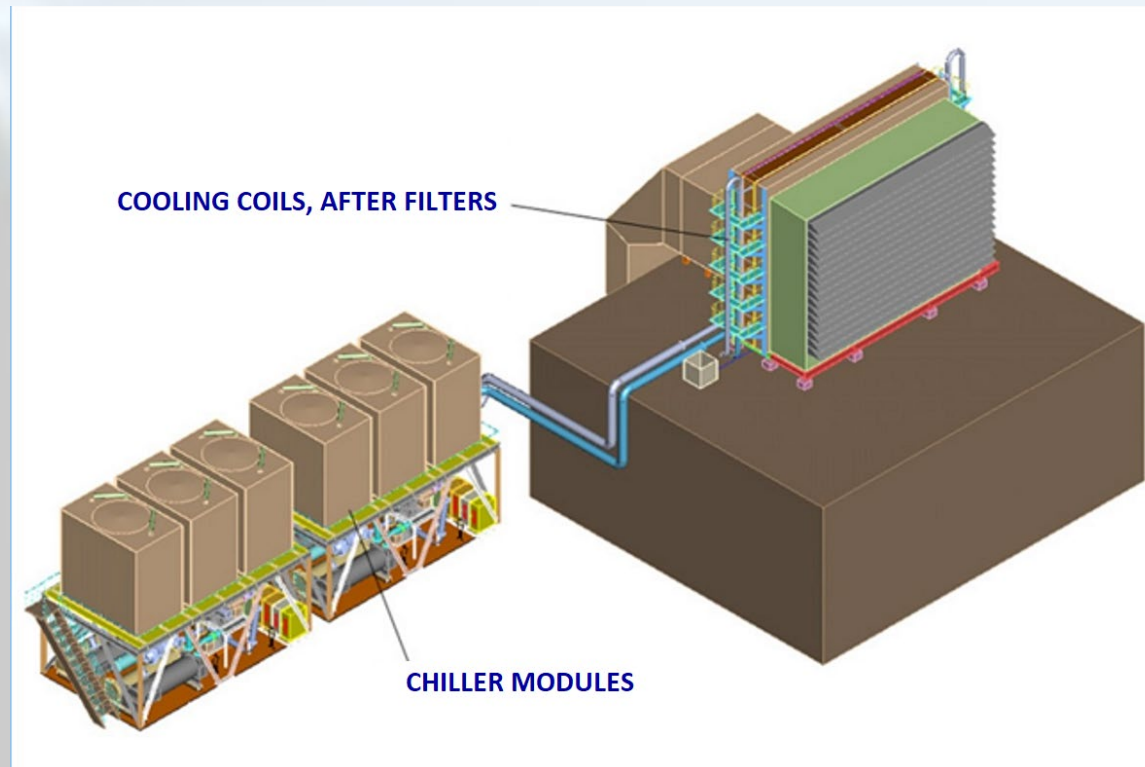


**HIGH PRESSURE  
PUMP SKID**



# REFRIGERATIVE (CHILLING) SYSTEMS,

✓ **ALTERNATIVE COOLING FOR EVAPORATIVE SYSTEMS, IF:  
THERE IS NOT ENOUGH WATER AVAILABLE  
AT YOUR PLANT**



## CHILLING SYSTEMS:

### ✓ ADVANTAGES:

- ***NO NEED TO WATER (AIR COOLED CHILLERS)***
- ***NO COOLING DEPENDANCY TO AMBIENT HUMIDITY***
- ***MORE POWER OUTPUT INCREASE***

### × DISADVANTAGES:

- ***HIGH INVESTMENT COSTS***
- ***HIGHER MAINTENANCE & OPERATION COSTS, COMPARED TO EVAPORATIVE SYSTEMS***
- ***MODIFICATION OF INLET AIR DUCT FOR COILS INSTALLATION***



## CHILLING SYSTEMS:



**INSTALLATION OF COOLING COILS  
IN THE DUCT, AFTER FILTERS**



**MODIFICATION/EXPANSION  
OF DUCT AT LOCATION OF  
COILS, TO DECREASE AIR  
VELOCITY**

## CHILLING SYSTEMS:



**FOREIGN PARTNER:**



**AIR COOLED CONDENSERS**



**AMMONIA CHILLERS**

# WE PROVIDE ALL INLET COOLING SOLUTIONS FOR YOUR GAS TURBINE!



**Rahavard Energy Co.**

You can reach us at:

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