WORSKSHOP 01

Transition for Thermal to SWRO: Strategies for Optimal Existing Thermal Plant Operation Before Retirement

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CEO & Founder- SWPC Sustainable Water & Power Consultant
United Arab Emirates

arwadex 2019

TUESDAY 23 APRIL 2019
09:00 - 11:00
InterContinental City Stars, Cairo

INTRODUCTION

The workshop is also aiming at highlighting the efficiency issues existing with the existing base load thermal plants in the new energy transition scenario whereby more and more energy in the grid in the GCC will be provided by PV plants.

Considering the residual life of the MSF/MED plants installed the course objective will illustrate possible scenarios for MSF/MED plant retirement without affecting the overall power plant cycle and for possible efficiency ameliorations that can be introduced as heat reclaimers, efficiency improvement etc. The course will also provide directions for an efficient decommissioning.

WORKSHOP OBJECTIVES

The objective of the course is to provide the course attendees an overall information on the constraints that derive from the operation of the thermal plants in the new energy scenarios.

The course will also provide few case studies where plants retrofits were carried out and will enable the attendee to be able to plan the strategy for the plant operation in the transition mode and optimize the OPEX and energy expenditures.

WORKSHOP CONTENT

The course contents will be slides in power point presentation (or adobe acrobat) that can be downloaded directly with USB.

WORKSHOP LANGUAGE

English

ABOUT WORKSHOP INSTRUCTOR

Corrado Sommariva is a consultant of International reputation in the field of desalination, power generation waste water and sustainability.

He has over 30 years of experience and has covered several executive positions in Consultancy firms for the last 20 years where he brought the Companies served to become market leaders in the GCC in the field of desalination, power, renewable energy and waste water.

He has served the President of International Desalination Association (2011-2013), President of the European Desalination Society (2004-2006), Chairman of WHO committee for safe water use from desalination.

Dr. Sommariva has published more than 100 leading edge papers and four books on desalination and sustainability.

Dr. Sommariva has a honorary doctorate from Heriot Watt University for his contribution to the development of desalination. In 2015 he was honored by the President of Italy with the title of Master of work. The workshop is aiming at describing the overall tariff evolution and the current marked difference between the tariffs from recent SWRO plant projects and the installed thermal plants.

الشريك التقني الدولي
الراعي المشارك
المستشار الأكاديمي
تنظيم
المتعاونون

الدورة 12

مؤتمر تحلية المياه في الدول العربية

19-18 شعبان 1440 | 24-23 ابريل 2019

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TRANSITION FROM THERMAL TO SWRO: STRATEGIES FOR OPTIMAL EXISTING THERMAL PLANT OPERATION BEFORE RETIREMENT

Dr. Corrado Sommariva

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CEO SWPC
President IDA 2012-2015

Why do we need retiring thermal plant ?

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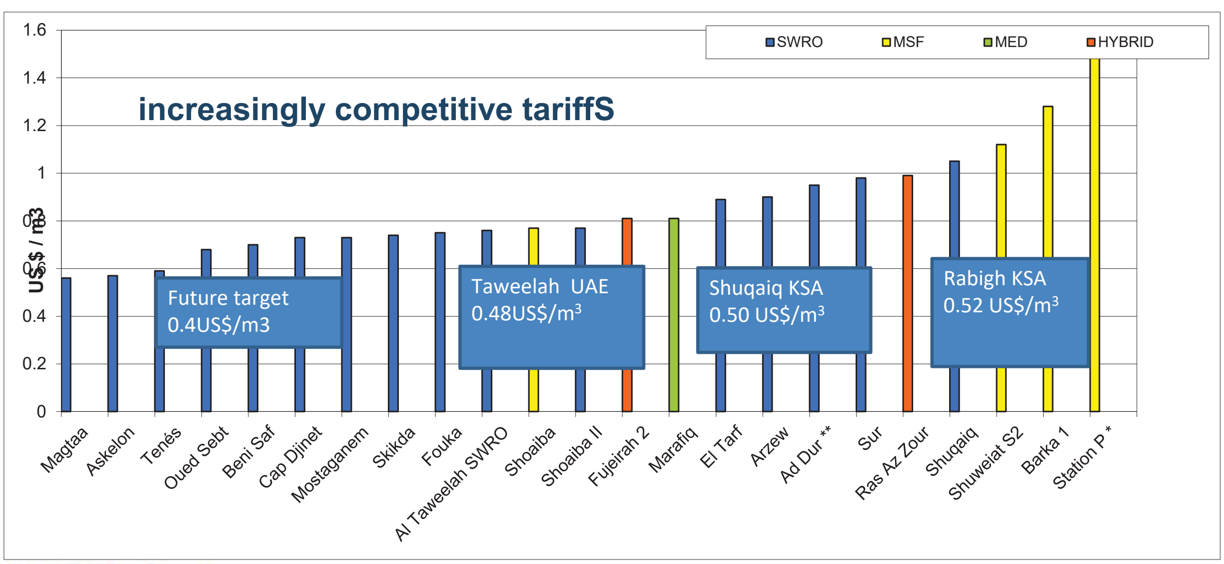
New tariffs scenarios



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New tariffs scenarios

	Cost of water	Energy consumption
	US$/m^3	kWh/m^3
Thermal (latest IWPP) 2010	1.2	20
SWRO	0.5	3

On surface to decommission a thermal desalination plant producing water at a tariff of 1 to 1.5 per US$/m^3 and huge energy costs appears a simple decision against the alternative of a SWRO plant at 0.5 US$/m^3 tariff and 2.9 kWh/m^3.

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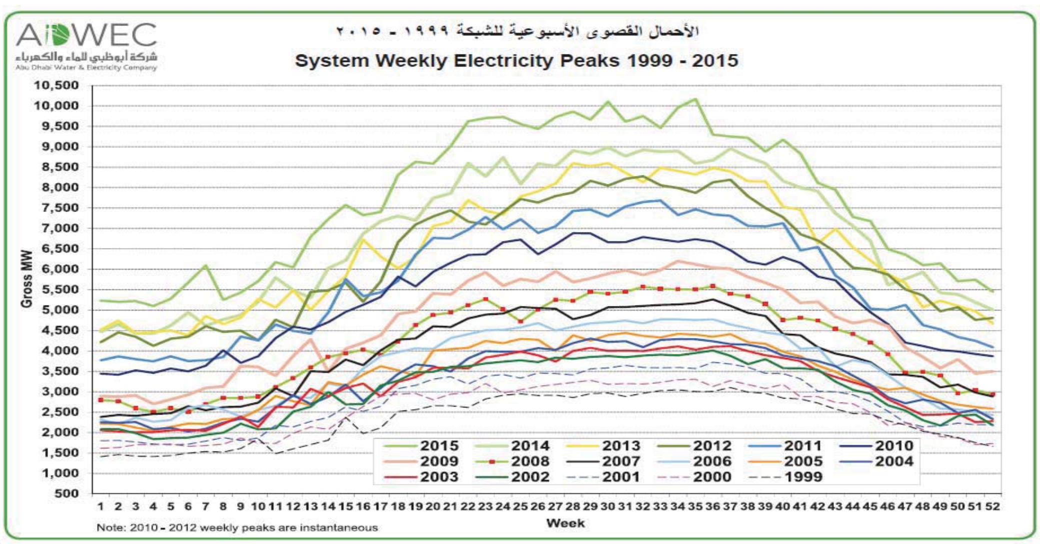
Old grid demand scenarios

Typical seasonal power demand in the GCC presents a typical curve Whose profile becomes sharper as the times goes by



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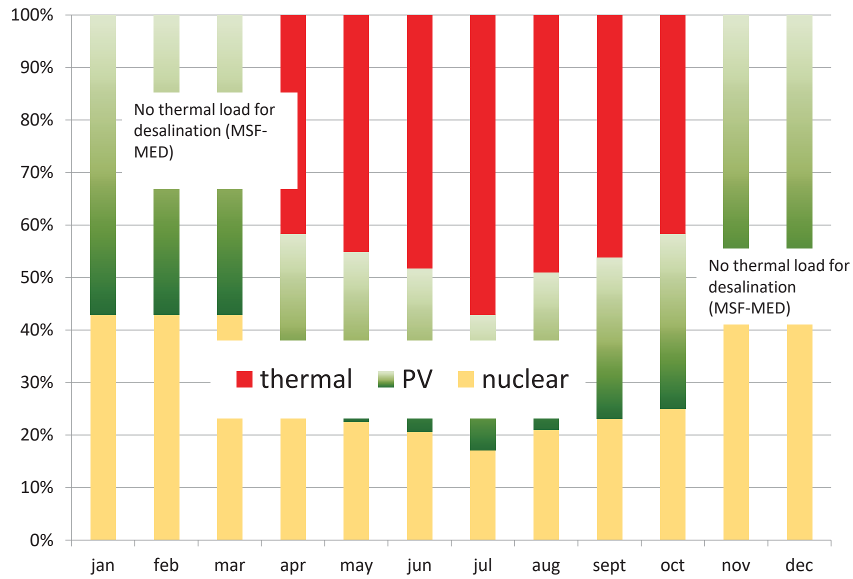
Old grid demand scenarios

With energy generation moving away from fossil fuel in GCC winter power demand will be met by solar or baseload nuclear plants.
Therefore there will not be enough thermal load to operate thermal desalination plant in future



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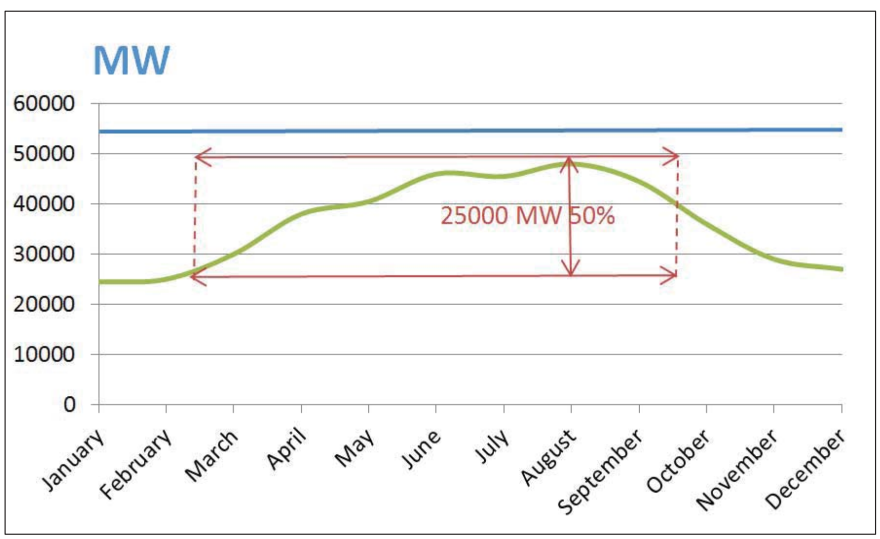
Old grid demand scenarios

The peak load in the Kingdom is extremely marked with 2500 MW used for less that 50 hours/ yr. This in turns implies a very inefficient use of fuel



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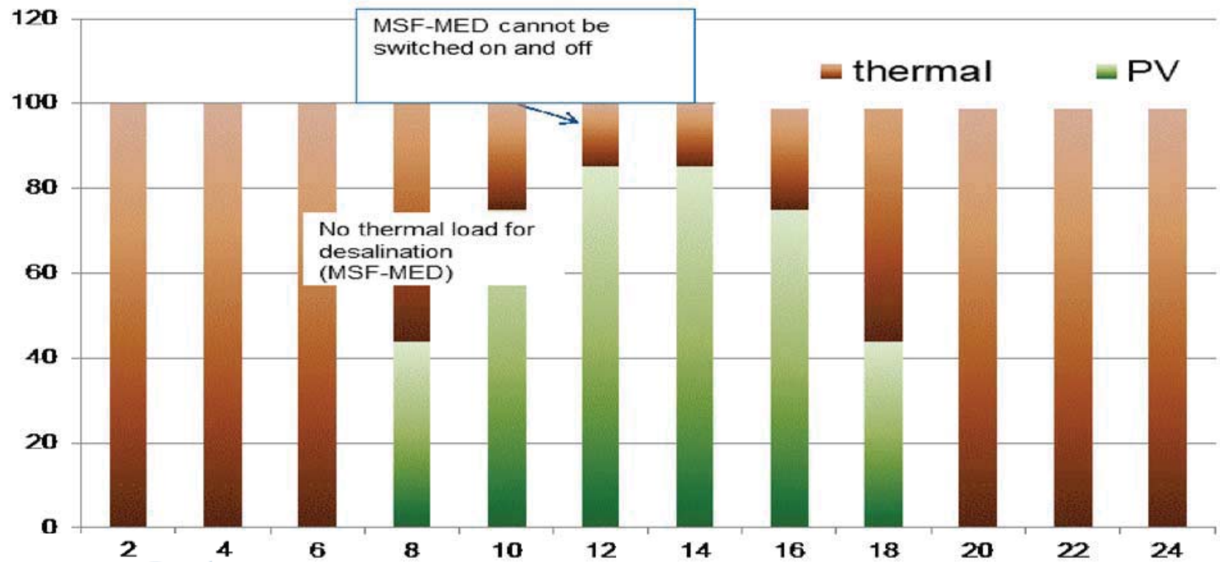
New grid demand scenarios



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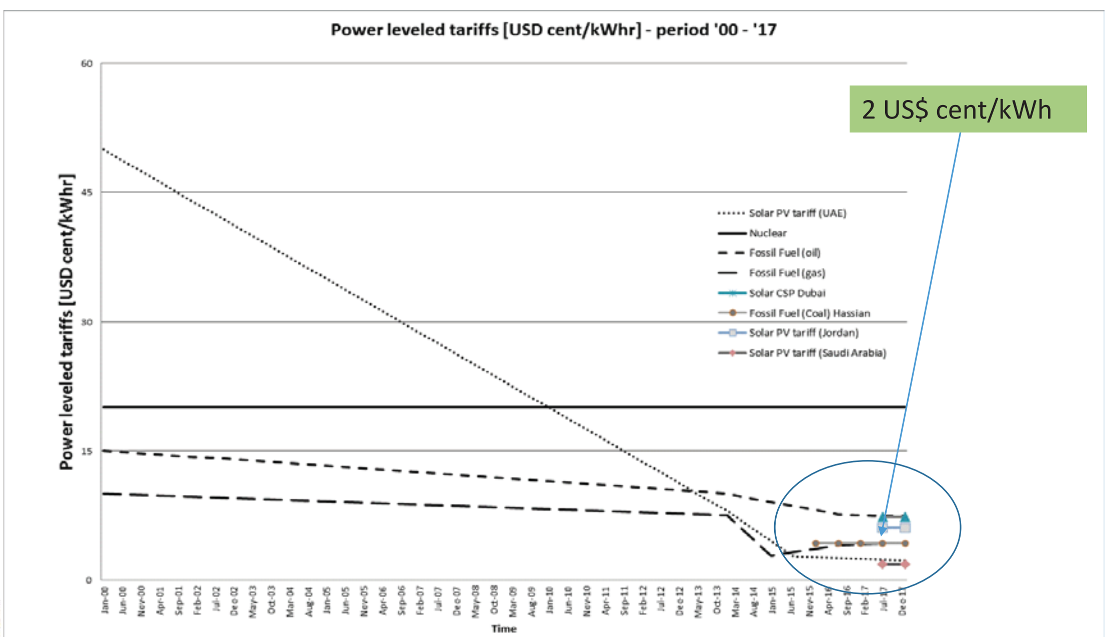
New grid demand scenarios

Energy price from PV system are reaching new targets as the time goes by



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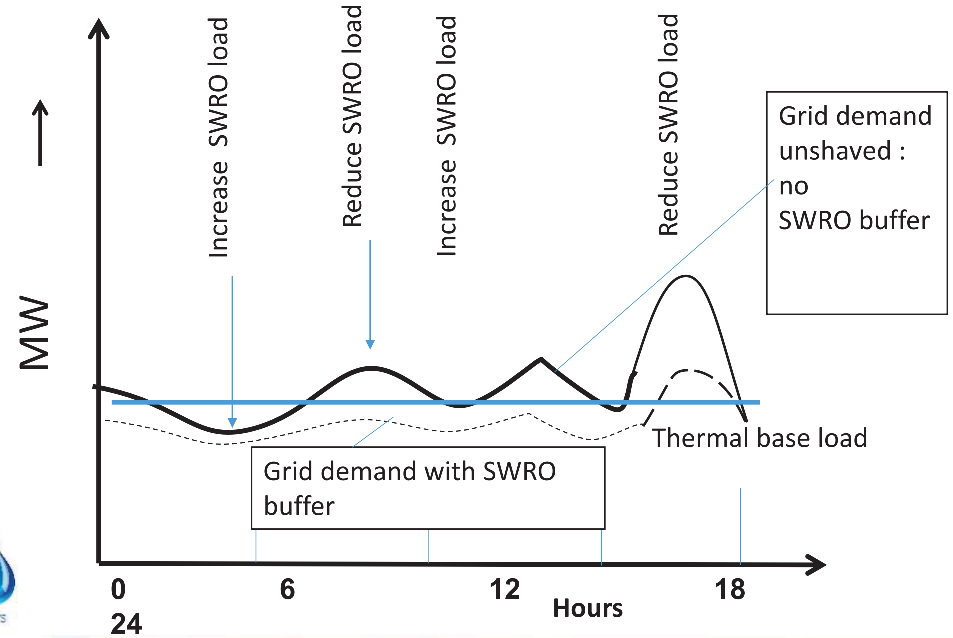
New grid demand scenarios



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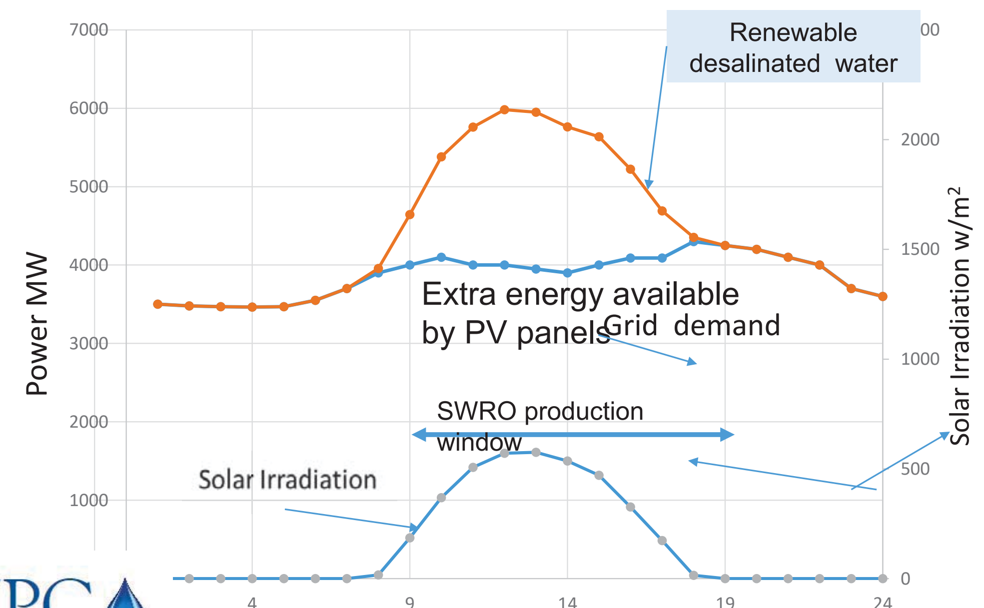
New grid demand scenarios



Peak load shaving and power demand managemen t

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Let's retire the thermal plant

What is the problem then ?

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Long term investments

In reality the technicalities of the nexus between thermal power and thermal desalination are much more complex

- The first challenge is how to take advantage of the benefits of recent SWRO tariff and at the same time deal with the existing thermal fleet until the investment costs are recovered.

- Azzour North completed and commissioned in the fourth quarter of 2016. costs $650 million
- Ras Al Khair completed and commissioned in 2015 cost US$7.2 billion (with power plant)
- Etc etc
- The dept on these investment needs to be paid

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Water power nexus

The other challenge is related to the water and power nexus. The majority of the existing large thermal desalination plants operates in a cogeneration scheme with the power plant; as such the desalination plant is the condensers for either a back pressure steam turbine or a pass out steam stream.

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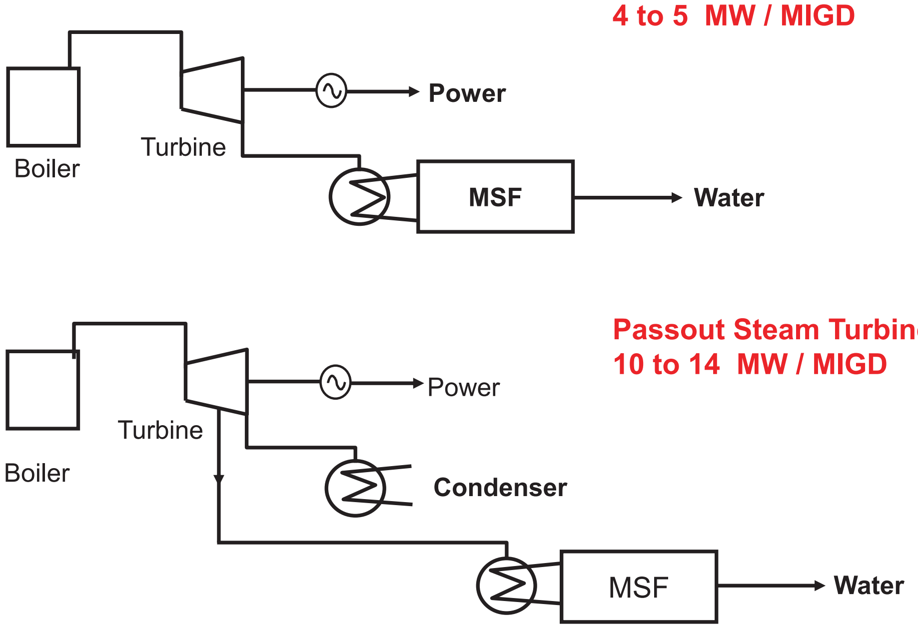
Water power nexus

Back Pressure Steam Turbine
4 to 5 MW / MIGD

Passout Steam Turbine
10 to 14 MW / MIGD



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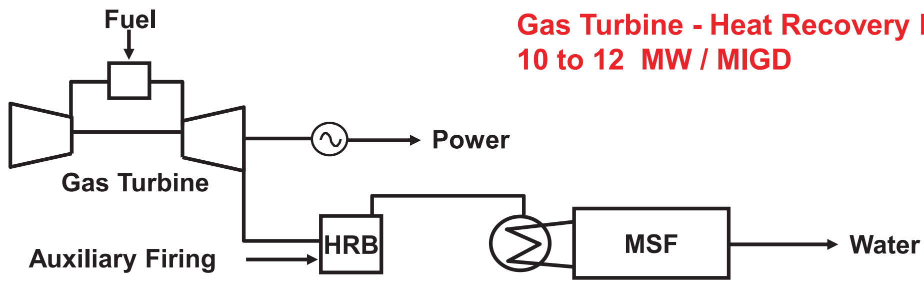
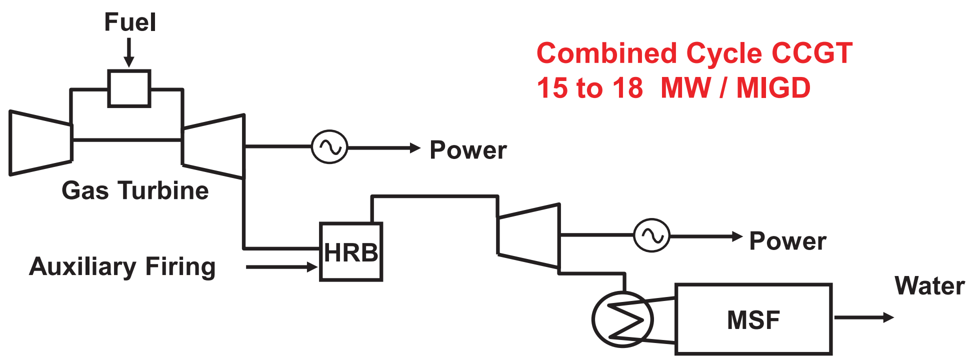
Water power nexus

Gas Turbine - Heat Recovery Boiler
10 to 12 MW / MIGD



Combined Cycle CCGT
15 to 18 MW / MIGD



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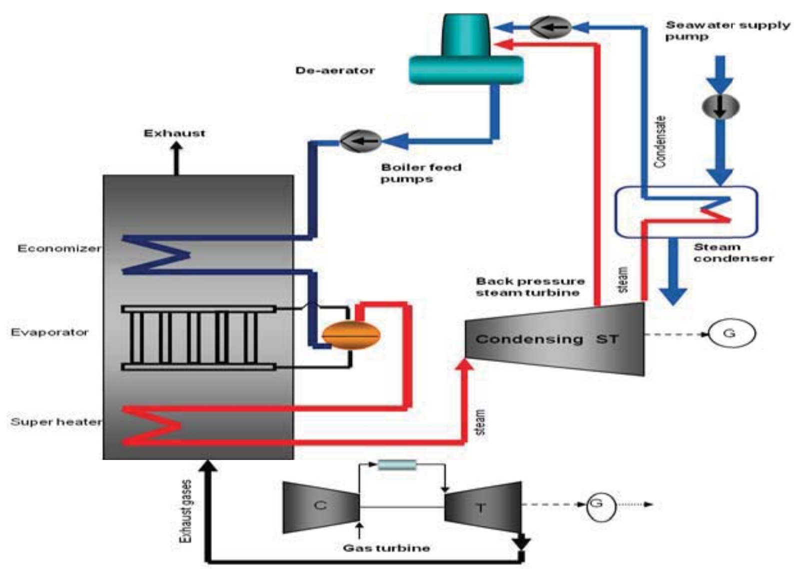
Water power nexus

Power plants require a heat sink where to condense the steam that has been used in the steam turbine.

A large amount of seawater through the steam condenser is needed



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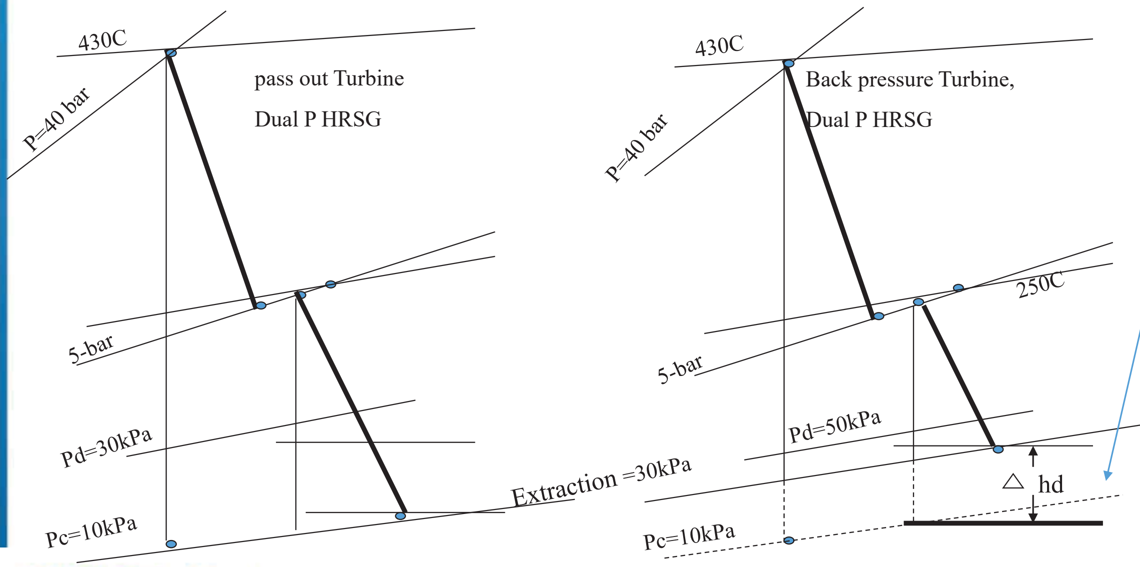
Water power nexus



There is no point to decommission a thermal desalination plant if there no possibility of taking advantage of this ΔH.

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Example

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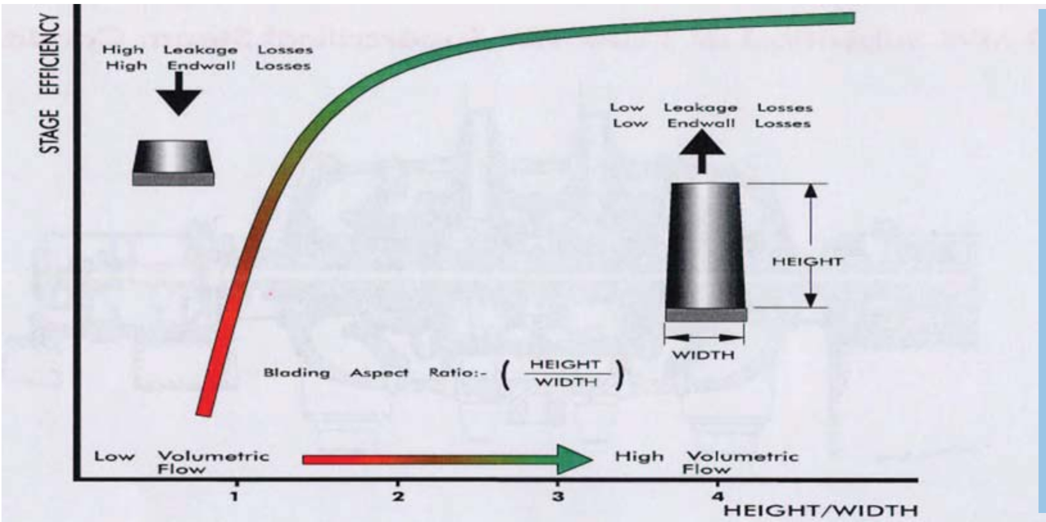
Possible optimization solution



Steam turbine blades however are designed for a certain volumetric flow and there is no much flexibility on flow variations

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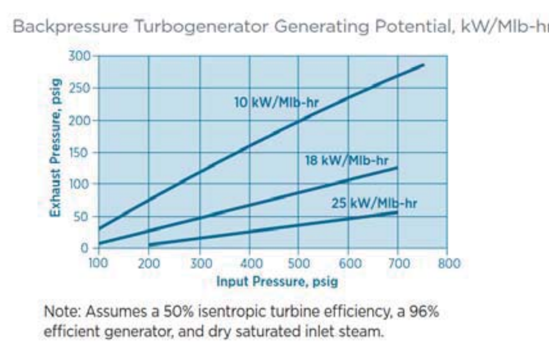
Water power nexus

Extraction pressure	**bar**	5	4	3	2.5	2	1.8
Specific steam consumption	**Kg/kWh**	7.8	7.1	6.6	6.2	5.9	5.7
Turbines power	**MW**	385	422	455	488	504	526



The table shows an estimation of the potential additional power that would be able to be generated for a set of 40 bar steam turbines operating at 430C feeding 100 MIGD MSF systems at various extraction pressures

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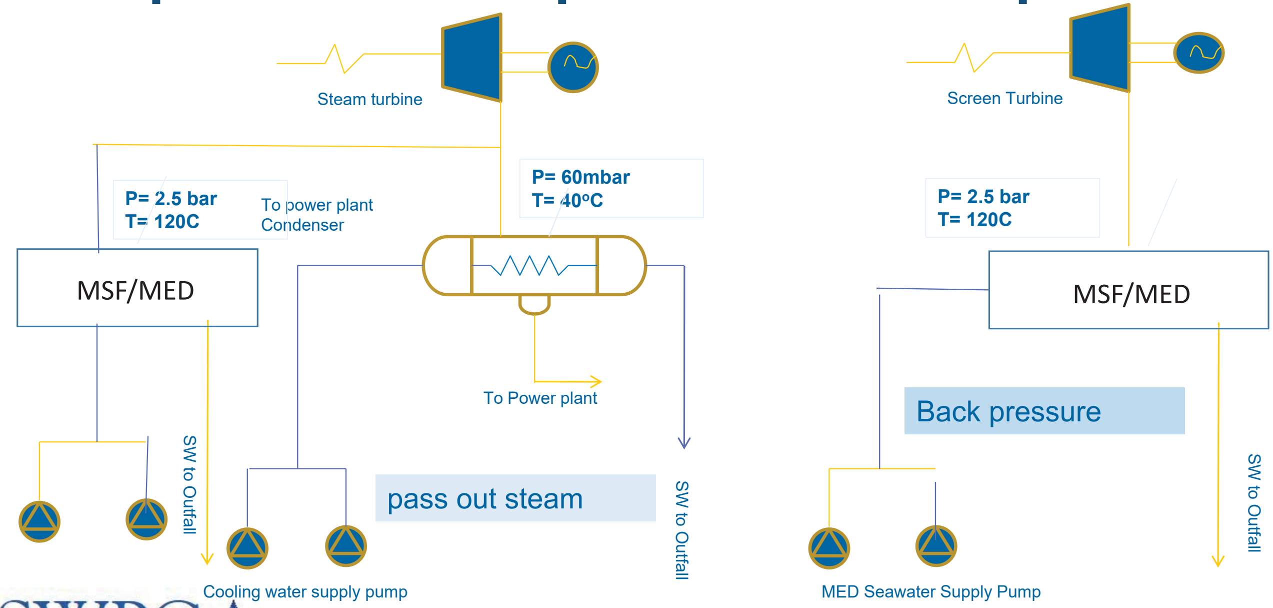
Water power nexus : pass out or backpressure ?



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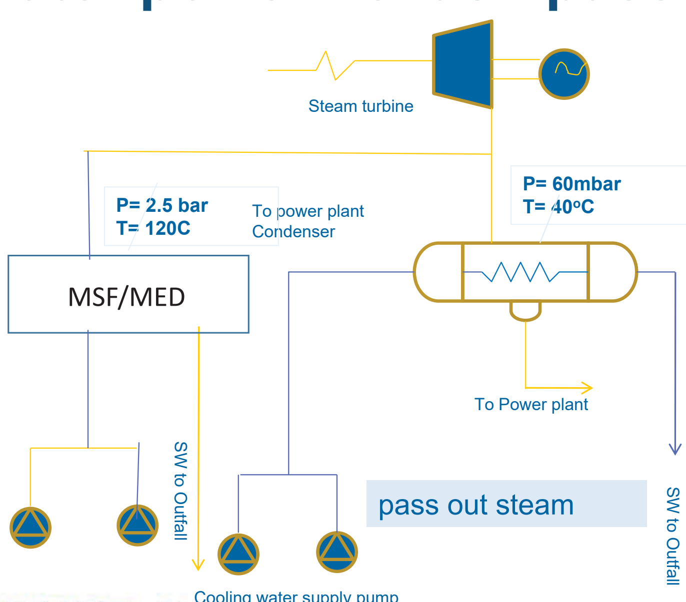
Water power nexus : pass out case study



Generally used for old power plants and for power projects were the ratio water to power is low.

Also used for small MSF/MED generating demin water for the power cycle

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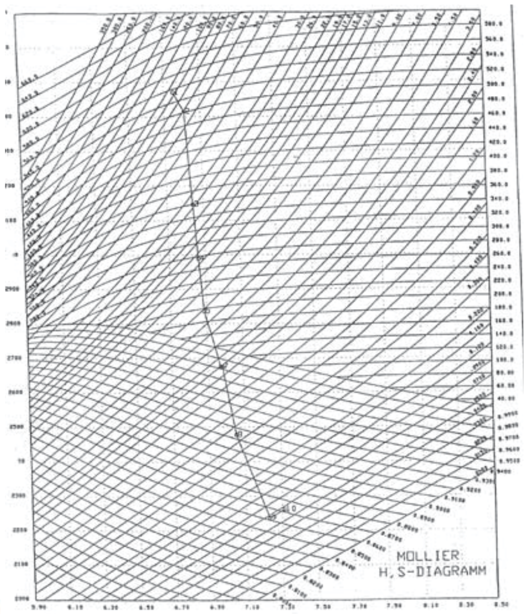
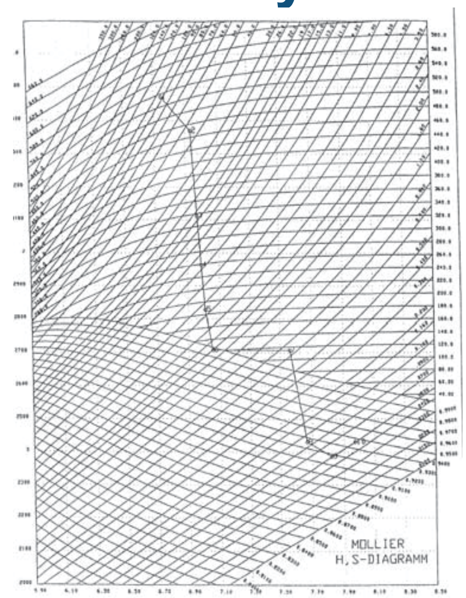
Water power nexus : pass out case study





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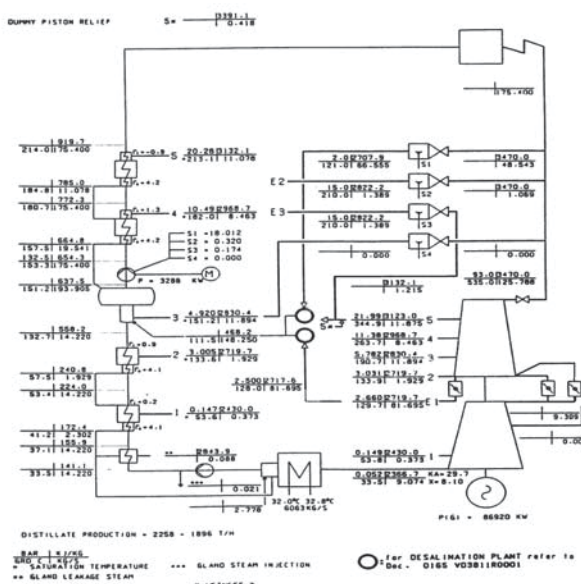
Water power nexus: pass out case study



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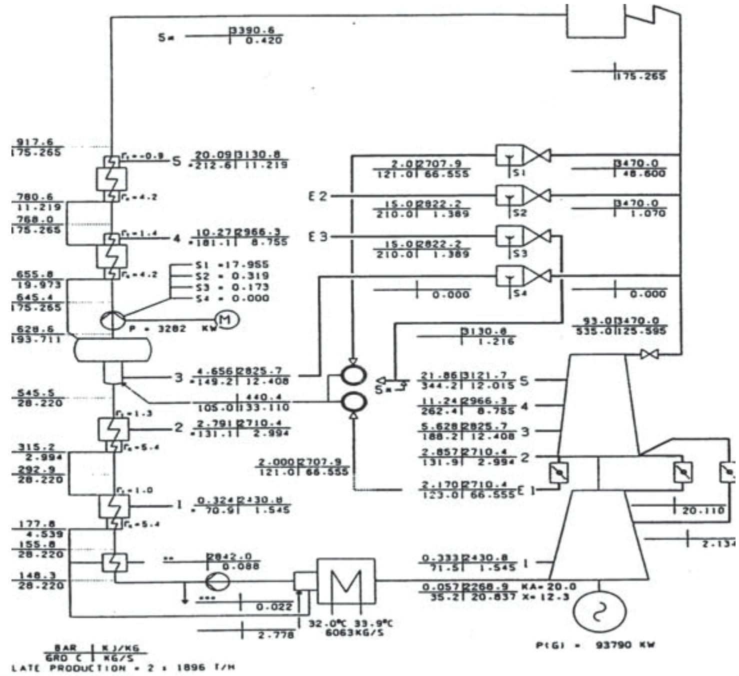
Water power nexus: pass out case study



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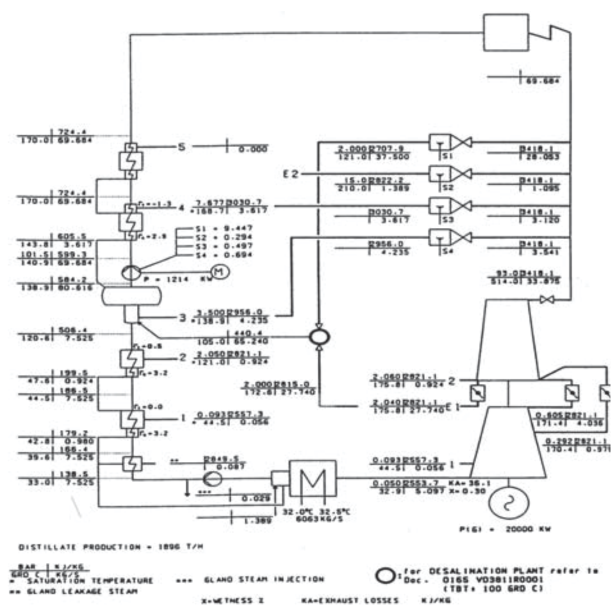
Water power nexus: pass out case study



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Water power nexus: pass out

In many cases the condenser of the pass out steam turbine can accommodate a steam flow that is much larger than the steam required for the desalination plant therefore decommissioning (FULLY OR PARTLY DEPENDING ON THE STEAM CYCLE DESIGN) the MSF distiller and replacing it with a SWRO would result IN

- Lower heat rate for the same power production or
- Same heat rate for higher power production
- Lower seawater consumption

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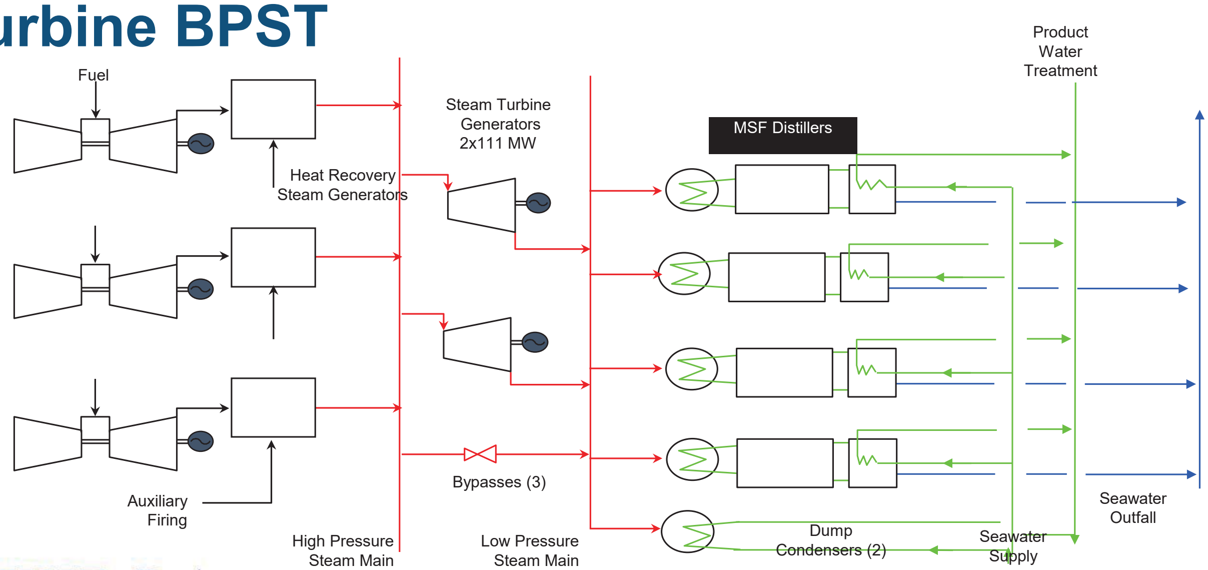
Water power nexus : Back pressure steam turbine BPST



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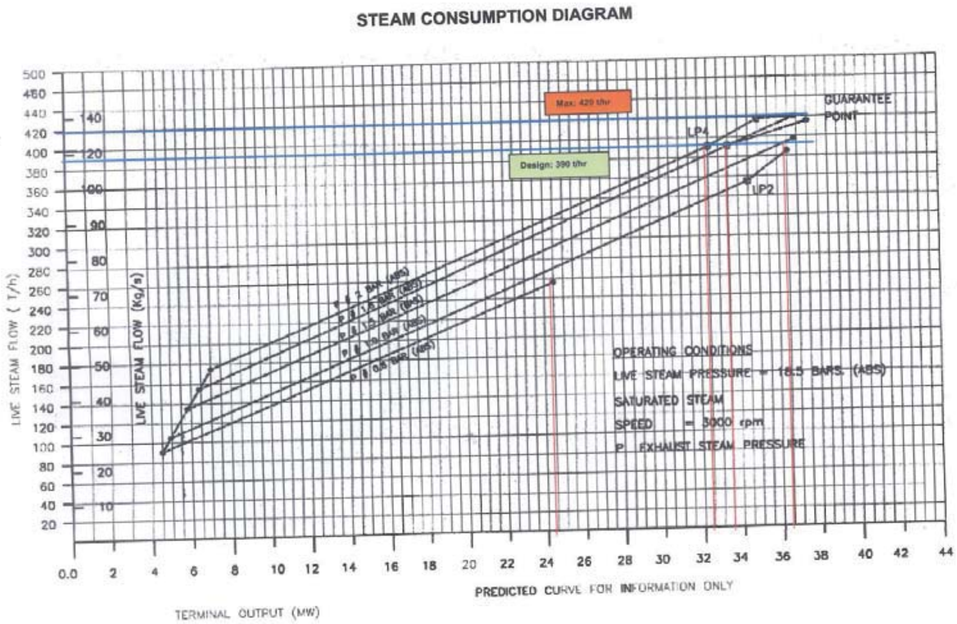
Water power nexus : BPST

With BPST arrangement it is possible to produce more power with less steam (hence less fuel) if the steam extraction pressure is reduced but there is a limitation on the minimum extraction pressure



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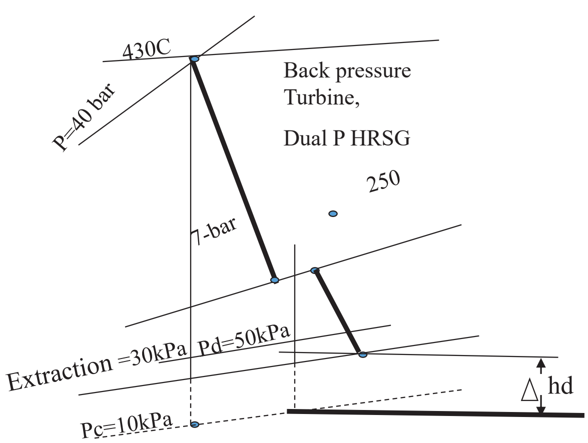
Possible optimization solution



If the back pressure is high in the order of in excess of 5 bar a low pressure turbine can be retrofitted.
But design for MSF and MED is based on low pressure such as 2 to 3 bar back pressure it is highly unlikely to get a low pressure turbine.

In some cases re-profiling would be possible ? But with efficiency losses

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Possible optimization solution

Lower the extraction steam as much as it is possible considering the limitation in the steam turbine and steam pipe size and condensing possibilities and mist formation.
Lower extraction pressure would bring about a lower heat rate.

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Possible optimization solution

Example

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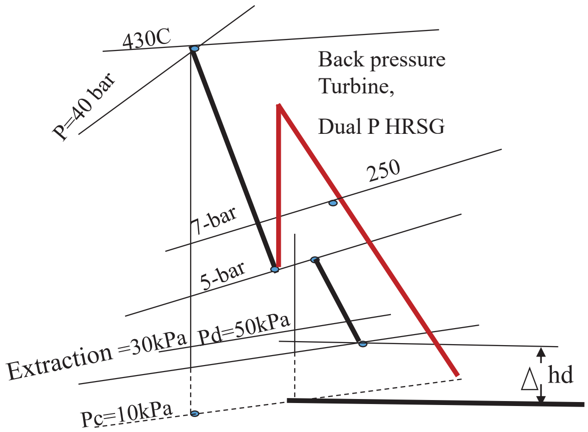
Possible optimization solution



Re Heat and condense

This is possible option that would enable a substantial additional power generation and fuel savings… but high CAPEX

Re Heat will required additional heat source(energy) if no waste heat is available.

Limited manufacturers of such low pressure steam turbine/retrofits is also a constraint.

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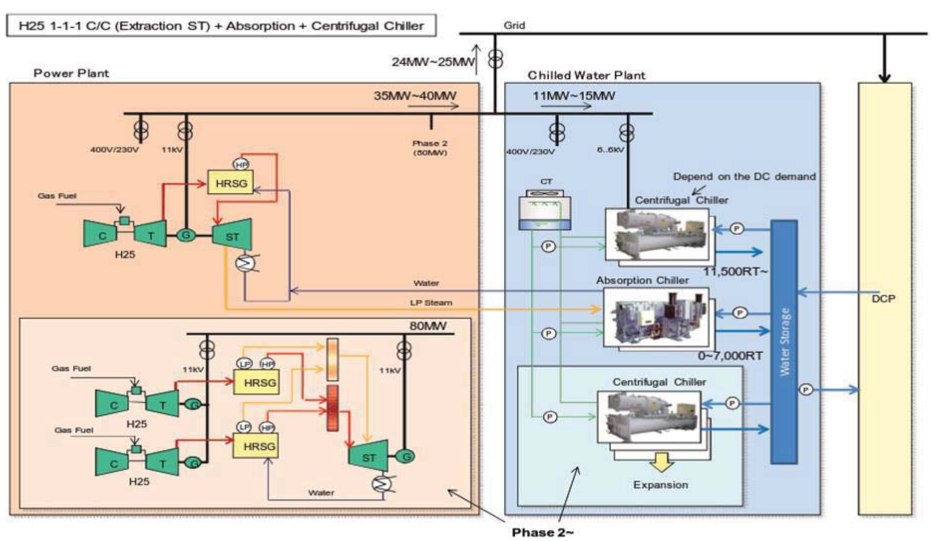
Possible optimization solution



- Power generation can be used to drive the rotary chillers
- Low pressure steam through extraction or through a low pressure generation source can be used to drive Vapour Absorption Machines

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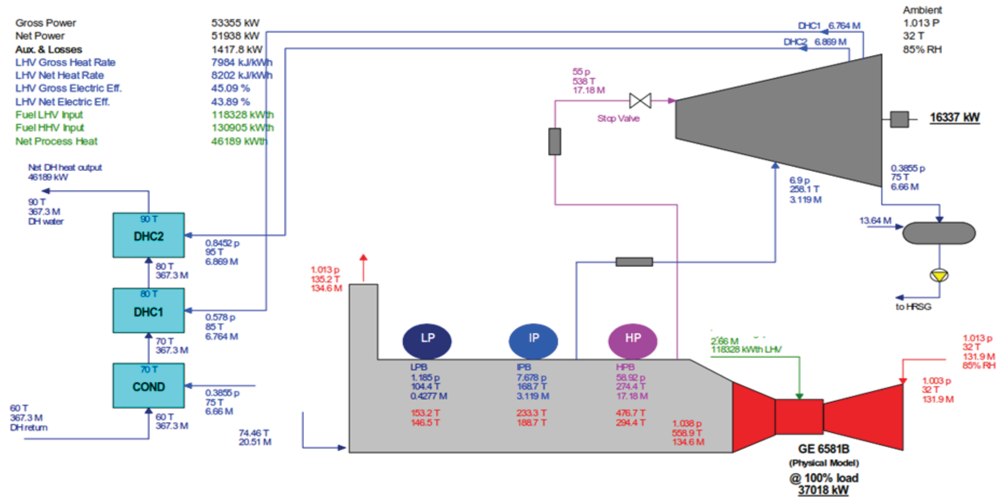
Possible optimization solution



Based on the available surplus steam due to MSF retirement, configuration of the power-chiller integration will be modelled.

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Heat reclaiming

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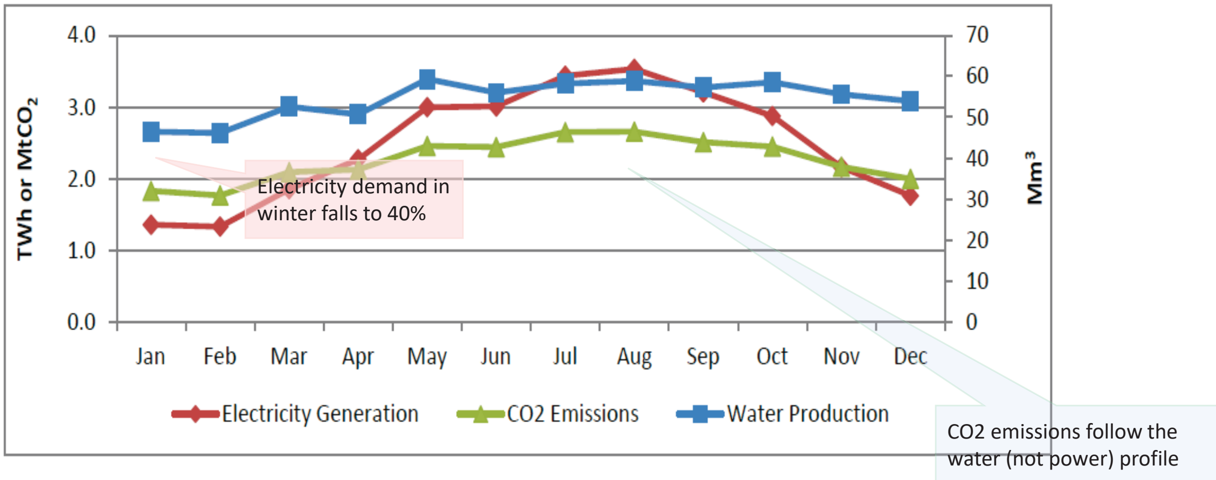
Possible optimization solution



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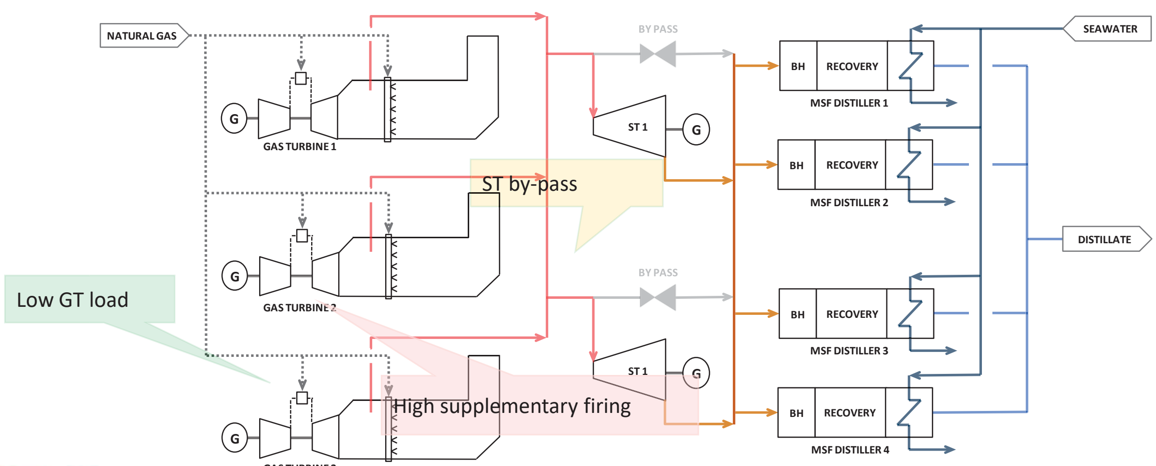
Possible optimization solution



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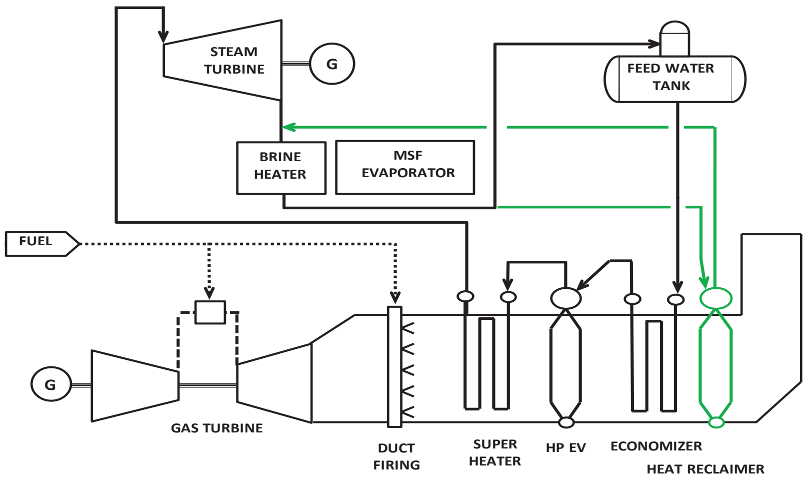
Possible optimization solution



A new low pressure cycle has been retrofitted taking advantage of the waste heat at low temperature.

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Possible optimization solution

Taweelah A2 Power-Desalination Plant, commissioned in 2001, was the first IWPP in the Gulf region under the privatization scheme promoted by ADWEA

Producing 720 MW by a Combined Cycle and 50 MIGD by four MSF distiller, was considered at that time the most efficient dual-purpose plants operating in the region

A high level of supplementary firing in the HRSG is required to match the large seasonal power-water demand fluctuations

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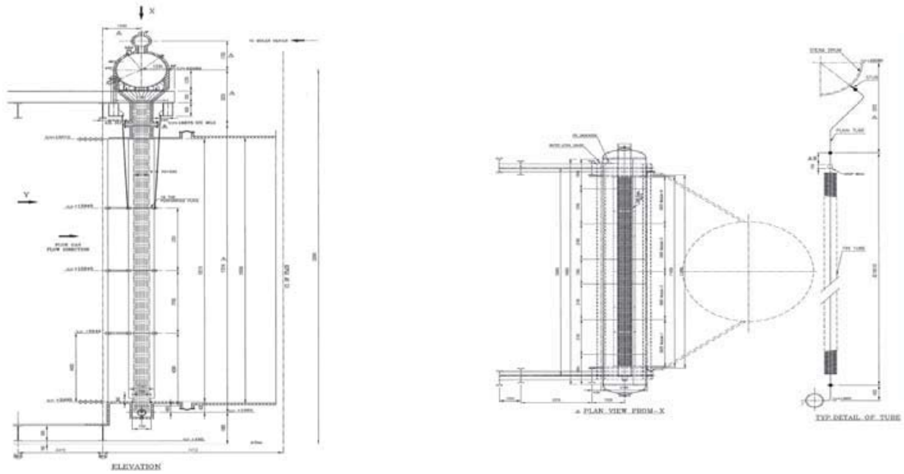
Possible optimization solution



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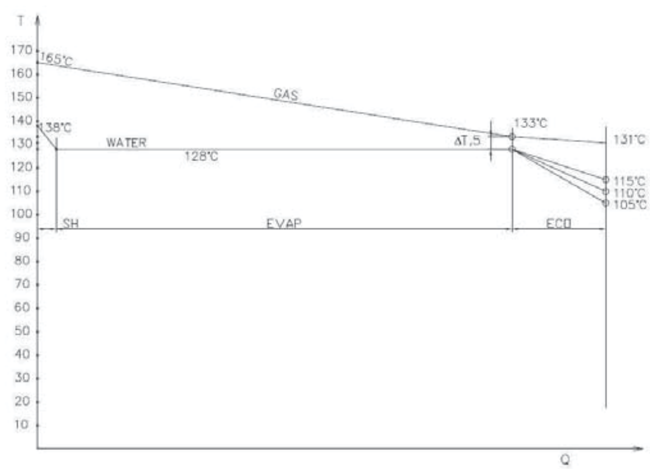
Ref: Molinari et all 2005

Possible optimization solution



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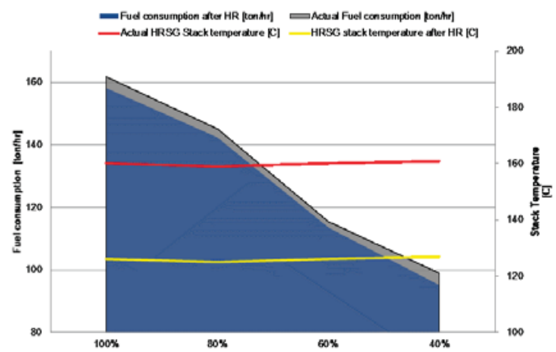
Ref: Molinari et all 2005

Possible optimization solution case study

The same project is now under installation in Fujairah



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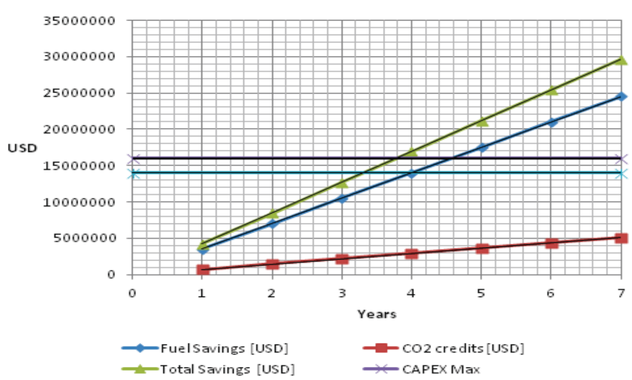
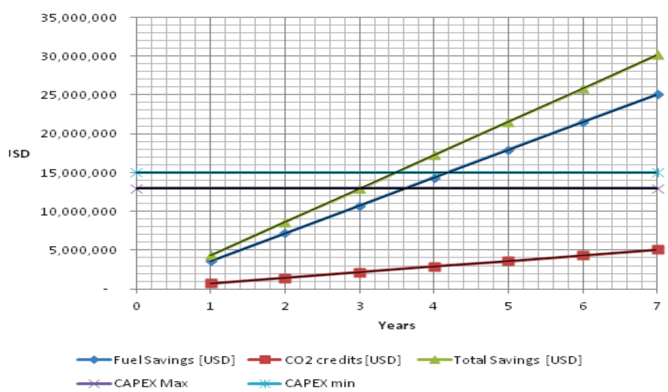
Possible optimization solution

Scenario 1 - Break Even Analysis Fuel savings
Fuel Price 3.62 USD/MMBtu



Scenario 2 - Break Even Analysis Fuel savings
Fuel Price 3.62 USD/MMBtu



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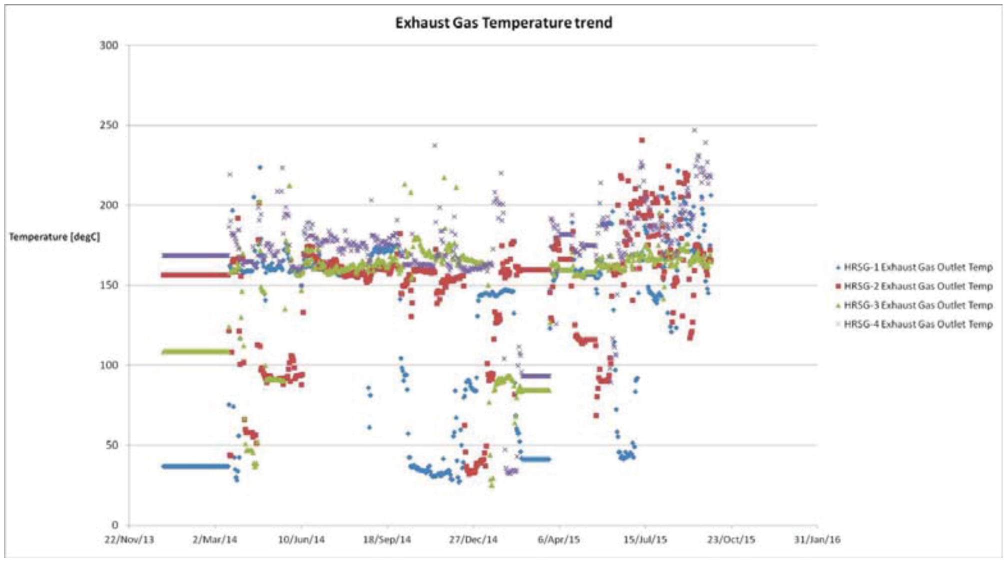
Possible optimization solution : case study



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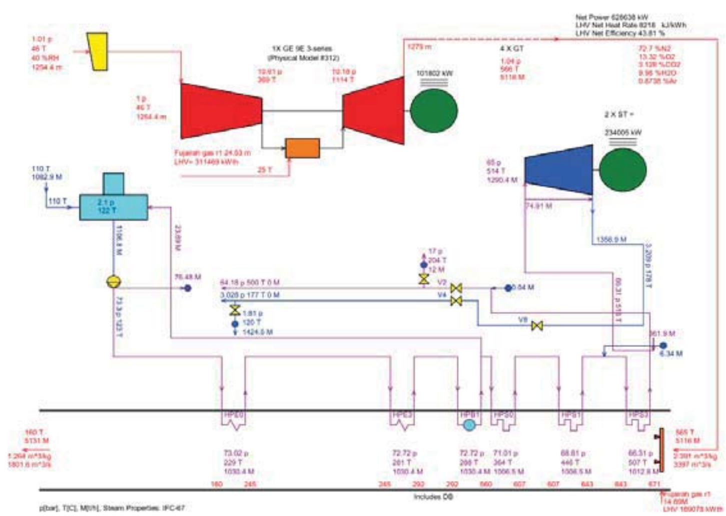
Possible optimization solution : case study

Case 1: 100% base load (9E)



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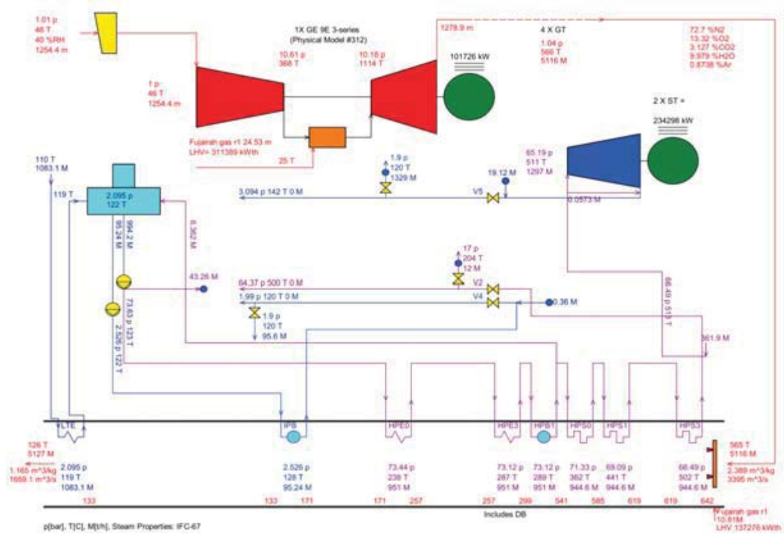
Possible optimization solution case study

Case 1A-1:
100% LP steam
generation (9E)
at 2.5 bar with
HR



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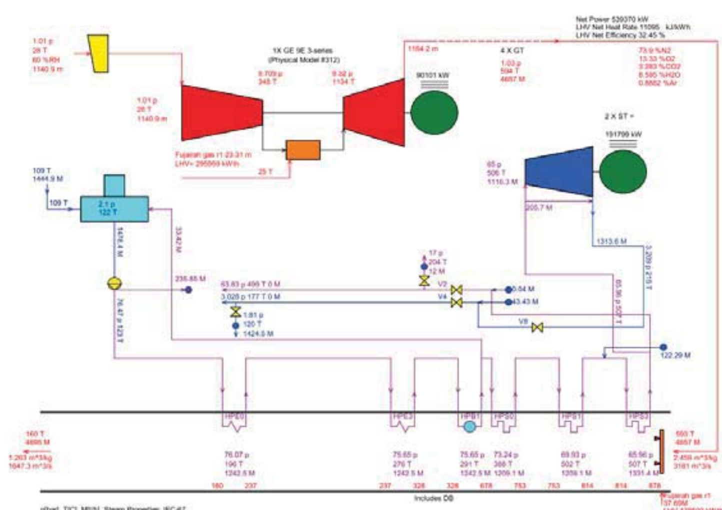
Possible optimization solution : case study

Case 1C-1: 60%
LP steam
generation at 2.5
bar with HR



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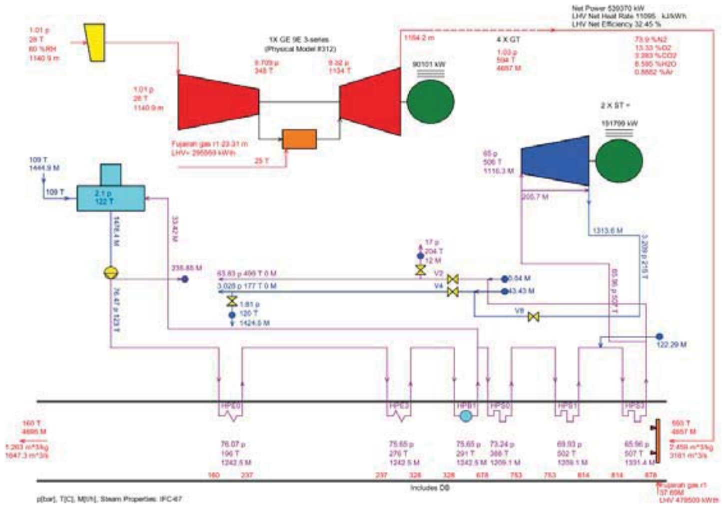
Possible optimization solution : case study

Case 1C: 60% reference case



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