Deep Ocean Water Applications

Power and Freshwater Technologies for Hawaii

Presented to

Rebuild Hawaii Consortium

By

Manfred J. Zapka, Ph.D.

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Marc M. Siah & Associates, Inc.
Consulting Engineers

www.mmsengineering.com

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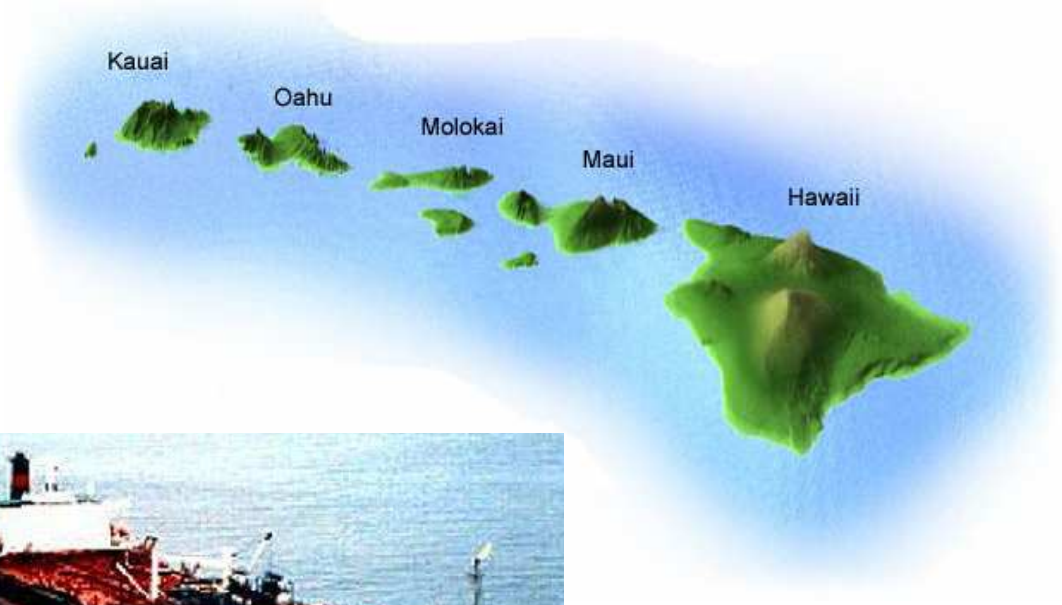
The views presented in this presentation are the opinions of the author and do not necessarily reflect the opinions of Marc M. Siah & Assoc., Inc.

Two top challenges for Hawaii



Energy = Oil **(for Hawaii)**

Project Example 1

Optimized desalination process using the renewable thermal resources of the ocean

Ocean Thermal Gradient Desalination OTGD

Freshwater

Challenge for Hawaii natural freshwater supply is approaching capacity limits

One supply solution Desalination

Available Desalination Technologies:

Reverse Osmosis

~ 80% of all desalination in US

Membrane

Distillation

~ 15% of all desalination in US

Thermal

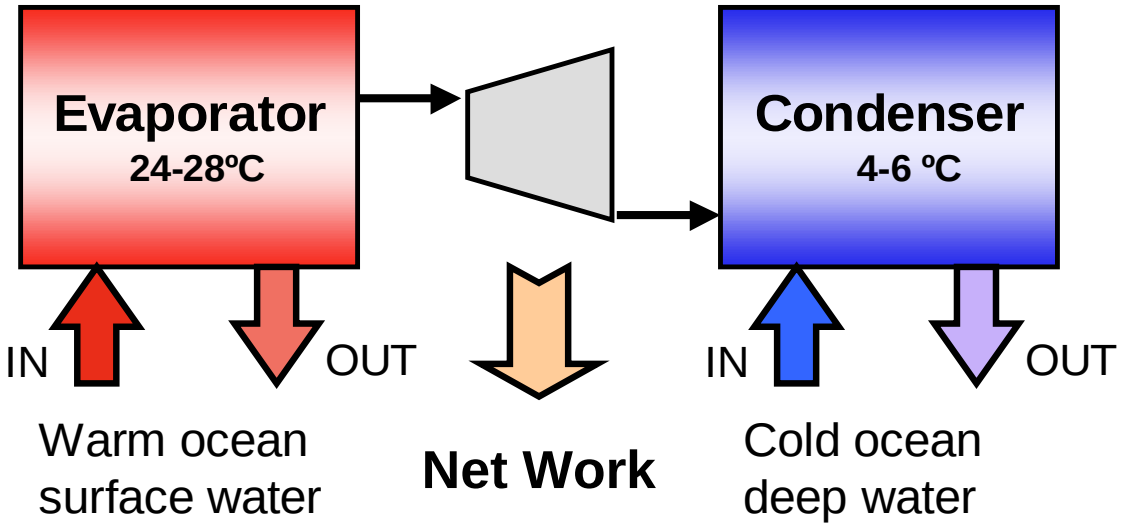
HONOLULU BOARD OF WATER SUPPLY

Deep Ocean Water Application Facility

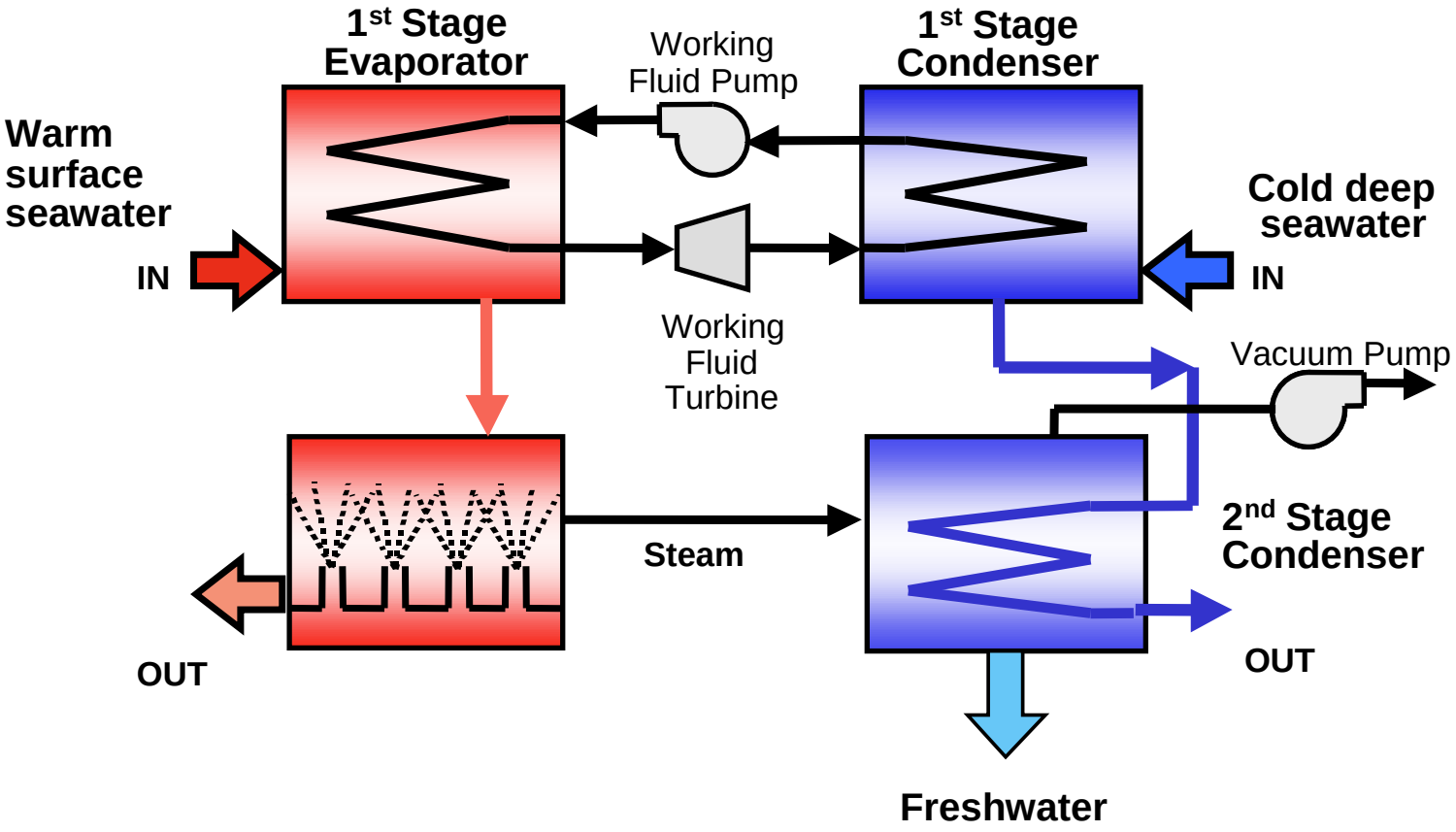
Meeting the Challenge to Satisfy Hawaii's Growing Future Freshwater Needs

freshwater production In combination with OTEC = distillation

OTEC is a ***Heat Engine*** which uses the warm surface water as the Hot Reservoir and the cold deep water as the Cold Reservoir



Conventional combined OTEC-Freshwater Unit



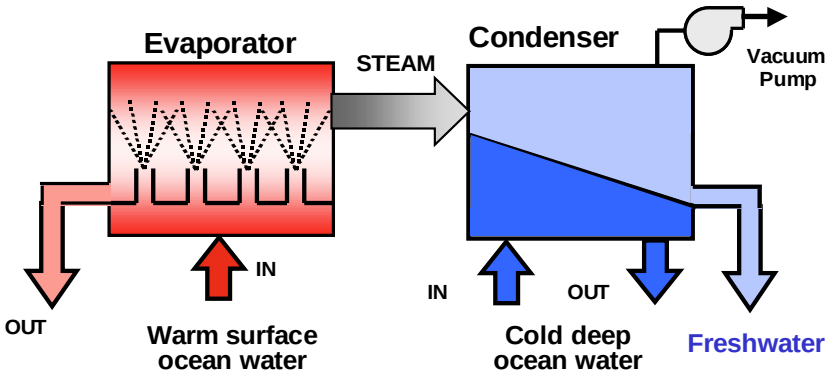
Critical issue in OTEC – Cold Deep Ocean Water (DOW)

Deep Ocean Water Pipe = expensive and hard to built

Optimization of the OTEC process to lower DOW pipe size and length

Optimization:

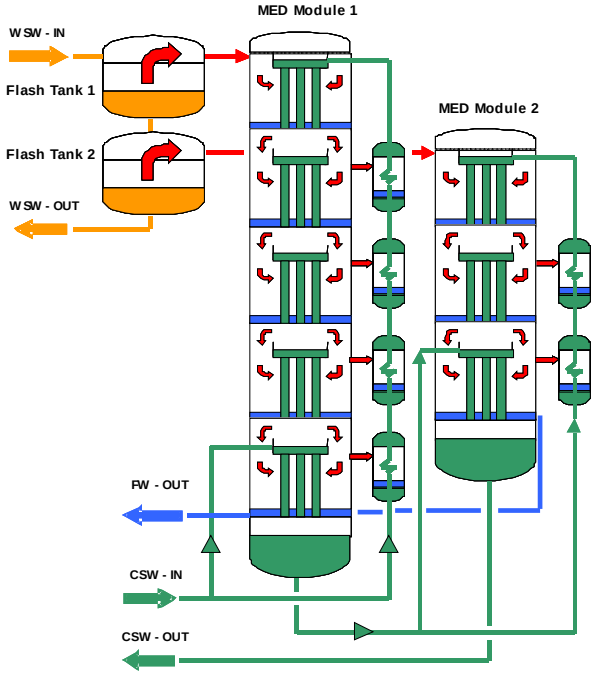
Conventional process = single stage flash evaporation



DOW / FW = 90-140

Need DOW pipe 13 feet diameter

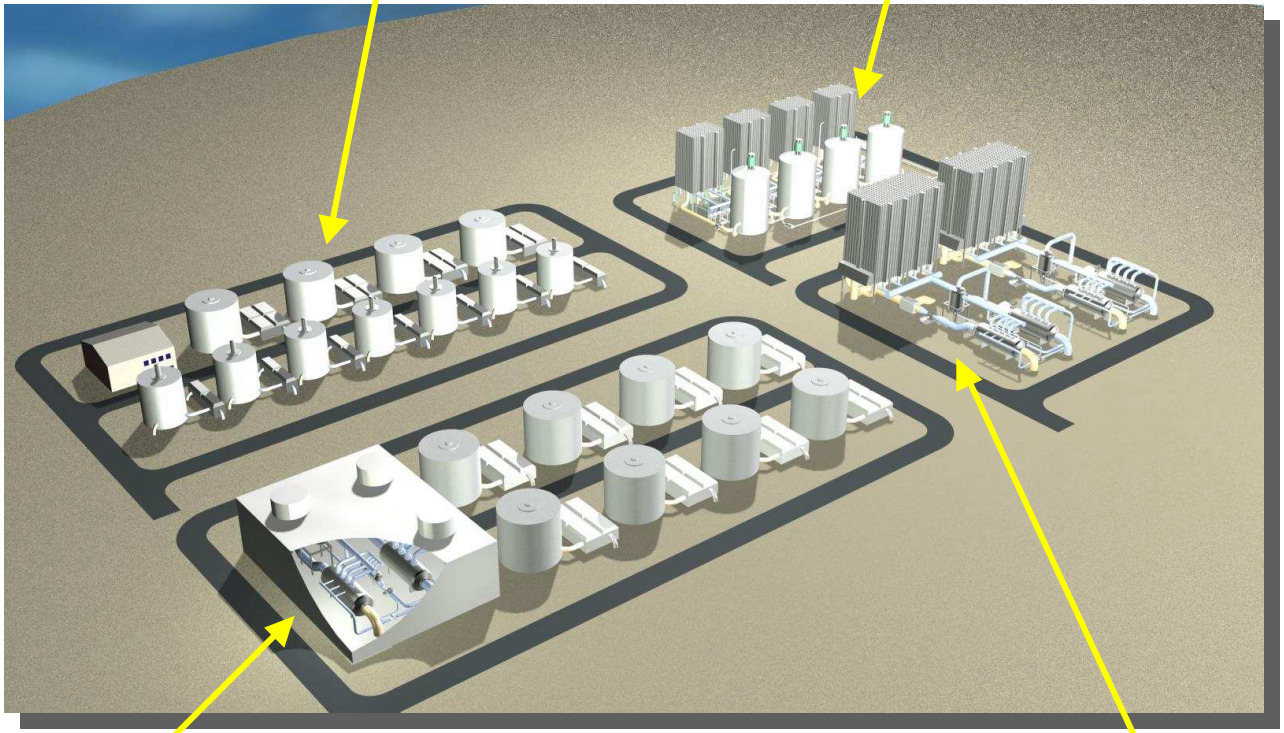
Optimized process = Multiple Effect Desalination (MED) with multiple modules



DOW / FW = 20-25

Need DOW pipe 6 feet diameter

Optimization of OTGD process integrated in OTEC



Development of Stand-alone DOWA-MED applications

Connected to thermal power plant direct seawater cooling system

WSW IN

OUT

MIXED DOW & SOW

IN

DOW

IN @ 77ºF

OUT@ 84ºF

SOW

Seawater coolant heat @ 7 deg F; 900 million gal per day

Diesel equivalent:

9,000 barrel = $650,000 per day

DOW / FW = 14

Need DOW pipe 5 feet diameter

DOW pipe at NELHA Big island

System Performance

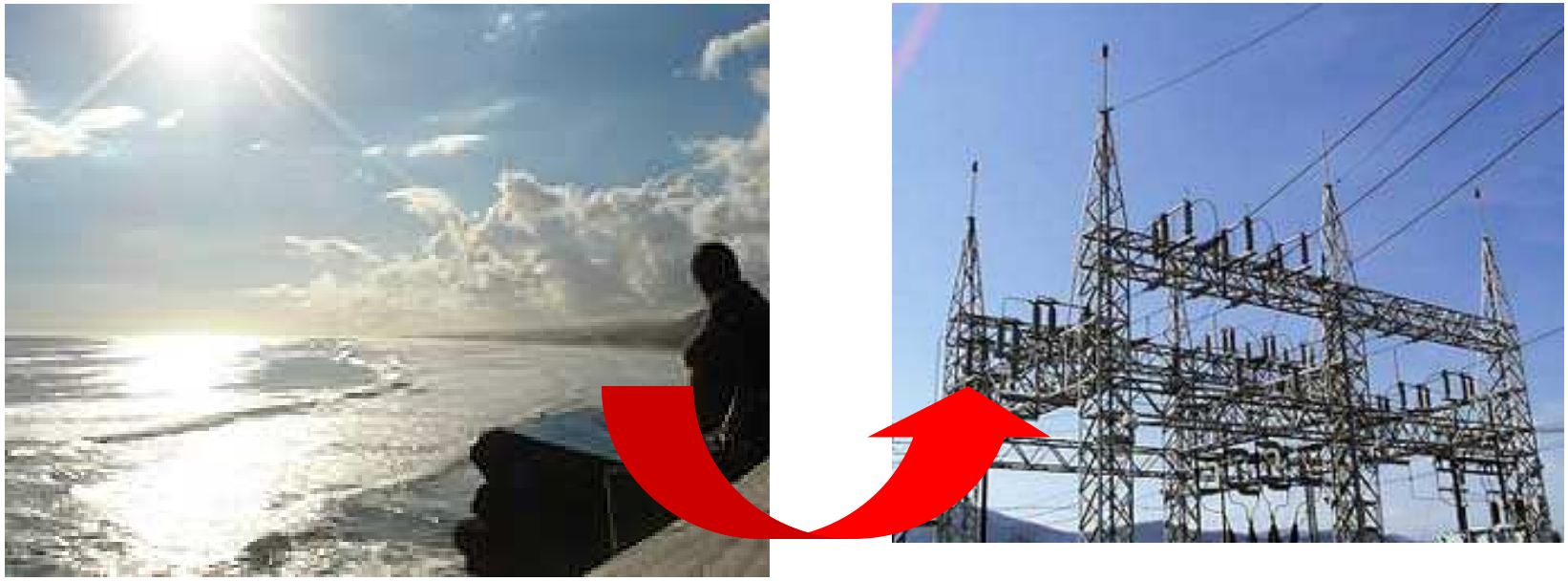
Reverse Osmosis Plant SWRO	
5	MGD design size
85 ppm Cl-	chloride level
~ 4.5 kWh / cbm	energy use
3.50	MW
$2.00	energy cost / kgal @ $120/MWh
$2.40	other O&M inlc. Replacement of membrane
$4.40	**per kgal total O&M**
~ $ 55,000,000	**Construction costs**

Stand alone DOWA-MED integrated into Power Plant	
5	MGD design size
6	MGD with power plant
7.5	MGD after blending
85 ppm Cl-	chloride level
~ 2.0 kWh / cbm	energy use
1.80	MW
$1.00	energy cost / kgal @ $120/MWh
$1.70	other O&M inlc. Replacement of of tube bundles
$2.70	**per kgal total O&M**
~ $ 50,000,000	**Construction costs**

Project Example 2

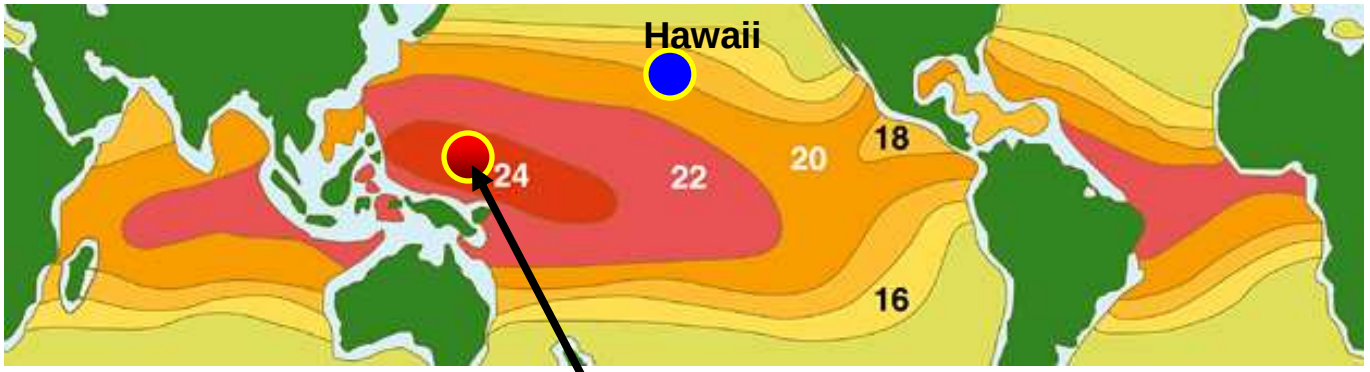
Design of an OTEC plant for an Island in Micronesia

Ocean Thermal Energy Conversion (OTEC)

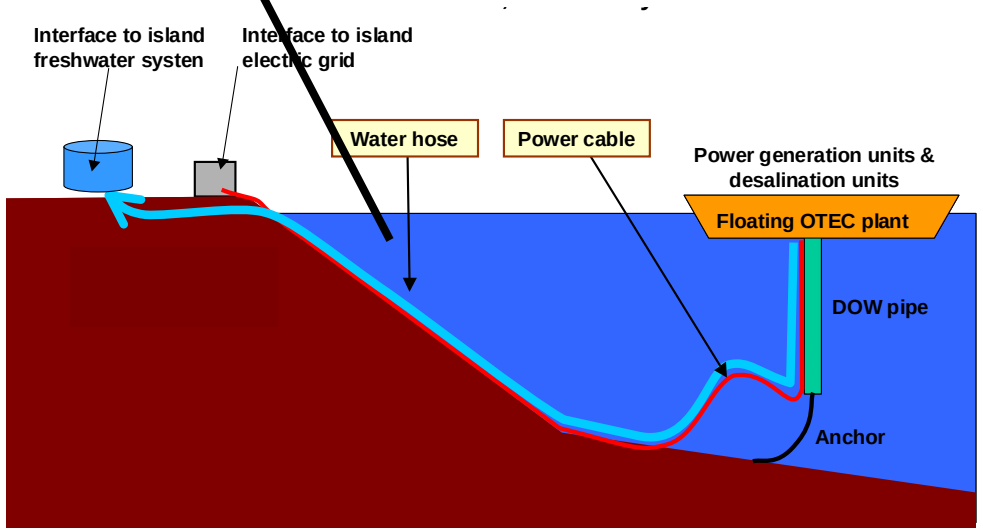


Electricity from the renewable resource of the Ocean

6 MW net OTEC plant for island in Micronesia



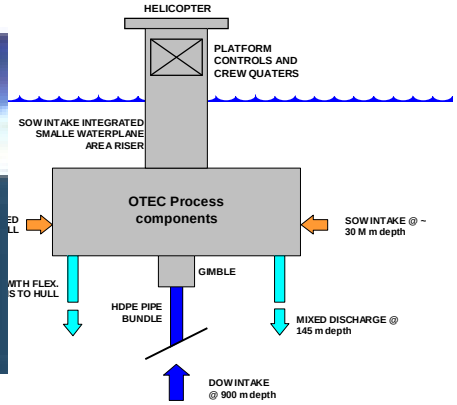
Map shows Delta T between SOW & DOW



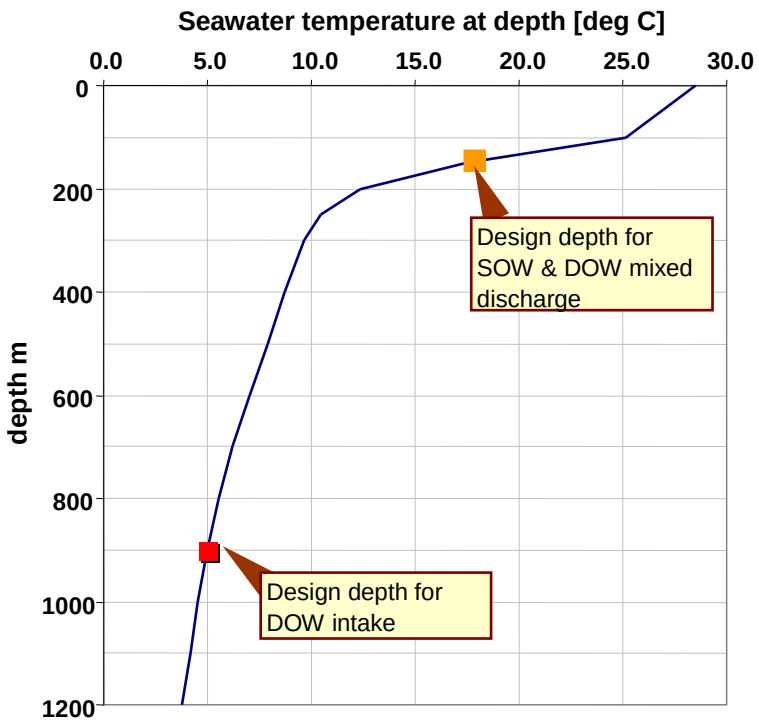
Two types of floating platforms considered

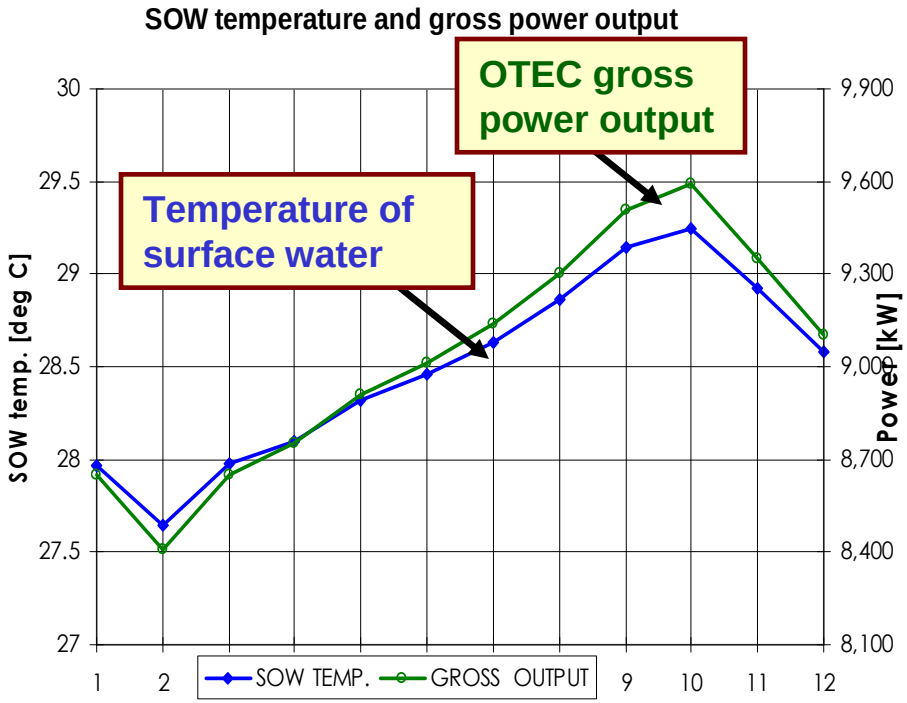
Conventional offshore barge / converted ship

Advanced semi-submersible / small waterplane area platform

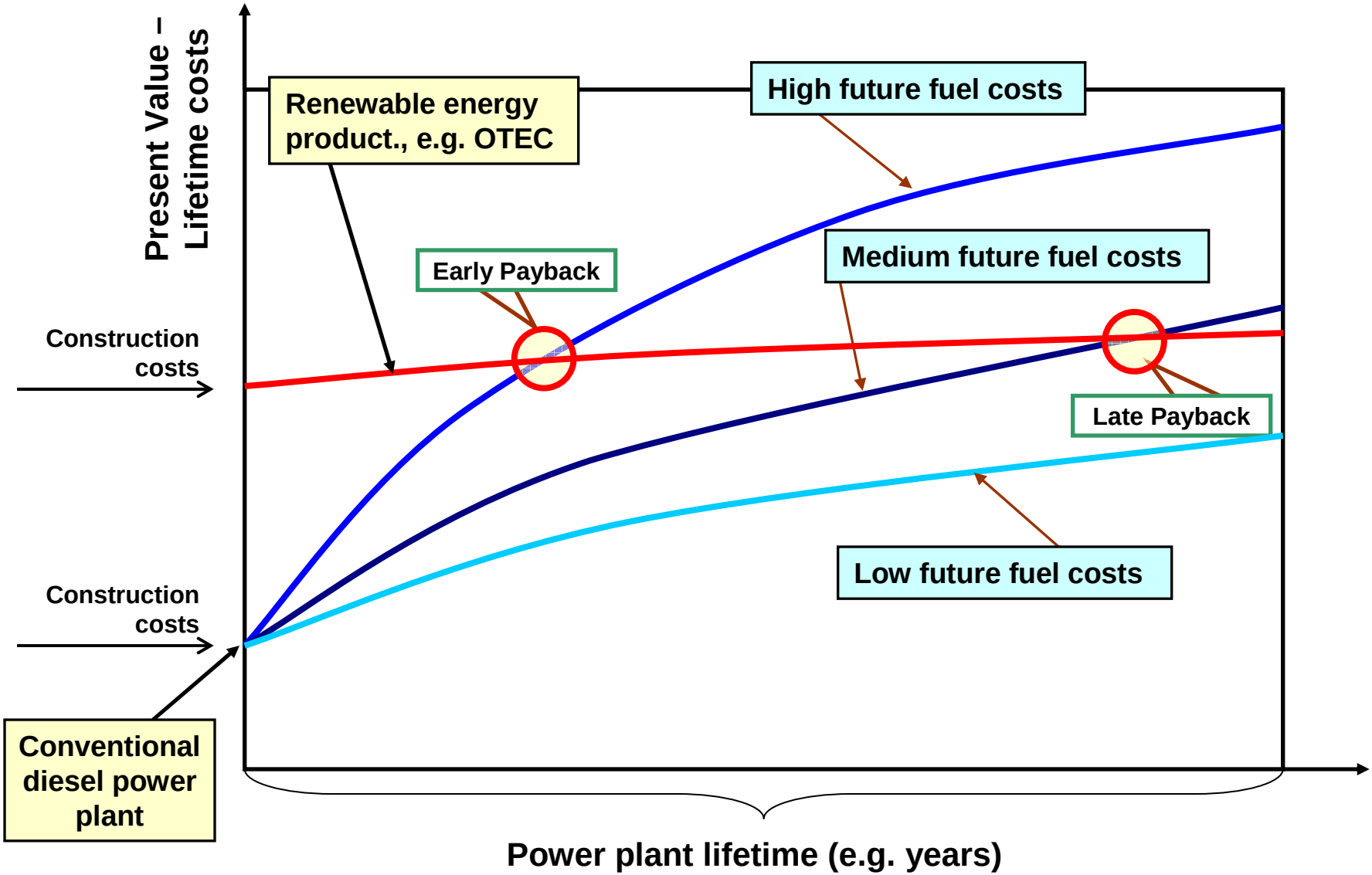


Process characteristics

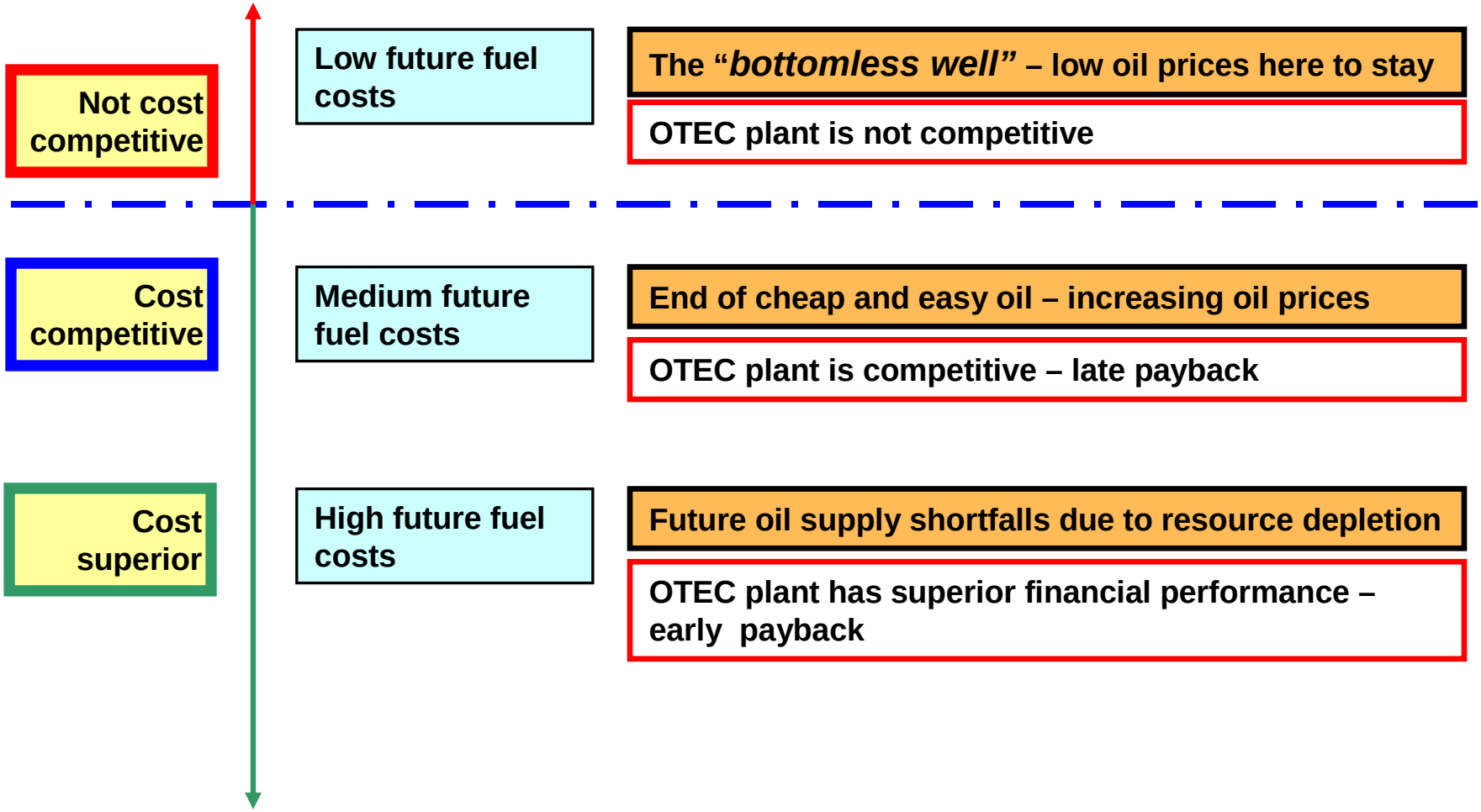




Economic Performance



Future oil prices – determine payback

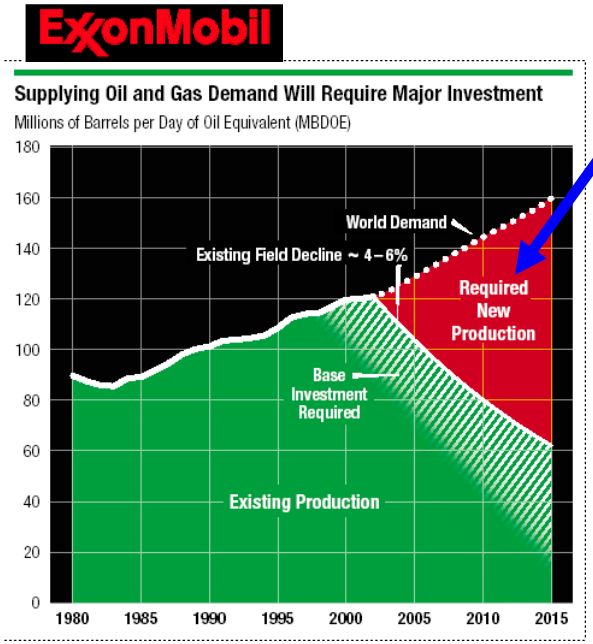


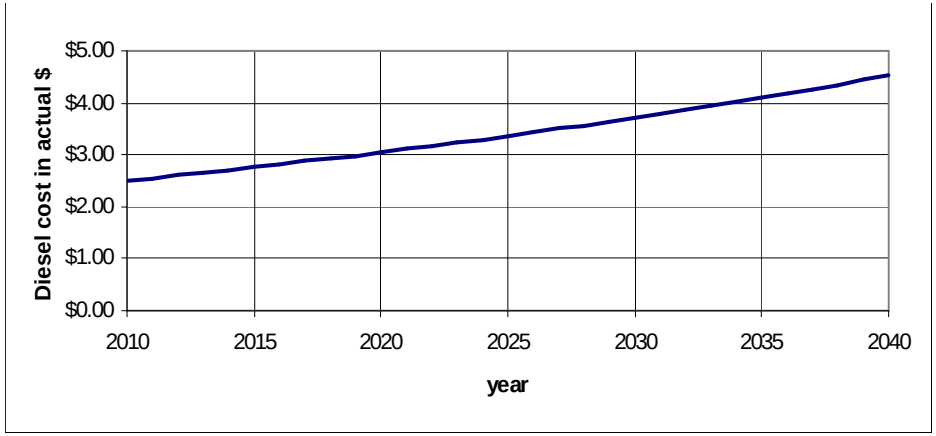
Defining future oil price scenarios

Medium future fuel costs

End of cheap and easy oil – increasing oil prices

Challenge = filling supply demand gap with increasingly difficult and costly oil products (new smaller conventional fields, unconventional oil, synthetic oil & fuel)





"Low oil cost scenario" for OTEC plant assessment

(2% rise is very optimistic)

Defining future oil price scenarios

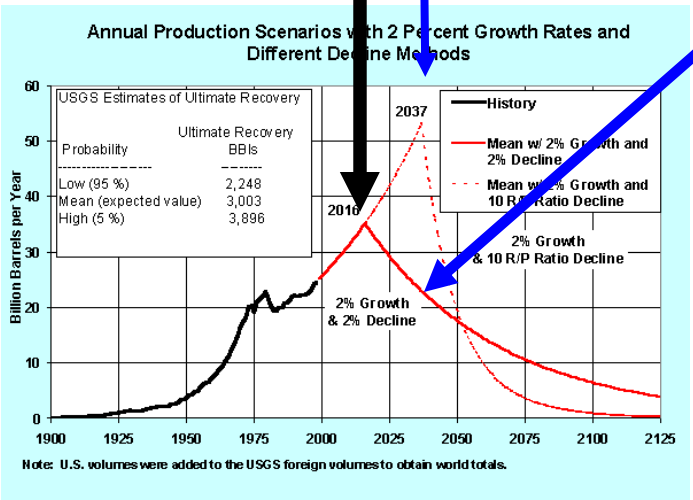
High future fuel costs

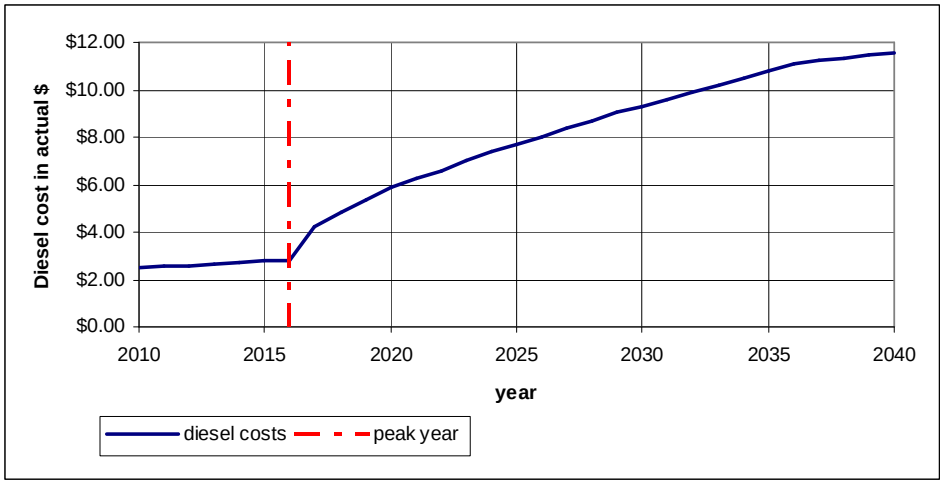
Future oil supply shortfalls due to resource depletion

Challenge = supply shortfalls in conventional oil create perpetual fuel crisis; decline in supply is inevitable and require mitigation

Peak in 2037

Peak in 2016





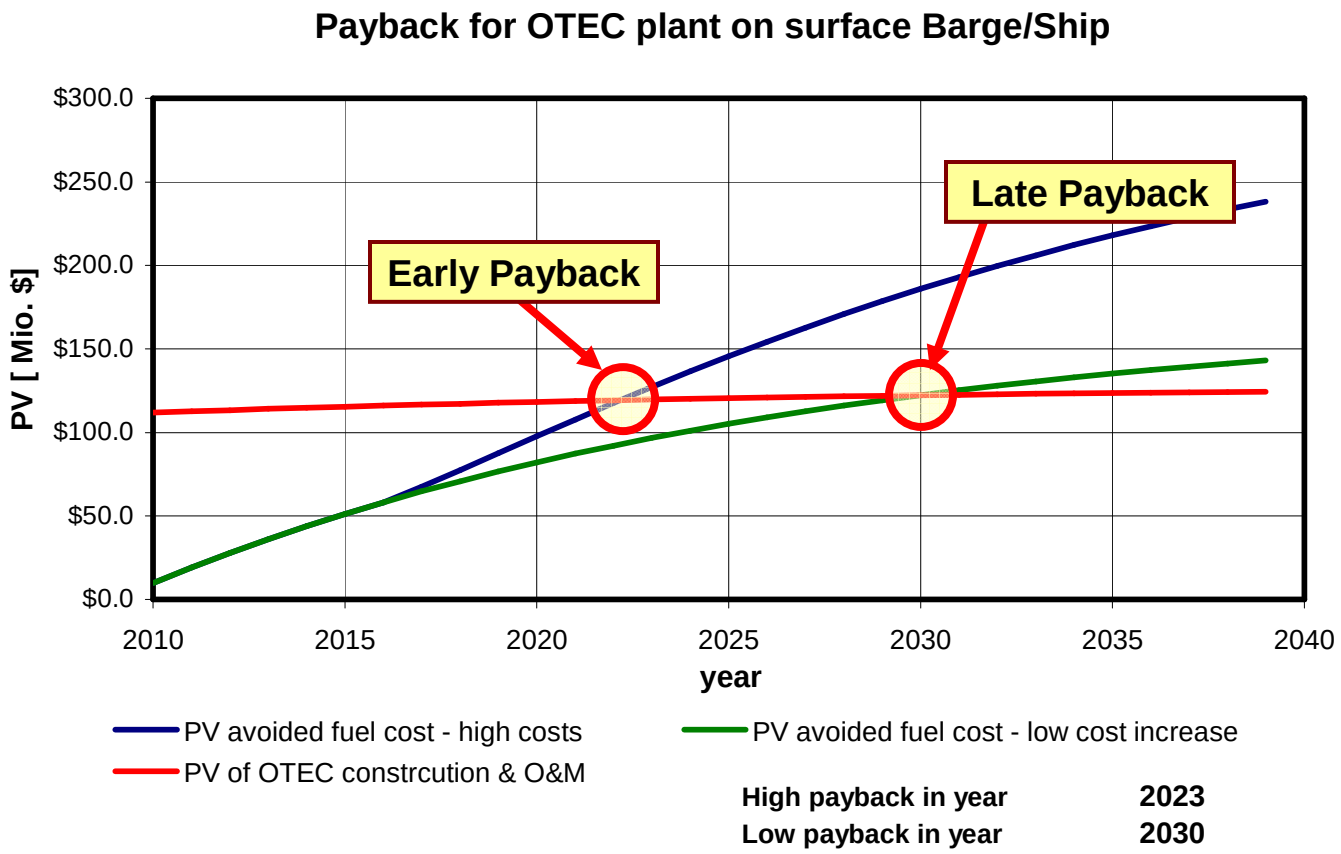
There is a 50% probability that 3,000 Gb or more are available as recoverable oil resource

3000 Gb Ultimately recoverable = "Expected" value

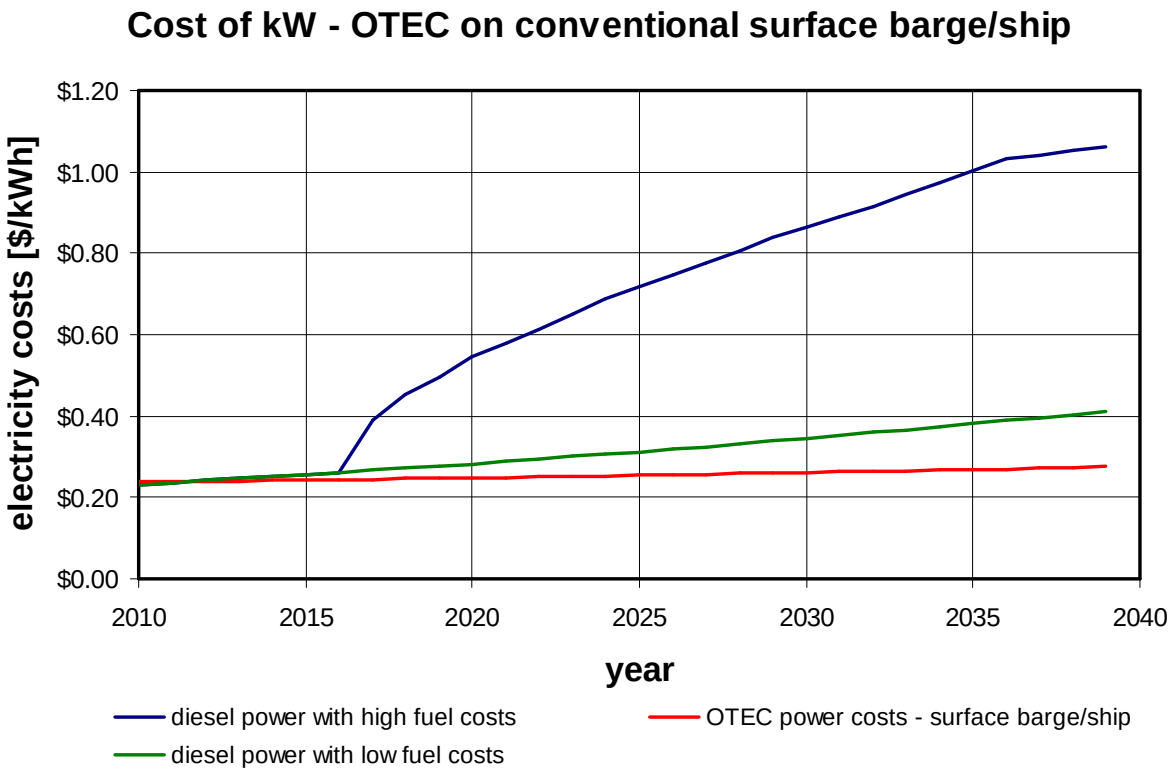
"High oil cost scenario" for OTEC plant assessment

Scary but realistic

Payback scenarios



Future electricity costs



Conclusions:

- Assessing competitiveness of future OTEC plants entails a critical look at a future world, where oil will not be dominant
- Energy-efficient technology is becoming readily available ..
- **But …**Biggest obstacle to implementation is the readiness to Energy Change, human beings are resistant to difficult Change
- Energy Change requires future vision and mental ability to cope with new and out of the box energy scenarios
- Early mitigation will be most crucial to manage declining availability, affordability, sustainability and security of future energy supply – Waiting until energy crisis happens spells dooms for Hawaii … **Peak Oil is huge Risk Management Problem .. Not only for Hawaii**

Thank you

Marc M. Siah & Associates, Inc.

Consulting Engineers

mzapka@mmsengineering.com