New technologies for storage (existing and to be tried)

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ENERGY OPTIONS FOR SIDS: TECHNOLOGIES, TOOLS, TARGETS AND TRAINING

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Why storage?

ENERGY SECURITY AND INDEPENDENCE

Only Local Source of energy

- Solar
- Wind
- Hydro
- Biomass
- Waste to energy

Storage is necessary for wind and solar

(Assume oil will not be discovered)

NEED TO ELIMINATE FOSSIL FUEL

To avoid dangerous consequences of climate change

To limit CO_2 concentration to 450 ppm

- Eliminate most fossil fuel by 2050
- Available non-fossil sources of energy, such as wind and solar, require storage

Variability of Energy Sources and Grid Stability

Present electricity grid (transmission and distribution lines) can only take about 20% variability (departures from normal power generated)

e.g., If power is supplied by wind or solar, the power generated should only fall by 20% of the total during period of calm or very overcast day)

- Otherwise it will lead to over demand and grid instability leading to outages.

Wind and Solar are variable

Hydro, bio-mass, Waste to Energy are less variable and are considered firm or stable sources of energy

How much do we need and how much do we have?

Need 1300 MW of Power by 2029 (OUR Projection)

Guess 1500 MW by 2050

- 450 MW (30%) Variable
- 1050 MW (70%) Firm

How much firm Energy Potential do we have available from our own resources?

- Hydro ~ 80 MW Potential – PCJ Study
  - Present ~ 24 MW
- Waste to energy ~ 80 MW Potential – PCJ + Private
  - Present - None

How much Wind and Solar (Variable) Potential do we have?

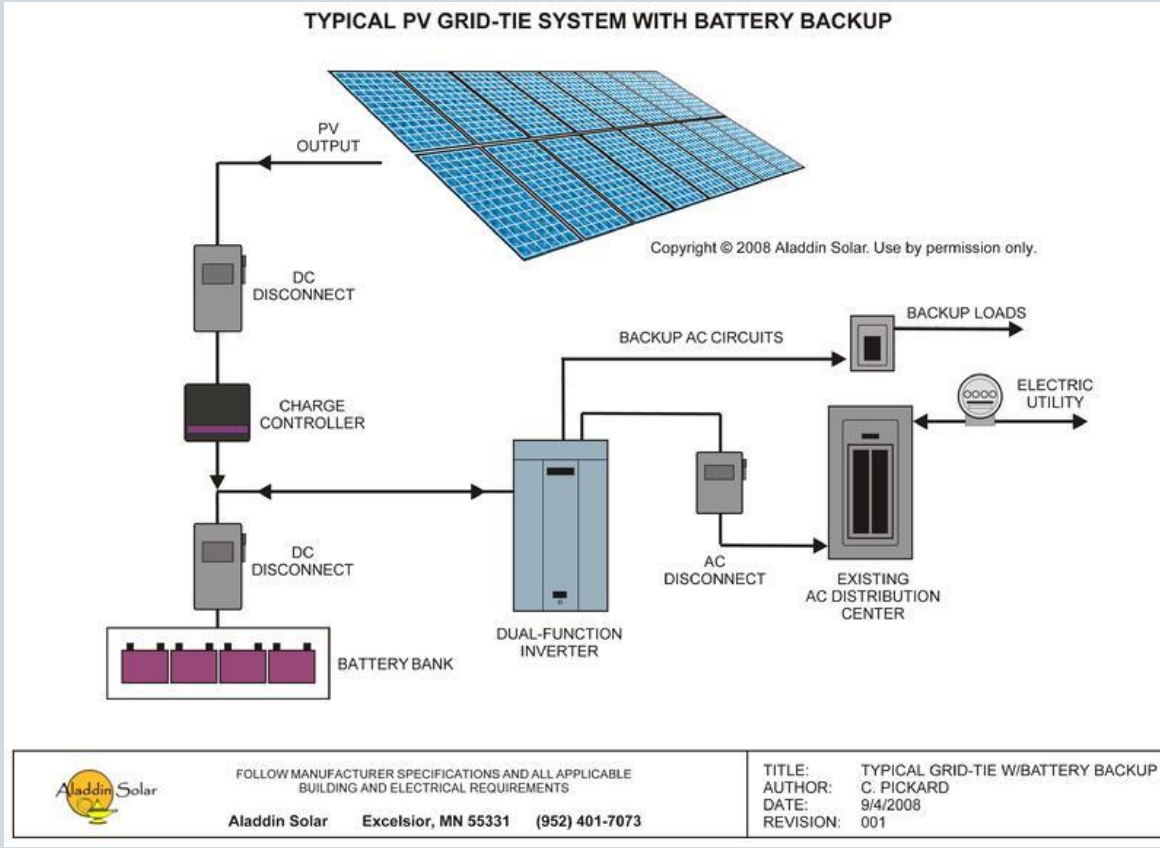
- Wind ~ 400 MW
- Solar ~ Much more than needed

Storage is needed if we are to provide all our energy needs by local sources

Need to store Wind and Solar Energy and extract from store when needed

Technology presently used in Jamaica on small scale:

- Lead Acid Batteries
- Not Economical
- Not suitable on large scale (MWs)



http://www.aladdinsolar.com/gridtiebatterybackup.html

Storage Systems for large scale electricity

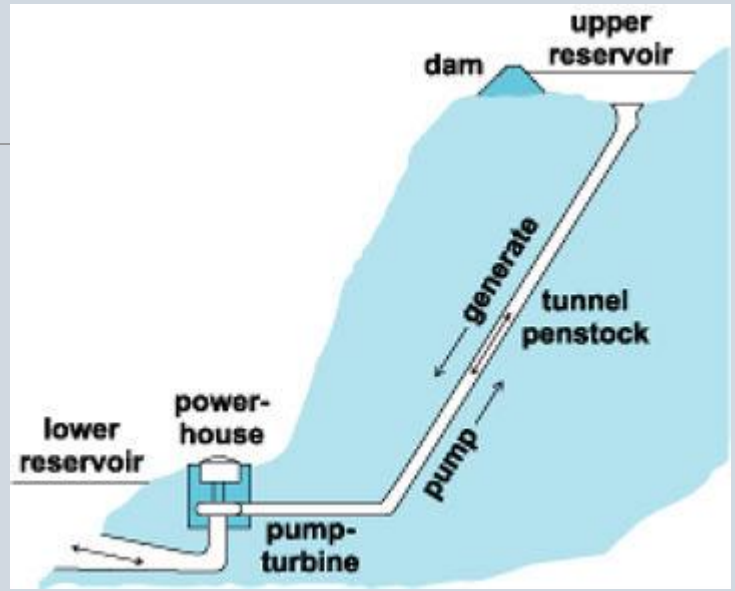
APPLICABLE TO JAMAICA	NOT APPLICABLE TO JAMAICA?
Solar thermal with storage	Compressed air or hydrogen stored in caverns ◦ Limestone
Ocean Thermal Energy Conversion (OTEC)	Liquid air (convert air to liquid and stored)
Pumped storage	Batteries, e.g., ◦ Flow ◦ Ni-Cd ◦ Lithium-ion
Storing energy under the sea (reverse of pumped storage)	Prohibitive cost will always be a factor for Liquid air and batteries?

Presently Used – Pumped Storage

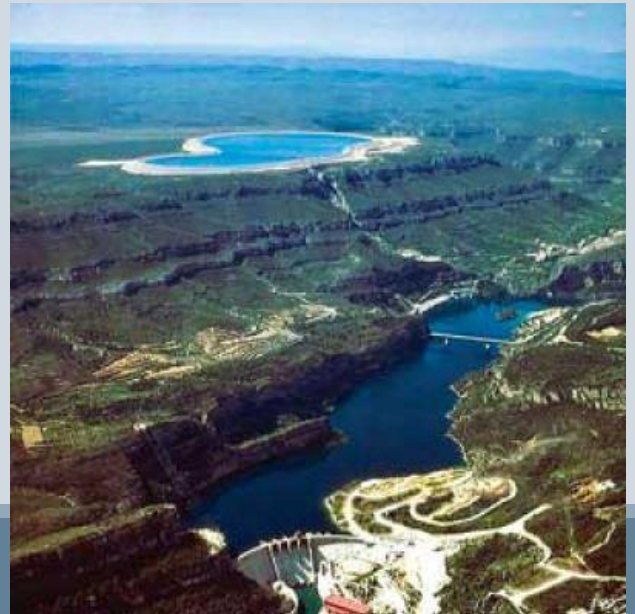
Pump water to elevated storage reservoir in times of excess renewable energy and recover by gravity in down-time or continuous basis

More expensive to operate compared to fossil fuel plant

Not much chance for making more economical?



Iberdrola's 635-megawatt La Muela pumped storage facility



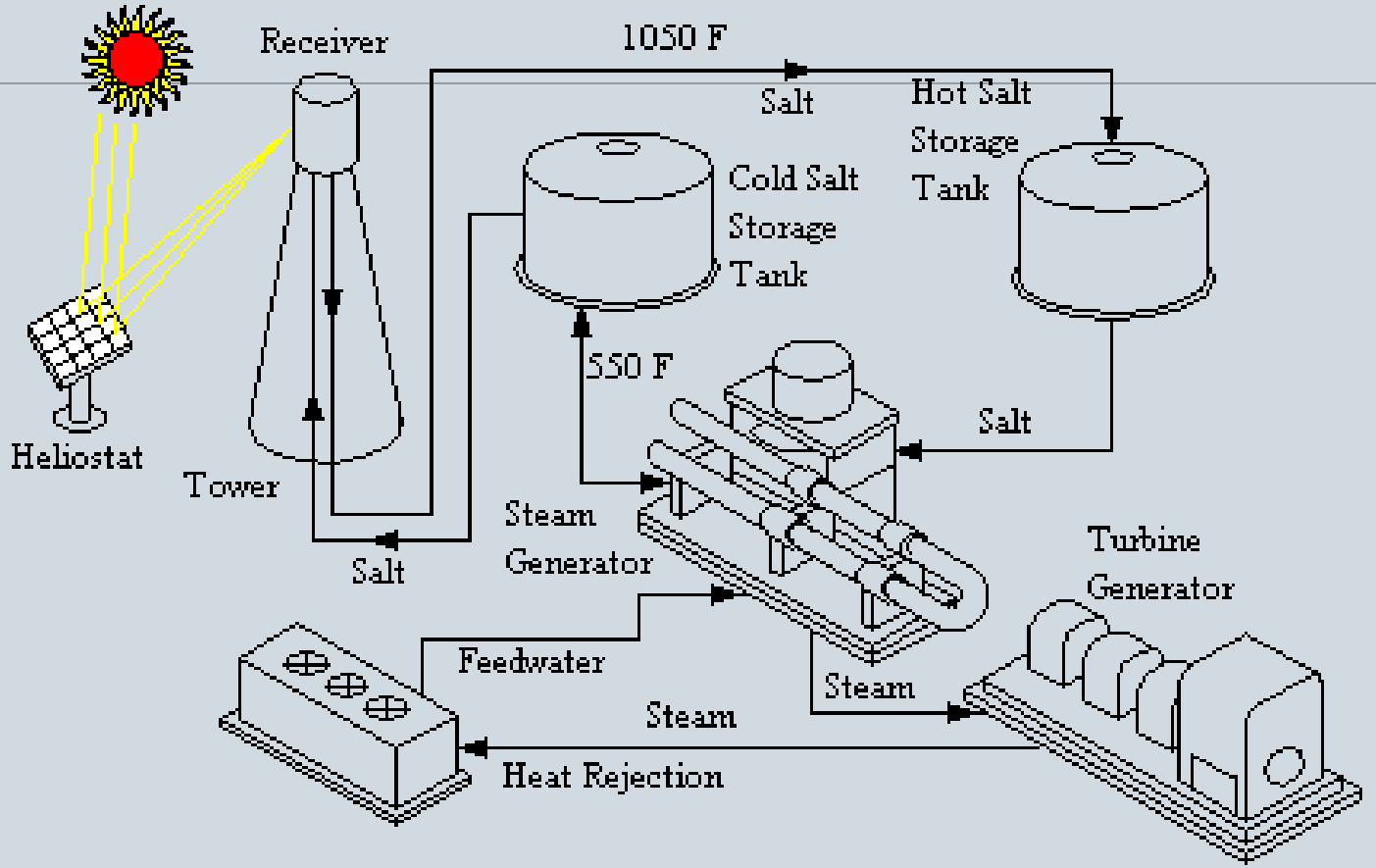
Alternatively, Pump air under sea

Presently Used - Solar Tower with storage

Sun's energy concentrated by mirrors
Concentrated solar Power (CSP)

http://www.torresolenergy.com/TORRESOL/gemasolar-plant/en

Schematic Solar tower thermal power plant with storage



More expensive to operate compared to a fossil fuel plant

Environmental Issue

Located in remote location to avoid bright sunlight

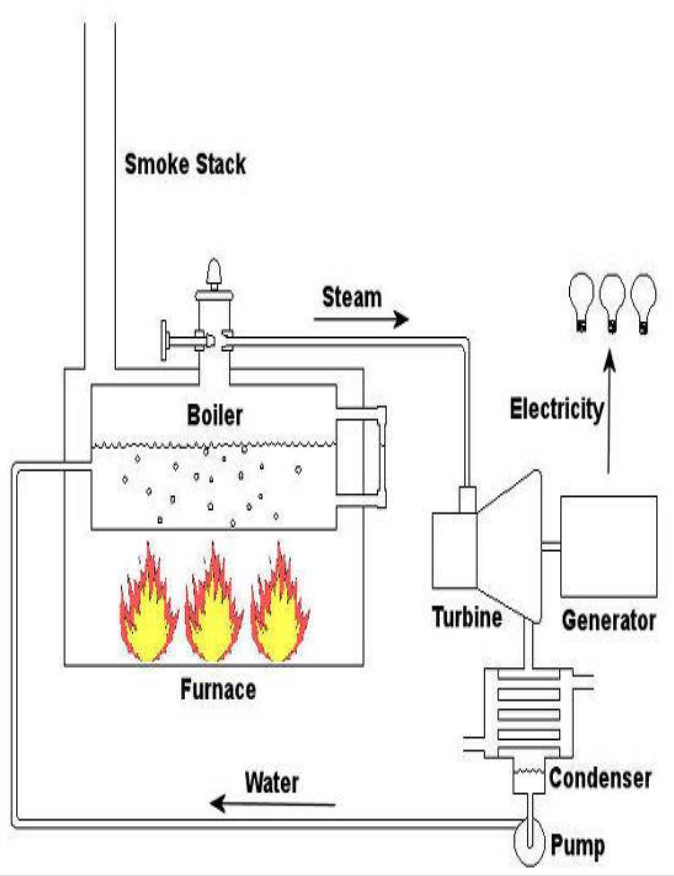
Heat singes feathers of birds

In Development
Ocean Thermal Energy Conversion (OTEC)

Uses the huge amount of solar energy stored in the ocean

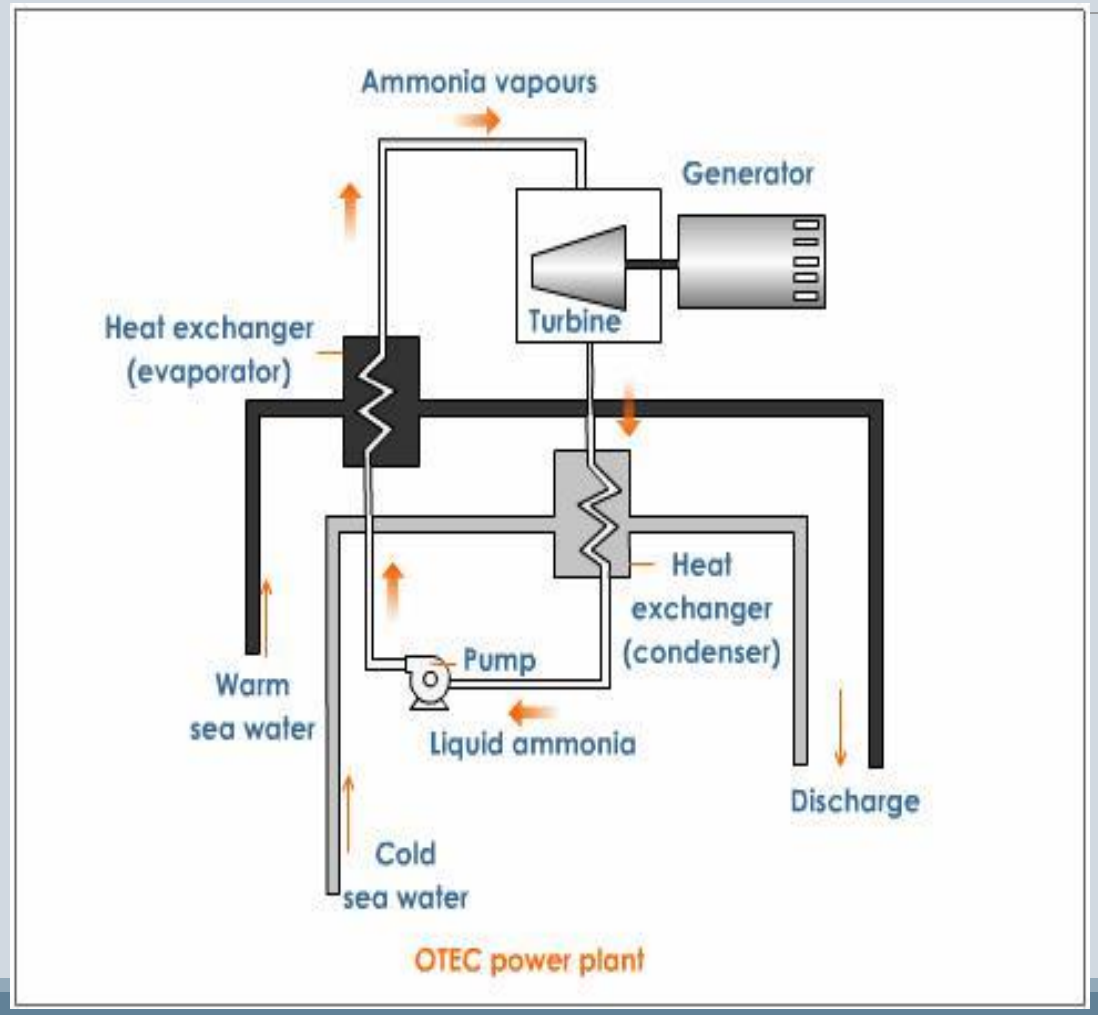
OTEC uses temperature difference between top (hot) and lower depths (cold) of the ocean/sea

Like a steam turbine generator

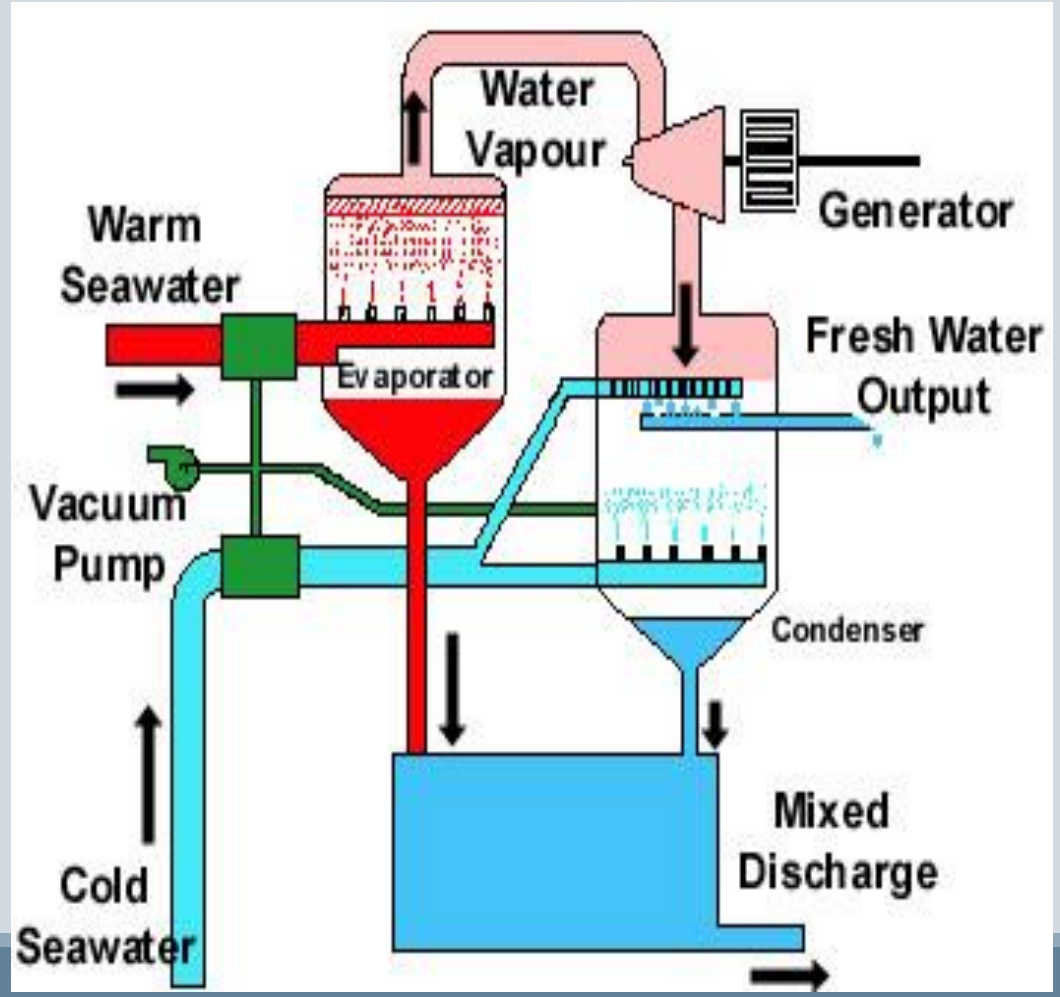


STEAM TURBINE	OTEC
Water	Substance that boils easily, e.g., ammonia or water in vacuum
Boiler fuelled by burning oil to produce high pressure steam	Boiler fuelled by warm surface of ocean to produce high pressure vapour
Turbine/generator driven by steam	Turbine/generator driven by vapour
Cold Condenser to turn steam back to water	Vapour condensed by colder water pumped from deep under surface of ocean
Process repeated	Process repeated

OTEC – Closed Cycle

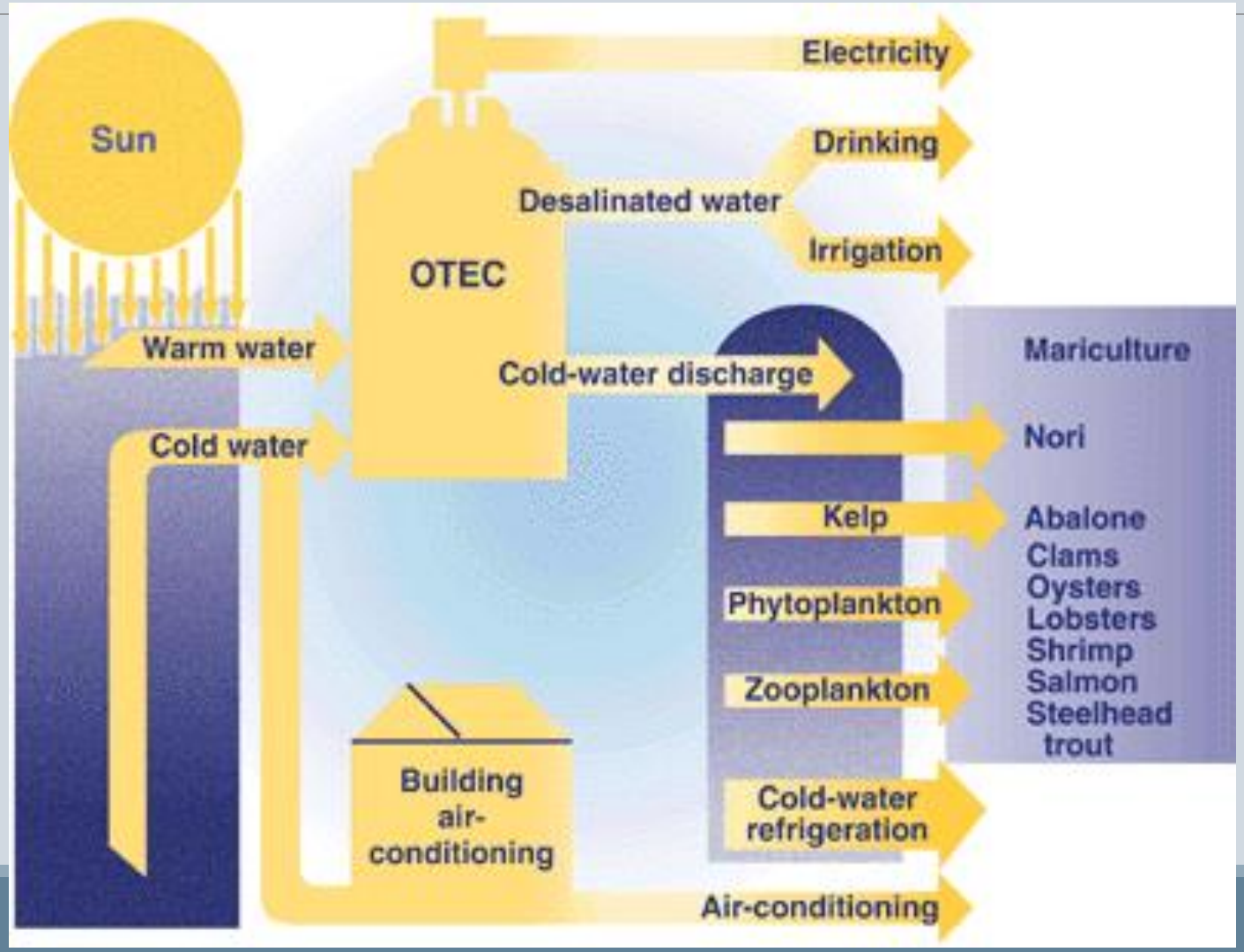


OTEC – Open Cycle



Environmental issues?

On contrary look at OTEC by-products of Open Cycle



210 kW open cycle NEHLA Experimental Plant in Hawaii

- Commercial plant yet to be built because it cannot presently compete with a fossil fuel plant
- Proposed plant in Bahamas put on hold
- 10 MW plant in to built in China by 2017
- OTI is negotiating with the Caribbean Utilities Company in Cayman for a 25 MW plant.

The Main problem is economics - How to make solar thermal with storage and OTEC competitive with Fossil Fuel

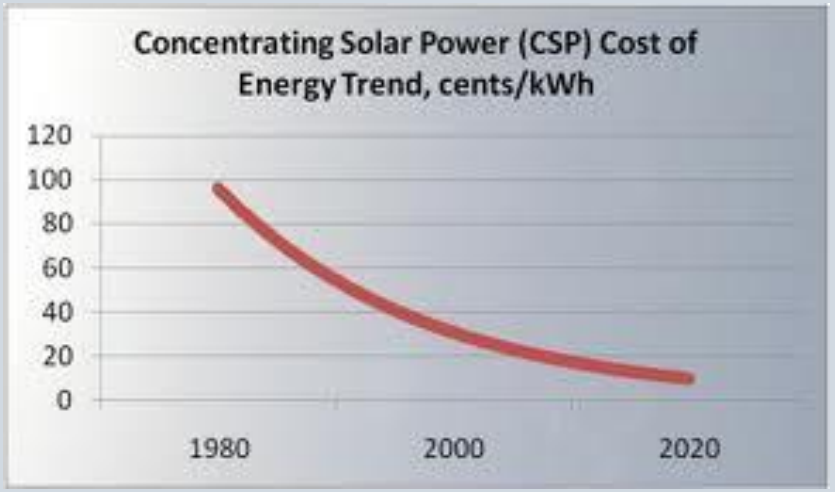
Need to find significant funding for international Research & Development (R&D)

- Improve design and manufacturing techniques to make cheaper
- Design so far for temperate climate where freezing is a problem; design for use in tropics

Economy of Scale

Costs will fall just (as it did for wind, solar PV)

Project cost of CSP →



Need to eliminate Fossil Fuel

To avoid dangerous consequences of climate change

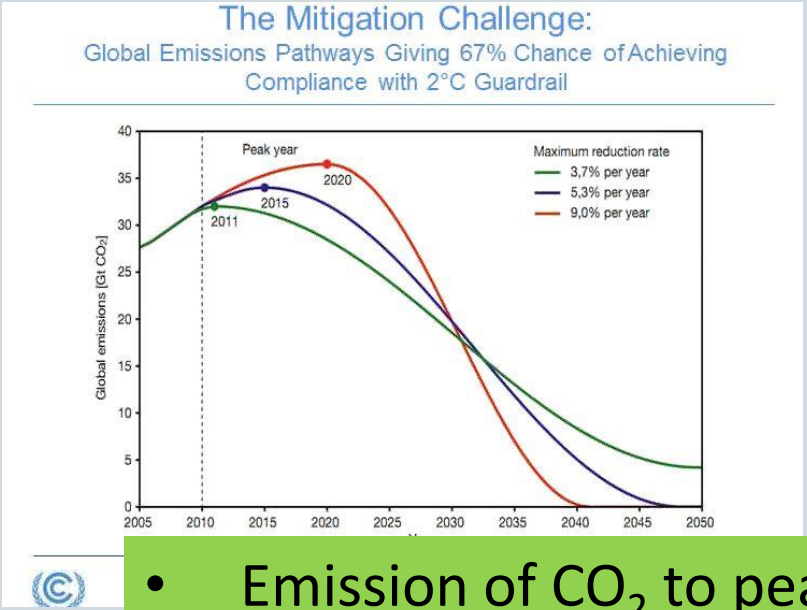
To limit CO2 concentration to 450 ppm

- Eliminate most fossil fuel by 2050

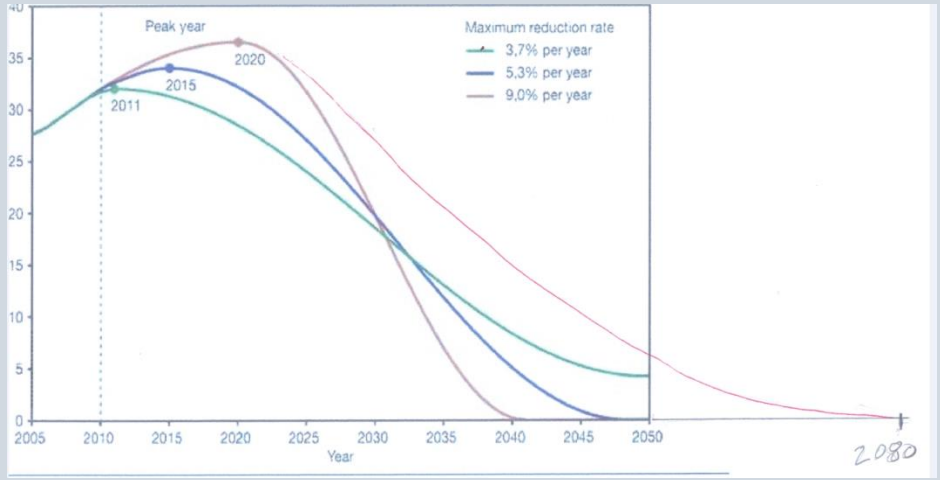
CO_2 pathways to achieve 450 ppm or 2^o C limit

Copenhagen accord (2009): To prevent dangerous anthropogenic interference with the climate system, (COP) recognizes "the scientific view that the increase in global temperature should be below 2 degrees Celsius"

Previous scenario



Present scenario



- Emission of CO_2 to peak in 2020 and there should be no emission after 2080
- Due to CO2 lifetime of ~ 100 years in atmos.
- Will apply even to Jamaica and other SIDS

Climate Change Green Fund

Contribute to the achievement of the ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC).

Promote

- the paradigm shift towards low-emission
- climate-resilient development pathways for developing countries
  - To limit or reduce their greenhouse gas emissions and
  - to adapt to the impacts of climate change,

It is intended to be the centrepiece of efforts to raise Climate Finance of $100 billion a year by 2020.

Most developed countries have committed to finance (but will they deliver?)

Present Modus Operandi

Largest chunk of available fund goes to adaptation project

Funding to reduce Greenhouse gases go to

- Foreign consultants to do studies in developing countries
- Development of small scale RE projects, e.g.,
  - Solar PV pumping for small farms
  - Electricity for communal purposes (community centres, computers)
  - Study effects of climate change on renewable energy

These efforts will never make us energy independent

Game changing plan needed
Look at how developed countries cooperate to achieve R&D when one country alone cannot do it:
Research on fusion power to produce power like the sun:

ITER (International Thermonuclear Experimental Reactor

An international nuclear fusion research and engineering project

Building the world's largest experimental tokamak nuclear fusion reactor in the south of France.

The ITER project aims to make the long-awaited transition from experimental studies of plasma physics to full-scale electricity-producing fusion power plants.

The project is funded and run by seven member entities — the European Union (EU), India, Japan, China, Russia, South Korea and the United States.

The EU, as host party for the ITER complex, is contributing 45% of the cost, with the other six parties contributing 9% each.[

What we need to do

Developing countries should agree to use a large chunk of the Green Fund to develop Renewable Energy (RE) that can be used for base load (firm) energy. They would then be energy independent using virtually free sources of energy (Wind and Solar).

Have large International R&D Centre(s) with objective:

- RE plant become affordable
- RE plants can compete with Fossil Fuel plant

SUMMARY

SIDs can achieve energy security and energy independence by using their natural (free) resources

Solar Energy especially can produce all the power needed

However it has to be stored for use at night and overcast days

Technologies to do this are available. They only need to become more economical by R & D

Agreeing to cooperate in the use of the Green Climate Fund collectively is one way of getting the necessary R & D done

HOW TO CONVINCE THEM OF THE COLLECTIVE GOOD?

Let us discuss

Should the process involve the larger developing countries such as South Africa and China?

The Group of 77 Developing Countries and China have always cooperated in UNFCCC conferences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G77+China stands up to developed nations

Nivedita Khandekar, Hindustan Times
WARSAW, November 20, 2013

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South Africa and China are already involved in R & D

CSP with storage to play a unique role in the South African energy market

By *Beatriz Gonzalez* on ***Feb 17, 2014***

One of the key features of concentrated solar power (CSP) technology is the potential to operate with storage and provide a truly dispatchable renewable energy supply.

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Partnership to build world's largest OTEC plant off China coast

Apr 24, 2013 by Bob Yirka report

The Plant is being built by the American Giant Lockheed Martin, so this is more of a development project, but there will certainly be lessons to be learnt

China's 12th five year plan, for 2011 to 2015, calls for installing 1,000 MW by 2015, and 3,000 MW of concentrated solar power plants by 2020. Plants either being planned or under construction (>3,000 MW):

1 MW Badaling Pilot Project — collaboration between the Institute of Electrical Engineering (IEE) and the Chinese Academy of Sciences (CAS)

12 MW (short term) / 300-MW (long term) project — collaboration between Xinjiang Qingsong Building Materials and Chemicals (Group) Co. and Guodian Xinjiang Company

50 MW project in Tibet by Huaneng Tibet Company

100 MW project in Sichuan Abazhou by Tianwei New Energy (Aba)

50 MW (TBD) by China Huadian Corporation

100 MW project in Golmud by GD ENERGY

100 MW project in Ningxia by Beijing Control Technology Co. Ltd

100 MW project (TBD) by Avic Xi'an Aero-Engine (Group) Ltd

100 MW project (TBD) by Guangdong Kangda

100 MW in Gansu by SETC Tianjin

1,000 MW in Qinghai by Lion International Investment Ltd.

2,000 MW in Shaanxi by Shandong Penglai Dianli and eSolar

Can we put it together?