FORUM ON RENEWABLE ENERGY AND WASTE-TO-ENERGY PPPS
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Integrating Renewable Energy in PPP Infrastructure Projects: Solar, Wind, Hydro and Energy Storage

CASE STUDY - EL HIERRO, SPAIN

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Proyectos hidráulicos y energéticos

REPUBLIC OF THE PHILIPPINES

PUBLIC-PRIVATE PARTNERSHIP CENTER

PRESENTATION OUTLINE

1. Solar Energy

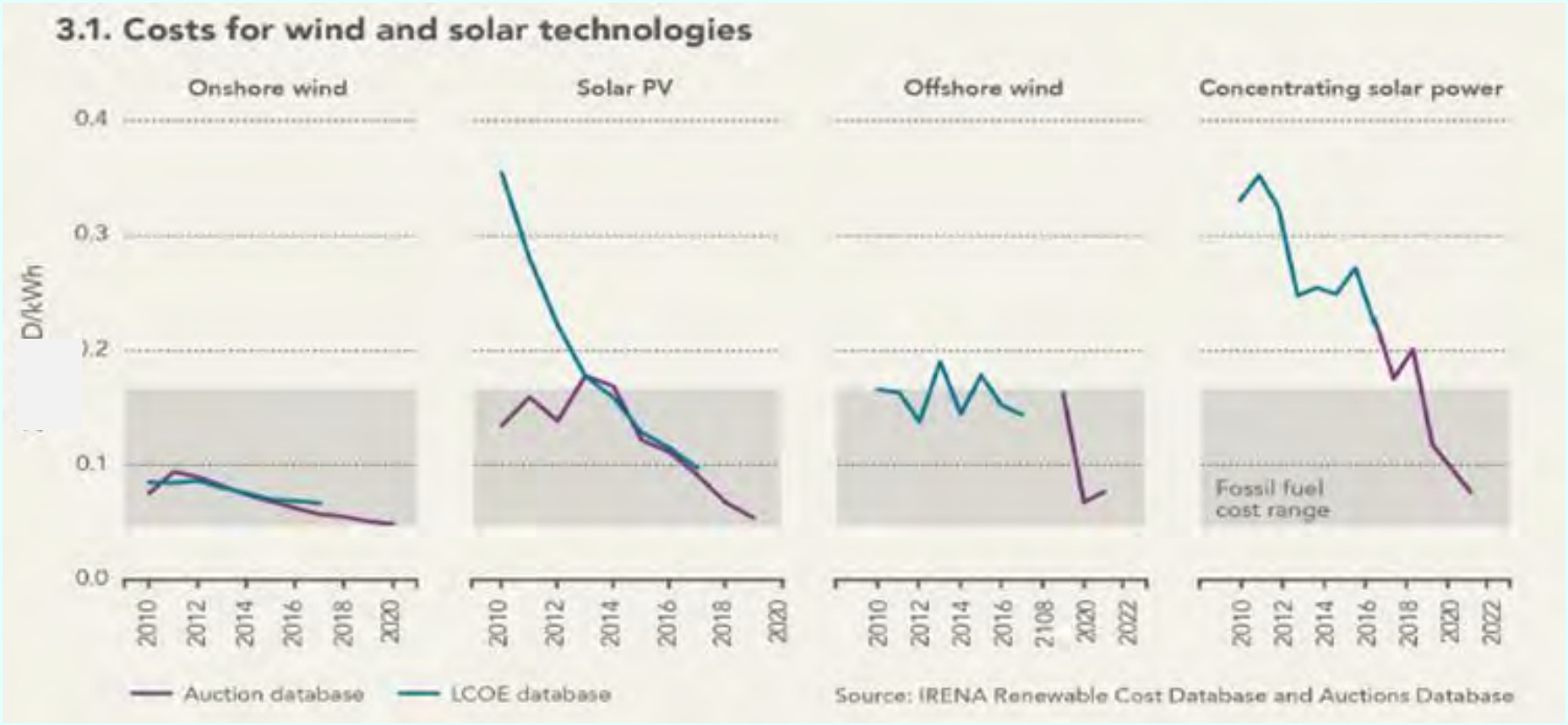
2. Wind Energy

3. Hydroenergy

4. El Hierro Case Study
   - Water as a battery and flexibility provider
   - Possible model to replicate in the Philippines

5. Conclusion

IS IT A GOOD TIME TO INVEST IN RENEWABLE ENERGIES?



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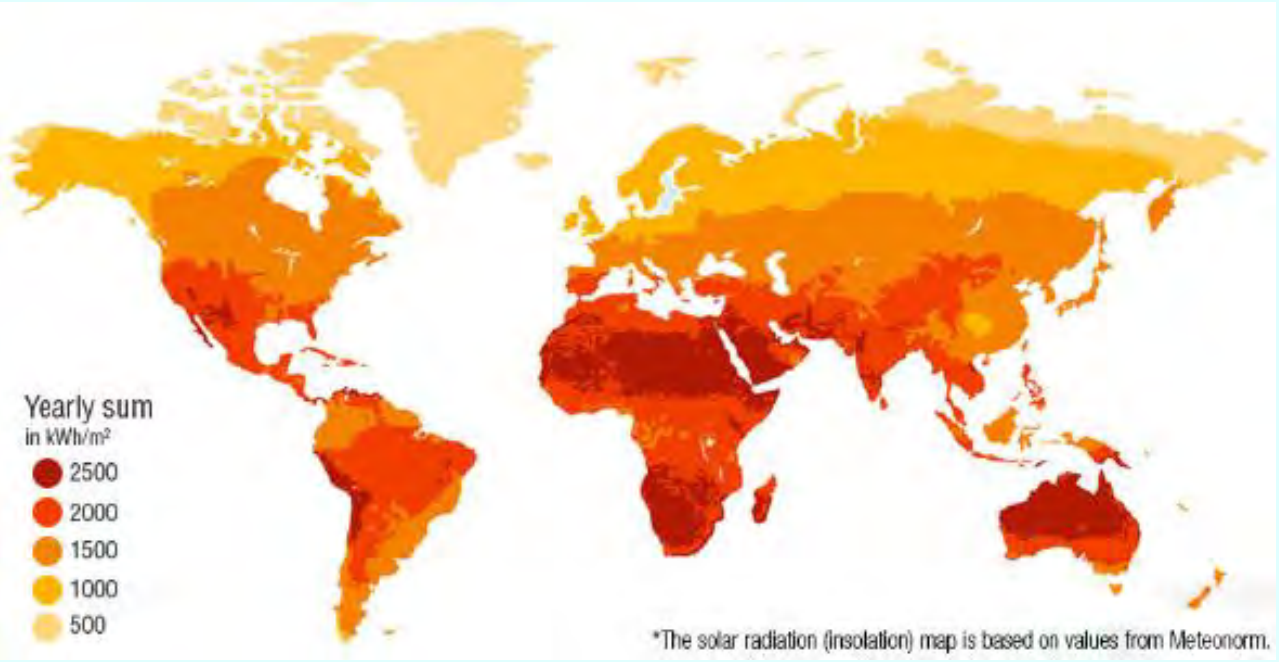
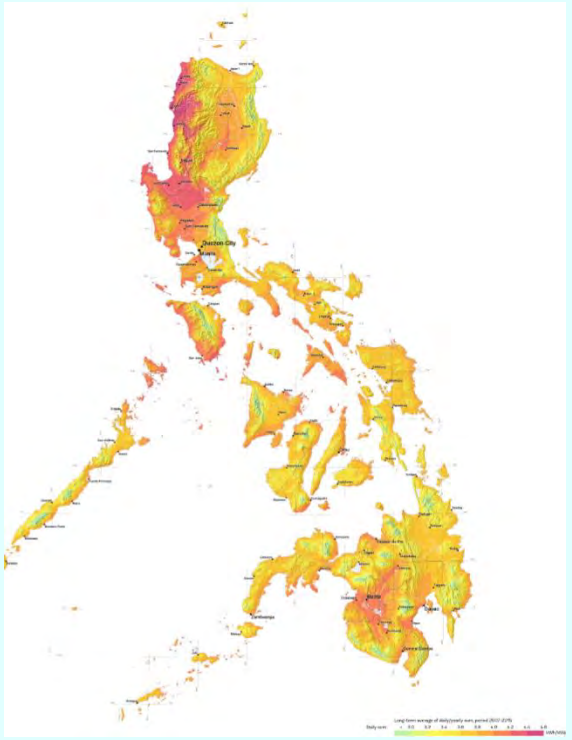
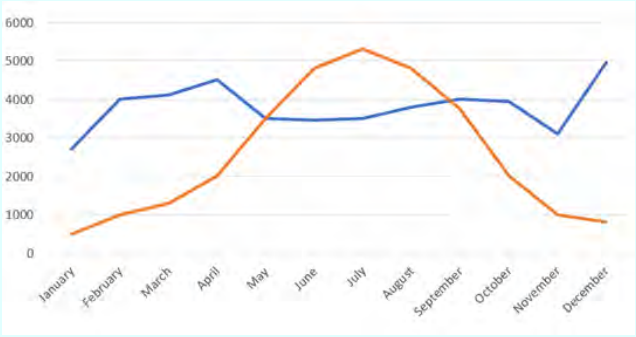
1 - SOLAR ENERGY

SOLAR RADIATION



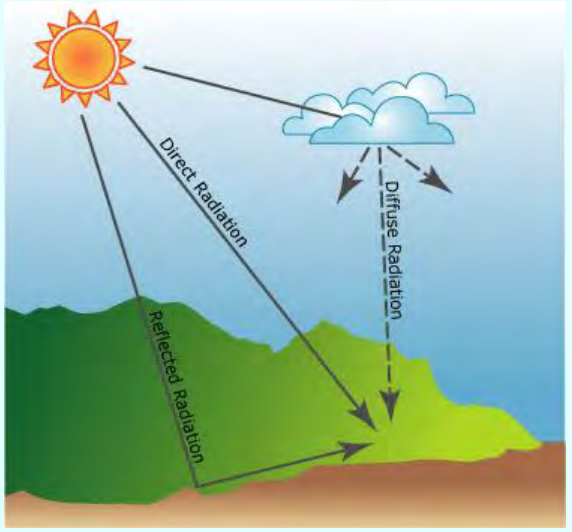




Monthly Production
Manila vs London

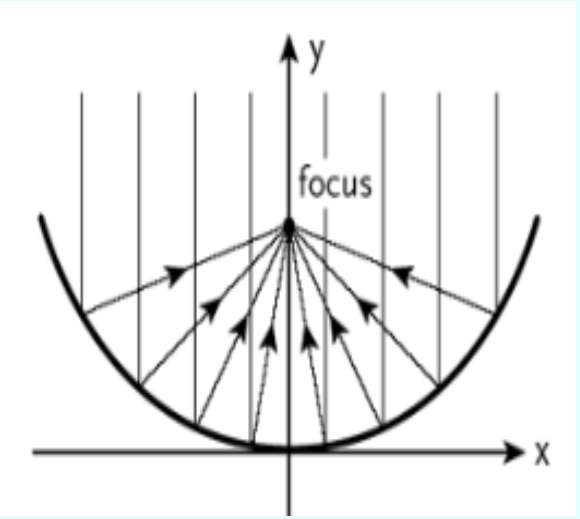
Irradiation
Topographical shadows
Temperature
Wind
Fog
Soil color

- ***Direct radiation:*** Direct solar radiation has a medium value of 1367 W/m2
- ***Reflected radiation:*** The one that rebounds on the soil
- ***Diffuse radiation:*** The one that comes indirectly from the atmosphere



MAIN SOLAR TECHNOLOGIES – LARGE SCALE PROJECTS

Concentrated solar power



- Sun rays
- Parabolic Mirrors

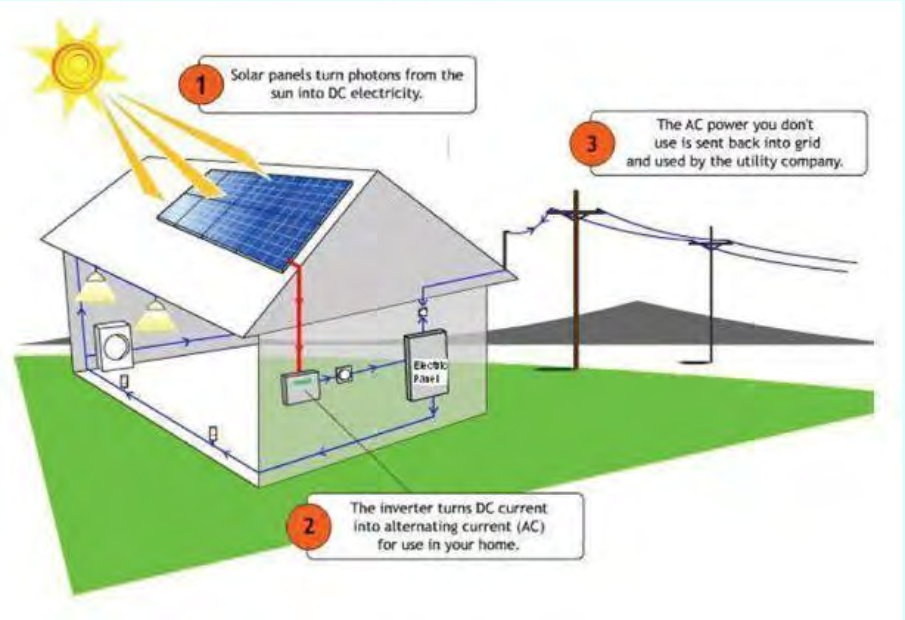
Photovoltaic

Photovoltaic is the only energy production technology that is not based on turbines

The more time perpendicular to the sun the more producción.

MULTIPLE SOLUTIONS

ROOFTOP-SELF CONSUMPTION



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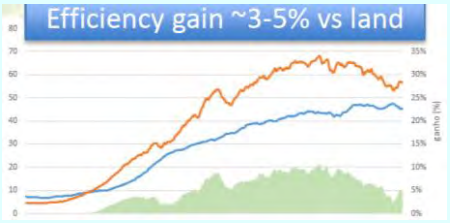
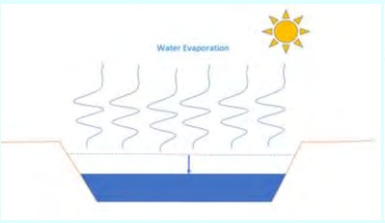
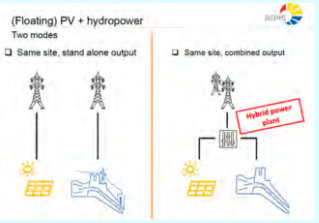
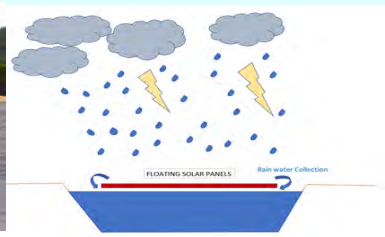
FLOATING SOLAR SYSTEM FOR WATER SUPPLY

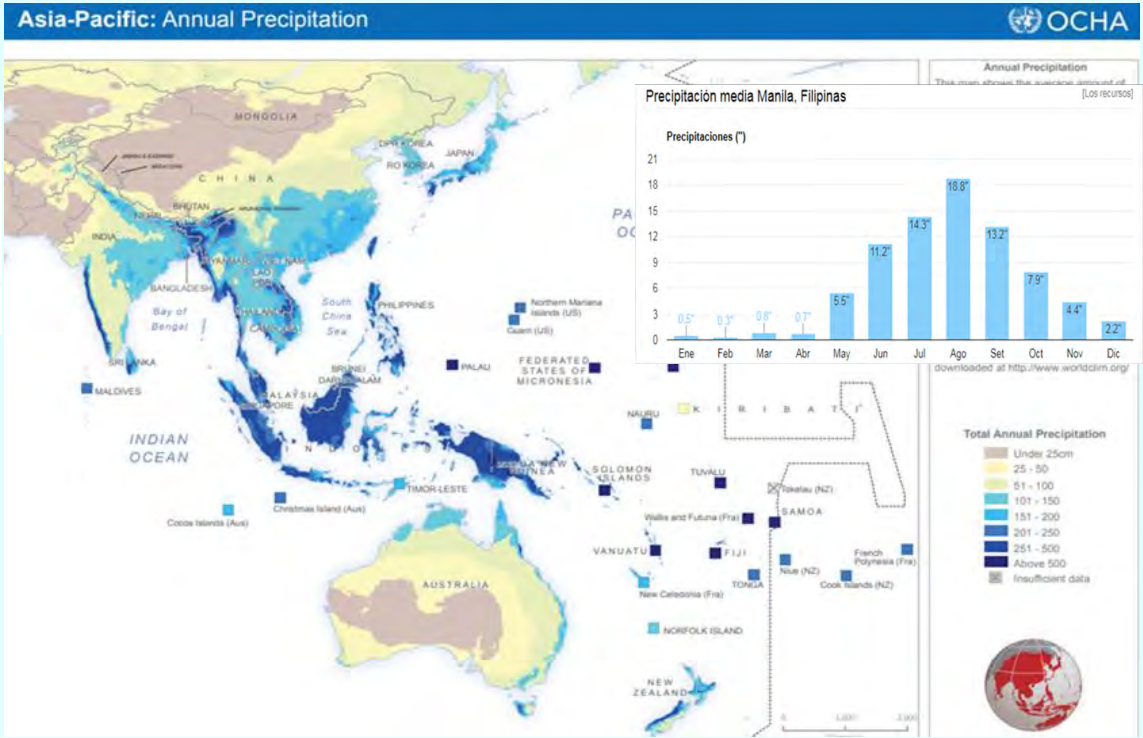
CAPEX component	FPV 50 MWp (US$/Wp)	Ground-mounted PV 50 MWp (US$/Wp)
Modules	0.25	0.25
Inverters	0.06	0.06
Mounting system (racking)*	0.15	0.10
BOS**	0.13	0.08
Design, construction, T&C	0.14	0.13
Total CAPEX	0.73	0.62



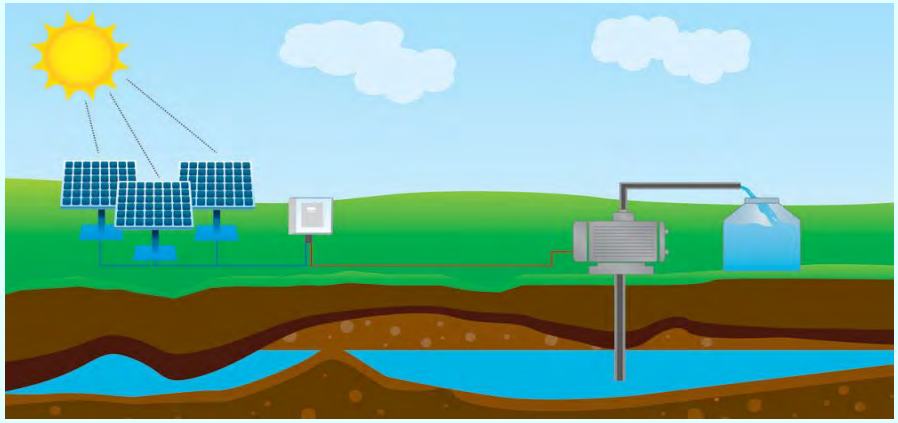




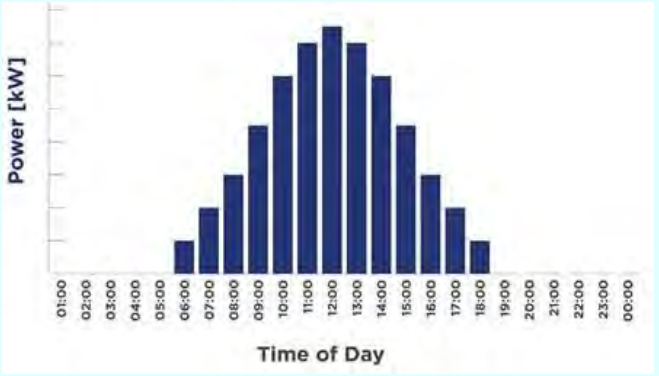




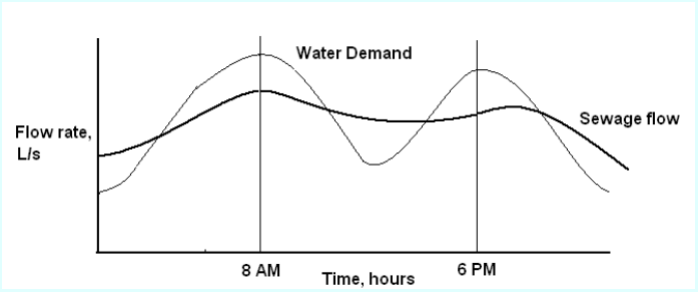
SOLAR PUMP FOR WATER SUPPLY AND/OR IRRIGATION



Pump water (well, river, dams, reservoirs)



Solar hourly production



Water household hourly demand

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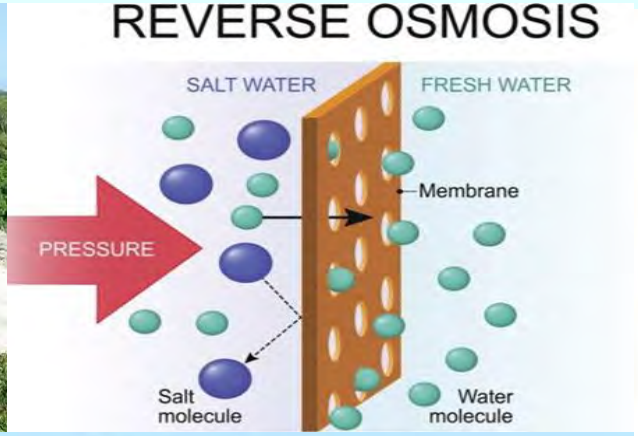
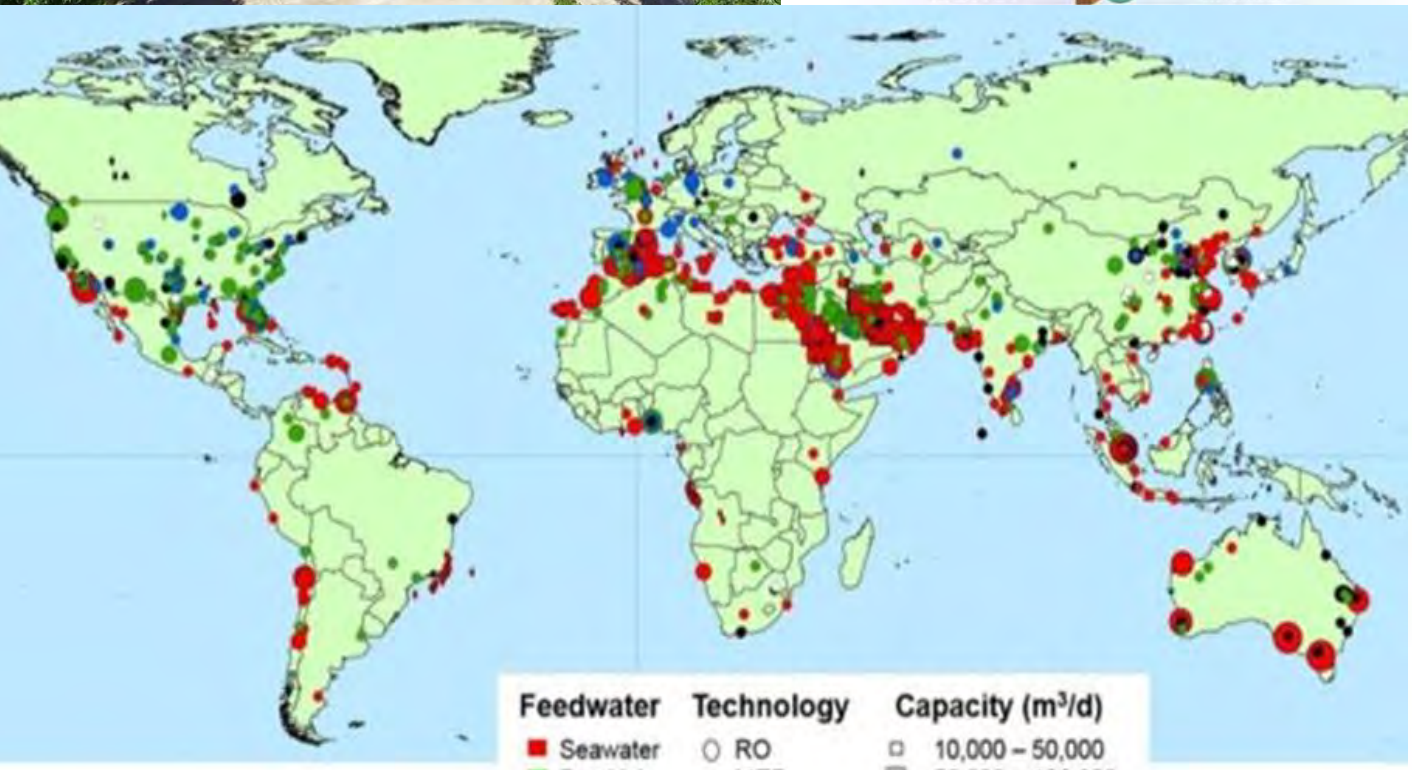
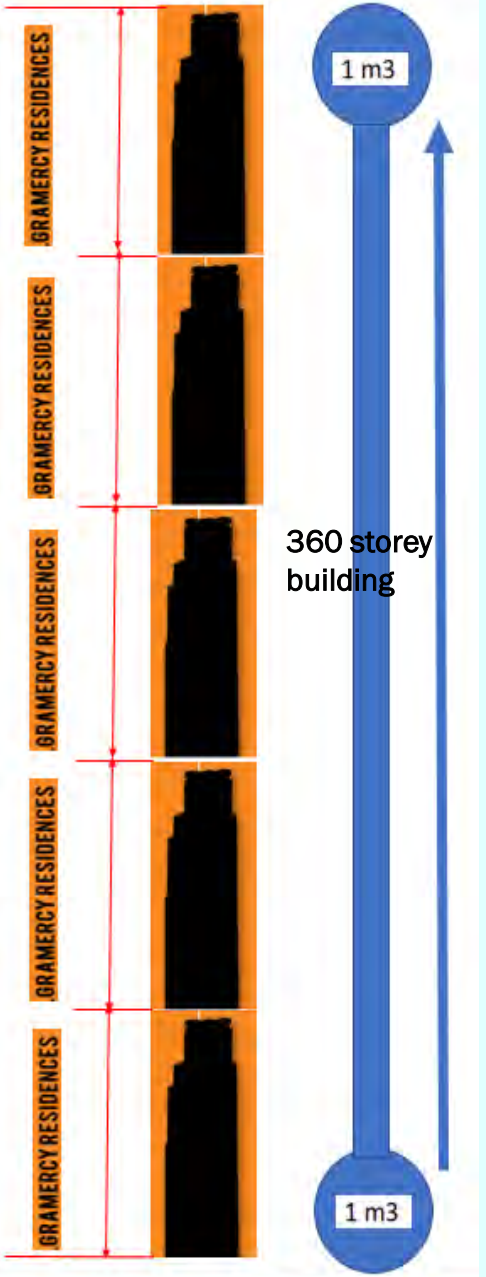
SOLAR DESALINIZATION PLANT

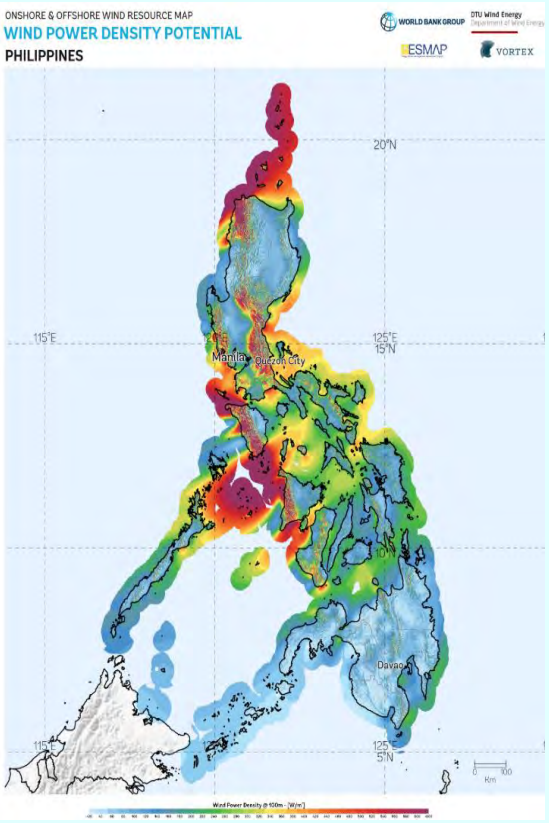


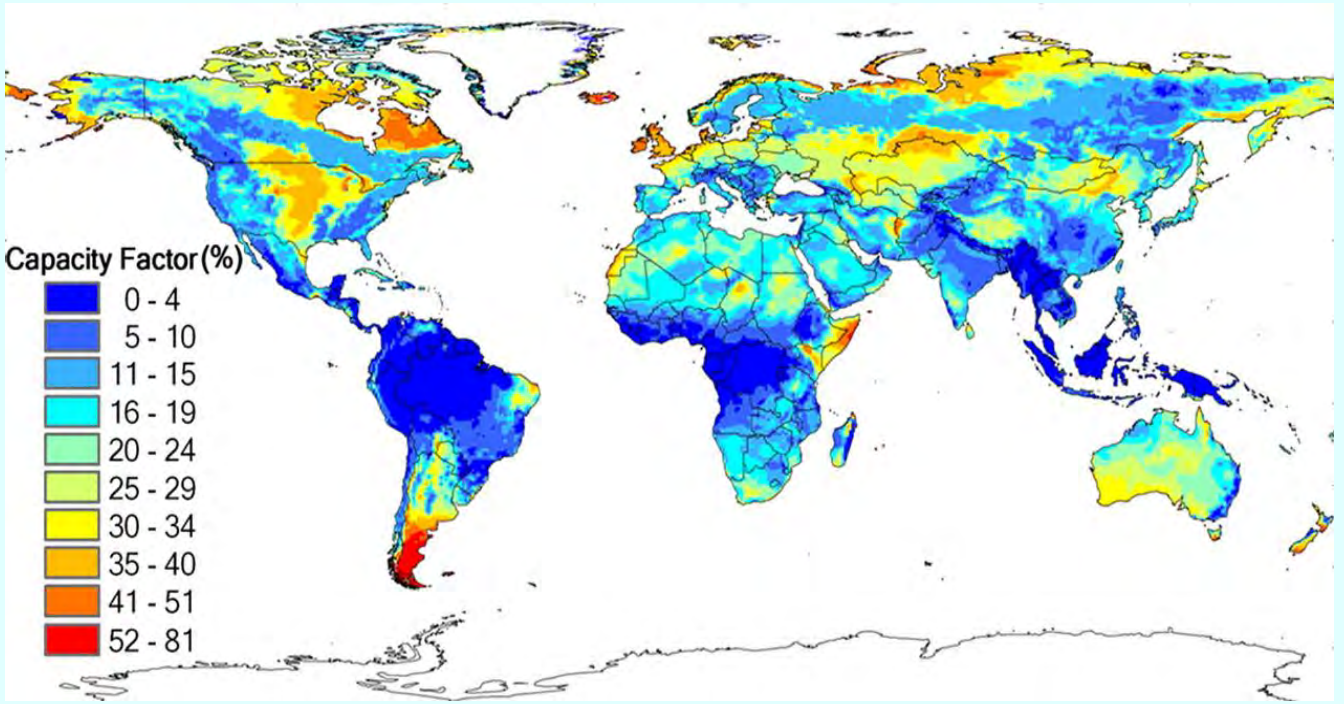


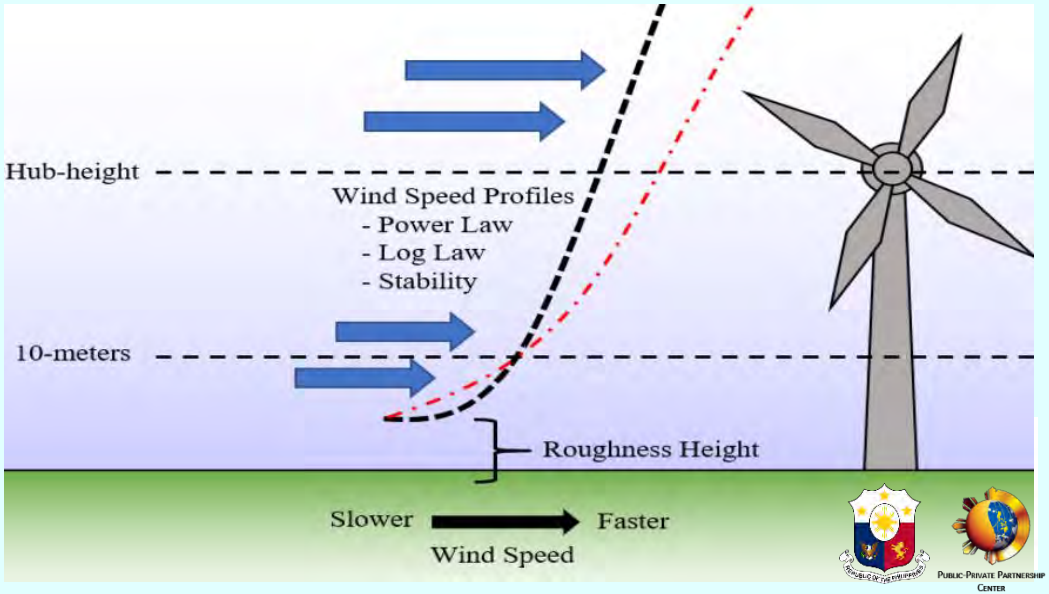


2 - WIND ENERGY

WIND ENERGY IN THE PHILIPPINES







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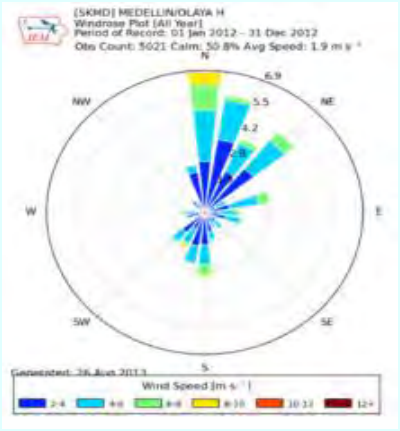
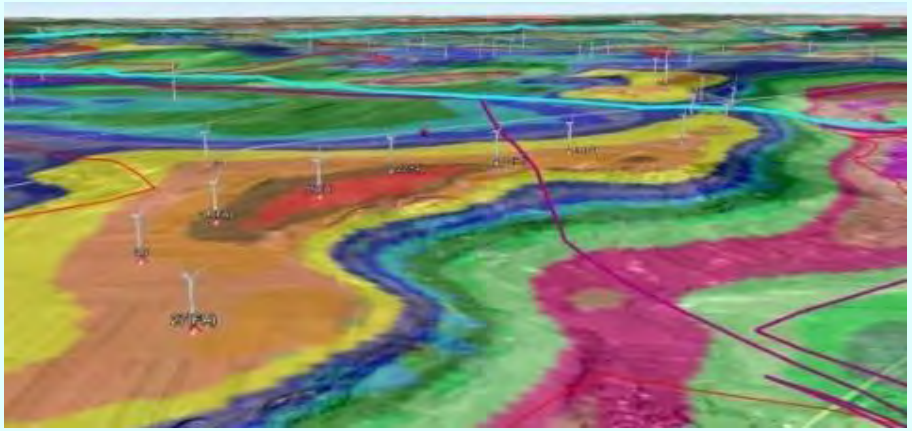
PREFEASIBILITY STUDIES

Resource analysis-wind study



Layout design



Geotechnical study-foundation design

Earth movements

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THE IMPORTANCE OF LOGISTICS

ROAD SURVEY

Port unloading

Slope vs truck traction

Curve

Tower diameter vs height of the bridge

DIFFERENT TYPES OF TURBINES

OFFSHORE/ONSHORE TURBINES

CONCRETE/STEEL TURBINES

BIG/SMALL TURBINES

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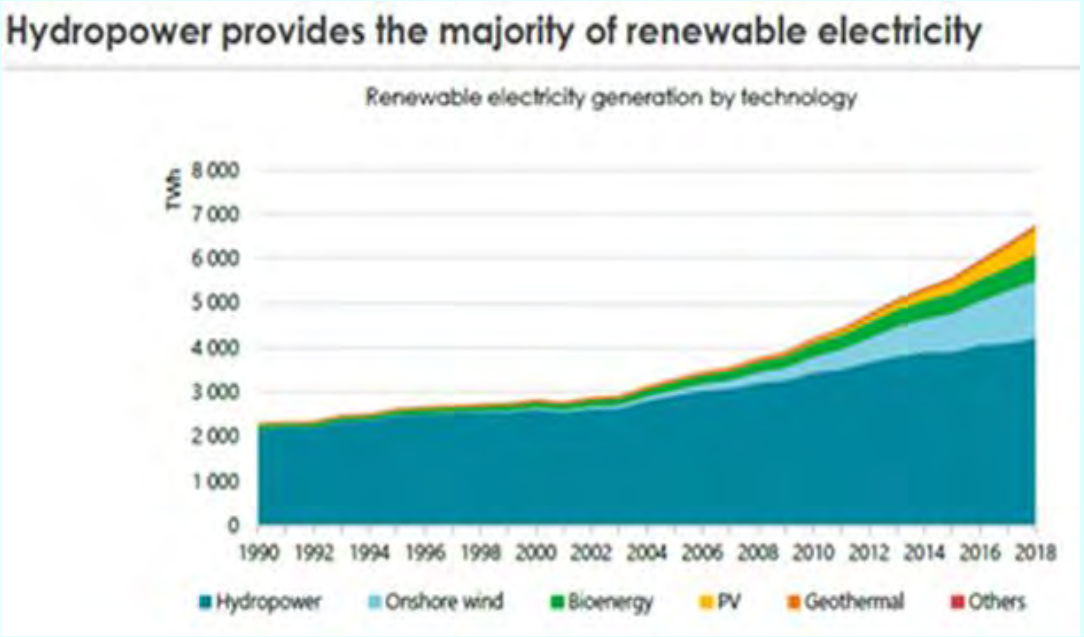
3 - HYDROENERGY

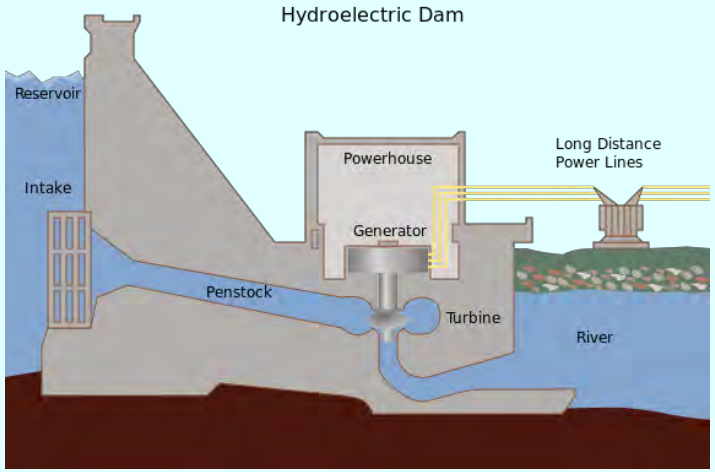
HYDROENERGY

- The first dam, Sadd el-Kafara Dam, was built in 2770 BC *(no longer operational)*
- To date, there are still many Roman Empire dams working. These dams are mainly used for irrigation purposes
- The first use of water for power was with the use of waterwheels
- All changed in the middle of the 19th century with the construction of the first concrete dams and cast iron turbines in order to create electricity
- Most ancient technologies are hydro (1850 cast iron and concrete) and oil (1870, Standard Oil founded by John D. Rockefeller)

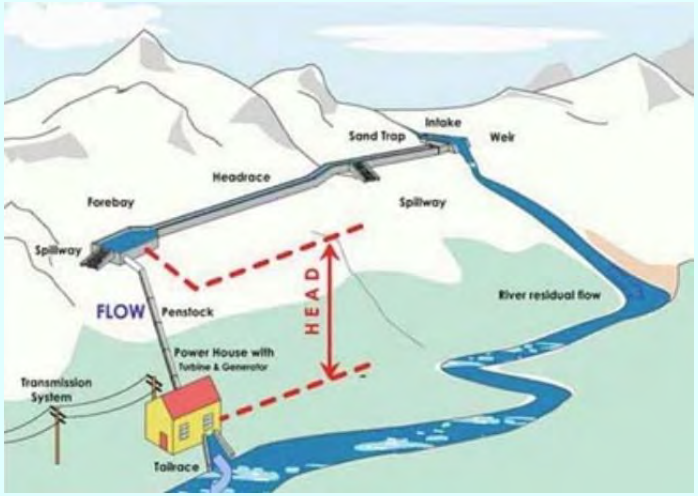


MAIN HYDRO TECHNOLOGIES

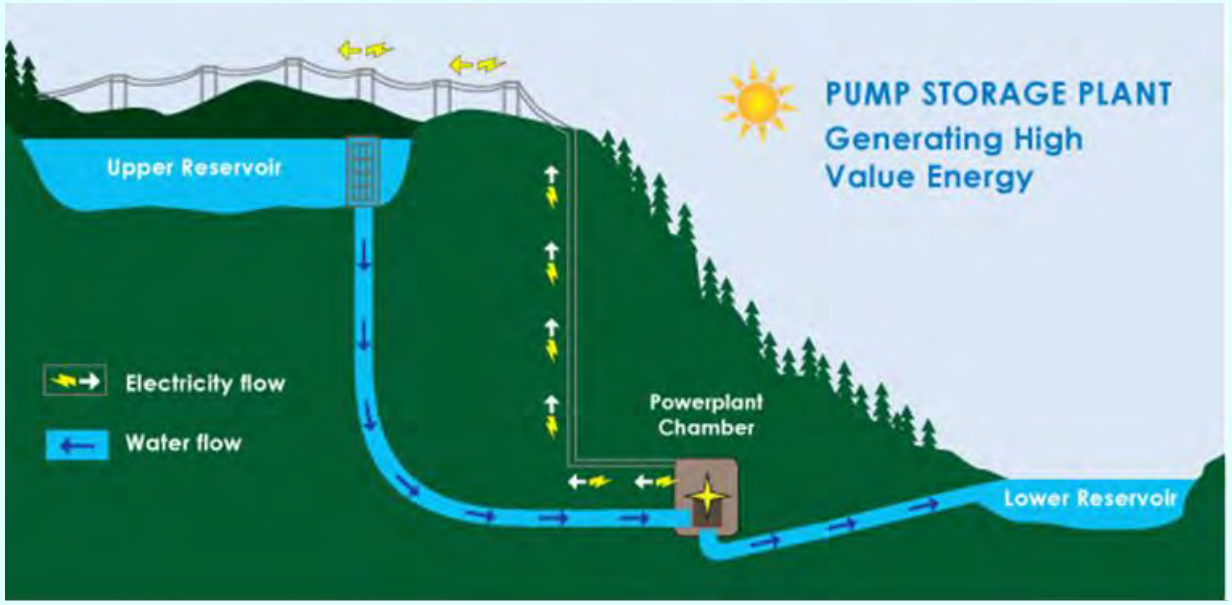
Type 1: Hydropower dams



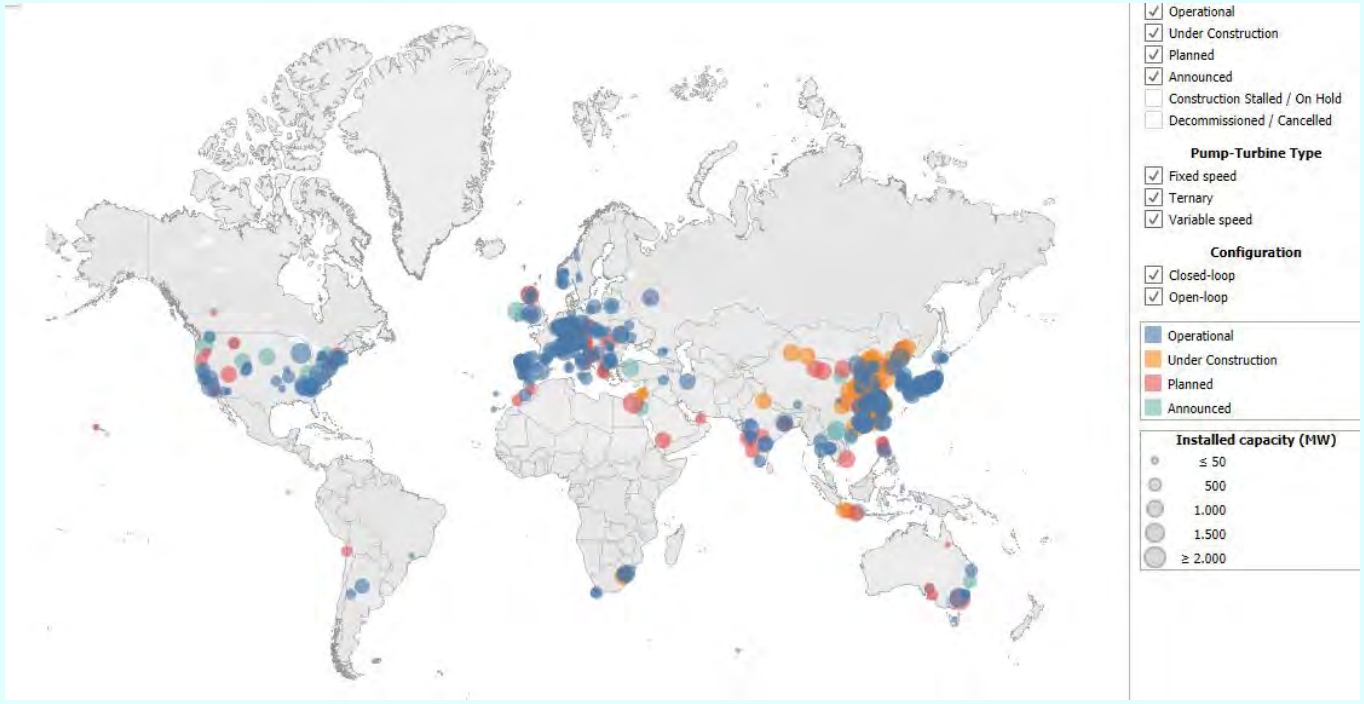
Type 2: Run-of-river power stations

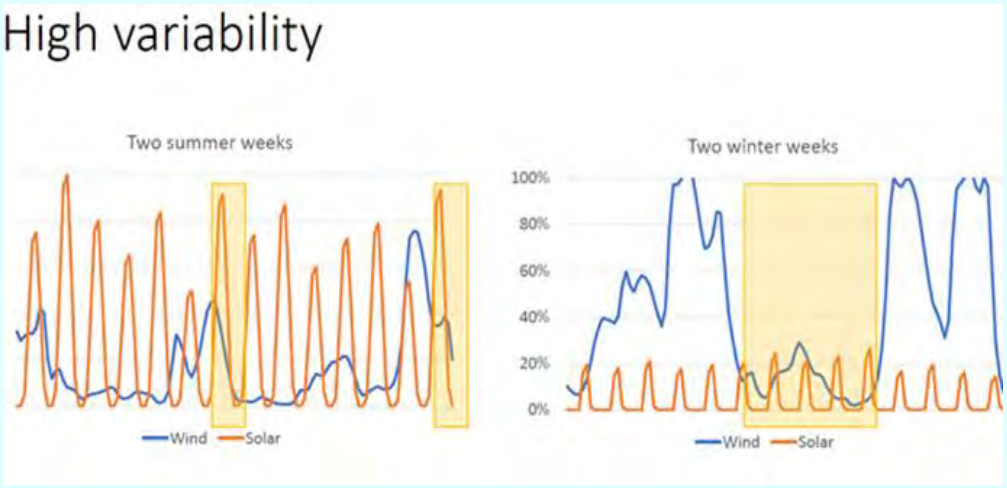


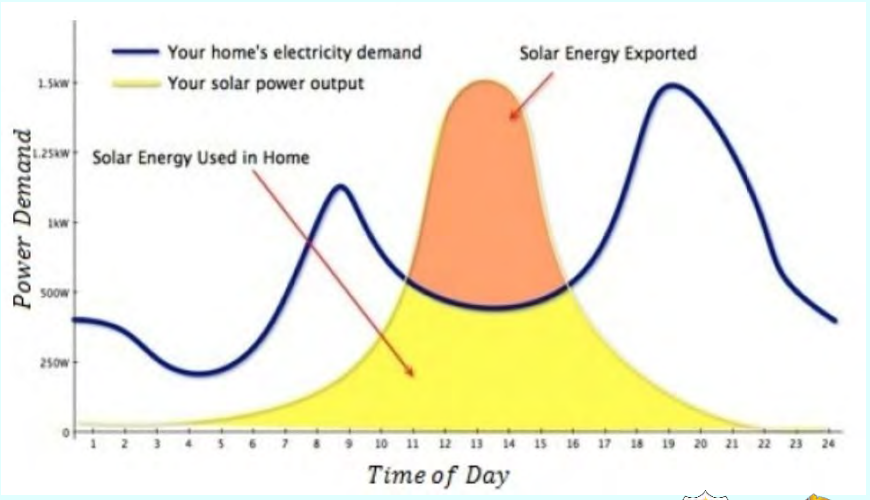
Type 3: Pump storage



The installation of renewable energies entails energy storage as shown in this map of all the pump energy storage in the world under construction, development and operation







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4 - EL HIERRO CASE STUDY

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EL HIERRO: WATER AS A BATTERY AND FLEXIBILITY PROVIDER

- UNESCO Biosphere Reserve
- UNESCO Geopark

El Hierro Island	
Area	268,7 km^2
Population	11880 hab
Energy power consumption	8 Mw

- Semi-desert island
- Water scarcity
- Touristic island
- Previously diesel genset as energy supply
- Not connected to Canary Island's electrical grid

Area Ranking	Name of island	Area
1	Luzon	109,965 km2
2	Mindanao	97,530 km2
3	Samar	13,429 km2
4	Negros	13,310 km2
5	Palawan	12,189 km2
6	Panay	12,011 km2
7	Mindoro	10,572 km2
8	Leyte	7,368 km2
9	Cebu	4,468 km2
10	Bohol	3,821 km2
11	Masbate	3,268 km2
12	Catanduanes	1,523 km2
13	Basilan	1,265 km2
14	Marinduque	952 km2
15	Busuanga	890 km2
16	Jolo	869 km2
17	Tablas	839 km2
18	Dinagat	802 km2
19	Polillo	629 km2
20	Guimaras	605 km2
21	Tawitawi	581 km2
22	Biliran	536 km2
23	Sibuyan	465 km2
24	Siargao	437 km2
25	Burias	424 km2
26	Culion	389 km2
27	Siquijor	337 km2
28	Ticao	334 km2
29	Dumaran	322 km2
30	Balabac	319 km2
31	Samal	301 km2
32	Sibutu	285 km2
33	Camiguin	255 km2
34	Calayan	196 km2
35	Olutanga	194 km2
36	Alabat	192 km2
37	Panaon	191 km2
38	Camiguin	166 km2
39	Bucas Grande	128 km2
40	Lubang	125 km2

Gorona del Viento El Hierro S.A.

Cabildo El Hierro	60% Público	LGU
endesa	30% Privado	Private Electric Utility
itc	10% Público	Public University

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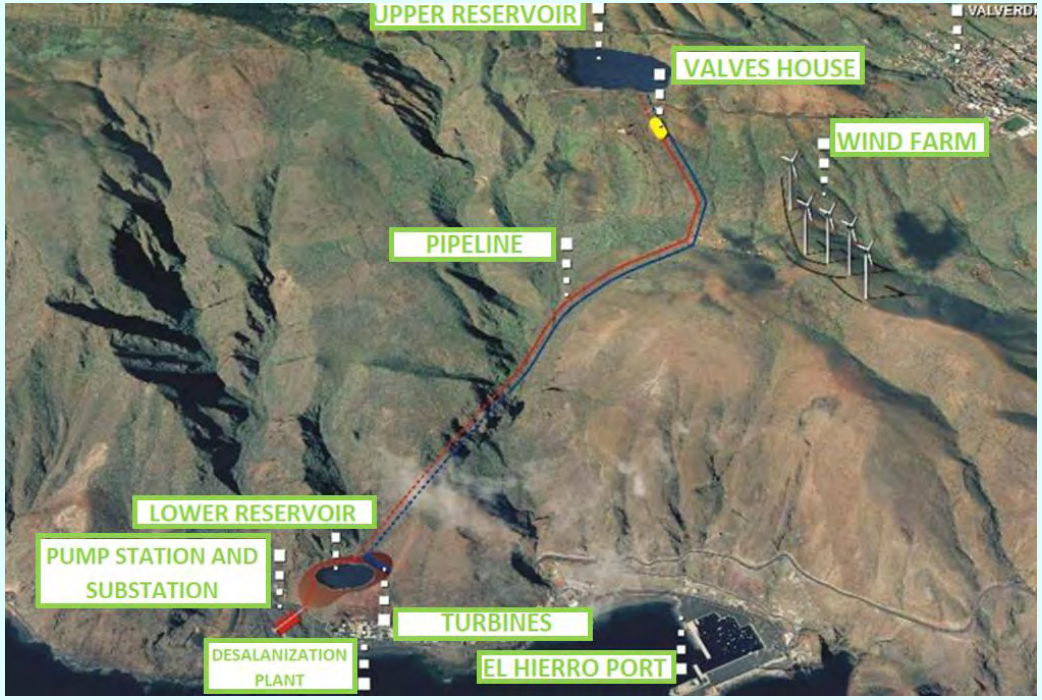
EL HIERRO: WATER AS A BATTERY AND FLEXIBILITY PROVIDER



-5 Turbines 2,3 Mw Total=11,5 Mw

-Pipeline (1200-800 mm)

-Pump Station (11 Mw)

-Upper and lower reservoirs (320.000 m^3)

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EL HIERRO: WATER AS A BATTERY AND FLEXIBILITY PROVIDER

-As there is always energy, there is always water available for 365 days and 24 hours per day with the desalinization plants for agriculture and water supply.

-This sustainable experience has made El Hierro a role model, giving a lot of publicity to the island where tourists from all over the world visit it due to its sustainable model. Fishing and organic farming are sought and the island has been declared as a "non fast food island".

-Several courses and training cycles have been created for students that want a specialization in renewable energies.

EL HIERRO: WATER AS A BATTERY AND FLEXIBILITY PROVIDER

-The benefits of the hydroelectric power plant have allowed investment in beneficial actions for the island and installed a network of electric vehicle charging points and subsidies for the purchase of electric cars (700 usd for every car) in order to favor sustainable transport.

-El Hierro Island Project has worked so well that its model will be replicated in the Gran Canaria, which is the largest island and capital of the Canary Islands with the installation of a 200 Mw Chira-Soria Central.

EL HIERRO: POSSIBLE MODEL TO REPLICATE IN THE PHILIPPINES

- In all the world, tourism development is linked with the availability of energy and water of enough quantity and quality.
- Tourism leaders have done a big effort and investment in order to have sufficient water for bulk water supply, energy and leisure 24h/365 days a year.

Some of these critical activities and industries strongly linked with water and energy are the following ones:

Water importance for tourism		Energy importance for tourism	
Bulk water supply	Agro-tourism	Internet connection	Air conditioning
Hotel swimming pools	Food cold storage	Phone signal	Sustainable transportation
Aquatic park	Food supply	Food refrigeration and conservation	Lighting
Golf pitches	Wellness and spa	Concerts and entertainment events	Others…

EL HIERRO: POSSIBLE MODEL TO REPLICATE IN THE PHILIPPINES

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EL HIERRO: POSSIBLE MODEL TO REPLICATE IN THE PHILIPPINES

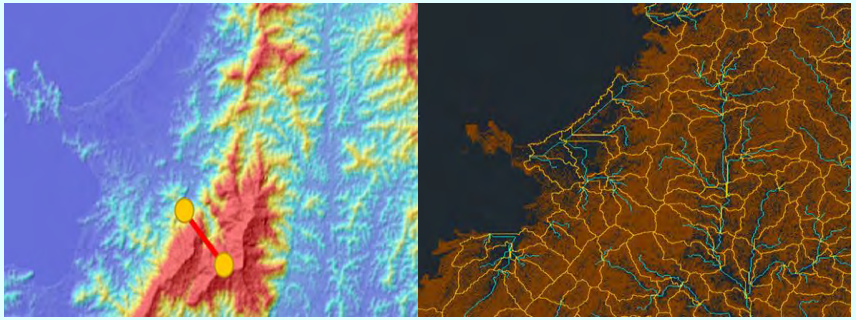
CURRENT PROBLEMS

- Diesel power plant equipped with diesel generators
- Water supply through deep wells with danger of water intrusion
- Weak electric and water supply system with regular blackouts, brownouts and water shortages
- Lack of capacity to absorb expected increase in economic development and tourist arrivals

SOLUTIONS FOR THE FUTURE

- Solar power 20 Mw+ pump storage hydro power 20 Mw
- Water quality and quantity guaranteed
- Sustainable energy guaranteed 24 hours a day, 365 days a year
- Sustainable transportation with electric energy

Budget	50 MUSD including distribution artery (energy + water + charging points)
Population	31,000 residents + 1 million tourists per year
Concession Period	50 Years
Water supply	1.000.000 m3
Fixed price every m3 of water for habitants (treatment not included)	0,3 USD/m3 (16 Php)=0,0003 USD/liter
Fixed price every kwh of energy	0,06 USD (3,2 Php)



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CONCLUSION

- ✓ In most of the countries of the world, especially in the most advanced ones, an energy transition towards renewable energies is taking place.
- ✓ Renewable energies are right now the most competitive energy technologies in terms of price.
- ✓ The limiting factor in this energy transformation is energy storage. The storage of energy through water is greater than 99% of the storaged power. The batteries are improving but on a large scale basis they are still more expensive than pumped storage.
- ✓ The Philippines has a good solar radiation, so solar energy can be very competitive due to its modularity, simplicity, production and price. The Philippines also has enormous hydroelectric potential as it is one of the rainiest countries in the APEC region. Therefore the water-energy binomial is a great potential to develop.
- ✓ The insular characteristic of the Philippines means that the renewable energy projects that can be developed will have to include energy storage to make energy supply sustainable.
- ✓ Technically the supply to the islands with renewable energies can be solved as it has been shown on the island of El Hierro in Spain.
- ✓ Preliminary studies show how solar energy plus water storage is technically and economically feasible. It is also a good project of sustainability and modernity for economic development.
- ✓ The Philippines can be a leader on the energy transformation by involving the entire society with self-consumption PPP and energy storage PPP.

For further information, please visit:
www.ppp.gov.ph
www.proyectoshidraulicosyenergeticos.es/en/

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