FROM FUEL BASED ELECTRICITY TO RENEWABLE ENERGY
The difficult path of a power generation operator on small isolated islands

EDT
GDF SUEZ

EDT : a company of the GDF SUEZ group

GDF SUEZ

Electricity
1st independant producer in the world
114.5 GW of installed generation capacity (18,4% from renewable energies)

219 100 employees in over 70 countries
EUR 84.5 billion in revenues in 2010

Natural gaz and LNG
1st buyer and importer of LNG in Europe
1st transmission and distribution network in Europe

Energy Services
1st provider of technical services in the world

Environnement
2nd provider of water and waste management services worldwide

ELECTRICITY OF TAHITI

EDT (Electricity of Tahiti) generates and distributes energy in over 20 islands throughout French Polynesia.

EDT is certified ISO 9001, ISO 14001 and OHSAS 18001, and is committed to :
-provide high quality services to its customers
-promote renewable energies

In Tahiti:

-Peak demand: 100 MW

-Annual demand in energy (2011): 485 GWh (80% of total demand in EDT's concessions)

-65 000 customers

-Installed generating capability:

- Diesel/Fuel generators: 162 MW
- Hydro: 47 MW

POWER GENERATION MIX IN TAHITI

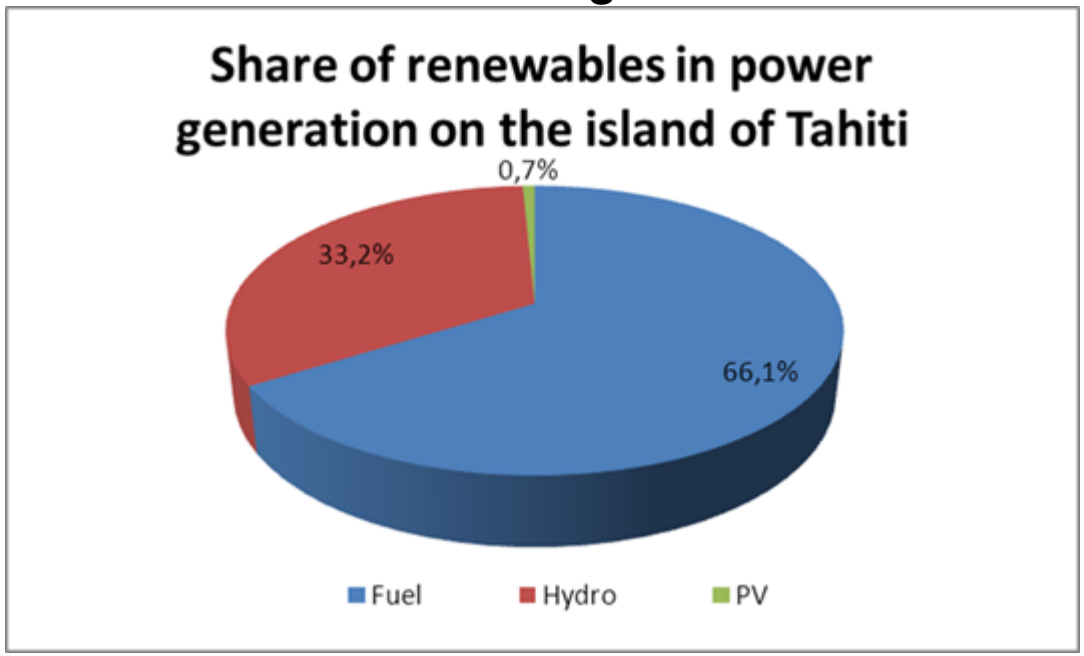
Energy produced in 2011:

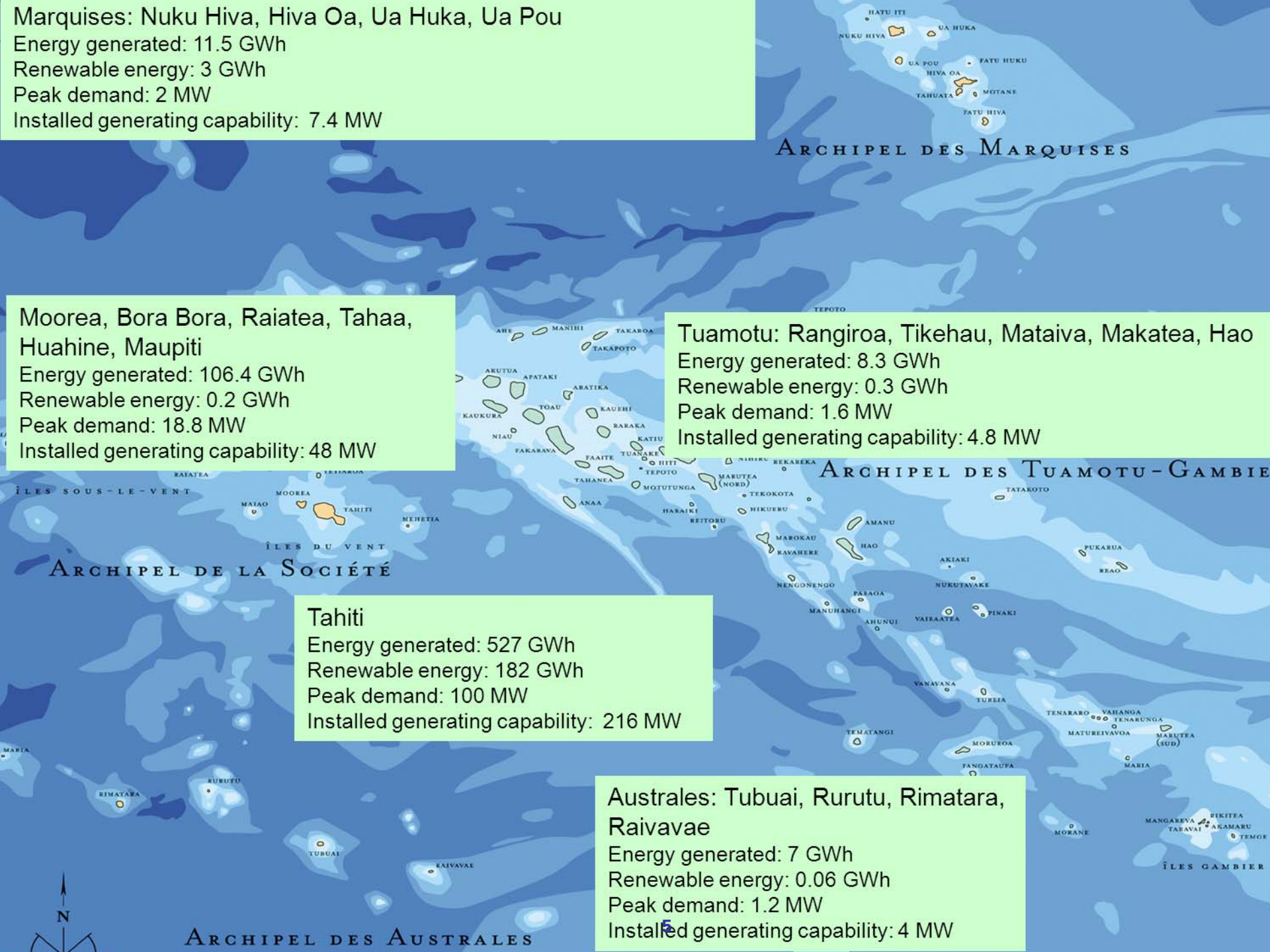
•Fuel power stations: 355 GWh

•Solar PV (connected to grid): 4 GWh

•Hydro: 178 GWh

34% from renewable energies




Marquises: Nuku Hiva, Hiva Oa, Ua Huka, Ua Pou
Energy generated: 11.5 GWh
Renewable energy: 3 GWh
Peak demand: 2 MW
Installed generating capability: 7.4 MW
Archipel des Marquises
Moorea, Bora Bora, Raiatea, Tahaa, Huahine, Maupiti
Energy generated: 106.4 GWh
Renewable energy: 0.2 GWh
Peak demand: 18.8 MW
Installed generating capability: 48 MW
Tuamotu: Rangiroa, Tikehau, Mataiva, Makatea, Hao
Energy generated: 8.3 GWh
Renewable energy: 0.3 GWh
Peak demand: 1.6 MW
Installed generating capability: 4.8 MW
Archipel des Tuamotu-Gambie
Îles sous-le-vent
Îles du vent
Archipel de la Société
Tahiti
Energy generated: 527 GWh
Renewable energy: 182 GWh
Peak demand: 100 MW
Installed generating capability: 216 MW
Australes: Tubuai, Rurutu, Rimatara, Raivavae
Energy generated: 7 GWh
Renewable energy: 0.06 GWh
Peak demand: 1.2 MW
Installed generating capability: 4 MW
Archipel des Australes
Îles Gambier
N

POWER GENERATION IN SMALL ISOLATED ELECTRIC SYSTEMS

EDT produces and distributes energy on 19 islands outside Tahiti.

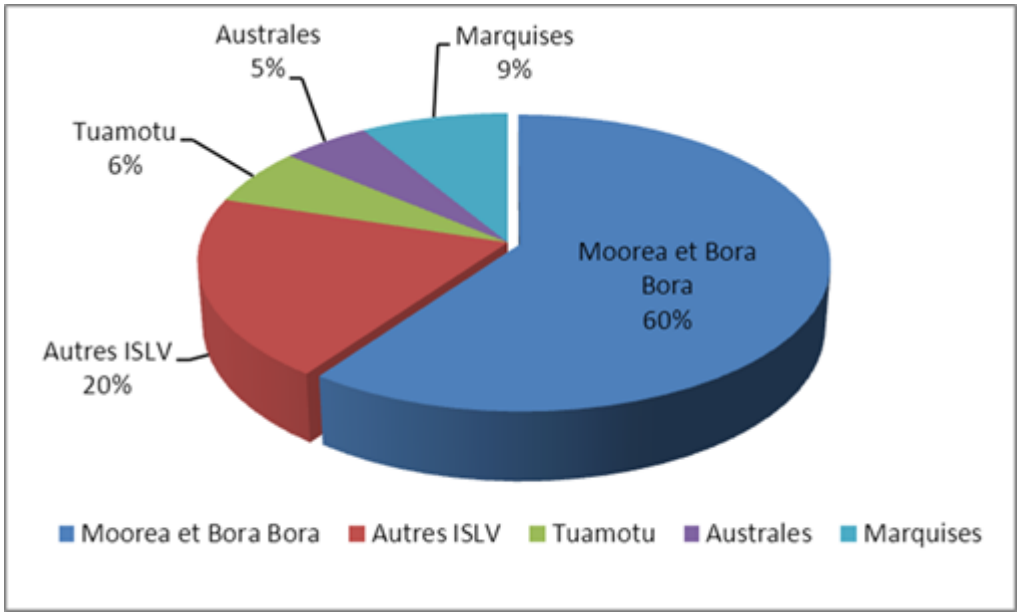
Energy production on these islands in 2011: 132.8 GWh

- Diesel: 129.4 GWh
- Hydro (in Marquesas islands only): 3 GWh
- Solar PV (connected): 0.4 GWh

2,5 % from renewable energies

Moorea and Bora Bora account for 60% of the total energy produced in « small islands » operated by EDT (Tahiti excluded).

In Marquesas, the share of RE is approximately 10-20%. On « small » islands equipped with Diesel-Solar hybrid power plants, the share of RE can exceed 50% (Makatea: 70%)



POWER GENERATION IN SMALL ISOLATED ELECTRIC SYSTEMS

Wide range of installations adapted to the size of each island:

	Production	Nb of clients	Generators
•Moorea:	38 GWh	5925	Medium speed diesel engines
•Bora Bora:	42 GWh	2661	Medium speed diesel engines
•Rangiroa:	4.8 GWh	1211	High speed diesel engines
•Tubuai:	2.8 GWh	746	High speed diesel engines
•Makatea:	0.07 GWh	40	Hybrid PV/Diesel

Power generation on these islands rely mainly on diesel, which remains the most cost efficient way to produce electricity.

The share of renewable energies is still small (mostly hydro in Marquesas).

Total annual fuel consomption: 34,5 millions liters

POWER GENERATION PROBLEMATICS IN SMALL ISOLATED SYSTEMS

High costs of production in smaller islands due to:

•High cost of fuel:

- CIF value in February 2012: 80.321 XPF/litre (0,89 USD/l)
- Due to isolation and difficulty to access and deliver fuel to some power stations.

•High operating costs:

- Due to remoteness and the small size of some installations, maintenance costs are high

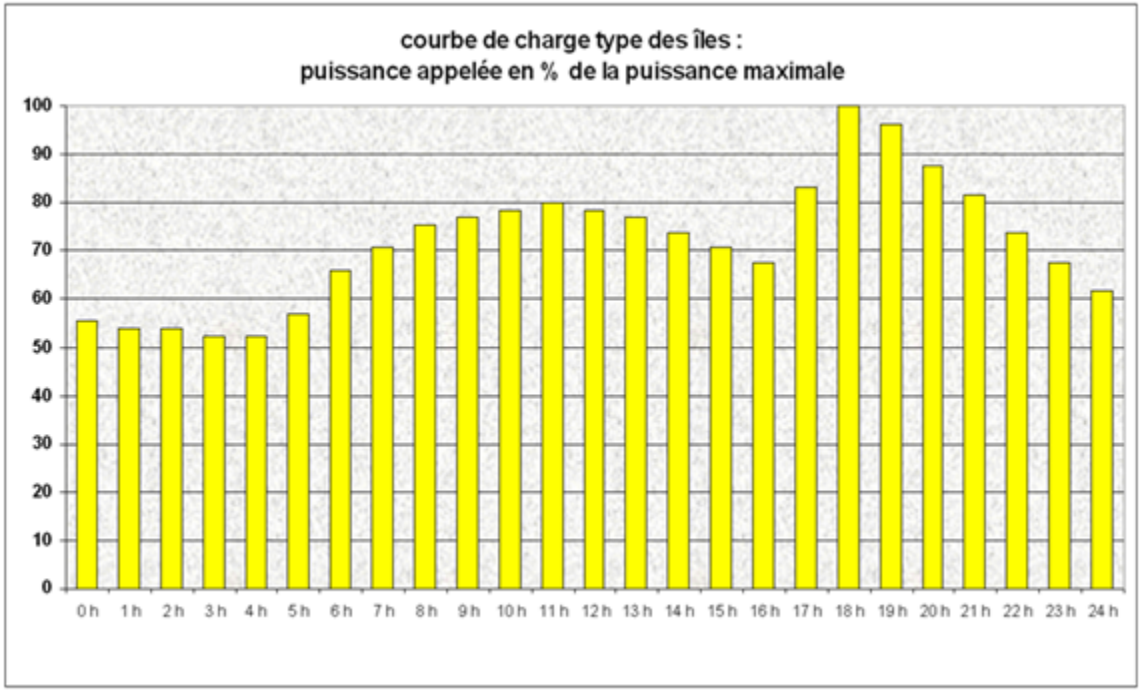
•Environmental issues:

- Noise reduction
- Oily water collection and treatment
- Cleaner emissions

•Problems on ownerships of properties (common issue in French Polynesia) make difficult to obtain sites for implementing power generation projects

POWER GENERATION PROBLEMATICS ON SMALL ISOLATED SYSTEMS

Typical daily load curve: night time low = 50% of the evening peak.

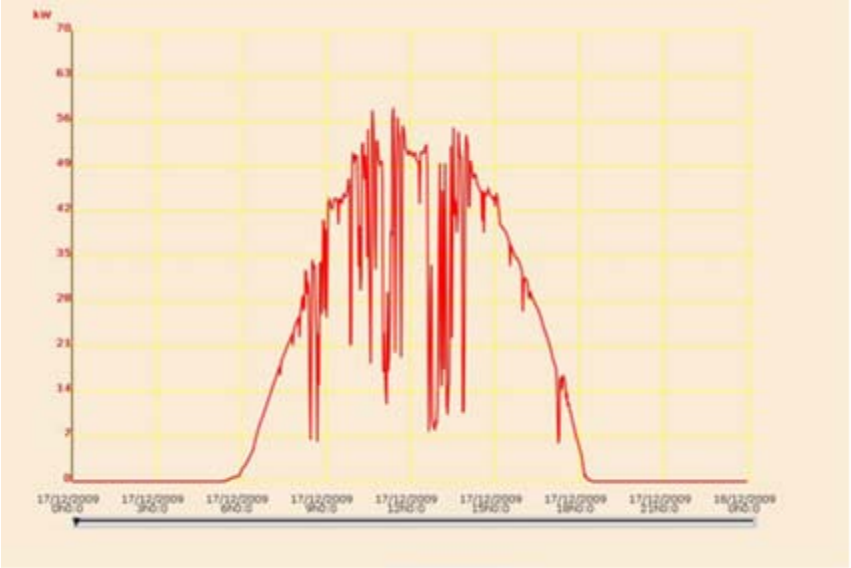


- The size of production units and the types of production tools must be adapted to the load profile.
- Peak load is in the evening: production equipments must be capable to generate power at all time (not the case of PV unless adding batteries for storage).
- To preserve stability of the system, share of intermittent energies must be limited to 20-30% of demand at all time. Beyond this limit, use of batteries is required.

POWER GENERATION PROBLEMATICS ON SMALL ISOLATED SYSTEMS

Intermittent or « fatal » energy sources

Production of photovoltaic or wind generators can vary instantly and significantly, with fluctuations of up to 90% of the peak power on PV installations and 100% on wind generators. Therefore, they are often qualified as "intermittent" or "fatal" energy sources.



These variations will cause inevitably voltage drops or surges that would impact the quality of the distributed power.

POWER GENERATION PROBLEMATICS ON SMALL ISOLATED SYSTEMS

Our generation plants are designed to meet demand at all time even with the two largest production tools out of service or in maintenance.

Renewable energies like wind or PV do not provide generation guarantee. On remote and non interconnected electric systems, it is necessary to have at all time enough generation capacity to garantee the supply of energy, even if some generators are out of service or in maintenance, or to compenste variations caused by intermittent energies.

Consequences:

•Redundancy of production tools required with generators to guarantee at all time the supply in energy, or installation of energy storage devices.

•Guaranteed generation capacity considering the loss of the two largest generators and remoteness cause higher investment costs but increase the quality of services

FROM PRODUCTION BASED ON FUEL TO RENEWABLE ENERGIES

French Polynesia is composed of roughly 120 islands spread in the middle of the South Pacific, on a surface as wide as Europe. Like other Pacific island countries, it is particularly exposed to the ever increasing costs of energy.

The development of alternative energy sources using renewable resources is therefore a strategic option to increase energy security of supply: that will both reduce dependency on imported oil products and FOREX expenses by using locally available and abundant resources (sun, water, wind, etc).

RENEWABLE ENERGY DEVELOPMENT PLAN:

Many Renewable Energy Technologies, but most are still experimental.

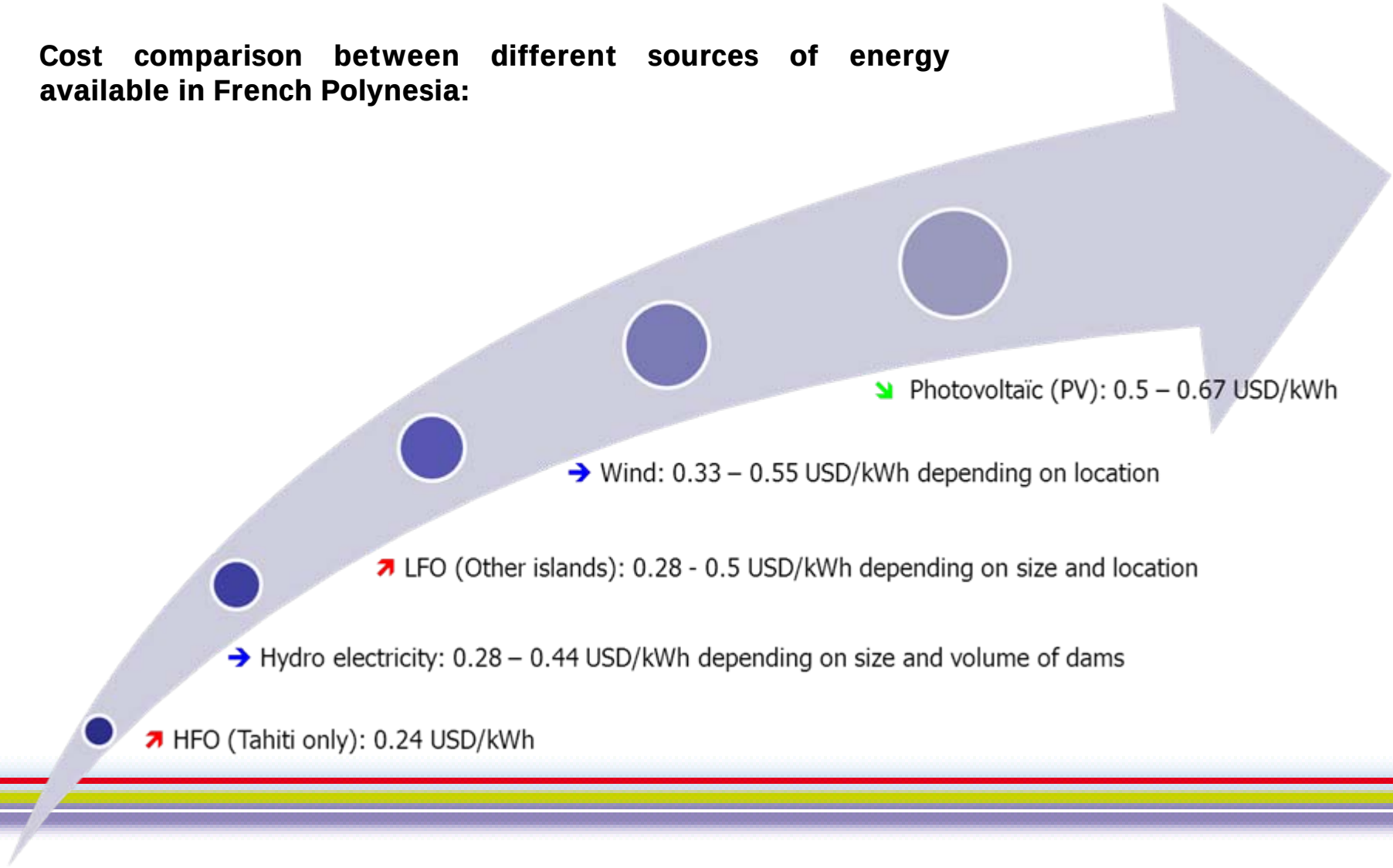
In order to reduce the share of fossil energies in its generation mix, EDT will focus on resources and technologies that are reliable, adapted to the needs of each site, and cost efficient.

In the short-term, our focus will remain on hydro and some PV.

Hydro still has lots of potential in Tahiti and the Marquesas.

FROM PRODUCTION BASED ON FUEL TO RENEWABLE ENERGIES

Cost comparison between different sources of energy available in French Polynesia:



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RENEWABLE ENERGY DEVELOPMENT PLAN:

Many RE projects have been developed by other operators than EDT in French Polynesia lately, but except a SWAC in Bora Bora, few projects have been carried out with success:

-Wave power generation project in Tahiti was once in study but is now abandonned or pending

-Biomass and anaerobic digestion of organic waste projects pending

-Wind-diesel hybrid power station in Makemo completed but encountering many problems with its wind generators.

Regardless of the technology, preliminary studies will be essential for the success of a project. Different aspects are to be considered:

-Logistics problems: lack of transportation and handling equipments on some remote sites, accesibilility problems

-High costs of local labor and transportation

-Scale of the project: some techologies have critical sizes

-Environmental issues

-Reliability of the technology

FROM PRODUCTION BASED ON FUEL TO RENEWABLE ENERGIES

HYDRO or MICRO-HYDRO:

In Tahiti

- 8 valleys not equiped yet, presenting high potentials: possibility for additional 25 MW and 100 GWh in annual production
- Vaiiha project in Tahiti: 10 MW and expected annual production of 24 GWh

In other islands:

- Improvement of existing plants and new micro hydro projects in Marquesas islands could bring additional 400-500 kW
- Possibility to have 500 kW of hydro on the island of Raiatea (2 GWh expected annual production).

FROM PRODUCTION BASED ON FUEL TO RENEWABLE ENERGIES

SOLAR PHOTOVOLTAIC (PV)

Today 9 MW peak of connected PV in Tahiti, this level can be raised up to 14 MW peak in the forthcoming years. In addition, 10 GWh of PV production is expected to be directly consummed by our clients and not reinjected in the grid.

On several islands of the Tuamotu, Diesel-Solar hybrid power stations have been built, with a share of PV over 50%.

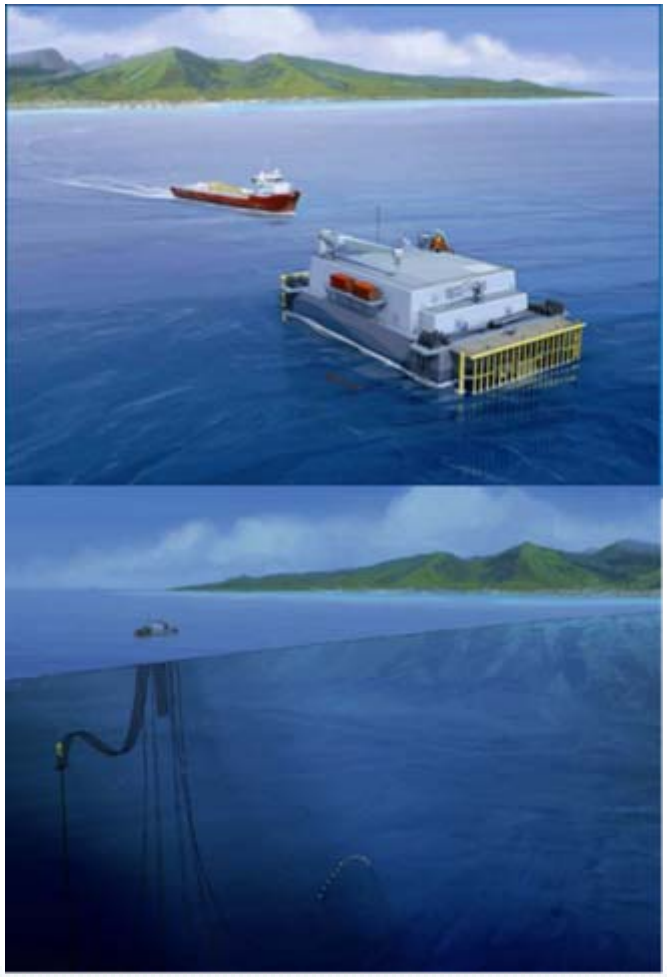
WIND TURBINES:

Wind conditions in French Polynesia are generally not very favorable (not enough wind). Therefore, only smaller units are better fitted to our environment:

•Necessity to be have easy to transport and install equipments, and masts easy to take down (before cyclones)

•Critical size, type of equipments and location choice are key factors (typical case of the wind-diesel hybrid plant of Makemo that has encountered many problems with its wind generators).

MARINE ENERGIES



Surrounded by nearly 5 millions km² of ocean, marine energies have therfore some potential in French Polynesia. However these technologies are not mature yet.

OTEC (OCEAN THERMAL ENERGY CONVERSION)

French Polynesia is located in an area with favorable conditions for OTEC, which uses the difference between cooler deep and warmer surface ocean waters to produce energy through a heat engine.

•Warm surface water is around 27-28°C

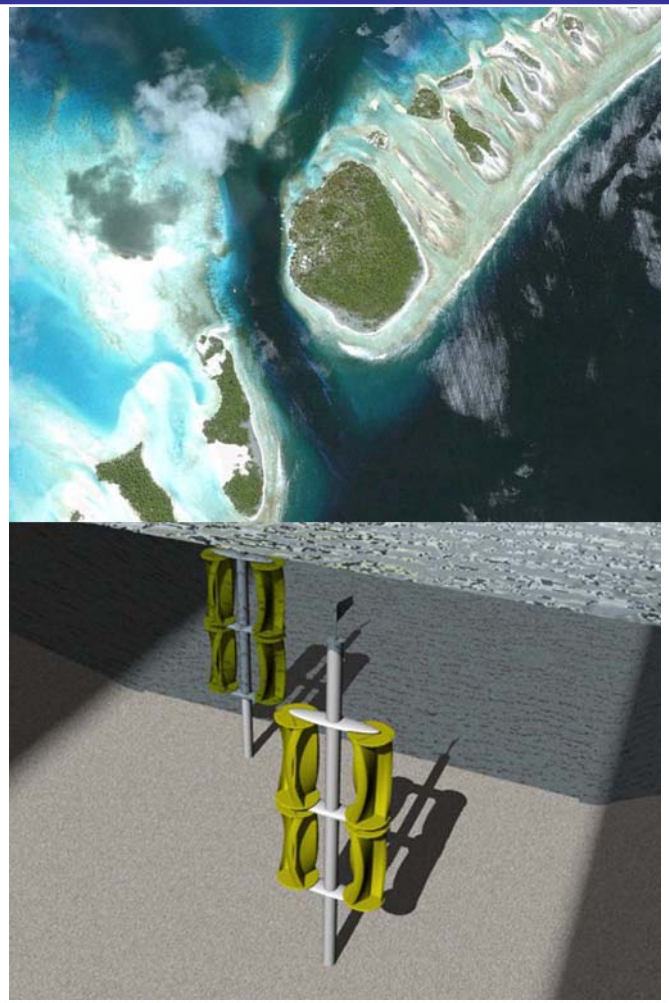
•Cold deep sea water at 1000 m depth is around 4-5 °C

Considering the potential temperature difference, French Polynesia is certainly among the best sites for OTEC applications. Furthermore, it's a technology that can be used for base load generation.

A10 MW OTEC project in Tahiti is currently being studied.

Besides power generation, cold deep sea water can be used for other applications such as air conditionning, which is already used in one of the hotels in Bora Bora. SWAC is a way of reducing electrical energy consumption.

MARINE ENERGIES



ENERGY OF MARINE CURRENTS:

In the Tuamotu, most atolls have passages in the coral reef allowing communication between the lagoon and the ocean, in which currents can be used to generate energy.

Although not widely used today, the potential of power generation from marine currents could be significant, when the technology will become mature. Like wind turbines extract energy from the wind, water current turbines convert the kinetic energy of marine currents into electric power.

Tuamotu atolls could be suited for testing this technology:

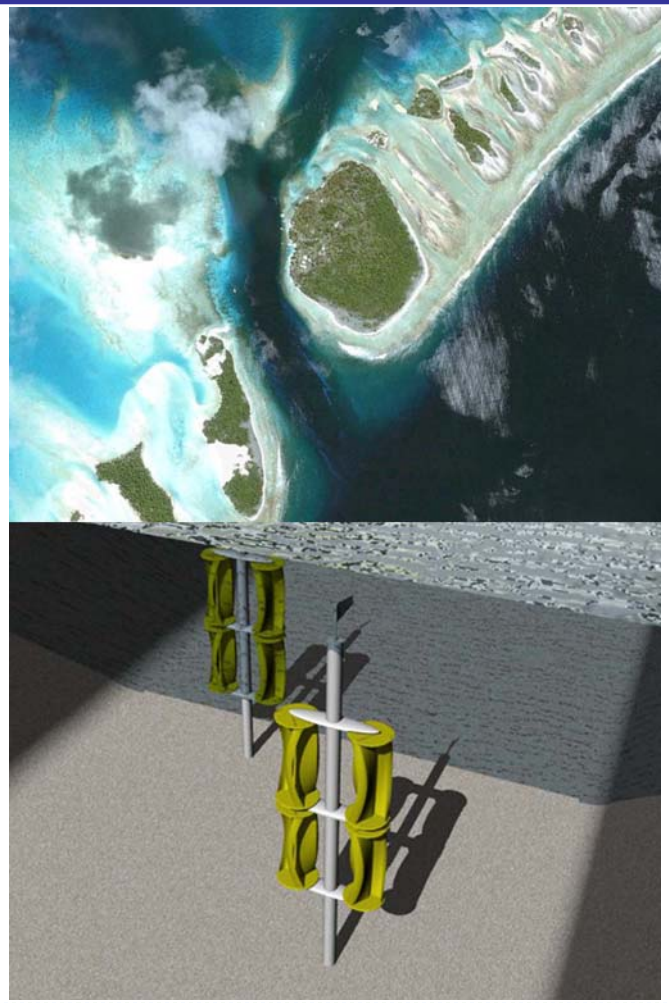
-Low demand, adapted for testing the technology at a smaller scale

-Villages located close to these channels

-Reduction of fuel consumption used for power generation (high cost of transportation and production in these atolls), and reduction of environmental risks (fuel delivered in drums)

-Currents in these channels are predictable

MARINE ENERGIES



ENERGY OF MARINE CURRENTS:

Project to install small experimental water current turbines (5 kW units), in the Tuamotu, with an estimated annual production of 12000-15000 kWh. (Feasibility study in association with IFREMER Tahiti).

The objective of this project is to:

- Test a prototype of water current turbines
- Check the impact of the project on the marine environment
- Check the aptitude of the équipements to resist to marine conditions

THANK YOU

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