In the harbour of Molène

Energy audit on Molene

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1 Introduction

In 2015, Molène joined the SMILEGOV[1] project through its membership in *l'Association Les Îles du Ponant* (AIP) and subsequently in the *European Small Islands Federation* (ESIN). The objectives of SMILEGOV, funded by the European Commission, is to establish a clear picture of the island's energy consumption, its emissions and how it is it supplied with energy, moving into an action plan for a more sustainable future, and to invite the island to join the Pact of Islands[2].

Process

Being late arrivers in the project, the work has been focused on understanding the documented situation of Molène and to use this knowledge to enhance the total project knowledge of small islands energy needs and solutions.

This report has been compiled by Senior Advisor Christian Pleijel, Vice President of ESIN (*European Small Islands Federation*) and Denis Bredin, Director of the AIP, with the kind help of Daniel Masson, Maire of Molène.

There are excellent data on energy and emissions on Molène in the AIP documents "Profil Énergie et Gaz à effet de serre – Molène" (2014), "Transition Énergétique des îles du Ponant – Molène"(2014) and "Atlas des îles de l'Atlantique (2009), prepared with the help of GIP Bretagne Environnement.

ESINs project manager has visited Molène once (July 2015) and has used the documents mentioned above, his own observations and interviews to compile a portrait where the island is observed from six different perspectives, a method described and used in his book on the small islands of Europe[3]: (1) Facts, (2) Identity and culture, (3) Optimism, (4) Pessimism, (5) Opportunities, and (6) Actions. The reason for not solely describing the energy and mobility situation on Molène is that issues as energy and mobility are closely related to tourism, trade & industry, transports, healthcare, culture, schools and demography.

Islands are miniatures of the world, solitary, clearly separated from the mainland by the sea. Being small, distant and vulnerable, an island needs to plan and develop itself in a cohesive and continuous manner, handling the complexity of local, regional and European politics, combining micro and macro scale.

September 2015,

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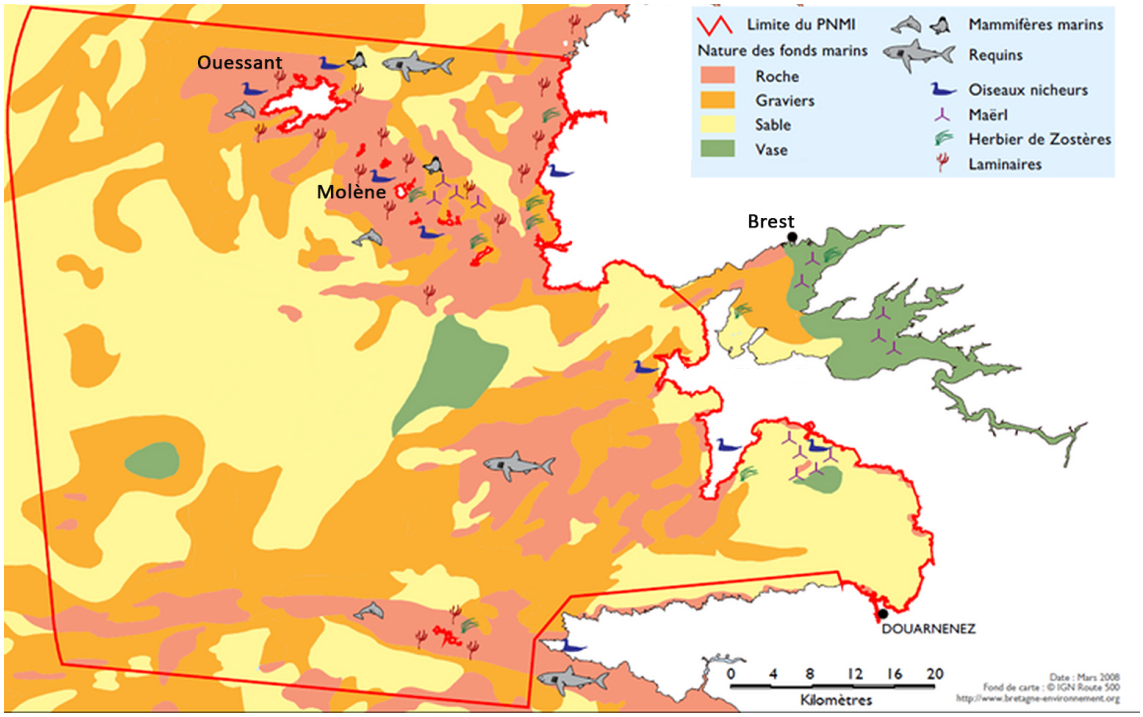
[1] http://www.sustainableislands.eu/
[2] http://www.islepact.eu/html/index.aspx
[3] http://europeansmallislands.com/how-to-read-an-island/

2 Summary

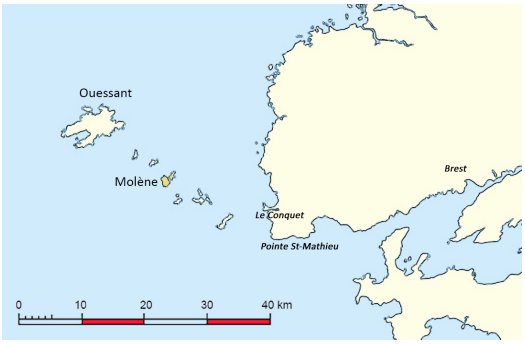
Baseline Year	2014
Population	216/363 residents
ENERGY CONSUMPTION	
Sea transports	4,783 MWh
Road transports	0 MWh
Industry	162 MWh
Fishing	324 MWh
Road transports	0 MWh
Residential	1,945 MWh
Tertiary	900 MWh
Sum of energy consumption	8,114 MWh
Per capita/216	37,565 kWh
Per capita/	22,337 kWh [4]
EMISSIONS	
Sea transports:	1,290 ton CO_2e
Road transports	0 ton CO_2e
Residential:	1,020 ton CO_2e
Tertiary	540 ton CO_2e
Sum of emissions	2,850 ton CO_2e
LOCAL ENERGY PRODUCTION	
Wind	0 MWh
Solar	0 MWh
Geothermal	0 MWh
Underwater turbine	to be measured
ACTION PLAN	
To save	384 MWh/year

[4] The European average is 28.439 kWh/person/year
http://www.energikunskap.se/sv/FAKTABASEN/Energi-i-varlden/



The Iroise Sea Natural Park

3 Facts



3.1 Geography

Molène is an archipelago halfway between Ouessant and the Cape Pointe Saint-Mathieu on the mainland of Bretagne in the Iroise Sea. Covering 3,550 km², the Iroise Sea borders the Celtic Sea to the west, the English Channel to the north and the Bay of Biscay to the south. It is considered to be one of the richest areas for marine life in the world, and is France's first marine natural park[5], created 2007. In winter, there are often violent storms with huge waves. High tides in the English Channel bring about strong north-easterly currents which reverses at low tide.

[5] www.parc-marin-iroise.fr

Molène is the largest island of nine: Bannec, Balanec, Triélen, l'île aux Crétiens, Quémènès, Litry, Morgol and Béniguet. The community and only port is located to the east of the island, opposite the two islands of Lédénes, connected to the main island at low springtides.

The island is very small land with a dry area of 72 hectares. It consists of granite and plated sand dunes rising 26 meters above high tide level.

The temperature is about 10 degrees in winter, in summer rarely more than 30 degrees. In summer the water temperature is 15 degrees and that is as warm as it gets.

3.2 Population

People have lived here since Stone Age 5,000 BC and had at most 673 residents in 1921, who were then living from fishing and sea wrack agriculture, growing wheat and rye.

Today the population numbers 216 in winter and 750 in summer[6]. There are about 20,000 one- or two-day visitors per year to the island. Summertime, the number of visitors can be 100 a day, thus about 10,000 during summer. The capacity to welcome visitors is 770 guest beds meaning the tourism density is 1,027 beds/km^2.

The human pressure on the island's fresh water system, on energy supply, on sewage and waste handling, postal services, healthcare, rescue, roads and ferries is calculated as follows:

Residents (365 days)	216	78,840 days
Summer residents (45 days)	750	33,750 days
Visitors (1 day)	20,000	20,000 days
Sum		132,950 days

132,950 man-days divided by 365 gives 363. The number of people using Molène is, technically speaking, equivalent to a population of 363. That is the average number of people being on the island any day of the year, moving around, eating, drinking, producing garbage, litter and emissions, sometimes needing help and healthcare, asking transportation to and from the island. 363 people is the base for calculating the island's ecological footprint. From an infrastructural and a sustainability perspective, Molène has a population of 363 people, not 216.

This human presence is very uneven since the island sociobiotope is used by thousands on summer days but by hundreds in winter. Still, the island has to have a system that can handle

[6] "Les îles du Ponant comptent aujourd'hui une population permanente de 15.724 habitants, multipliée par 6 en haute saison." Marie Languille "Tourisme et accessibilité dans les îles du Ponant" (2010)

full human pressure, being oversized and overexpensive most of the time.

3.3 Governance

Administratively, Molène is a commune of the Finistère department of Brittany in north-western France. It is now member of "Communauté des communes du pays d'Iroise.

3.4 Trade & Industry

The most important trade is fishing. Four fishing boats are in use three of which three supplies their respective families, and the fourth, larger, is shared between three fishermen / families. They catch shellfish (langoustes, homards, crabes dormeurs, araignées) and local fish (vieilles, merlans, maquereaux, congrès, bar). Two of them are harvesting abalones by scuba-diving. One farmer cultivates potatoes since two or three years.

The second most important trade is being a seaman. Many islanders are employed on the boats between Brest, Molène and Ouessant, some in the French merchant navy.

The third most important trade is public service, which employs eleven people including the post office (own by the municipality).

Next in line comes tourism, for example kayaking in the Molène archipalgo. There is also a creperie and a restaurant on the island.

There is no electrician on the island.

There is no fuel station on the island, but the municipality orders the diesel coming every Saturday and then sell it on non-profit to islanders who bring their cans and canisters to the port. Gasoline is more complicated to handle because of flammibility and must shipped here by boat.

The Proxi Super

The grocery shop – a very important part of the social and economical structure on an island - is managed by Christina and Bruno Delerue who moved here in 2014 and established it as part of the French *Proxy* chain.

Mr & Mme Delerue with daughter

Food prices are about 5% higher compared to the mainland but this is not a big problem for the merchant since there are no cars on the island (because they do not have a car ferry). People do not have the possibility to go to the mainland and stock up. In contrast, many order goods through the internet and so they get back catalog via the ferry.

The post office

3.5 Public Service

The doctor comes once a week, there are nurses on the island and a helicopter landing site for emergency cases. No dentist, no hairdresser.

The school has seven pupils on seven levels (primaire, secondaire et collège) with one teacher for primaire and an itinerant teacher system (shared with several of les Îles du Ponant).

Rainwater tank system on Molène

3.6 Freshwater

There is a shortage of water on the island and freshwater used to be rationed. Rainwater is collected with an interconnected system of tanks (see map). The tanks are individual cisterns as well as an impluvium (small pool) built in 1976.

In 1989, the diver Pierre Stervinou discovered an underground water source and three boreholes were drilled at 21, 23 and 52 meters deep. With that, water rationing on the island came to an end but is still fragile and shortage is a serious threat.

Still in high season with many residents and visitors, there may be a water crisis which is solved by getting water with a tanker from the mainland (so was the istuation when ESINs project manager visited the island in July, 2015).

m/s Fromveur II coming in to Moléne

3.7 Transports

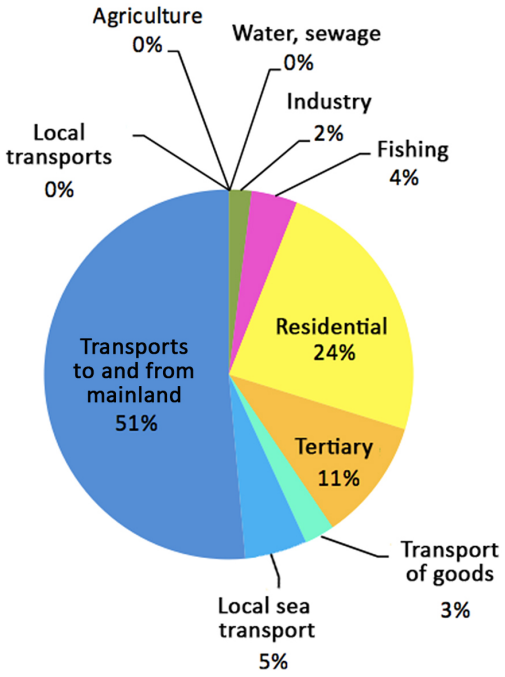
The island is served by the Penn Ar Bed[7] and Finist'mer companies, moving 420,000 people to and from Molène per year.

In winter, the pen ar bed is the only company operating, there is one morning crossing from Brest via Le Conquet port on the mainland every day, and, every second day, one more tour in the afternoon. From Molène to Brest, the timetable is a bit complicated with two crossings a day three days a week, otherwise a single crossing.

Summertime, traffic is idle with more than 40 percent of the passengers being transported in July and August, and 80 percent during the six months of April to September.

There are no cars in Molene to the exception of three vehicles used on the island for utilitary purposes: the municipality has a small electric car, there is an ambulance, as well as a small truck for garbage collection. Two-wheeled motor vehicles were banned twenty years ago.

3.8 Energy Use

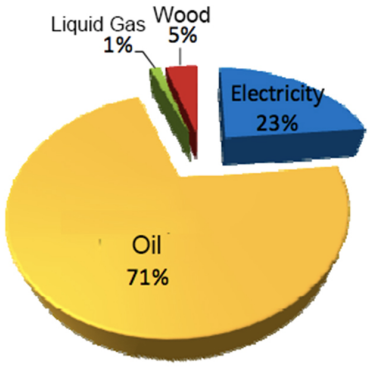


Molène island uses 8.114 MWh a year[8].

Of this, 59% is used for transports, mainly between the island and the mainland and for traveling to and from mainland ports connected to these journeys. Only 5% is used for local sea transportation, 3% for transport of goods and close to 0% for local land transports since there is practically no road traffic on Molène.

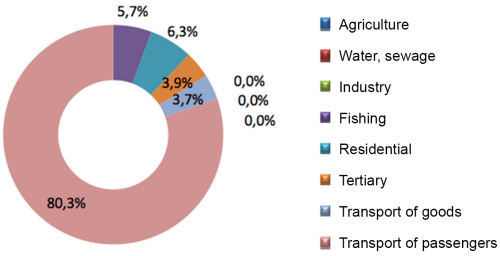
[7] http://www.pennarbed.fr/en/

[8] 697 tonnes of oil equivalent (TEP) according to "Profile Énergie et Gaz à effet de serre - Molène" (Fevrier 2014)



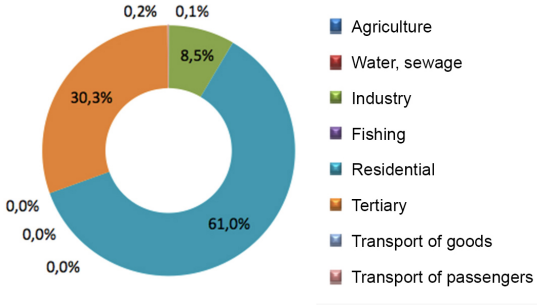
Energy sources on Molène

Oil is the island's main energy source /71%), followed by electricity (produced on the island with oil).



Use of oil on Molène

Oil is used mainly for transports.



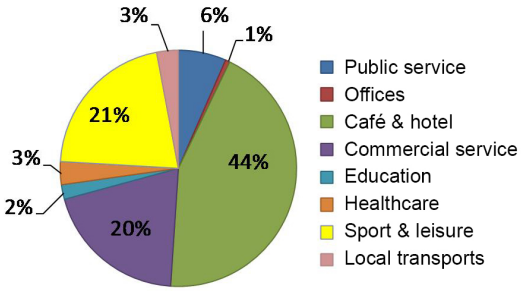
Use of electricity on Molène

Electricity is used mainly for residential and tertiary use

Typically 60 per cent of the energy consumption of a Molène household is for heating, about 20 per cent is for hot water (shower, dishes etc.) and the remaining 20 per cent is used for household electricity devices such as fridge, washing machine, lighting, TV, computers and other devices.

The total energy cost on Molène was 771.790€ in 2011 which means 3,573€ per capita (counting 216 inhabitants).

The tertiary sector uses 11% of the total energy used on Molène = 900 MWh, and causes 18% of the greenhouse emissions.



It is mainly cafés, hotels and restaurants (tourism) which uses energy, 66% of it being electricity.

3.9 Local Energy Production

Electrification on Molène started in 1938 but only for a few hours a day.

Today, electricity is produced using three diesel generators of 150, 225 and 320 kVA which consume some 100,000 liters of fuel oil a year to serve 330 clients.

The yearly energy production on Molène is 1,112 MWh (2014).

A sea cable proved impossible to install due to deep and uneven

depths, strong and uneven currents and sharp underwater rocks.

3.10 Emissions

The emissions from the island consist of sewage, waste and greenhouse gas (CO_2-equivalents), of which the latter should be balanced against Molène's ability to store carbon.

(a) Sewage

The sum of sewage on the island is 160 litres x 363 man-days x 365 days = 21 million litres. Most of it is grey water (from showers, bath, dish and washes) and a smaller part is blackwater from toilets comprising bacteria, nutrigents and medicine spill.

(b) Solid waste

Molène produces 166 tonnes of solid waste a year. Half of the waste is composted; the rest of is collected in recycling facilities centrally in the harbour and moved to mainland services in Brest.

Recirculated waste comprises 13 tonnes of newspapers, 4 tonnes of cartons, half a tonne of cans and other metal scrape, almost 2 tonnes of plastic, some 36,000 aluminium cans and 7 tonnes of glass.

There is no glass crusher or paper baler on the island, which might be useful given the distance to and cost for transporting waste to the mainland.

The amount of waste is almost half a tonne per capita and year (counting 216 inhabitants).

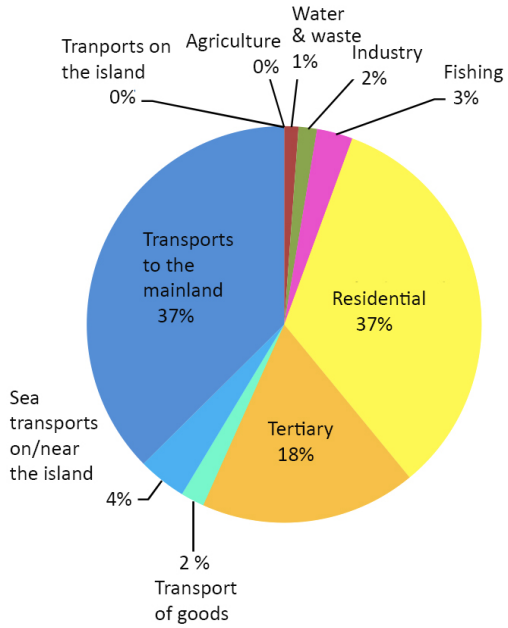
(c) Greenhouse gas[9]

On Molène, the total yearly emissions of greenhouse gas are 2,850 tonnes of CO_2e. Transports are the villain, followed by residential use of energy.

Since Molène is not connected to a grid, electricity is produced with oil which leads to a very high CO_2e factor per kWh produced: 0,777 kg of CO_2 (compared to 0,023 on the main-

[9] Human emissions of CO_2 have augmented from 270 ppm to 380 ppm in 100 years. Parallel to this, the average temperature on Earth has increased with almost 1°C. We call this the 'greenhouse effect', gases contributing to this are carbon dioxide (CO_2), nitrogen oxide (NO_x), methane (CH_4), freones, water steam and ozone. Carbon dioxide is the most frequent by volume with 379,64 ppm (2015). Although the degree of methane is low, methane is 25 times more efficient than carbon dioxide in producing heat. This is why all gases should be included in discussions on temperature changes and possible actions on lowering their effects. In order to measure this, CO_2-equivalents (CO_2e) are used, which define the amount of any greenhouse gas needed to produce as much heat as CO_2. One kilo of methane gas has the same effect as 21 kg carbon dioxide.

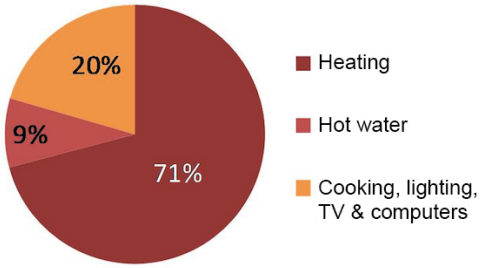
land or on an island connected to a grid).



3,000 tonnes of CO_2e per year totally from Molène

Due to this, a building on Molène produces twice as much green-house gas as a building on the mainland.

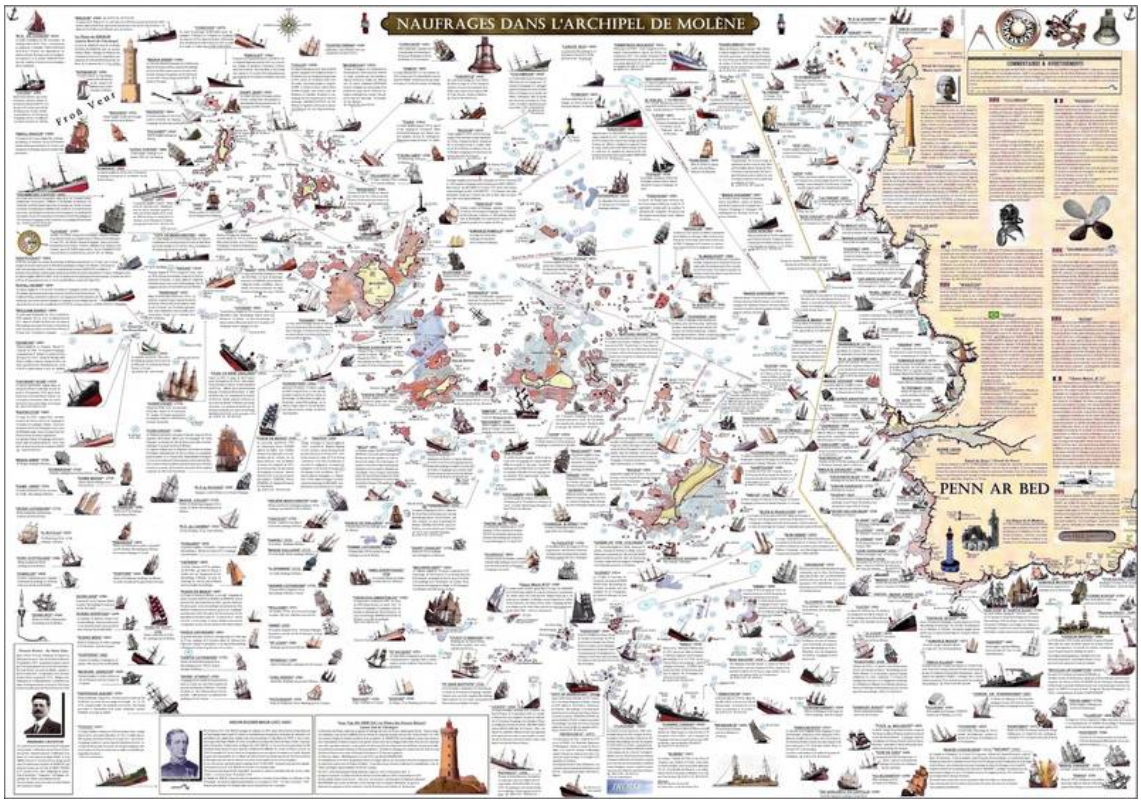
A typical Molène home has an area of 69 m^2 and use 25 MWh a year.



71% of energy used in Molène homes is for heating

The 216 residents use totally 2 GWh each and are responsible for 33% of the emissions.

All in all, a molenais emits 13 tonnes of CO_2e a year.



Wrecks in the Iroise Sea around Molène

4 The culture and identity of Molène

Molène has three outstanding caracheristics: the rugged sea, the small size of the island, and its remoteness.

Because of the harsh conditions in the Iroise sea, there are many lighthouses and many local legends describing tragedies at sea, and the courage of the molenais rescuing them, a bravey commemorated on many places on the island.

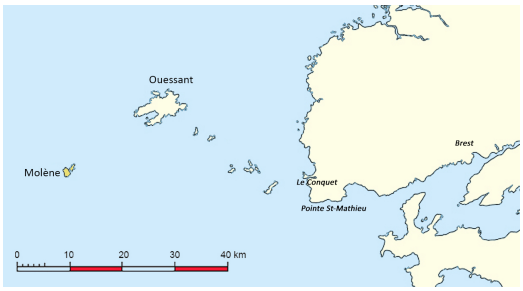
The island is tiny with close contact between the islanders. Every morning, the Mayor walks from his home to the town hall. These 100 meters usually takes him an hour because people stop him to have a chat on many different matters.

Daniel Masson is Maire of Molène

The municipal council includes two summer residents (this is very unusual in islands societies in general).

There is no property register and no property tax.

There is no police or gendarme on the island.



The percieved and the real remotenss of Molène

Molène is not so remote counted in kilometres but it is quite distant counted in time.

Molène is at 7 nautical miles, almost 14 km, from the port of Le Conquet. The trip takes about 60 minutes. People are used to voyage at 70 km/h and perceive the distance to be much greater and the island to be much more remote than it really is.

Adding to this sense of remoteness is the fact that the island for forty years was known to be one of only places in France without a bakery.

Not getting a freshly baked baguette or a croissant for breakfast coffee is just as unthinkable for a Frenchman as the French would not be the leading language in the civilized world.

But the world is getting better: the grocery shop is now baking bread and Molène has lost one of its surprisingly well-known features – not having a bakery.

5 Optimism

A program to curb energy consumption and produce renewable energy was implemented in July 2009 by the Regional Councils of Brittany and Finistere, French energy provider EDF and the French National Environment and Energy Agency (ADEME).

The inhabitants of Molene have received energy-efficient light bulbs and water savers free of charge. They are also benefitting from a 60% grant for the purchase of a more ecological refrigerator. The program aims at encouraging decentralized electricity production through renewable energy up to 75KWp from photovoltaic panels. The program aims at Reducing Energy Consumption by 16%.

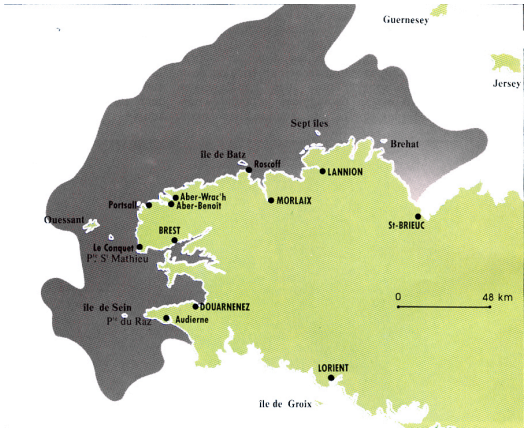
Seaweed gatherers from Plouguerneau presently exploit the seabed of Molène, acknowledged as one of the largest meadow of algae in Europe. These seaweed gatherers of modern times use boats equipped with 'scoubidous', a kind of articulated arm used to collect the algae.

6 Pessimism

Depopulation, an ageing population and sea level rise due to the greenhouse gas effects threaten Molène.

The smallness and low altitude of the island makes these threats even more dangerous.

The island is also under threat of overfishing and oil spills, having experienced the Amoco Cadiz catastrophe in 1978, releasing 1,6 million barrels of crude oil (250,000 m^3) into the sea (sea the map to the right), hitting Molène with full strength, killing 20,000 sea birds and having a huge impact on marine life.



The oil spill of Amoco Cadiz

Other oil accidents include Olympic Bravey, 1976 (800 tonnes of oil), Amazzone 1988 (2,100 tonnes) and Boelhem 1976 (2,000 tonnes).

7 Opportunities

Molène, Ouessant and Sein are part of the "Transition énergétique des îles du Ponant " project aiming at creating energy profiles of the islands, calculating emissions, making plans directed at coming to terms with the problems and possibilities found in making these profiles and emission calculations, and developing action plans in close cooperation with the inhabitants of each of the islands.

A SABELLA turbine being lowered into the sea

In july 2015 (plugged in september to Ouessant electric network), a SABELLA turbine[10] was installed on the seafloor in the famous tidal stream "Fromveur" between Ouesant and Molène, connected to Ouessant by a 2,000 meter underwater cable. It is 17 meters high and weighs 400 tonnes, built for this hostile environment, pre-orientated in the direction of the tidal currents with a profile of its symmetrical blades helping to capture the ebb and flow.

The rotor activated, at slow speeds (10 to 15 rpm), by the tides powers a generator, which exports the electricity produced to the Ouessant's coast via a submarine cable anchored and embedded at its landfall.

Like wind turbines, a power conversion/transformation module regulates electricity produced by the variable speed generator to deliver an electric signal in compliance with the specifications of the local grid.

The dimensions of the turbines are adapted to suit the bathymetry of the site to prevent disturbance to navigation and to keep the effects of swell to a minimum.

The SABELLA turbine fits best in sites with strong currents that are not areas suitable for deep-sea fishing (trawlers, pot haulers, gillnetters). Not even line vessels, fishing for sea bass, operate frequently in the fromveur area areas.

10 http://www.sabella.fr/fiche.php?id=112&lg=gb

8 Action Plan

The actions planned for Molène in the '*Boucle Énergétique des îles de la mer d'Iroise'* include:

(a) Lowering energy consumption:

Renovation of 70 houses, tracking people's everyday consumption through operation 'Trak o Watts des îles', action FROID which is upgrading household machinery, action LED/changing lightbulbs.

(b) Producing local energy from renewable sources:

- Photovoltaic generators on Ledenez

- Photovoltaic installation on one of the municipal buildings to charge an electric car.

(c) Smart use and stocking of energy taking peak hours in consideration

(d) Communication

These actions are calculated to save 385 MWh per year.

9 Sources

Association Les ïles du Ponant "Profile Énergie et Gaz à effet de serre - Molène" (2014)

Association Les ïles du Ponant "Transition énergétique des îles du Ponant - Molène" (2014)

Colas, Sébastien: Atlas des îles de l-Atlantqie (2009)

Languille, Marie "Tourisme et accessibilité dans les îles du Ponant" (2010)

Communes insulares d'Ouessant, de Molène et de Sein: Dossier de candidature, Boucle énérgetique locale

Photo page 11: http://www.parc-marin-iroise.fr/

Map on page 4: Le Parc Naturel Marin d'Iroise, Agence des Aires Marines Protegées (2008) http://www.bretagne-environnement.org/Media/Atlas/Cartes/Parc-naturel-marin-d-Iroise

Map on page 11 by Michel Cloatre and Georges Pennec.

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