



*DESIGNED TO ADAPT. BUILT TO ENDURE.*

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## **SUSTAINABLE SOLAR SOLUTION 1,000 PANEL INSTALLATION**

November 2013

## Project Overview

For over 50 years, Polypack, Inc. has manufactured shrink wrap equipment offering packaging alternatives whose end result is source reduction. Shrink Packaging reduces the amount of packaging mass, and therefore reduces the amount of packaging waste that ultimately finds its way to our landfills. Continuing in a long-standing tradition of sustainability, in 2011 Polypack began a new kind of sustainability project, one that would ultimately result in a 1,000 solar panel array that can provide all of the power required to run the manufacturing facility, as well as the office space and attached automotive museum.

## Choosing The Right Option for the Region

One of the challenges of renewable energy is that there is no "one size fits all" solution. Different locations lend themselves more to wind power, hydro power, tidal energy, geothermal energy, etc. Here in Tampa Bay, Florida, the obvious answer is the generation of power through the use of photovoltaic cells, more commonly known as solar panels. Unfortunately, as the saying goes, "There is no free lunch." While the entire Nation knows Florida as "The Sunshine State," we are also at the mercy of hurricanes and the associated high speed winds. The decision was made to pursue a long-term system that, like the equipment we manufacture, is built to endure.

## On the Winds of Change: Ushering A New Design Approach

One of the most important aspects of our solar installation is its unique design. Rather than employing the traditional method of bolting down mounting hardware to the roof, our design uses spray foam to secure the mounts in place on the rooftop. This approach delivers several benefits which makes it ideal for our application. The spray foam provides a unified mounting surface which is strong enough to sustain a Category 5 Hurricane. The spray foam also provides insulation to the facility, reducing the amount of energy required for heating and cooling throughout the year. The spray foam roof also reflects sunlight, reducing the amount of heat absorbed by the buildings during peak hours. The mounting hardware itself is also a unique design.

The mounting system for the solar panels was completely designed in-house by Polypack, Inc. The mounts are made from 11 gauge stainless steel and the legs of the mounts are perforated to allow the spray foam to permeate through the surface. They are manufactured from 304 stainless, which offers excellent corrosion resistance and long-term durability. Combined with the unified spray foam surface, the end result is a fully-integrated photovoltaic system capable of withstanding winds in excess of 157 miles per hour.





## Energy, A Problem to be Solved - By Alain A. Cerf

Hundreds of years ago, energy as an artificial power in the service of humanity, was an unknown concept. The Sun was a god; Rah in Egypt, Kinich Ahau for the Mayans, and Apollo for the Greeks. The Sun made life possible on planet Earth. Blessed be the Sun. The Sun god lost his status of revered divinity when the Pagan religions gave place to monotheistic religions. Thousands of years later, a materialist Sun is making a comeback.

Energy is currently one of the principal components of the economy. In the 19th century, steam machines burning wood (and later coal) were following the industrial revolution. In the 20th century, oil and gas complemented and, in some cases, replaced the coal. Nuclear energy made its entry and other types of so-called renewable energy sources such as hydroelectric, biomass, photo voltaic and wind supplement the burning of the fossil fuels.

More energy is always needed, given the increase of the world population and civilization's demand for better access to all the gifts of modernity: automobiles, jets, air conditioning, computers, gadgets, etc.



Rah - Egyptian Sun god

## Fossil Fuels

There is a strong commitment to supplement or even replace the energy coming from non-renewable resources such as coal, oil and gas with energy from a source which is sustainable. As we say "natural gas", we should say *natural coal* or *natural oil*; while it comes across as eco-friendly, it is not. Two main arguments support the theory:

**1) Fossil fuels are non-renewable. When they are all used to make energy, no more will be left on the earth.**

Numbers concerning the reserves of fossil fuels keep changing with the discovery of new



Kinich Ahau, Maya Sun god

sources. Lobbying for research, drilling and speculation add another layer of uncertainty. Regardless if it is 30 years or 100 years or even a little bit more, it does not change the fact that some day, in a not too distant future, we will run out of fossil fuels.

As the majority of decisions are dictated by short term policies, those in the energy business try to keep going for as long as possible with the same technology. The main factor is to make money, and unfortunately, to leave the resolution of potential problems to the next generation. There is no hurry and the status quo is accepted. Some experimentation with the new technologies of renewable energy are welcomed as a learning process (which could be useful someday) and also as a nice gesture, almost philanthropic, toward the "green" portion of the population.

## **2) Burning fossil fuels creates emission of carbon dioxide or CO<sub>2</sub>. It is a natural gas already present in the atmosphere in very small quantities.**

Carbon dioxide is useful for the growth of all forms of vegetation. At the same time, the flora keeps the quantity of CO<sub>2</sub> at a stable, acceptable level. With manmade CO<sub>2</sub>, the percentage of carbon dioxide in the atmosphere is increasing and will form a cloud slowing down the radiation of heat away from the earth. Consequently, the temperature on earth will increase, with the melting of the ice and a rise of sea level to follow. Another effect of excessive CO<sub>2</sub> is that the weather will follow a different pattern and will undoubtedly cause some damages on earth.

Not everyone supports the concept of the greenhouse effect caused by carbon dioxide, but the majority of scientific organizations as Science Academies agrees with the reality of the danger for our planet. Even if some doubt should remain, we face a risk and we need to react positively and to replace the fossil fuels now rather than waiting for their complete lack availability to pose a problem.

## **Nuclear Energy**

Nuclear energy is an important source of energy in the world today. The nuclear reactors do not create carbon, they are clean in that regard. The problem is quite different, as they create radioactive waste which is being disposed of by being buried in the ground. They will keep their radioactivity for centuries and therefore we leave the problem of their safe-keeping to the next generations. There is a simple rule: do not do what you cannot undo. Already, in some places, some leaks have been detected. There are a great number of unknown safety factors involved with the disposal of the radioactive wastes.

The incidents at Three Mile Island in the United States, Chernobyl in the Ukraine, and more recently Fukushima in Japan further illustrate the dangers inherent with nuclear reactors. To make matters even more complicated, the cost of operating them safely keeps getting more and more expensive.

## Renewable Energy

Renewable energies are generally regarded as those which will not exhaust the natural non-renewable resources of planet Earth. At the same time, they do not create some form of pollution, such as the carbon dioxide emissions.

### Photo Voltaics

Solar cells, or Photo Voltaics (PV) have been around for decades. The production of electricity is fairly easy with photo voltaic panels. It is safe, it is clean, and the scale is not a factor. For home applications, installations of a few kilowatts or even megawatts are possible. As we will see later, the main problem is the storage of the generated power. Without any sun (at night or when it is raining) the source of energy disappears.

### Mirrors and Concentrators

Another solution is to use mirrors to concentrate the rays of the sun on a boiler. It was experimented with at the end of the 19th century, in France, by Augustin Mouchot. A small steam engine was powered by a boiler in the center of a mirror. This small steam engine was running a printing press. The newspaper was called "Soleil Journal" and sold in the Tuileries (next to the Louvre) in Paris.

Today, special liquids such as sodium are used to transfer heat to turbines. In order to account for the intermittent availability of sunlight, it is possible to create some thermal storage of the very hot liquid and access it later to generate power.



[Mouchot's Sun-Powered Printing Press](#)  
[Paris, France 1882](#)



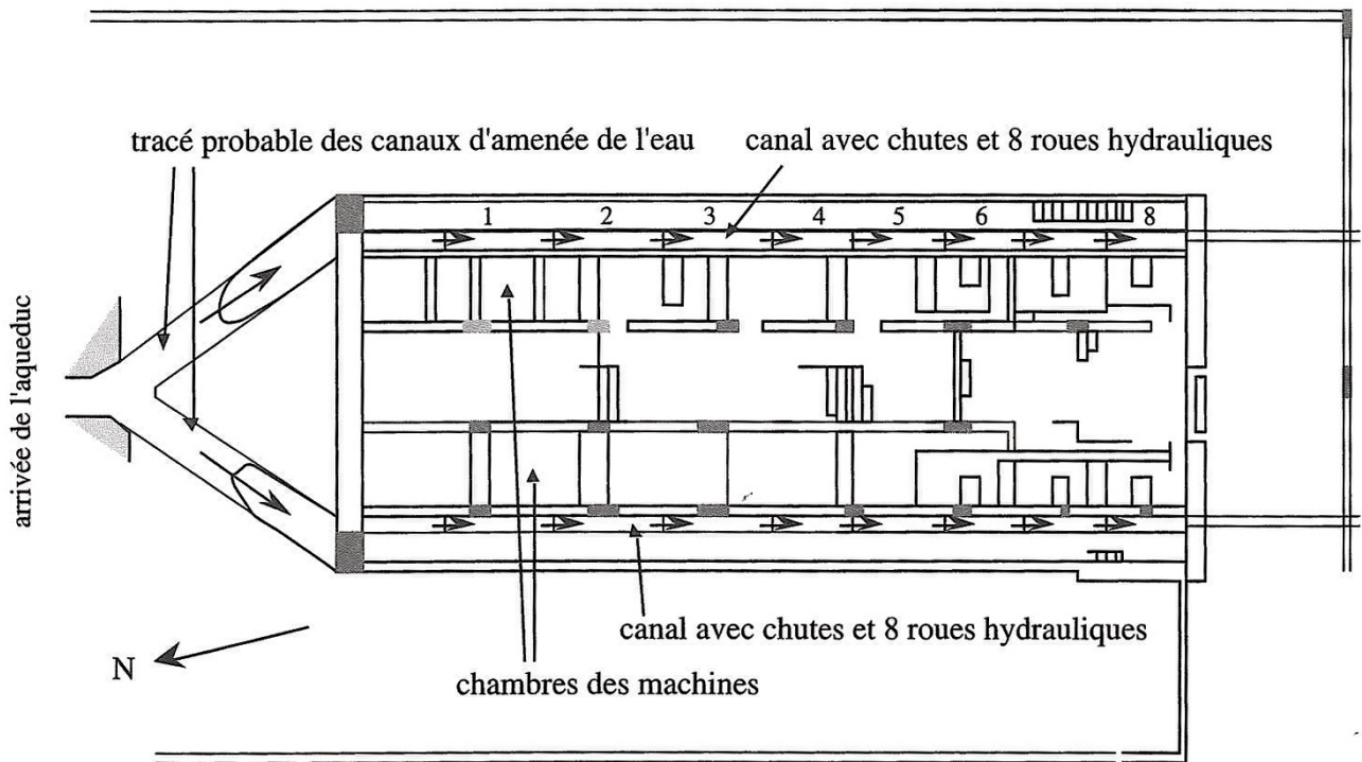
## Hydraulics

Hydraulics are an ancient source of energy. In the 2nd century A.D., the Romans in Gaulle (actual France) installed a facility to mill grain by using sixteen water wheels fed from a single aqueduct. It is the first documented industrial project involving hydraulics.

Water wheels, with or without a dam to create a reservoir, were widely used. Today, the development of hydraulic technology is limited by the number of sites available. Otherwise, it passes the test with flying colors: No CO2 or other waste, it is renewable, it operates 24 hours a day and 365 days a year with a reservoir large enough to override the dry seasons.



Remnants of the Barbegal Hydraulic Mill



Plan Showing the 8 Hydraulic Water Wheels on Each Side

## Wind Mills

In Denmark at the end of the 19th century, Poul La Cour produced electricity with a generator driven by a wind mill. The next step was to make hydrogen by electrolysis and to use that hydrogen for the lighting of a school. To this day, Denmark is still a leader in the production of wind mills. There are some drawbacks to this technology. Of course, it is sustainable/renewable and it does not produce carbon, but if there is no wind, no current is generated and we are back to the problems inherent with photo voltaics. On a small scale, this problem was solved by Poul la Cour through electrolysis of water to produce hydrogen. As fossil fuels begin to be phased out, the storage of this energy will be an absolute necessity.

One complaint with wind mills is the noise level associated with them. Another problem is the aesthetics. It is not very appealing to have a wind mill in your back yard. One approach to both of these problems is to install the wind mills far from human dwellings.



[Wind Mill Generator for Hydrogen Production  
Denmark, 19th Century](#)

## OTEC - Thermal Ocean Energy

Ocean Thermal Energy Converting, or OTEC, is another option. It was invented by a French Scientist, Georges Claude.

The first experimentation was in Cuba in 1930. The hot surface water of the ocean is used to boil ammonia which then runs a turbine. The ammonia is cooled by some fresh water coming from the sea bed, 600 meters deep or more. The energy to pump the cold water has to be deducted of the energy coming from the turbine. Georges Claude was next, experimenting outside the coast of Brazil in 1935 from a 10,000 tons ship. Both experiments were short-lived due to storms and difficulties in pumping the water.

A final project was started in Abidjan, a French colony in Africa, but Georges Claude passed away in 1960 and France gave up on OTEC. The Japanese, on an island in Micronesia named Nauru, installed a small unit of only 20 kilowatts for experimentation and were successful. Finally, in Hawaii, there is a larger unit of 10 MW engineered by Lockheed Martin.

One limitation for thermal ocean energy is the necessity to draw from very deep waters to supply cold water, while not being too far from the coast. Otherwise, there is no pollution, it is a renewable resource and it can run around the clock.

## Tidal Energy

The sun is the great provider of green energy through direct radiation or indirectly with the rain (hydroelectric) or the wind. The moon - lunar energy - with some help from the sun is responsible for the tides. The idea is an old one, and many water wheels in Europe and the USA located in the estuaries were supplying energy for mills.

During the eighteenth century in the north of France (next to Calais) a sophisticated system of reservoirs, canals, gates and water wheels was established to mill grain. The gates were closed and opened to keep the flow of the water in the same direction for the water wheels.

The first tidal plant of importance is in French Brittany in the estuary of la Rance. The power generated is 230 MW. It is now 50 years old, and while a success, it was never duplicated. In South Korea there is a tidal plant at Shihva generating 255 MW.

La Rance and Shihva are designed with turbines contained in a dam, which is creating the reservoir. Another approach, more recent, was developed in Ireland and England. The turbine is a wheel of a large diameter with generally a big hole in the center to let go the fishes. The wheel is lowered from a barge on the seabed. The generator is also under water. The components can be retrieved and lifted to the surface for maintenance.

Again in French Brittany, at Paimpol-Brehat (not far from la Rance) the French utility company EDF (Electricité de France) experiments with the wheels named "hydrolienne" that are made by Openwheel in Ireland. The first wheel was tested in 2011 and four wheels should be connected to the grid in 2014, supplying 2 megawatts.

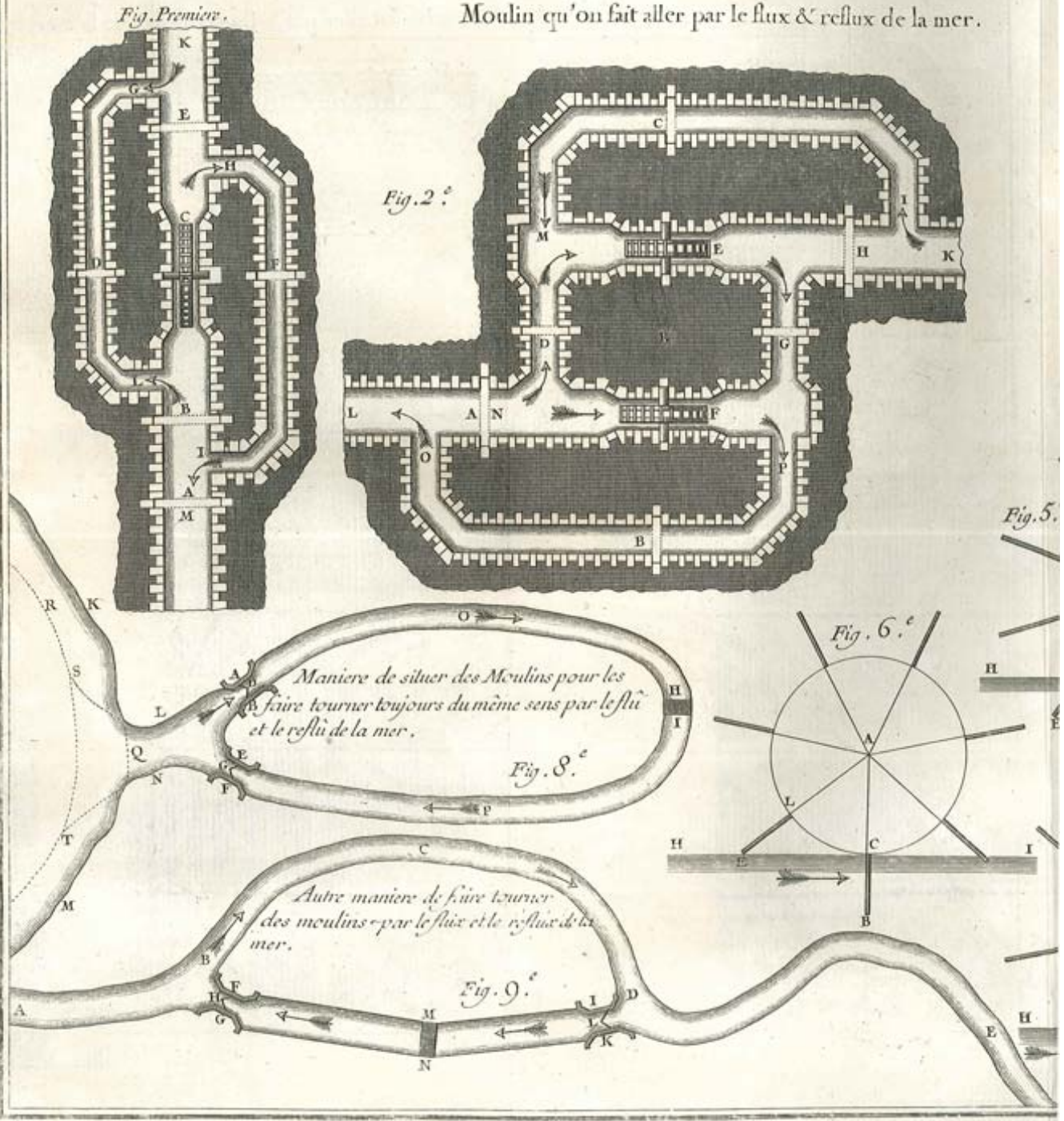
Tidal energy is renewable and clean, but when tide is reversing its motion, we will be back to the storage problem. Protagonists of tidal plants point out the possibility of establishing several plants at locations with a different timing for the low and high tides.



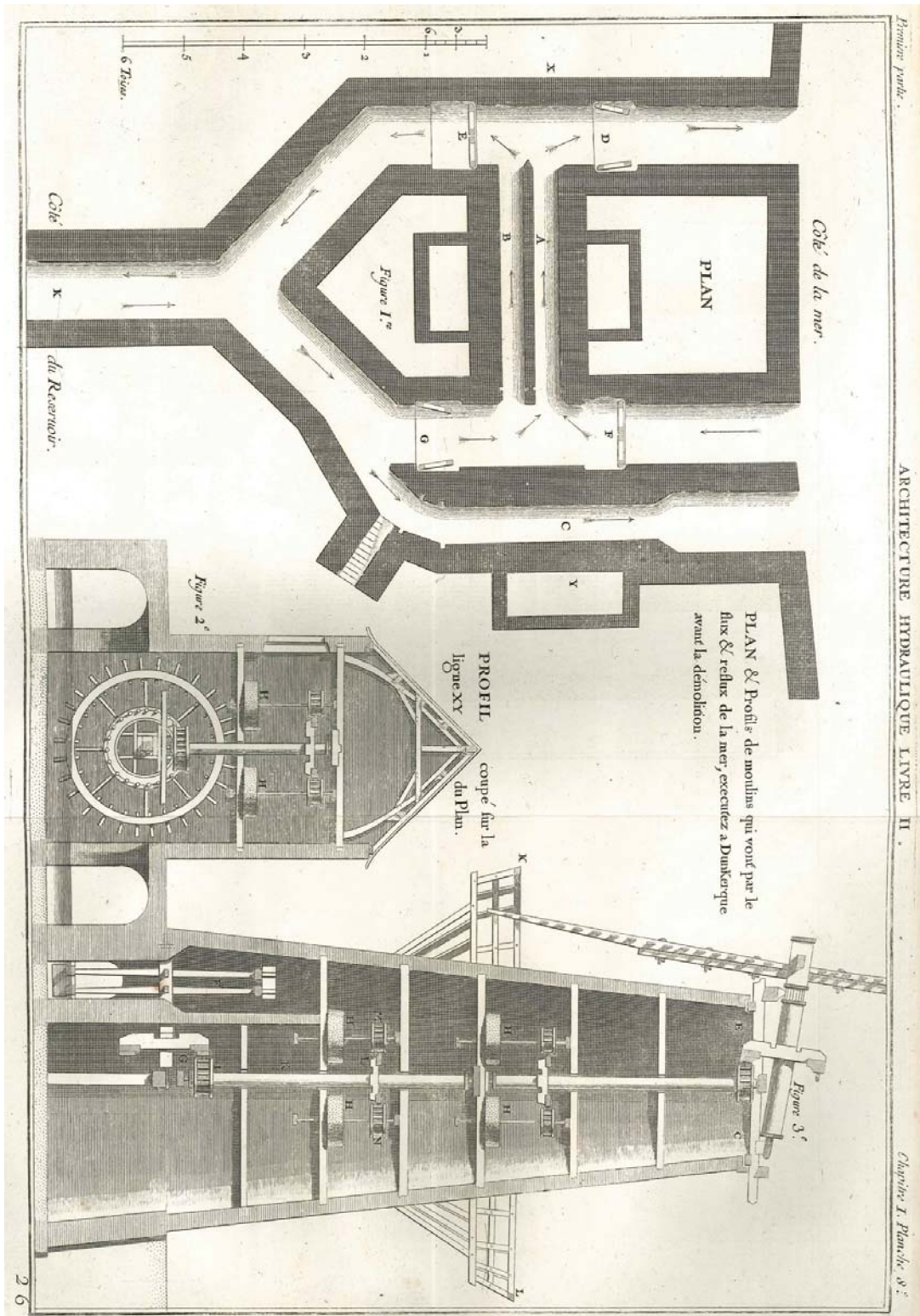
Première partie.

ARCHITECTURE HYDRAULIQUE LIVRE.

Moulin qu'on fait aller par le flux & reflux de la mer.



Tidal Plant Diagram - Dunkerque, France 18th Century



Tidal and Wind Powered Mill - Dunkerque, France 18th Century



## Geothermal Energy

There are many forms of green energy and one of the best is the geothermal energy, if the underground is hot enough to supply heat, geothermal energy can be used for heating or for generating electricity. Iceland is fully dependant on geothermal energy for all off its energy needs except for transportation.

## Bio-Mass

Finally there is the bio-mass; "à la mode" in some countries, such as France. There is a double edge: to transform wastes, or plants or trees in energy is not a bad idea if, as for the trees, the forests are replenished. As one typical product of bio-mass is methane gas, the combustion of the gas will create CO2. There is a possibility of reforming the methane in hydrogen and, with the next generation fuel cells to produce electricity without polluting the atmosphere with carbon.

## Polypack's Photovoltaic System Profile

A one kilowatt solar panel will produce an average of 4.7 kilowatt/hour in Florida. After incentives from the federal government and incentives from the utility company, the investment will be paid off in six years. After six years, the energy produced is free.

### Cost Component Analysis (based on Polypack's installation):

Solar Panels	20%
Electrical Hardware (inverters, etc.)	15 %
Hardware to Mount Panels	5 %
Labor, Electrical and Panel Installation	37 %
Roof Preparation (not applicable to new construction)	23 %

There are incentives, but there is a catch; they are deductible from the profit taxes. No profit : no incentives. The federal government gives a 30% credit to deduct from income taxes. The 30% is based on cost of installation of the solar panels. In Pinellas County the utility company distributes some money: first to ask, first to be served. It is 1 million a year. There is also a catch, the IRS will consider the money from Duke Energy as an income and income taxes have to be paid. It is a paradox.

How long will a photovoltaic installation last? Current estimates are a minimum of twenty years. The solar panels themselves represent only 20% of the total cost for an existing building and 25% for a new construction project. As with all technology, the price of the panels will go down and their efficiency will increase. As a result, after some time it is feasible to consider panel replacements in order to obtain more energy from the system.





**A business can easily go solar without being bankrupt, and if cash flow is tight, there are loans available. The following is a formula based on Polypack's experience and is subject to change.**

**1)** First number: A 1 kW system produces an average of 4.7 kWh per day in Florida.  
 $4.5\text{kWh} \times 365 \text{ days} = 1642 \text{ kWh}$ , a value of \$ 226 per year (kW priced at 13.8 cents)

**2)** Second number: What is the cost to install one kilowatt of solar panels, after deduction of the 30% tax credit from the federal government? We can examine costs for installation on a new building, the costs for an installation on an existing building with some prep work required on the roof, and the costs of both options, with interest, if there is a bank loan involved.

**2A)** New building, no loan : \$1,200 with a savings of \$ 226/year = 5.3 years  
New building with a six year loan : \$1,320

**2B)** Old building with roof prep required: \$ 1,550 with a savings of \$ 226/year = 6.8 years  
Old building with roof prep required and a seven year loan : \$1,700

These numbers can be multiplied by the number of kilowatts installed in order to extrapolate for site-specific installations.

At the present time, Duke Energy pays only 2 or 3 cents per kilowatt for energy being sent back to the grid. As a result, there is no financial motive to overproduce.

### **Now the good news...**

**A)** If there is a loan, the cash flow of the business will not be affected; the repayment of the loan is done with the financial savings on energy.

**B)** For 6 or 7 years, nothing happens, but when the loan is paid off the energy is free (as a footnote, depreciation of the installation or energy expenses are treated the same for the fiscal outcome, they are deducted from the taxable income).

**C)** The money invested in the solar installation will create jobs; those jobs will create revenue for the government.

**D)** Last, but perhaps the most important, is the reduction of carbon dioxide emissions in the atmosphere. All Scientists agree on the seriousness of the problem, with the exception of some residing on the payroll of fossil fuel companies. Our 270 kW installed will reduce the carbon emissions by 300 (three hundred) tons per year.

**There is no reason for *not* transitioning to a solar powered system, or to some other form of green energy.**

## Conclusion

Sooner or later all the energy we produce will be *green*, which means renewable and non-polluting. The prime mover will be electricity for everything, including land transportation. Electric cars will be the norm but, of course, using *green* electricity. Otherwise, the pollution problem is just moved, one notch, from the automobile to the plant producing the electricity. Air traffic will still depend on fossil fuels, awaiting some invention.

It will not happen naturally. One hurdle is the governments prevailing on private goals that are more interested in immediate returns on their investments than in safeguarding the world for the next generations of humanity.

The efficiency of storage solutions will have to be solved; extracting hydrogen from the water by electrolysis, storing the hydrogen and later, producing electricity with the fuel cell. Today, going from electricity to hydrogen and back again results in a loss of 70%. The technology is still new and improvements will be made. Also, the catalyst in the fuel cell is platinum, which is expensive and of limited availability. It will have to be replaced by another material, such as nitrogen doped nano tubes.

Today, energy storage is expensive. Consider the 270 kilowatt photo voltaic system installed on the roof of Polypack and the Tampa Bay Automobile Museum. In the early hours of the morning and late afternoon the efficiency is low, but at noon time it is higher and covers more than our needs. In the morning, we borrow energy from Duke Energy ( the utility Company in Pinellas County) and at noon we send back energy to them. If it is raining we are dependent on Duke Energy.

On Sunday, or any day we do not work, we send our energy again to Duke Energy. It is perfect, but only because we are an exception. We are in the 1% of users in Florida that are involved with clean energy.

If more people were doing the same with photo voltaics, Duke Energy would be obliged to keep the turbines on standby, waiting for the sun to set or for the rain to fall. Florida Progress would be saving some money on fuel, but will have to extend the time necessary to pay back for the fossil fuel generators. In fact they will have to increase the rates, as we have two systems competing to supply energy.

As an educated guess, 50% of our energy is coming from direct radiation and 50% is coming from storage. As there is a less of efficiency in converting electricity to hydrogen for storage and converting back to electricity with the fuel cells, the 50% of stored electricity will need extra panels on the roof. The storage can be performed by the users generating energy, or by the utility company, as the grid will not disappear. The grid will help balance the need in energy versus production between the different users. An intelligent distribution system will have to be a national balancing act of the various sources of green energy with the demand. The grid will allow for less storage with a better distribution and balance.



Whichever the system, there is a cost associated with a loss in efficiency and the purchasing of more equipment for storage. The transition to green energy will accelerate when the energy storage costs with fuel cells or other devices will be less expensive.

To begin the process, financial incentives are necessary. Rules or laws will have to be implemented for the incorporation of solar panels into new buildings . A carbon tax will also dissuade people from relying on fossil fuels.

A tax of 10% on the energy sold by utility companies could be distributed to users investing in green energy. In our Company the expense in energy is .6% of the sales. We perform our manufacturing with machine tools and all the buildings are air conditioned; we consume a lot of energy in our daily operations. A tax of 10% will be less than 1 thousand of the amount of sales and can be easily supported. The tax should be limited to non residential users.

The tax, which increases the cost of electricity, will be an incentive to go solar. Another effect will be the creation of new jobs through the implementation of solar installations. There must be a partnership between the users and the utility companies. As the cost of solar panels, fuel cells or electrolysis systems decline, the tax will be reduced.

This is an idea in need of refinement, but since nobody is eager to sacrifice some money to save the planet, a financial incentive will have to be offered. Without any incentives it is impossible to get the ball rolling. It has to be a government initiative. The same system can be applied to other forms of green energy as wind power. No progress will happen without a stick and carrots.

Alain A. Cerf 5/21/2013