LA SAGESSE UNIVERSITY

FACULTY OF “POLYTECH”

Sustainable Home

Course Title: **Renewable energy sources**

Course ID: **MCE 560**

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I. Introduction

1. What is a Sustainable Home?

In today's world, where the Earth's environment is on the edge of dying due to the damage of human activities that have a negative impact on the Earth's ecosystem, sustainable housing design is important. For civilizations to combat global warming, they must take action to change their way of life means adopting an environmentally friendly strategy of living in their own homes.

A sustainable house is an environment-friendly home, this house is built in a way that respects resources, optimizes electricity and water use, and will remain longer with quality systems. Sustainable houses use low-impact, high-performance materials.

2. What about this project?

The purpose of this project is to build a house in a jungle, where the primary resources are not available for example electricity, sewage, drinking water... so we will produce our primary resource by using all the renewable energy that we can.

The location that we will pick will have mild weather, as the climate is cold in winter and warm in summer.

In this project, our main purpose is renewable energy, and we will talk a little bit about geometrics and materials needed for building the house.

Finally, after talking about everything we will put a conclusion based on cost, efficiency etc... And everything to see if it is worth It to build this home.

II. Picking up the location

We have picked Jezzine the location to build the house, because we found that Jezzine has a mild weather.

1. Location coordinates:

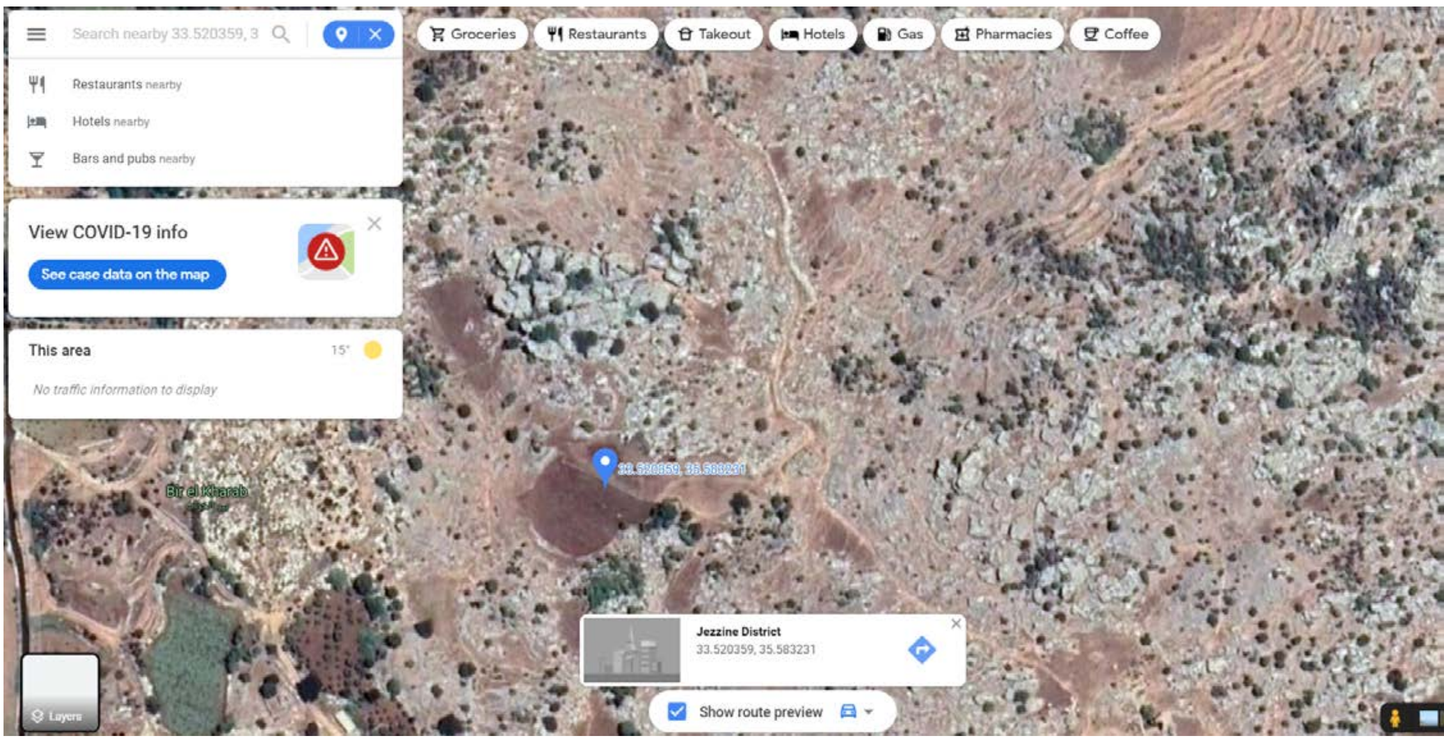


Figure 1

Figure 1 shows us the location that we picked on google maps and the coordination of the home is 33.520359,35.58323.

2. Some information about the location

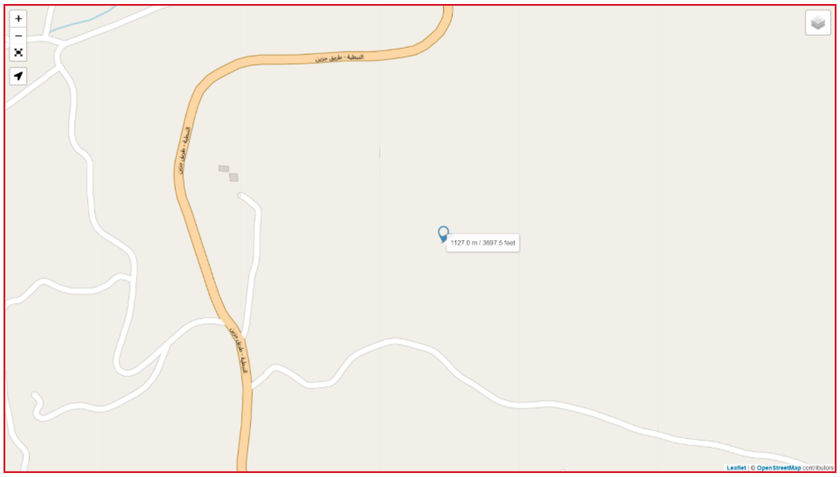


Figure 2

By using this [site]() we can find that the elevation of our location is 1127.0 m/3697.5ft like shown in figure 2

III. House design

1. Design

To build a house sustainable, there are many design that must be taken into consideration; the material used etc... There are many design considerations that must be taken in the consideration. To have high energy efficiency all the year and here we are talking about climate of the house.

2. Orientation of the house

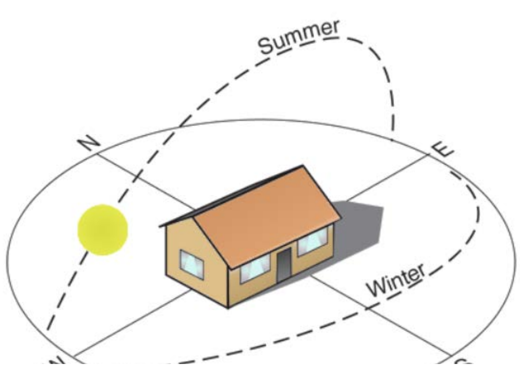


Figure 3

The need for extra heating and cooling is significantly reduced when the orientation is built properly.

Ecolive Home will be built on a North-South corner block as shown in figure 3, which is perfect since it receives the most amount of northern sun. We need to take into consideration having a big terrain around the house to be sure that the sun will not be blocked by nearby properties.

3. Passive cooling and heating

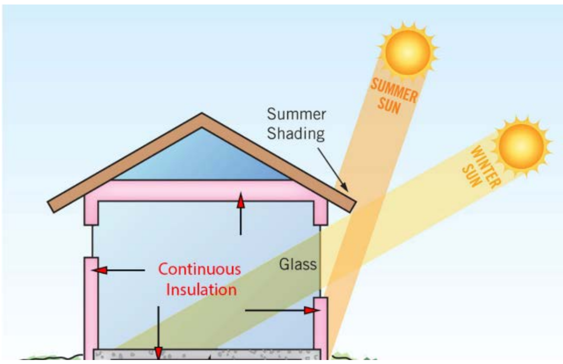


Figure 4

To construct a sustainable home, passive solar heating and cooling is required. It makes use of smart design strategies to let low winter solar into the building envelope while blocking high summer sun with shading devices. Like shown in figure 4.

4. Glazing

Glazing has a significant impact on a building's energy efficiency. Windows can keep warm air inside the building envelope during the winter and keep warm air out during the summer with proper design.

Most of the windows are designed to be oriented to the north for better lighting and to the south for better cross flow ventilation.

The glazing on the north side of the building has been determined to be around 20-25 % of the floor area of the space it is lighting.

5. Another design aspect

1. Isolation

Isolation plays a significant role in keeping energy costs down in a house.

2. Paint

The paint used on the walls and ceilings is one of the most obvious materials. Paint selection is critical since some paints, particularly solvent-based paints, can pollute the indoor environment by producing fumes.

IV. Introduction to hydrogen

a. What is hydrogen

Hydrogen is a clean fuel that produces only water when burned in a fuel cell. Natural gas, nuclear power, biomass, and renewable energy sources such as solar and wind power can all be used to make hydrogen. These characteristics make it a desirable fuel for transportation and electricity generation. It can be used in automobiles, homes, portable power, and a variety of other applications.

Hydrogen is an energy carrier that can store, transport, and deliver energy generated by other sources.

b. Why to use hydrogen

Hydrogen is a kind of energy storage. Energy stored as hydrogen in the form of a gas, or a liquid can never be lost until it is needed, making it ideal for emergency generators and other mission-critical energy applications. Other energy storage types, such as batteries and capacitors, lose their stored energy over time and must be recharged on a regular basis, even while not in use.

Hydrogen is one of the cleanest storage methods to produce hydrogen you only need water, and you will produce hydrogen and oxygen.

3. Hydrogen efficiency

Most internal combustion engines have an efficiency of around 25%, and power plants have a 35% efficiency. A stationary fuel cell can have an efficiency of more than 80% when used in a combined heat and power system.

4. Hydrogen and environment

The only consequences of hydrogen fuel cell utilization are water and heat; no pollutions or greenhouse gases are created. When compared to traditional fossil-fueled generation methods, even when fossil fuels are used to power a fuel cell, emissions are greatly reduced. The yearly average NOx emission rates for electric generation plants in 25 lb/MWh. A stationary fuel cell powered by natural gas, on the other hand, produces about 0.01 lb/MWh of NOx.

5. Hydrogen for domestics

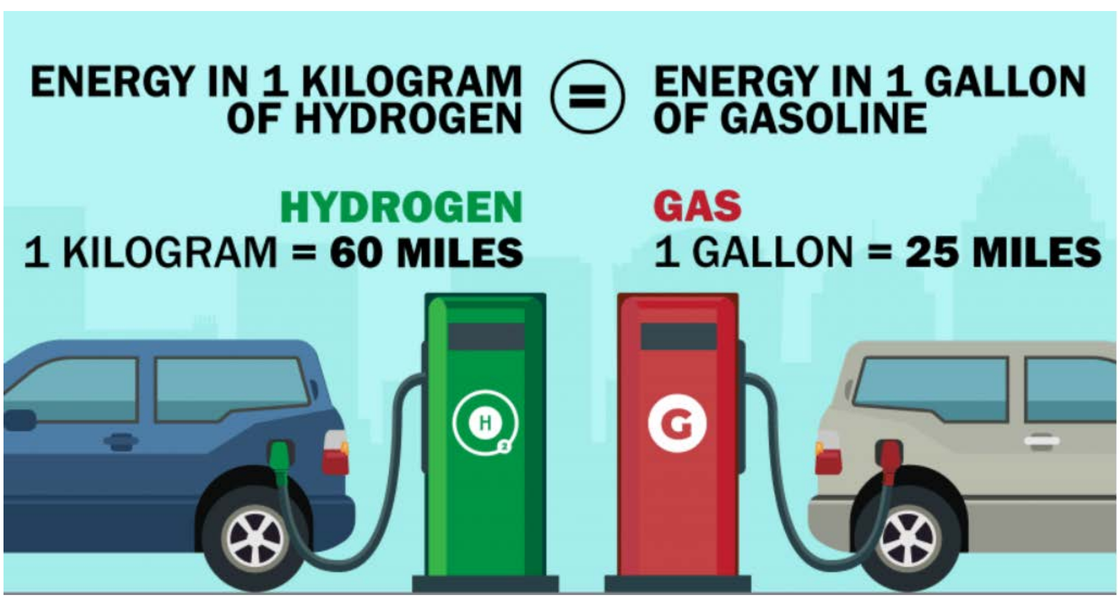
Hydrogen can be made from a variety of resources present in the world. Waste, biomass, wind, sun, tidal, wave, and geothermal energy can all be used to generate hydrogen. Water electrolysis, natural gas steam reforming, coal gasification, thermochemical production, and biological gasification are all examples of production technology. With so many hydrogen generation options, we can produce sustainable energy in a cost-effective and efficient manner, reducing our reliance on foreign oil and other fossil fuels.

6. Hydrogen for transportation

Vehicles with traditional combustion engines are sometimes hefty and inefficient. Hydrogen-powered vehicles use hydrogen fuel cells instead of combustion engines, which convert energy to electricity more effectively.

Because there are less vibrations from moving parts, fuel cells make the car more efficient and quieter. Hydrogen fuel enables cars to travel greater distances with less refueling, making it perfect for heavy-duty tractor trailers and public transportation buses that travel hundreds of miles at a time.

Vehicles with zero emissions, such as hydrogen fuel cell-powered public buses and drayage trucks, can idle without polluting the environment. Drivers can keep their cars running.



7. Hydrogen needed

We will consider powering the home for 8 months in our calculation without using solar and wind power. the fact that we used 8 months are that the hydrogen can be stored without being lost. We need to remember that the hydrogen will be used to heat the water, heat the condition at home, heat food, and finally for transportation.

We will make some average calculation to the hydrogen needed. Knowing that 8 months are more than we need. We will establish that we need 500kWh per months as average.

We need 39kWh to produce 1Kg of hydrogen like shown in this reference, and 1 kg can generate 33.6kWh like shown in this reference.

So, to power the house for 8 months I need 8x500kWh=4000kWh.

I need $\frac{4000kwh}{33.6kwh}$ =119kg to power the house in 8 months

And finally, I need 119x39kWh=4643KWh. We will take it 5000kWh

Considering that we need to consume all of hydrogen in the 4 months of summer, in each month we need $\frac{5000\ kWh}{4months}$ =1250kWh.

Each day we need $\frac{1250kWh}{30day}$=41.67kWh=42kWh.

The average sun light in summer is more 13 hours so we will take 10 hours to be on the safe side: 42/10=4.2kW for the electrolyze.

Nb: all this calculation is based on estimation. And this calculation is based on extreme value (more than needed).

Finally, we need to consider that even in winter or in the 8 months we have the wind system and the solar system that will help us to produce electricity. In this calculation we didn’t consider this system helping us for having an extreme calculation. It better to produce more than needed. Like mention before hydrogen can be stored without being lost.

V. Introduction to electricity system used

1. Statistics information

The average home uses about 500 kWh per month. So that is 16.6 kWh per day or 0.7 kWh per hour. The home will be powered 220V and 20Amps.

2. Introduction to the electricity technologies used

When building a sustainable home, we need to focus on renewable electricity and because of our location we found that producing electricity with solar energy and wind energy is the best solution. The two energies will be combined to power up the home and the rest will be stored in hydrogen.

In the section bellow we will give small introduction to wind and solar energy.

3. What is solar energy

It is the system that converts solar energy to electricity. Solar panels convert sun light into electrical energy for the residence and can be mounted on the roof or on the ground.

4. What Is Wind Energy

Another approach to generate renewable energy at home is with wind turbines. They are made from blades attached to a rotor, mounted on a tawer. The rotor spins when the blades turn, sending kinetic energy to a generator, which converts it to useful electrical energy.

5. Wind Energy Vs Solar Energy

Both solar and wind power have significant environmental benefits. however, they are more expensive than regular fossil fuel power. The better is primarily determined by your available space and money. Solar panels are often less expensive, more compact, and tolerated better in urban and suburban settings. They are also seen to be a more dependable energy source because they can absorb energy on cloudy days, while turbines only spin when it is windy.

And the excess of wind turbine will result in noise pollution. Therefore, in our project the Solar energy will be the main energy and the wind will be the backup plan.

VI. Introduction to geothermal heating/cooling

1. What is geothermal heating/cooling

A ground-coupled heat exchanger is an underground heat exchanger that can both capture and release heat back to the earth. They warm or cool air or other fluids using the Earth's near-constant underground temperature for residential, agricultural, or industrial purposes.

The choice of heating system is frequently based on grower preference, which may be based on experience, rather than engineering considerations, such as usage of available geothermal resources or even the most cost-effective system. Factors such as the type of crop or probable disease problems may also have an impact.

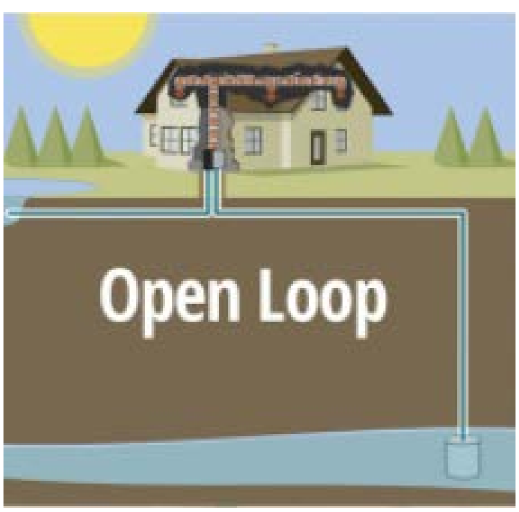
A heat pump is essentially a refrigerant loop that transports heat through a vapor-compression refrigeration cycle. the average temperature 1.82 Meters underground is roughly 11˚C. Because underground temperatures are significantly more consistent than air temperatures throughout the year, using the earth saves a lot of energy.

An earth loop heat exchanger provides a higher temperature differential than typical A.C. condensers or cooling towers, especially during the hot and humid summer.

There is insignificant seasonal temperature variation below 10 meters. Much like a cave, the stable ground temperature is warmer than the air above during the winter and cooler than the air in the summer.

2. Type of geothermal heating/cooling

a. Open loop system

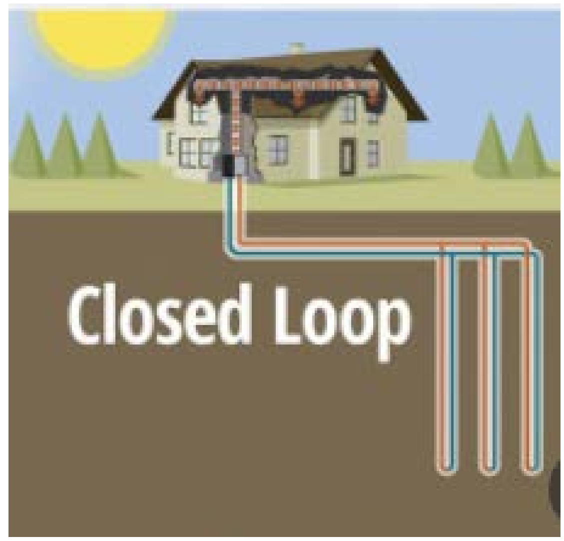


A geothermal heat pump system that uses groundwater from a standard well as a heat source in the winter and a heat sink in the summer is known as "Open-Loop." The groundwater is pushed through the heat pump, which extracts or rejects heat depending on the season, and then the water is disposed of properly. Groundwater is an ideal heat source/heat sink since its temperature is stable throughout the year.

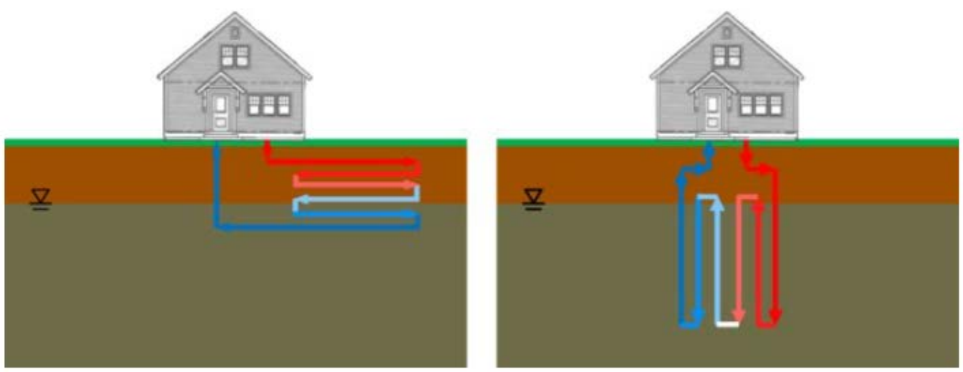
But this system cannot be installed everywhere.

b. Close loop system

A geothermal heat pump system that uses a continuous loop of special underground plastic pipe as a heat exchanger is referred to as "closed-loop." The pipe is connected to the internal heat pump to create a sealed underground loop that circulates water or anti-freeze solution, depending on where you reside. A closed-loop system, unlike an open-loop system that uses well water, recirculates its heat-transferring fluid in a pressurized conduit.



c. Type of close loop



- Horizontal Close loop

Horizontal closed loop systems are often the most cost-effective for modest installations, especially new development when enough land is available. Pipe is buried in trenches dug using backhoes or chain trenchers in these sites. Each trench has up to six pipes, normally in parallel connections, with a minimum of a 0.3 meter between pipes and 3 to 4 meters between trenches.

Advantages	Disadvantages
lower first cost	high land area requirement
fewer special skills	limited potential for HX limited potential for HX w/groundwater w/groundwater
less uncertainty in site conditions, but soil conditions can vary seasonally	wider seasonal temperature swings, lower efficiency

- Vertical Ground Coupled

In many circumstances, vertical closed loops are desired. Because the land space necessary for horizontal loops would be prohibitive, most big commercial buildings and schools employ vertical loops. When the soil is too shallow for trenching, vertical loops are employed. Vertical loops also reduce the amount of disruption to existing landscaping. A U-tube (or, more rarely, two U-tubes) is inserted in a well dug 30 to 1200 meter deep for vertical closed loop systems. Because ground conditions can vary widely, loop lengths per ton of heat exchange might range from 40 to 900 feet. For most installations, many drill holes are necessary since the pipes are often connected in parallel or series-parallel combinations.

Advantages	Disadvantages
low land area requirement	high cost
stable deep soil temperature	does not work well in some geological conditions
adaptable to many sites	Need experienced vertical loop installer, not conventional well driller.

VII. Hydrogen system

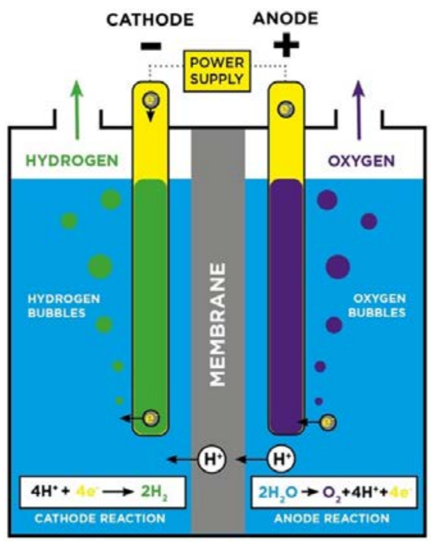
The hydrogen fuel cell system is separated into three phases:

- hydrogen production
- storage
- use and application.

1. Component needed

a. Electrolyser

The electrolyser is a device that creates hydrogen by a chemical process (electrolysis) that uses electricity to separate the hydrogen and oxygen molecules that make up water.



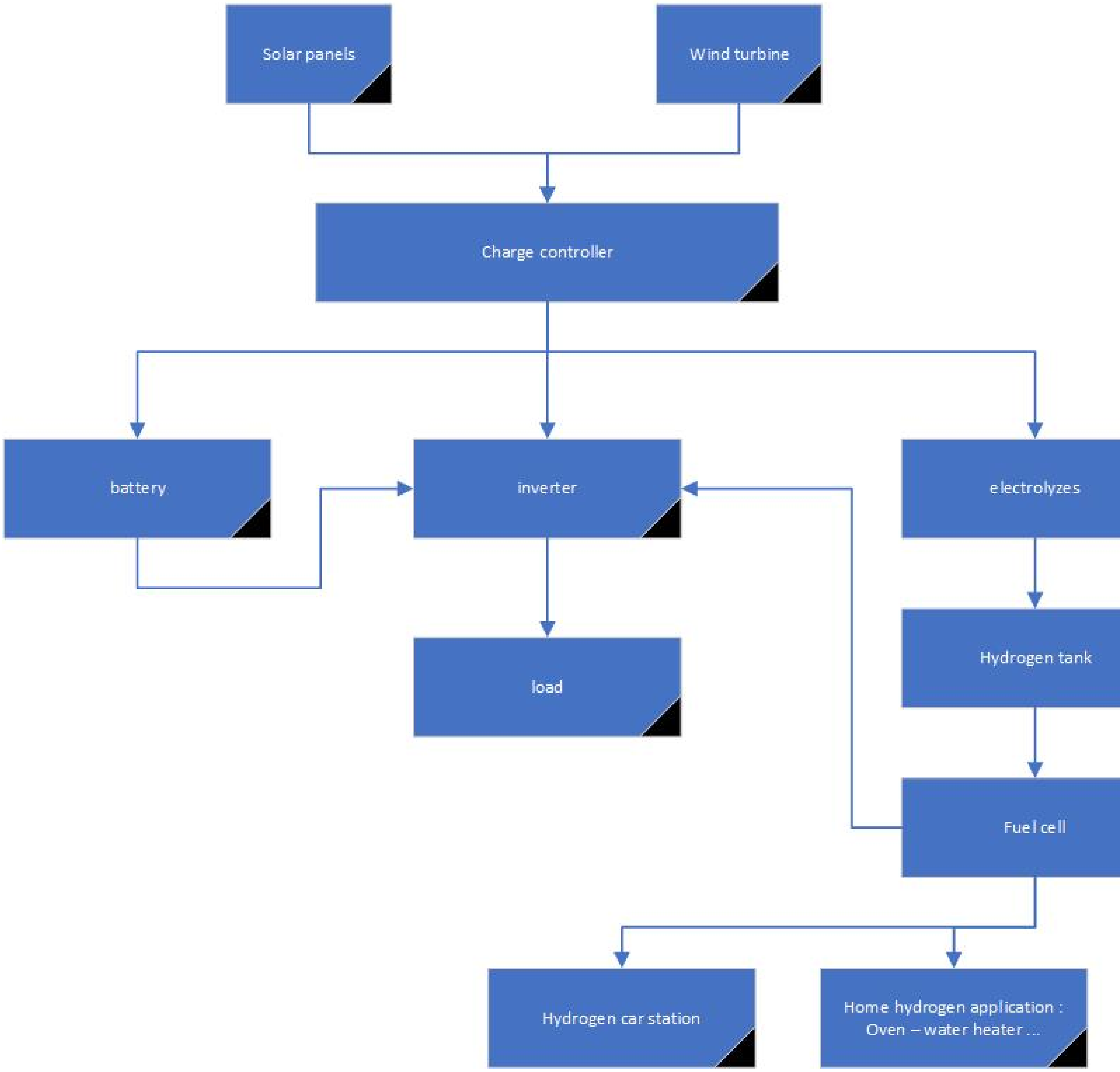
b. Hydrogen storage tank

The storage tank is a tank where we can store the hydrogen, we need to be sure these tanks are yearly maintained. The hydrogen is a flammable gas, so we need to be sure that we don't have a leakage.

c. Hydrogen Fuel cell

A fuel cell produces electricity using the chemical energy of hydrogen in a clean and efficient manner. Only electricity, water, and heat are produced when using a hydrogen fuel cell

2. Diagram


Solar panels
Wind turbine
Charge controller
battery
inverter
electrolyzes
load
Hydrogen tank
Fuel cell
Hydrogen car station
Home hydrogen application :
Oven – water heater …

3. Fuel cell

We need 5000w electrolyze we will choose T5000 , 5000W/5000=1

So, we need one fuel cell.

4. Hydrogen Storage

Because compressing hydrogen gas is the simplest and most practical way to store it, we chose a cylindrical storage tank for compressed hydrogen. Volume, pressure, and temperature were the primary design characteristics for the hydrogen gas storage. Commercial electrolysers on the market can produce hydrogen at pressures of up to 30 bar. At a pressure of 3 bar, the chosen electrolyser pushed hydrogen into storage.

For safety reasons and to avoid extreme temperature swings, the tanks will be installed underground.

The easiest way to decrease the volume of a gas, at constant temperatures, is to increase its pressure. So, at 700 bar, which is 700 times normal atmospheric pressure, hydrogen has a density of 42 kg/m3, compared with 0.090 kg/m3 under normal pressure and temperature conditions. we need a compressor to compress the hydrogen before putting it in the tanks.

5. Electrolyze

We have chosen the Hy PEM XP2 2400 Rack.

VIII. Solar and Wind System

1. Component needed

a. Pv module

It is made from semiconductor, also named solar panels, panels that transform solar energy to electricity.

b. Battery

Even if we will use hydrogen, we need battery. The usage of battery come into two stages; the battery will help the inverter to give 220v when the Pv panels don't give the desire voltage. In summer we will use battery for in night and conserve the hydrogen for winter. The battery in our system is called short term storage.

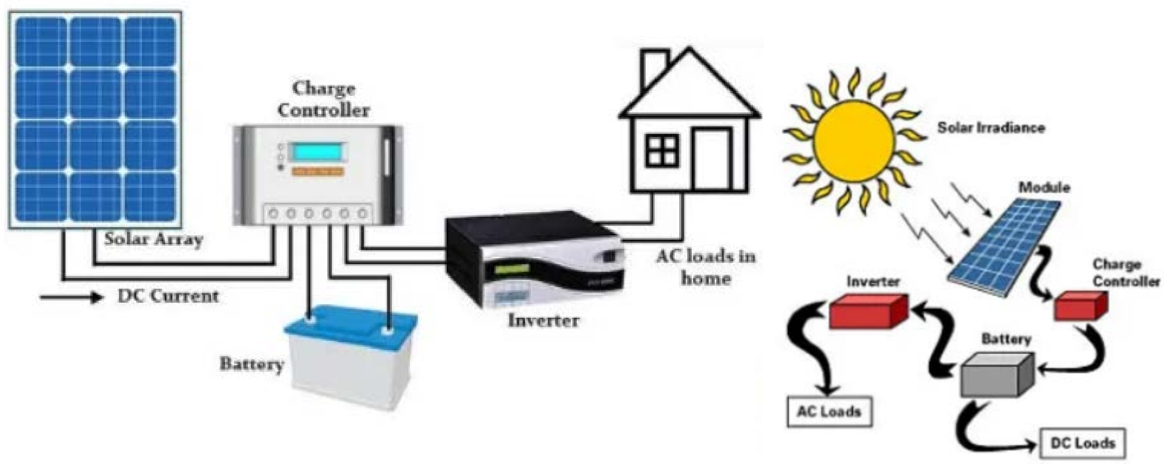
c. Solar charge controller

Is used to charge the battery safely by regulating the voltages and current from the PV panels and prevents battery overcharging and prolongs the battery life.

d. Inverter

Convert from DC delivered by the battery or the PV or the wind turbine into a clean 220v AC

2. Diagram



The system that we will build is a standalone system or Offgrid system, so this system will operate independently without grid.

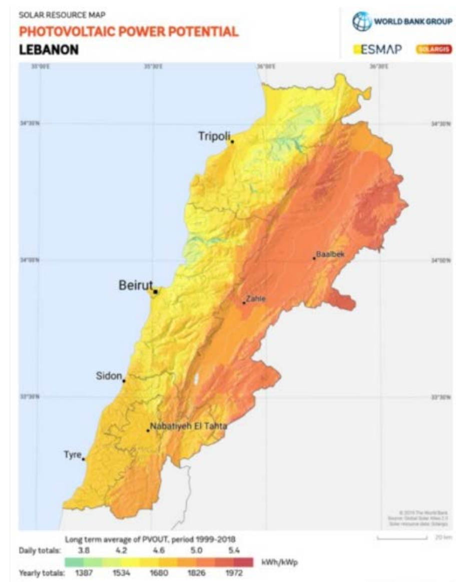
3. Electricity needed

Before making any calculation, we need to know how much the home will need electricity so we will build a table of the home load to have an estimation about the power needed

Individual Load	Quantity	Watts	Hours/day	W.h
Computer & accessories	1	150	7	1050
Iron	1	1000	0.3	300
Lighting	18	370	7	2590
Refrigerator	1	200	24	4800
Television	3	375	6	2250
Washing machine	1	360	1.5	540
Kitchen appliance	-	500	3	1500
Hoover	1	2000	0.5	1000
Electrolyze	1	5000	10	50000
Total connected devices		10955	Daily load	64030

4. Pv solar needed

We will use Longi 425 W 24V Mono PERC Solar Panel solar panel to be our solar some of the characteristics:



- Materials: Anodized Aluminum
- Cell configuration: 72 cells
- Pmax: 425w
- Open circuit voltage: 48.3V
- Short circuit current: 11.23A
- Normal voltage: 24v
- Current at max power: 10.5

We use the Longi because this product is very popular, and the manufacture give up to 12 years warranty.

To define the average of sun light in day we have used the picture and we will define it as average of T=4.5 hours per day

To obtain the peak Power PV: $P = \frac{E}{T} = \frac{64030}{4.5} = 14.228kWp$

The current needed is: $I_{DC} = \frac{P}{V_{DC}} = 592.87Amps$

And know we need to know how much panel we need .to do so we will calculate the number of parallel solar panels and then the number of series panel:

- Parallel calculation: $N_{P} = \frac{I_{DC}}{I_r} = \frac{141.83}{10.5} = 56.46 \approx 57\ Panels$
- Serries calculation: $N_{S} = \frac{V_{DC}}{V_R} = \frac{24}{24} = 1\ Panel$

The total will be N_p x N_S=57x1=57 Panels

The solar panels will be directed to face the east having a roof and the angle is between 15 and 30 degrees.

5. Battery needed

We will put the calculation based on one full day with no sun, no wind, no Hydrogen.

We will use a Gel battery because of the duration of live and because this battery is recycled. We will use UB-8D AGM - 250 AH, 12V-DC. And here we used a 12v because of the price having two battery is 12V are cheaper and better than using one 24v battery

The total of E needed are 15230Wh x 1 day= 15.23 kWh

We take 15230Wh and not 64030 because we don't won't to feed the electrolyze from the batteries.

For safety reason the E resulting by the calculation will be divided by the max allowable of discharge $E_{safe} = \frac{energy\ storage\ required}{\max depth\ of\ discharge} = \frac{15230}{0.75} = 20.31kW.$

the capacity of the battery is $C = \frac{E_{safe}}{Vb} = \frac{20.31}{12v} = 1693\ Amps.h.$

And know we need to know how much batteries we need. to do so we will calculate the number of parallel Batteries and then the number of series batteries:

- Total calculation: $N_{T=} \frac{C}{C_b} = \frac{1693}{250}$ = 6.772 $\approx 6\ Batteries$
- Serries calculation: $N_{S=} \frac{V_{DC}}{V_B} = \frac{24}{12} = 2\ Batteries$
- Parallel calculation $N_{P=} \frac{Nt}{Ns} = \frac{6}{2}$ = 3 $Batteries$

6. Voltage controller

Because of the usage of 6 batteries we will need a charge controller that can handle the 24v and the 6 batteries so we use the Xantrex C Series - C35, C40 & C60 we will buy the C60 24V. so we will use to controls the flow current so we need to calculate the max current to be sure

that he can handle it and the $I=I_{sc} \times N_P \times F_{safe}$ = 11.23 x 57x 1.25=800.14 Amps

I_{sc}: is the short circuit current of the panels and from the datasheet the current are 11.23Amps

$N_{P:}$ is the number of panels that we will use and, in this project, and from the panels section we have define it to be 14

F_{safe}: is a standard number that is equal to 1.25.

The total number of controllers are:

$N_{CONT}=\frac{I}{Amos\ each\ controller}=\frac{800.14}{60}=13.33\approx 14\ controllers.$

7. Inverter

So, to calculate the inverter we need to calculate the devices that may run at the same time

So, returning to the table we P_{TOTAL}=5155 watt.

For this project we will take the P_{total}=5000w, we agree that not all the devices will run together but we need to assume that we have the geothermal heating system and the electrolyze pump. So, we choose the AIMS Power (PWRIG500024120S 5000W 24V Pure Sine Power Inverter Industrial)

8. Wind energy

After finishing from the solar system, we can begin with the wind turbine. We won't do any calculation for the wind because the wind is a backup source and when the wind works the solar panels will not deliver all their power.

The wind turbine must be between 7 and 18 meters, in our case, the site where we build our project, don't have nothing that block the air. So, we don't need to install the wind turbine too high, and this will decrease the installation cost.

When putting a wind turbine, we need to see the max wind speed.

And for that we will pick a WINDMILL 1500 W Wind Turbine Generator Kit 24v 31 mph and up to 110 mph as a max speed and this turbine generate a 24v DC output so the wind controller is include we can connected automatically to the inverter.

Having this turbine will help us boost the electricity production in winter.

IX. Geothermal system

In this project we will use the close loop horizontal system, knowing that the efficiency of the vertical is better.

1. Component needed

a. Geothermal Heat pump

Boiler/Tower heat pumps differ slightly from geothermal water source heat pumps. Additional insulation of internal co-axial coils, thermal expansion (TX) valves, and heat exchangers suited for geothermal operating conditions are usually required due to the greater fluid working range. A geothermal heat pump can be used safely in a Boiler/Tower system, but this is not always the case.

b. Distribution system

To spread the heat or cold in the house using pipelines, the system extracts heat from the liquid and distributes it around your home.

c. Heat exchanger

Heat exchangers, which consist of metal shells and tubes, transmit heat from one location to another. It is also known as a loop since it contains circulating fluids.

2. Installation

Horizontal loops are put in 1- to 1.5-meter-deep excavations. Deeper ditches may necessitate sidewall supports, increasing the cost of installation. Several circuits can be built in the same trench, one on top of the other.

The loops are located at shallow depths, where the undisturbed earth temperature naturally changes with the seasons. This reduces efficiency while also increasing overall pipe length. The average operating temperature range for a loop is 1.67°C to 37.87°C.

Vertical and surface water systems are more difficult to install than horizontal loops.

Horizontal loops demand a lot of space, about 232 m^2 per ton. The trenches are between 46 and 67 meter long per ton.

3. Ventilation System Design

a. Enthalpy Wheels

Both sensible and latent energy can be transferred using enthalpy wheels. The enthalpy wheels can warm outdoor air to temperatures of 4.4°C or more in cold weather. They can also humidify the outside air, effectively halving the humidity load. Enthalpy wheels can lower both the sensible and latent levels of outside air in hot conditions.

An enthalpy wheel's typical leaving air temperature is roughly 26.67°C dB, 19.4°C wb. In many climes, no further cooling is necessary. The heat pumps can manage any additional load.

b. Templifiers

A Templifier is a heat recovery device that converts water to water. It can take low-grade heat from a source loop and utilize it to heat a hot water loop that is 21.11°C to 26.67°C warmer. The Templifier can heat a hot water loop from the ground loop in geothermal applications. The hot water loop can be used for ventilation, entrance heaters, and other heating loads that a heat pump cannot readily handle. When utilized in 100% outside air systems, the hot water loop can have antifreeze at quantities appropriate to avoid freezing.

Using a Templifier with an Enthalpy wheel instead of natural gas or electricity to heat or cool ventilation air can save money. A pipeline for natural gas.

c. Water-to-Water Heat pumps

Water-to-water geothermal heat pumps can use the earth loop to create either hot or chilled water. The water generated by the water-to-water unit can be utilized to heat or cool the ventilation air, depending on the situation.

The usage of electricity and natural gas to directly condition the ventilation air is avoided using water-to-water systems. They are not as efficient as a Templifier/enthalpy wheel setup in cooling mode because compressor effort is required. However, they are often less expensive.

X. Transportation system

a. How electric and hydrogen car work?

- A lithium-ion battery powers an electric car's motor, which in turn powers the vehicle's different components. The batteries are recharged by plugging them into the power grid, much like any other electrical device like a computer or phone. When braking, certain electric cars may provide themselves with a brief recharge by turning the heat generated into electricity.
- Hydrogen automobiles also include an electric motor powered by hydrogen fuel cells, which allow hydrogen to combine with oxygen to produce energy and water vapor chemically. The engine is powered by electricity, while the water vapor is harmlessly released into the atmosphere. Fuel cell electric vehicles, commonly known as hydrogen fuel cell automobiles, are refueled with hydrogen at service stations with pressurized natural gas tanks.

b. Disadvantage of Hydrogen and Electric Cars

Electric car

The range of electric automobiles is possibly the biggest disadvantage when contrasted to the time it takes to recharge. This varies depending on the battery and charging station, but in general, the range and refueling times make long-distance travel more difficult in an electric car than in a hydrogen or traditional combustion engine.

While high-power charging stations allow for faster recharging, they can be more costly to operate. High-power charging stations, for example, are roughly ten euros more expensive per kilowatt-hour in Germany (typically 0.30 Euros per kilowatt-hour) but can be as much as 0.90 Euros per kilowatt-hour on non-partner networks.

The cost of recharging varies by country, with France charging 2.25 Euros every 100 kilometers (based on an average of 15 kWh per 100 kilometers), whereas the same distance in the UK would cost 3 Euros.

These problems can be avoided by using a hybrid electric/combustion engine system, in which the traditional engine serves as a backup or support system for the battery.

Hydrogen car

The absence of infrastructure to enable hydrogen vehicles is the primary issue. Due to a dearth of refueling facilities, hydrogen vehicles are currently not a practical alternative for many people. However, hydrogen infrastructure is thought to be simple to scale up, thus this difficulty might be handled with the correct investment and support.

The expense of hydrogen electricity is another major issue. Hydrogen-powered vehicles are not inexpensive, and refueling costs vary widely between countries. In the United States, for example, the cost of refueling a hydrogen-powered car is four times that of recharging an electric car. However, with the cost of hydrogen fuel cells having plummeted by more than 80% in recent years, this appears to be changing as well.

c. Advantage of Hydrogen and Electric Cars

Electric car

Electric vehicles have a more developed infrastructure than hydrogen-powered automobiles. Governments all across the world are investing in infrastructure such as charging stations at existing gas stations and highway rest stops, shopping mall parking lots, and even on the side of certain streets. The UK also provides financial assistance for the purchase and installation of household charging stations.

Electric vehicles are also less expensive than hydrogen-powered vehicles, and recharging costs are lower during off-peak grid periods, making them a suitable long-term investment.

Electric automobiles are quiet and emit no exhaust fumes, resulting in no noise or pollution, and they also require no energy when stationary.

Hydrogen car

Hydrogen automobiles have many of the same advantages as electric cars, including the absence of polluting emissions.

While producing hydrogen gas is a complicated process, it is the most plentiful element in the universe, making it a renewable fuel source.

Hydrogen automobiles are also faster to refill than electric cars, and they have far longer ranged. Renault's Kangoo Z.E. Hydrogen and Master Z.E. Hydrogen, for example, include range extender fuel cells that provide over 350 kilometers of range and charge times of only 5-10 minutes.

Range:

The range of an electric automobile is significantly dependent on the vehicle you purchase. The more expensive vehicles, such as the Tesla Model S Long Range, have a range of 375 miles, compared to the Nissan Leaf Acetan's real-world range of 150 miles.

Vehicles powered by hydrogen fuel cells have longer ranges and refueling periods. For example, the Hyundai Nexocan travel 414 miles on a single charge and takes only five minutes to fill up, as opposed to the hours it can take to charge an electric vehicle. However, because there are no models at the cheap end of the market, hydrogen-powered vehicles remain expensive to purchase.

d. Conclusion

In our project we will use hydrogen car and not electrical car

XI. Cost

1. Solar and wind cost

Component	Price/1	Total price	References
Solar panels	$205	$11685.00	Longi ref
Batteries	$844.75	$5068.50	Batteries ref
Voltage regulator	$179.00	$2506.00	Reference
Wind	$1,750.00	$1,750.00	Reference
inverter	$1299.00	$1299.00	Reference
Total		$22.238	

2. Hydrogen system

Component	Price/1	Total price	References
T5000	Need quotes	-	references
Tank	1400perkg	$168000	references
Hy PEM XP2 2400 Rack.	Need quotes	-	references
Total		Cannot be defined	-

3. Geothermal system

For geothermal, the cost cannot be defined online, for a solution that manages heating, cooling, and at least a portion of your hot water needs, the average starting investment for a geothermal heating and cooling system ranges between $18,000 to $30,000.

XII. Conclusion

The only problem of this system is the cost, we will need an extremely excessive cost. The economic congestion in Lebanon and the lack of electricity have given the Lebanese people a great deal of experience in installing solar energy. Therefore, solar energies are something that cannot be replaced at the moment. But the hydrogen system is a new concept that is still in the development phase. In our opinion, Hydrogen is the future. So, building this house will give us a lot of experience for the future and after all one day the only resource will be the hydrogen.

For the geothermal system, we find that these technics are worth the price. Having this system will decrease the power used in every houses.

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