Leaving Certificate

Technology

20XX / 20XX

Higher Level Thematic Brief

Exam Number: _____

Contents

Thematic Brief

Fossil fuels provide approximately 95% of the world's total energy demands. However at the current rate of use there may be severe shortages in the next 10-15 years. This may render our current lifestyles unsustainable.

With reference to the theme above design and make a device that will assist in the conservation of energy. The device must incorporate a mechanical and/or electronic system.

Analysis of Thematic Brief

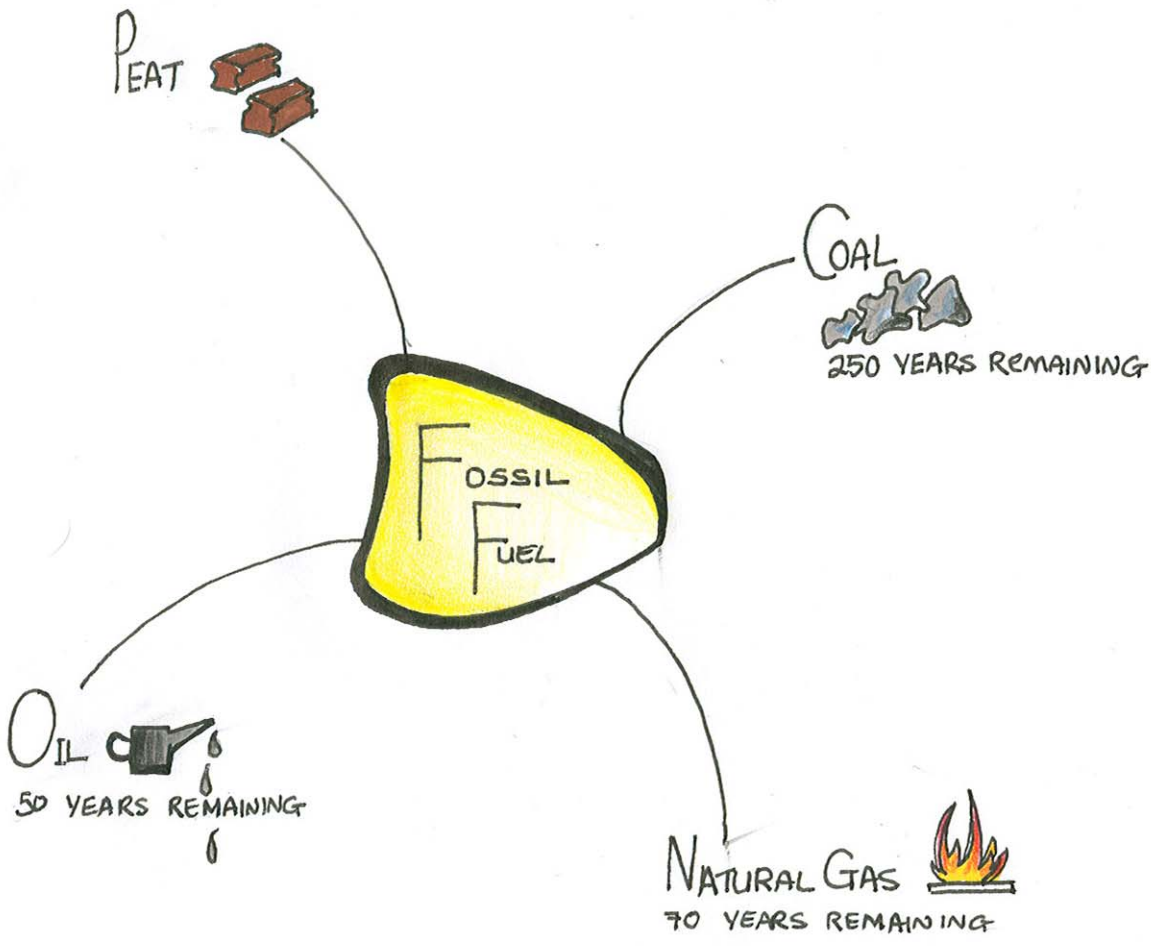
Energy Usage

All these products require some form of energy to operate them. This energy is mostly derived from fossil fuels.

We use energy every day of our lives. Energy powers our cars, trains, planes and boats. Energy warms our homes. We use it to cook food, play our favourite music, watch television and to work/play on our computers. Energy is required to operate machines used in factories and agriculture.

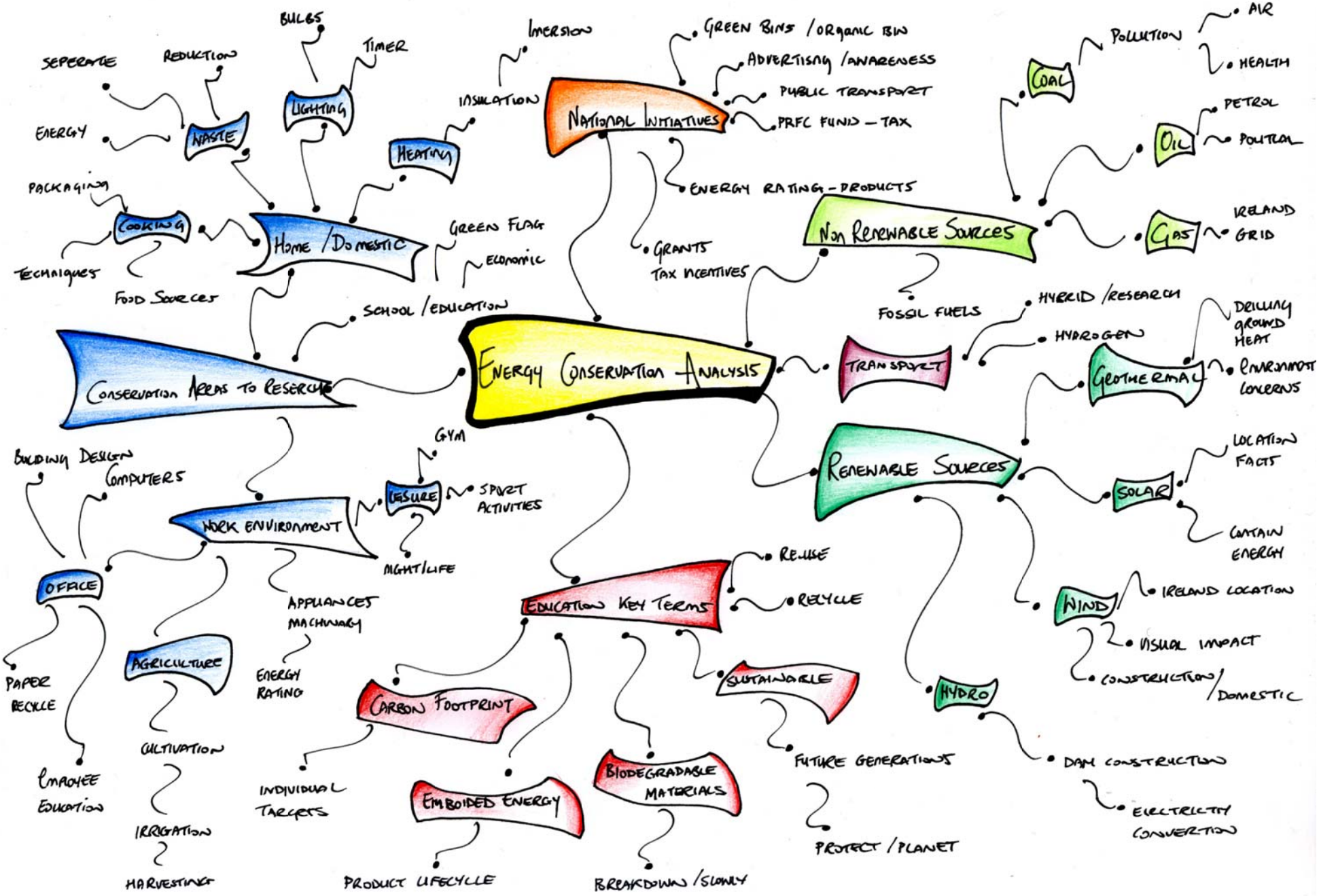
Nearly all of this energy is provided by fossil fuels. Fossil fuels provide around 66% of the world's electrical power, and 95% of the world's total energy demands. Coal, oil and gas are the three main forms of fossil fuels. Nine of fifteen ESB power stations in Ireland are powered by one or more of the fossil fuels generating 3951 megawatts of energy while the remaining six are hydro powered producing only 220 megawatts of energy. The fuel we use for transport is produced from oil. Oil is also used to produce other products such as plastic.

As technology has developed, countries have become more industrialized and people more mobile our dependency on fossil fuels to provide the necessary energy to keep up with all these changes has increased. The problem is that fossil fuels are not going to provide our energy requirements forever. With reserves running low, it is expected that they will run out in a short space of time.



Conservation of Energy
In order to make fossil fuels last longer we need to conserve energy. Conserving energy means that we try to decrease the amount of energy used or use the energy that is available in an efficient way. A second way of conserving energy is to replace non-renewable resources with renewable energy.

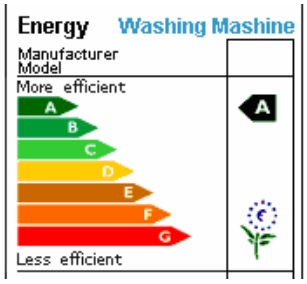
Some ways of conserving energy is shown on the Energy Conservation Analysis mind map on the next page.



Current ways to conserve energy:

Home:

- When buying appliances look at the energy label and purchase the most efficient one you can afford. An appliance with a rating of 'A' is most efficient while a rating of 'G' is the least efficient. An 'A' or 'B' rated appliance will use less electricity than one with lower ratings.



- Turn the lights off when leaving a room and use "task" lighting rather than whole room lighting when a small amount of light is required.

- Use energy saving light bulbs.

- Do not leave appliances in standby mode. Televisions in standby mode can use up to as much as half the electricity as when it is switched on.

- Use a timer on the immersion heater.

Transport:

- Buy fuel efficient or hybrid cars.
- Use public transport when available or car pool.
- Make the least amount of journeys necessary in a day.
- Cycle or walk.

Renewable Energy:

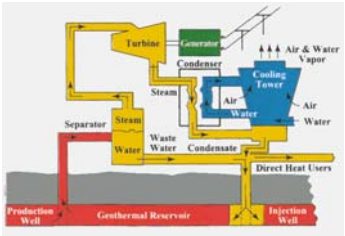
Renewable energy is energy that does not run out. If we use renewable energy to provide some of our energy needs then this will help to make fossil fuels last longer. There are many types such as solar, wind, hydro, wave, geothermal, tidal, biomass. There are two problems with renewable energy: set up costs to produce these energies is more expensive and some are dependent on weather conditions such as solar and wind.

Hydro Energy
Flowing water is used to rotate a turbine which causes a generator to produce hydro-electricity.

Wind Energy
Coastal areas where the wind is strongest is the best place for wind generators. To be effective an average wind speed of around 25 km/h is required.

Tidal Energy
As the tide goes in and out the changes in water levels is used to turn a turbine which is connected to a generator.

Solar Energy
Is energy from the sun. Solar panels can be used to provide heat and photovoltaic cells can be used to generate electricity directly from the sun.



Geothermal Energy
The steam produced by heating cold water as it passes through hot rock can be used to drive a turbo generator, or passed through a heat exchanger to heat water to warm houses.

Biomass Energy
Plant and animal waste is used to produce fuels such as methanol, natural gas, and oil. Rubbish, animal manure, woodchips, seaweed, corn stalks and other waste can also be used.

Having carried out my research I believe I have one of two choices: (a) design a device that will conserve energy or (b) design a device that gets its energy from a renewable energy source. I have decided to concentrate on designing a device that will help to conserve energy using a renewable form of energy. It should operate a simple output device that will reduce the demand on fossil fuels to provide energy to operate it.

Specifications of chosen Parameters

- The device must help to conserve energy or use energy more efficiently.
- The device must include a mechanical and/or electrical system.
- The device should operate a simple output device
- The device should be of every day use and be part of or protect our 'lifestyles'.
- The device should be easily manufactured in the technology classroom.
- The finished product should be strong and durable.
- Due consideration should be given to the environmental impact of the project during the planning and production phase.
- Material selection should minimise this impact and/or lend itself to recycling.

Overall Management of the Project

I have 2 double classes and one single class of technology per week. The project work will be designed and manufactured during the two double classes over a period 11 weeks. In order not to waste time I have set out a plan of how I will manage the project below.

Time	Wk1	Wk2	Wk3	Wk4	Wk5	Wk6	Wk7	Wk8	Wk9	Wk10	Wk11
Analysis of Thematic Brief											
Overall Management of Project											
Research, Investigation & Specifications											
Design Ideas and Selection of Solution											
Sketches and Drawings for Manufacture											
Environmental Impact											
Production Planning											
Product Realisation											
Evaluation & Critical Reflection											

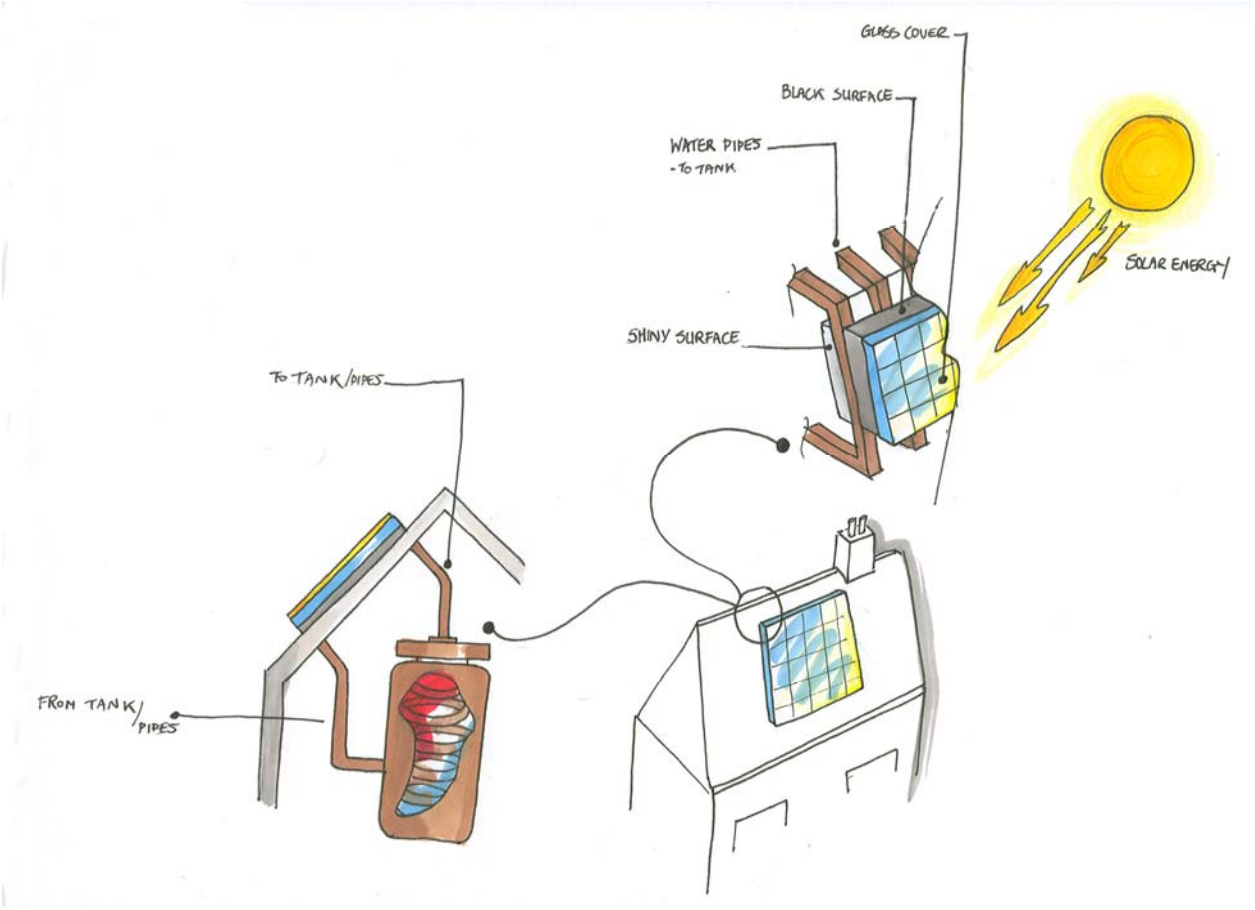
Resources: I have access to a fully equipped LC Technology room. Machine tools available to me include: drill, lathe, strip heater, scroll saw and a vacuum former. I also have access to a wide range of plastics and metals. I do not have access to a woodwork room. I have to pay for the materials that I use and would like to keep material costs under €20 in total.

I also have to consider my own skill level. I must be able to make my final solution in the Technology classroom. If I make the design too difficult it will be hard to complete within the timeframe. The project folder must be completed within the same timeframe so I will need to allocate some of my class time to documenting my work on a PC.

Research, Investigation and Specifications of Brief

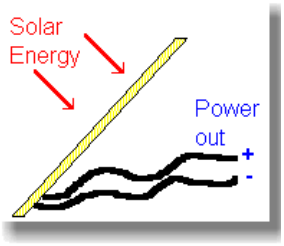
The most practical types of renewable energy to consider using in my project are solar, wind and hydro.

Solar Energy
Solar energy is energy from the sun. Solar panels on a house roof are used to heat water as it flows through pipes in the panel. The pipes are painted black so they get hot when the sun shines on them. Solar panels help to reduce the amount of electricity, oil or gas used to heat water.



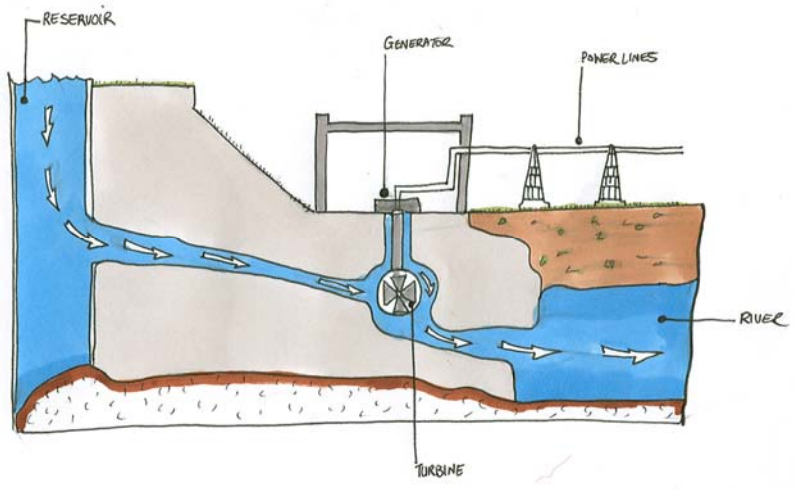
Solar cells called "photovoltaic" or "photoelectric" cells convert light directly into electricity.

These cells are used to power devices such as calculators.



Solar energy could be used to power simple projects. Instead of using the suns energy an artificial light source, such as a lamp, can be used in the technology room. Most projects using solar power use photocells in conjunction with a solar motor. This motor can operate on the relatively low voltages generated by solar cells. I think that this is certainly a viable option for this project and would incorporate both mechanical and electronic components.

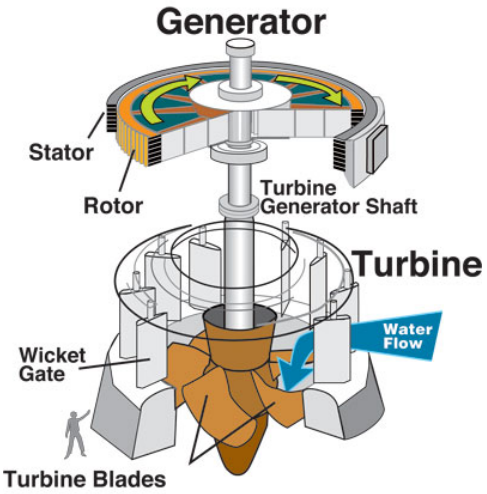
Hydro Energy
Moving water is used to turn a propeller called a turbine, which then turns a metal shaft in an electric generator that produces electricity. Power lines are connected to the generator and they carry electricity to homes and businesses factories and farms.

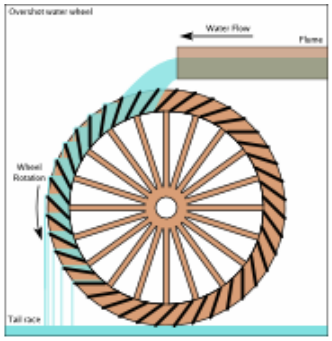


Hydro power is one of the most popular types of renewable energy used in the world today. It is used to generate more power than solar and wind combined. Here in Ireland we also use hydro electricity generated from the power station in Ardnacrusha.

It can be used by me for this project as it is possible to demonstrate it on a small or model scale. In order to demonstrate Hydro power you need a water source which will run over a turbine or a wheel. The turbine or wheel must be connected to a generator. As the wheel or turbine turns under the force of the water it makes the shaft of the generator rotate generating electricity.

The water can come from above or below the wheel in order to get it to turn. This type of power was used historically with industries such as mills harnessing it to turn stones which ground the corn to make the flour.



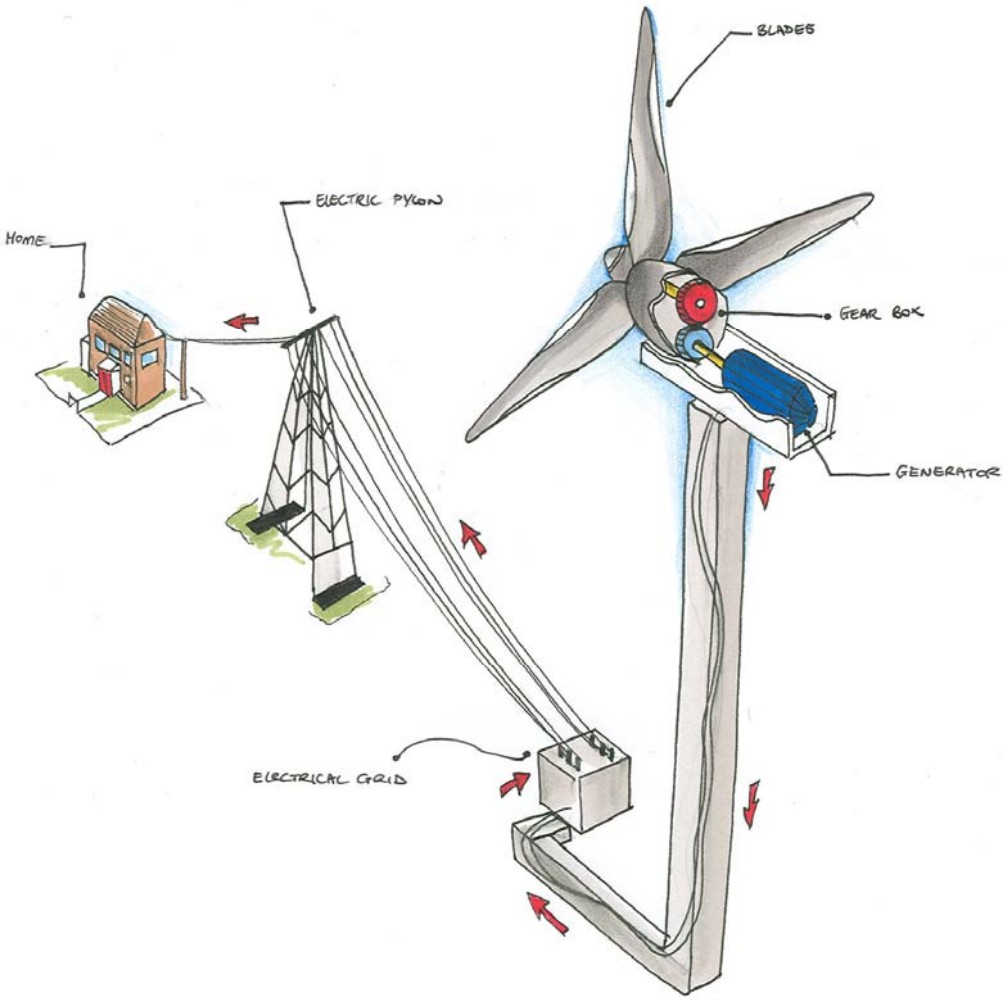


Wind Energy
The energy in the wind turns two or three propeller-like blades around a rotor. The rotor is connected to the main shaft, which spins a generator to create electricity.

Wind turbines are mounted on a tower to capture the most energy. At 100 feet (30 meters) or more above ground, they can take advantage of faster and less turbulent wind.

Wind turbines can be used to produce electricity for a single home or building, or they can be connected to an electricity grid for more widespread electricity distribution.

Wind energy could be demonstrated in the technology room with natural wind being replaced by a hair dryer or compressor.



Generators

In order to use wind or hydro energy a generator is needed for the project. A dc motor, stepper motor and solar motor are available in the technology room and each one could be connected to act as a generator. A stepper motor can divide one complete revolution into a number of steps. It has a very strong magnetic field which makes it harder to turn than the other two motors. It produced the most current when tested using an ammeter but appeared to provide an intermittent current supply. A solar motor produced less current than the stepper but more than the dc motor. It has less resistance to turning than the stepper motor. The dc motor produced the least amount of current.

Dc motor

Solar motor

Stepper motor

Solar Power
If I decide to use solar energy than there is a wide range of photovoltaic and photoelectric cells available that will convert light energy to electricity.

Will produce a maximum of 100mA.

Waterproof solar panel will produce a maximum of 160mA.

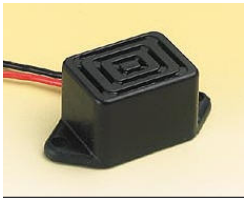
These solar panels are designed to produce a current from 100mA to 1000mA.

Output Devices
As the project is a model, a large amount of current will not be generated. Therefore the output device should operate on a small amount of current. Possible output devices are: LEDs, bulbs, buzzer, 7-segment display or a motor.

LED

Dot matrix display

7-segment display



Buzzer

motor

My Brief and Specifications

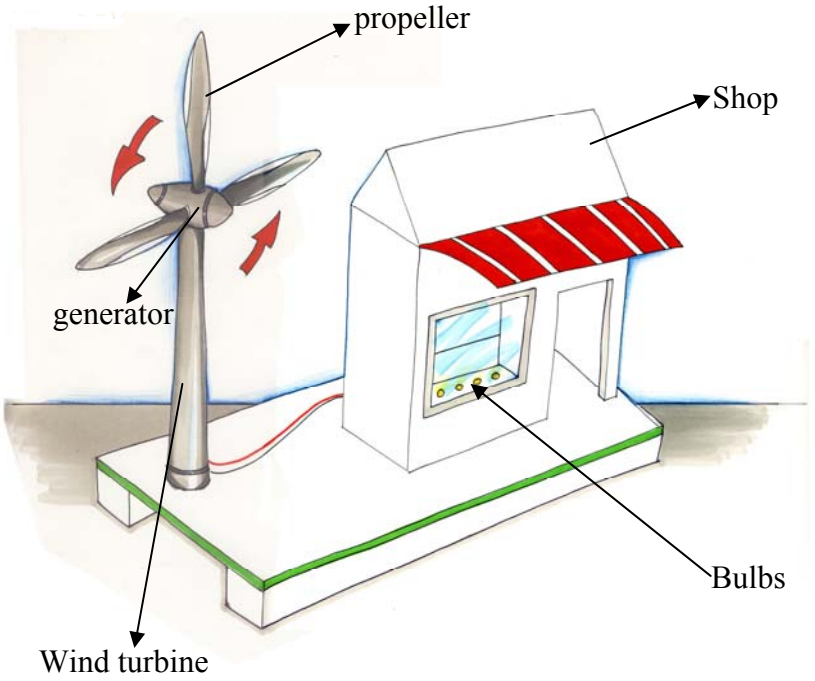
Design and make a device that will generate electricity using a renewable energy source. The electricity produced should be sufficient to operate a number of lights and suitable for use in the home or workplace. The device should incorporate a mechanical and/or electronic system.

- The device must use renewable energy as its power source.
- The device should produce electrical energy.
- The current generated should be able to operate 4-5 lights or LEDs.
- It should be suitable for home and work use.
- Environmental impact should be considered when selecting materials and components.
- The device should be strong, durable and finished to a high standard.
- All components and elements should be accessible for assessment.
- It must be possible to manufacture the device in the Technology classroom.
- The device should be aesthetically pleasing and well presented.

Design Ideas and Selection of a Solution

Idea 1: Wind Energy

In this solution a wind turbine is used to power the lights for a front shop window display. Shops leave their display lights on at night to protect the shop and its contents from thieves and also to continue to display their goods even when they are closed. Replacing the energy used here with renewable energy would conserve huge amounts of energy.



How it works: The propeller is turned by the wind. This turns the central axle in the generator which uses a magnet and coil arrangement to generate current. This current is connected to the bulb- using electrical wire- in the shop window display, causing it to light.

Positive Factors:

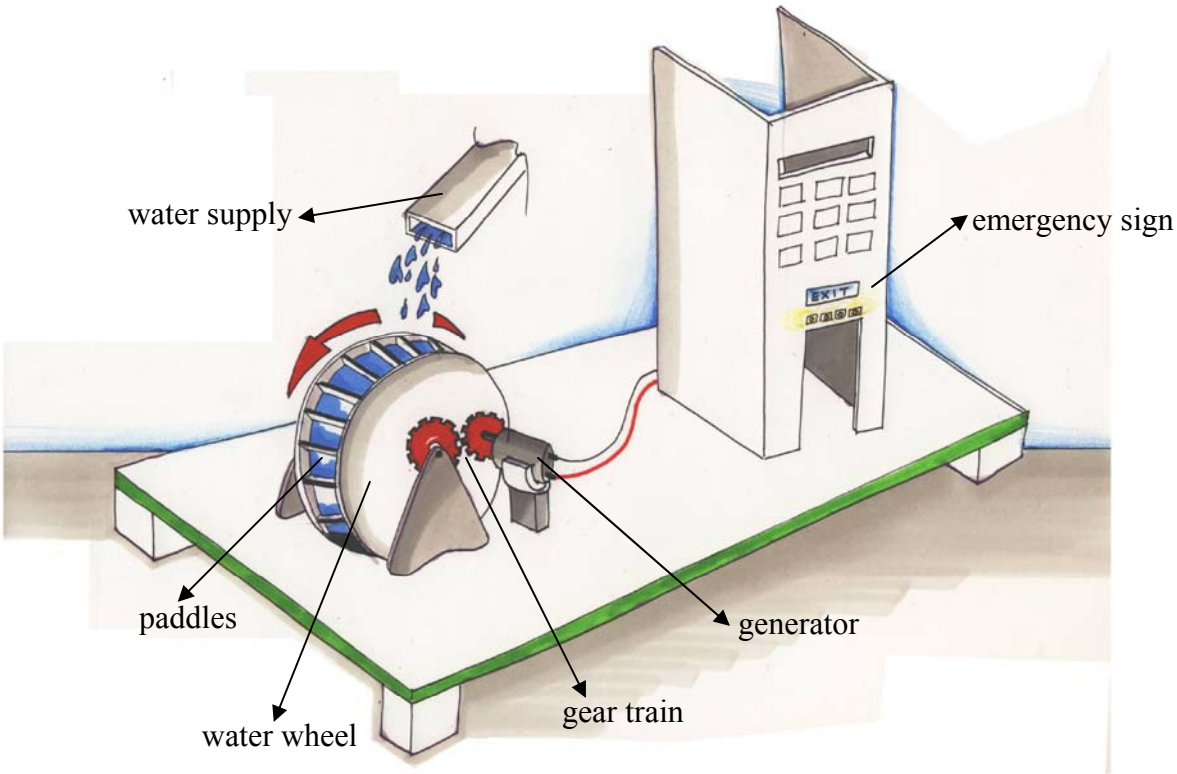
1. Huge amounts of energy could be saved over the duration of a year.
2. The electrical wiring in this project would be straight forward.
3. I believe that this could easily be adapted for use in the real world.

Negative Factors:

1. I feel that the mechanical components in this project would be difficult to make. I think that the production of the propellers would be difficult.
2. There would be a wide variety of materials and production processes needed to complete this project.

Idea 2: Hydro Energy

The second idea I am considering is to use Hydro electricity to power an emergency exit sign. Although these signs use low level light which consume small amounts of energy every hour, they still use a large amount of energy in the course of their life.



How it works: The paddles on the wheel are moved forward by the water. The wheel turns a gear wheel which in turn turns a smaller gear attached to the generator. The gear ratio gives a speed increase and increases the power produced by generator. The generator is in turn wired to the LED's causing them to light.

Positive Factors:

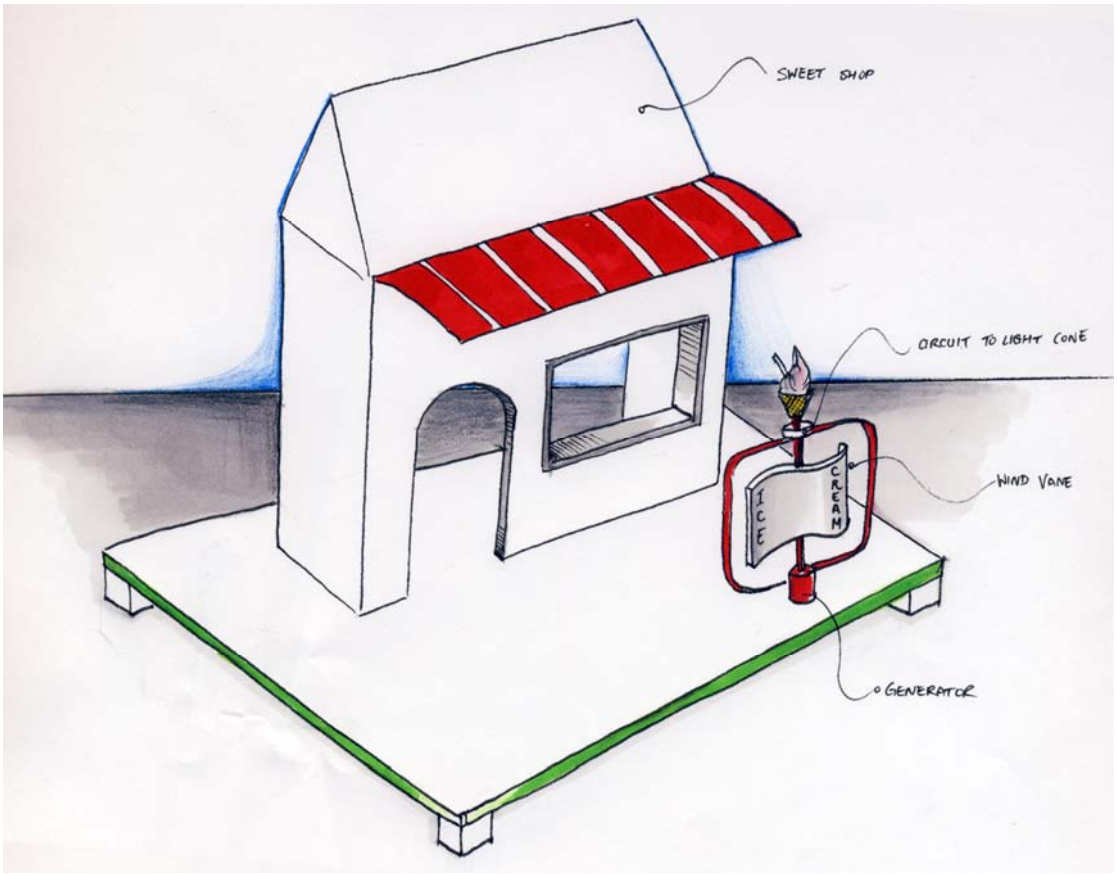
1. Emergency lights are on all day everyday and consume sizable amounts of energy during the course of their life. By powering an emergency exit light with water it would conserve the amount of non renewable energy used.
2. Our lifestyles are generally lived out in buildings, with a lot of time spent indoors at home, at work and at our hobbies i.e. the cinema. All of these public and commercial buildings must have emergency exits. Therefore this idea would have applications which would help us carry out our daily lives and also contribute to our safety.
3. I think a model of this project could be easily and simply made and could be made to demonstrate the idea clearly.
4. The project uses both mechanical and electrical components. I think that in this case I could produce the majority of mechanical parts and have a large input into the production of the electronic circuitry.

Negative Factors:

1. This project will also have a lot of materials and manufacturing processes that will have a negative environmental impact.
2. Although the mechanical components for this project will be challenging to make I am concerned that the electronics will be a little simplistic.
3. I am also concerned that this might be a challenging project to complete within the given timeframe.

Idea 3: Wind Energy

In this solution a piece of rectangular metal or acrylic is curved into an 'S' shape as part of a shop sign. The sign is placed on the path outside the shop to help attract customers. It is used to generate electricity to light the ice-cream cone on top of the sign.



How it works: The 'S' shape is pivoted at both ends and acts like a wind vane. The wind vane is rotated by the wind making the central axle in the generator turn which uses a magnet and coil arrangement to generate current. This current is connected to the circuit used to light up the ice-cream cone on top of the sign.

Positive Factors:

1. Shop signs use a lot of electricity so this would be one way of reducing the energy needed for signs.
2. It could have a simple circuit such as a bulb to light the cone or a more complicated circuit that makes the cone light flash.
3. Signs like this are very popular outside sweet shops and could easily be changed to advertise different products for sale.

Negative Factors:

1. I think it would be difficult to shape the wind vane and get the circuit and generator to fit into the top and bottom discs of the sign.

2. There is not a constant supply of wind so the sign would not work all the time.

3. The sign would work better if placed on the wall or roof of the shop where the wind could be more effective

4. There would be a wide variety of materials and production processes needed to complete this project. It would be difficult to bend acrylic or sheet metal to make the wind vane.

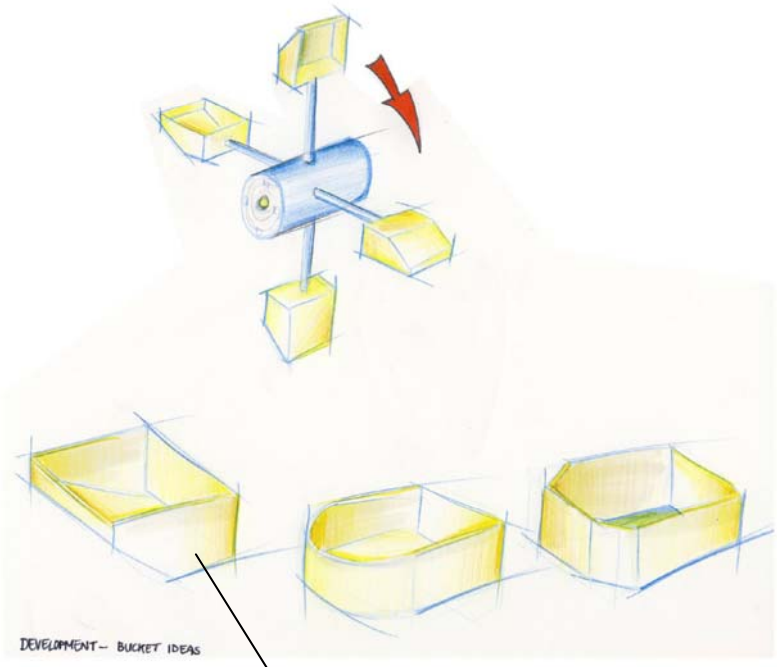
Optimum Solution

Having considered all three possible solutions I have decided to choose solution 2, hydro power. I have chosen this idea for the following reasons:

- It incorporates both mechanical and electronic components.
- It fully answers the brief
- It utilises a renewable energy source
- It has applications in the home and in the workplace.
- It uses renewable energy to power an emergency exit light which is a new and novel way to power such a light.
- I have a lot of interest in this particular idea.
- I think that I can make solution 2 to a high level within the time constraint.

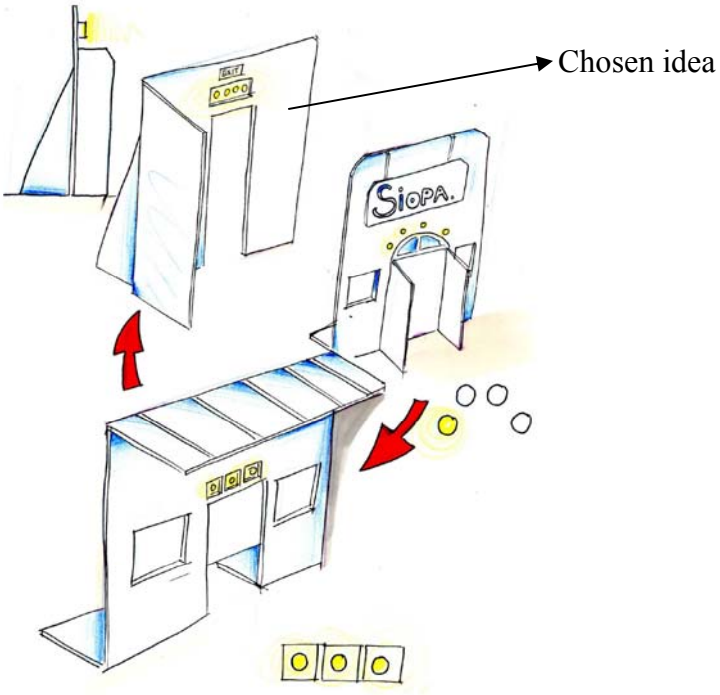
Refining the Solution:

In the original idea I had used a waterwheel which had a conventional design and used paddles which turned as the water ran over them. I have decided to simplify this idea as it would take to long to make it. I will use four water scoops to power the generator instead. The four scoops will be connected to a centre drum. The sketch below shows some ideas I had for the water scoops.

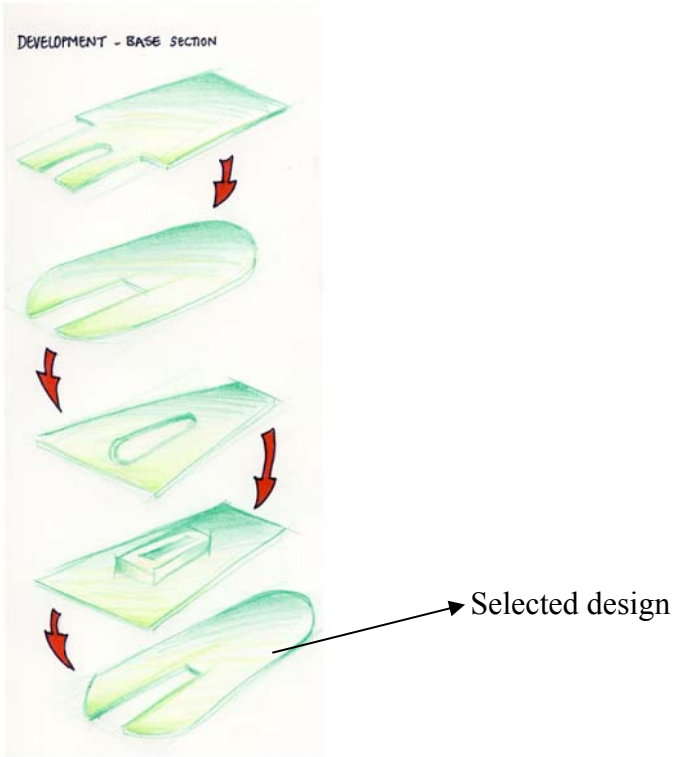


Chosen design

The sketch below shows some other ideas I had for the shop front and light display. I decided to pick the simplest design as it would not take long to make.

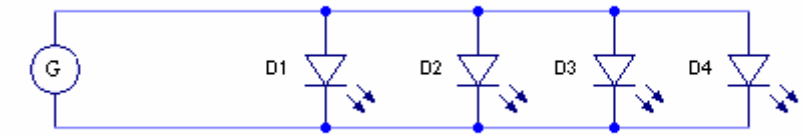


In most cases the water wheel is partly submerged in running water. Therefore the base needed to be adjusted to demonstrate this effect. Some of the ideas I considered are shown in the sketch below.

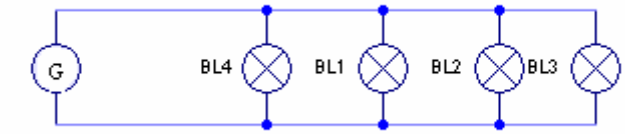


Circuits

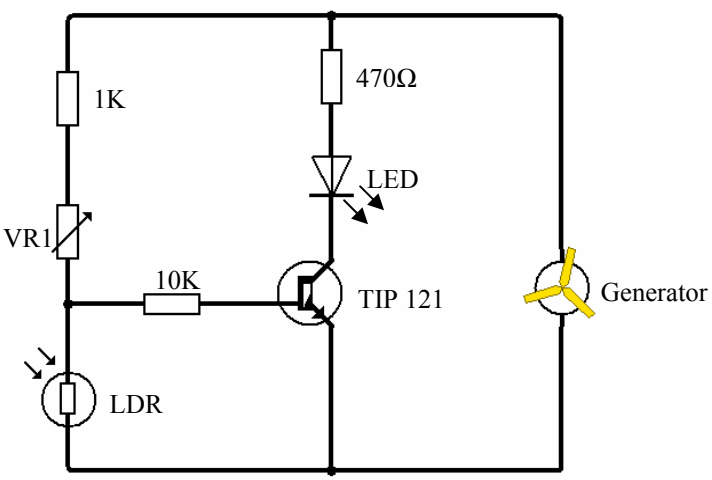
4 LEDs arranged in parallel. LEDs only require 20mA of electric current to operate.



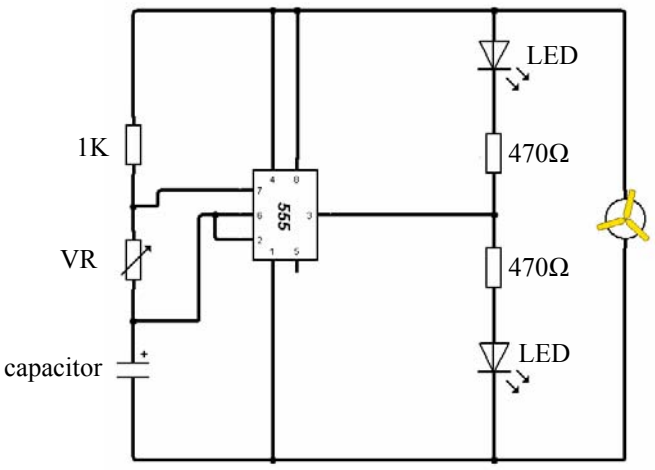
4 Bulb arranged in parallel. Depending on the bulb selected the operating current ranges from 60 – 200 mA. A lot more than that required for the LEDs.



The circuit opposite could be used to Turn on a LED when it gets dark. The level of darkness at which the LED lights, is set by the variable resistor. Using a TIP 121 increases the current available to light LEDs in the circuit compared to an ordinary transistor.



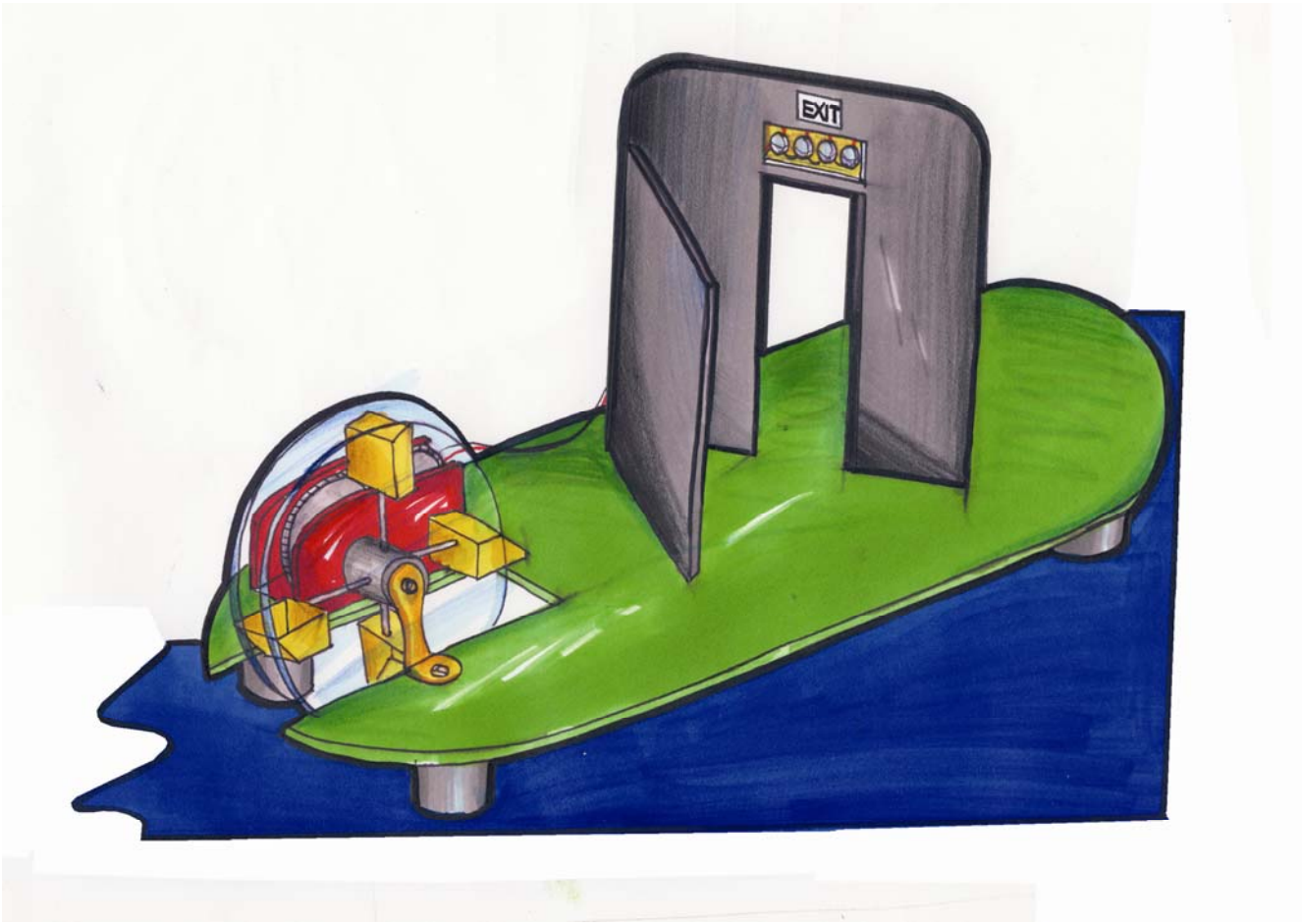
This circuit uses a 555 timer configured in the astable mode. The two LEDs will continually flash on and off. This could be used to draw attention to an emergency sign.



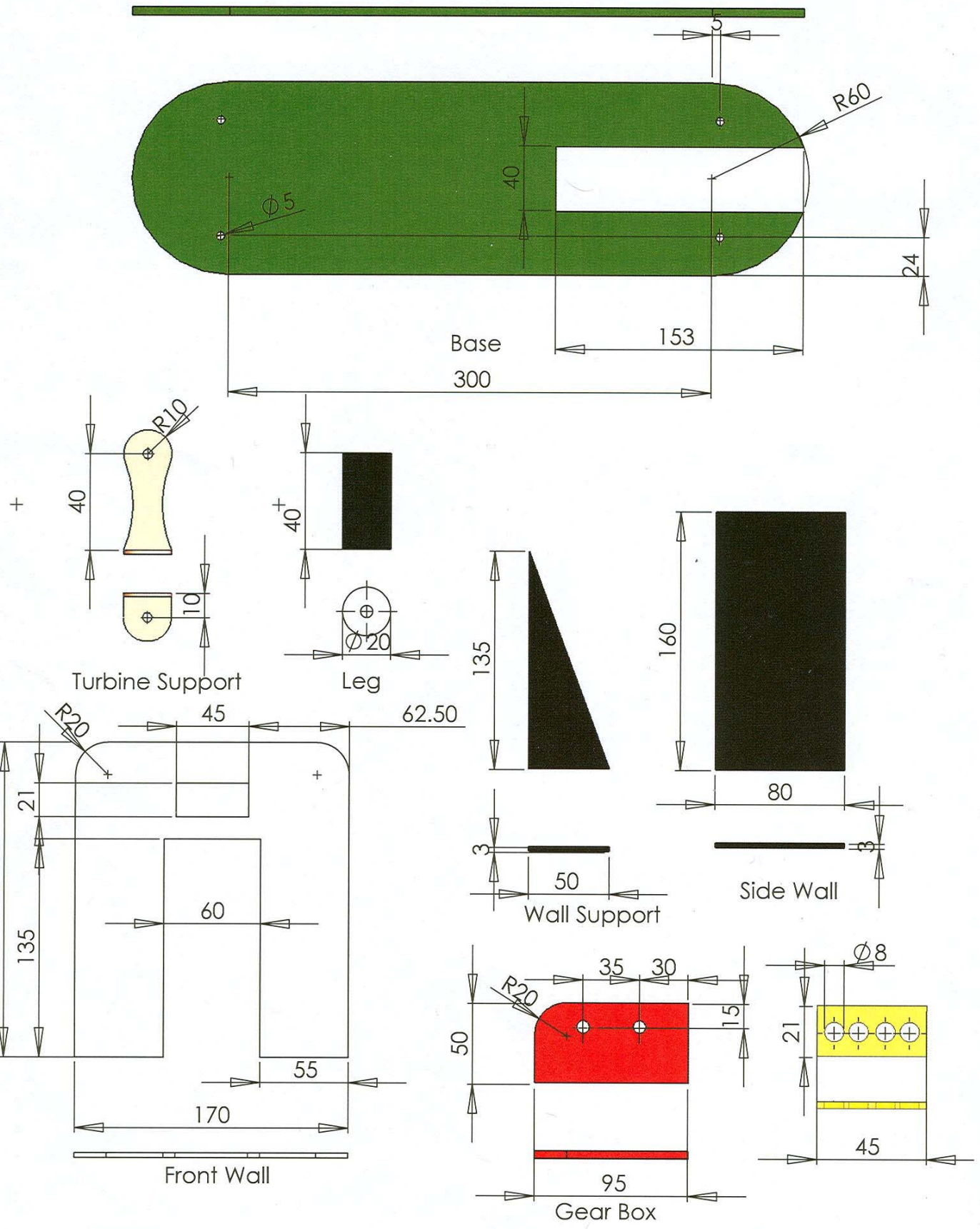
Optimum Solution

I chose the first circuit as it is the easy to make and my soldering skills are not very good. I am sure that the generator in the project will be able to produce enough current to light the four LEDs.

A complete sketch of my design



Sketches and Drawings for Manufacture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R60
40
Ø5
24
Base
153
300
R10
40
10
Turbine Support
40
Ø20
Leg
135
160
80
3
3
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Wall Support
Side Wall
R20
45
62.50
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Gear Box
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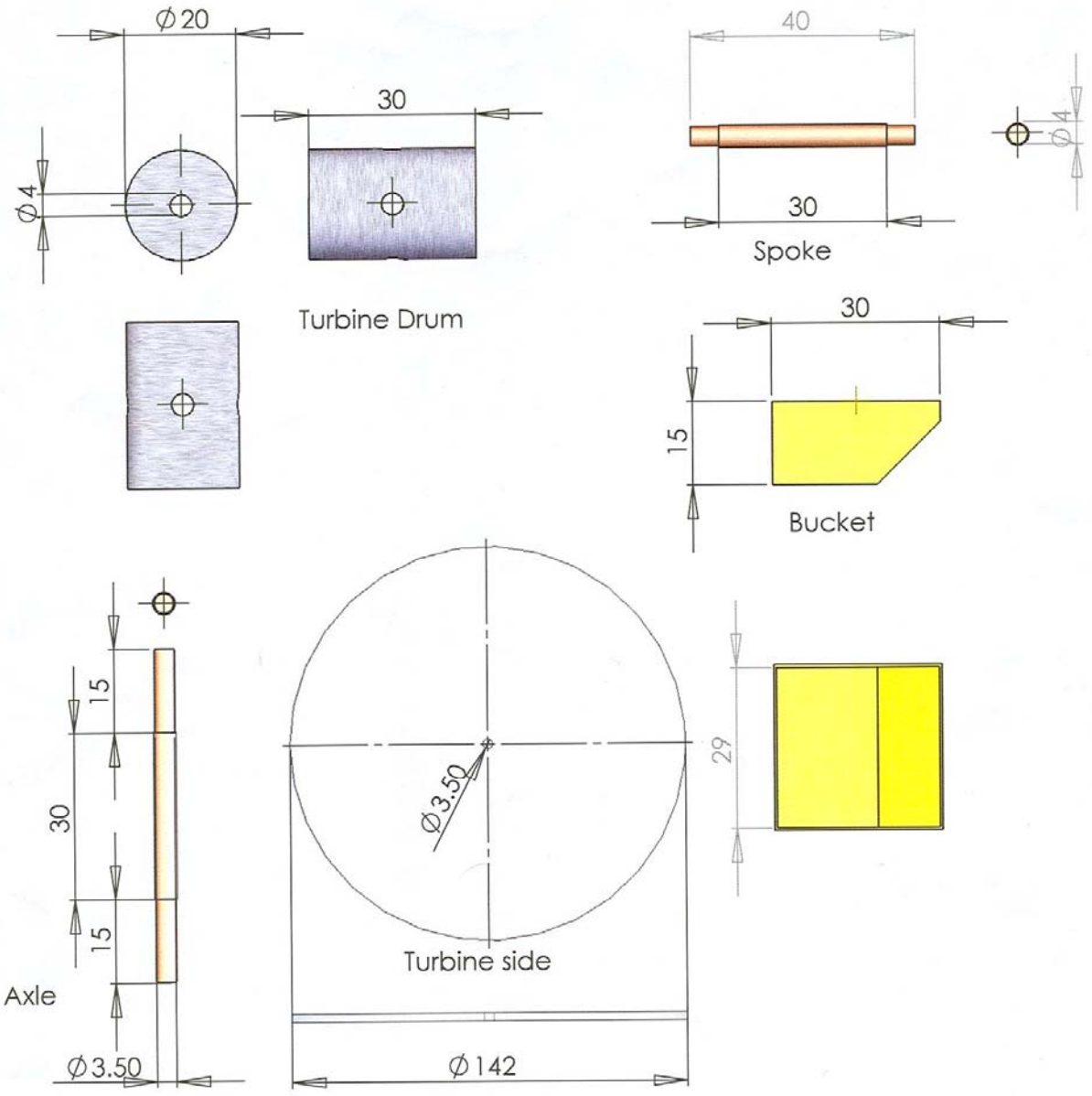
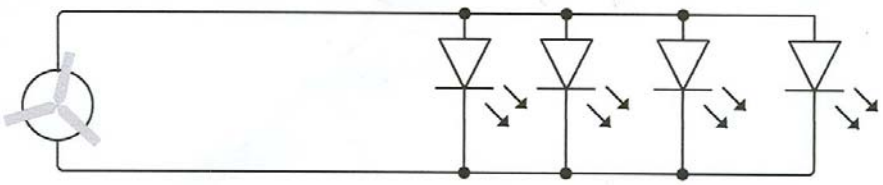
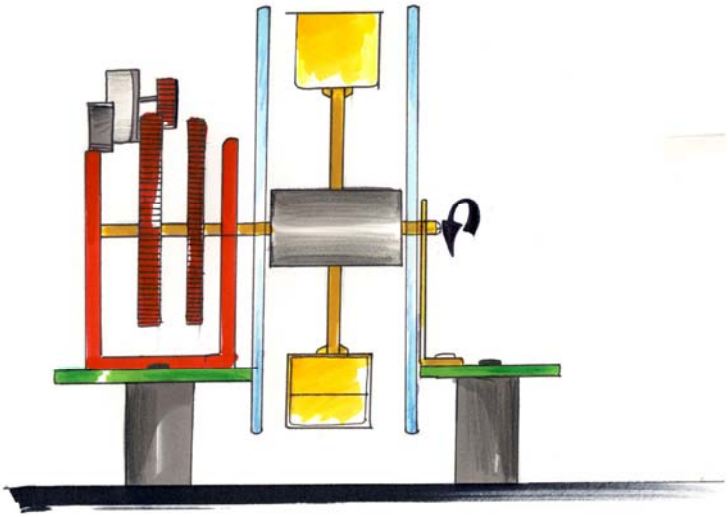
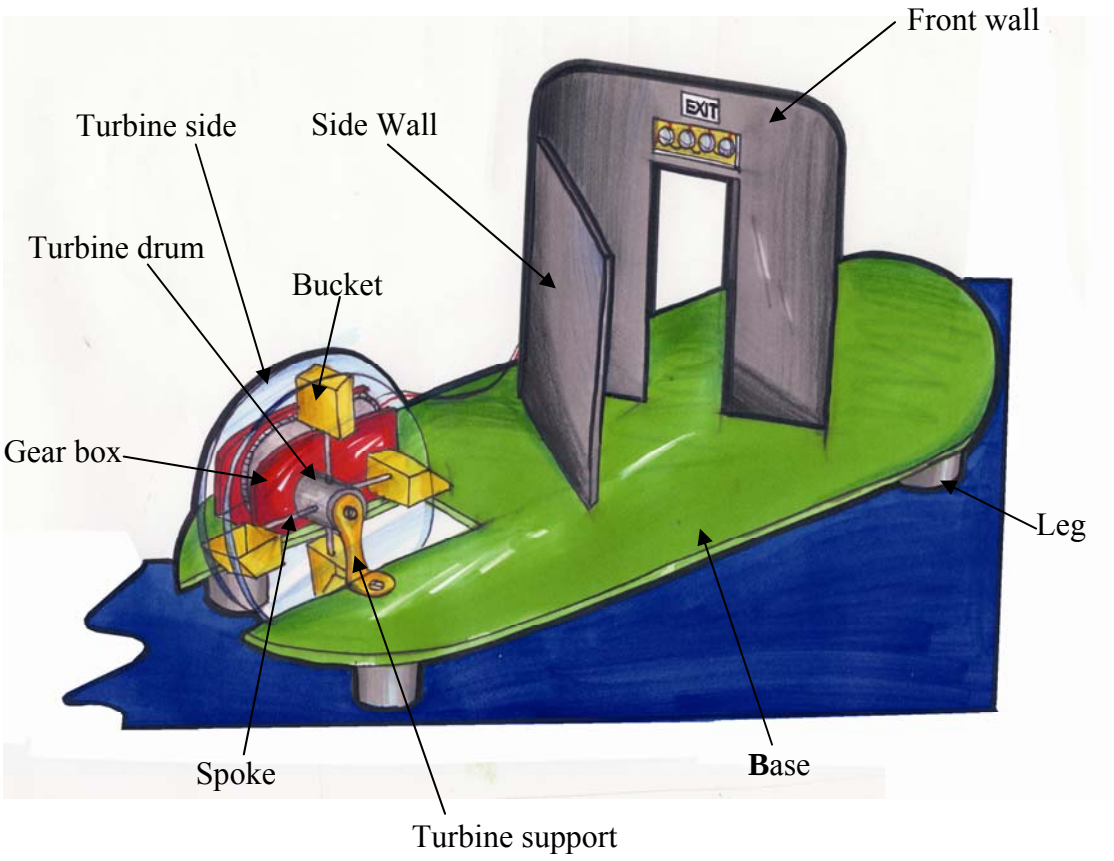


Turbine to generate electricity to power the L.E.D's





Assembly of water wheel and gear box.



Assembled solution.

Environmental Impact

From the start of the project I have had to think about the impact that it will have on the environment. As the theme of the project is the conservation of energy, it is important that the project would be environmentally friendly and cut down on the use of fossil fuels which emit harmful fumes when burnt to generate electricity.

I chose to make this project from acrylic which is not as friendly to the environment as wood. I chose acrylic because I have made a lot of projects from acrylic and it is easy to achieve a very good finish on acrylic.

A big disadvantage is that acrylic is made from crude oil and sometimes coal which are not a renewable energy source. A lot of energy is used to produce acrylic. This includes the energy to extract the crude oil and coal from the ground, the energy used to process the raw material and the energy to transport the material to the stores for sale.

However on the positive side it would be possible to recycle most of the plastic used into other projects. Recycling the acrylic would help reduce the demand on crude oil to produce new acrylic. Also acrylic is a thermoplastic which means it can be heated and made into new useful products.

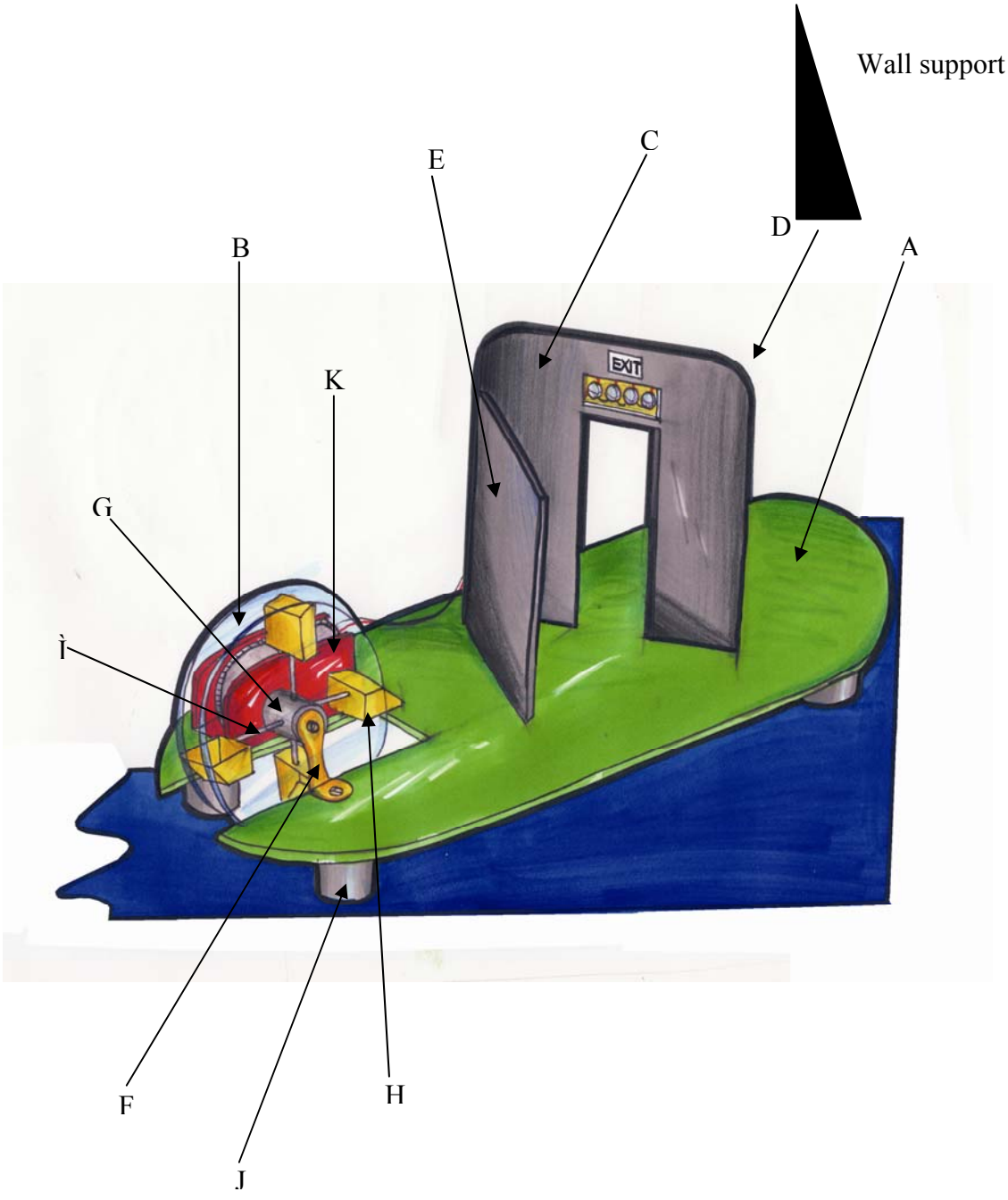
I have also designed the project to use a minimum amount of material to reduce waste. I could have made a complete house but this would only have used more acrylic and would not make the model work any better than it does. Also the fact that there is no battery required reduces the amount of energy wastage.

The advantage of wood is that it is a renewable energy source but I do not think that this project would look or work as well as it does in wood. If I were to make this project again I would use renewable materials such as wood where possible such as the door frame and wall to improve the impact that this project makes on the environment.

The total cost of this project is €12.22 cent. This is within my €20 budget. I feel that I have kept the cost of this project to a minimum using the least amount of material possible. I have also endeavoured to minimise the amount of production processes. This I feel has reduced the environmental impact of the project. A detailed break down of materials and costs are shown below. To reduce waste the material was cut to the minimum size required to produce each of the parts.

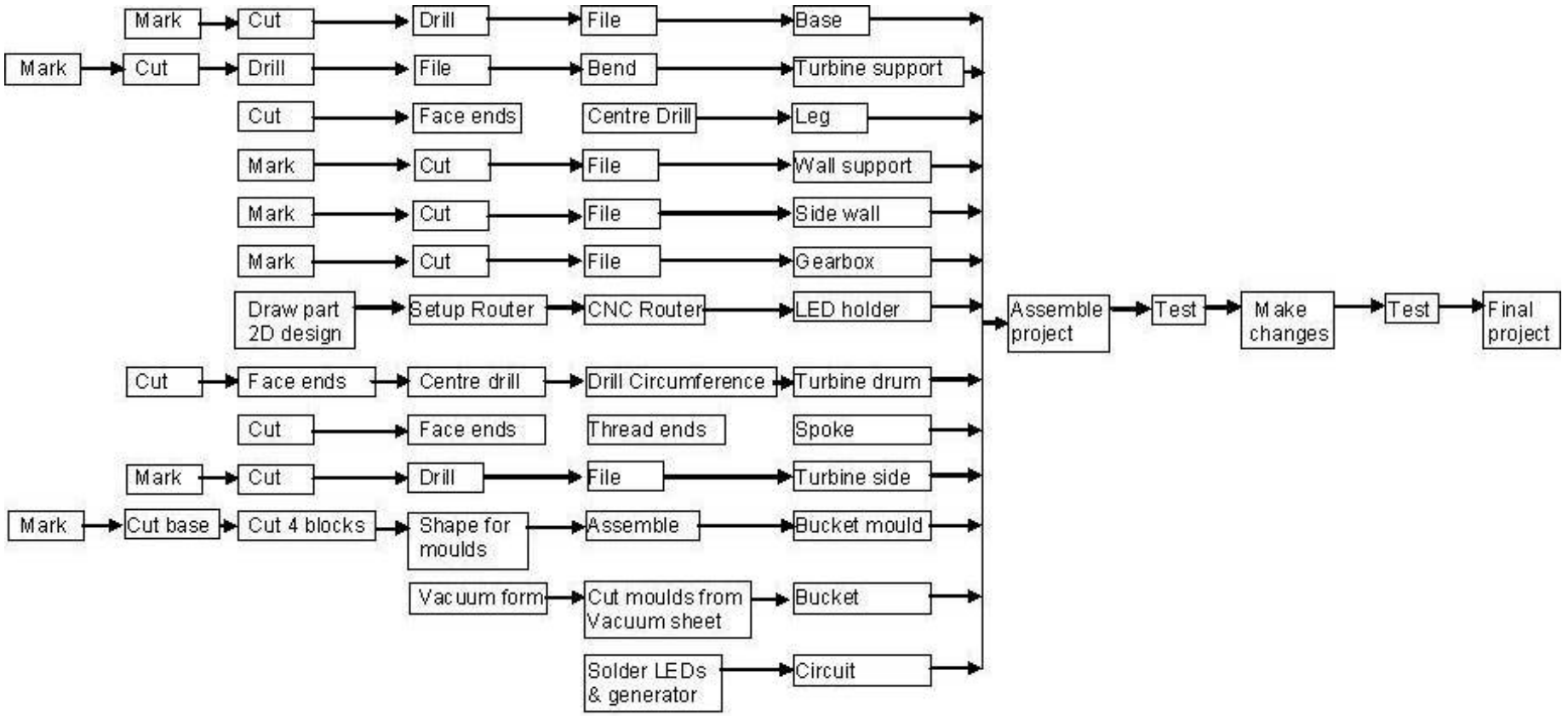
MATERIAL	NAME	DIMENTIONS mm	PRICE €
Acrylic Clear	Turbine side	142 x 142 x 3	1.05
Acrylic Green	Base	200 x 80 x 3	0.21
Acrylic Black	Front wall	250 x 360 x 3	1.17
Brass	Turbine support	100 x 20 x 1.2	1.68
Aluminium Bar	Turbine drum	dia 20 x 40	0.4
Polystyrene	Buckets	58 x 55	0.33
Brass bar	Spokes	dia 8 x 265	0.41
Nylon Bar	Legs	dia 20 x 180	1.65

Production Planning


Wall support
C
E
D
B
A
K
G
I
F
H
J
EXIT

Part	Description	Material	Dimensions	Classes
A	Base	Green acrylic	200 x 80 x 4	2
B	Turbine side	Clear acrylic	142 x 142 x 3	2
C	Front wall	Black acrylic	170 x 200 x 3	2
D	Wall supports	Black acrylic	120 x 130 x 3	1
E	Side Wall	Black acrylic	160 x 80 x 3	1
F	Turbine support	Brass	100 x 20 x 1.2	2
G	Turbine drum	Aluminium	Dia 20 x 40	2
H	Buckets	Polystyrene	300 x 300	3
I	Spokes	Brass	Dia. 8 x 265	2
J	Legs	Nylon	Dia. 20 x 80	2
K	Gear box frame	Red acrylic	160 x 100	2
	Wooden mould	Wood	300 x 300	2

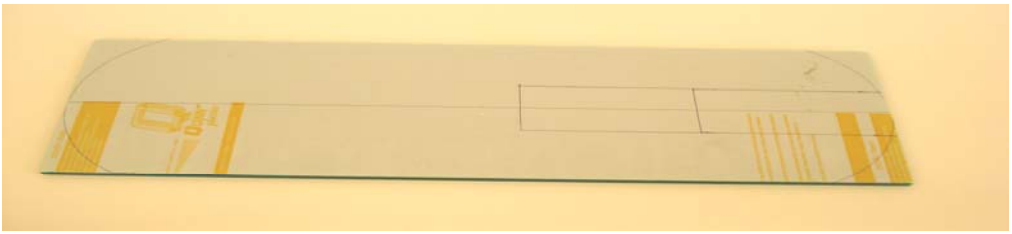
Components	**Quantity**
LEDs	4
Solar motor	1
Gears	4
Screws M6x12mm	4
Blots M3	4
Cap Nuts M4	5



The WBS diagram above shows the sequence of steps required to produce each part of the project.

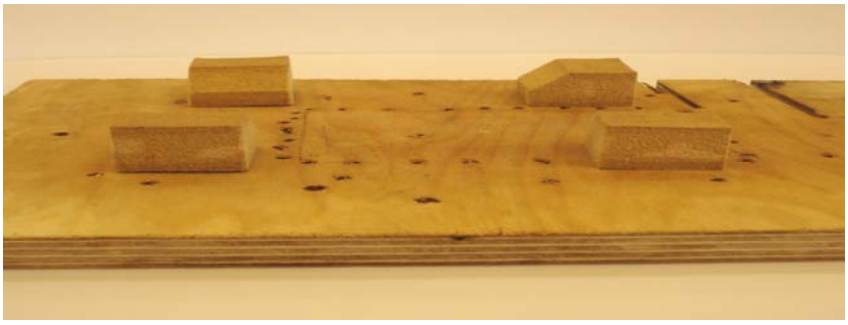
Product Realisation

- Mark out the main base section on green acrylic. Cut it out using a fret saw. File and polish the edges.

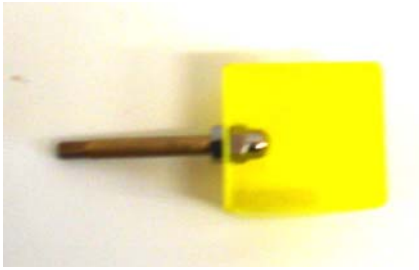


- Mark out on black acrylic the wall and door.
- Cut the wall and cut out the door, file the edges and polish.
- Cut out slot for the LED holder above the door using a coping saw.

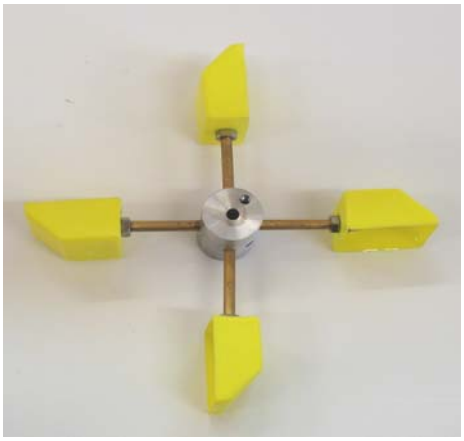
- Using wood cut and shape four moulds for the scoops and attach them to a wooden base to form a vacuum forming mould.



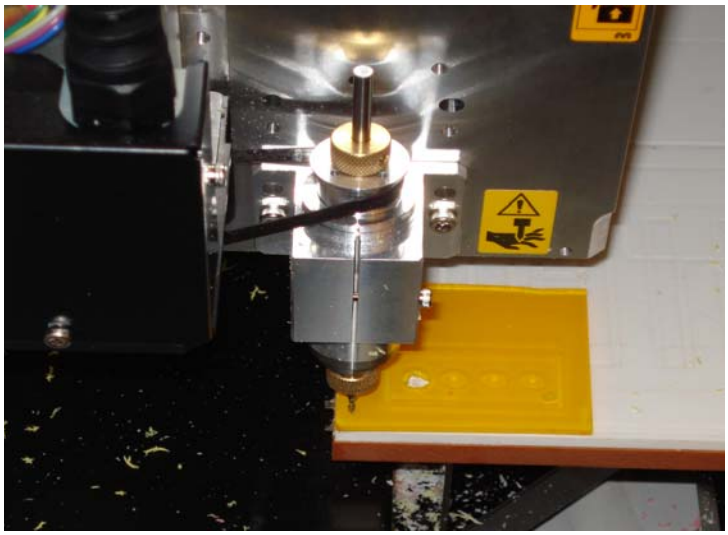
- Vacuum form the scoops using yellow HIPS.
- Cut and thread four brass axles and attach one to each of the scoops.



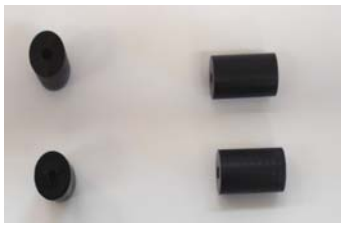
- Cut a length of aluminium for the turbine drum. Centre drill and face both ends on the lathe.
- Drill four holes at 90° to each other on the centre line of the turbine drum circumference.
- Drill a hole for a grub screw between any two of the four holes.
- Insert a scoop brass axle in each of the drilled holes as shown and glue in place.



- Cut out the LED holder on the CNC router.
- Glue into wall above the door.



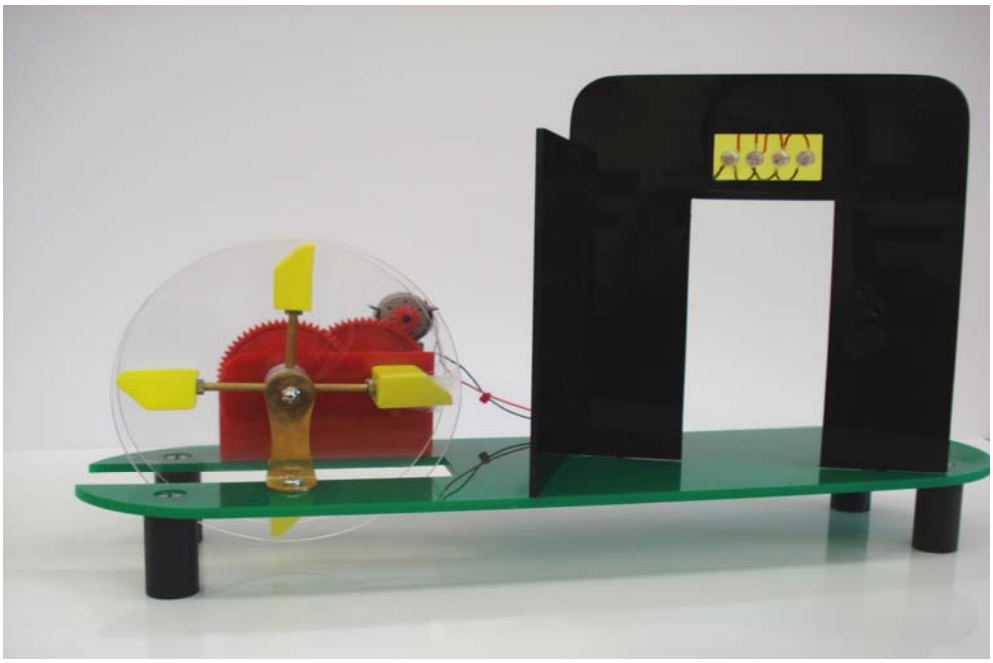
- Cut four black nylon lengths for the base legs, centre drill and face each end on the lathe.



- Mark out, drill, cut, file and bend brass bracket for water wheel.

- Mark and cut out gear box sides and base using fret saw.
- Drill for gear shafts and glue together putting the gears in place at the same time.

- Solder four LEDs in parallel and solder to a solar motor.
- Assembly the project.



Evaluation and Critical Reflection

I am happy that the project has satisfied the final brief and specifications. The project produces electricity to light 4 LEDs using hydro energy. Hydro energy is a renewable energy source so contributing to the conservation of non renewable energy sources. The project incorporates both a mechanical and electronic system. The project is strong and durable, and the finish is of a high quality. I was able to manufacture the whole project in the technology classroom. The use of coloured acrylic has made the project look very good. I believe that the project has applications in the real world and could be utilised in the home or workplace.

I have tested the project in the lab using a tap as the water source. I found that the tap did not apply enough force to allow the LED's to light fully but it did get the LED's to light to some extent. When I tested the project by turning the wheel with my hand I found that the LED's light fully. This suggests to me that the gear ratio of the project is not sufficient to amplify the turning of the wheel to produce enough electricity to light the LED's. If I were to do this project again I would use a gear train with a higher ratio. I would select possibly a 6:1 gear ratio. I could achieve this by attaching a 72 tooth gear wheel to the waterwheel and mesh this to a 12 tooth gear on the generator. If this proved not to work I would investigate the use of a pulley wheel arrangement which could also be used to increase the speed of the generator and would also reduce friction. I believe however that this solution would be liable to slip.

Another change I would make is to include more buckets, at least four placed at 45º between each pair of buckets. This would provide a more continuous rotation of the wheel as there would be less of a gap between the buckets.

Another way of improving the rotation is to increase the length of the spokes from the turbine drum to each of the buckets. This would help by increasing the torque.

I would also design another way of attaching the door frame and wall to the base. I have used glue which is not very strong. If the project fell it would break along this joint. A solution would be to use some square wood doweling to increase the area in contact with the base and the door and wall frame.

Hydro energy works very well if there is sufficient water to rotate the water wheel. However if there is a dry spell there may not be sufficient water. For times like this the circuit could be modified to include a rechargeable battery which will supply electrical energy when the water wheel cannot.

I would also add extra strength to the base by placing two more legs at the centre of the base.

At the start of the project I developed a production plan. The plan was useful as it allowed me to get an indication as to how long the project would take to complete. I used my research and also my experience from previous projects to predict the number of classes the project would take. Having looked at the work needed to be completed I predicted that I should be able to finish the project within 24 class periods.

Although I had put a lot of work into the plan I found that I needed extra time to complete the project. The main reason for the extra time was that the water scoops took up more time than I had allowed. The first time I tried to make the scoops I found that they became deformed. I then needed to drill extra holes in the template and remake the scoops in the next class. Also the CAD drawing took longer to produce than I had expected. This is shown on the revised Gantt chart.

I am pleased that the production plan helped me to stay focused during the production of the project and helped me to complete the project within the time and budget constraints.

Time	Wk1	Wk2	Wk3	Wk4	Wk5	Wk6	Wk7	Wk8	Wk9	Wk10	Wk11
Analysis of Thematic Brief											
Overall Management of Project											
Research Investigation & Specifications											
Design Ideas and Selection of Solution											
Sketches and Drawings for Manufacture											
Environmental Impact											
Production Planning											
Product Realisation											
Evaluation & Critical Reflection											