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Group 1C EWB Challenge Final Report

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EXECUTIVE SUMMARY

Introduction

The EWB challenge is an initiative to try and improve the Dawul Wuru community.

Dawul Wuru Aboriginal Corporation is an Indigenous organization located in Cairns, Queensland that administers the affairs of the Yirrganydji people who are traditional owners of the coastlines stretching from Cairns to Port Douglas.

The project goal is to determine and design the most efficient, economical and portable method of providing reliable power to Dawul Wuru Aboriginal Corporation sites.

This report documents the creation and implementation of a solar powered generator for use within the Dawul Wuru community.

The report will cover all aspects of the design and development processes and how the conclusion was drawn, as well as the physical implementation process of the device and any prerequisites which are needed beforehand.

The group has taken the opportunity to design an energy system that is transportable, scalable, clean and renewable.

The people of the Dawul Wuru community have very short land tenures on their houses and hence require an energy solution that can be relocated when moving is necessary.

It was determined that a solar powered trailer would accomplish this.

Design Development

There were many factors that required consideration when beginning the design for the energy system.

It was ensured that the system would be accessible for all people of the area who may need use of the system, and hence a simple design was prioritized.

Having a design that would work throughout all seasons of the year was also a large priority.

Safety was a priority as something that would potentially be dangerous for users would cause many issues.

Because of the short land tenures present with the Dawul Wuru people, creating a system that was transportable was a necessity as well.

The Yirrganydji people also have a strong connection with the land and sea, so an energy source that damaged this in any way would have been disrespectful and wouldn't not meet the client's requirements.

This is because the organisation's primary goal is to preserve, promote and protect the cultural heritage of the Yirrganydji people and their way of life.

For the final design ideas, the types of energy sources were quickly narrowed down to: wind, geothermal, hydro, solar, bio and ocean energy.

The different considerations mentioned above were analysed and compared, and a decision matrix was created for a final design option to be selected.

Immediately geothermal and hydro could be ruled out as they could not be made transportable.

Bioenergy could similarly be ruled out as it emitted greenhouse gasses when utilised meaning it was not a clean energy source.

Ocean energy restricted the location that the customer could be residing, hence the final decision came down to solar energy and wind energy.

Utilising the decision matrix made it obvious that for the specified priorities for considerations that solar energy would work best, as solar energy is easier to be made transportable than wind energy, which would have required compactable wind turbines.

Assessment and Testing

To test if the design was viable for the Dawul Wuru community a 3D printed a design of the solar powered trailer was created.

Using Autodesk, a CAD design of the solar panel, battery and trailer was constructed and later physically produced via a plastic 3D printer.

This was an ideal representation of the solar powered trailer that had been drawn and designed.

It was identified that the wheels were too small and were not ideal for the terrain, especially during the wet season where there would be lots of mud.

The design was changed from normal car wheels to use off-road tires to solve the problem identified.

The prototype model that was made was not the best representation of the design as it contained no electrical or mechanical components, it was purely for an idea on scale and small level durability tests.

Although the final product would be made of a material stronger than plastic such as a metal alloy it was determined that the design for the wheels after changing to off road tires and the structural design of the trailer was acceptable for the final construction.

Once integrated into the Dawul Wuru service area's community, it would have social, environmental and economic effects on the community.

The environment would benefit from this change as solar power is entirely clean and has no damaging properties on the land or flora and fauna.

Economically however the community may find it difficult to fund the implementation of the solar powered devices, however, over time they will be saving money overall due to the renewability of solar power.

Society would benefit from having access to these devices as they would have to be less frugal with the amount of energy, they consume meaning larger gatherings with a heavier reliance on the consumption of energy would be possible.

Overall quality of life would improve as well as more remote communities gain access to reliable electricity.

Implementation

The usage of the portable solar panel framework will require cautious arranging and coordination. Community interview will be an indispensable portion of the method to ensure that the framework meets the needs and inclinations of Dawul Wuru service area residents.

A support plan will be built up to guarantee the long-term usefulness and maintainability of the framework. The solar panels would be accessible for purchase to the individuals of the Dawul Wuru community.

Because of the durability of solar panels in general and the explicit design of the trailer system, little maintenance would be required for the user regardless of the amount of use they get out of the product.

Although the initial cost per unit is quite high, this would make for a much cheaper cost over long periods for the user and funding could possibly be secured to reduce the cost.

The aim was to complete this project within 3-6 months after starting, if the funding application was successful from the Federal Government's Indigenous clean energy initiative.

Conclusion

The solar powered trailer's versatility, sustainability, and transportability make this a viable option for the Dawul Wuru community.

It is a design that can last in the community for a lifetime and can be transported anywhere in the area via the use of a vehicle.

It can also survive in various terrain and weather conditions, including during the wet and cyclone season.

If more time had been allowed for this task a more functional prototype could have been crafted and tested on many more functions.

However, the proposed project should still meet the goals of providing scalable, clean and renewable energy to the Dawul Wuru region.

INTRODUCTION

BACKGROUND

The Dawul Wuru Aboriginal Corporation operates in the North Eastern Queensland region, in the area between Cairns and Port Douglas in far north Queensland, Australia.
They were established in 2010 to protect, secure, support and promote the rights and interests of local Indigenous communities, Traditional Owners and Custodians, most specifically the Yirrganydji people.
The Yirranydji people have inhabited this area of the country for thousands of years, and the land continues to be a vital part of their lives, their culture and their heritage.

The region is ecologically diverse, supporting many different types of biomes including rainforest, wetlands, beaches and oceans.

The border of the Great Barrier Reef also reaches into Dawul Wuru's sphere of influence, and provides significant cultural value for locals as well as ecological value for the whole planet.

Figure 1: Aerial photo of the Great Barrier Reef (from Great Barrier Reef Picture Tour, Cairns Australia, n.d.)

Dawul Wuru and the Yirrganydji people continue to take responsibility for looking after the environment in the region, both traditionally and via government contracts and initiatives (Engineers without Borders 2022a).

The issues these projects are designed to address are encapsulated well in a statement from the Yirrganydji Cultural Landscape Management Plan:

"We as the Yirrganydji people, guardians and custodians of the Cairns to Port Douglas coastline, are concerned for the future health of our country. We are concerned about our cultural landscape, heritage and bio-cultural values and the loss and degradation to sites and places of cultural significance, diminishing and loss of language, traditions, practices, lore, customary knowledge and traditional ways, depletion of traditional marine and cultural resources (e.g. food and medicine) through to loss of access to country." (Yirrganydji Cultural Landscape Management Plan, n.d.).

Towards this end, Dawul Wuru has established a main office in Cairns containing a range of equipment to enable various ongoing conservation projects as well as providing assistance to local communities.

This site is used to store equipment and resources as well as including a main board room/meeting room, kitchen facilities, office spaces, and a carport that stores three 4WDs in use by rangers.

Figure 2: Photograph of the Dawul Wuru office in Cairns (Engineers without Borders, 2022b)

From this location they provide ranger services and community support to various areas such as Yarrabah in the south-east, as well as various areas north of Cairns such as Dungarra, Ellie Point, Yorkey's Knob, Taylor Point, Double-Island, Wangetti, and Yule Point being among the existing and potential sites.

Dawul Wuru Aboriginal Corporation have partnered with Engineers Without Borders in order to look at ways their goals can be achieved in more unique and creative ways, with input from thousands of students across Australia.

One of the development areas that Dawul Wuru has expressed interest in was energy.

Currently, most of the energy in Cairns and surrounds (and therefore, Dawul Wuru's office and sites) are either from the Powerlink or Ergon power networks, which are primarily coal-fired.

In keeping with their environmental goals, and in line with their spiritual connection to keeping the land safe, Dawul Wuru wish to explore alternative options for sourcing electricity that are more sustainable and have less environmental impact than conventional coal-fired power and wish to "lead the way amongst their peers and partners in use of sustainable energy." (Engineers Without Borders, 2022c).

PROBLEM DEFINITION

Towards this end, one of the project opportunities outlined in the EWB challenge documentation was a transportable and scalable energy system, for providing energy to all manner of sites for up to 20 years, and, due to lapses in land tenures, have the ability to be packed up and moved when required.

During the background research stage of the EWB challenge, group 1C decided to start researching different methods of power production to decide what a solution for this might look like.

The mission statement presented was: "*How might we determine and design the most efficient, economical and portable solution for providing power to Dawul Wuru sites?*", to encapsulate both the goal of determining which power generation method was best, and the goal of then providing a practical application of that method in the EWB challenge's context.

DESIGN DEVELOPMENT

DESIGN CONSIDERATIONS

Protecting Country

When implementing a transportable energy source into the Dawul Wuru community, it is of high importance to consider the environmental impacts that could occur.
The design brief (Engineers Without Borders, 2022c) explicitly emphasises the importance that the land, sea and country have to the Dawul Wuru community, and it is imperative that it is respected and upheld as much as possible.
To avoid damaging the ecosystem or the land in any way, a clean and renewable energy source must be created and one that produces preferably zero greenhouse gas emissions.

Because of these restrictions, any device that implements the use of biofuel or fossil fuel is not feasible as they will both produce some amount of greenhouse gas emissions and environmental destruction.

It is also important to consider the impacts that the creation of the device will have on the environment. Even though it likely would not be created on Yirrganydji land itself, needless harm to the environment should be avoided and resources and materials should be found from ethical sources where possible.

Creating a large plant or building generating energy may require a large amount of land which would be extremely harmful to the scenery and wildlife living in the area, so a smaller, compact device would be a better implementation for this renewable energy source.

Because of the connection that the Yirrganydji people have with the land it is crucial that the protection of this land is a high priority when considering the design of the device used to generate renewable energy.

Accessibility

When developing a renewable, clean energy source for use by Dawul Wuru and the Yirrganydji people, it is of high priority to consider the issue posed by the accessibility, or lack thereof, that would arise.

When creating a device that can harness energy, there is a strong chance that over time, errors will occur and without anyone with training or experience to operate and maintain it, these issues cannot be fixed.

To make maintenance and operation easier for users, a friendly user interface should be a priority as well as a descriptive instruction manual included.

Designing an energy source that requires too many people to operate or mobilise would also cause an accessibility issue as those living alone and with few social connections would not be able to utilise this device.

It is also important to consider the compatibility that the device will have with electrical devices of the buildings and ensuring that it will be able to generate the required amount of energy.

It's not enough to simply supply electricity - access to electricity needs to provide real, tangible improvements to the quality of life of local communities.

Flexibility/Transportability

Making an energy source transportable and adaptable has many priorities to consider.

For example, the size and weight of the solution needs to be compact and lightweight so it's easy to move it from one place to another.

This also includes making the project as modular as possible and easy to disassemble when necessary. This may include things such as quick-release fasteners, snap-fit connectors, or other methods to allow for easy assembly and disassembly.

Method of transportation also needs to be considered – will something like a 4WD vehicle be appropriate, or can the item be too large?

Perhaps the solution can be compact enough that multiple units can be transported in one vehicle or trailer.

Finally, the solution itself needs to be durable enough that transportation and disassembly/assembly won't cause undue damage or wear and tear.

Safety

When considering safety implications for the project, a variety of factors come into play that all affect the outcome of an energy project.

Any solution must be adapted to the working conditions unique to the coastal area of North Queensland where Dawul Wuru operates.

For example, weather conditions can be a major factor in considering safety for a power solution.

Operating areas for Dawul Wuru are often subject to harsh weather conditions such as storms, high wind, and flooding, so all equipment and work areas involved with the project need to be resilient to such conditions.

Also, when working in a coastal area, it's not just personal safety that must be considered but also

the safety of local flora and fauna – especially marine life which is sensitive to any environmental change.

Finally, electrical safety is important.

As electricity in and of itself can be a dangerous thing, it's important to follow correct electrical safety procedures and ensure that all equipment is grounded correctly, all wiring and electrical components are insulated, and proper PPE is worn when necessary.

Seasonality

Dawul Wuru Is located on the coast of far north Queensland hence, being located right on the coast of the beach.

This area tends to have high temperatures, averaging 25 – 30 degrees all year round (TravelOnline, 2023). Being near the beach it is often very windy from the ocean tides coming in from the sea onto the land (Smuts C, 2021).

The Jimburralji season runs from January to May and is very windy as it is cyclone time of the year (Bureau of Meteorology 2016).

Also, the Yiwanyji season runs from July to September and is another windy time of the year (Bureau of Meteorology 2016).

Being located on the coast of the beach means that ocean energy is also a very easily accessible option. This area tends to have lots of sunshine (similar to the coast of Perth) with consistent warm weather, meaning that solar energy through sunlight is available nearly all year around.

This is more prevalent in the Wumboji season which runs from September to November and is the most humid and hot time of the year, reaching high temperatures with lots of sunshine (Bureau of Meteorology 2016).

The Jawarranyi season runs from November to January which is the storm time when it first rains.

Even with January being in the storm time in this area, the Climate Data organisation states “In January there are an average of 8.34 hours of sunshine per day and a total of 258.4 hours of sunshine.” (Climate Data 2021).

The Jimjim season runs from May to July which is a cooler time with little dew and little amounts of rain (Bureau of Meteorology 2016).

The Jawarranyi and Jimjim seasons are seasons where certain renewable energy methods would not be as utilised compared to other times of the year as there is less sunshine and wind (Bureau of Meteorology 2016).

Financial Impact

The cost of a transportable and scalable clean energy system needs to be as low as possible for

Dawul Wuru Aboriginal Corporation and the communities it provides services to.

The need for these energy systems is to power some current infrastructure as well as provide electricity to any new sites in the future.

Therefore, the cost of the transportable and scalable power unit needs to be minimal whilst still being effective and maintaining client expectations.

The cost criteria will be split into two criteria with equal weighting: initial cost, and ongoing cost per month.

The initial cost will encompass cost of materials, wages, transportation and any other cost that is necessary in the initial start-up and construction of the chosen energy solution.

The second criteria being assessed will be the ongoing cost.

This accounts for all the money that needs to be spent per month to ensure the transportable energy system is always working, this can include maintenance wages, cost of materials for repair and any other labour costs.

A major factor affecting these costs is the community context - depending on what the solution is, it needs to be determined who is going to be shouldering the costs of this power system - will it be individual households, or will resources need to be pooled together from the wider community?

Government grants and subsidies from other sources can also be taken into consideration.

Sourcing of Materials and Resources

Using locally available materials and resources that are culturally acceptable and environmentally friendly from Cairns to Port Douglas stretch of coastline is a worthwhile consideration for Yirrganydji people.

Firstly, using locally sourced materials for a clean energy project can reduce the environmental impact associated with transporting materials over long distances, such as carbon emissions from vehicles, and financial impact associated with shipping prices.

Secondly, resources don't just mean materials - labour and manpower from local communities should be used where possible.

This can have a positive, immediate economic impact over outsourcing employment to other areas, as well as allowing locals to take ownership of the project beyond just "purchase of a product".

DESIGN OPTIONS

Wind Energy

The premise of wind energy is that kinetic energy is generated through the moving of air on large wind turbines (United Nations 2022).

Turbines are designed to rotate in order to generate the most amount of kinetic energy possible.

Rotor blades extend from the hub which when rotated, causes the drive shaft to turn and through the gearbox and high-speed shaft, kinetic energy is converted to electricity in the generator, as seen in Figure 1 below (Alternative Energy Tutorials 2010).

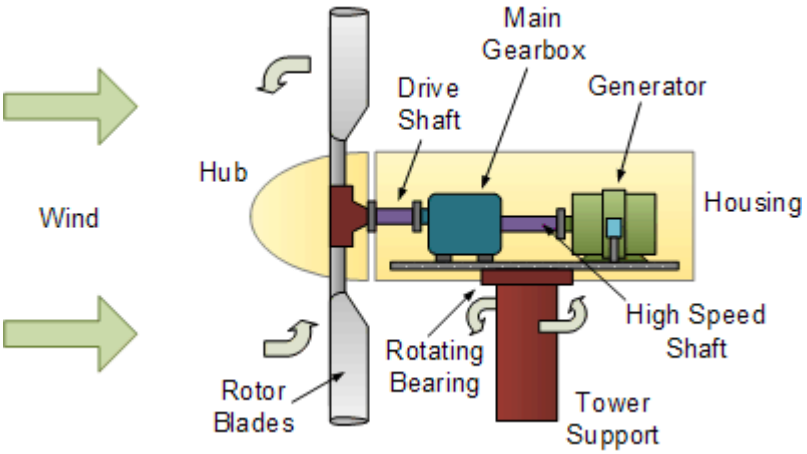

Figure 3: Diagram of a wind turbine (Alternative Energy Tutorials 2010).

There are both positives and negatives to using this as a potential solution to the energy requirements of the Yirrganydji community.

Beginning with the benefits, it is a completely clean and renewable energy source, meaning that it produces no greenhouse gases, nor does it require any additional resources to operate.

These were specifications provided by the EWB challenge brief (Engineers Without Borders, 2022b) and make it a viable solution to their energy issues.

It is also a very safe method of generating electricity as there is little risk involved, so long as the design is housed, earthed and protected correctly.

Finally, it would not cost much to manufacture such an energy source and it would cost little to maintain.

There are however some limitations to this design.

The first is that having such an obstruction as a wind turbine would cause a significant amount of both noise and visual pollution.

Another downside is that depending on the current weather, the amount of electricity may vary slightly.

This may not cause too much of an issue, as in general the North Queensland coastal area experiences large amounts of wind regardless of the season, but it is a factor to consider regardless.

There is also the issue of large wind turbines endangering the natural aerial wildlife of the area.

It may also require professionals to construct the design which on top of the cost of materials would make it quite expensive compared to the other design options (Herbert et al. 2007).

If it were to be decided as the final design, it would need to be made into a portable device.

One method of doing this would be to create a device such that it can be disassembled and moved to different locations.

Even with a design that collapses, the difficulty of travelling with such a large device, even compacted, would be great.

To counter this, the turbine could possibly be attached to a trailer of sorts which would allow it to be packed inside of and connected to the back of a car with ease.

Looking at similar, already existing designs, it seems that the cost would be around $240,000 USD for a complete system (Williams 2012).

Geothermal Energy

Geothermal energy is a renewable energy source that harnesses the heat energy stored in the Earth's crust (NREL 2019).

This energy is harnessed by using that heat to boil water, which produces steam that drives turbines to generate electricity.

When implementing geothermal energy as an energy solution, consideration must be given to the following factors (IRENA 2022):

RESOURCE AVAILABILITY

Not all locations are suitable for generating geothermal energy.

Digging deep enough into the ground to reach somewhere that generates heat is very geographically dependent; places higher above sea level, for example, are far less suitable as more digging is required.

ENVIRONMENTAL/FINANCIAL IMPACT

While the generation of the energy itself is environmentally neutral, digging into the earth and finding a location to put the power plant can have a negative environmental impact as well as being very expensive.

Transportability: Geothermal power plants are normally a permanent installation and therefore aren't very flexible for being transported to another location.

Hydro Energy

When water is channelled via water turbines, electrical energy is produced that is released as water flows through rivers, streams, waterfalls, or reservoirs.

The pressure of the flowing water on the turbine blades causes the shaft to revolve.

The revolving shaft drives an electrical generator, which converts the motion of the shaft into electrical energy.

Most typically, water is dammed, and the flow of water out of the dam to power the turbines is controlled by opening or closing sluices, gates, or pipes. This is frequently referred to as penstock.

More than 160 nations around the world use hydropower to produce electricity in some capacity.

Due to its minimal greenhouse gas emissions, it is a renewable energy source that provides the flexibility to supply base or peak electricity loads.

Additionally, it has a high ramp rate and low running cost.

Other advantages of hydroelectricity include:

Low environmental impact: It is one of the most environmentally friendly forms of energy production available to us today.

Water is a renewable resource that never runs out (although supply of water can be variable depending on environmental conditions).

Low carbon emissions are also produced through this method.

Hydroelectric energy is consistent, unlike other sources of energy like solar, wind, or coal.

To suit supply and demand, the flow of water used to generate electricity can be simply changed.

As a result, energy waste is decreased because electricity may be made available when it is needed.

However, hydroelectricity also comes with its drawbacks too.

The potential negative effects of hydroelectric electricity on the environment may be its biggest drawback. Through their development, dams have the potential to harm or otherwise have an impact on the ecosystem both upstream and downstream.

The cost of initially constructing a dam is another drawback of hydroelectricity.

Even if they don't cost much to run, it might take a dam a long time to pay for itself.

Digging a large dam also has potential negative environmental impact if the site isn’t picked carefully.

Water may and does experience cycles of excess and scarcity, which should be considered while assessing the benefits and drawbacks of hydroelectric power.

The production of energy can be significantly impacted by lower-than-normal water levels, which is a drawback of hydroelectric power (ARENA 2018a).

HYDRO ENERGY IN AUSTRALIA

With yearly average rainfall of less than 600 mm and 50% of its surface receiving less than 300 mm,

Australia is the driest inhabited continent on the planet.

Due to the significant year-to-year changes in rainfall, evaporation rates, and temperatures, Australia's surface water supplies are exceedingly limited and unpredictable.

In Australia, a significant portion of the economically feasible hydro energy potential has already been used.

There are more than 120 working hydro power stations in Australia, with most of the nation's hydroelectricity generated by Hydro Tasmania's network of power plants and the Snowy Mountains Hydro Scheme in New South Wales (National Geographic 2023).

TYPES OF HYDRO ENERGY

A flexible way to manage the electricity use is provided by the pumped hydroelectricity system.

Water is directed through rotating turbines in the conventional hydroelectric power generation process after flowing from a dam or reservoir where it has been stored.

These turbines then start to generate power.

In pumped hydro, two dams one higher than the other operate in a cycle to pump water into the upper reservoir when demand is low.

Pumped hydro operates on the same fundamental principle.

Potential energy is then created and saved for later use.

See figure 2 below for an example of this (Office of Energy Efficiency & Renewable Energy 2018).

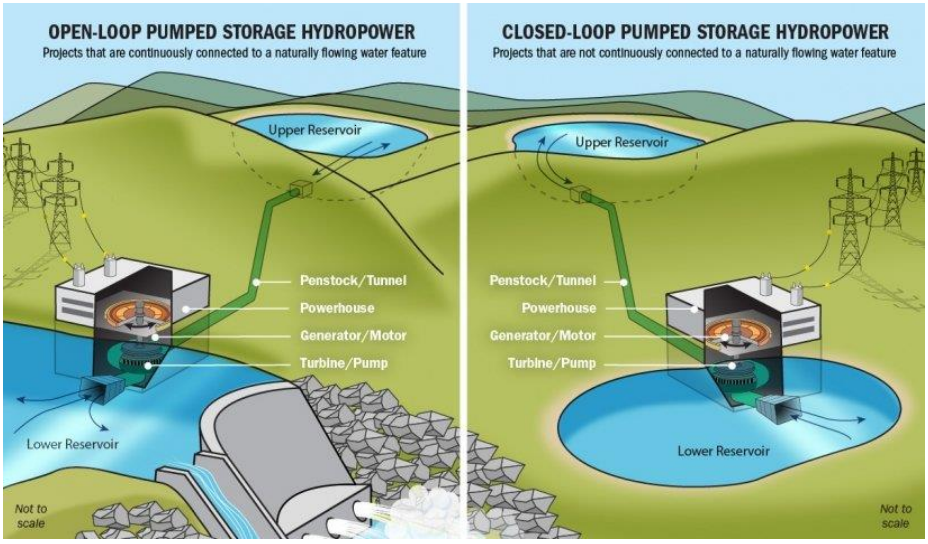

Figure 4: Diagram depicting pumped hydro energy (Office of Energy Efficiency & Renewable Energy, 2018).

DIVERSION

Diversion uses a canal or penstock to direct part of a river through it in order to harness the energy production potential of the river's natural elevation decline.

Water flow is controlled by gates, valves, and turbines in a penstock, a closed pipe that directs water to turbines.

It's possible that a diversion won't need a dam. Below in figure 3 a diagram depicting the system can be seen (Anaza et al. 2017).

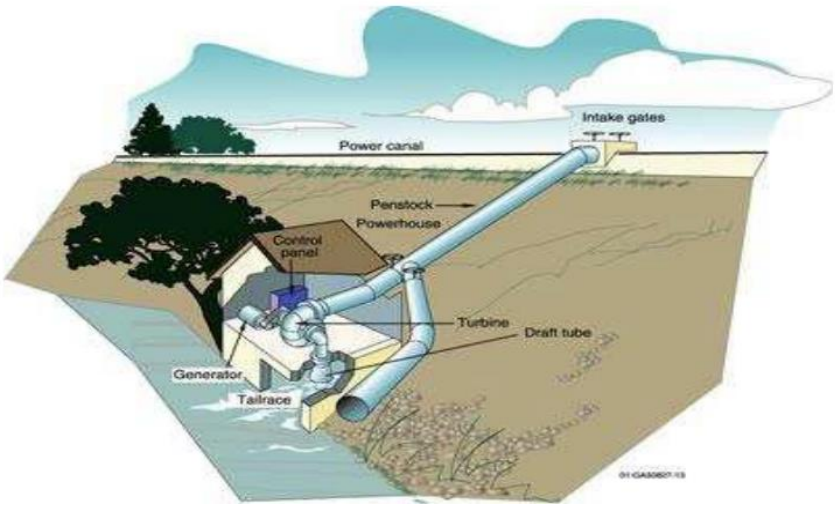

Figure 5: Diagram depicting diversion hydro energy (Anaza et al. 2017).

IMPOUNDMENT

A dam is used by an impoundment plant, which is often a big hydroelectric system, to hold river water in a reservoir.

Released water from the reservoir spins a turbine as it passes through, starting a generator that generates power.

The water may be released to address shifting energy requirements as well as other purposes, including flood control, leisure activities, fish passage, and other environmental and water quality requirements.

Figure 6 below shows an example of this (Amruta 2023).

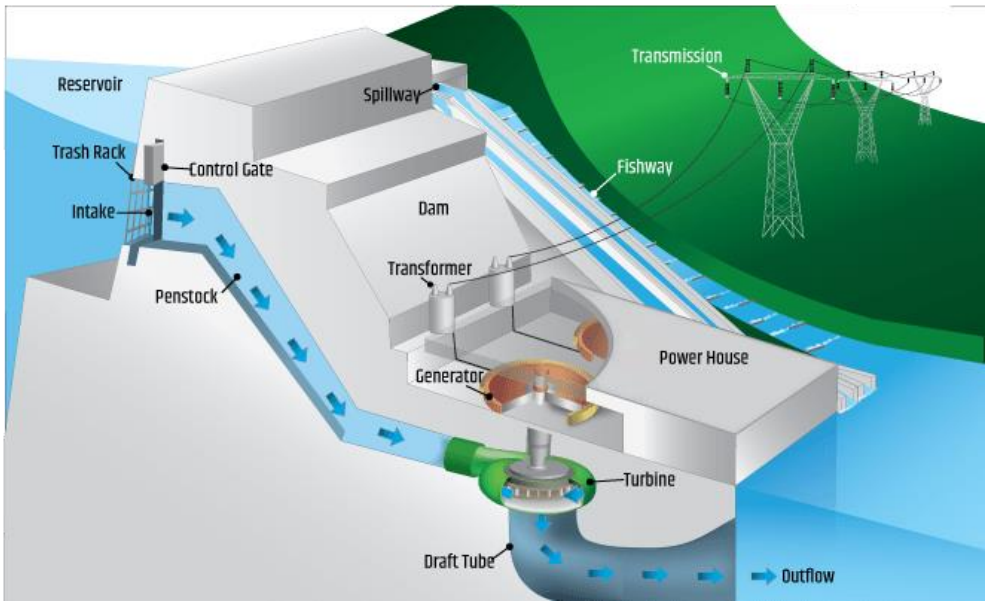

Figure 6: Diagram depicting impoundment hydro energy (Amruta 2023).

Solar Energy

Solar energy is light energy which is emitted by the sun which can be turned into an effective energy form (Solar Energy Technologies Office 2022a).

Solar power is renewable, hence being a sustainable energy source that lessens the reliance on fossil fuels, hence reducing global warming and causing less harm to the environment (Glover E, 2022).

Solar powered energy is something that is predicted to be available to use for another 5 billion years, meaning that it is a renewable source of energy that will last a very long time (Turgeon, A and Morse, E 2022).

The main way solar energy is harnessed and used is through solar panels then converted into energy, which can be used, as shown below in figure 5.

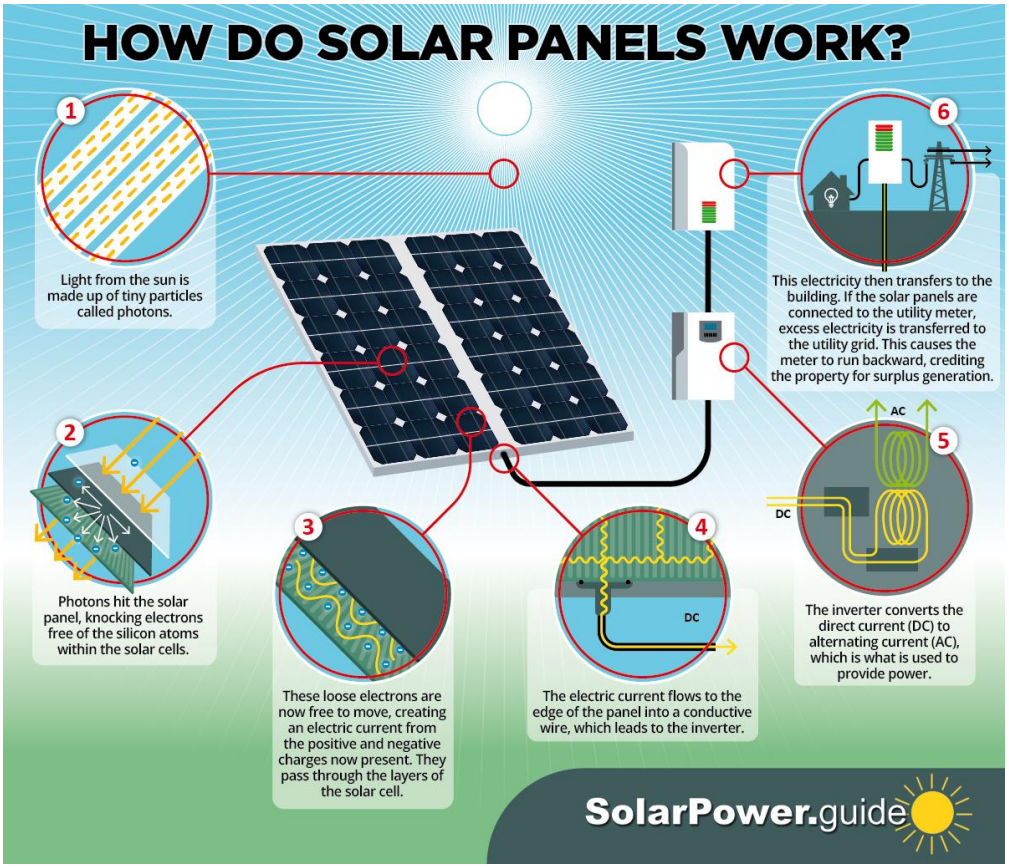

Figure 7: Diagram showing the process of converting solar energy to electricity (Roberston J, 2020).

Solar powered energy can create long term savings as the power can be used on anything that needs power and electricity, hence making savings on the electricity bill.

They also have low maintenance as long as the panels are kept clean, they should be able to work for many years with no problems at all (Glover E, 2022).

Dawul Waru is in Queensland which has the highest average solar panel cost of $6212 in Australia which could be due to the abundance of sunlight compared to other places in Australia (Wrigley K, 2022).

Although the main way solar energy is harnessed and used is through solar panels on roofs of buildings and homes, there are other ways in which this energy can be harnessed.

Innovative ideas such as portable solar panels on a trailer or on wheels and solar powered carts that charge phones are just two examples of how solar energy can be used differently.

A disadvantage to solar energy is that in places with climates that do not see sunshine as much, using solar energy might not be as beneficial.

Furthermore, solar panels can also be expensive to purchase, and it can take time to break even on the savings made, with most customers breaking even in around 8 or 9 years (Aggarwal V, 2018).

Ocean Energy

The Yirrganydji people have a close relationship with the sea.

Their culture is built around the ocean, meaning there is no shortage of ocean that can be used for harnessing energy (Dawul Wuru, 2014).

Although there is a drawback to this, because they have such a connection to the sea and to the water, it could be seen as disrespectful to put structures into the ocean.

There are three types of ocean energy; wave, tidal and ocean thermal.

Out of these three, generating energy from the waves is the costliest.

Tidal stream tech captures kinetic energy of currents flowing in and out of tidal areas (such as seashores). Tidal stream devices operate in arrays, similar to wind turbines (ARENA, 2018b).

The Australian government website, ARENA, states that "The cost of wave energy remains significantly higher than competing alternatives, including other renewable energy sources such as wind or tidal power.

This is due to the engineering challenges associated with installing and operating infrastructure in the ocean environment and more particularly the cost associated with foundation engineering" (ARENA, 2021).

Figure 6 below shows an example of how energy can be harvested by the waves in the ocean (Kaszubska G. 2021).

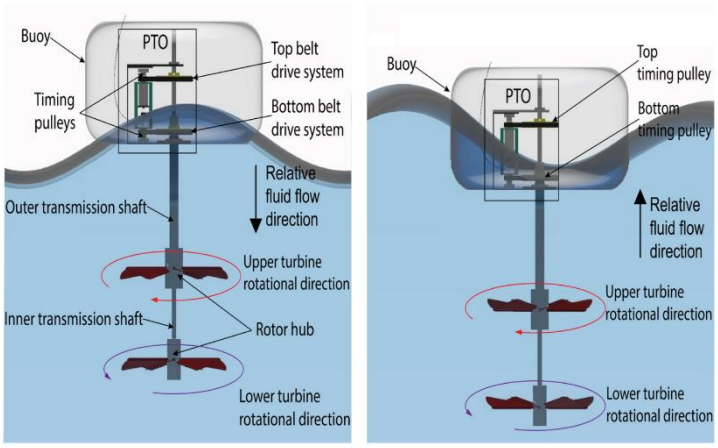

Figure 8: Diagram depicting ocean energy being harvested (Kaszubska G, 2021).

DESIGN SELECTION

When taking the main design considerations into account - Seasonality, Protecting Country, Transportability, and financial impact, Solar Energy presented itself as the best option, as per the decision matrix shown below (figure 7).

Decision Matrix

		DESIGN CONSIDERATIONS								
	WEIGHT	Seasonality		Protecting Country		Flexibility/Transportability		Financial Impact		TOTAL
		4		4		4		3		15
SOLUTIONS	Solar Energy	3	12	4	16	4	16	4	12	56
	Bio Energy	4	16	2	8	2	8	4	12	44
	Hydro Energy	3	12	2	8	2	8	3	9	37
	Wind Energy	4	16	3	12	3	12	3	9	49
	Geothermal Energy	5	20	1	4	1	4	2	6	34
	Ocean Energy	5	20	3	12	3	12	2.5	7.5	51.5

Score out of 5

Score out of 75

Table 1: The decision matrix used during discussion by EWB Group 1C to select a design.

The biggest factor in this decision was transportability - most of the other options explored, including Hydrogen, Geothermal, and Ocean energy, despite being carbon neutral, required a permanent power plant installation, which isn't suitable for a land tenure that expires after 20 years.

This was an important thing when considering the final design - Solar energy is affordable, reliable, and easy to deploy at different scales compared to the other options presented.

Solar panels are fully modular and come in various sizes, addressing scalability requirements, and making it adaptable to many different budgets.

They don't require any environmental damage to deploy - instead of needing to dig out a construction area and build a facility, you just need a small amount of open space that can see the sun - meaning that minimal environmental impact is caused too.

After making this decision, Group 1C set about designing a system for deploying solar energy to Dawul Wuru sites in the form of a self-contained trailer, with solar panels, a battery, and off-road capabilities to deliver electricity to a wide range of areas.

FINAL DESIGN

APPROACHING THE FINAL DESIGN

The most overarching design consideration necessary for this project were the environmental factors.

The impact that design would have on the environment and the Dawul Wuru service area was paramount in making a design decision.

This is because the organisation's primary goal is to preserve, promote and protect the cultural heritage of the Yirrganydji people and their way of life, which ties in deeply with preserving the environment and not causing harm to the land.

These considerations led into the final design decision of a solar system transported on a trailer.

Being a renewable source of energy that can be highly transportable to anywhere in the Dawul Wuru service area is something that would provide the most effective help for the community.

This would also increase the use of renewable energy sources and lessen the reliance of non-renewable energy sources.

The trailer is made of metal, which is very strong and durable, hence the trailer will be able to last for a long period of time.

Something else that came into consideration when creating this final product was making something that would last a long period of time.

If the solar panels are regularly cleaned and the trailer is kept in good condition, then this should last beyond 10 years.

The construction of the final design of the trailer has been put together to be compact, yet efficient.

This means that the design itself of the trailer is not larger, but the solar panel being the largest thing of this design.

Due to the nature of a trailer, the final product can be transported by anyone that owns a vehicle with trailer hooks, although trucks and SUVs are best suited.

Compaction

The solar powered trailer is not small but is certainly not too large that it would be a pain to travel with.

It is very compact and efficiently put together to ensure that there is no unneeded room and that the solar panel is the main piece on the trailer.

Its compaction also means that it is easy for any vehicle to transport the trailer around, however SUV's and trucks would be best suited.

Although it is compacted the trailer is still able to produce enough energy and help give and store energy to the Yirrganydji community to use.

Trailer features

As this solar powered trailer has wheels it can move anywhere that a vehicle can reach and can be attached to the back of any vehicle with towing capabilities.

The trailer has off-road tires to navigate through the rural environment such as dirt, grass, gravel and mud during the wet seasons.

The trailer is very lightweight meaning that it is easier for people to control and drive with it attached to their vehicle as well as not slowing the vehicle down too much.

Being highly transportable means that this trailer can be set in a location in Dawul Wuru's service area with the most sunlight to ensure maximum energy gained.

The trailer is also able to withstand conditions such as rain and hail when being transported which is vital during the wet seasons.

Also, it is very cheap to transport as it would only cost the fuel in the car as there are no added transportation costs aligned with the trailer itself which makes it sustainable and a cheap option.

The solar powered trailer's versatility, sustainability, and transportability make this a viable option for the Dawul Wuru Aboriginal Corporation and the community it provides services to.

The Prototyping Process

Firstly, the group took all their compiled design ideas and ended up with a list of all parts needed for a solar powered trailer system.

They then began designing a layout for this idea by drawing a rough prototype of the trailer (figure 8).

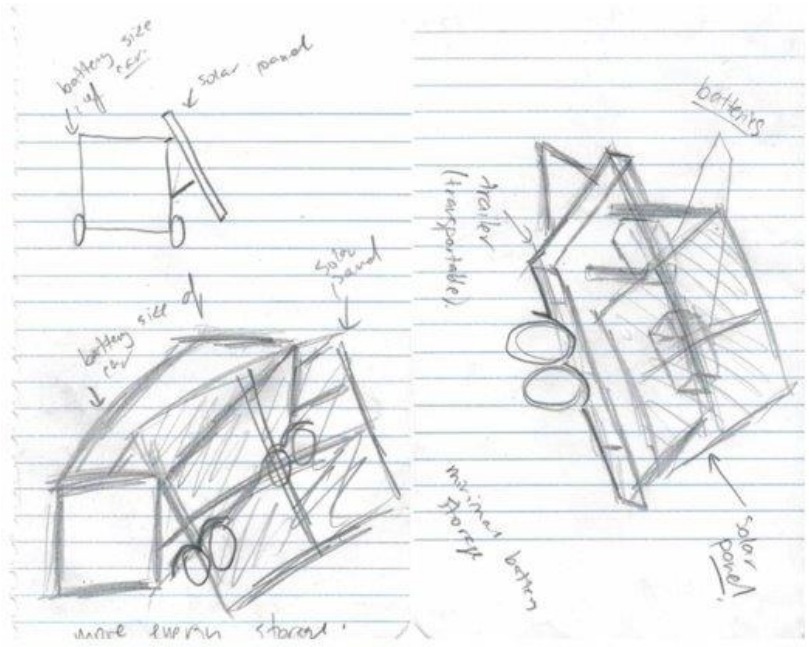

Figure 9: Prototype drawings sketched by the group.

This drawing on paper was then improved to a 3D CAD drawing design, laying out the design of all the elements of the trailer to try and scale out the size of the trailer (figure 9).

To test if this product was viable for the Yirrganydji community, the group 3D printed a design of the solar powered trailer, as shown in figure 10.

Each part was designed individually, with the objective being less about creating a functional product, and more about using a scale model to display what a functioning unit could potentially look like.

The FDM (Fused Deposition Modelling) 3D printing process involves heating plastic in a nozzle, which deposits it in thin layers, one on top of the other.

As each layer cools and solidifies, the printer moves up in the Z-axis to print the next layer until the entire object is complete.

Heating the plastic at 200 degrees meant that protective gear such as heat gloves and glasses were worn to ensure safety.

3D printing this design was the most cost-effective method of testing and creating a prototype of this trailer. The only downside to this method was that it took three attempts to create and took over a day to 3D print.

After the print was completed all parts that were printed separately were then assembled with superglue and coloured with spray paint, which ended up being a cheap and realistic scale model of the solar powered trailer.

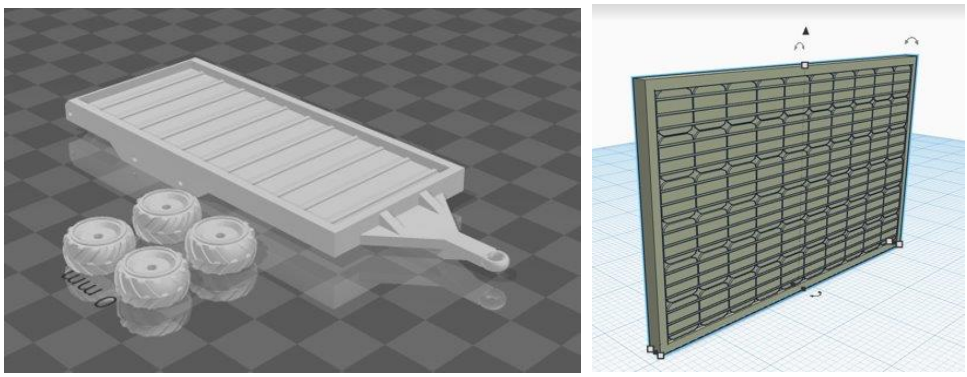

Figure 10: CAD designs of each part for the trailer.

Figure 11: The 3D printed trailer prototype.

THE FINAL DESIGN

Summary

After careful deliberation over the design considerations, solar energy was chosen as the energy source for this project.

To meet the criteria of transportability, efficient and economical a solar powered trailer was designed.

The solar power trailer contains a 9 by 5 feet Australian standard sized trailer, a collapsible solar panel and a covered area for a battery for energy storage.

The solar power trailer has been designed to be easily transported from location to location by anyone,

Design Components and Features

The solar panel trailer designed by the team consists of the following components: a trailer, solar panels, batteries, chassis assembly and tyres.

These features are vital to the design of the trailer to ensure it can be used for efficient energy production.

The Trailer

The trailer that is included in the final design is an Australian standard 9x5 feet unit.

There are side panels on the edges of the trailer to help with weather protection of the inside components.

The trailer also has wheel guards that are built in to give the wheels protection, there is also a spot for a spare wheel located at the front of the trailer near the chassis assembly.

The design can be seen in figure 11 sourced from Trailer Plans located in Brisbane, Australia (Trailer Plans, 2023).

Figure 12: Intended base trailer design before the addition of solar equipment.

Solar Panels

The solar panel is attached to a bracket on the trailer that can be angled in a 45-degree elevation.

This feature gives the trailer the advantage of having a solar panel that can be folded down into the trailer for easier travel.

This feature can be seen in figure 12.

The solar panel also takes up majority of the space on the trailer, this is to maximise as much possible energy capture available.

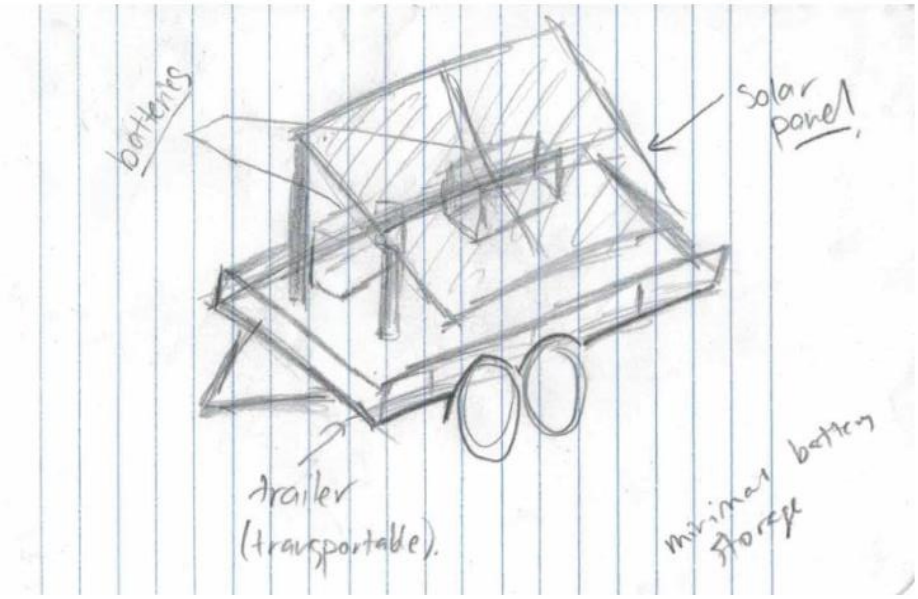

Figure 13: Initial sketch of trailer design.

Batteries

Also seen in figure 12 there are two battery boxes that are located underneath the solar panel.

These are used for the storage of the energy captured by the solar panels and thus its output can be used in the Dawul Wuru sites for their requirements.

In this design, the batteries are only protected from weather by the solar panels but in the final design chosen by the group there is a housing that protects them in the areas not covered by the solar panels.

Chassis Assembly

The trailer has a chassis assembly at the front which allows it to be attached to any vehicle that has a tow bar on the back.

Unfortunately, this means that the trailer cannot be transported by any vehicle, but tow bars are very common and if not available from factory, a towbar kit can be purchased for around $400 (Repco, 2023).

Tyres

Due to the likelihood of travelling on uneven, rough and unmaintained roads and in some circumstances no road at all.

The tyres on the trailer need to be able to last these conditions, this is why the group has opted to swap out conventional trailer tyres for a tougher more durable tyre.

The more durable tyre will help to ensure the solar panel trailer reaches the goal of lasting longer than 10 years.

ASSESSMENT AND IMPLEMENTATION

DESIGN ASSESSMENTS

The Yirrganydji community is known for its natural beauty and cultural significance.

Incorporating the proposed portable solar panel technology in these sites will have social, environmental and economic impacts.

Social Impact

From a social standpoint, the adoption of transportable and portable solar panels for Dawul Wuru Aboriginal Corporation benefits the local people in a number of ways.

In distant locations, where access to energy is frequently limited, these solar panels offer a dependable and sustainable source of power.

According to an article by Yudiatmaja 2021, “the installation of solar panels reduces several aspects of social relationships in the rural community” (Yudiatmaja et al., 2021).

The residents’ quality of life is improved by the availability of electricity since it allows them to use better lighting, run minor appliances, and recharge electronic gadgets.

It also creates prospects for economic development, healthcare, and education. Rural areas can benefit from clean, long-lasting illumination sources provided by portable solar panels, especially at night.

By doing so, the necessity for dangerous kerosene lights or candles which provide fire and health risks is removed.

For women and children, who in particular frequently experience heightened vulnerability in dimly lit locations, adequate lighting increases safety, decreases accidents, and improves the general well-being of community members.

The availability of energy through portable solar panels also considerably improves education.

Evening study sessions are now available to students in remote locations, assisting them with self-study, test preparation, and assignments.

Additionally, it makes it possible for students to use electronic learning tools like tablets, laptops, and e-books, which improves their educational experience and increases their knowledge base.

In remote areas, having access to electricity empowers kids and enhances educational achievements.

Furthermore, portable solar panels on wheels might be a useful resource in crisis and catastrophe scenarios.

In the event of natural catastrophes or other crises, they may be immediately deployed to provide an emergency power source for lights, medical equipment, and communication devices.

This aids in boosting local communities' resilience to emergencies and effectiveness in disaster response.

Environmental impact

Introducing portable solar panels in the Dawul Wuru sites can have multiple environmental implications too.

The use of solar panels reduces dependency on fossil fuels, reducing glasshouse gas emissions and battling climate change.

Solar energy is a clean and sustainable source of power.

Local communities may help create a cleaner, more sustainable future by using solar energy. (Solar Energy Technologies Office, 2022b).

Additionally, these solar panels' accessibility offers more flexibility in capturing solar energy.

They may be deliberately placed to catch as much sunlight as possible during the day, maximising energy production.

This flexibility is especially beneficial in locations with fluctuating sun exposure or where fixed solar systems might not be possible owing to topography or land restrictions.

It is important to note that the deployment of portable and transportable solar panels needs to be done with great care for the Northen Queensland environment.

To reduce any potential negative effects, such as habitat disruption or harm to the local flora and fauna, appropriate land use planning and environmental assessments should be carried out.

Sustainable development depends on involving local stakeholders and taking their viewpoints into consideration when making decisions (Gunerhan and Hepbasli, 2008).

Economic impact

The installation of solar energy panels can have a positive economic impact on the Yirrganydji people by reducing energy costs for households in the local communities.

Solar energy provides long-term savings, and the use of transportable solar panels can further decrease expenses by capturing and storing excess energy in storage batteries for wet weather conditions.

The stored energy would then be shared with other households in the communities resulting in cost-effective energy supply that powers their basic household electrical appliances for their daily needs.

This reduces electricity costs, increases financial resources for families and improves the quality of life for the Yirrganydji Indigenous people in the Cairns to Port Douglas Region.

The estimated cost of installing solar panels with a trailer in these sites is roughly estimated to be $6000.

These panels will last over 10 years if regularly maintained and this cost is generated back from the electricity produced.

Envision of the Yirrganydji local people establishing solar energy-powered cafes that serve indigenous cuisine to visitors interested in bush tucker experiences and the rich history and culture of the communities.

These cafes can also provide exhibition spaces for local artifacts and storytelling sessions, creating a unique experience for visitors and supporting the local economy. By transitioning to solar energy, the Yirrganydji people can save on fuel purchases and maintenance costs associated with diesel systems, while also potentially selling excess power to the grid, fostering sustainability, and creating economic opportunities for their communities.

Indigenous women, who play a specific role in Yirrganydji society, can utilize solar energy to engage in traditional weaving activities and generate income by selling handmade items to tourists and visitors.

IMPLEMENTATION PLAN

Design Implementation

The process of implementing the design into the Dawul Wuru community is something that must be detailed explicitly for a fast integration of the device.

The implementation process would take place over several weeks and the creation of a Gantt chart assists in keeping track of this.

Through the Gantt chart (Figure 13), a thorough plan is formed which is highly specific and detailed.

This process includes the community consultation that must occur first, the manufacturing of the devices themselves, the transportation of the units from their manufacturer to the Yirrganydji area, and finally, the distribution of the units to individual owners.

There are also many considerations that must be carefully looked at and analysed when creating an implementation plan.

The primary considerations are the pricing of the product, whether government funding can be applied, how community consultation will be undergone, the fact that each person requires an individual ownership of their own device, the maintenance that will be required after the design has been implemented, and how the device will be used by the public.

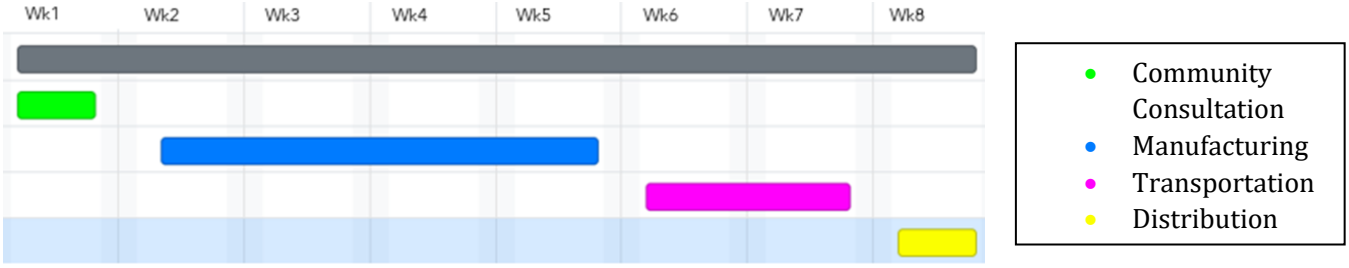

Table 2: Gantt Chart projecting the estimated time allowances for the implementation plan.

Ordered Implementation Process

COMMUNITY CONSULTATION (EST. 1 WEEK)

Creating a specific process to follow for the implementation of the device means that all steps required for the integration of the design can be performed quickly and with minimal error.

The first step required when implementing the design is community consultation.

This is crucial and must occur before any other aspects of the implementation can happen.

By presenting the plans made and any steps going forward as part of the implementation process, the people of the Yirrganydji community can have a full understanding of the project and any changes that may be happening.

As their community is the people whom we're aiming to improve the living of, it's important that their thoughts and opinions on the matter are considered.

This is estimated to take around one week to enact.

This should be enough time for Engineers Without Borders to discuss their plans with multiple areas of the community, as well as receive any immediate feedback.

A further exploration of the community consultation process is provided below, under the implementation considerations subheading.

MANUFACTURING (EST. 4 WEEKS)

Once the community have been informed of the entire implementation process, manufacturing of the devices can begin.

Because the Yirrganydji land is a rural area, creating the devices in a larger city such as Adelaide or Brisbane would be a much more efficient method.

The company, Trailers Down Under manufacture trailers at an affordable cost and would be easily able to handle a large order in order to create enough for providing to the Dawul Wuru community.

They are also located in Brisbane, meaning that they are at a suitable distance from the Yirrganydji land and transportation of the devices from their place of manufacturing would not be too time consuming or difficult (Trailers Down Under 2023).

Their products accurately address the requirements that the device would need and an image of one of their products is presented to the right.

For the manufacturing of the solar panels, the company Arise Solar is a local solar panel manufacturer that also offer's their wares at a reasonable price.

They also offer a 25-year warranty on the solar panels and include the installation in the initial cost.

When shown the design of the solar powered trailer devices, they would likely be able to adapt the installation, and further assistance could be provided by other electricians and mechanics hired with the initial funding of this project.

Figure 14: Trailer as shown on the Trailers Down Under website

Additional discounts may even be possible as the solar panels required for this design are on a smaller scale to traditional on-roof designs (Arise Solar 2023).

The number of devices that will need to be manufactured is unknown at this moment as it is unsure how many people of the local community need the device implemented into their home.

Once the community have been consulted on the design and the implementation plan, it will be possible to gauge their interest and discuss with them how which residents would want such a device implemented.

TRANSPORTATION (EST. 2 WEEKS)

Once the devices have been created at their manufacturers, they must be transported to the Dawul Wuru service area before the products can be distributed to the people of the Yirrganydji community.

Due to the flexibility of the devices, transportation to the remote location of the Yirrganydji area will not be difficult, however multiple vehicles with towing capabilities will be required.

The distance between from Brisbane to the Yirrganydji area is approximately 1,750 kilometers (Google 2023).

This means that a trip taken along this path will take around 20 hours of travelling, making it a multiple day trip to transport.

With multiple vehicles being used to take the devices down, this transportation time can be greatly reduced.

Because multiple trips will be required to transport all the devices and the full number of machines is as of yet unknown, a generous portion of time has been allocated to the transportation of the products, being 2 weeks.

DISTRIBUTION (EST. 1 WEEK)

Finally, the only thing remaining will be to distribute the portable solar powered generators to those initially interested in the device as expressed during the community consultation.

This should not take long as the region is small in area and devices could be taken to each household in a short amount of time.

Some of this time will also be dedicated to assisting the community with the installation of the products.

Although they should be easy to install and operate, brief tutorials on the use of the device could be provided and assistance be given with any who are struggling to make use of the machine.

IMPLEMENTATION CONSIDERATIONS

Individual Ownership

Due to the individual nature of this solution provided to the power issue present in the Yirrganydji community, each user will need to own their own device for use in their home.

With today's electricity expectations and usage amount, each individual requires access to a power source that is consistent and constant.

When there are interruptions to the constant supply of electricity, issues arise within the house.

Because of this it is important that each person in the community utilizing this design has their own device. Due to the expensive nature of the solar panels and since there is personal ownership of each device, part of the cost will have to be covered by the user themselves.

This may be initially difficult to fund, however, once installed and operating at maximum efficiency, consumers will save greatly in the long run.

Pricing

After applying this government rebate, the average cost for the construction and materials required of a 5kW solar panel system is around $5,000.

To combine these solar systems with a trailer, it would likely cost approximately an additional $1,000, meaning that people wanting to install these systems would need to pay around $6,000.

As mentioned earlier, the amount of money that would be saved because of far cheaper electricity bills is a strong enough compensation to this.

Sourcing of Materials

All required necessary materials for Team 1C's EWB challenge for the transportable solar energy project are factory manufactured, and these will be sourced and purchased from local businesses such as Go Green Energy and other suppliers within Cairns or the nearby Far North Queensland areas.

The materials would include PV solar panels, inverters, storage batteries, solar generators, and connector cables (gogreenenergy, 2016).

SOLAR PANELS

Solar panels for the project will be sourced from local businesses or suppliers in Cairns or nearby regions, such as Go Green Energy (gogreenenergy, 2016) Photovoltaic (PV) panels, which convert sunlight into electricity using the photovoltaic effect, will be considered for purchase.

The average cost of a residential PV solar panel system in Australia ranges from AUD $3,500 to $10,000 (ECOFLOW, 2022) per kilowatt (kW) of installed capacity.

While solar panels perform best under direct sunlight, they can still generate electricity during cloudy or overcast conditions.

The lifespan of solar panels is typically long, with most manufacturers offering warranties of 20 to 25 years.

are considered a clean and renewable energy source (ARENA, 2018c) as they do not emit greenhouse gases during operation. However, there are some environmental concerns associated with their production and disposal.

Photovoltaic solar panels (Energy.gov, n.d.) are a reliable and sustainable source of electricity for the local Yirrganydji communities in Cairns. While there are some environmental considerations, the benefits of using solar energy outweigh the potential drawbacks.

INVERTERS

Inverters are a vital component of Team 1C's solar energy project.

They transform the direct current (DC) electricity produced by solar panels into alternating current (AC) electricity that can be used safely by the Yirrganydji people to power their household appliances.

Team 1C will explain all the functions of the solar system in detail, from the solar panels to the inverters, to the generators, connector cables, and the safe use of household appliances to the Yirrganydji people in their communities.

The efficiency of a solar panel system depends largely on the quality of its inverter. (Hielscher Electrical, 2020).

The inverter must be able to convert the electricity from the panels into usable energy with minimal losses and must be able to perform at the optimum levels to serve the communities' electricity needs.

There are different types of inverters available on the market and each type has its own advantages and disadvantages, (Selectronic, 2023) depending on factors such as the size and design of the system, the amount of shading on of the location, the integration of monitoring and storage technologies, and the compatibility with off-grid or grid-connected applications.

Team 1C will consider all these factors carefully and select the best inverter for their transportable solar energy project for Yirrganydji communities.

STORAGE BATTERIES

Storage batteries are an important component of Team 1C's solar energy project.

They allow excess electricity generated by solar panels to be stored for use during cloudy days or at night when the panels are not capturing enough sunlight.

Lithium-ion batteries, which are highly stable and safe, will be used for storage.

These batteries do not overheat and can be placed indoors without additional cooling requirements.

The advantages of having solar storage batteries include the ability to use solar power at night, (SolarRun, 2022) reduced dependence on the grid, protection from power outages, and support for the transition to an all-electric home. Additionally, solar batteries can reduce a household's carbon footprint and future-proof its energy needs (SolarRun, 2022).

In terms of affordability, the cost of a home solar panel system with battery storage starts at around $3,500 (Solar Calculator, 2023) battery-storage for a basic installation.

Prices are steadily coming down as demand and mass-production increase. Several states in Australia (Follows S., 2020) currently offer battery rebates and incentives, making the cost of home battery storage more accessible to many homeowners.

As for safety, when installed and operated correctly, solar batteries pose minimal risks to human health or the environment.

They are suitable for use in the Yirrganydji indigenous communities in Cairns and Port Douglas regions.

PORTABLE SOLAR READY GENERATORS

Portable Solar Ready Generators are an ideal solution for providing electricity in remote locations.

They are designed to be easily transported and can be used to power essential appliances and devices.

Unlike traditional fossil fuel-fired generators, Portable Solar Ready Generators (GenWorks, 2023) use solar panels to generate electricity, making them a clean and renewable energy source.

They are safe to operate and do not produce harmful emissions or pollutants.

In accordance with the electricity needs of the Yirrganydji indigenous communities, these generators can be easily transported to a future new location after their existing land tenure expired, allowing them to resettle with access to electricity generating materials.

The EWB Team 1C would also train the local people how to operate the equipment during the initial installation process, so they would be able to operate the system themselves in the future.

This would be the practical approach to transferring skills and knowledge to the local Yirrganydji people.

Government Funding

To assist with the initial cost of materials and manual labour required to construct and transport the device, there are government funded renewable power incentives which the people of the local community would be eligible for.

The Australian Government's "small-scale Renewable Energy Scheme" applies to those looking to install any small energy system such as: a small-scale wind system, a hydro system, solar water heaters, air source heat pumps or a solar panel system.

This scheme entitles individuals to an "upfront discount off the total cost of their system, or a quantity of small-scale technology certificates which can be created and sold following installation."

Maintenance

It is crucial that these devices are well maintained.

The longevity of the systems is an aspect of high priority, otherwise the fact that it has been made transportable is made redundant.

The design of the trailer is created in a way that it is highly durable, and the process of transporting it, even over far distances or high speeds, should cause minimal damage.

The photo-voltaic panels themselves should last anywhere between 25 and 30 years, meaning that minimal maintenance on the device will be required. In the unfortunate circumstance that a malfunction does occur in the device, depending on the damage different actions can be taken.

For any damage caused by general wear and tear to the trailer itself, it can simply be taken to a traditional vehicle mechanic and any damage can be repaired.

For damage to the solar panels, most electricians will be capable of performing any necessary repairs, however in certain situations, a more specialized person may be required.

Community Consultation

Community consultation is a highly important part of implementing the design into the Yirrganydji area.

By speaking with the local community, ideas and solutions to the transportable energy problem they are experiencing can be presented and it be ensured that both parties fully understand the design being implemented, and how that will happen.

This consultation could happen in a few different ways.

The easiest method and the method that would provide the most understanding for the entire community would be to prepare a presentation which clearly outlines the group's ideas and the implementation plan being put in effect.

Safety

Should the device only be used as directed by the safety handout provided with the device itself, the machine should not pose much of a safety risk to users.

The design houses all electronic components on the inside of the device and nothing dangerous would be left exposes that users may injure themselves on.

Unless the user dismantles the product revealing the electrical components, exposing them to rain or other external elements, the device should be perfectly safe.

The only other safety concern is during the construction of the device; however, it would only be performed by professionals who work with solar panels and electrical systems often so safety precautions will be taken in line with industry standards.

Utility

The use of the device is very simple and once installed and properly set up, very little interaction with the machine itself will be required.

One time that users will need to interact with the machine would be to adjust the fuse switches for testing whenever errors occur with their power supply, as the device will be fitted with safety features including circuit breakers.

Another instance that would involve the user interacting with the solar generator is when they are required to move it to a new destination.

Due to the user-friendly interface, users will be able to easily disconnect the power supply unit from the house.

CONCLUSION

After carefully reviewing the task outlined by Engineers Without Borders, it was decided that the best design area to solve was the requirement of a clean, renewable and transportable energy source.

Immediately, background research was performed on the area and the interactions within the community itself.

Once a strong understanding of the way the community operated, the creation process of a design which solved this issue could begin.

The transportable solar panel design appropriately addresses the issue presented through the EWB design brief and the filtering of ideas led EWB Group 1C to arrive at a solution that solved this issue most effectively.

The utilization of many different sources of energy were considered for the final design of the solution, the primary ones being Hydro, Wind, Solar, Bio, Geothermal and Ocean Energy.

Solar power was of course found to be the most effective method of generating energy and would also be possible to be made into a transportable device.

Through the creation and evaluation of a prototype, it was possible to refine the specific details of the wheels and solar panel integration.

It was found through this that sturdy, off road wheels would be required for the trailer design, particularly because the Yirrganydji land is such a rural area.

After creating a 3D model of the trailer and solar panels using CAD, it was 3D printed and the physical prototype could be tested in terms of its durability and scaled sizing.

The electrical and software aspects of the design could not be created in the prototype as no one with specific skills in that area was available during the creation of the prototype, however much was still able to be learned involving the physical aspects of the design.

Having a full understanding of what the design would entail was integral so that the social, environmental and economic impacts could be explored.

As explained, these are largely positive, and the implementation of the design would be a highly beneficial action for the community.

Through analysing how the community would be affected by the implementation of the design, a complete implementation plan was created.

This involved the consultation that would occur with the local community, the manufacturing of the device, how the units would be transported to the Yirrganydji land and the distribution of the product to people of the local community.

Should the EWB corporation decide to endorse the design, the implementation plan could be followed, and a great service be provided to the people living in the Yirrganydji area.

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