Group 4 - Workshop ATC320 - from 10.30 to 12.30

ACTIVITY 1

1. Photovoltaic (PV) panels in Solar water purification - Trung Kien Nguyen

PART 1

no	Design Criteria	Satisfy expected design criteria	Tick ()
1	At least use minimum 3 different approaches’	Analyse (conducting a detailed analysis of the water quality in Yuendumu at a localized scale. It focuses on understanding the specific contaminants present in the local water source and tailoring the water treatment system accordingly. The analysis is typically conducted at the community level or specific water sources within the community.)	Y
		Reduce (reducing the presence or concentration of contaminants in the water through treatment processes, such as filtration, disinfection, and sedimentation. The reduction is typically achieved at the point of water treatment or purification, and the scale is generally localized to the community or specific water source being treated.)	Y
		Eradicate ()	
		Prevent ()	
		Predict (using predictive models, monitoring, and data analysis to forecast potential water quality issues or contamination events. Predictive models can help identify trends, patterns, and potential risks in water quality, allowing for timely interventions and preventive measures. The scale of prediction can vary, from localized predictions for specific water sources or communities, to regional or larger-scale predictions for broader areas.)	Y
2	At least use 1 or 2 different technologies	Example 1 (4G/5G technology) May be used in Remote monitoring, control, troubleshooting and diagnostics, Cloud-based Data Analysis, Mobile Apps for User Interface, …	Y
		Example 2 (IoT) IoT can be used to remotely monitor and manage solar-powered water purification/filtration systems. Sensors can be deployed to collect data on water quality, system performance, and maintenance needs. This data can be transmitted wirelessly to a central system for real-time monitoring and analysis, allowing for timely interventions and optimizing system efficiency.	Y
		Example 3 (RFID - Radio Frequency Identification) RFID technology can be used for inventory management, tracking, and maintenance of components and spare parts used in solar water purification/filtration systems. It can help streamline the supply chain, improve maintenance scheduling, and ensure timely replacement of parts, thus enhancing system reliability and performance.	Y
		Example 4 (choose your own)	
		Example 5 (choose your own)	
3	At least use 3 or more different devices	Example 1 (Sensor) Smart sensors can be used to monitor various parameters, such as water quality, flow rates, pressure, and system performance. This includes Water Quality Sensors, Flow Sensors, Solar Irradiance Sensors, Temperature Sensors, …	Y
		Example 2 (IoT device) This includes IoT-based Remote Monitoring and Control Systems, IoT-enabled Water Dispensing and Billing Systems, IoT-based Predictive Maintenance Systems, …	Y
		Example 3 (Supercapacitors’ device) This includes Solar/Wind energy Storage System, Power Backup System, Power Conditioning System, Voltage Stabilization System, Start-up Power System, …	Y
		Example 4	
		Example 5	

4	At least list minimum 3 benefits	Benefit 1: Renewable and Sustainable Energy Source: PV panels harness the power of sunlight to generate electricity, making them a renewable and sustainable energy source.	Y
		Benefit 2: Long-term Saving: While the initial installation cost of PV panels may be relatively higher, they offer long-term pros.	Y
		Benefit 3: Energy Independence and Reliability: PV panels provide a decentralized and independent source of electricity, reducing dependence on the grid or other external energy sources.	Y
5	At least list minimum 3 Impacts	Impact 1: Environmental impacts: PV panels are a clean and renewable source of energy, producing electricity without emitting harmful greenhouse gases or air pollutants.	Y
		Impact 2: Social impacts: Access to clean and safe drinking water is a fundamental human right and plays a crucial role in improving public health and well-being.	Y
		Impact 3: Economic impacts: While the initial installation cost of PV panels may be higher, they can offer long-term economic benefits.	Y
6	At least list minimum 3 guiding principles	Access & equity: Ensuring equitable access to clean and safe drinking water powered by PV panels is essential.	Y
		Health & safety	
		Appropriateness	
		Affordability	
		Environmental health: Consideration of environmental health is crucial in designing and implementing PV-powered water purification/filtration systems.	Y
		Sustainable livelihoods: Ensuring that the use of PV panels in water purification/filtration systems contributes to sustainable livelihoods for the local community is important.	Y
7	At least list minimum 2 Constraints	Constraints 1: Cost: The cost of PV panels and associated equipment, such as batteries, inverters, and controllers, can be a significant constraint, especially for communities with limited financial resources.	Y
		Constraints 2: Maintainance and Operation: PV panels require regular maintenance and operation to ensure optimal performance and longevity.	Y

PART 2

Benefits:

1. Renewable and Sustainable Energy Source: Unlike fossil fuels, which are finite and depleting, sunlight is abundant and freely available, making PV panels an environmentally friendly choice for powering water purification/filtration systems. By utilizing PV panels, the reliance on non-renewable energy sources can be reduced, leading to a more sustainable and eco-friendly solution.

2. Long-term Saving: Once installed, PV panels require minimal maintenance and have low operating costs as they do not require fuel or have moving parts. Additionally, PV panels have a long lifespan of typically 25-30 years or more, allowing for long-term savings on electricity bills. PV panels can also provide an

opportunity for revenue generation through feed-in tariffs or net metering, where excess electricity generated by the panels can be fed back to the grid or stored for later use, resulting in potential financial benefits.

3. Energy Independence and Reliability: This can be particularly beneficial for remote or off-grid locations, such as the Yuendumu Indigenous Community, where access to electricity may be limited or unreliable. PV panels can provide a reliable and consistent source of electricity, ensuring continuous operation of the water purification/filtration system even during power outages or disruptions. This can lead to increased energy independence, improved system reliability, and reduced risks of water shortages or disruptions due to power failures.

Impacts:

1. Environmental impacts: By using PV panels to power water purification/filtration systems, the reliance on fossil fuels and other non-renewable energy sources can be reduced, resulting in a positive environmental impact. PV panels also do not consume water during electricity generation, unlike some conventional power generation methods, which can have significant water usage and environmental impacts. Overall, using PV panels can contribute to mitigating climate change, reducing air pollution, and conserving water resources.

2. Social impacts: By using PV panels to power water purification/filtration systems, communities, especially those in remote or off-grid areas like the Yuendumu Indigenous Community, can gain access to clean and safe drinking water. This can lead to improved health outcomes, reduced waterborne diseases, and enhanced quality of life. PV panels can also provide opportunities for skill development, job creation, and economic empowerment through local installation, operation, and maintenance of the PV systems, resulting in positive social impacts for the community.

3. Economic impacts: By reducing or eliminating the reliance on expensive fossil fuels for electricity generation, PV panels can result in cost savings on electricity bills, especially in remote or off-grid areas where access to electricity may be limited or costly. PV panels can also provide opportunities for revenue generation through feed-in tariffs or net metering, where excess electricity generated by the panels can be fed back to the grid or stored for later use, leading to potential economic gains. Additionally, PV panel installations can stimulate local economies through job creation, investment, and infrastructure development, resulting in economic growth and development.

Guidelines:

1. Access & equity: This includes making sure that the technology is accessible to all members of the community, regardless of their socio-economic status, geographic location, or cultural background. It also involves addressing any potential barriers or inequalities in terms of installation, operation, and maintenance of the PV systems, and ensuring that the benefits are shared equitably among community members.

2. Environmental health: This includes using environmentally friendly materials in the production, installation, and maintenance of PV panels, as well as ensuring that the systems are designed and operated in a way that minimizes potential negative impacts on the environment, such as water usage, waste generation, and pollution. Additionally, proper disposal and recycling of PV panels at the end of their lifespan should be taken into account to minimize environmental impacts.

3. Sustainable livelihoods: This includes considering the economic viability of the technology, as well as providing opportunities for local job creation, capacity building, and skill development in PV panel installation, operation, and maintenance. The systems should be designed in a way that supports long-term sustainability

and resilience of the local livelihoods, and fosters economic empowerment and self-sufficiency within the community.

Constrains:

1. Cost: PV panels can be expensive to purchase, install, and maintain, which may pose challenges in terms of affordability and cost-effectiveness for some communities, particularly those in low-income or marginalized areas.

2. Maintainance and Operation: This includes cleaning, monitoring, and repairing or replacing components as needed. In remote or hard-to-reach areas, accessing and maintaining PV panels may be challenging, leading to potential constraints in terms of logistics, technical skills, and availability of spare parts.

3. Passive Solar Still - Ethan

The below design criteria are used by a team member to satisfy his/her design idea with a standard design criterion. Please use the below 7 design criteria that your design idea should satisfy.

no	Design Criteria	Satisfy expected design criteria	Tick ( )
1	At least use minimum 3 different approaches'	Analyse (and/or)	yes
		Reduce (and/or)	yes
		Eradicate (and/or)	
		Prevent (and/or)	yes
		Predict	
2	At least use 1 or 2 different technologies	Nanostructured Hydrophilic Polymers	yes
		Phase Changing Materials (PCM)	yes
3	At least use 3 or more different devices	Hydrogels	yes
		Solar Still	yes
		Condenser	yes
4	At least list minimum 3 benefits	Reduced dependence on external resources	yes
		Economic benefits	yes

		Improved water quality	yes
5	At least list minimum 3 Impacts	Cultural Impact	yes
		Health Impact	yes
		Environmental Impact	yes
6	At least list minimum 3 guiding principles	Access & equity	yes
		Health & safety	
		Appropriateness	yes
		Affordability	yes
		Environmental health	
7	At least list minimum 2 Constraints	Energy requirement for water vaporization	yes
		Maintenance of hydrogels	yes

Benefits –

With solar stills installed within communities, the dependence on external resources is cut down. The communities where water is difficult to access are able to produce their own purified water without usage of fuel or electricity.

Economic benefits can be observed in terms of reducing costs for purchasing and transporting purified water from external sources, this means the less populated communities' economies can be supported and aid in reducing poverty.

The solar stills can provide improved water quality to communities without purified water, in turn reducing risks of waterborne illnesses and overall improved health.

Impacts –

The indigenous peoples have deep connections to the land and water, meaning introduction of new devices and technologies has potential to disrupt their traditions and harm cultural practices or beliefs.

With the incorporation of hydrogels, it also incorporates potential harmful chemical or microorganism pollution if not properly maintained.

Whilst solar stills themselves don’t require electricity or fuel to run, the manufacturing and installation may have environmental impacts. The materials used and sourced to construct the still could be sourced from environmentally sensitive areas, whilst installation processes without pre-emptive scouting may disrupt habitats and ecosystems that are extremely important to the indigenous peoples.

Overall, the use of a solar still can provide a range of benefits to Aboriginal people, including improved health, cultural preservation, economic benefits, and environmental sustainability. However, it is important to carefully consider and address any potential negative impacts, and involve

Aboriginal people in the planning and implementation of the solar still to ensure that their perspectives and needs are taken into account.

The two constraints tied to this design idea are energy requirements for water vaporisation and maintenance of hydrogels. With the design idea being a solar still, the form in which the water is vaporised is from the sun's heat, this means during the night and potential cloudy days, the solar still may not be able to purify water. The other is the maintenance of hydrogels, due to hydrogels being produced in complex ways, access to producing is limited to a handful of companies or factories. This results in communities having to wait for new hydrogel components which in turn harshly reduces purification efficiency.

5. Gravity-fed system using solar energy - Promit Prosun Barua

no	Design Criteria	Satisfy expected design criteria	Tick ()
1	At least use minimum 3 different approaches'	Analyse (and/or)	
		Reduce (and/or)	✓
		Eradicate (and/or)	✓
		Prevent (and/or)	✓
		Predict	
2	At least use 1 or 2 different technologies	Solar Energy	✓
3	At least use 3 or more different devices	DC Pump	✓
		Solar panel	✓
		Solar charge controller	✓
		Battery	✓
4	At least list minimum 3 benefits	Benefit 1	✓
		Benefit 2	✓
		Benefit 3	✓
5	At least list minimum 3 Impacts	Impact 1	✓
		Impact 2	✓
		Impact 3	✓
6	At least list minimum 3 guiding principles	Access & equity	✓
		Health & safety	✓
		Appropriateness	
		Affordability	✓
		Environmental health	
		Sustainable livelihoods	
7	At least list minimum 2 Constraints	Constraints 1	✓
		Constraints 2	✓

Benefits:

- No fuel is required to generate the energy for this system as it is dependent on solar energy.
- The use of gravity for water distribution and solar energy for energy supply will reduce the cost for maintaining this system massively.
- A very eco-friendly approach to supplying water to a community and simple design with minimum use of devices.

Impacts:

- Due to its simple design this system can be made easily accessible to people provided with necessary guidance and training since no digital literacy required.
- Water supply shortage can be eradicated with the use of this system.
- Proper implementation of a good water distribution system can prevent spread of many waterborne diseases and water contamination.

Constraints:

- Absence of sunlight for a long time, for example: rainy or cloudy day can cause battery drain and shut down the pumping of water eventually the whole distribution system.
- Unexpected harsh weather conditions can pose a threat to the durability of the system if it is not strong enough to withstand strong winds.

6. Reverse osmosis system - Nuyang Rai

No	Design Criteria	Satisfy expected design criteria	Tick ( )
1	At least use minimum 3 different approaches	Prevents drinking water being infected	✓
		Reduce number of sick people	✓
		Eradicate water-borne diseases	✓
2	At least use 1 or 2 different technologies	Wind power	✓
3	At least use 3 or more different devices	Onshore wind turbines	✓
		Pressure pump	✓
		Pre-filters	✓
4	At least list minimum 3 benefits	Impurities are removed	✓
		Better taste	✓
		Money saved	✓
5	At least list minimum 3 Impacts	System needs to be looked after regularly	✓
		Water wasted to remove impurities	✓
		Consumption of energy	✓
6	At least list minimum 3 guiding principles	Efficiency	✓
		Accessibility	✓
		Sustainability	✓
7	At least list minimum 2 constraints	Costly	✓
		Energy needed to operate	✓

BENEFITS:

- The reverse osmosis system removes any impurities from water so that people can drink it without the risk of getting sick.
- It also improves the taste of the water as the reverse osmosis system removes substances such as chlorine and sulfur that can affect the taste of the water.

- The reverse osmosis system can also help people save their money as it reduces the necessity to buy bottled water.

IMPACTS:

- The reverse osmosis system needs to be looked after regularly so that no malfunctions occur and change parts that are getting old and that could potentially cause an issue.
- It also uses a significant amount of water that is needed to flush out the impurities from drinking water. It will be difficult to dispose of the wastewater safely as it will have concentrated impurities.
- The reverse osmosis system consumes energy in order to operate such as powering the pressure pump that pushes water through the membrane.

CONSTRAINTS:

- Costly: Installing and maintaining reverse osmosis systems can be expensive, particularly for smaller communities or families. Membranes and pumps are two examples of system parts with potentially significant prices. There may also be additional expenditures for maintenance, repairs, and monitoring.

- Energy needed: Reverse osmosis systems need a lot of energy to run, which can be a problem in places with spotty electricity availability.

Ultrafiltration (UF) and reverse osmosis (RO) membrane - Truong Pham Tuan Nguyen

Part 1

no	Design Criteria	Satisfy expected design criteria	Tick ( )
1	At least use minimum 3 different approaches’	Analyse (and/or)	
		Reduce (and/or)	yes
		Eradicate (and/or)	yes
		Prevent (and/or)	yes
		Predict	
2	At least use 1 or 2 different technologies	Ultrafiltration	yes
		Reverse Osmosis	yes
3	At least use 3 or more different devices	Storage tank	yes

		Distribution system	yes
		Pressure vessel	yes
4	At least list minimum 3 benefits	Versatility	yes
		Retention of Essential Minerals	yes
		Size Exclusion	yes
5	At least list minimum 3 Impacts	Water Reuse and Resource Recovery	yes
		Product quality	yes
		Environment impacts	yes
6	At least list minimum 3 guiding principles	Pressure	yes
		Membrane material	yes
		Fouling	yes
7	At least list minimum 2 Constraints	Costly	
		Water quality limitation	

Part 2:

BENEFIT:

- Versatility: RO membranes may be utilised for a variety of water sources, including saltwater, brackish water, and wastewater, making them adaptable to a wide range of applications and industries.
- Retention of Essential Minerals: While eliminating bigger impurities, UF membranes often preserve critical minerals like calcium, magnesium, and potassium. This is especially useful in situations where preserving water's mineral content is critical, such as drinking water treatment or food and beverage manufacturing.
- Size Exclusion: Because UF membranes have wider hole sizes than RO membranes, they may separate suspended particles, colloids, bacteria, and certain viruses from water. Because UF is great at

eliminating turbidity, particle debris, and other bigger molecules from water, it is an excellent choice for pre-treatment in water treatment operations.

IMPACT:

- Product quality: Depending on the pore size and rejection characteristics of the membrane, both UF and RO membranes can improve water quality by eliminating impurities such as suspended particles, bacteria, viruses, dissolved salts, and other pollutants. This can result in higher-quality water that can be used for drinking, industrial activities, and other purposes.
- Water reuse and Resource recovery: RO membranes, in instance, may provide high-quality treated water that can be reused for a variety of applications, including irrigation, industrial operations, and groundwater replenishment. Furthermore, RO can aid in resource recovery by creating concentrated brine that can be processed or used for resource extraction, such as the extraction of precious minerals or metals from wastewater.
- Environmental impact: UF and RO membranes can help to save the environment by eliminating the need for chemical treatments like coagulation, flocculation, and disinfection that are commonly employed in traditional water treatment operations. This can lead to less chemical use, less energy use, and a lower carbon footprint, resulting in a more sustainable water treatment technique.

CONSTRAINT:

- Costly: Purchase and maintenance of UF and RO membranes can be costly. Replacement of broken membranes can be expensive, and system maintenance may need specialised knowledge.
- Water quality limitation: UF and RO membranes do not remove all forms of pollutants from water. For example, they may not remove some chemical substances or germs.