Selected Topics in Contemporary Issues

Applying WEF Nexus & Low Carbon in Designing of a New Development Project

LOCATION — El-Negala

TEAM 19

Name	Task(s)	
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Kareem Amr Abdelsamie	Proposing Alternatives	
Mohamed Ahmed Hasan	Studying Similar Projects	
Youssef Ahmed Ibrahim	Nominating Best Components	
Ahmed Ali Mahmoud Hassan	Stating the objectives of the new development project in the light of the SDGs.	
Youssef Ahmed Assy	Food Flowcharts	
Ahmed Khaled Saad Ali	Waste Alternative Flowcharts	
Yehia Mohamed Hesham Mohamed	WEF Nexus Implementation Benefits	
Ahmed Ashraf Marzouk	Proposing separate conceptual flowcharts for the nominated water and energy	Conceptualizing the comprehensive project flowchart that achieves WEF Nexus and Low Carbon approaches.

PHASE 1

1. SWOT Analysis

1.1 Strengths

1.1.1 Water

Because of the natural scarcity of water in Nagela, a concern has emerged for collecting the rainwater. Many water cisterns are available in Nagela that provide a considerable amount of fresh water. There are 323 water harvesting cisterns, comprising 305 new water harvesting cisterns (water capacity of 29 728 m^3), and 18 cisterns from ancient Roman period (water capacity of 9 007 m^3).

Also, the region does have some wells as seen on the map in Figure 1.

Figure 1 - Wells on Google Map

1.1.2 Energy

Surprisingly, Nagela is a promising region for clean and renewable energy. The wind can be exploited to generate electricity using wind farms. The mean wind speed at a height of 100 meters is 6.3 meters per second as seen in the wind atlas in Figure 2. The country is already farming wind turbines multiple cities in Egypt, which makes it possible to address Nagela as a potential resource for such projects.

1.1.3 Food

Nagela is a coastal region as seen in Figure 3 which opens up a potential for sea productions like fishing industries and by products. The fisheries are a solid resource for organized production of fish and sustained supply of food in general.

Furthermore, the environment is considered one of the cleanest in Egypt with an air quality index of 42 (a very low index, which is better.) This makes it a probable place for farming olive, barely, and wheat; nonetheless, it's a challenging proposal, for its poor soil and water scarcity.

A promising experiment by the FAO in Egypt consolidated the aforementioned probability for farming which accomplished:

- 127 demonstration plots established for olive and fig cultivation, and theoretical and hands-on training and agricultural inputs provided, to support adoption of GAP practices.
- 27 new olive farms established.
- 31.59 tons of improved, drought-resistant varieties of barley and wheat seeds distributed to 527 beneficiaries.
- 70 home gardens established, and women trained in seedling cultivation and organic vegetable production, in compliance with GAP practices

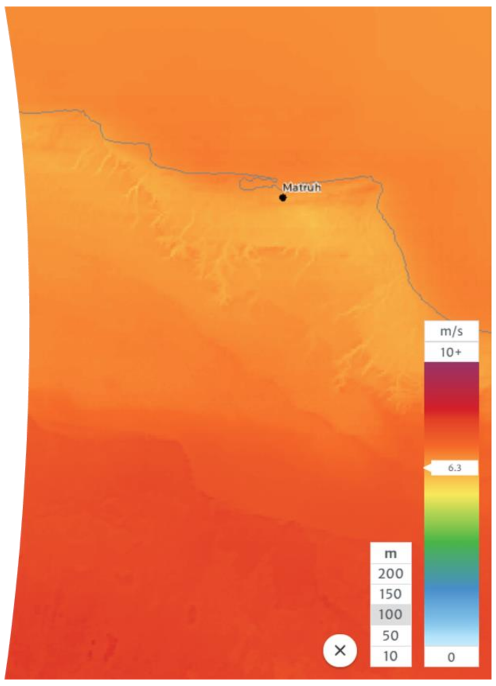


Figure 2 - Wind Atlas

1.1.4 Waste Management

The animal wastes are used as natural fertilizers which is a good use of waste.

1.2 Weaknesses

Nagela faces many challenging problems, like lacking a proper infrastructure, which renders any logistics dependent operations inefficient with more cost.

1.2.1 Water

Unfortunately, Nagela has no direct access to any sustainable fresh water source like the Nile River. This affects all other economical aspects of the region: limiting the farming methods for example.

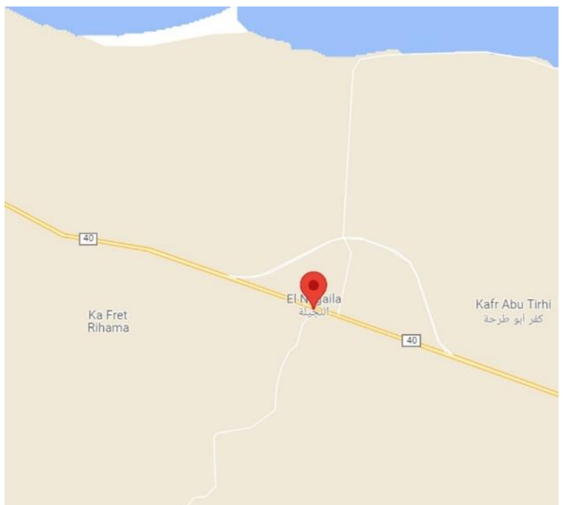


Figure 3 - Nagela on Google Map

1.2.2 Energy

The region has a basic electricity setup: still dependent on wooden electricity towers that have low maintenance apparently.

1.2.3 Food

As mentioned above, the place lacks a direct access to a reliable fresh water source, which makes it hard to practice normal farming. Furthermore, raising livestock can be an expensive operation with low opportunity for expansion or achieving a considerable production. On top of that, the place lacks organized markets to distribute food products.

1.2.4 Waste Management

The region doesn't amount to much wase material to raise any alarming weaknesses regarding the waste management.

1.3 Opportunities

Considering the strengths mentioned in 1.1, the place does, in fact, have potential resources that can be employed for promising opportunities. In addition, economical opportunities are predicted as a result of some government initiatives like the construction of the New Gargoub sea port, which will probably open up a multitude of trading and logistics facilitation options.

1.3.1 Water

The place does already have a working and proved model of harvesting rain waters using canisters, that proved to be very beneficial in planting olive, barely, and wheat. This suite the opportunity of expanding at large this model to harvest more rainwater. Furthermore, the region can be mined for underground water to organize and pipeline the extraction and usage of this water and put it to best use.

The is a desalination plant providing 3500 cubic meters a day. This can be a leading plant for further expansions and construction of new ones.

1.3.2 Energy

The place features a clean and sustainable with relatively high speed (6.3 m/s) winds through the year. This is an opportunity for wind farms that can supply the whole region and satisfy the needs for the other production aspects of water desalination, and food production.

1.3.3 Food

Following the FAO experiment in Egypt, the aforementioned figures in 1.1.3 can be higher orders of magnitudes especially if the opportunities in 1.3.1 are accelerated to provide the rainwater for even more fields of olive, barely, and wheat.

Fisheries like in Port Said can be a perfect opportunity for the coastal regions in Nagela to provide nutritious sea food and offer the opportunity to turn the wheel of sea industries and byproducts.

1.3.4 Waste Management

The fisheries constructed will provide many sea byproducts to be reused and employed in aquaponics and farms inn general as a fertilizer. Also solid wastes will be combusted just to get rid of them and generate electricity.

1.4 Threats

The region doesn't have clear threats or even artificial ones but unpredicted and natural situations.

1.4.1 Water

There is no reliable source of fresh water; this makes the place threatened with unpredictable water shortages, which can endanger farmed crops and raised livestock, in addition, to people.

The dependance on the uneven and changing patterns of rainwater is problematic, and this is expected to get amplified with shortcomings of climate change.

1.4.2 Energy

No solid energy solutions (production and infrastructure) are implemented to suffice the needs of the region; these constraints the freedom of expanding other projects of desalination, modern irrigation systems, and even new energy constructs.

1.4.3 Food

The natural condition of the soil makes the options of plant types very tight. This limits the nutritional capacity of the market, and this, in turn, makes the community malnourished, hindering the general workforce and production.

1.4.4 Waste Management

Again, the lacking of proper infrastructure renders any new waste management solutions and projects inefficient, this would threaten the pipelines of waste susceptible to leaks and delays.

2.0 Alternatives

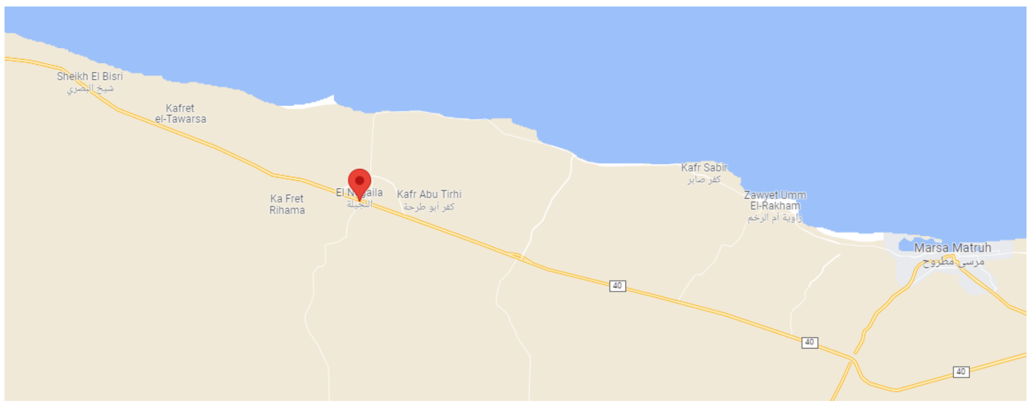
In this section we will provide alternatives to the problems we discovered following the SWOT analysis on the area.

2.1 Water Alternatives

2.1.1 Mediterranean Sea Desalination

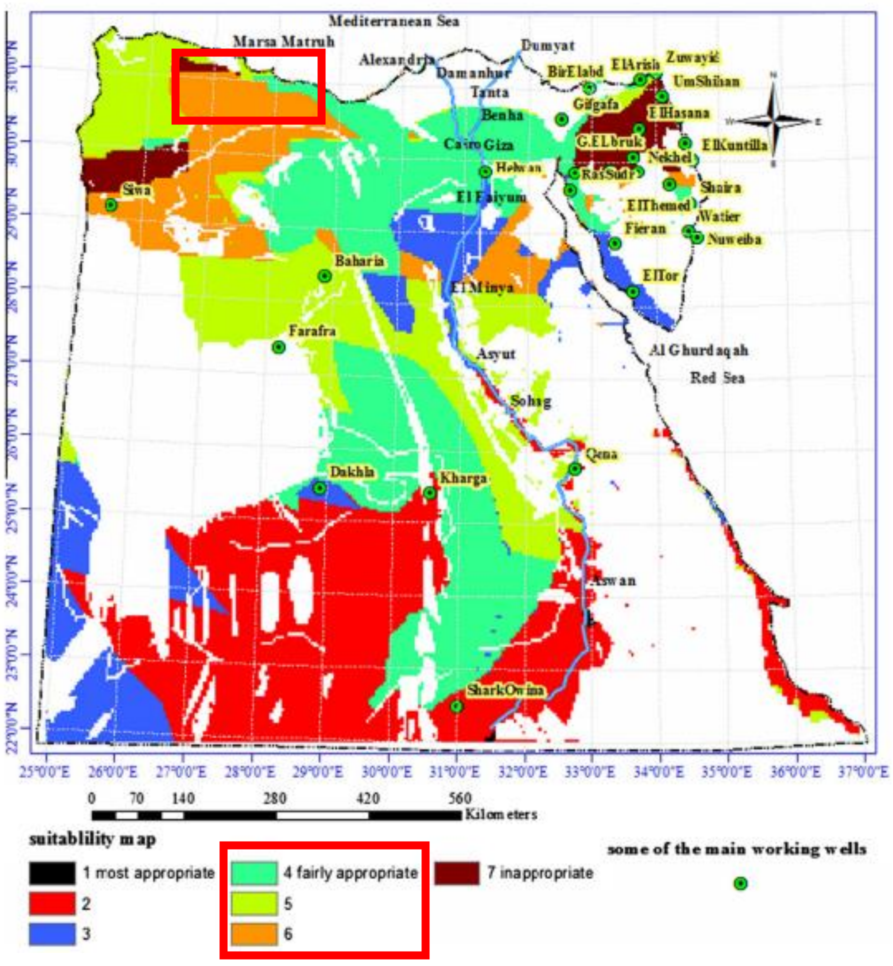
Currently the area is dependent on rain water as a source of fresh water. This is risky since rainwater is not stable and draught is increasing as time passes. As seen on the map, the area is a good candidate for sweater desalination plants near the Mediterranean sea.

A plant that can produce 7000 cubic meters per day is suitable for this area. The size of the plant is moderate which will not consume a huge amount of energy.



2.1.2 Ground Water

The area is know to be a good source for ground water; However, the water salinity is high and will require desalination.



2.1.3 Wastewater Reuse

We can treat water using secondary treatment for irrigation of non-consumed plant. For irrigation of food or for drinking water, we can use tertiary treatment.

2.2 Energy Alternatives

We can have different alternatives for this area for producing energy. This area has a good average wind speed, as well as, a high photovoltaic power potential (PVOUT) of about. The Mediterranean Sea can be used as a source of wave energy; however, wave energy is very limited to low power outputs.

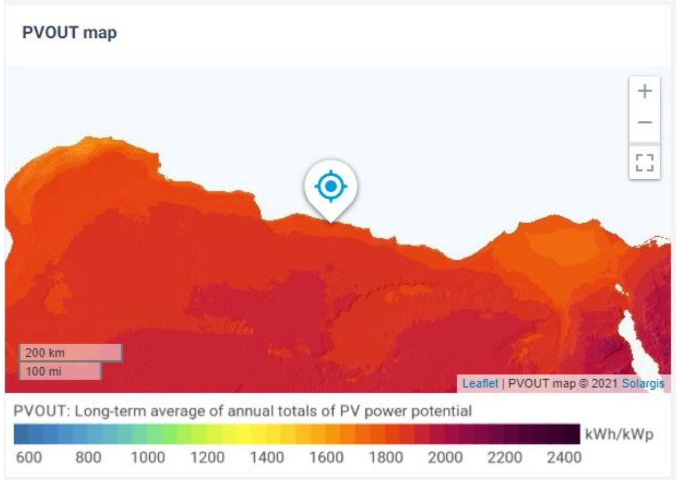
Energy output can be used to support the water desalination plant as it required a good amount of power supply to operate.

2.2.1 Wind Energy

The average wind speed is about 6.2 meter per second at a height of 100 meters, can reach 7.27 meters per second at 200 meters. Wind speed increases even more, up to 6.6 meters per second, by placing our wind farms in the sea. This can be capitalized this to build wind farms. We have different types of wind farm vertical axis wind turbine (VAWT) and horizontal axis wind turbine (HAWT), in an area with large open space the HAWT is preferred.

2.2.2 Solar Energy

The area has a specific yield/output of 1827.2 kWh/kWp (kiloWatt-hour per kiloWatt-peak), typically per year. The specific yield/output is the amount of energy (kWh) produced for each kWp of power of the solar panels over a year. Which is a high value based on the following figure.



2.3 Food Alternatives

Due to the low water supply in the area, we need farming techniques that use as little water as possible. This is why drip irrigation is recommended, which is one of the most water efficient techniques, compared to other types of irrigation like flooding and springling irrigation.

Addon, on top of the limited supply of water, the area has poor soil quality. However, being a coastal region, aquaponics systems will be perfect choice to increase crops as well as fish supply, which does not require soil to grow crops. The downside this is not suitable for all types of crops. Water produced reusing waste water could be used to irrigate crops that are not farmed using hydroponics systems.

It is not recommended to raise livestock in the area as this will be a burden on the water supply in the area. Instead surrounding areas could supply cattle.

2.4 Waste Management

Waste water can be redirected to water treatment plants to reduce the load on the infrastructure and to produce mineralized water for irrigation, fish farming and aquaponics.

Solid wastes will be combusted to generate electricity just to get rid of these wastes not to mainly generate power, cause wind turbines are more dependable and better.

3. Similar projects for proposed alternatives

Similar projects for energy

1- Zafarana wind farm

Zafarana wind farm consists of 3 phases: Zafarana I, Zafarana II, and Zafarana III. It is based on a 3-blade wind turbines principle. Zafarana I supplies a nominal capacity of 33 MW, while Zafarana II and III supply total nominal capacity of 46.86 MW.

The technical requirements of Zafarana wind farms are service parts, control systems, maintenance, and trained staff to organize the process.

This project diminished the emissions of CO_2 drastically compared to the fossil fuels generators. The indicator target level for Zafarana I is 64250 t/a and in Zafarana II and III is 108000 t/a.

Added value of the project

- CO_2 avoidance costs (Zafarana I: < EUR 19/t CO2, Zafarana II/III: < EUR 7/t CO_2, according to the GEF method)
- Transmission and distribution losses have decreased by 20%.

2- Gabal El Zeit wind farm

Gabal El Zeit wind farm is located in the red sea region; the wind speed reaches 10.5 m/s as average at 25 m above the ground. It is based on a 3-blade wind turbines approach. It also consists of 3 phases with capacity of 580 MW.

The technical requirements for this project are control systems, maintenance, and trained personnel.

This project increased the amount of clean and renewable energy in the Egyptian national grid, reduced the amount of greenhouse gases, and minimized the negative impact of the implementation on the surrounding environment.

Added value of the project

- Greenhouse gases and CO_2 reduction by about 49400 Tons compared to fossil fuels power plants.
- Added 1% of the total production capacity in Egypt.

Similar projects for water

1- The practice of harvesting rainwater (RWH) project in India.

The central water commission has estimated the total surface run-off of India as 188 million hectare-meters. However, only 36% of this run-off is harvested. RWH refers to collecting and harvesting rainwater before it drains away. Rainwater harvesting can be done at individual household level and at community level in both urban as well as rural areas.

The technical requirements for this project are catchment, collection system, and utilization system.

Surface type	Coefficient	
	High	Low
Roof:		
Metal, gravel, asphalt, shingle, fiber-glass, asbestos, concrete	0.95	0.90
Pavement:		
Concrete, asphalt	1.00	0.90
Gravel, brick	0.70	0.25
Ground surface:		
Hard flat ground without vegetation	0.75	0.25
Hard flat ground with vegetation	0.60	0.15
Lawns:		
Flat, sandy soil	0.10	0.05
Flat, heavy soil	0.20	0.15

Added value of the project

- Produces high quality water
- Reduces the flow of storm water
- Reduces soil erosion
- Reduces silting

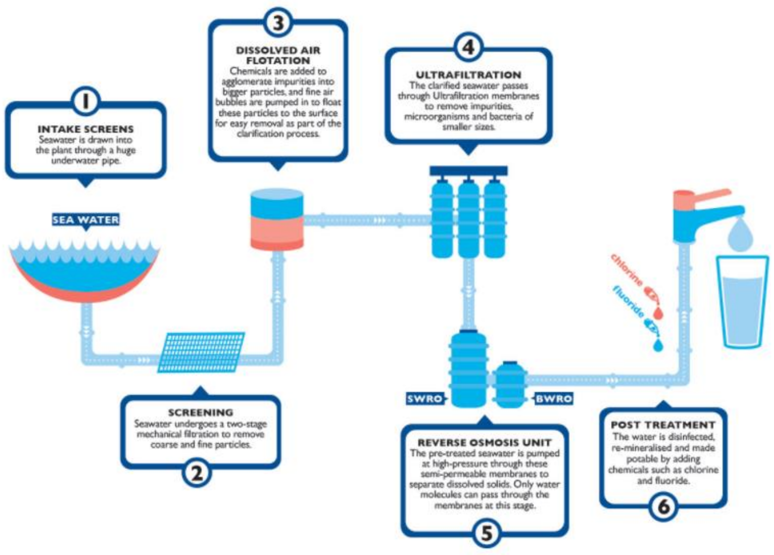
2- Tuas seawater desalination plant

Singapore's first desalination plant is the largest of its kind in Asia. It achieved the lowest desalination seawater price in the world. Tuas seawater reverse osmosis plant has a sufficient capacity of 110,000 m^3/day which is around 10% of the national demand.

Technical requirements of the project are intake structure, mechanical rake course screens, and inlet channels.

Added value of the project

- Covering almost 10% of the national demand.
- Lowest price in the world



Similar projects for wastewater treatment

Waste Management Program in India

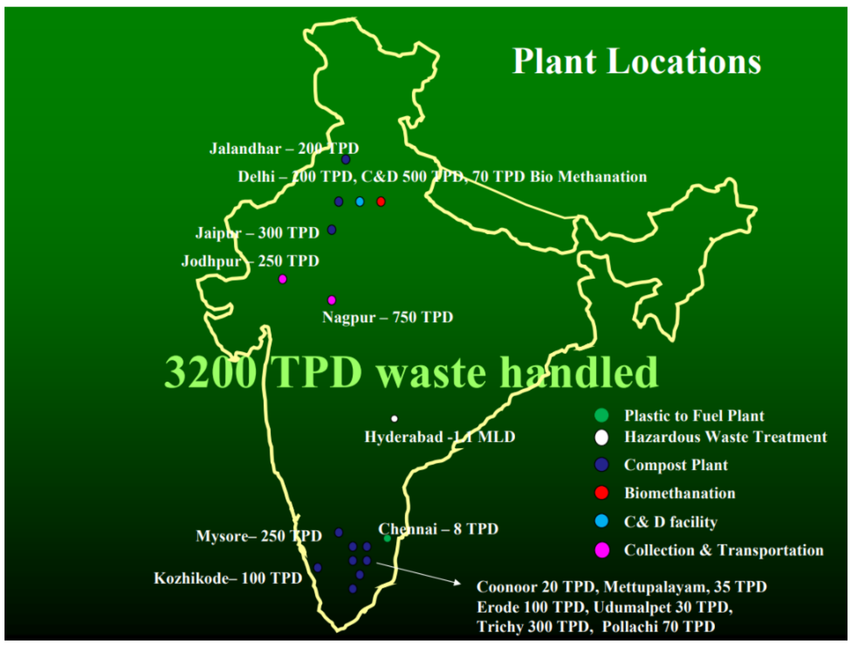
This project aims to supply and install 10000 twin-bin dustbins with double swing stand at 92 railway stations in India. Their basic principles for this project are 4Rs: Refuse, Reduce, Reuse, and Recycle.

- Refuse: buying anything without need
- Reduce: the amount of garbage generated
- Reuse: everything to its maximum.
- Recycle: anything that can be recycled.

The technical requirements for this project are collecting, twin-bin dustbins, and recycling centers.

Added value of the project

- Clean urban landscape.
- Prevent open dumping
- Reduce greenhouse gas emissions



Similar projects for farming

Hydroponics farming in Maharashtra – India

It was implemented in two villages: Dhangar -Takli village and Gadegoan village. Each unit consists of 200 trays. A set of 20 trays produces 200 kg of livestock each day to feed 20 cattle. Use of maize seeds to cultivate fodder.

The technical requirements for this project are framework of PVC pipes, shade net, cooling techniques, spray jets and water tanks.

Added value of the project

- Conserves less amount of water
- Cost effective which saves 15,000 rupees per month.
- Increasing milk quantity

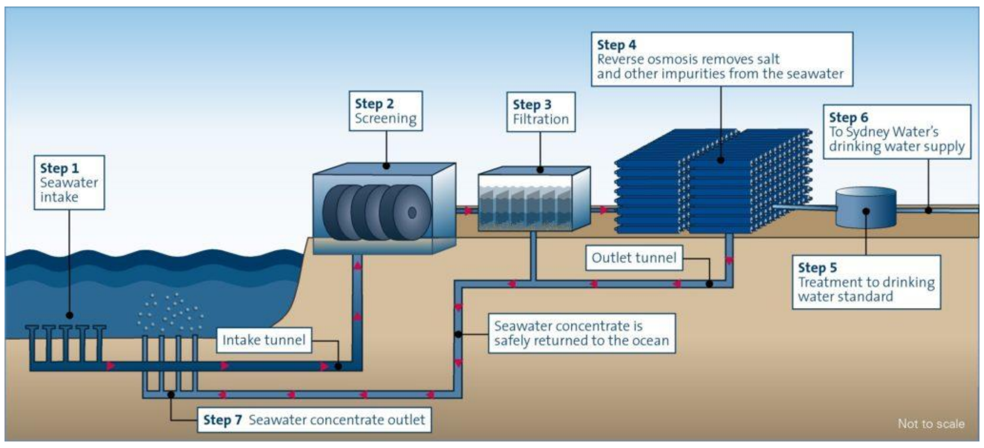
4. Nominating the best components

4.1 Water Management

In this section, the best water management components for the project will be discussed. Based on SWOT analysis, it can be concluded that the main source of water in El Negeila is rainwater which should be managed efficiently to store for further use in agriculture and other areas. There are already a lot of cisterns dedicated to harvesting rainwater. So, our preferred alternative would be to expand on water desalination projects.

The desalination plant could rely on reverse osmosis to extract the harmful minerals from seawater. Reverse osmosis would be used for its high energy efficiency compared to other desalination methods. The desalination plant will consist of five components: intake, pre-treatment, treatment, post-treatment, and waste disposal.

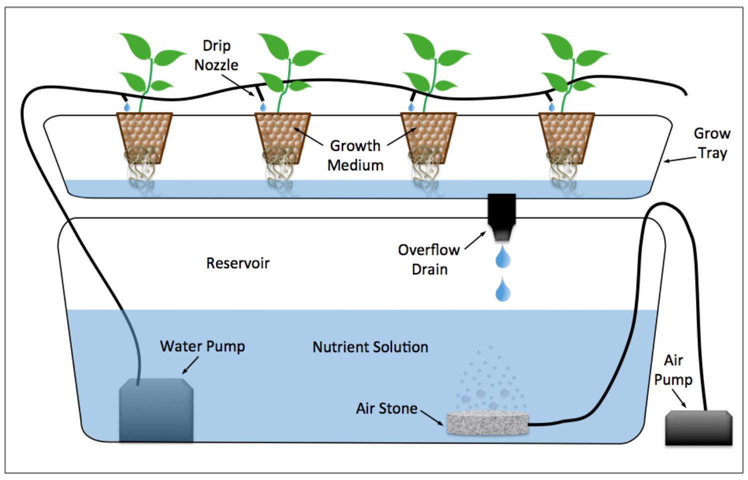
The intake system is responsible for transporting seawater to the pre-treatment station through an intake pipeline. The pre-treatment phase gets suspended material out of seawater producing clean seawater and passing it down to the next stage. The treatment phase then would use reverse osmosis to remove salt producing to streams: pure water and brine stream. Pure water passes on to the next stage of post-treatment where chemicals like lime and chlorine are added to water protecting it from contamination along the pipelines and preparing it for safe human consumption. The waste disposal stage would receive the brine stream, treat it, and then send it back into the ocean. Solid waste could be sent to landfills.



4.2 Food Management

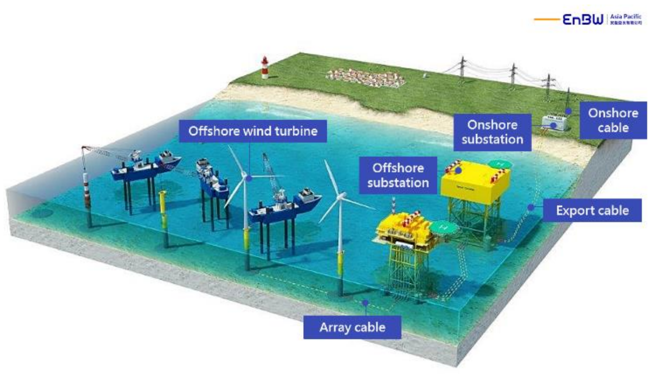
Considering freshwater scarcity and soil poor quality in El Nagela, a perfect solution would be to build indoor hydroponics that control the agricultural environment, substitute soil for water, and ensure more efficient management of water resources. An indoor hydroponic should typically consist of growth trays for plants stacked vertically for optimum space usage, LED lights, growth mediums like coconut husk, and sensors. Sensors could be used to moderate and control the level of nutrients in water.

Hydroponics avoid the need for pesticides since a soil-free environment minimizes the risks of harmful creature invasions. It will also offer sustainable and predictable food production through the seasons. This solution will provide El Nagila easier access to diet diversity. Hydroponic farms are more efficient water-wise than traditional farms since they consume up to 90% less water; this would greatly help with the water scarcity problem facing El Nagila.



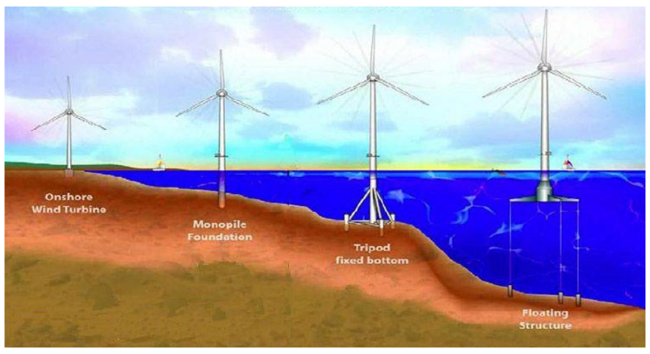
Sensors could be used for efficient nutrient dosing and LED lighting to ensure the agricultural product is safe and healthy. The vertical growth trays will allow for the optimal exploitation of space. Water acts as a substitute for soil. All of these components together constitute a whole system that is sustainable and efficient.

4.3 Energy Management



Since higher wind speeds are available offshore and El Nagila overlooks the Mediterranean Sea, an offshore wind farm could be a great opportunity for harvesting a wind energy that is renewable and sustainable. An offshore wind farm is an optimal solution for both El Nagila's limited land area and limited access to energy. Keeping the wind farm offshore will also protect residents from operational and construction noise; however, this noise could be lethal to specific fish species. This should be considered when choosing a specific location by analyzing the different fish species in each area, and their noise sensitivity.

The offshore wind farm will consist of three-blade wind turbines, wires, an offshore substation, and an onshore substation. The electricity generated by the wind turbines go through the wires to the offshore substation where voltage is stabilized and maximized



to be redirected to the onshore substation which redirects electricity through electric towers. The wind turbines foundation could be a tripod which is a steel tube extending above and beyond sea level and anchored in the seabed. This foundation offers better reliability than other foundations like the monopile and gravity base. The tripod is much stiffer and more resistant to stress.

4.4 Waste Management

Water from the sewers coming from houses, factories and animals will pass through primary and secondary treatment to be available for irrigation, fish farming and aquaponics.

For solid wastes, coming from houses or factories to just get rid of them we will combust them , try maintain the air pollution and generate electricity.

PHASE 2

5. Stating the objectives of the new development project in the light of the SDGs.

5.1 Main Objective

The main objective of this new development project is to develop a sustainable community in “El Negaila” city in Matrouh. A community that can withstand and rebound from unpredictable impacts of disasters. This means that we should provide basics services and infrastructure such as renewable energy resources, clean water and sanitation, fresh local food with diversity. Also, the community should be well trained and educated to be able to deal with new technology and to not cause significant loss and waste in resources. Also, these development project that will be build in the new city will provide decent jobs and business opportunities to both genders. It will also increase the use of green energy and management of resources and waste management will reduce pollution

5.2 Project Objectives

- Make a more independent and sustainable community
- Basic services
- access to clean and renewable energy: (Wind Turbines & Solar panels)
- increase global percent of renewable energy
- increase Fresh and local food: (using aquaponics and drip irrigation to produce most of what we need)
- agriculture diversity
- Increase green areas
- Protect biodiversity and natural habitat
- Easy access to clean drinking water and sanitation: (Rainwater harvesting & sea water desalination)
- Affordable, accessible, and sustainable transport systems: (To be supported by investors and stakeholders to connect all parts of the development project)
- resilient and inclusive infrastructure
- increase resource efficiency
- Provide decent jobs and business opportunities to both genders from suggested projects => Increase employment rate
- Reduce poverty:
- Training and educating local citizens to deal with new technologies and reduce waste
- Reduce liquid discharge as possible: this will also reduce waste volume hence decrease cost of waste management
- Reduce the impact in environment by keeping track of air quality and waste management and reuse
- Reduce pollution: (through using clean sources of energy and waste management)
- Reduce marine pollution: (By using organic fertilizers and reducing fossil fuels and non-renewable sources of energy)
- Reduce ocean acidification: (By reducing greenhouse gases emissions)
- Conserve the ecosystem
- Safe and affordable housing: (To be supported by investors and stakeholders to support families coming from other cities for employment)
- Conserve the ecosystem and biodiversity

5.3 Objectives in the light of SDGs

1. No poverty: Making sure to end poverty in all of its forms

- Good Education and training for resources use and management efficiency and new technologies
- Descent jobs and good income
- Increase employment rate

2. Zero Hunger: Making sure to end hunger, achieve food security and improve nutrition and promote sustainable agriculture

- Fresh and local food availability
- Agriculture diversity and sustainability
- Access to education

3. Good health and well-being: Ensuring healthy lives and promote well-being for all at all ages

- Increase green areas
- increase access to clean and fresh water and sanitation
- access to clean & renewable energy
- Reduce pollution

4. (Quality education): Ensuring inclusive and equitable quality education and promote lifelong learning opportunities for all.

- Education and training for resources use and management efficiency and new technologies

5. Gender Equality: Achieving gender equality and empower all women and girls

- Providing equal job opportunities for both gender in the projects

6. Clean Water and Sanitation: Ensuring availability and sustainable management of water and sanitation for all

- Increase access to clean drinking water and sanitation
- Reduce wastewater
- Manage and reuse of wastewater
- Reduce marine pollution
- Reduce ocean acidification

7. Affordable and clean energy: Ensuring access to affordable, reliable, sustainable, and modern energy for all

- increase global percent of renewable energy
- reduce waste energy
- increase resource efficiency

8. Decent work and economic growth: Promoting sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.

- Increase business opportunities
- Increase job opportunities with good income

9. industry innovation and infrastructure: Building resilient infrastructure and sustainable industrialization and foster innovation.

- Clean and affordable water (water supply to resident)
- Electrical grids (Energy from wind turbines and solar panels)

10. Reduced inequalities:

- Providing equal job opportunities for both gender in the projects

11. sustainable cities and communities: Making cities and human settlement inclusive, safe, resilient, and sustainable

- Good infrastructure and basic services (such as Energy grids, water supply)
- Use of renewable energy sources such as wind turbines and solar pannel

12. responsible consumption and production: Ensuring sustainable consumption and product patterns

- Educating people and aware them of reducing resources use
- good management of resources and waster

13. Climate Action: take urgent action to combat climate change and its impact

- Reduce pollution and greenhouse gases
- Educating people and aware them of reducing resources use
- good management of resources and waster

14. Life below water: conserve and use the oceans, seas and marine resources for sustainable development.

- Reduce marine pollution
- Reduce ocean acidification

15. Life on land: protecting, restoring and promoting sustainable use of terrestrial ecosystems, sustainable manage forests, combat desertification, and half and reserve land degradation and halt biodiversity loss

- Reduce pollution
- Increase green areas

17. partnerships for the goals:

- Partnership with UNDP and governmental authorities and investors

6. Flowcharts

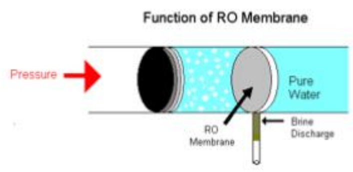
6.1 Energy Alternative Flowcharts

Negaila energy relies on wooden electricity towers, which is unstable and exposed to failure. In our proposed solution, we will use the wind as source for energy to sustain the energy source in Negaila. Wind speed is about 6.3 meters per second at height of 100 meters only.

6.1.1 Wind farm: Energy is Output

Negaila is a civilized region with about 113413 persons. So, our wind farm will be established near to the sea to avoid noise issues. This wind farm will produce about 20 MWATT of electrical energy. This energy will be distributed on the water desalination, home uses, and electrical grid.

6.1.2 Reverse Osmosis: Energy is Input

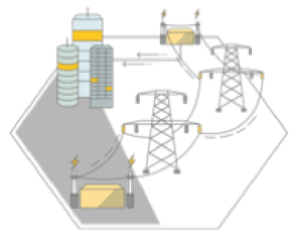


in Negaila, people rely on rains for daily water usages. This infrastructure is not reliable and depends on weather changes. Water coming from sea and ground water will be desalinated for use. Reverse osmosis will take the energy from the wind farm to apply the needed pressure for desalination.

6.1.2 Home: Energy is Input

From our wind farm, energy will be supplied to home throughout the day. This will provide the sustainable source of energy for houses.

6.1.3 Electrical grid: Energy is Input



As we said before that Negaila has a high potential in wind energy production. So, we expect our energy production will go beyond the water desalination and home usages. Hence, we recommend pushing this remaining electricity into government electrical grid and to be stored in batteries if needed.

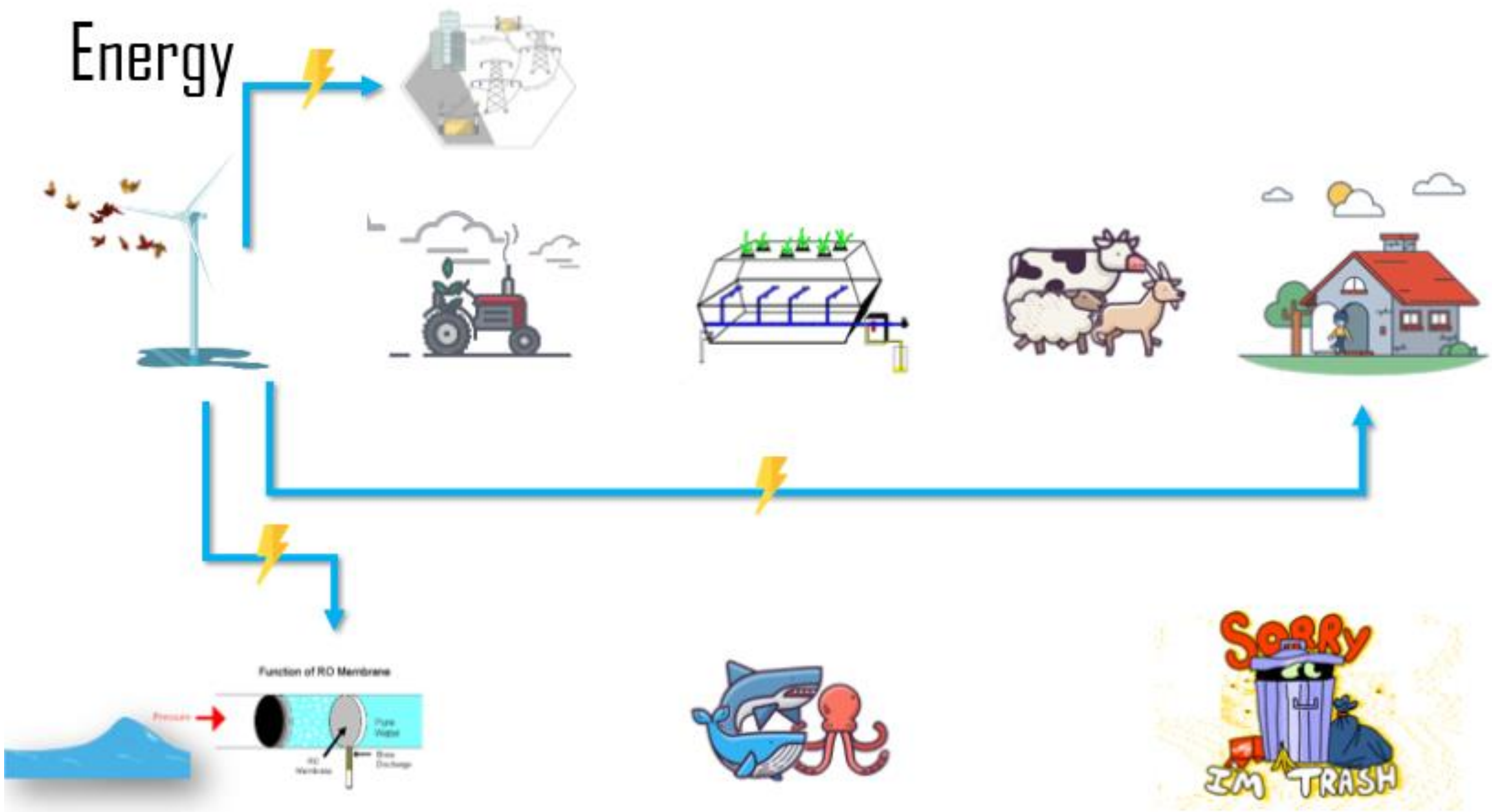


Figure 4. Energy flowchart

6.2 Water Alternative Flowcharts

6.2.1 Reverse Osmosis: Water is Output

In reverse osmosis, water will go through more than one process. Firstly, pre-treatment, solid wastes are removed using screening and filtering. These wastes are redirected to the sea for marine life. Secondly, the reverse osmosis, water will go into single directional filter to remove any particles from water. Remaining water will be brine, which will be a waste. Lastly, Conditioning, adding chemicals to water to purify it for human usage.

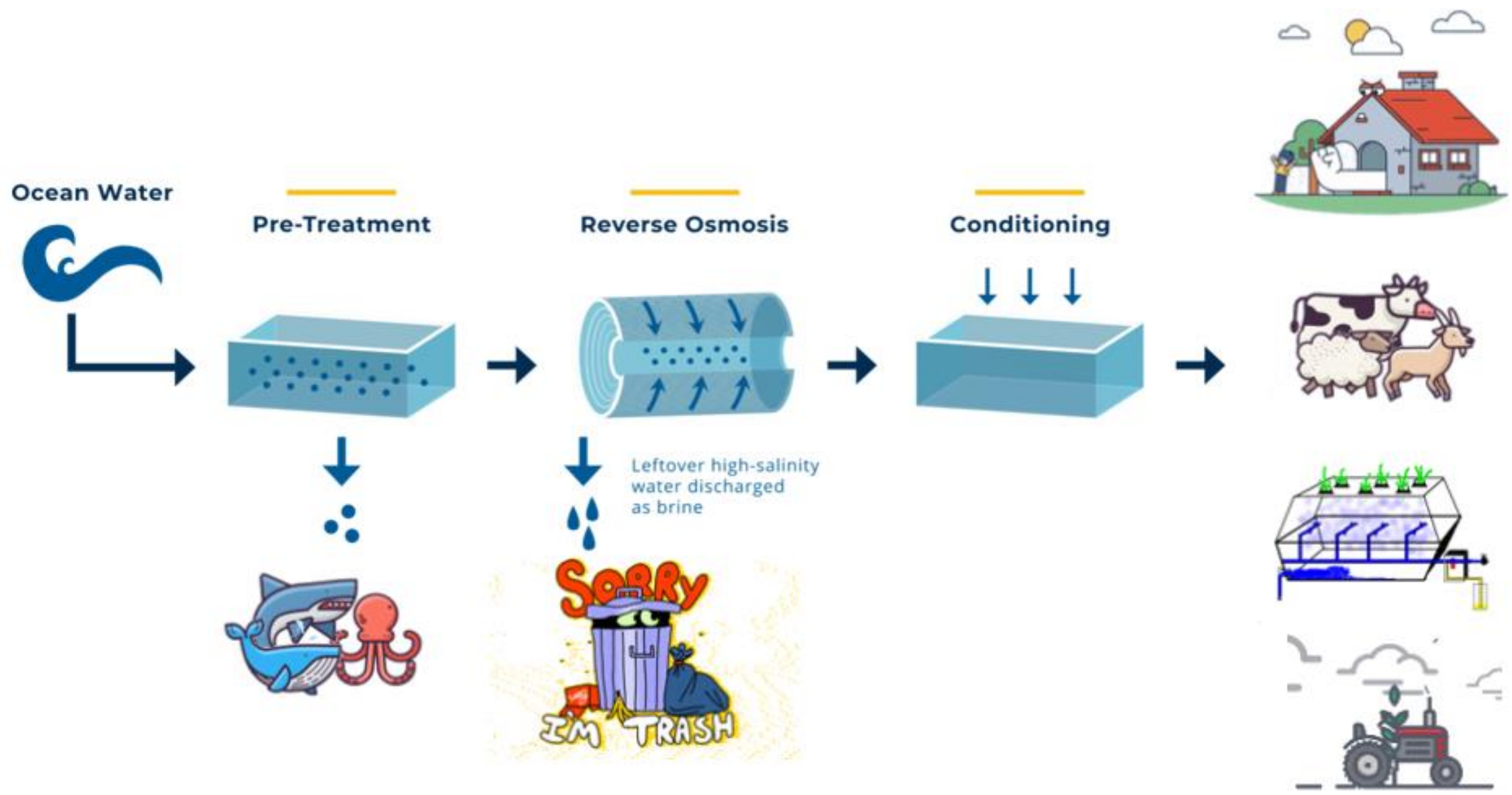
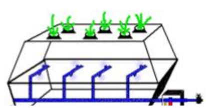


Figure 5. Reverse Osmosis process

6.2.1 Agriculture: Water is Input

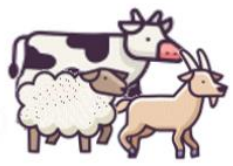
In agriculture we use drip irrigation. Hence, desalinated water will be pumped into the pipes and supplied to the agriculture. Using drip irrigation will reduce wastes in water resources. Hence, it will save us energy as we use reverse osmosis for water desalination.

6.2.2 Aquaponics: Water is Input



As we need a source of freshwater to grow our plants in aquaponics system, we will use the desalinated water to water the plant in the desert. This water will have nutrition's from marine life. Then, this water will return again to marine life.

6.2.3 Livestock: Water is Input



Negaila is popular for its livestock, which requires a sustainable source for freshwater to stay alive. Our desalinated water will be suitable for animal in Negaila. Also, we will give a secondary treated water for livestock usage as will be demonstrated in wastewater management

6.2.4 Home: Water is Input

Homes will be supplied water from desalination process with the aim to make it a sustainable resource of water.

6.2.5 Marine life: Solid wastes is Input

In pre-treatment, solid waste will be removed. These wastes will be redirected again to the sea for marines to preserve sea nutrition.

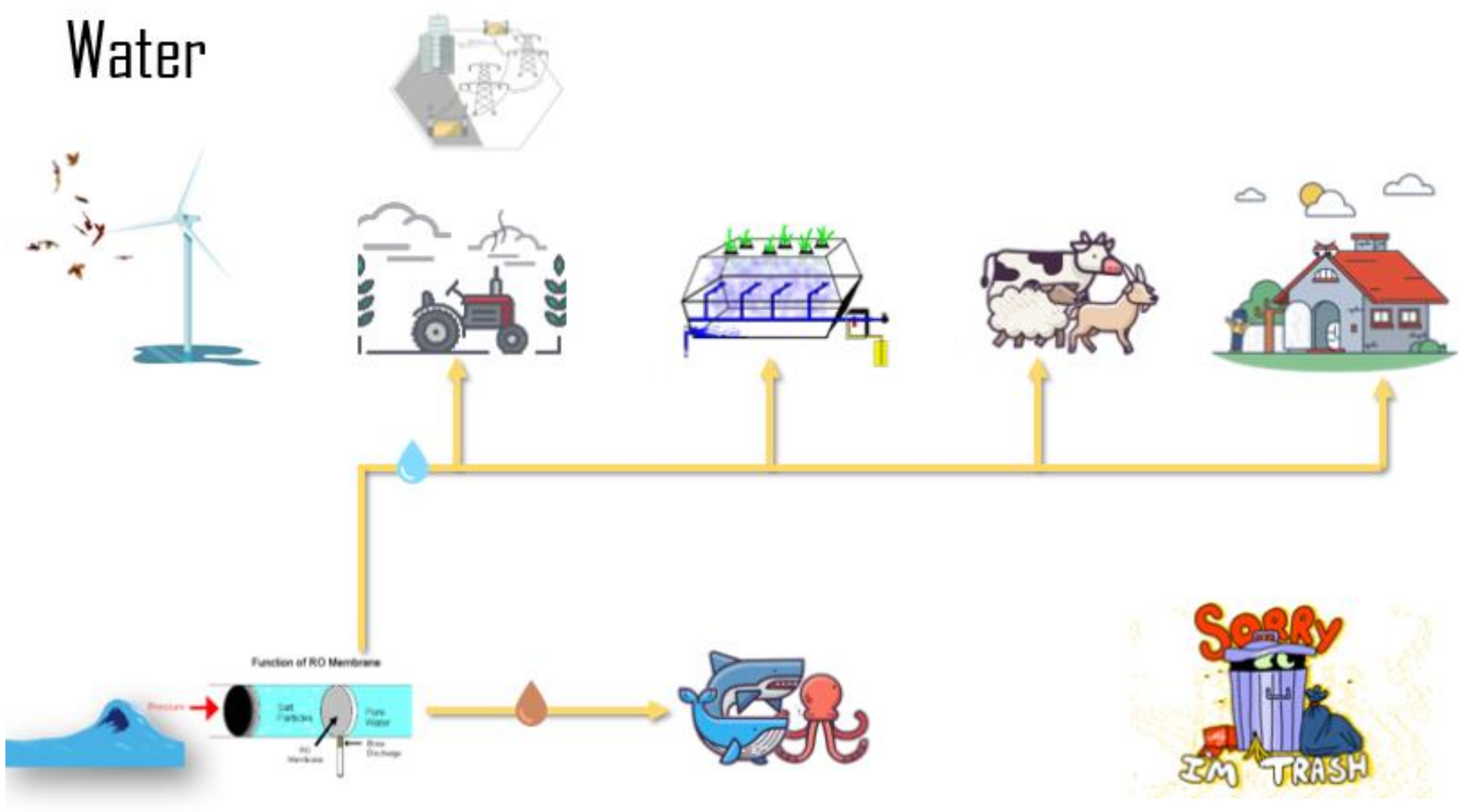
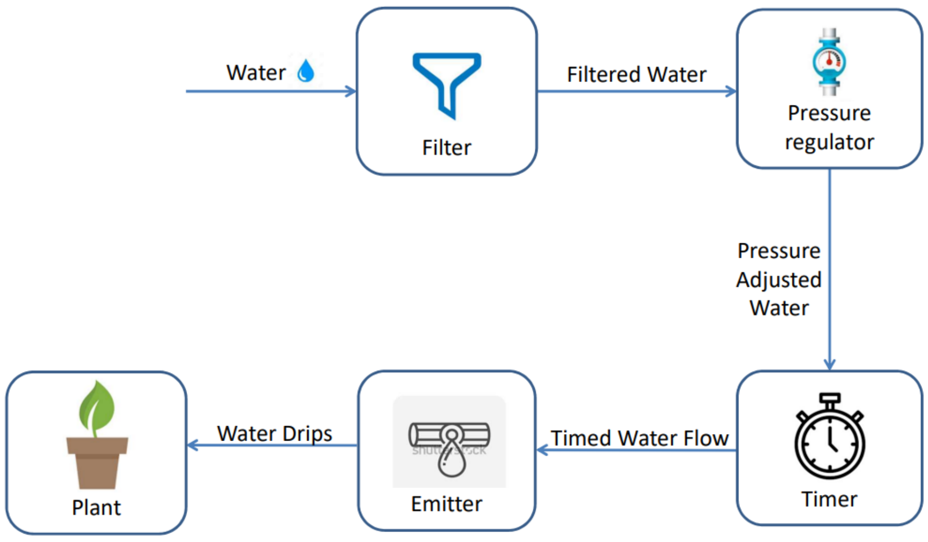


Figure 6. Water flowchart

6.3 Food Alternative Flowcharts

6.3.1 Drip Irrigation

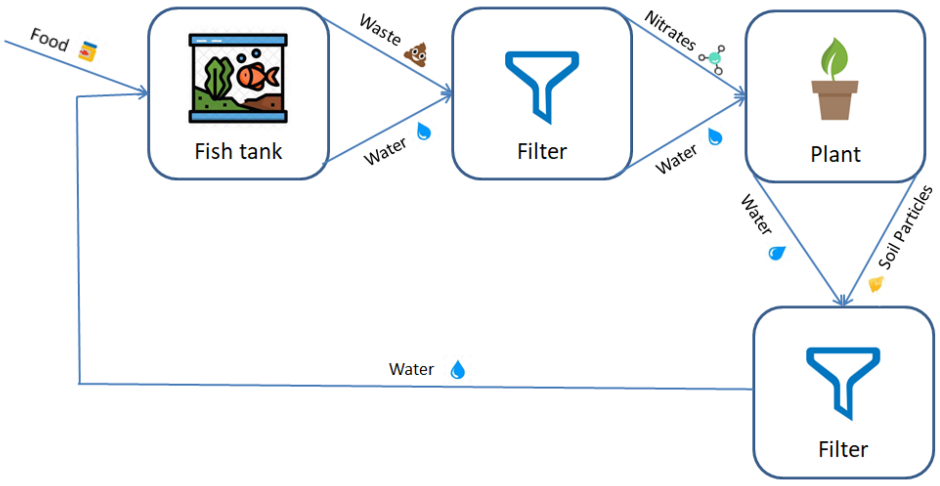
Drip Irrigation is the best way to water your plants as water and nutrients are delivered directly to the plant root without any loss of water and no water overflow. IN addition, plants are watered in exact suitable watering times to assure the plants grow fast as possible with the greatest yield produced.



As seen in the flowchart water first passes through a filter to remove any impurities and to make sure it's healthy for the plants, water then passes through a pressure regulator mostly to reduce its pressure to make sure no overflow occurs. A timer is there to make sure water passes only in the allowed times so plants are always having their most suitable amount of water in the adjusted times. Lastly water passes through an emitter to make sure that there is no water wasted with no use, only its needed water amount delivered directly to the plant's roots.

6.3.2 Aquaponics

Aquaponics integrates aquaculture and hydroponics into one production system. Aquaponics relies on the food introduced for fish, which works as the system's input. Afterward, the water (now ammonia-rich) flows, together with un-eaten food and decaying plant matter, from the fish tank into a biofilter.



As illustrated in the flowchart we can see that the fish's food is our only input to the system and this food is consumed by the fish in the fish tank and those fish produce waste that are rich in nitrates, So the water from the fish tank is passed to a filter to remove any solid waste and pass the filtered water to the plants. Plants then consume the nitrates in the water as food then the water is then passed to another filter to remove any soil particles then passed again to the fish tank so the enclosed loop continues over and over. This method allows the recycling of the fish waste instead not using it at all.

6.4 Waste Alternative Flowcharts

6.4.1 Water Waste Treatment

We will apply until secondary water treatment on water from sewers, so firstly we must apply primary treatment.

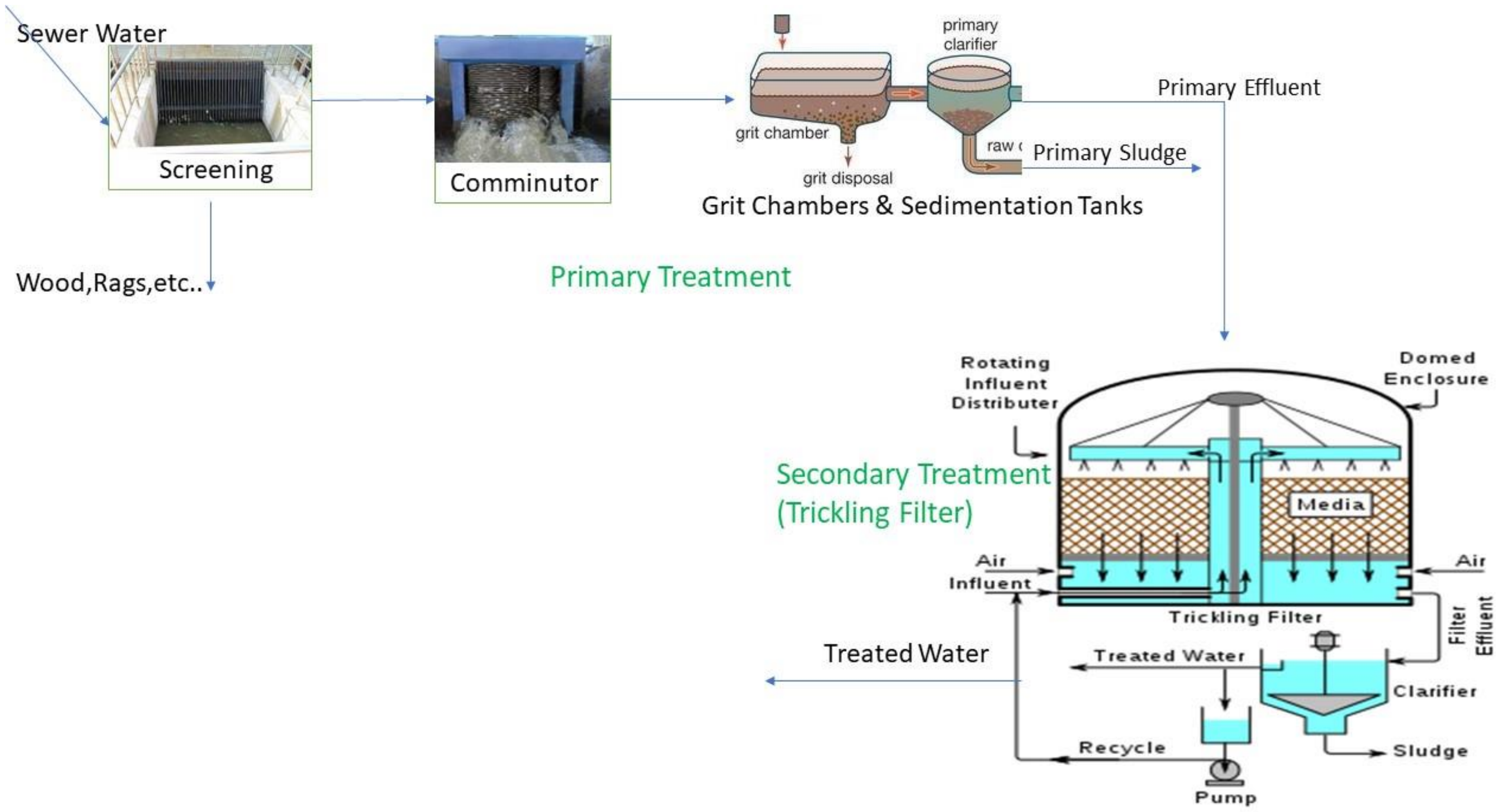
Primary treatment gets rid of material that will float or settle easily by gravity. It includes the physical processes of screening, crushing, sand removal and settling. The screen is made of long, tight, narrow strips of metal. They block floating ruins such as wood, rags and other big trash that could suffocate pipes or pumps. Screens are mechanically cleaned, and material is quickly disposed of by burial on the factory floor. A comminutor can be used to shred the chips that pass through the screen. The shredded material is later removed by a settling process.

Grit chambers are tanks designed to slow the flow so that solids like sand, coffee grounds, etc.. settle out of the water. About solids that pass-through screens and grit chambers, they are removed from sewage (water from primary treatment) in a settling tank. These tanks, also known as primary clarifiers, provide a residence time of about two hours for gravity settling. As sewage slowly flows through them, the solids slowly sink to the bottom. The settled solids - called raw sludge or primary sludge - are moved along the bottom of the tank by mechanical scrapers. Sludge is collected in a bouncer where it is getting to be removed.

In Secondary treatment, we get rid of soluble organics that escape primary treatment. It also eliminates more suspended solids. We accomplish that by biological processes, in which microorganisms consume organic impurities as food, converting them into carbon dioxide, water and energy for their own growth and reproduction. Wastewater treatment plants gives us a suitable environment for this natural biological process, steel and concrete. Removal of soluble organic matter at treatment plants helps maintain the dissolved oxygen balance of receiving streams, rivers or lakes.

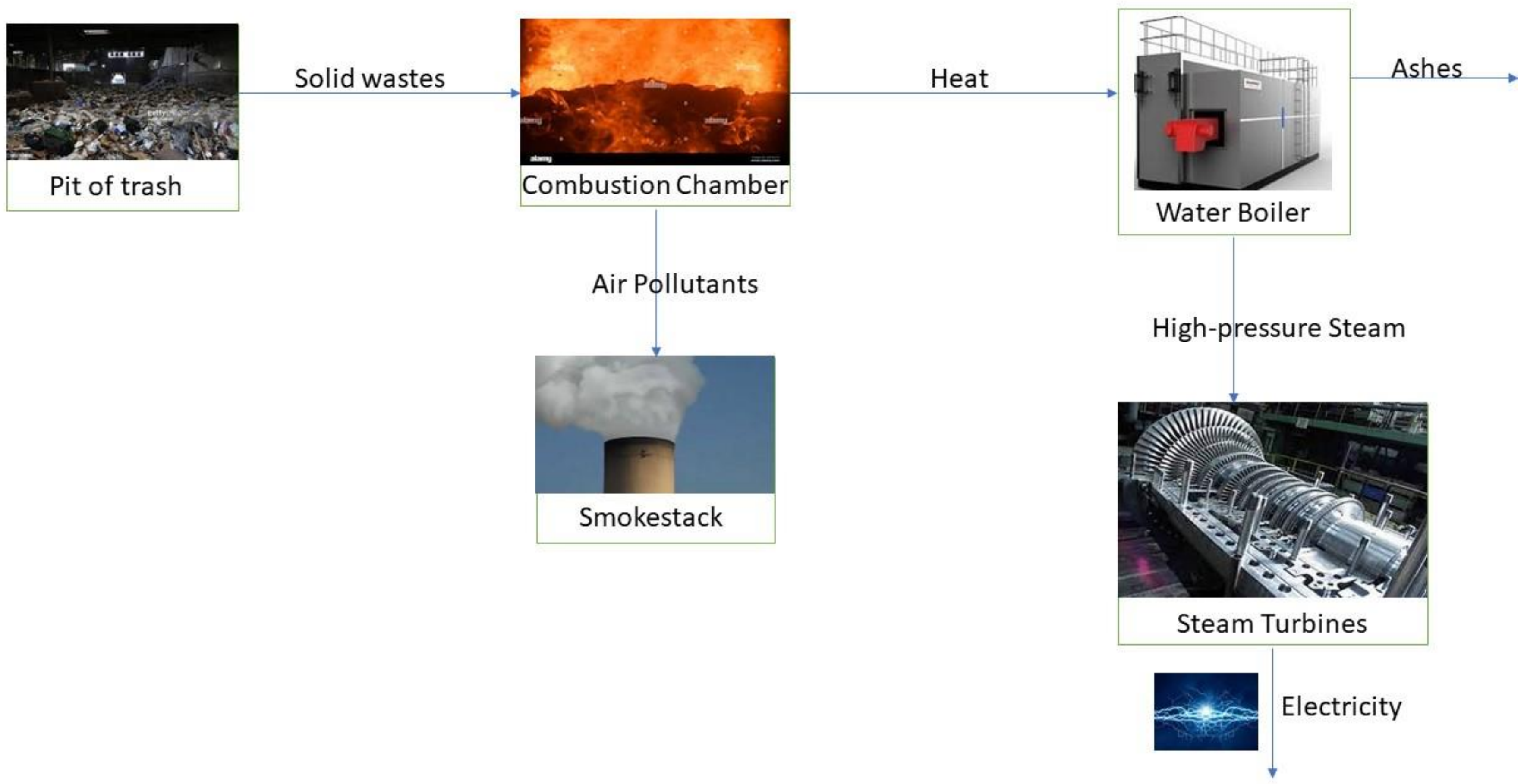
A trickling filter is just a tank filled with a deep stone bed. The sedimented sewage is continuously sprayed on the top of the stone flowing by the stones to the bottom, where it is collected for further processing. As the wastewater flows down, bacteria gather and increase on the stones. The steady flow of sewage over these growths enables microorganisms to absorb dissolved organic matter, thereby reducing the biochemical oxygen demand (BOD) of sewage. Air flowing upwards through the spaces between the stones helps in giving sufficient oxygen for the metabolic process.

A settling tank, called a secondary clarifier, is located after the trickling filter. These clarifiers remove microorganisms that are washed off the rocks by the wastewater stream. We can add more trickling filters if we want to improve the efficiency of treatment.



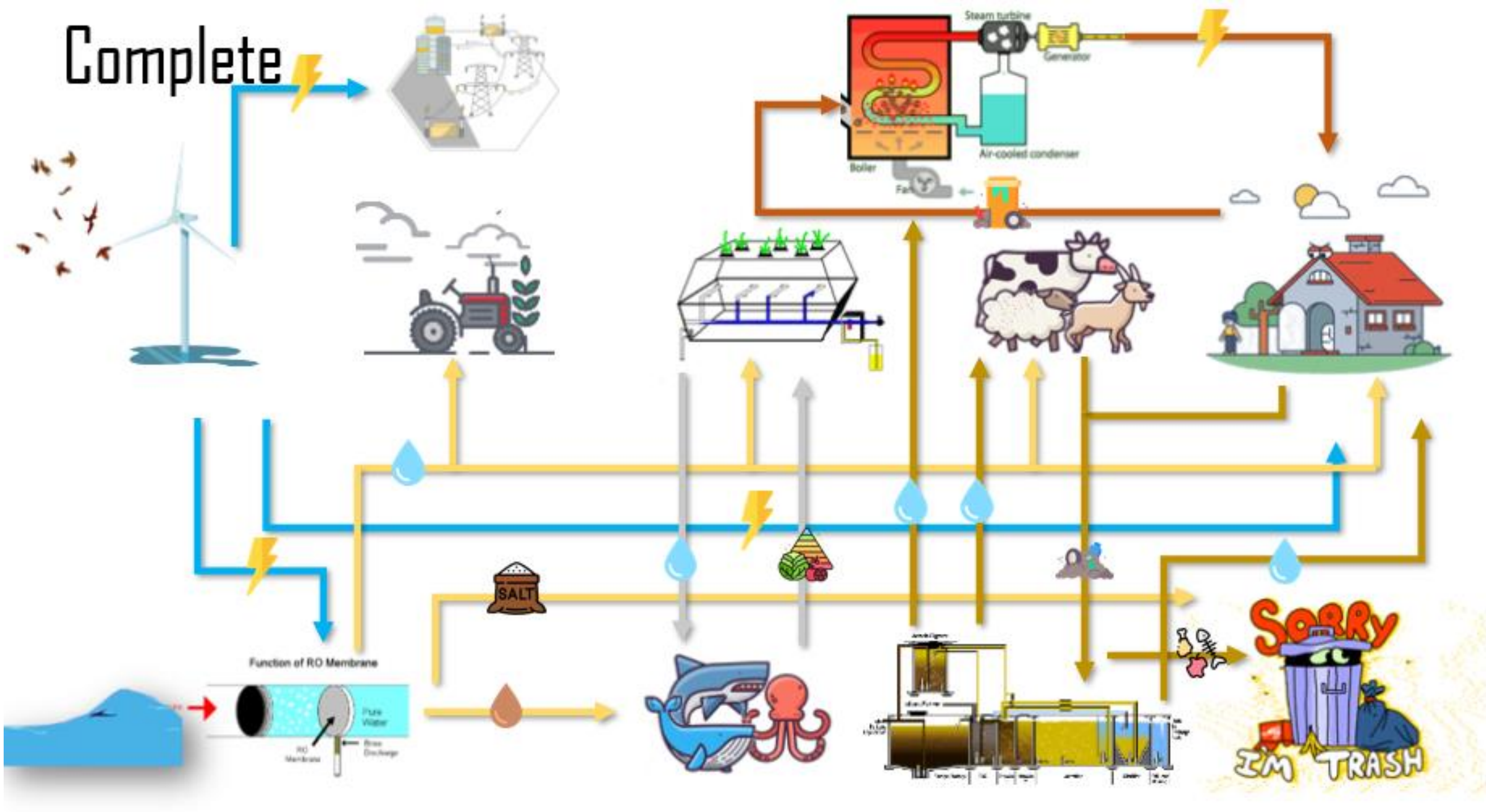
6.4.2 Solid Wastes

We are going to transform solid wastes coming from houses and factories into a form of energy (electricity) using municipal solid waste (MSW). The main objective here is to get rid of these solid wastes, so why not also generate a small source of power taking into consideration air pollutants in the process. The process of generating electricity in a mass-burn waste-to-energy plant starts by dumping the waste in a large pit. Using a crane's claw to transfer waste to a combustion chamber to be burned. The heat released from that combustion is used to turn water in a boiler to steam. The high-pressure steam turns the blades of steam turbines generating electricity. To maintain the pollution of this waste-to-energy plant, an air pollution control system removes pollutants from the combustion gas then released through a smokestack. Lastly, Ashes are collected from the boiler and air pollution control system.



7.Comprehensive Project Flowchart

In this flowchart we have merged the four previous WEF Nexus flowcharts. This allows us to understand the ins and outs of the system. Hence, we can control our resources used and distribute it properly. This flowchart demonstrates the relation between different aspects of our proposed system and indicates the harmony between its parts.



8. Benefits of Implementing WEF Nexus

8.1 Wastewater Treatment Benefits

8.1.1 Economical

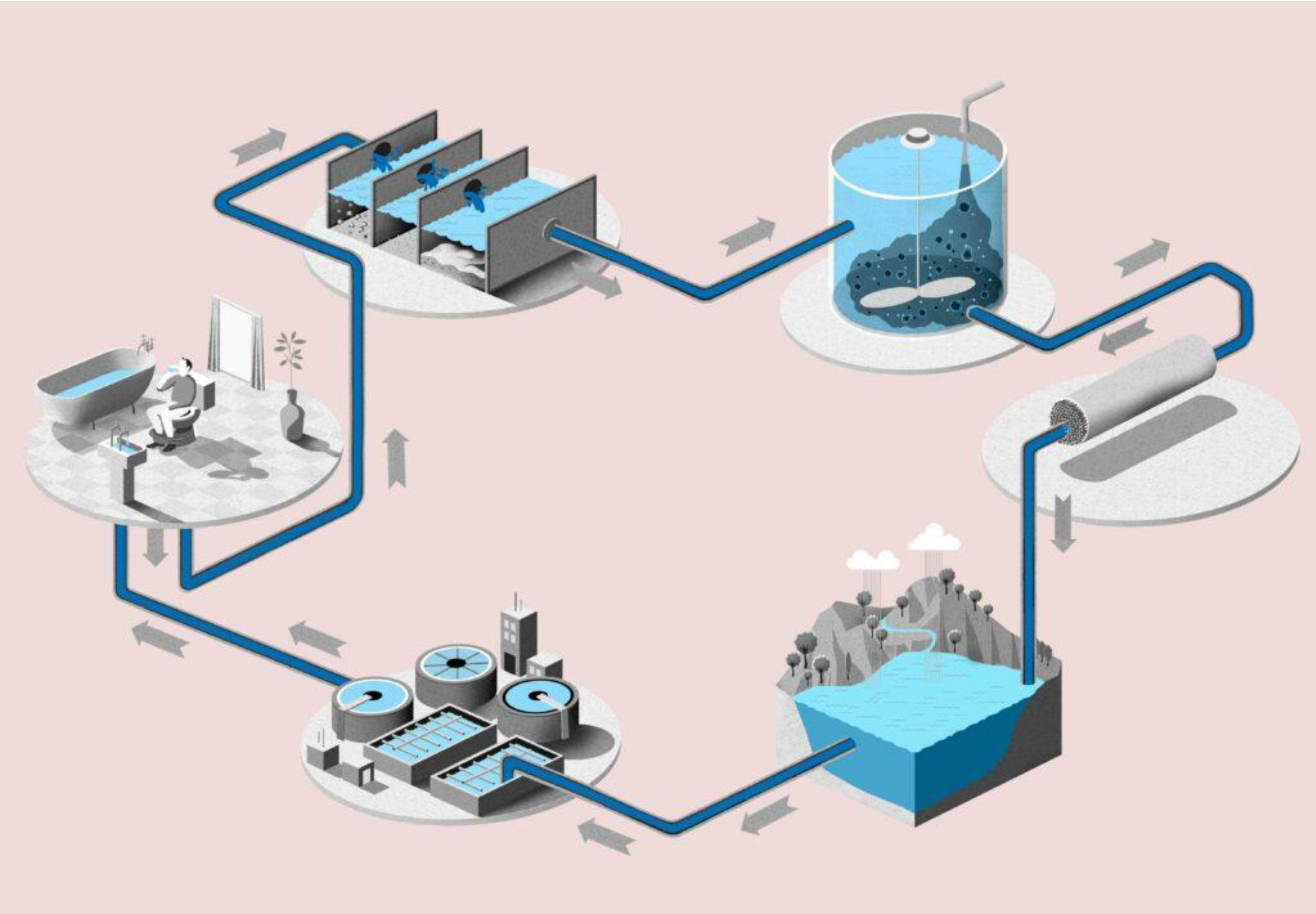
- Reuses waste in the production of biogas using the anaerobic digestors.
- Uses biogas to generate electricity.
- Upgrades biogas to RNG (renewable natural gas or biomethane).
- Reuses processed water in agriculture giving off enhanced crops' quality.

8.1.2 Social

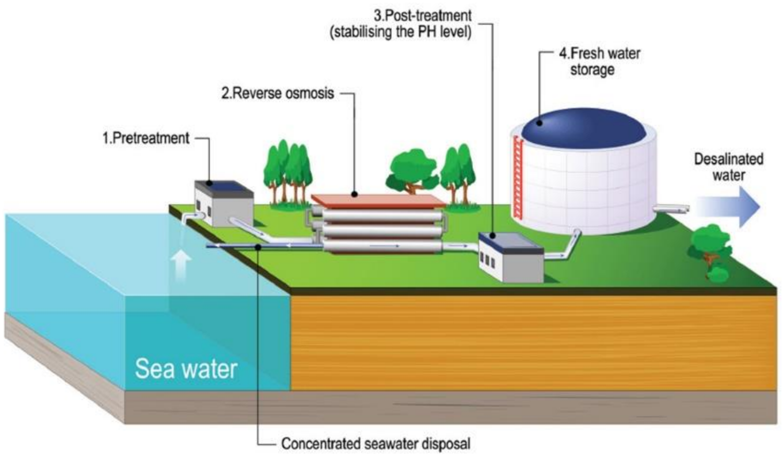
- Enhances human and animal waste management.
- Reduces diseases that are spread through waste as cholera, typhoid, and hepatitis.
- Lowers the price of water residential as well as enterprise subscriptions.

8.1.3 Environmental

- Reduces methane gas which is a main contributor to global warming.
- Reduces carbon dioxide concentration in the atmosphere.



8.2 Water Desalination Benefits



8.2.1 Economical

- Reduces water transport cost.
- Reduces GERD dam impact on freshwater.

8.2.2 Social

- Avoids water shortage crisis.
- Provides coastal areas with freshwater.

8.2.3 Environmental

- Disposes of brine in a safe manner.

8.3 Clean Energy Benefits

8.3.1 Economical

- Increases the amount of energy produced.
- Reduces the cost per energy unit produced.
- Increases the amount of energy exported.
- Reduces the amount of energy imported.
- Limits the energy monopoly - where the sun is not confined to a specific country.
- Reduces the area used per energy unit produced.
- Reduces the time needed to reuse the energy resource.
- Uses the energy produced in wastewater treatment.

8.3.2 Social

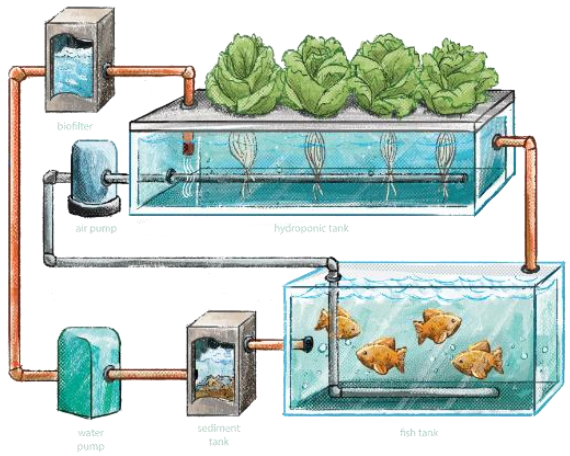
- Lowers the tax rates.
- Provides sufficient energy for heating and lightening of houses.
- Can be installed within residential units for energy self-sufficiency and energy trade.

8.3.3 Environmental

- Reduces the use of fossil fuel (non-clean resources).
- Reduces carbon dioxide emissions which have negative effect on the climate.
- Uses clean thermal energy in water desalination.
- Increases the livelihood of green fields.

8.4 Modern Agricultural Systems Benefits

8.4.1 Economical



- Increases food production efficiency.
- Increases the rate by which crops mature.
- Reduces the cost of energy used by 55%.
- Produces minor amounts of biogas.
- Exploits deserted areas in food production.
- Avoids lands of poor soil quality.
- Reduces pesticides use and so their cost.
- Increases fishery production.

8.4.2 Social

- Increases food quality by reducing chemicals used.
- Reduces food pricing due to larger production mass.
- Reduces direct contact between plants and soil (water in aquaponics).
- Enhances human health and general wellbeing.
- Reduces poverty and hunger.

8.4.3 Environmental

- Reduces water used in agriculture down by 68%.
- Acts as natural air filter due to increased carbon dioxide gas absorption
- Reduces carbon dioxide emissions resulted from the burning of rice husk – where it is used in hydroponic systems.

8.5 WEF Nexus Bigger Picture Benefits

8.5.1 Economical

- Enhanced job market.
- Achieves self-sufficient community.

8.5.2 Social

- Achieves societal prosperity.
- Increased job vacancies.
- Increased employment opportunities.

8.5.3 Environmental

- Limited pollution.
- Reduced greenhouse gases.
- Increased safely produced energy.

Water·Energy·Food
NEXUS