Chapter 5
THEORETICAL BASIS

5.1. Application of Organic Architecture

As the theme for the architectural approach, organic architecture can promote a harmony between humans and the natural world, delivering messages through the design for the world to be better. Organic architecture is a living tradition that is taking new and exciting directions (Pearson, 2002). Organic architecture will inspire people, expressing the respect for nature with a celebration of the beauty and harmony of the natural forms, flows, and systems that are offered. The visual characteristics of organic architecture is poetic, radical, idiosyncratic, and environmentally aware. It embodies the harmony of place, person, and materials. There are eight key themes of organic architecture:

- Building as nature

  Building is seen as an organism. Living organisms offer endless ideas one of which is metamorphosis and the concept of "design from within" where design borns from a seed and grows outward. Several organism concepts that can be applied in the building are:

  - Fusiform

    Sharks in general have fusiform shape (Sherman, 2003), a torpedo like shape with a slightly rounded head and a long, thin tapering body. Other marine animals furthermore embody the same shapes such as wahoo, barracudas, tunas, etc.

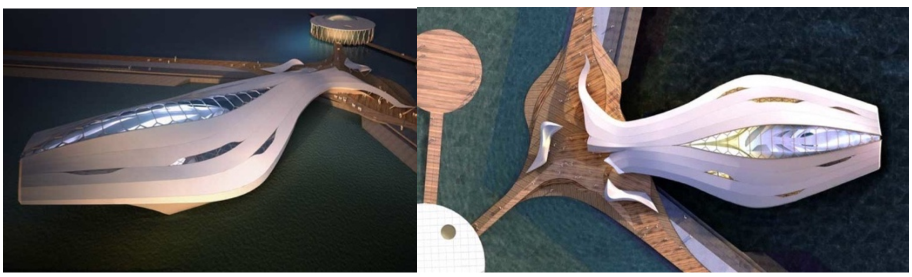

Figure 21. Fluid Pavilion in Yeosu by Peddle Thorpe Architects
(Source: www.mymodernmet.com)

An example of fusiform shape of a building can be found in the Fluid Pavilion (Kim, 2009). Its shape was inspired by whales. With flowing lines and smooth façade, Fluid appears as an aquatic animal.

- Gills kinetic façade

  Sharks use gills to aid in respiration (Shark4kids, 2021). The water flows into the shark's mouth through the throat, followed by leaving the body through the gills, enabling gas exchange.

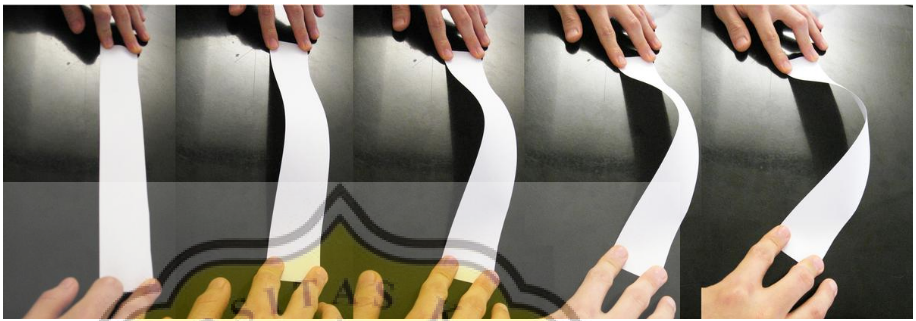

Figure 22. Kinetic façade based on gills
(Source: Structurae, n.d.)

Yeosu Pavilion uses a kinetic façade system that symbolizes fish gills (Salla, 2012) with 100 moveable louvers to respond to sunlight conditions.

Figure 23. Kinetic façade of Yeosu Pavilion by soma architecture
(Source: www.visualarq.com)

The louvers are made of glass-fibre reinforced polymer (GFRP) (Knippers Helbig Advanced Engineering, n.d.). To create an asymmetrical bending, the actuators are placed at the top and bottom. The use of gill façade in the building furthermore allows the light to radiate inside and outside of the building and provides views both ways.

- Continuous present

The design will be in the state of change and never finished. The design of the building can be enhanced through time to time, adjusting to the users or function of the building.

- Form follows flow

The building form follows the flow of energy. This can be applied from all kinds of energy such as the wind. The wind is the most important element in shaping an architectural form (Kormanikova et al, 2018). Building can be an obstacle to the wind flow affecting flow pattern and speed.

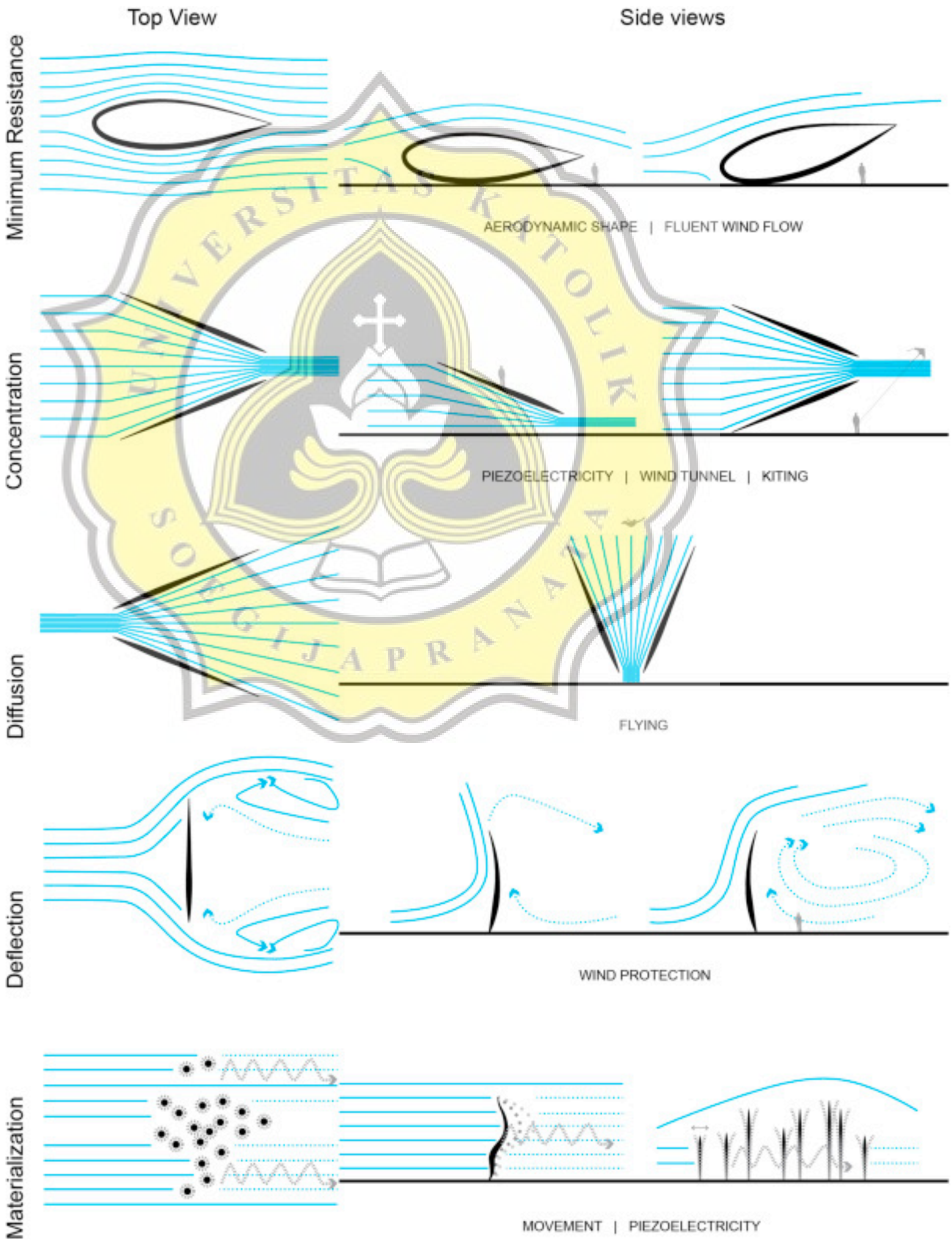

Figure 24. Architectural shape as a response to wind flow
(Source: Kormanikova et al, 2018)

The figure above explains the five principles about how architecture can deal with wind: Minimum resistance, Concentration, Diffusion, Deflection and Materialization. The five principles can be found in numerous projects. Below are the examples of how architecture design can utilize the wind flow for the building though shapes:

1. Minimum resistance

   Nordpark Railway Stations by Zaha Hadid Architects uses fluid shape architecture where the aerodynamic design is important for the environment of the Alps.

2. Concentration

   Bahrain World Trade Centre by Atkins Architects uses wind concentrated between the two towers. The wind shape squeezes and accelerates flowing through the turbines, harnessing wind energy.

3. Diffusion

   Shaolin Flying Monks Theatre by Mailitis Architects uses topography like shape where space between each step allowing the wind to blow through the structure, resulting in a massive airflow for the turbines.

Figure 25. Architectural buildings on utilizing wind flow
(Source: Kormanikova et al, 2018)

4. Deflection

Tjibaou Cultural Centre by Renzo Piano uses double skin façade for passive ventilation with the help of the trees located on the east and west side as a funnel effect, directing the wind towards the building. If stronger wind occurs, the louvers of the façade are closed to deflect the wind for protection

5. Materialization

Strandbeest, developed by Theo Jansen uses a skeleton shape made out of yellow tubes making them able to "walk on the wind".

Other energy includes structural forces, wind, heat, water currents, earth energies, electrical, magnetic fields, human energies consisting of body, mind and spirit.

- Of the people

Buildings are meant for people. The design should begin with the people to express their needs and wishes. The form and structure will then follow resulting in curvilinear interiors.

- Of the hill

An organic building should be seen growing out of the site.

- Of the materials

The materials of a building express themselves of their qualities.

- Youthful and unexpected

The concept should be explored feeling youthful and playful much like a child's adventure to explore, to learn, to accept the unexpected with designs that are sometimes eccentric, surprising, and unexpected. Buildings can be powerful or disturbing on their symbolism, mythology and use of metaphors.

- Living music

Organic architecture is alive, through harmonies and discords, its diverse rhythms and syncopated movements, and its asymmetrical proportions and structure produced by the pattern of the building that keeps playing over and over, telling the same thing.

In order to create a pattern, the building should implement repetition in the design: (Chan, 2012)

❖ Repetition in forms

Regular rhythm is created by repeating elements with similar characteristics.

Figure 26. Left: Church of the Plains by Aalto. Right: Riola Church by Aalto
(Source: Chan, 2012)

For example the repetition of a single wall unit or vertical opening in Church of the Plains or simple shape to composite the roof in Riola Church.

❖ Repetition in structure

Structure rhythm is made by the combination of beams and columns with similar size and shapes.

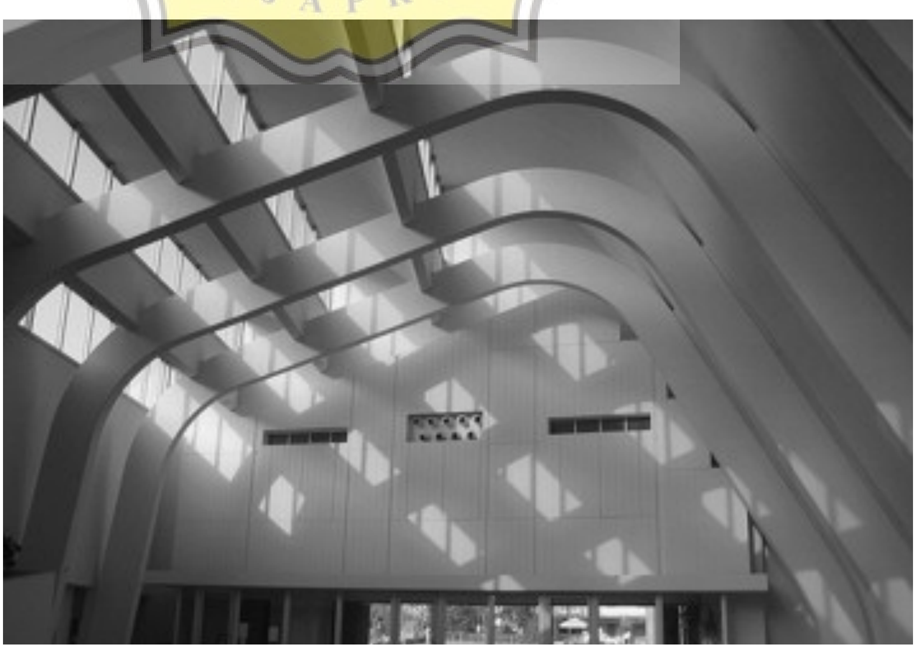

Figure 27. Interior of Riola Church by Aalto
(Source: Chan, 2012)

This can be seen in Riola Church, which has a repetitive curved beam and column structure.

5.2. Applications of Structure and Technology Towards Core Issues

- Building structure in avoiding coral damage

Very Large Floating Structures (VLFS) are artificially man-made floating land parcels on the sea (Wang, 2011). This structure is furthermore commonly used for floating airports, bridges, breakwaters, piers and docks, etc. (Andranov, 2005).

Figure 28. Various systems of VLFS
(Source: Andranov, 2005)

As seen in figure the VLFS consists of:

1. A very large floating structure.
2. An access bridge connected with the shore.
3. A mooring facility.
4. A breakwater

Pontoon VLFS platform rests on the water surface and is intended for deployment in calm waters such as in a cove, a lagoon or a harbor. This structure is flexible compared to other kinds of offshore structures, so that the elastic deformations are more important than their rigid body motions.

Table 77. Pontoon-type VLFS advantages and disadvantages
(Source: Ko, 2015)

Advantages	Disadvantages
Large dimensions	vulnerable to wave actions
The larger the structure is, the more stable it floats	vulnerable to currents
Easy to prefabricate and then towed to destination	Needs to be moored by a superstructure to prevent it from moving around
Cost effective when the water depth is large	Although large dimensions can be achieved, several floating structures are usually needed to create a floating city.
Environment friendly as they do not damage the marine ecosystem (directly), or silt-up deep	Complicated connections between the floating structures
Easily removed or expanded	
The facilities and structures on VLFS are protected from seismic shocks	
No suffer from differential settlement	

To enable the structure to float, these VLFSs are developed by: (Wang, 2011)

- Mooring systems

  The mooring system ensures that the VLFS is kept in position so that the facilities installed on the floating structure can be reliably operated as well as to prevent the structure from drifting away under critical sea conditions and storms.

Figure 29. Left: Chain/cable, Middle: Tension Leg, Right: Rubber fender-dolphin (Source: Wang, 2011)

  - Chain/Cable
  - Tension leg
  - Rubber fender-dolphin

- Mitigation of hydroelastic response

  One of the earliest methods is by constructing bottom-founded breakwater close to the VLFS. It showed that the bottom- founded type breakwater is effective in reducing the hydroelastic response as well as the drift forces. However, such type of breakwater still possesses some drawbacks that include massive construction material requirements, difficulty in construction, occupying precious sea space, and difficulty in removing the breakwater if the VLFS is to be relocated elsewhere, not environmentally friendly, and the reflected waves from the breakwater could result in coastal erosion.

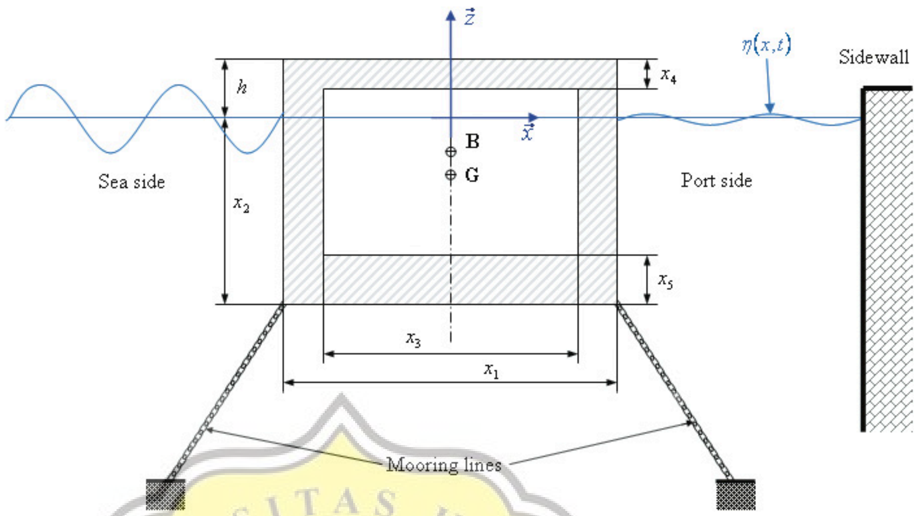

Figure 30. Floating breakwater
(Source: Elchahal et al, 2009)

The floating box-like breakwater moored with mooring lines has been proposed as an alternative to the conventional bottom-founded type breakwater for protecting VLFS from a severe sea. For floating breakwaters: (Elchahal et al, 2009)

- ❖ These are less expensive than fixed structures in deeper water.
- ❖ Poor soil conditions may make floating breakwaters more feasible to use than heavy rubble mound breakwaters.
- ❖ They can dissipate the wave energy without stopping the water flow under the structure, so they produce minimal interference on water circulation, sediment transport, and fish migration; thus, minimizing the impact on the environment.
- ❖ They can be moved and rearranged easily in different layouts or transported to another site.
- ❖ If ice formation causes a problem, floating breakwaters can be removed from the site.
- ❖ These are not as obtrusive as fixed breakwaters and can be aesthetically more pleasant.

- Connector

VLFS is usually constructed in modules due to its massive size. The modules are fabricated in shipyard, and later to be connected on site on the sea by welding or by rigid connectors. It is recommended that hinge or semi rigid connectors are effective to reduce hydroelastic response compared to rigid connectors.

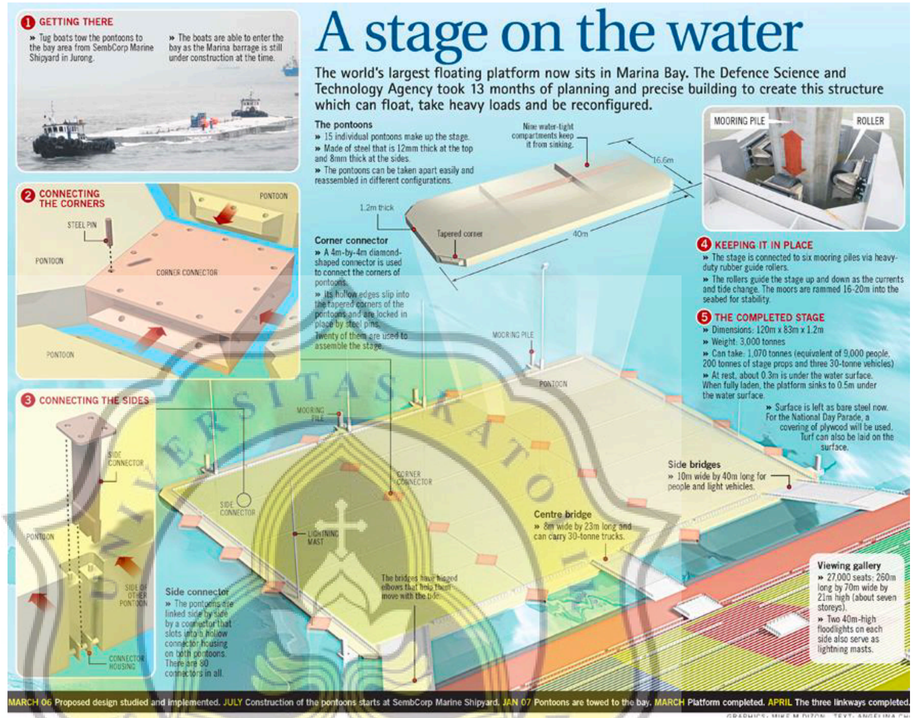

Figure 31. Pontoon VLFS of Singapore's floating stage
(Source: Maritime and Port Authority of Singapore, 2015)

- Building technology as alternative energy producer

  To produce energy for the building, the building should house the technologies listed below:

  - Fuel cells

    Fuel cells are electromagnetic devices that can generate electricity like batteries and can be considered as electrochemical internal combustion engines (Ali, 2008). A fuel cell is essentially a reactor that combines hydrogen and oxygen to produce electricity, heat, and water.

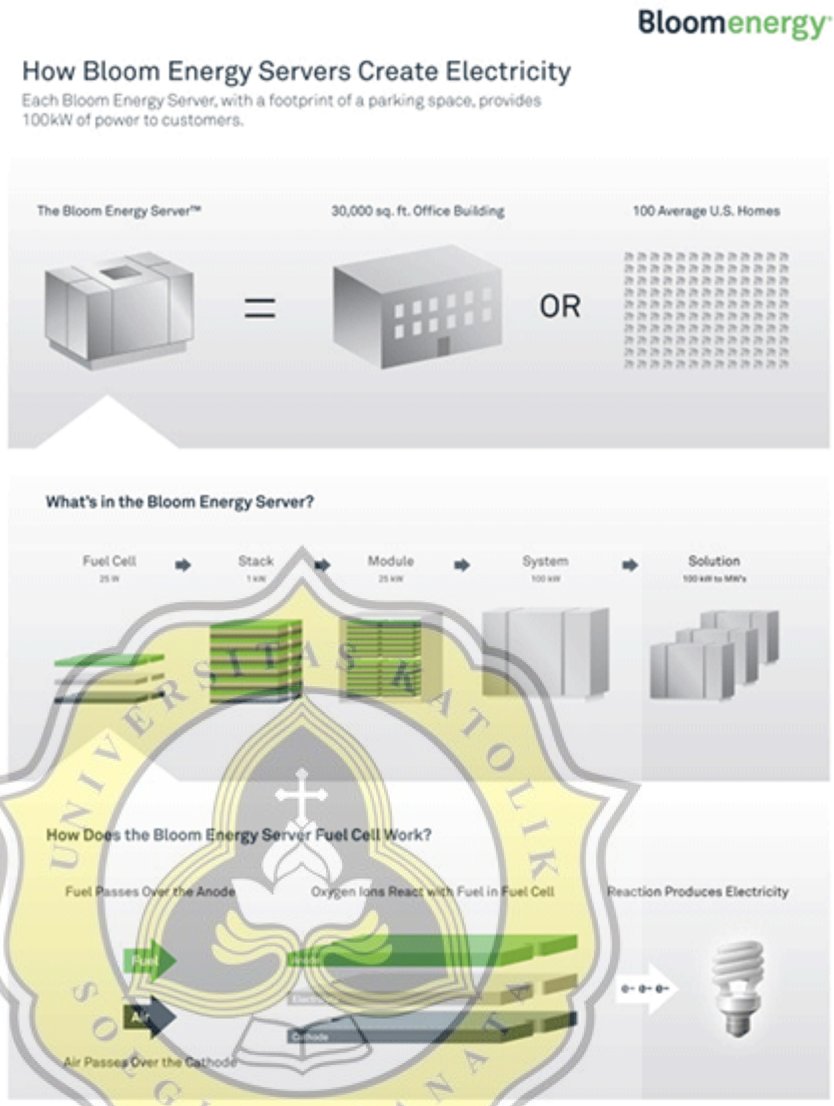

Figure 32. The process of fuel cells
(Source: www.fastcompany.com)

One of the most common kinds of fuel cell is the proton exchange membrane fuel cell (PEMFC). Some other types are phosphoric acid fuel cell (PAFC), solid oxide fuel cell (SOFC), alkaline fuel cell (AFC), and molten carbonate fuel cell (MCFC).

- Reverse Osmosis (RO)

  Reverse Osmosis (RO) technology uses semi-permeable membranes and high pressure to separates salt from the seawater. (Bahar & Hawlader, 2013)

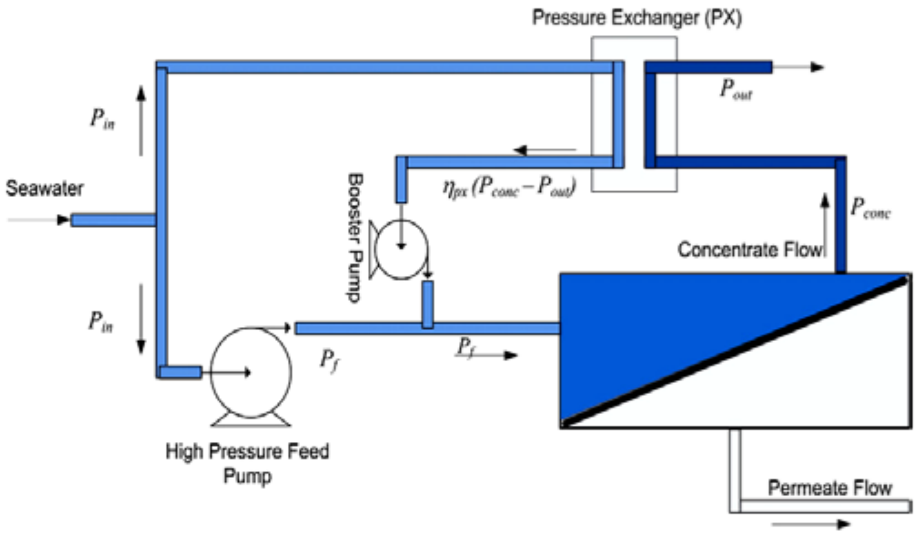

Figure 33. RO desalination process
(Source: Bahar & Hawlader. 2013)

It must be taken to consideration that the technology cannot run in hot or warm water since the membrane performance can be deteriorated with the temperature of 40C and above.

- Living Machine System

Liquid waste in the building could be manage by using a Living Machine System. Living Machine System is an emerging wastewater treatment technology that utilizes a series of tanks, which support vegetation and a variety of other organisms. The Living Machine System uses plants and animals in its treatment process to create clean non-potable clean water. (United States Environmental Protection Agency)

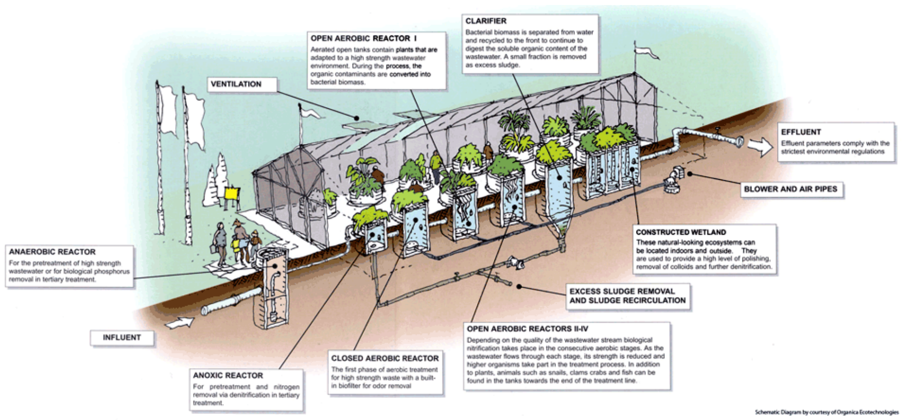

Figure 34. Findhorn Living Machine System process
(Source: www.theecologist.org)

Living Machines as being a wastewater treatment system that:

- Is capable of achieving tertiary treatment.
- Costs less to operate than conventional systems when used to achieve a tertiary level of treatment.
- Does not require chemicals that are harmful to the environment” as a part of its treatment process.