

Article

Environmental Awareness: Issues of Taoyuan Natural Gas Energy Station and Algal Reef Ecology

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Abstract: The conflict between energy and ecological issues in Taiwan was explored to find how the coexistence relationship among humans, ecology, and energy could be obtained. To raise more awareness of ecological issues, public furniture was chosen as a medium to review this concept. We took Taoyuan's algal reefs and a natural gas receiving station as representatives of ecological issues and researched the balanced relationship between humans, ecology, and energy. Through a questionnaire survey, the respondents' evaluation of using public furniture for environmental protection was investigated. The results showed that the public understood environmental advocacy and ecological issues, which showed the increasing society's attention to these matters.

Keywords: Environmental protection, Furniture design, Public furniture, Sustainable development, Ecological advocacy

1. Introduction

In the four major referendums, the ecological issues have attracted public attention to ecology and energy production. People have realized the existence of algal reefs around the Taiwaneses sea. Currently, Taiwan relies on imported energy sources. The Ministry of Economic Affairs estimates that from 2021 to 2027, Taiwan's annual electricity consumption will grow by 2.5%, with half of the electricity generated using natural gas. Therefore, it is necessary to build natural gas stations along the northern coast, located in the Guantang Industrial Zone in Taoyuan. Once this referendum was initiated, a struggle between the government and reef protection groups has been occurring while the other seeks to protect valuable ecosystems from destruction and allow citizens to make choices. The energy demand keeps increasing. Thus, it is necessary to balance stable energy supply and ecological protection. Ideally, sufficient energy is demanded to meet humans' needs while also preserving the environment. The relationship between these two aspects was investigated in this study. Energy sources and ecology need to be harmonized as neither can be neglected. Taking furniture as a tool, a positive and proactive attitude towards such matters was proposed. The relationship between furniture and people is close. The algal reefs are a spiritual symbol for people to reflect on the current situation in Taiwan and care for living in sound environments.

2. Materials and Methods

We analyzed the background of algal reefs and energy, as well as their mutual influence to understand the challenges of the environment and economy from a citizen's perspective in a dual-purpose approach. The core values of human interaction with algal reefs and energy were studied using various means.

2.1 Algal Reef

Most people may not have heard of algal reefs, and even think that this ecosystem is neither as cute nor beautiful as coral reefs that attract tourists. This led CPC Corporation in Taiwan to overlook the rich ecology of the algal reef seabed. The Taoyuan algal reef stretches about 27 km and is a continuous algal reef that is rare to find. The porous environment provides a variety of habitats for hiding and living for many organisms and nurtures many world-class conservation species, making it the best marine nursery. Its importance and influence are profound, as shown in the Table 1. The main reef-building organism in the Taoyuan algal reef is coralline algae, which fix the free calcium in seawater into their cell walls. The limestone made after growth and death is used to build reefs. Its appearance resembles a thin shell growing flat on rocks to form reefs, stacking layer by layer like a mille-feuille pastry. The accumulation rate of algal reefs is extremely slow; they grow less than 1 cm in 10–20 years and have been forming for approximately 7600 years, making them a unique and precious natural landscape. However, due to long-term pollution from human

activities and coastal development projects, the survival of algal reefs has been threatened, posing an imminent threat to the continuation of biological life. Even if it is impossible to completely protect the coral reef ecology, harmful impacts on the original ecological environment can be reduced. To sustainably inherit a better Taiwan for future generations and descendants, the economy or industries must be developed in a way that minimizes harm to the environment and living organisms.

Table 1. Importance and impact of algal reefs.

Item	Algal Reefs	Disappearing of Algal Reefs
1	Gene bank	The destroyed habitat makes it difficult for new species to reproduce.
2	Excellent wave absorption function	Unable to effectively reduce the erosion of seawater on land.
3	Carbon fixation function	It's like abandoning a natural large carbon sink.
4	Mitigate the crisis of global warming	Algal reefs also create a sustainable food source, with a large number of benthic organisms supporting abundant fish populations. Blindly developing and constructing will hinder the development of fisheries as well.
5	World-class natural heritage	Losing the sustainable environmental ecological value.

2.2 CPC Facility

To keep up with the trend of non-nuclear homes and zero carbon emissions, "increasing gas and reducing coal" is the key to energy transformation. Therefore, the government plans to increase natural gas from 32 to 50% by 2025, and it is also estimated that the demand for natural gas will exceed 20 million m³. In 2016, CPC Corporation built a third natural gas receiving station with a capacity of 3 million m³ on the coast of Datang Bay, supplying gas to the Datang Power Plant. The original plan included reclaiming land from sea totaling 77.2 ha and constructing a north pier of 4280 m and a south pier of 800 m at Kwuntung Industrial Port. If completed successfully, it can supply liquefied natural gas (LPG) of up to six million tons annually. However, if there are difficulties in establishing the third natural gas receiving station on land, it could bring a significant gap in energy transformation (Lu Guozhen, 2021). In an era where industries increasingly rely on electricity development, supply falls far short of demand. Taiwan's small island territory has a dense population where as much as 98% of its energy relies on imports. Being an island nation means that power cannot be supported across borders either. The government must promote industrial upgrades and propose corresponding policies. Otherwise, no matter how many power generation facilities are built, it will not be easy to meet unlimited electricity demands which could oppress the ecological environment and compress people's quality of life.

For the climate crisis, it is worth considering the role of energy. As the economy continues to grow, the demand for electricity in industries increases every year. Phasing out old units, replacing coal with natural gas, and providing a stable power supply for people are all steps towards achieving 1. However, there are too many unstable factors with natural gas, such as excessive reliance on imports which may indirectly affect Taiwan's price stability and economic development due to future price fluctuations. The arrival and departure of natural gas ships can be affected by weather conditions and sea storms, leading to risks of power outages. There is also a risk of too many natural gas receiving stations as they could be abandoned idle in the future. The benefits and impacts of connecting to natural gas are depicted in Table 2. Nevertheless, the U.S. Energy Department has estimated that natural gas is likely to become the mainstream energy source in the future. Therefore, how to appropriately address these issues is also a common topic of this initiative.

Table 2. Benefits and impacts of using the third liquefied natural gas terminal.

Item	Benefits of building the Third Liquefied Natural Gas Terminal.	Impact of moving the Third Liquefied Natural Gas Terminal
1	Energy transition, reduce coal and air pollution	Impact on carbon reduction schedule and energy stability.
2	Supply gas locally, stabilize power supply	Put existing natural gas equipment at risk.
3	Achieving a balance in gas supply between the northern and southern regions.	Power shortage happens in the northern region.
4	Reduce carbon emissions and develop clean energy	Increase coal and reduce gas usage, unable to improve the air pollution, carbon emissions, and air quality of coal-fired units in the short term.

2.3 Ecological Furniture

Ecological furniture refers to using ecological elements in furniture design and enhancing public awareness and concern for ecological issues through design and functionality. Using the principles of biomimicry, natural forms, and structures can be integrated into the design to achieve more efficient and sustainable designs. For example, eco-friendly materials can be used, energy-

saving technologies applied, and information related to ecological conservation is provided. Ecological furniture presents the environmental awareness of the public through exhibitions, community activities, and public spaces to stimulate public interest and reflection on ecological issues. In addition, ecological furniture can be combined with other design elements such as art, technology, and social innovation to achieve a more comprehensive and integrated effect.

3. Results

The controversial issues of ecological conservation and energy transition were investigated in this study. Due to the indirect relationship between algal reefs and the educational nature of marine museums, it is necessary to promote ecological education so that visitors from society can reflect on the environmental situation of Taiwan. To design the research, the following was considered.

1. Controversial issue for a mutual influence between ecology and energy to achieve symbiosis that everyone needs to think
2. Ecological education for the awareness of issues through public furniture to achieve a multiplier effect
3. Marine museum most relevant to this topic with an educational nature to convey this issue
4. Public or people to focus their attention on the issues
5. Public art furniture with unique styling and appearance to increase the curiosity of the public

We focused on the "symbol" technique in design methods, using representative natural elements or images, such as algae reefs and receiving stations, and incorporated them into furniture design. In the "transformation" technique, natural elements or resources are transformed into design elements with practical value, such as using wood resources to create furniture with unique styles. Through these symbolic and transformation techniques, we transformed natural resources into design elements with practical value and aesthetic experience from nature to increase public awareness and concern for ecological issues. We designed a balanced three-person resting chair by extracting elements from algae reefs and receiving stations. Wood was used to fabricate the most direct shape of an air tank, making the circular air tank simple yet not plain; paired with transport pipes combining metal and wood to showcase the natural gas transportation process. In the curved part of the pipe, the oxidizing effect of red copper was used to create a corroded appearance by seawater to reflect on the precious algae reef ecology and natural gas stations. The irregular cushions represented algae reefs with different colored fabrics in a diverse sense of nature. Figure 1 shows is a hand-drawn draft, transforming the expressed concepts and design elements into concrete images, simplifying the presentation of complex issues.



Fig. 1. Sketch of chair with natural elements.

Figure 2 below shows the dimensions of the three views. The dimension of the air tank seat was 480 mm in length, 480 mm in width, and 460 mm in height. The pipeline on the left offered a double seat, measuring 870 mm in length, 280 mm in width, and 410 mm in height. The total length of the three-seater resting chair was 1280 mm.

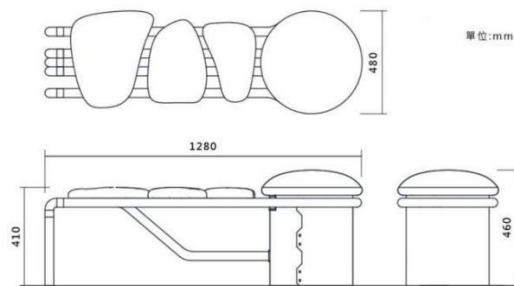


Fig.2. Three-dimension image (Source: From this study)

After the 1:1 physical sample, the model was fine-tuned (Fig. 3). The detailed production process is described in Appendix 1.



Fig. 3. Photo of chair.

The purpose of the design of the chair was to promote ecological issues and increase social awareness. By organizing and analyzing relevant literature, an innovative design was created to achieve this goal. In the design, the following frameworks were applied.

1. Background story to understand the status of furniture in modern life and its relevance to ecological issues
2. Creative techniques to explore how design elements can achieve a balance between ecology and furniture
3. Abstract concepts by transforming them into tangible design works
4. User interactions through questionnaires and exhibition experiences to gain insights and feedback

4. Discussion

To attract more attention to social issues, furniture was used as a medium to create a design with a different appearance from typical public furniture, combining aesthetics. However, to verify whether this design successfully presented the issue and resonated with the audience, we conducted a questionnaire survey (Appendix II), collecting 103 feedback responses to confirm the effectiveness of the design. In the questionnaire survey, respondents were asked about their level of concern and importance regarding relevant social issues through various methods. Feedback on the presentation of coral reefs and elements in the design was collected after showing semi-openly using images. Additionally, respondents were asked about their preference for the design, as well as other relevant opinions and suggestions. Based on the feedback, public views and reactions toward social issues were understood. By analyzing the survey results, the design and promotional strategies were adjusted for further improvement and innovation. By integrating social issues into designs, more attention was paid to and more discussions were made among people which increased societal awareness and promoted change. 66.9% of the respondents had seen this issue on television or the internet. However, 30% were not familiar with this issue, and only 2.9% delved into it (Fig. 4). These data showed that many people needed more information and awareness to pay attention to this issue.

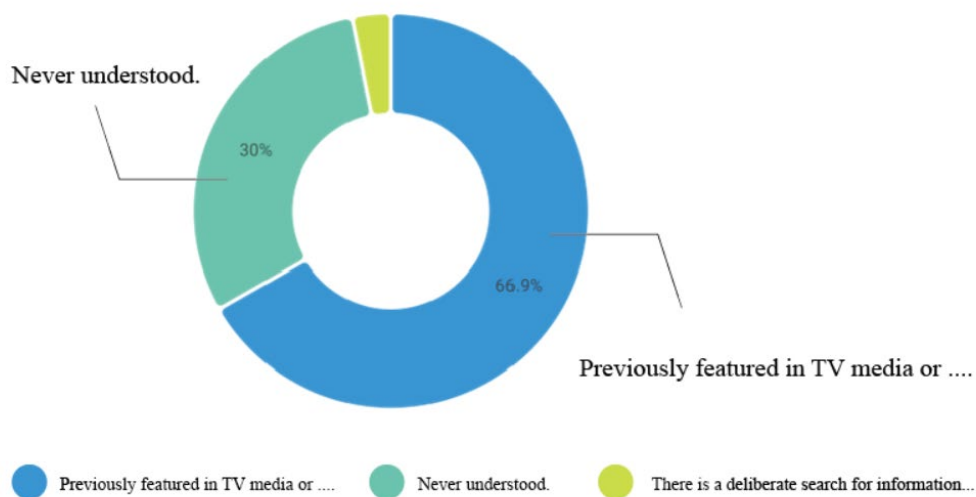


Fig. 4. Respondents' understanding of this issue.

Most respondents felt curious about the designed public furniture and spent a longer time seeing the design to understand the background of the story. Through the exhibition and participation of physical objects, a deeper understanding of the issue was implanted in the audience's concept, which promoted advocacy and enhanced identification.

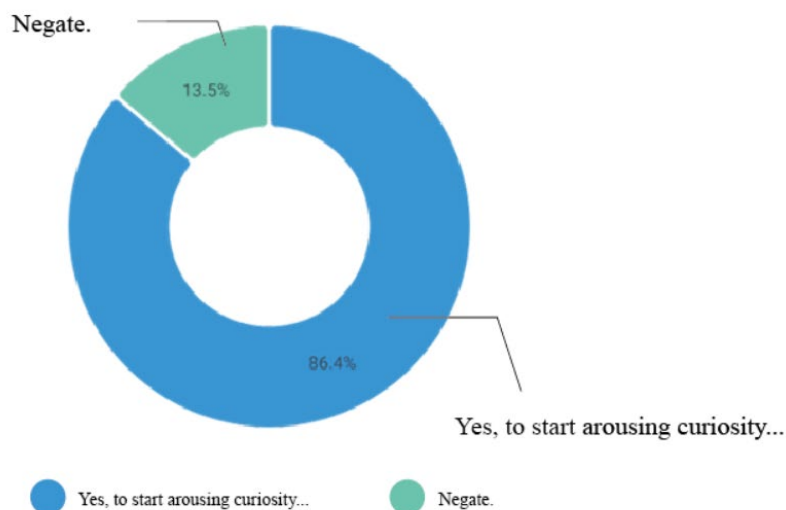


Fig. 5. Willingness to explore background story of design.

The survey results showed that it is necessary to satisfy the public's expectations by enhancing the association and acceptance of the design (Fig. 5). These results are important in achieving sustainable development and for continuous promotion and education to increase public awareness and attention to these important issues. The coexistence of humans, ecology, and energy is always important. The created public furniture design attracted the public's interest in algal reefs to a high degree. The design was attractive enough to generate discussion on ecological issues. Through a survey, the public could perceive algal reefs and gas stations. Future designs are necessary for public expectations to enhance the awareness of the public on ecological issues.

5. Conclusions

It is generally easy for viewers to overlook initiatives presented in text or on posters. By using objects as aids, viewers can more easily understand the initiative. We obtained and analyzed feedback through a questionnaire survey for the interactive displays in this study. The design of the public furniture was different from common ones. Its unique appearance attracted people's attention, making them curious to observe and learn more about the story behind this design. Respondents needed explanations to understand the background story. In exhibitions and promotions, explanations about the concepts and stories behind the design need to be

offered to enhance the public’s understanding and appreciation of the works. It is necessary to balance creative objects with stories. In furniture design, the importance of appearance and story content is crucial to avoid furniture being too eye-catching at the expense of neglecting storytelling. The practicality of works needs to be improved by strengthening practical functions, such as adding storage space, which can make relevant proposals more acceptable to the public. ecological issues can be integrated into public furniture design using the visual elements of concretization as an effective method. It increases public awareness of ecological issues and conveys issues to more people for sustainable development goals. The created design in this study provides a reference for future design and research in related fields for ecological issues. It is demanded to explore more possibilities in design to achieve harmonious coexistence between humans and the environment.

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Appendix A

Using wood, red copper, and iron pipes for experimental construction, the gas cylinder part is machined with a CNC machine to create a framework (see Figure A2). By utilizing the bending properties of curved plywood, it is cut into shape and wrapped around to form a circular rather than round shape (see Figure A2). The main wood chosen is white waxwood (*Fraxinus Chinensis*), known for its high strength, resistance to deformation, and beautiful grain. After gluing together, it is cut and rounded off to form cylindrical sections (see Figure A2). Copper sheets are used for decoration in joining different materials and fixed onto the gas cylinder with copper nails (see Figure A2). Five pipes are threaded through using copper tubes for stability (see Figure A3). The seat cushion is made of high-density foam covered with fabric in various colors to resemble irregular coral reefs (see Figure A4), finally secured onto the five-pipe plane using snap fasteners (see Figure A5).

Prototype production: First use 3D printing to create a prototype, and select the appropriate scale (see Figure A1).



Fig. A1. 3D printing prototype (Source: From this study)

Physical production: After 1:1 proofing of the physical object, fine-tune the size and then produce the final physical size.



Fig. A2. Air tank manufacturing process (Source: From this study)



Fig. A3. Wood part manufacturing process (Source: From this study)



Fig. A4. The process of making seat cushion soft packs. (Source: From this study)



Fig. A5. Photos of results (Source: From this study)

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