SJ-1: ENERGY EFFICIENCY TRAINING CURRICULA

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Basic Information

Project title:

Please provide the training curriculum title. The title should be brief, unique, and informative.

Aquavoltaics Development, Education, and Environmental & Social Review (ESR)

Project Developer:

Please enter the name of the responsible organization.

Green Energy and Environment Research Laboratories(GEL) of Industrial Technology Research Institute(ITRI)

APEC Economy:

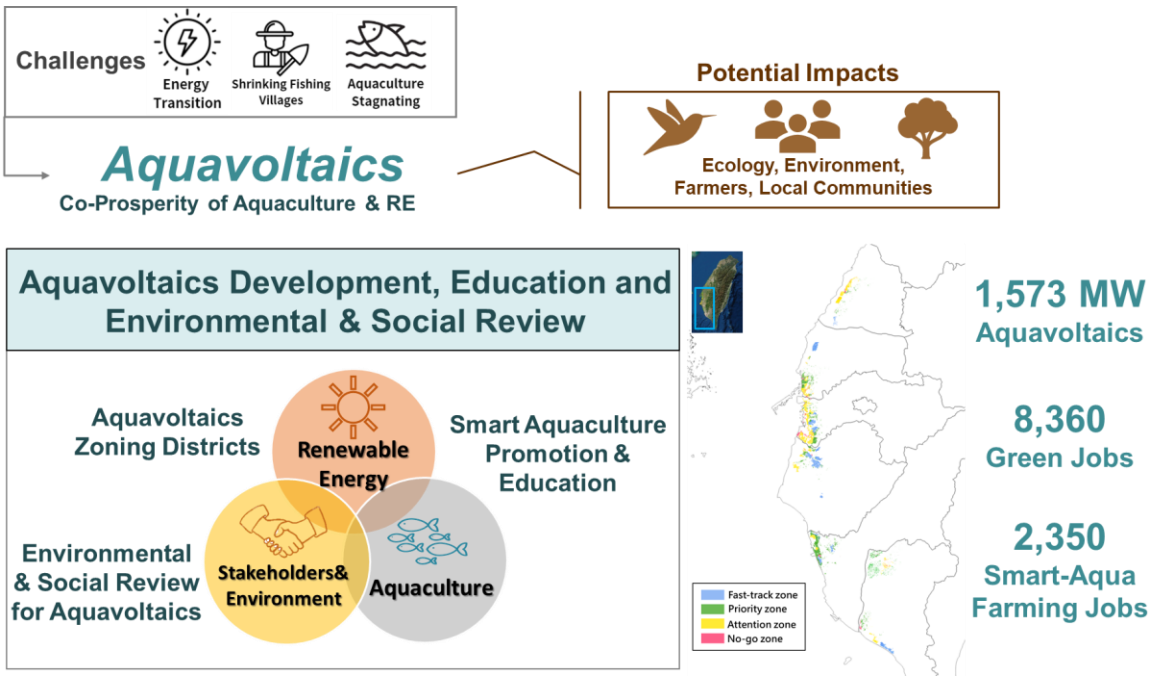
- ☐ Australia
- ☐ Brunei
- ☐ Canada
- ☐ Chile
- ☐ China
- ☐ Hong Kong, China
- ☐ Indonesia
- ☐ Japan
- ☐ Korea
- ☐ Malaysia
- ☐ Mexico
- ☐ New Zealand
- ☐ Papua New Guinea
- ☐ Peru
- ☐ Philippines
- ☐ Russia
- ☐ Singapore
- ☒ Chinese Taipei
- ☐ Thailand
- ☐ United States
- ☐ Viet Nam

Project Overview:

Please provide a brief summary of curriculum, its contents and its purpose.

With the increasing impact of climate change, the aquaculture industry, which many remote fishing villages depend on for their livelihood, has faced significant challenges in recent years. To achieve the goal of energy transition as well as reviving fishing communities, the government launched the "Aquavoltaics" policy aiming for co-development of aquaculture and solar power industries in 2020. However, most of the aquavoltaic systems are located in remote fishing villages, leading to conflicts between the interests of various protected species, natural habitats, and local communities. Hence, to put the concept of co-prosperity of aquavoltaics with society and ecology into practice, this project, “Aquavoltaics Development, Education and Environmental & Social Review (ESR)”, has been initiated, becoming the first and emblematic plan to implement a “Just Energy Transition” in Chinese Taipei.

Through a series of actions, including facilitating stakeholder partnerships, public engagement in decision-making, and capacity-building activities, a total of 20,334 hectares of land across six municipalities have been designated as aquavoltaics zones, introducing the solar PV industry and investment into fishing villages. It also prompted the joint efforts of the public sector, academic experts, and civil societies to help local fish farmers to make the transition to smart aquaculture, providing more low-carbon and sustainable aquatic products to consumer markets. The implementation of this project has brought about many positive changes, not only fostering greener economic development and employment opportunities in fishing communities, but also raising public awareness of equality, inclusivity and sustainable development.



■ Environmental and Social Review for Aquavoltaics - Towards a just energy transition

Despite the global consensus on transitioning to renewable energy sources, green energy developments may still be controversial. In many remote fishing villages where constructions of ground-mounted Aqua-Photovoltaic systems (AquaPV) are underway, conservationists are worried about damage to ecological environment. For instance, PV panels may also be used in wetlands, thus impacting the habitats of water birds (such as Anatidae, Scolopacidae, and Charadriidae like Black-faced Spoonbill, Tufted Duck, Eurasian Curlew, and Nordmann's Greenshank), disrupting their ability to forage and rest. Others are concerned that extensive deployment of PV systems will in turn destroy the rural landscape and quality of life.

The implementation of the "Environmental and Social Review (ESR)" for aquavoltaics centers around the full consideration of stakeholders' interests and impacted environment and includes several steps.

a. This approach leveraged ecological map data first as a tool for environmental impact assessment to reduce negative influence on local ecology and environment.
b. It also investigated the impacts of aquavoltaics on fish farmers, industries, and local communities on various levels. The socio-economic issues, including dimensions of land use, public infrastructure and services, livelihood and economy, social relations, culture and landscape were analyzed.
c. Public engagement activities were then organized to involve all relevant stakeholders (solar PV companies, academia, fish farmers, communities and civil society organizations) in decision making. For instance, developers are required to communicate with all aquaculture households, allowing less-dominant individuals such as female farmers and the elderly to voice their opinions.
d. The environmental and social issues and indicators were identified and consolidated into issue identification reports and guideline documents.
e. A total of 20,334 hectares of land have been classified into four levels – Fast-track Zone, Priority Zone, Attention Zone, and No-go Zone, guiding the aquavoltaic development into less controversial areas. Corresponding measures are recommended for the different zones.

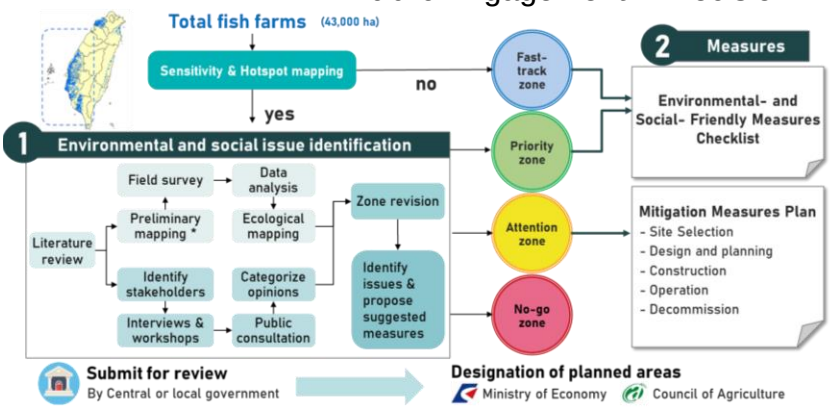
Strong collaborations and engagement among all stakeholders are needed to implement such an approach. For example, solar energy developers must learn from local fish farmers about the local aquaculture practices, and hire local workers for facility maintenance. To maintain the aquaculture yield, developers could restore idle aquaculture ponds and recruiting young farmers. Meanwhile, the farmers ought to learn smart farming techniques, and upgrade their facilities for the smart energy system. The solar energy companies should collaborate with ecologists to design sympathetic project sites which are compatible with the local ecosystem. Therefore, this project provides diverse capacity-building activities to encourage innovation and empower stakeholders of different genders and backgrounds. Local service centers were also established to distribute relevant information and provide long-term support for stakeholder communication. Based on scientific research methods, this approach not only created

tangible environmental and social impact indicators, guideline documents, and standardized processes, but also more importantly incorporated the indicators into regulations. This serves as the first step in implementing a just energy transition and inspires broader societal reflection on green energy development and ecological-social balance.

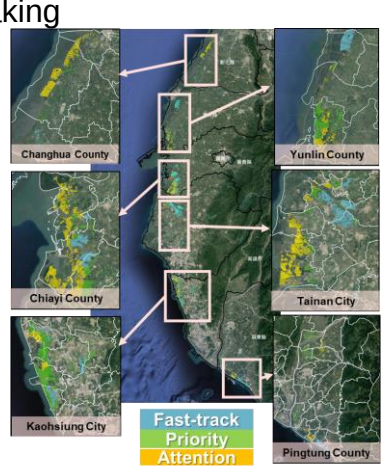
Water Birds Foraging in Fish Farms

Traditional Aquaculture

Public Engagement in Decision-Making



Environmental and Social Review for Aquavoltaics



AquaPV Zones across Six Municipalities

■ Aquavoltaic Economy and Job Creation

Aiming at energy transition, Chinese Taipei has been accelerating deployment of renewable energy as the primary strategy. In promoting ground-mounted solar-PV installations, optimizing land use is the key principle due to limited land resources. Therefore, the government has been promoting aquavoltaics policy since 2020, with a target of installed capacity of 3.5 GW. However, the traditional aquaculture is susceptible to influences of external environment and climate, resulting in unstable yields. Consequently, the labor-intensive and arduous aquaculture work have led to a continuous outflow and aging of the population in fishing communities. According to official statistics, the average age of the fish farmers in aquaculture industry was 59-67 years old in recent years. The total yield from 2019 to 2022 decreased from 269,808 metric tons to 245,103 metric tons. As the yield continued to decline year by year, the waning industry has led to a stagnated development of fishing villages.

The promotion of aquavoltaics policy is crucial to fishing communities. The aquavoltaic systems must be built over embankments or canals of aquaculture farms while also maintaining aquaculture production. With an increasing number of solar PV enterprises investing in the aquaPV development, the local industry has grown considerably and a medley of job opportunities have emerged. Since 2020, 52 aquavoltaics projects have been approved in accordance with the ESR process. With these projects under construction, it is anticipated that a total of 1,573 MW installed capacity of aquaPV will be achieved by 2026, ushering in nearly USD$2.7 billion invested in aquaculture communities, creating employment for 2,350 aquaculture workers and 8,360 green jobs, and boosting the local economy.

In Qiedin, Kaohsiung City, a group of farmers initiated the first AquaPV project to double the use of aquaculture farms. They not only take advantage of revenue from both food production and electricity, but also successfully transitioned to smart aquaculture, developing low-carbon and sustainable aquaculture products.

■ Smart Aquaculture Technology R&D and Talent Cultivation

Fisheries are a significant industry in Chinese Taipei, with inland aquaculture accounting for nearly 40% of the total fisheries production value. Traditional aquaculture products include numerous species (e.g. milkfish, shrimp, and clams), which are raised in open ponds, and are often affected by environmental factors, such as climate condition, water quality, and soil. The production solely relies on farmer's experience and climate. With the worsening climate change, the traditional aquaculture is facing greater impacts as a result. When PV panels are installed over the fishponds, they can prevent cold damage during the winter and reduce water temperature in summer. For instance, the panels can shade part of the water surface, helping to regulate the water temperature in the pond as well as providing farmers a shady place to escape the intense heat of summer. More importantly, the system ushers in additional and stable revenue from green energy, supporting the installation of smart control systems on fish farms, such as energy management systems and environmental control systems, as well as the transition to smart aquaculture farms integrated with green energy. Hence, it not only stabilizes yield but also further enables aquaculture traceability, introducing the supply of lower-carbon, safe, and sustainable aquaculture products into the consumer market.

In addition, according to the Fisheries Census, the average age of aquacultural farmers in aquavoltaics is 55 years old, lower than the average age range of all aquaculture fishermen, which is 59 to 67 years old. This shows that aquavoltaics can attract more younger people to return home and take over their family aquaculture business. Thus, to meet the need of relevant technical talent cultivation, this project offered related technical R&D and training programs. In these programs, we partner with two universities and two aquaculture associations to organize seminars of co-prosperity development of aquavoltaics, exploring AI-powered smart aquaculture technologies. The low-carbon and sustainable oyster-electricity symbiosis platform has also been established to assess the feasibility of combining semi-automated oyster farming platforms with solar PV system and develop related water quality sensing systems. As such, this project not merely facilitated the development of new technologies and cultivated more innovative technical talents, but also promoted the smart transformation of traditional aquaculture to effectively combat the impacts of climate change.

Oyster-electricity symbiosis systems

Smart Aquaculture

How is the material administered?
Self-guided

1. Documents such as the issue identification reports of ESR, response measure guidelines, friendly measure self-assessment form, and aquavoltaics application/installation guidelines have been provided since 2020, and relevant documentation is published on the website of ESR, along with a consultation service window available, for users to browse and work with.
2. Over 20 capacity-building activities have been organized. Academic experts as well as specialists in the ecological environment, public sociology, and aquaculture practices were invited as lecturers, and relevant stakeholders (solar energy developers, aquacultural farmers, local communities, and civil societies) were involved, so as to better the public understanding of the environmental and social review policy content and promote diversified dialogues and exchanges. Presentation materials of each session are available on the website of ESR for users to read and learn.

Assessment Methods (e.g. testing)
Please describe assessment methods for this curriculum here.

1. Since 2020, the project has completed the review and approval of the development permits for 52 aquaPV projects, equivalent to 1,573 MW installed capacity of solar energy, and has been undertaking systematic result assessment of project site development progress. Longer-term statistical analysis of the actual industrial development and employment demographic changes will also be carried out in the future.
2. The project has organized over 20 capacity-building activities and smart aquaculture training programs with participants from the solar and aquaculture industries, as well as other related fields. Activity satisfaction questionnaires and attendance studies of each activity were administered for analysis and used to improve program design and content each year.

Programs for implementing project
Please describe programs for implementing training here.

1. Public Engagement in Decision-Making

AquaPV development is regulated by ESR mechanism. Therefore, this project has established relevant impact indicators and standardized processes for aquavoltaics zoning and project development permit review. Also, to uphold the spirit of justice and inclusion, the project inventoried and created the stakeholder network prior to establishing the relevant processes. This network includes academic experts, local communities, civil societies (e.g. ecological groups and social groups), aquaculture industry (individual fish farmers and aquaculture associations), and solar energy developers (companies and technical personnel). Stakeholders were encouraged to engage in the decision-making process when opinions of stakeholders were solicited via interviews and public briefings.

Then, relevant opinions were aggregated into the impact indicators in ESR to stipulate and improve the review process of development permits.

For instance, in the process of establishing ESR, the project invited academic experts to engage in activities including collaborative gatherings and interviews to create the aquavoltaics co-learning circle. In the process, experts provided advice on the operation and indicators of ESR. A total of 32 academic experts with expertise in energy, environment and ecosystem, socioeconomics, or aquaculture practitioners formed the review board. These academic experts further serve as lecturers in capacity-building activities and provide consultation services to improve understanding of aquavoltaics policy and relevant technologies among stakeholders, thereby establishing the networked resources of various stakeholders and an open and mutually-beneficial partnership.

2. Website of Environmental and Social Review for Aquavoltaics

This project built an ESR website (https://www.sfea.org.tw/) in 2021. The “Zoning Check System” “Application Resources,” and “Activities” are clearly established. Moreover, GIS systems and open data are available to enable users to swiftly find applicable aquaPV zones for planned installations, as well as the relevant issues and documentation involved, so as to lower the barriers to public participation. “Application Resources” offers relevant guidelines and education resources. “Activities” provides information and materials regarding various public policy briefings and capacity-building activities so that users can access information, facilitating communication and learning. As of the end of March 2024, the website had reached over 180,000 views.

3. Capacity-building Activities for ESR

To enhance the knowledge of relevant industries and individuals on the ESR, since 2020, the project has organized 20 sessions of capacity-building activities related to the ESR for local governments, the aquaculture industry, solar energy developers, or teams with the potential for ESR issue identification or response measure execution. For example, there have been workshops on friendly measures and response strategies, writing classes for documents of the ESR, and seminars of collaborative circles for aquavoltaics, among others. These activities have attracted up to 1,373 participants, with an even female-male ratio in the number of participants and a participation rate of 50% each year.

Year	Topic	Session	No. of Participants
2020	Aquaculture Salon in Taixi, Yunlin County	1	10
	Executive Team Consensus-building Meeting	1	55
	Training Course-Aquavoltaic Fast-track Zone Application Procedure	1	41
2021	Executive Team Empowerment Program	4	100
	Aquavoltaics Policy Briefing	1	52
	Aquavoltaics Policy Briefing	2	226
2022	Aquavoltaics ESR Application Document Writing Course	3	317
	ESR Experts Workshop	3	239
2023	ESR Writing Course	3	313
	ESR Capacity-building Workshop	1	20
	Total	20	1373 (even female-male ratio)

4. Local Service Centers

To continue to address the controversies over construction or operation after aquaPV project site development, the project established two local service centers in Tainan City and Chiayi County. Through a group of dedicated consultation staff or organizing public briefings, this allows the public to offer suggestions or seek assistance as well as building communication channels with solar energy developers and local governments. The service centers have assisted with communication and coordination of approximately 100 people since 2022.

5. Smart Aquaculture Technology R&D and Talent Cultivation

In line with aquavoltaics development, low-carbon smart aquaculture products and market demand increased. Hence, the project initiated research and development of smart technologies, such as oyster-electricity symbiosis technology and water quality sensing technology. Regarding the oyster-electricity symbiosis technology, there are approximately 15,496 individuals working on oyster farms, which are well-known to be labor-intensive. However, traditional oyster farming employs tens of thousands of polystyrene-based floating devices, resulting in a challenging waste issue. Solar PV systems combined with oyster farm platform not only replaces the polystyrene forms replaced, preventing plastic waste entering the ocean, but also introduces a smart operating system to assist with farming and harvesting. Additionally, the application of water quality sensing system in the field of aquavoltaics enables remote control of the aquaculture environment and real-time analysis of water quality (e.g. biotoxicity indicators). This enables aquaculture farmers to improve the both products and aquaculture environment for the traceability certification of smart aquaculture.

In addition, the project co-organized the “Seminar of Symbiotic Co-prosperity Development with Aquavoltaics together with Solar PV Generation System Association (PVGSA)” and Aquaculture Development Association in 2023. Two local universities and two local aquaculture associations were invited to provide speakers to talk about topics including an introduction to aquavoltaic policy, AI-powered smart aquaculture technologies, and creation of co-prosperity development with aquavoltaics. The participants included approximately 40 local aquaculture farmers and technical personnel in the solar energy sector.

Appendix

The Aquavoltaics Development, Education and Environmental & Social Review (ESR) project is pioneered to be in line with Chinese Taipei's net-zero target and just energy transition concept. The Industrial Technology Research Institute, a world-leading applied technology research institute, launched this project in 2020 with the long-term support and funding from the public sector.

Project Outline

With many challenges ahead, this project aims to foster a just, smart and low-carbon transition for all in the following way:

Challenges	Strategies	Benefited Groups	Outcomes
Ageing and declining fishing communities	AquaPV zones dedicated and deployment	Solar companies, fish farmers and communities, aquaculture workers	Boosting aquaPV Economy & Job Creation
Eco-Social Impacts of aquaPV	ESR -Public engagement -Capacity building activities	Ecology, academia local communities, civil societies, aquaculture industry	Energy transition with justice and inclusivity
Climate Change Challenges to aquaculture	Smart aquaculture education and outreach	Solar companies, fish farmers and communities, aquaculture workers	Smart transition and talent Cultivation

Key Facts

- **Innovate a clear path** towards energy transition target with **20,334 hectares** of aquaPV zones being designated. This boosts an emerging **aquavoltaics economy** and creates **job opportunities** (2,350 aquaculture workers, 8,360 green jobs, USD$2.7 billion investment to be expected).
- Establish ESR, **the first ever approach** that seeks **co-prosperity** of aquavoltaics with greatly impacted ecology, environment and society and **inspires the society** to fulfill **just energy transition**.
- Public engagement and capacity building activities **empower less-dominant stakeholders,** including **women and the elderly,** to participate in decision making.
- Diverse **education programs** and **communication services** for stakeholders are implemented to help them cope with aquaPV development and adapt to smart transition.
- Approaches of the project, such as ESR and education programs, are standardized, documented, implemented with **assessing methods** including questionnaires and statistical analysis, enabling its **practicability** and **replicability**.
- A total of **1,573MW aquaPV** is expected by 2026, with more to be deployed through this project to achieve the target of **3.5GW**.

Additional Project Details

- Image:
- Please attach an image that represents this project.

- Upload:
- Please attach a file associated with your project.
- Website:
- Please provide the project website.
- Website of Environmental and Social Review for Aquavoltaics (https://www.sfea.org.tw/)

Contact Information

- Contact Name: Ms. Lee Han-Yun.
- Contact Email: hanyunlee@itri.org.tw
- Contact Phone Number: +88627720089 #720