

TA-6619 REG: Marine Aquaculture, Reefs, Renewable Energy, and Ecotourism for Ecosystem Services

Context

Global aquaculture production surpassed wild-caught production in 2017 and is valued at \$250 billion. Per capita consumption of fish is predicted to increase from 13 kg in the 1990s to 22 kg in 2030. The global market for aquarium organisms has been valued at \$4.89 billion and is predicted to grow 11%/year to \$11 billion by 2028. Many countries from China to UAE are building large new public aquariums, creating a new market. Most aquarium fish are caught in the Philippines and Indonesia using cyanide resulting in a high mortality during capture, handling and transport, and damage to coral reefs. The wild-caught food-fish trade has been flat since 1995, and wild stocks of most high-value food-fish such as grouper have been dramatically overfished. After 30 years of research, increasing numbers of both aquarium and food fish and invertebrate species can now be reproduced and grown in aquaculture facilities and sold to the global market. In 2001, Subic Bay Marine Exploratorium, Inc. (SBMEI) opened Ocean Adventure (OA), the first open water marine theme park in SE Asia. SBMEI is famous for providing marine environmental education to thousands of Filipino students, the general public and foreign visitors, and for marine animal rescue and rehabilitation. Now OA would like to enhance its business model by adding solar power, new and rehabilitated coral reefs, and aquaculture facilities to grow marine aquarium fish, shellfish and food fish for sale.

Solution

The ambitious goal of this new business is to replace a significant percentage of the Philippines' wild-caught aquarium fish trade with cultivated fish and invertebrates, and to culture food fish, rehabilitate coral reefs, sell tours of the reefs, sequester carbon dioxide from seawater, protect the coast and to produce solar power to run OA and for sale to the grid. In order to upgrade and fully utilize the \$6m marine theme park and facilities, SBMEI will partner with a team of aquaculture experts from QRS Aqua Inc. and CCell Ltd. an artificial reef company to form Subic Blue, Inc. They will convert under-used buildings and equipment to create a high-volume, full-cycle breeding facility to produce food fish and high-value aquarium species for the international marine aquarium trade.

Technology

1. Regenerative Aquaculture/Artificial Reefs/Carbon Sequestration: New proprietary breeding techniques will be used to raise (full-cycle, tank-born) fish and invertebrates for local sale and export to the global aquarium and seafood markets starting with 30+ species and a production target of 1m animals per year. A percentage of the multi-species production (fish and inverts) will be placed on 1 ha of coral reefs damaged by Mt. Pinatubo ash. Solar powered Artificial Reefs (ARs) will remove carbon dioxide from seawater by causing calcium carbonate to accrete onto metal ARs, increasing habitat structure for cultured reef fish, and will serve as pens for invertebrate culture on sandy seabed. The ARs also will attenuate waves and help to protect the coast and planned OA Green Yacht E-marina from wave action. Multi-trophic aquaculture will be set up at different depths and in different water columns. For example, mussels and algae will be grown along mooring lines, while sea cucumbers, giant clams and sea urchins will be grown in AR cages on the seabed. All will help remove excess nutrients from fish farming activity and improve water quality. Selectively-bred heat-tolerant coral micro-fragments will be grown for restocking marine protected areas locally and elsewhere in the Philippines (target 175,000/year) thus increasing resilience of coral reefs.

2. Renewable Energy: 1MW of rooftop solar will be installed with 30% excess capacity for profitable 'Power to X' projects and energy sales back to the Subic grid and used to power AR calcium carbonate deposition, dockside high-voltage E-vessel (boat) and car charging stations for OA and visitor vehicles.

3. Ecotourism: Solar electric glass-bottom guided boat tours of coral reefs, ARs, mangroves and aquaculture operations along with underwater reef cams installed so that adopt-a-coral or fish patrons can watch their adopted animals online, and students can participate both directly and remotely to track their reef science projects.

PROJECT SUMMARY

PROJECT NAME:

Subic Blue

CAPITAL COST:

\$ 5.1 million

DEVELOPER:

QRS Aqua Inc. & CCell Ltd.

PROJECT HOST:

Subic Bay Marine Exploratorium, Inc. (Ocean Adventure)

GEOGRAPHICAL LOCATION:

Subic Bay Freeport Zone, Philippines

TYPE OF PROJECT:

Renewable Energy, Aquaculture (Aquarium and Food Fish), Ecotourism, Coral Reef Rehabilitation, Coastal Protection, Carbon storage

PROJECT TIMELINE:

2023-2028

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Business Model

Sales of cultured organisms will produce most of the \$7.3 million pre-tax cash flow in years 2 to 5 (see page 4). Because the cultured organisms are not wild caught with cyanide, mortality is reduced, and a premium price can be obtained. For example, a wild-caught Mandarin goby sells for \$50 while a cultured goby sells for \$159. Food fish and invertebrates will be sold to wholesale fish and shellfish traders at premium prices. Milkfish fingerlings will be sold to aquaculture facilities in the Philippines (production target of 2m fingerlings/year). The estimated annual savings of US\$300,000/year from generating the majority of SBMEI's energy needs from a solar energy system will pay the capital costs of the infrastructure upgrades, while increasing energy availability for SBMEI, and provides a 'power to X' opportunity for SBMEI when revenues using excess energy can be realized during daylight hours in excess of US\$0.06/KWH. Solar powered metal ARs will cause calcium carbonate accretion that speeds up coral growth so that the ARs will be an attraction for snorkel and boat tours along 1 km of coastline. New fish culture displays for visitors, will increase 'edu-tainment' services marketed to school groups and companies for retreats.

Financing

The initial investment of \$5.1 million is expected to produce cumulative pre-tax cash flow of \$7.3M in years 2 to 5, and cumulative pre-tax cash flow of \$29M in years 2 to 10. Funds will be used to upgrade and expand existing facilities, *ex situ* fingerling nurseries, organizational cost including recruiting and training of new staff, and operating losses for the first two years. OA will contribute lagoons, land, buildings and equipment to the new venture at discounted rates. A hybrid financial model of debt plus equity will reduce shareholder dilution. US\$3m equity financing and \$2m debt financing/credit line will meet CAPEX needs and short-term operating expenses.

Results

The new facilities will be the first aquarium fish farm and coral nursery in the Philippines, and the only operation producing large quantities of dozens of tropical fish for sale and for placement back onto protected reefs. In addition to bringing a new regenerative business to SBMEI, the new operations will create an additional 30+ jobs, provide solar energy for SBMEI and the local grid, rehabilitate local coral reefs damaged by Pinatubo volcano ash and provide real-life marine education to thousands of tourists and students from the Philippines and overseas.

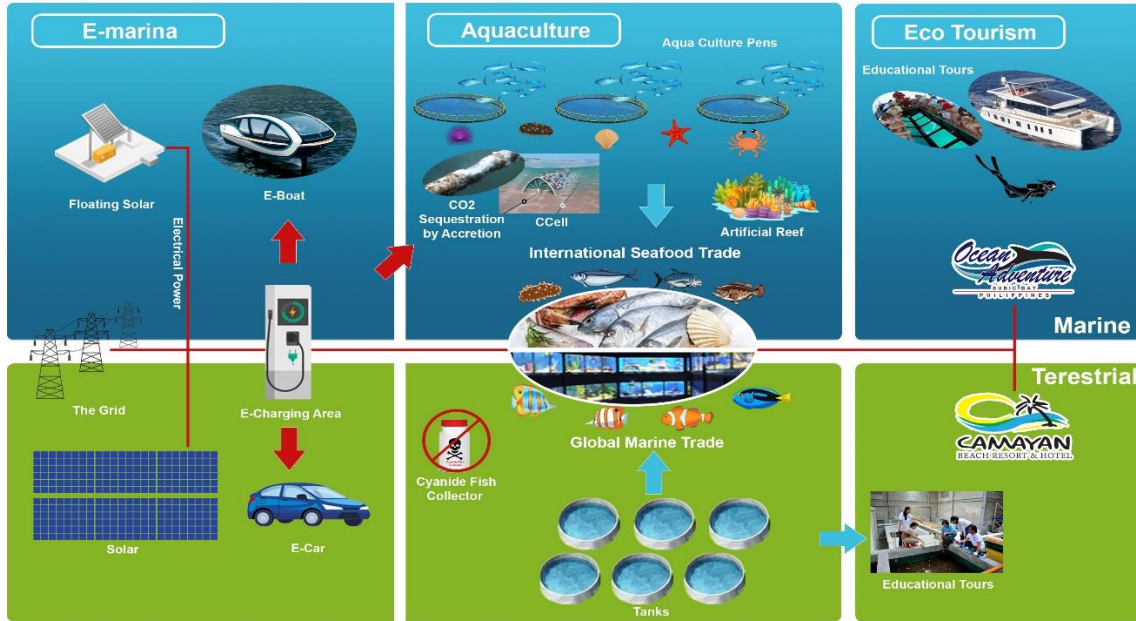
Lessons Learned

Cultured aquarium fish are worth far more per pound than most food fish. The average food fish sells for \$7.50/kg whereas cultured tropical fish for the aquarium industry average over \$725/kg with some rare hybrid Angelfish selling for over US\$8,000 each. However, a few food fish such as the Napoleon wrasse can be cultured, and can sell for as much as \$100/kg in Chinese restaurants. Most of these fish are severely overfished in most locations.

Developer

Three companies -- QRS Aqua Inc., SBMEI/OA and CCell Ltd. are committed to working closely to make Subic Blue successful. Together their Boards, staff and teams of experts have expertise and dozens of years of experience in the aquaculture farming, sales, marine science and governance, engineering, law, aquarium design, restoration ecology, renewable energy and culture of dozens of different species of high-value tropical fish and invertebrates. QRS provides aquaculture project management and technology services specializing in tropical marine ornamental organisms and seafood. QRS brings innovation, deep sectoral knowledge, and aquarium trade connections to generate scalable, efficient, science-guided, and ethical production and sales of fish and invertebrates. The QRS CEO, Mark Dimzon has 20 years' experience in aquaculture including SEAFDEC, Underwater World Singapore, Dubai Mall Aquarium and Underwater Zoo, Waikiki Aquarium, Honolulu and The National Aquarium of Abu Dhabi, UAE. SBMEI's OA has a long history of culturing marine organisms for ocean education, and is ready to expand the culture operations for reef rehabilitation and sales of organisms to reduce wild catch. Ocean Adventure's advocacy for environmental protection and its corporate social responsibility programs are strongly supported by the SBMEI Board which includes internationally renowned animal behaviorist and conservationist Gail E. Laule. OA's team will be led by a co-founder Scott Sharpe who has 30 years' experience in marine operations. CCell designs and builds digitized, solar powered ARs to grow calcium carbonate rock and mimic the behavior of natural coral reefs. These structures protect the coastline from waves and provide an ideal habitat for a wide range of marine life. C-cell ARs will reduce carbon dioxide, create more reef habitat on the damaged reefs in Subic Bay, and help to regenerate coral reef organisms while serving as an aquaculture habitat and tourism site.

SUBIC BLUE Marine Resource Center



TA6619 MARES - Marine Aquaculture, Reefs, Renewable Energy and Ecosystem Services

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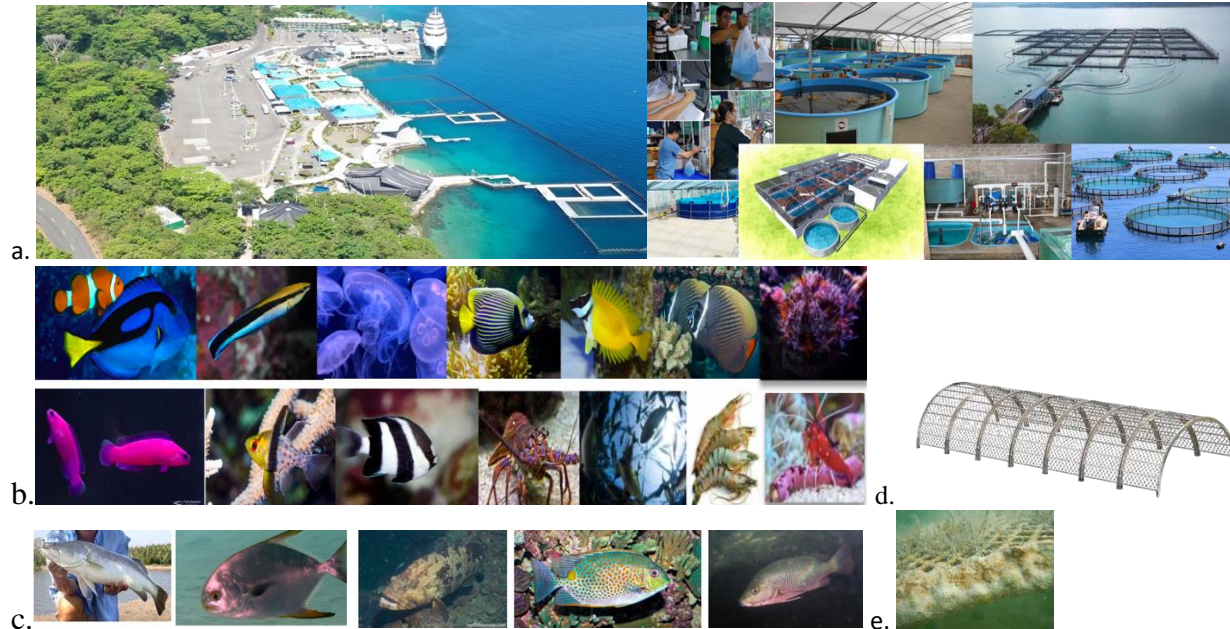


Figure a. Ocean Adventure, Subic and aquaculture cages. b. Marine aquarium fish and invertebrate species and c. food fish. d. Solar powered metal Artificial Reef with e. carbonate accretion to enhance coral growth and removing carbon dioxide from seawater.

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Item	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Renewable Energy										
Capital Cost (1)	\$ 1,750,000									
Revenue (2)	\$ 72,000	\$ 180,000	\$ 180,000	\$ 180,000	\$ 180,000	\$ 180,000	\$ 180,000	\$ 180,000	\$ 180,000	\$ 180,000
Costs (3)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Marine Aquaculture										
Capital Cost	\$ 2,000,000									
Revenue (4)	\$ -	\$ 1,800,000	\$ 2,700,000	\$ 3,510,000	\$ 4,563,000	\$ 5,019,300	\$ 5,521,230	\$ 6,073,353	\$ 6,680,688	\$ 7,348,757
Costs (4)	\$ (1,065,000)	\$ (1,374,000)	\$ (1,488,275)	\$ (1,620,346)	\$ (1,766,487)	\$ (1,938,097)	\$ (2,126,716)	\$ (2,334,037)	\$ (2,561,923)	\$ (2,812,422)
Rigs, Reefs & Defenses										
Capital Cost	\$ 500,000	\$ 500,000								
Revenue (5)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 1,500,000	\$ -	\$ -	\$ -	\$ -
Costs (6)	\$ (12,000)	\$ (13,200)	\$ (14,520)	\$ (15,972)	\$ (17,569)	\$ (19,326)	\$ (21,259)	\$ (23,385)	\$ (25,723)	\$ (28,295)
Marine EcoTourism										
Capital Cost	\$ 300,000				\$ 50,000					
Revenue	\$ 73,000	\$ 109,500	\$ 120,450	\$ 132,495	\$ 145,745	\$ 160,319	\$ 176,351	\$ 193,986	\$ 213,385	\$ 234,723
Costs (7)	\$ (36,000)	\$ (39,600)	\$ (43,560)	\$ (47,916)	\$ (52,708)	\$ (57,978)	\$ (63,776)	\$ (70,154)	\$ (77,169)	\$ (84,886)
Co- Benefits										
Jobs (pax)	25	30	35	40	40	40	45	50	50	50
CarbReduct (TCO2e)	4	4	4	4	4	4	4	4	4	4
Total Cap Cost	\$ (4,550,000)	\$ (500,000)			\$ (50,000)					
TotalCashflow	\$ (968,000)	\$ 662,700	\$ 1,454,095	\$ 2,138,261	\$ 3,051,981	\$ 4,844,218	\$ 3,665,830	\$ 4,019,763	\$ 4,409,258	\$ 4,837,877
IRR	21%									
NPV @7.5% Disc rate	\$16,819,953									
(1) Solar panels, inverters and installation \$900,000. Battery storage, car park structures \$850,000										
(2) Revenue will come from SBMEI total electric bill savings, currently at \$50,000 per month using grid power.										
(3) All costs to clean and maintain systems will be paid by SBMEI from its share of savings										
(4) Worst case scenario - 35% of physical capacity. Revenue is farm gate prices = 20% of retail price - 10% sales costs										
(5) Nominal revenue from invertebrate sales and eco tourism is included in MAQ and MET projections. \$1.5M in 2029 will come from investor in E-Marina/Resort										
(6) Maintenance costs										
(7) Drivers/guides/maintenance, with refit in 2028										