# The Six$^{th}$ Naphtha Cracking Project and Economic Development

A Land Expansion Project that Will Elevate National Economic Competitiveness

Coexistence and mutual prosperity of "industry" and "ecology"

## *The petrochemical industry is intimately associated with our daily lives*

Petrochemical products are around in practically every aspect of our lives; things we see and use everyday, such as toothbrush, towel, food container, clothes, building materials, decorative materials, transportation vehicles, amusement machines, medical devices, 3C and high-tech products, have petrochemical components in them. One example can depict the importance of petrochemical industry in its application to the apparel industry. A synthetic fiber factory with an annual output of 90,000 tons only occupies an area of 5,000 square meters (roughly the size of a soccer field). But to produce an equal amount of wool requires a pastureland as big as 40,000 square kilometers (bigger than the total area of Taiwan). Based on Taiwan's output of synthetic fibers in 2018 at 1.58 million tons, we need an area 20 times as big as Taiwan in order to produce the same amount of wool. Intimately associated with our lives, petrochemical industry not only provides us with comfort and high-quality living, it is also an indispensable industry to the development of economy and technology civilization.


## *Characteristics of Taiwan's petrochemical industry and its underlying problems*

Taiwan's petrochemical industry was developed as an integrated system, with upstream, midstream and downstream segments intimately linked. Such a system, having achieved considerable scale in the past few decades, is unique in the world and has assisted in the development of Taiwan's economy.

Before The Six[th] Naphtha Cracker Project, the self-sufficiency rate of ethylene in Taiwan was only 38%. As a direct result of the Project, the self-sufficiency rate is over 100% now.In addition, a portion of the products produced by The Six[th] Naphtha Cracker Plant is available for export, mainly to Taiwanese merchants in China. The remainder is used domestically for midstream and downstream plants for processing and export. This has enabled these producers to be free from import pricing and supply disruptions; they have become more competitive in the international marketplace.

At the present, however, the petrochemical industry in Taiwan remains susceptible to adverse market forces both at home and abroad. For example, the country still depends heavily on imported raw materials, such as IIR, to make inner tubes and light oil – light oil imports reached 7 million tons each year. Taiwan must be self-sufficient in these types of materials to ensure that its industries will be free from uncertain global raw material prices and availability.

Also, world-class petrochemical plants have started up in China and the Middle East. The output of ethylene from just the Middle East may account for up to 20% of the world's total ethylene output. These plants' low cost advantage will have an adverse economic impact on the petrochemical industry in Taiwan. Also, Europe, United States and Japan are actively expanding related facilities. Thus, petrochemical industry is not an energy-consuming, low efficiency industry. On the contrary, for a country like Taiwan that is scarce in land and densely populated, it is a vital industry that is essential for creating economic prosperity and elevating living standard.

The total output of Taiwan's petrochemical industry accounts 28.2% of that of the manufacturing industry. The importance of petrochemical to Taiwan can be seen. Petrochemical related companies in Taiwan should focus on the R&D and manufacture of high value added products to retain their global competitiveness.


## *The inception of The Six$^{th}$ Naphtha Cracker Project*

In view of the long-term shortage of basic petrochemical materials in Taiwan that dampened development of the midstream and downstream petrochemical industries, Formosa Plastics Group proposed The Six$^{th}$ Naphtha Cracker Project for alleviating the problem and acquired government approval in 1986. The first selection for the project site was a 280-hectare property in Lizi, Yi-Lan. Due to subsequent irrational objections of local opposition, the project was moved to Guanyin, Taoyuan in 1988, and then aborted for similar reasons.

In 1991, with blessings of both the local government and the residents, the project chose to settle down in the off-shore industrial zones in Yunlin County of Mailiao and Haifong, by way of reclamation, for building up an oil refinery plant with annual capacity of 25 million tons of crude oil, naphtha cracker plants for producing 2.94 million tons ethylene per annum, and other petrochemical plants, heavy machinery plants, a co-generation plant, and the Mailiao Industrial Harbor. In addition, in view of the serious power shortage in Taiwan, which impacts greatly on people's lives as well as on businesses, a thermal power plant with a capacity of 3 million kilowatts was therefore planned; all of the generated power will be incorporated into the TPC power supply system, for assisting on the relief of the domestic power shortage.

Total investment of 53 plants in the four phases of The Six$^{th}$ Naphtha Cracker Project, including the industrial harbor and the power plant, was US$27.39 billion, and the project was completed and has already began production.

## *Land reclamation*

The Mailiao and Haifong Zones that accommodate The Six[th] Naphtha Cracker Project are situated at the estuary of Chuoshui Creek at the northern end of Yunlin County. Approximately 8 km long from south to north, the area extends more than 4 km along the coastline out toward the sea. A great portion of the land lies below sea level most of the time and one can observe some sandy land at low tide which is totally submerged during high tide. The Cracker Project required massive land reclamation efforts to create 2,255 hectares of new land. Since the two sections have a waterway segregating them from the fish farms along the coast, geological improvement to shore up the foundation was required before the plants could be built.



Land reclamation was carried out by first constructing dike of stone in the sea and enclosed the area expected to be the base of plant, then sand was extracted from government-sanctioned waters to level up the area inside the embankment.

Mailiao is located in a region that is commonly dubbed "head of the windstorm and end of the waterflow," with the northeast monsoon blowing half of the year. Inconvenient transportation and poor weather made the reclamation work doubly formidable. It is truly a giant undertaking to turn sea into mulberry fields.

Pipeline end of land reclamation

land reclamation

Transformed the ocean into land as the plant base.

Mailiao Harbor is the first industrial port in Asia to win EcoPorts Certification

## *The Six[th] Naphtha Cracker Project / magnitude and facilities*

### 1. Civil works

- **Land reclamation :** 109.15 million cubic meters of sand were poured to create land, sufficient in volume to construct a three story tall, eight-lane wide building along the 373 km-long stretch of freeway from Keelung to Kaohsiung. The total area of reclaimed land is 2,255 hectares, about 8% the size of Taipei City (27,180 hectares) or equal to 0.062% of Taiwan's land area.
- **Engineering foundation :** The total length of piles driven amounted to 4.7 million meters and the total amount of concrete used reached 9.04 million cubic meters (approximately 1.97 million tons cement).
- **Plant construction :** 53 plants were built within a single complex, including oil refineries, naphtha cracker plants, co-generation plants, power plants, heavy machinery plants, boiler plants, wafer fabrication plants and petrochemical-related plants. Piping inside the plant area alone extends for 3,000 km.
- **Complex area :** The area of the entire complex totals 2,603 hectares, more than four times the total of the Linyuan (403 ha),Dashe (109 ha), and Toufen (95 ha) petrochemical industrial zones.




EcoPorts Certification granted to Mailiao Harbor on September 7, 2018.

The water quality in Mailiao Harbor is good, which provides the white-spotted puffer and other tropical fishes a fine habitat.

### 2. Mailiao Harbor

Mailiao Harbor occupies an area of 476 hectares. With a water depth of 24 meters during midtide, the harbor can accommodate 300,000 ton vessels. It is also the first industrial harbor that is privately invested, developed and constructed. Moreover, Mailiao Harbor is the first industrial port in Asia to win EcoPorts Certification. It is the second-largest harbor in Taiwan with a cargo throughput up to 70 million tons per year, trailing only behind that of Kaohsiung Harbor. Although Mailiao Harbor was constructed for industrial purposes, its operations in Yunlin County incorporates the vast adjacent hinterland area into the port zone. Consequently, the access to convenient marine transportation promotes development of local industry.

Chinese white dolphins can be seen taking a leisurely swim, reflecting the balance that has been achieved between economy and ecology.

Independent power plant has helped ease Taiwan's power shortage.

### 3. Independent power plant

The Project includes a large thermal power plant equipped with three power generation units that each generate 600,000 kW of electricity, for a total generating capacity of 1.8 million kW. All electricity generated has been sold to the Taiwan Power Company and incorporated into the national power grid. This contribution has helped ease Taiwan's power shortage.

### 4. Oil refinery

Upon the completion of the Phase IV expansion, refining 540 thousand barrels of crude per day, the equivalent of 25 million tons of petroleum annually, The naphtha capacity increased to 3.75 million tons/year, which is sufficient to supply for the entire Mailiao Complex. Other petroleum products, including gasoline, diesel and kerosene are exported to overseas markets.

### 5. Naphtha cracker plant

There are three naphtha cracking plants (NCP,) producing ethylene, propylene, and butadiene. Ethylene capacity is 2.935 million tons annually, the biggest capacity in Taiwan and the largest single-plant area capacity in Asia, supplying people's livelihood, special chemicals, information, high-tech and other industries. The plants are industrial infrastructure of national importance.



### 6. Co-generation plant

The plant is designated to generate electricity, steam, and water for industrial use, as well as produce hyperpure water, nitrogen, oxygen, and compressed air for use by plants within the complex. The largest co-generation plant in Taiwan, it has 16 generation sets with a total capacity of 2.75 million kW. After supplying onsite manufacturing needs, excess electricity is sold to Taiwan Power Company to ease Taiwan's power shortage.

### 7. Machinery Shop and Boiler Shop

The machinery shop mainly engages in the design, manufacture, installation , and construction of oil refining and petrochemical process equipment such as reactors, towers, pressure vessels, heat exchanger, etc. We have obtained ASME S, U, U2 & R certificates. The overall manufacturing capability is 12M$^{\varnothing}$x120MLx2000MT, it means the actual capability of producing a single equipment is up to 12 meters in diameter, 120 meters in length and 2,000 tons in weight. The Cogeneration Department and the boiler shop thereof engage in planning, design, manufacturing, installation, and construction of 50-150MW cogeneration plants and the power plants with capacity up to 600MW for Independent Power Producers (IPP).

### 8. Silicon Wafer plant

This wafer plant is a joint venture owned by Formosa Plastics, Asia-Pacific Investment and Japan's SUMCO TECHXIV CORPORATION for the production of silicon wafers used in semi-conductor, with an annual capacity of 3.84 million pieces for 200mm and 3.36 million pieces for 300mm. Silicon wafers are the most important substrate materials for integrated circuit of semiconductors and are also supplied for use as solar battery substrate material.

### 9. Formosa Asahi Spandex Co. Ltd.

Formosa Asahi Spandex Co. Ltd., with an annual capacity of 5,000 MT for spandex and 21,000 MT for polytetramethylene ether glycol (PTMG), is a joint venture between Formosa Plastics and Asahi Kasei of Japan. Spandex is widely used in functional clothes and medical products and has become an indispensable added fiber in manmade fibers.


Huge Tower


PP Reactor


Application of Spandex fiber

Silicon Wafer plant

## *The Six[th] Naphtha Cracker Project Investments*

| Product Category | Investing Company | Factory | Product | Capacity (10000 MT/Y unless otherwise noted) |
|---|---|---|---|---|
| **Petroleum Products** | **Formosa Petrochemical Corp.** | Refinery plant | Naphtha, gasoline, diesel | 2,500(Refinery) |
| | **Simosa Oil Co, Ltd.** | Asphalt plant | Asphalt | 30 |
| **Petrochemicals & Chemical Products** | **Formosa Plastics Corp.** | Acrylic Acid & Ester plant | AA/AE | 10.8/15.4 |
| | | Polyvinyl Chloride plant | PVC | 49.8 |
| | | Vinyl Chloride Monomer plant | VCM | 80 |
| | | High Density Polyethylene plant | Caustic Soda | 133 |
| | | Caustic Soda plant | HDPE | 35 |
| | | Ethylene-Vinyl Acetate plant | EVA | 24 |
| | | Acrylonitrile plant | AN | 28 |
| | | Linear Low Density Polyethylene plant | LLDPE | 26.4 |
| | | Methyl Methacrylate plant | MMA | 9.8 |
| | | C4 plant | MTBE/B-1 | 17.4/3.2 |
| | | Epichlorohydrin plant | ECH | 10 |
| | | NBA plant | NBA | 25 |
| | | SAP plant | SAP | 6 |
| | **Nan Ya Plastics Corp.** | Plasticizer plant | Plasticizers | 44 |
| | | Epoxy Resin plant | EPOXY | 16 |
| | | Propionic Anhydride plant | PA | 22.8 |
| | | Isooctanol plant | 2EH | 20 |
| | | Bisphenol A plant | BPA | 42 |
| | | Ethylene Glycol plant | EG | 144 |
| | | Hydrogen Peroxide plant | ESO/$H_2O_2$ | 2/2 |
| | | 1,4-Butylene Glycol plant | 1,4BG | 12 |
| | | Iso-nonyl Alcohol plant | INA | 11.5 |
| | | Maleic Anhydride plant | MA | 6 |
| | **Formosa Chemicals & Fibre Corp.** | Aromatic Hydrocarbon plant | BZ/PX/OX/MX | 133/197/48/10 |
| | | Styrene Monomer plant | SM | 132 |
| | | Purified Terphthalic Acid plant | PTA | 110 |
| | | Phenol Synthesis plant | PHENOL/ACETONE | 44/27.1 |
| | | Polypropylene plant | PP | 60 |
| | | PABS plant | PS/ABS/PBT | 20/14/3 |
| | | Polycarbonate plant | PC | 20 |
| | **Formosa Petrochemical Corp.** | Naphtha Cracker plant | Ethylene | 293.5 |
| | **Formosa BP Chemicals Corp.** | Acetic Acid Plant | HAC | 30 |
| | **Nan Chung Petrochemical Corp.** | Ethylene Glycol plant | EG | 36 |
| **Fiber** | **Formosa Plastics Corp.** | Carbon Fiber plant | Carbon Fiber | 0.88 |
| | **Formosa Asahi Spandex Co.** | Spandex plant | SPANDEX/PTMG | 0.5/2.1 |
| **Power Generation** | **Formosa Petrochemical Corp.** | Utilities Supply plant | Steam<br>Electricity | 11,580 T/H<br>2,754MW |
| | **Mailiao Power Corp.** | Power station | Electricity | 600MW X 3 |
| **Electro-Mechanical** | **Formosa Heavy Industries Corp.** | Equipment for Machinery Shop | Equipment for refinery, petrochemical plants | 4.3 |
| | | Boiler Shop | Equipment for Cogeneration and utility power plants | 500T/H X 4ST |
| **Electronics** | **Formosa Sumco Technology Corp.** | Wafer fabrication plant | 8-inch wafers<br>12-inch wafers | 3.84million pcs.<br>3.36million pcs. |

Mailiao Industrial Complex - FPG seeks common prosperity and sustainability for industry and ecology


Wang Zhan-Yang Memorial Park in Mailiao Industrial Complex

## *Environmental Protection Plan in The Six$^{th}$ Naphtha Cracker Project*

In order to reinforce our environmental protection, FPG established Safety Health & Environment Center to monitor and control the air, wastewater, waste articles, noise and ecological environment conditions. We adopted most advanced Best Available Control Technology (BACT) to reduce the negative impacts on the environment. The invested budget for pollution control and prevention is about US$3.99 billion. The outcome is very significant. It not only surpasses our national official standards but also meet the standards of the most developed countries.

Take the air pollution as an example, in the thermal power plant, we adopt sealed systems for coal transportation and storage in order to prevent the coal dust or ashes blown out of the system to cause pollution. All of the emitted gas has to pass various treatments, such as ventilated denitrification and desulfuration, static electricity dust collection to make sure the pollutants were eliminated before the gas emitted. As to water pollution control, we set up 8 comprehensive wastewater processing pools. Before flowing out, all of the wastewater will be well treated by chemical and biological process treatments. It's proven the flown out wastewater is clean for keeping the carps. Meanwhile, Mailiao Industrial Complex is the only complex which process waste within the complex area in Taiwan. We have 2 incin erators which can process 150 tons of waste daily, a immobilization factory, a landfill site and an ash pond.

Energy saving projects have reduced 10.3 million tons of $CO_2$ emissions = Equivalent to carbon capture of 27,798 Daan Forest Park

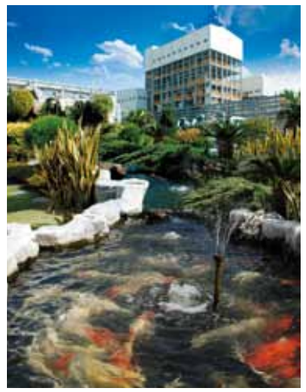
Water saving projects have reduced 98.8 million tons of water consumption per year = 43,930 Olympic-size swimming pools



Flocks of black-tailed gulls are searching for food in Mailiao harbor area.

A Taiwan blue magpie is walking around the Mailiao Industrial Complex.

Wang Zhan-Yang Memorial Park in Mailiao Industrial Complex



Discharged water with proper treatment can be used to breed koi carp.

## *Circular Economy at Mailiao Industrial Complex*

In order to achieve the best profit-making point between economic development and environmental ecology, FPG established the "Energy Saving and Carbon Reduction and Pollution Prevention Promotion Organization" in 2007, with a long-term investment in human resources and material resources, promote energy saving and emission reduction and cross-company, cross-factory energy resources integration work.

The organization has conducted several projects to reduce water consumption, including process water reduction and wastewater and rainwater recycling. As a result, the complex has attained a water recycling rate of 86.2%. According to calculation, the Mailiao complex uses every drop of water 7.3 times. In addition, 1,779 water saving projects have reduced 98.8 million tons of water consumption per year. This amount is equivalent to the water consumed by 1,083,000 people in one year. This is also equivalent to conserving water of 43,930 Olympic-size swimming pools.

On the energy front, task groups also put in a lot of efforts to slow global warming effect and to improve energy efficiency, as well as to improve heat recovery and to develop alternative energy such as wind turbines. Up to the end of 2018, FPG has conducted 5,980 energy saving projects at Mailiao Industrial Complex. It has reduced 10.3 million tons of $CO_2$ emissions, which is equivalent to 1,452 million trees' carbon uptaking for one year. This is also equivalent to carbon capture of 27,798 Daan Forest Park.

Improve energy efficiency, as well as to improve heat recovery

Mailiao Industrial Complex is the only complex which process waste within the complex area in Taiwan


As a gesture of gratitude for the increased sponsorship in school lunch from FPG, Magistrate Chang Li-shan invited the Chairman of FPG to join lunch with students at Zhen-Dong Elementary School in Yunlin

## *Feedback to the local community*

There were only a few agricultural activities and fishing pools in the early development stage of Mailiao area. Due to poor geographical and weather conditions, the area lacks resources and faces severe problem of brain drain. However, the Sixth Naphtha Cracking Project has created many employment opportunities and has brought economic prosperity to Mailiao Township. The presence of various shops has gradually enriched local life. Mailiao is also the only township seeing population growth in Yunlin in recent years.

Formosa Plastics Group has always adhered to the concept of "taken from the society to benefit the society", giving feedbacks to society through practical actions, combining corporate resources and creating a better community together with its neighbors.

### Local Infrastructure

FPG has always valued its work on education, fostering talent over decades. In addition to establishing schools, FPG has been a dedicated participant in reconstruction projects of old school buildings and a sponsor of school lunch for students in Yunlin. At the same time, it has successively donated public facilities to Mailiao and the neighboring townships. Both software and hardware equipment are also provided for free to the disadvantaged groups. FPG concerns and takes care of the community in the most practical way.



### Health Improvement

In order to provide quality health care for local residents, Formosa Plastics Group has conducted health improvement project and established Yunlin Chang Gung Memorial Hospital to improve local medical services and quality. Residents can get good medical care without time-consuming transportation.

### Agriculture and Fishery Counseling

Formosa Plastics Group cooperates with professional academic teams to promote agriculture and fishery counseling programs, assisting local farmers and fishermen by introducing a scientific management model called "less pesticides and less antibiotics", turning Mailiao into a township of non-toxic agriculture. In addition, local agriculture and fishery are promoted by marketing campaigns, and in recent years, the products such as lettuce, Taiwan tilapia, and tomatoes from Mailiao have been well-received by international markets.

Yunlin Chang Gung Memorial Hospital increases the medical quality for local residents

Free health check and care for local residents

Coaching of agricultural and fishing industries to assist in the development of local agricultural and fishing industries

Sponsoring the cultural and artistic performance in the countryside to inject cultural atmosphere

### Culture Cultivating

Mailiao is located in the coastal zone, where there are few opportunities to see performing arts. Formosa Plastics Group has sponsored a number of Taiwanese arts and cultural groups such as Taiwanese opera troupes, puppet troupes, children theater troupes, etc., in the hope of bringing shows and performances to nearby towns as well as a cultural atmosphere. By doing so, the arts and cultural groups can also obtain capital and applause to gradually grow and prosper.

## Projected economic contributions

Total investment in one to four phase of The Six[th] Naphtha Cracker Project is US$27.39 billion, of which environment protection budget is US$3.99 billion. The contributions of The Six[th] Naphtha Cracker Project to Taiwan are multiple. It boosts the confidence of the private sector, stabilizes development of the petrochemical industry, promotes upgrade of the petrochemical industry and balanced regional development, and shortens the gap between city and countryside. Other materialized benefits of the project include:

- The self-sufficiency rate of ethylene increased from 38% in 1994 to over 100% in 2018.
- Annual production value in 2018 has reached US$45.02 billion.
- Increasing government tax revenue by an average of at least US$586 million annually over the past 5 year.
- It leads the middle and down stream industries development and improves industrial output and working opportunities.
- Mailiao Harbor offers a more accessible gateway to local commerce, and improves the economic growth for the region.
- The excess electricity of the power plant will solve the problem of power shortage in Taiwan.
- We created land area of 2,255 hectares for Taiwan.



## Outlook for the future

In its more than six decades of operations, Formosa Plastics Group, approaching everything with the attitude of "seeking perfection," has been adhering to the spirit of "diligence and simplicity" and the goal of developing manufacturing industry to make a contribution to the national economy. Taiwan is an island country characterized by scarce resources and a small domestic market. Most products must rely on export. Only by observing the traditional virtue of industriousness and persistently seeking the development of manufacturing industry can the country maintain its economic growth. That is why Formosa Plastics Group has surmounted towering obstacles to push for The Six[th] Naphtha Cracker Project. Thanks to assistance and support from all sectors, we will put forth all our efforts to complete this gigantic undertaking and establish a new milestone for the economic development of the country. We beseech your continuing support and advice. Let us work together to create a better tomorrow.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