



經濟部能源局

BUREAU OF ENERGY, MINISTRY OF ECONOMIC AFFAIRS



12 Key Strategies for Taiwan' s 2050 Net-Zero Transition (Draft)

Key Strategy 1 - Wind/Solar PV

Bureau of Energy, MOEA



Outline

- 1. Status Analysis**
- 2. Goal and Pathway**
- 3. Promotion Schedule**
- 4. Administration Responsibilities**
- 5. Strategies and Measures**
- 6. Expected Benefits**
- 7. Supervision and Management Mechanism**
- 8. Conclusion**



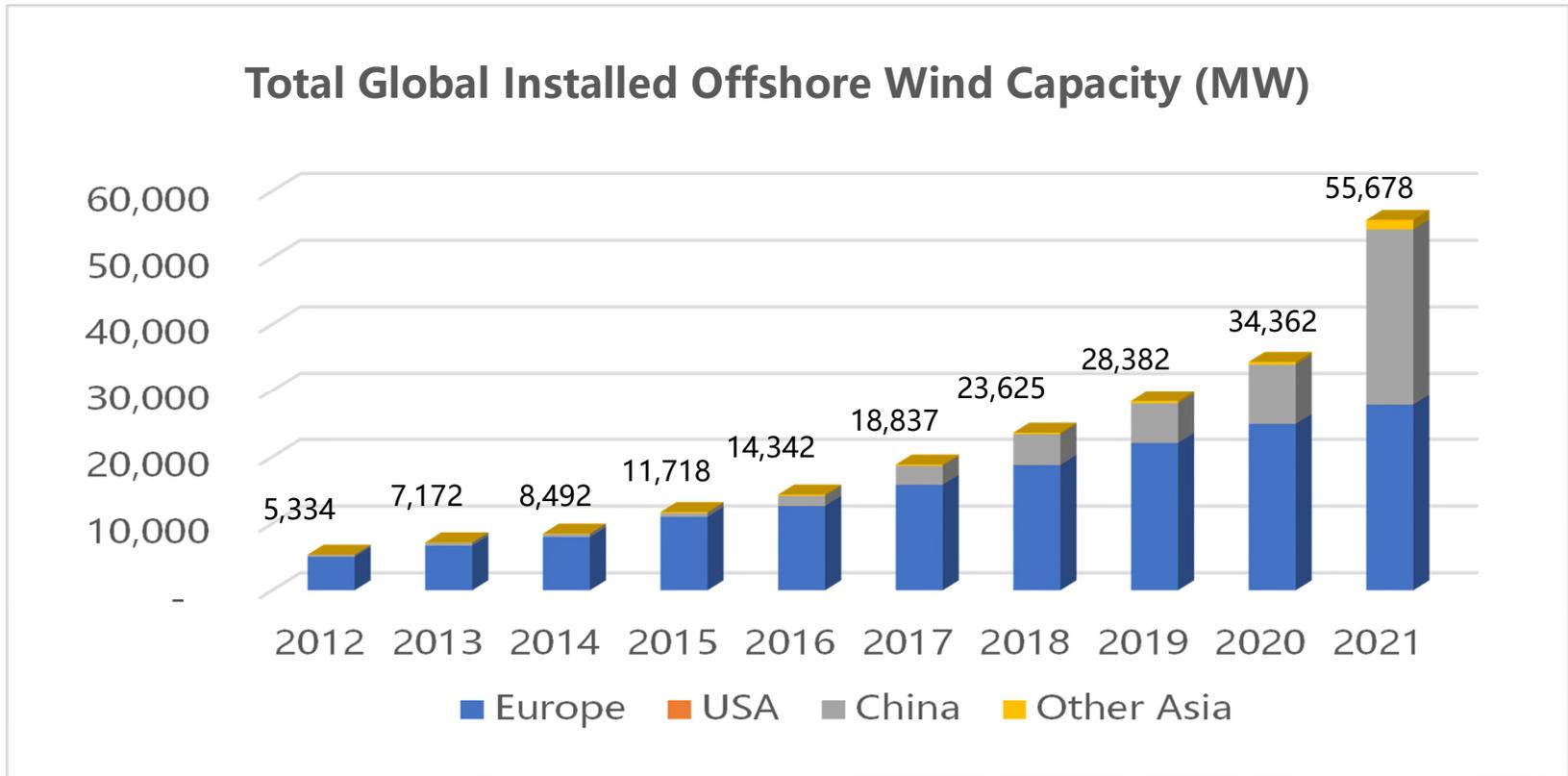


1. Status Analysis - Global Offshore Wind (1/2)

Global Installed Offshore Wind Capacity

■ COVID-19 limited the growth of installed capacity.

- In 2021, total global installed capacity reached **55.7 GW**, with a new installed capacity of **21.3 GW**.



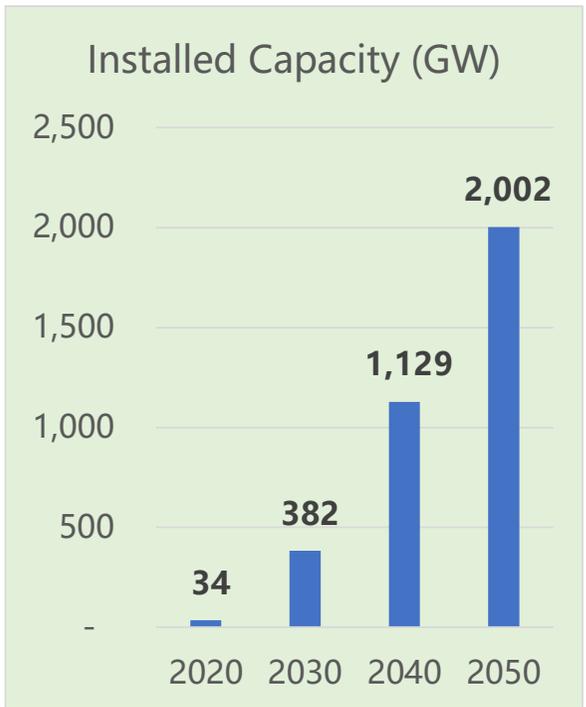
Source: IRENA (2022), ITRI (2022)



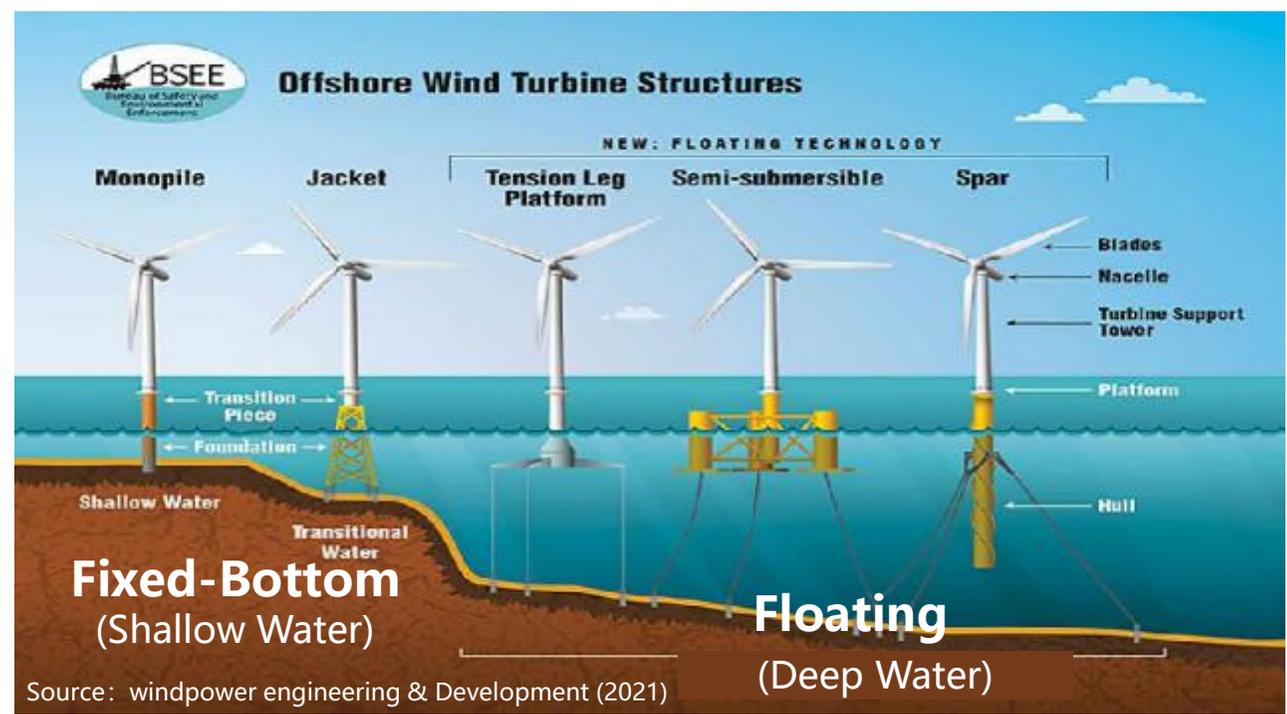
1. Status Analysis - Global Offshore Wind (2/2)

Future Development Trend

- **Significant Increase in demand**
To achieve net-zero, it is expected that the global offshore wind capacity will need to exceed **2,000 GW** in **2050**.
- **Global Development Trend**
larger scale, deeper water depth and floating offshore wind.

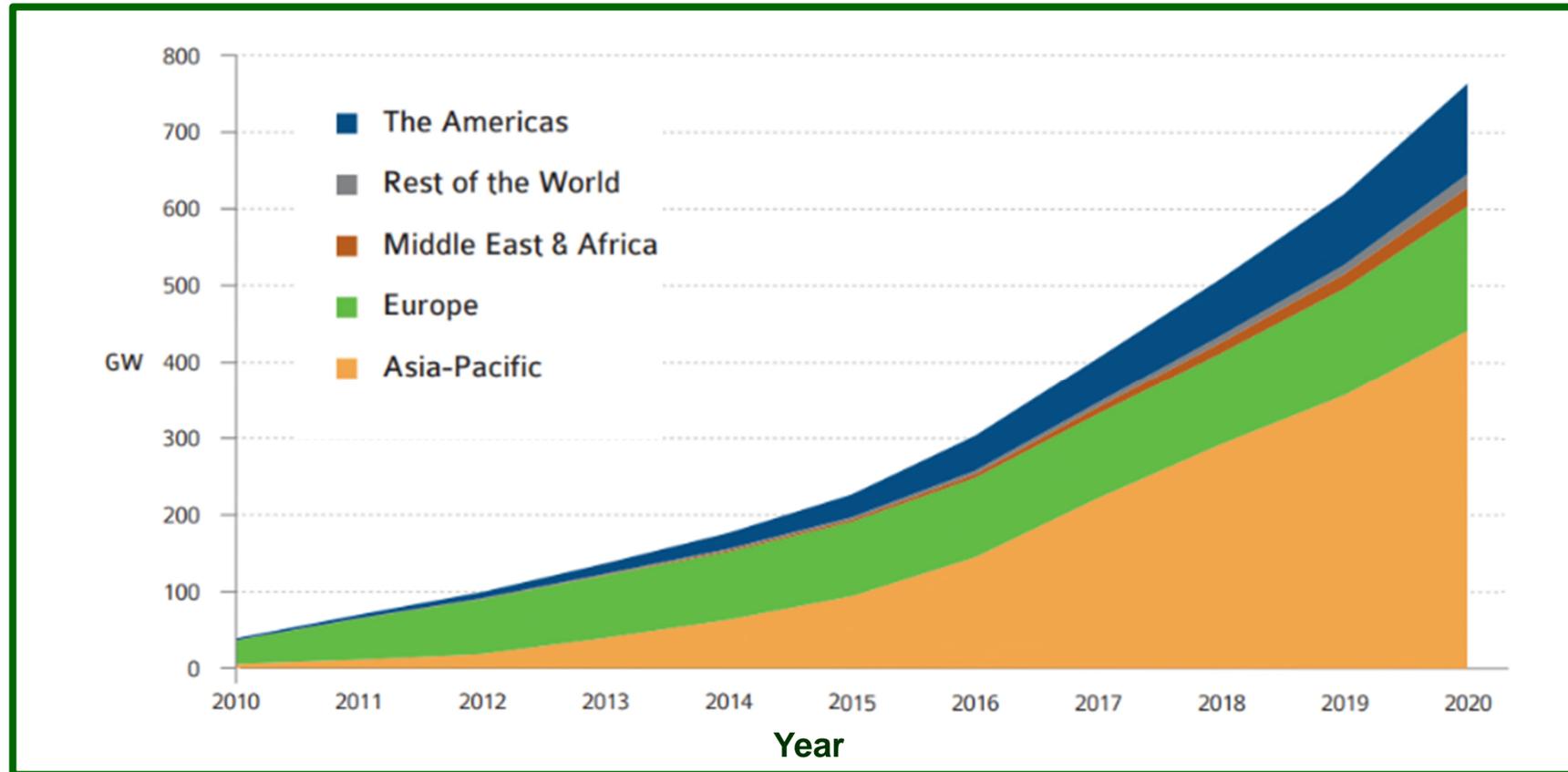


Source : IRENA (2021) , ITRI (2022)



Source: windpower engineering & Development (2021)

1. Status Analysis - Global Cumulative PV Installation



Global PV Installation

- The total cumulative installations amounted to about **773 GWp** at the end of year 2020.
- The cumulative installations in 2020 were three times larger than that in 2016.

1. Status Analysis - PV Technology

- **Crystalline Si solar cells:**

Over 90 percent of the world's PV modules are made from Silicon. The highest cell efficiency and commercial module efficiency are over 26% and 21%, respectively.



- **High carbon reduction** due to the lowest cost.

- **III-V multi-junction solar cells:**

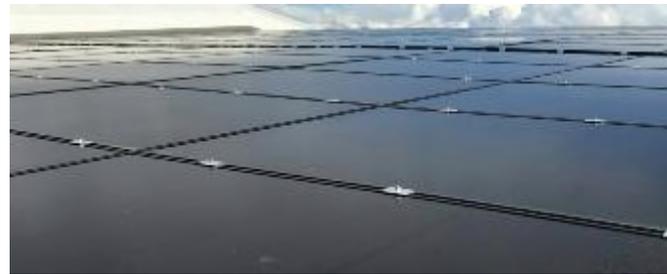
The cell efficiency is up to 40%. The modules have been used to space satellites and other niche applications due to the very high cost.



- **Very low carbon reduction** due to high cost.

- **Thin-film solar cells :**

The module efficiency is up to 18%. The global market share is lower than 10% due to its slightly lower efficiency and higher cost.



- **Low carbon reduction** due to only 10% market share.

- **Si-based tandem solar cells:**

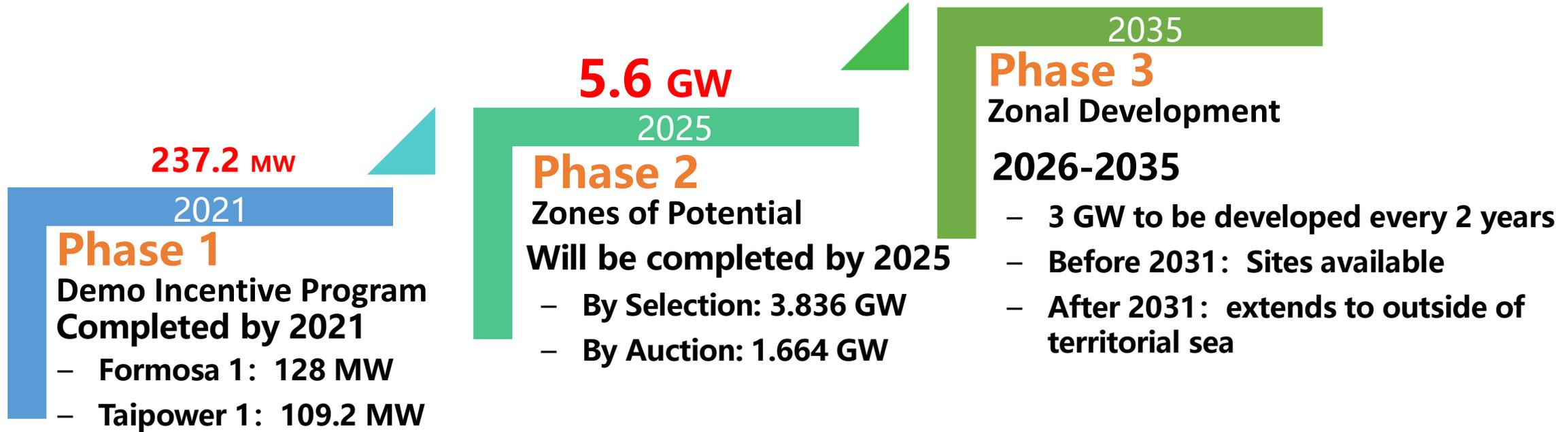
The mini-module efficiency in the lab is over 30%. The long-term stability, further cost reduction and commercially large-scale processing need to be well developed.



- **No carbon reduction** until now; **High potentials of carbon reduction** in the future due to the high efficiency.



2. Goal and Pathway - Roadmap

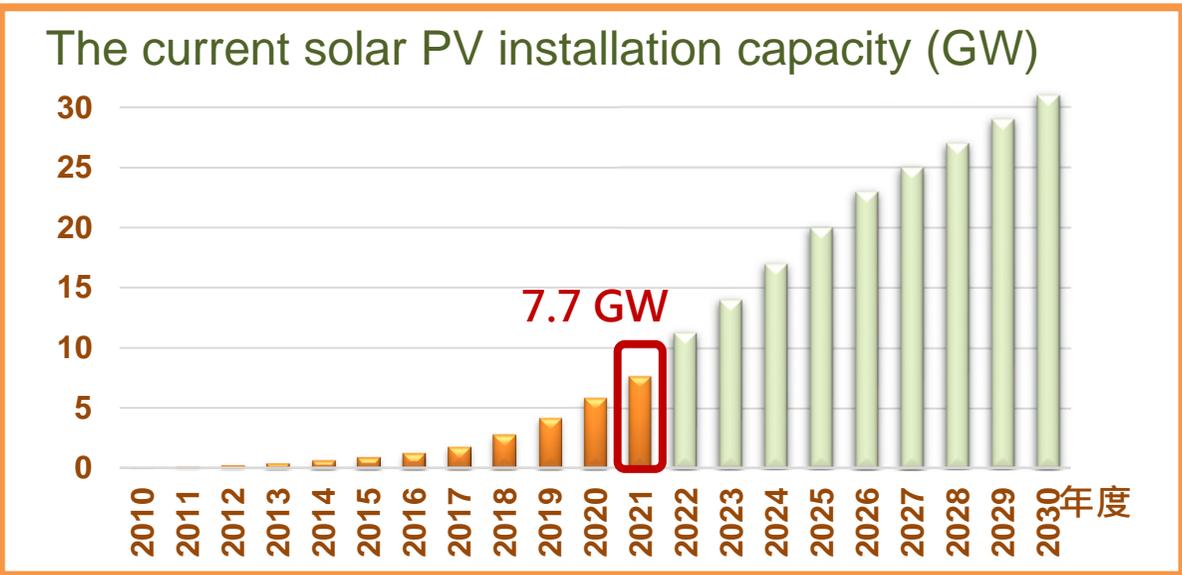


5.6 GW by 2025

13.1 GW by 2030

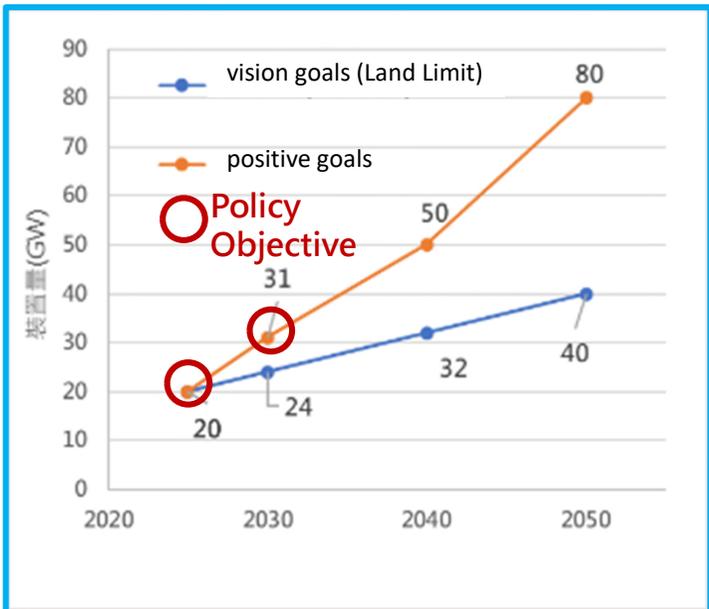


2. Goal and Pathway - Roadmap



The PV installation capacity in Taiwan

- **Solar PV was developing the fastest in 2021, accounting for 7.7 GW.**
- **The electricity generation in 2017 was 1,667GWh, exceeding 7,920GWh in 2021, higher 4.75 times generated than in 2017.**



PV電廠(台南)



社區屋頂型(台南)



BIPV(南瀛綠都心)



水上型太陽光電(彰濱)



農漁電共生太陽光電



3. Promotion schedule - Short-term tasks

Policy Promotion

- Steady and pragmatic promotion strategy to achieve **installation goals**.
- **Spatial inventory** of developable sites and supporting infrastructure.

Industrial Development

- Build independent **key component** manufacturing capacity to accommodate the characteristics of domestic industry.
- Build independent **marine engineering** service capability for the domestic demand in service.

Technology Development

- Develop new **floating** technologies and expand wind farms towards deeper water depths.
- Develop local **digital O&M** technologies to reduce costs and stabilize power generation.

Local Talent Cultivation

- Provide GWO basic and advanced training programs to meet the demand for **offshore wind farm engineers**.
- Train **technical professionals** for wind turbine O&M and marine engineering.



3. Promote schedule - Long-term tasks

Field	Major Promotion Task
Offshore Wind	<ul style="list-style-type: none">■ Policy Promotion<ol style="list-style-type: none">1. Selection mechanism and wind farm development for Round 2 of Phase 3.2. Spatial inventory of developable sites and supporting infrastructure.■ Industrial Development<ol style="list-style-type: none">1. Promote the industrial technical capacity for floating offshore wind farms.■ Technology Development<ol style="list-style-type: none">1. Develop new floating technologies.2. Develop local digital O&M technologies.■ Local Talent Cultivation<ol style="list-style-type: none">1. Train O&M technical professionals for floating offshore wind farms.



3. Promotion schedule - Short-term tasks

Develop Suitable Installation Space

- Promote **rooftop** solar PV in priority.
- Improve land value in use.
- Conduct outdoor **agriculture and electricity symbiosis** demonstration.
- Amendment of **“Renewable Energy Development Act”**

Improve System Safety and PV Module Recycling

- Improve **safety** of solar PV **system structure**.
- Reduce **total waste** and increase disposal value.

Promote Grid Inter-Connection Flexibility

- Strengthening of the **power grid** and **shared step-up substation** to solve grid connection problem.
- Promote generator solar PV combine with **storage**.



3. Promote schedule - Long-term tasks

Field	Major Promotion Task
Solar PV	<ul style="list-style-type: none">■ Develop Suitable Installation Space<ol style="list-style-type: none">1. Master the national energy land use and future planning.2. Expand new field to install solar PV facilities.3. Demonstrate expanding offshore solar PV installation by companies.■ Develop High Efficiency Si-tandem Solar Cells<ol style="list-style-type: none">1. Develop low-cost, high-efficiency (>24%) Si-tandem solar cells.2. Develop new solar cells technology for commercial mass production.3. Develop Si-based tandem solar cells (>29%).



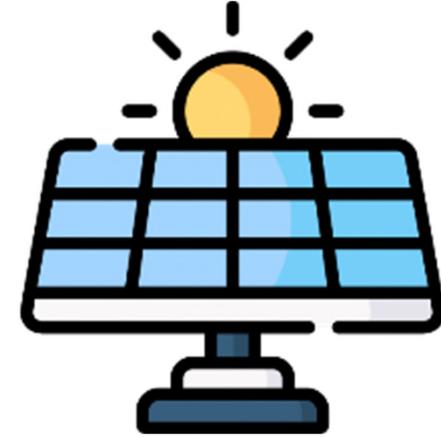
4. Administration Responsibilities



Offshore Wind

Competent Authority: MOEA

- **Policy Promotion :**
SEC, MOEA, NSTC, MND, MOTC, MOI, OAC, COA
- **Industrial Development :**
MOEA
- **Technology Development :**
NSTC , MOEA
- **Local Talent Cultivation :**
MOTC, MOEA



Solar PV

Competent Authority : MOEA

- **Develop Suitable Installation Space:**
MOEA, MOI, COA, MOST, MOF
- **Improve System Safety and PV Module Recycling:**
EPA, MOEA
- **Promote Grid Inter-connection Flexibility:**
MOEA and state-owned enterprise



5. Strategies and Measures - Planning (1/5)

Policy Creates Market Demand

■ Steady and Pragmatic Promotion Policy

- A 3-phase strategy (Demo Incentive Program, Zones of Potential, and Zonal Development)
- **Phase1**: Verify the administrative, technical and financial feasibility.
- **Phase2**: 5.5 GW has been allocated and will be installed by the end of 2025.
- **Phase3**: Provide a stable market demand for offshore wind after 2026 and promote sustainable development of the local industry.



■ Spatial Inventory of Developable Sites and Supporting Infrastructure

- **Spatial inventory of developable sites**
 - Offshore wind will be developed towards deeper water depths and outside of territorial sea. Potential development sites involve fishing activities, military exercise areas, waterways and other areas, and will be discussed with various ministries to identify possible sites.
- **Supporting infrastructure**
 - Inventory of existing wharfs and **planning for potential ports**.
 - Planning of **potential grid connection points and common corridors** to meet the demand for offshore wind power capacity and be in line with the Phase 3 schedule.



5. Strategies and Measures - Planning (2/5)

Market Supports Local Industry Development

■ **Manufacturing:** Build key component manufacturing capacity

● **Wind turbine(WT) key components**

- Facilitate the global WT manufacturers (SGRE/Vestas) to build the nacelle assembly and production base in Taiwan, driving the domestic key components of wind turbines to enter the WT system supply chain.

● **Large steel component production capacity**

- Establish a domestic underwater foundation production base at Taipei Port and Xingda Port to build up domestic production capacity for large steel components and to drive the downstream supply chain.

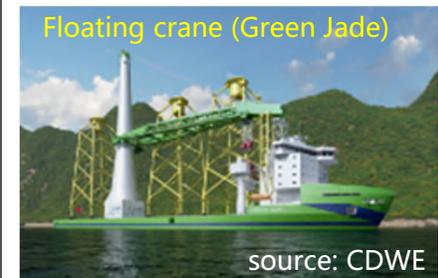
■ **Marine Engineering:** Build independent marine engineering service capability

● **Construction support vessels**

Support vessels such as wind farm **CTV**.

● **Construction vessels**

Multifunctional floating crane (Green Jade) for the transport and installation of underwater foundations and large wind turbines.





5. Strategies and Measures - Planning (3/5)

Optimize Technology and Increase Installed Capacity - Floating Technology

■ Policy Leading: Floating Offshore Wind Demo Program

- Development of floating offshore wind power demonstration **incentives program**.
- Verify the feasibility of regulations, technology and infrastructure of **floating wind farm** in Taiwan.

■ Technology Verification: Verify floating technology and establish independent technology capacity for marine engineering of deep water depth.

- **Risk assessment:** System load assessment and post-disconnection risk assessment.
- **Testing and verification:** Stability analysis of wind turbine and floating platform coupling, power generation efficiency analysis.
- **Marine engineering:** Evaluation of optimal installation methods and port facility requirements.
- **System O&M:** O&M strategy planning and operation status monitoring.



Source: Kincardine (2022)



5. Strategies and Measures - Planning (4/5)

Optimize Technology Development to Increase Installed Capacity - O&M

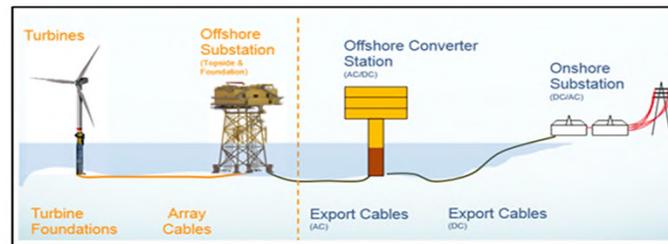
■ Enhancing Performance, Reducing the Cost

- The wind farm is entering the O&M period, and it is necessary to build up **local O&M technology** capacity in response to the Taiwan's environment.
- Using the strength of Taiwan's **IOT** to develop **unmanned/intelligent technology** and reduce O&M costs.
- Develop **O&M information platform** and **integration system for marine engineering scheduling**, integrating information regarding weather windows, component logistics and vessels to improve operations and maintenance efficiency.

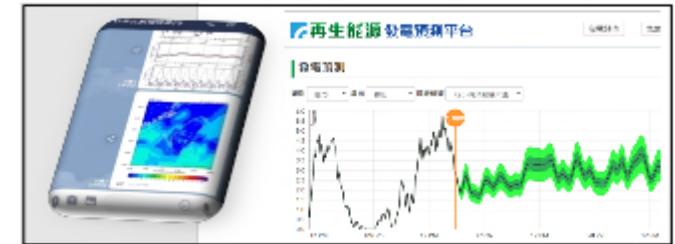


Drone inspection of
blades
MIRDC (2022)

ROV inspection of
underwater structures
AROWIND (2022)



Offshore Wind Farm Monitoring
and Health Diagnosis
Energies (2019)



Climate window and power
generation forecast
ITRI (2021)



5. Strategies and Measures - Planning (5/5)

Local Talent Cultivation Measures

- **Short-term:** Training of local talent in line with the GWO.
 - Training of 5 modules on the foundations of **GWO** certification required for wind farm operations and GWO-compliant local personnel.
- **Mid-term:** Training technical professionals for wind turbine O&M and marine engineering.
 - New **module** on **professional marine engineering operations** such as offshore lifting operations. Training for professional **marine engineering** operators
- **Long-term:** Training professional operators for intelligent inspection of wind farms.
 - New **ROV underwater foundation inspection module** to train professional operators in **wind farm O&M intelligent inspection**.



5. Strategies and Measures - Planning (1/5)

Develop Suitable Installation Space



Promote rooftop solar PV in priority

- Expand inventory of **agricultural facility roofs, industrial roofs, public roofs** and **private roofs**, etc.



Improve land value in use

- Compounded utilization of land: Inventory of land that can be used in **combination**, collect domestic and global successful cases, publicity of ROC 's **fishery and electricity symbiosis** policy related measures, and promote more possibilities for the compound use of land.
- Revitalization** of unfit agricultural land and public idle land.



Conduct outdoor agriculture and electricity symbiosis demonstration

- For the successful demonstration species of **agricultural and electricity symbiosis** cases, applications for outdoor agricultural and electricity symbiosis will be permitted by agricultural administration department.

Amendment of Renewable Energy Development Act

- Require new buildings, additions of buildings, and rebuild that meet certain conditions **should be equipped with solar PV generation equipment on the roof.**
- Existing building roof space can still be expanded, and efforts should be made to solve the **regulatory** and **economic** obstacles faced by rooftop solar PV.

5. Strategies and Measures - Planning (2/5)

Reliable PV System



Aging test and management of the support structures



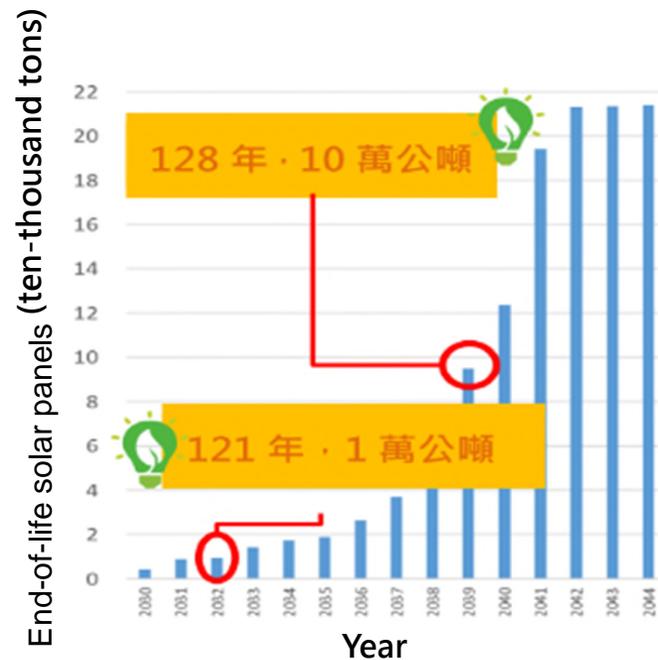
Educational Training for system inspection and feedback

■ Improve the safety of structure in PV systems

- **Installation regulation:** The PV rules and requirements in Taiwan are shown in "Regulations for Installation of User's Electricity Device."
- **Support structure:**
 1. The support structures of PV systems should be **standards-compliant**.
 2. The use of surface coating and weathering resistance materials is effective for corrosion resistant. If needed, ensure the system use the **corrosion resistant panels**.
- **Education and training:** Taiwan Photovoltaic Industry Association and PV Generation System Association are able to train the workers to improve the quality and safety of the PV systems.

5. Strategies and Measures - Planning (3/5)

High-value PV Recycling

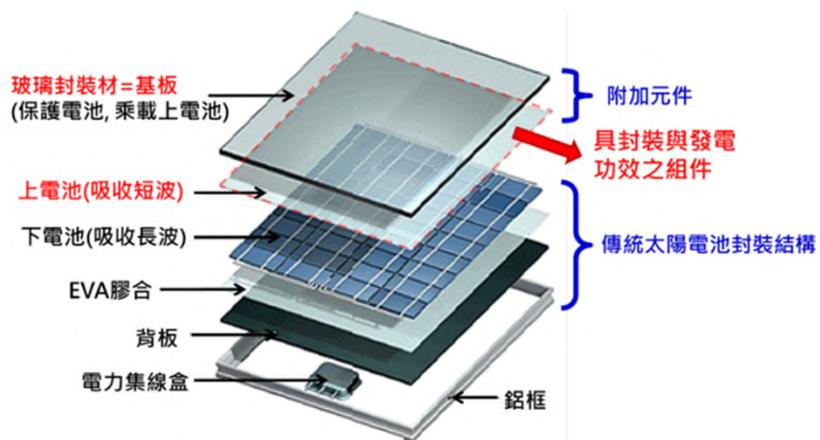


- Lower the PV waste and increase recycle value
 - The target is developing a process to **recycle end-of-life solar panels** that is able to recover most of a PV module's weight and reduce the total recycle cost.
 - So far, the resources recycling plants **crushed the panels as different materials**. However, the purity of these materials are difficult to increase in value, so they can only be used as CLSM and slagging flux instead.
 - High-value PV recycling is aimed to develop **high-speed**, low recycle cost, high recovery rate, and environmentally friendly processes to increase resource recycling.

5. Strategies and Measures - Planning (4/5)

High Efficiency Si-tandem Solar Cells

Silicon solar cells+ wide-bandgap top cell
→ Si-based tandem



- **Improve module efficiency for reducing land requirement**
 - When the module efficiency improved from 20% to 30%, the electricity generation can increase 60%.
 - The PV installation in Taiwan is going to increase to 40-80 GW in 2050. This project can anticipate the land requirement decreasing to 130-400 thousand hectares.
 - The project should develop several key technologies and invent new products for employment promotion.

Goal	2021~2025	2026~2030	2031~2035	2036~2040	2041~2045	2046~2050
Traditional Si modules	>23%	>24%	>24.7%	>25.3%	>25.8%	>26.3%
Si-base tandem modules	Cell efficiency >29%	Pilot-line Commercial Module	>29%	>30%	>31%	>32%

5. Strategies and Measures - Planning (5/5)

Promotion of Power Grid Accessing to PV

- **Improve the Power Grid & Step-up Substation for Accessing the Renewable Energy**
 - **Improve Power Grid**: Allow access to the renewable energy on the condition that the power systems remain safe and stable.
 - Recently, Taipower would build 9 stations and 10 lines for improving power grid.
 - **Build Step-up Substations** : Taipower would build step-up substations to boost electricity generated from the renewable energy.
- **Combine with Energy Storage with PV system**
 - Advantages of combining storage, **smart grid and PV systems are balancing electricity loads and providing resilience.**
 - With an storage system, we can **optimize the yield of the solar system.**
 - MOEA held "Bid Opening of 2022 Bidding and Capacity Allocation Processes for ESS Integrated with Solar PV Equipment" in 2022





5. Strategies and Measures - Funding

2023-2024 Funding Planning

Offshore Wind



Solar PV

BOE, MOEA	NT\$ 1627 M
DOIT, MOEA	NT\$ 340 M
IDB, MOEA	NT\$ 260 M
BSMI, MOEA	NT\$ 220 M
CGS, MOEA	NT\$ 240 M
Taipower	NT\$ 19276 M

BOE, MOEA	NT\$ 824 M
IDB, MOEA	NT\$ 28 M
BSMI, MOEA	NT\$ 66 M
CPC	NT\$ 557 M

NT\$ 21,963 M

NT\$ 1,475 M



5. Strategies and Measures - Social communication planning



To respect the opinions of the general public and stakeholders, the MOEA held a social communication meeting on the key strategy of “Wind/Solar PV” on December 17th, 2022.

Offshore Wind

- Relevant units have been invited to conduct joint review meetings of the Zonal Development sites to confirm all environmentally sensitive areas have been excluded .
- The developer must obtain the approval of the EIA preliminary review meeting and Taipower’s grid-connection review before participating in the Zonal Development selection process.
- Excellent traditional fishing grounds have been excluded and fishery compensation during the construction period will be provided.

PV

- Confirming scopes and without ecological and social issues in that place, and after the issues are identified and reviewed by environmental and social inspections, the location will be announced for promotion in priority.
- In order to protect stakeholder ’s rights and benefits, companies which require a construction permit must hold a local session before applying for construction.



6. Expected Benefits

Offshore Wind



Solar PV

	2025	2030		2025	2030
Cumulative Installed Capacity	5.6 GW	13.1 GW	Cumulative Installed Capacity	20 GW	31 GW
Annual Carbon Reduction*	10.59 M tons	24.65 M tons	Annual Carbon Reduction*	12.55 M tons	19.45 M tons

Expected Benefits

- ❑ Establish independent **key component manufacturing** capacity.
- ❑ Establish localized **marine engineering service** capabilities.
- ❑ Establish a **co-prosperity** mechanism between offshore wind farm development and ecology, environmental sustainability, fisheries resources and fishermen's livelihoods.

- ❑ Expand solar PV installation and **boost the demand of domestic industries.**
- ❑ Overall planning with **national spatial planning** to achieve green energy and environment coexistence and co-prosperity.

* Carbon reduction calculation is based on the 2020 Electricity Emission Factor (0.502kg CO₂e/ kWh).



7. Supervision and Management Mechanism

Offshore Wind

Solar PV

Supervision and Management Mechanism

- The **authority** will supervise and evaluate the overall progress of the projects.
- Review the content and results of the actions through irregular **task meetings**, so as to adjust the execution methods or amend the indicators in a proper manner and enhance the effectiveness.

Supervision and Management Mechanism in Each Field

- **Progress control of the developing sites:** According to the development progress of the administrative contract and the IRP commitment, carry out relevant contract supervision and progress tracking.
- **Progress control of installation targets:** Rolling review of offshore wind power installation and promotion targets, development plans and programs.

- **Ministry of Economic Affairs Task Force:** Implement schedule management and control on the current year's cases to speed up work progress.
- **Cross-unit coordination at the sub-ministerial level:** The deputy minister of the MOEA invites the sub-ministerial chiefs of relevant departments to coordinate matters about relaxing regulations.
- **Joint review mechanism for administrative procedures:** Invite the central competent authority, local government executive departments, and companies to negotiate, communicate and interpret regulations.
- **Local working groups promotion:** Form a working group with the deputy city (county) mayor in order to track the handling of the resolutions of the joint review meeting.



8. Conclusion - Future Outlook

Offshore Wind

- The government will release domestic market opportunities and policy supporting measures to encourage the industry to invest in the **R&D of key technologies**, and gradually achieve the target of 13.1 GW by 2030 according to the established policy objectives and rolling review of the selection mechanism.
- Promote **floating offshore wind demonstration program** and extend the development to **outside of territorial sea, away from the shore or deep water depth**, to achieve the offshore wind installed capacity target of 40-55 GW by 2050.

Solar PV

- Without affecting the environment and the original use of land, promote **compound land use** with the relaxation of laws, and strengthen new energy technology and research and development ability simultaneously, **combine with the energy storage facilities** and **upgrade power grid technology**. Improve manufacturing processes, PV module' s efficiency, promote the replacement of old equipment and support energy-saving measures in the same time, in order to cope with the expanding demand for electricity and the goal of net zero carbon emissions.
- In the process of solar PV promotion, we will continue to use Taiwan' s Pathway to **Net-Zero Emissions** in 2050 as the basis to achieve social balance and solve related problems in the future, ensure the sustainable development of solar energy, and assist in the establishment of a net-zero environment.



8. Conclusion - Assessments Involving Just Transition

Offshore Wind

Solar PV

Possible Affected Objects

- Offshore wind development involves stakeholders such as **environment ecology, fisheries, aviation, radar, military, ship safety**, construction prohibit and local government.

- Stakeholders involved in the development of ground-mounted PV include **land owners, original land users, and those affected during construction**.

Just Transition and Promotion Mechanism

- Developers should comply with the "Electricity Act," "Regulations on Registration of Electricity Industry," and the relevant sub-laws for **application requirements** of offshore wind farms, and are advised to communicate with stakeholders.
- A clear offshore wind power **development policy** and a phased release of development capacity to attract domestic industrial participation and workforce demand, and increase **domestic employment**.

- Establish a **public consultation mechanism** with stakeholders for the development of fishery and electricity symbiosis.
- The MOEA has required companies that have obtained establishment permits to hold **local sessions** before applying for construction in order to protect the rights and interests of stakeholders involved in solar PV development.



Thank you



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Bureau of Energy, MOEA

