



Land Use Conflicts of Solar and Current Status of **AquaVoltaics** in Taiwan



台灣環境規劃協會

Yuping Chen



台灣環境規劃協會

Taiwan Environment and Planning Association, TE&P

- Founded in 2020, we advocate that environmental planning and local participation are key to ensure sustainable development of renewable energy.

We provide tools and expertise of **integrated planning**

Best Practices
& Guidelines

Impact assessment
& local engagement

AgriVoltaics &
community energy

Landscape &
sense of place



**inclusive
solar farm**



Ecosystem &
biodiversity

Dual use of land
& sustainability



Local engagement
& benefit sharing

Yuping Chen

Founder / Executive Director

Education

- MSc Conservation & Biodiversity, University of Exeter, UK
- MSc Environmental Sciences, University of East Anglia, UK
- MS in Environmental Health, National Taiwan University

Work Experience

- CEO, Taiwan Ecological Engineering Foundation
- Assistant Researcher, Food and Fertilizer Technology Center for the Asian and Pacific Region, Taipei
- Executive Secretary, Taiwan Ecological Stewardship Association
- PM and GIS Analyst, Observer Ecological Consultant Co., Ltd.





Outline

- Energy transition in Taiwan
- Land use conflicts of Solar
- Past experience of Alibi AgriPV
- Current status of AquaPV
- The way forward for Land-based APV



2019-2020 Fish farmers protested against the aqua-PV policy

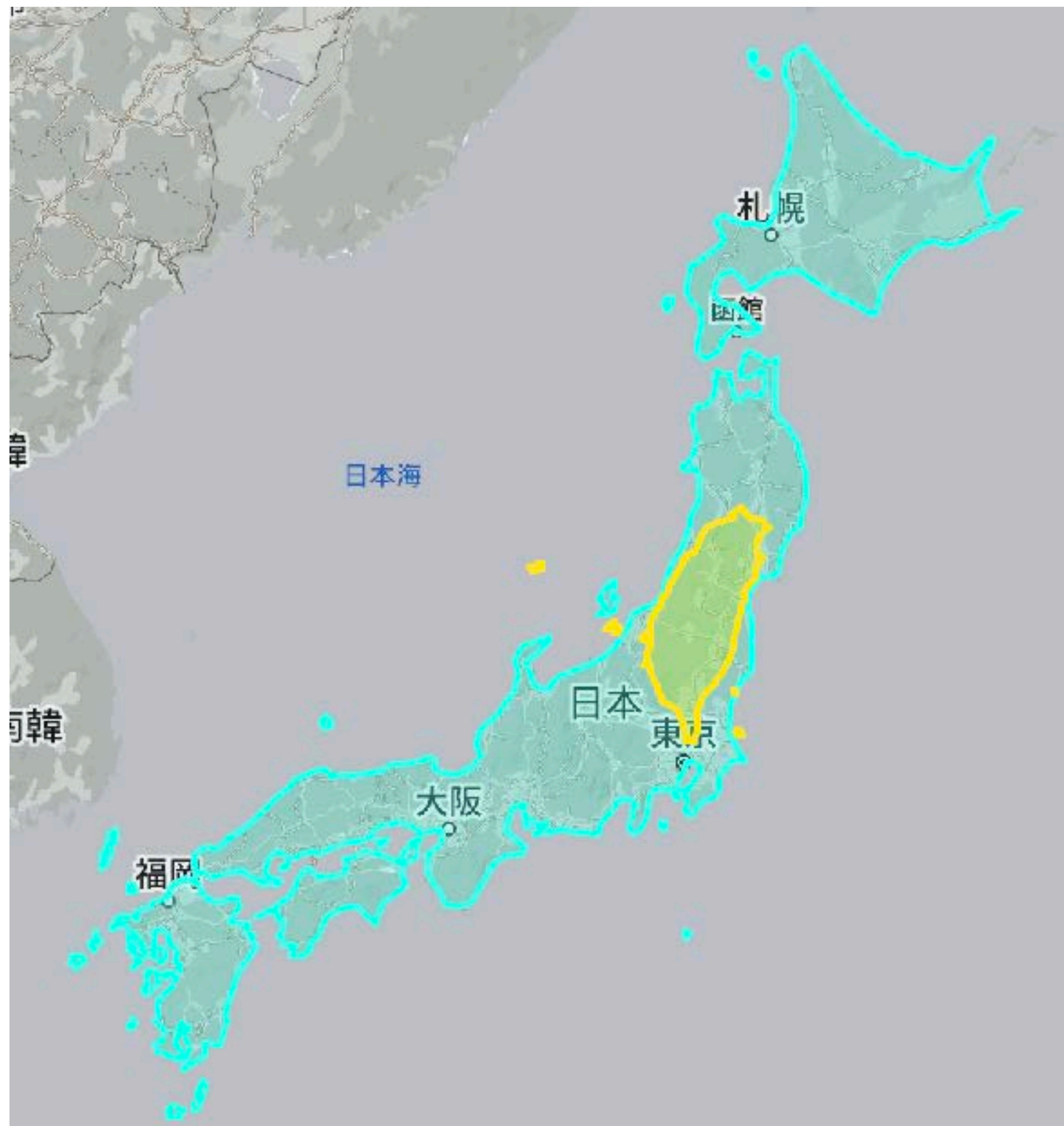


Japan is 11 times bigger than Taiwan

Japan's solar capacity is 8 time more than Taiwan

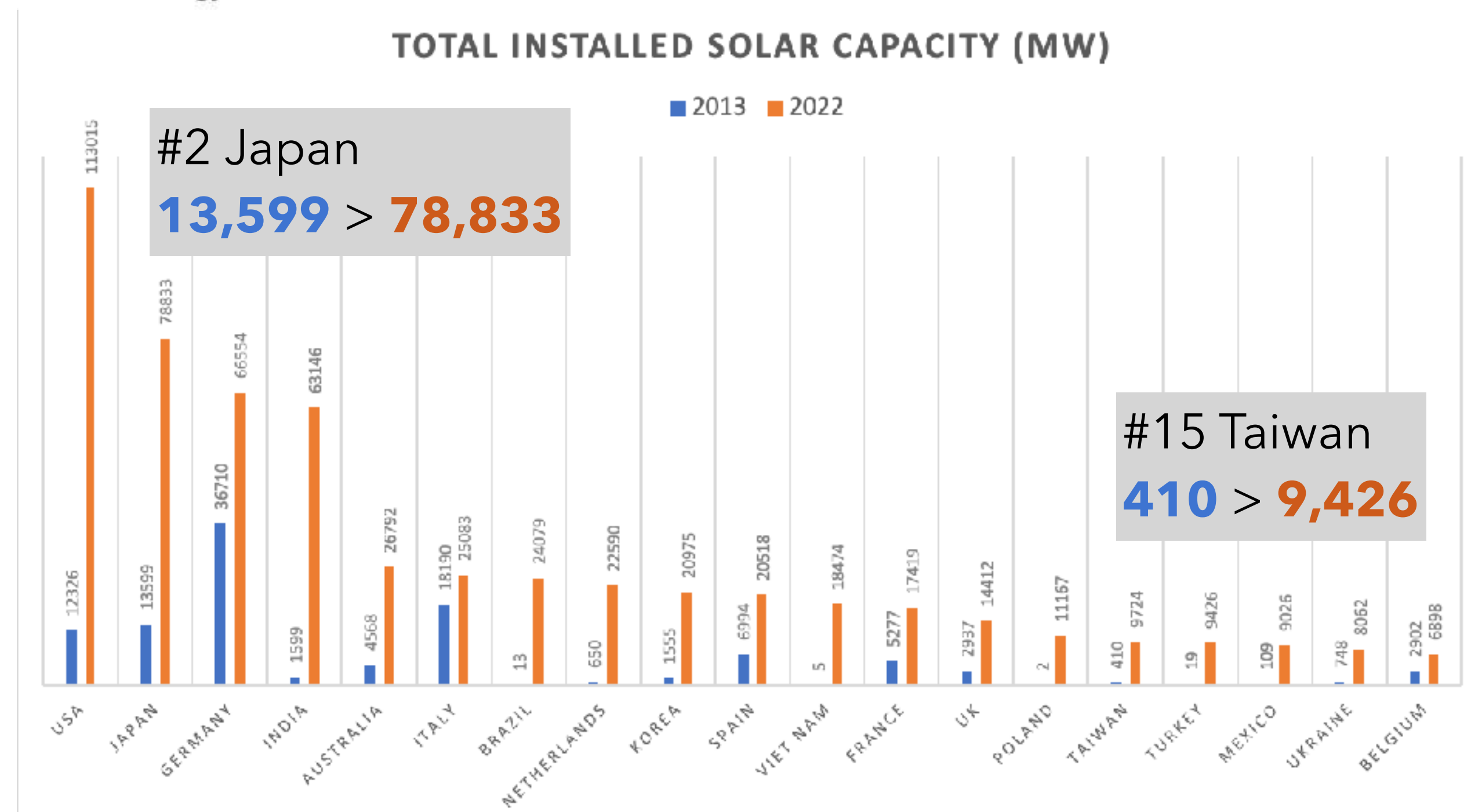
Taiwan's geography

- 31% flatland & lowland area (<100 m)
- 40% hills and plateaus (100~1000 m)
- 29% high mountainous area (>1000 m)



Density ratio (kW/ha flatland)	11	0.7	2.7	6.5	0.4	0.2
	Taiwan	UK	Germany	Japan	France	India
Installed solar PV capacity [GW]	10	15	67	85	17	63
National Land Area [thousand km ²]	36	240	360	380	540	3,290
Flatland area [thousand km ²]	9 (26%)	210 (88%)	250 (69%)	130 (34%)	370 (69%)	2,570 (78%)

Resource: Renewable Energy Statistics 2023



Energy transition in TW

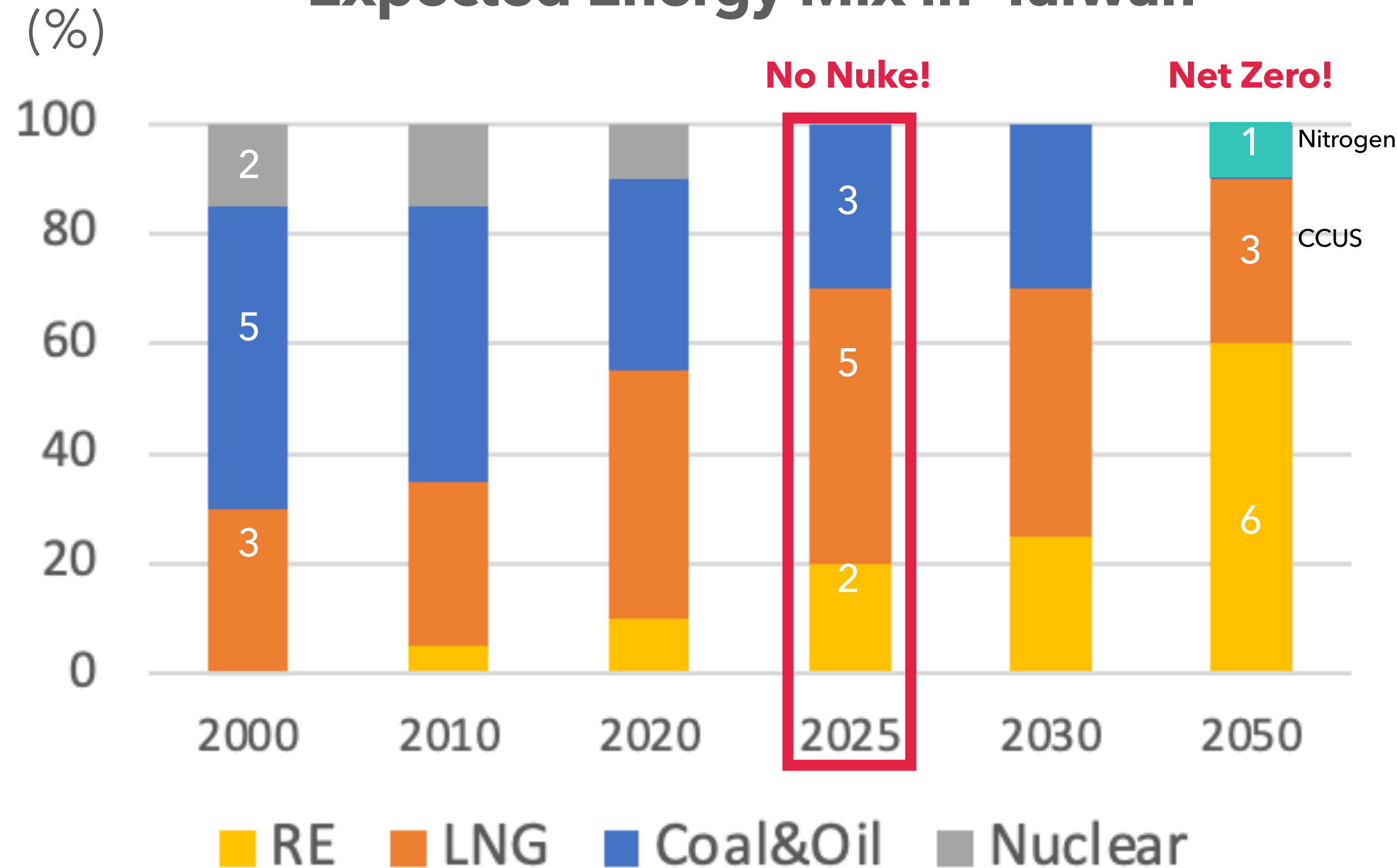
President Tsai's
RE vision 2016-2023

solar target →

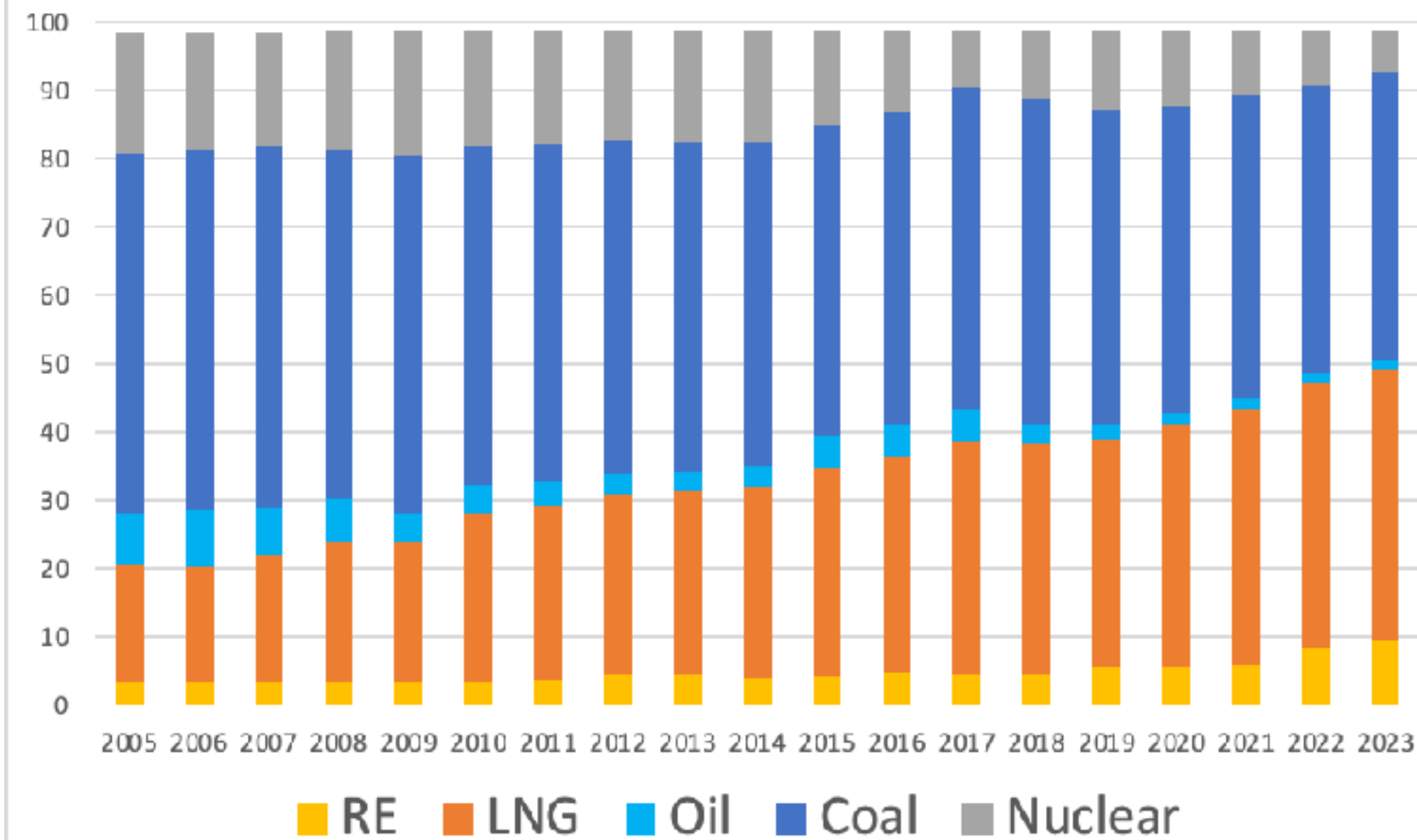
2025: 20 GW
2030: 31 GW
2050: 40-80 GW

- Nuclear issue resurfaced
- RE installment behind schedule
- No sign of energy reduction

Expected Energy Mix in Taiwan



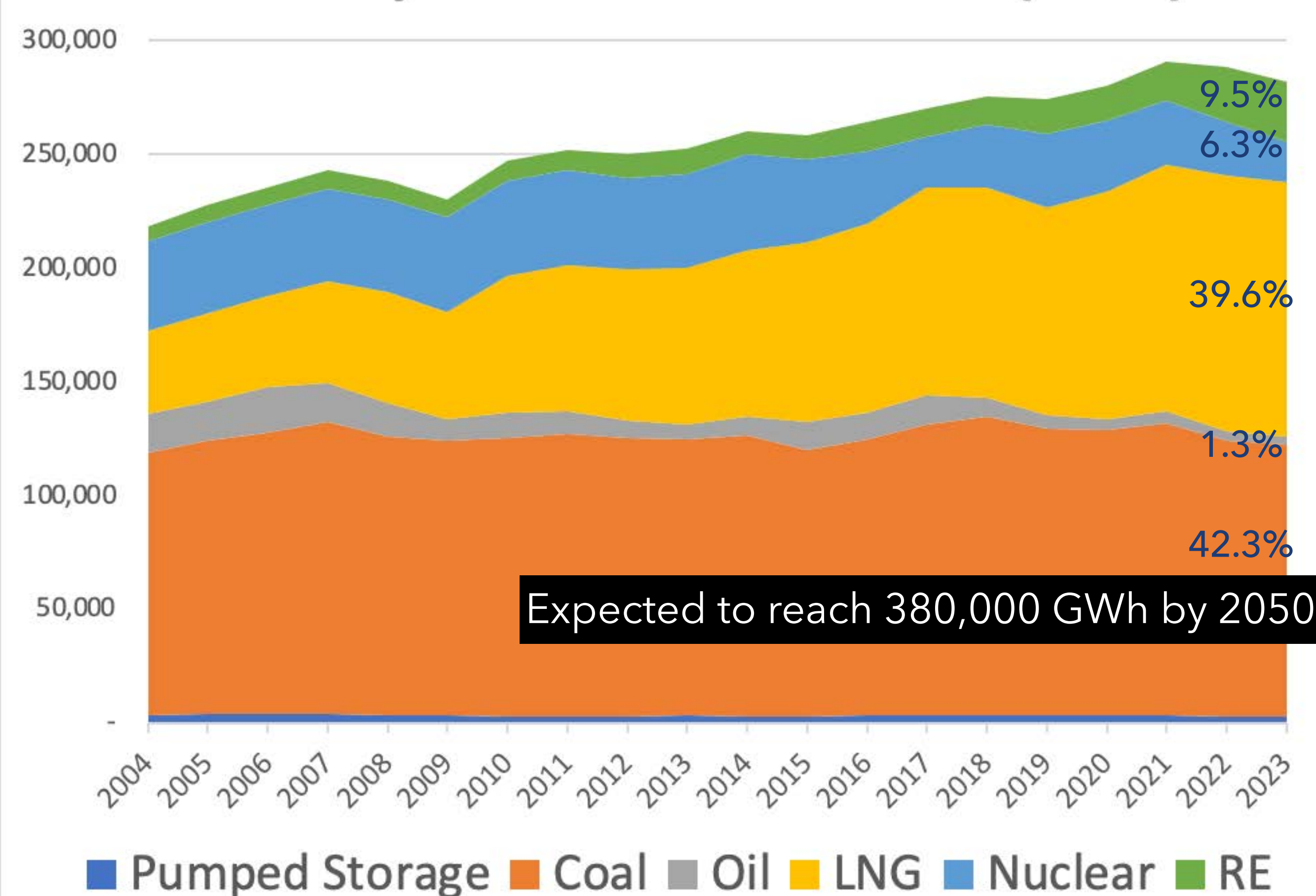
Actual Energy Mix in Taiwan (%)



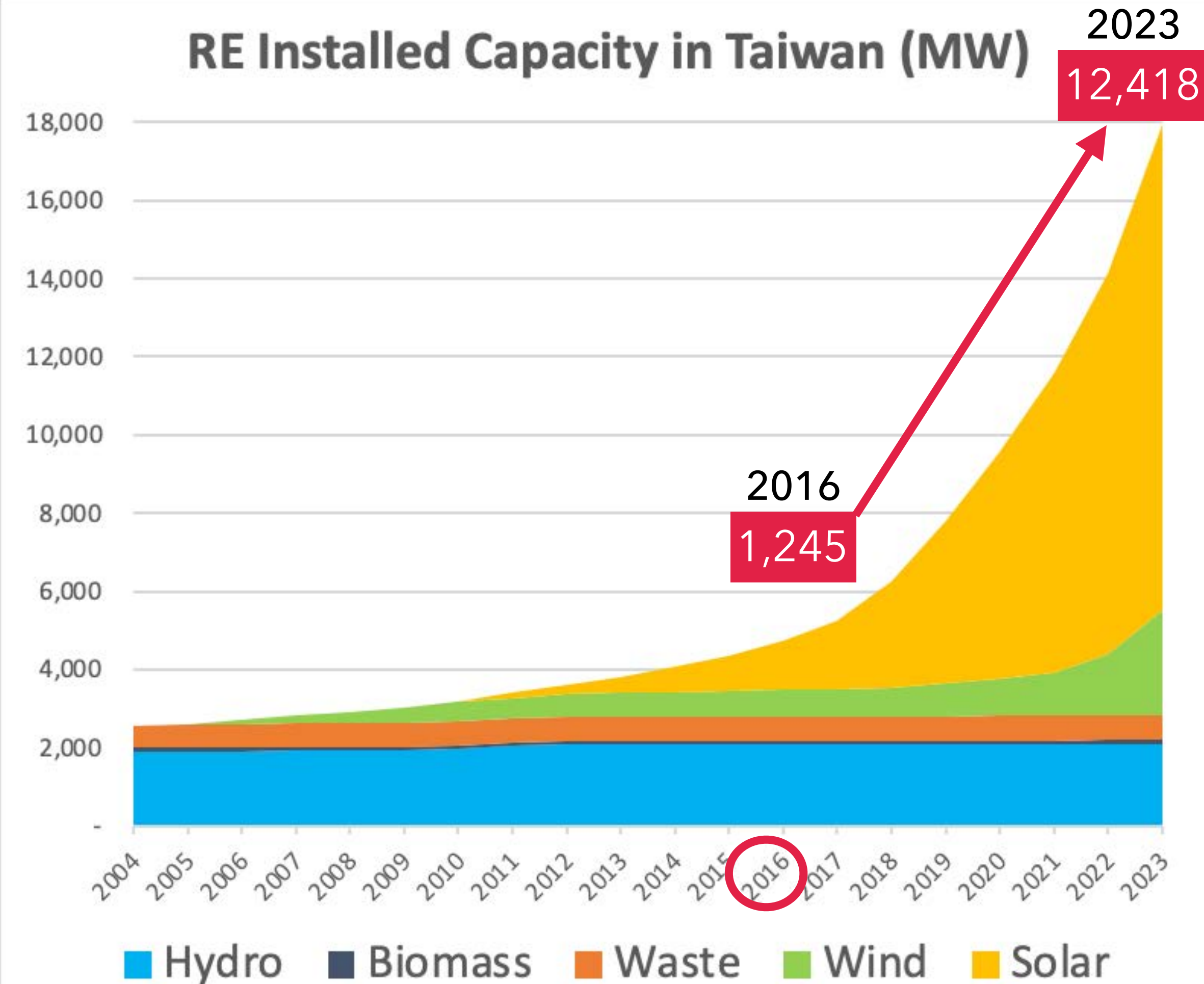
Electricity generation of RE is 9.5%

Solar generation is only 4.6% while taking up roughly 10,000 ha of space

Electricity Generation in Taiwan (GWh)

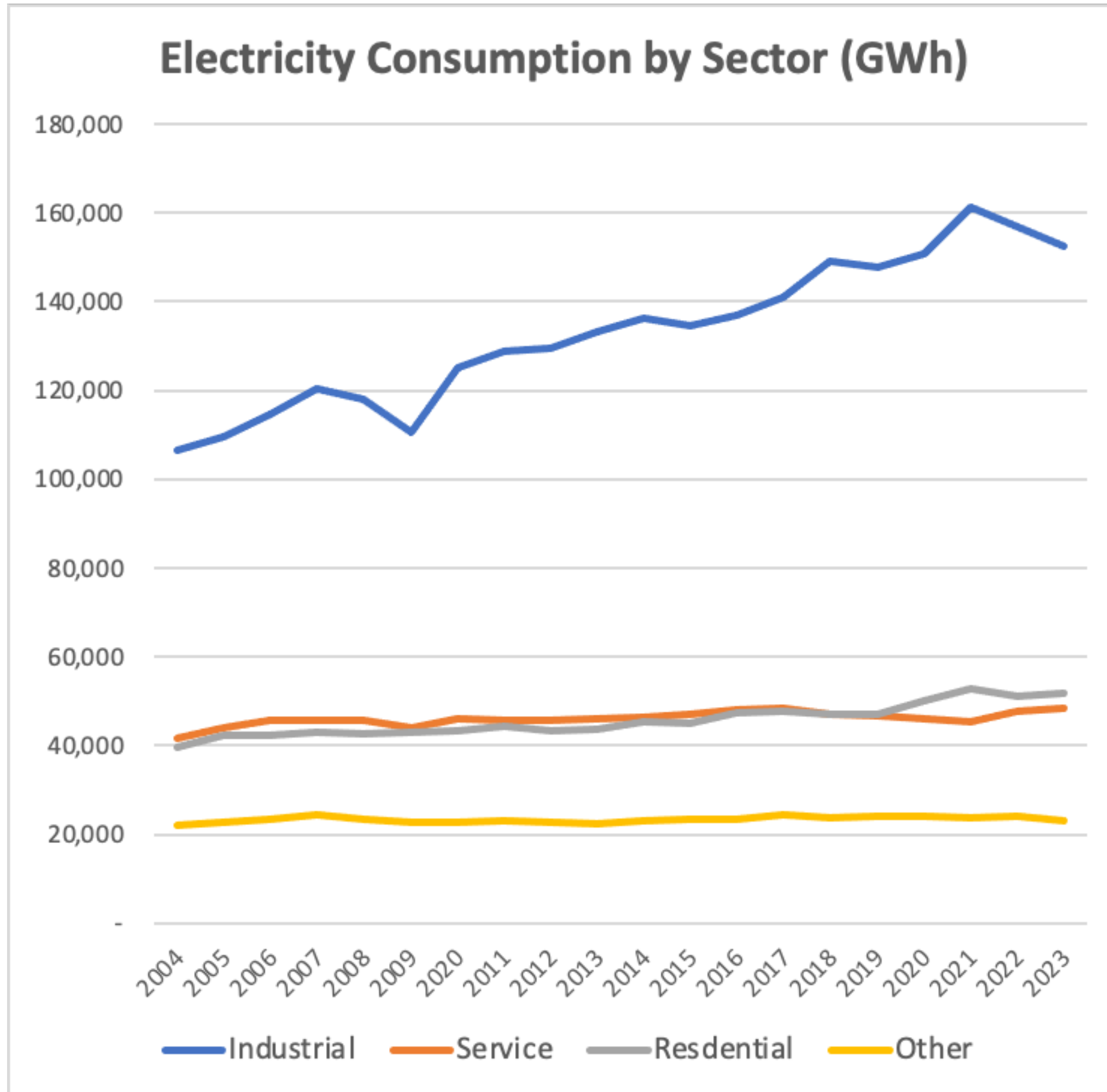


RE Installed Capacity in Taiwan (MW)

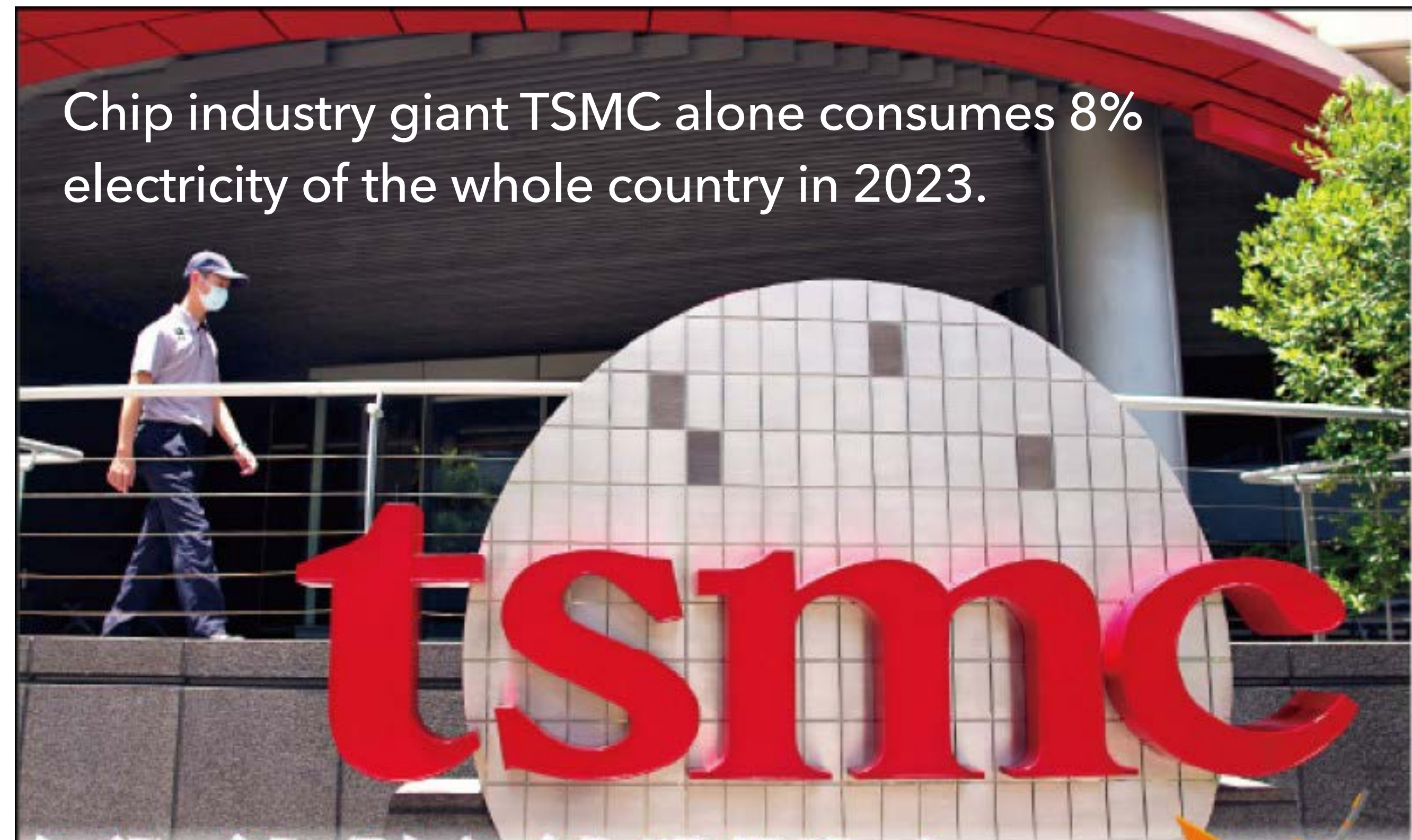


*Geothermal is only 7 MW and not included

More than 50% of electricity consumption is for industrial use



Resource: Energy Administration, Ministry of Economic Affairs, R.O.C.



Chip industry giant TSMC alone consumes 8% electricity of the whole country in 2023.

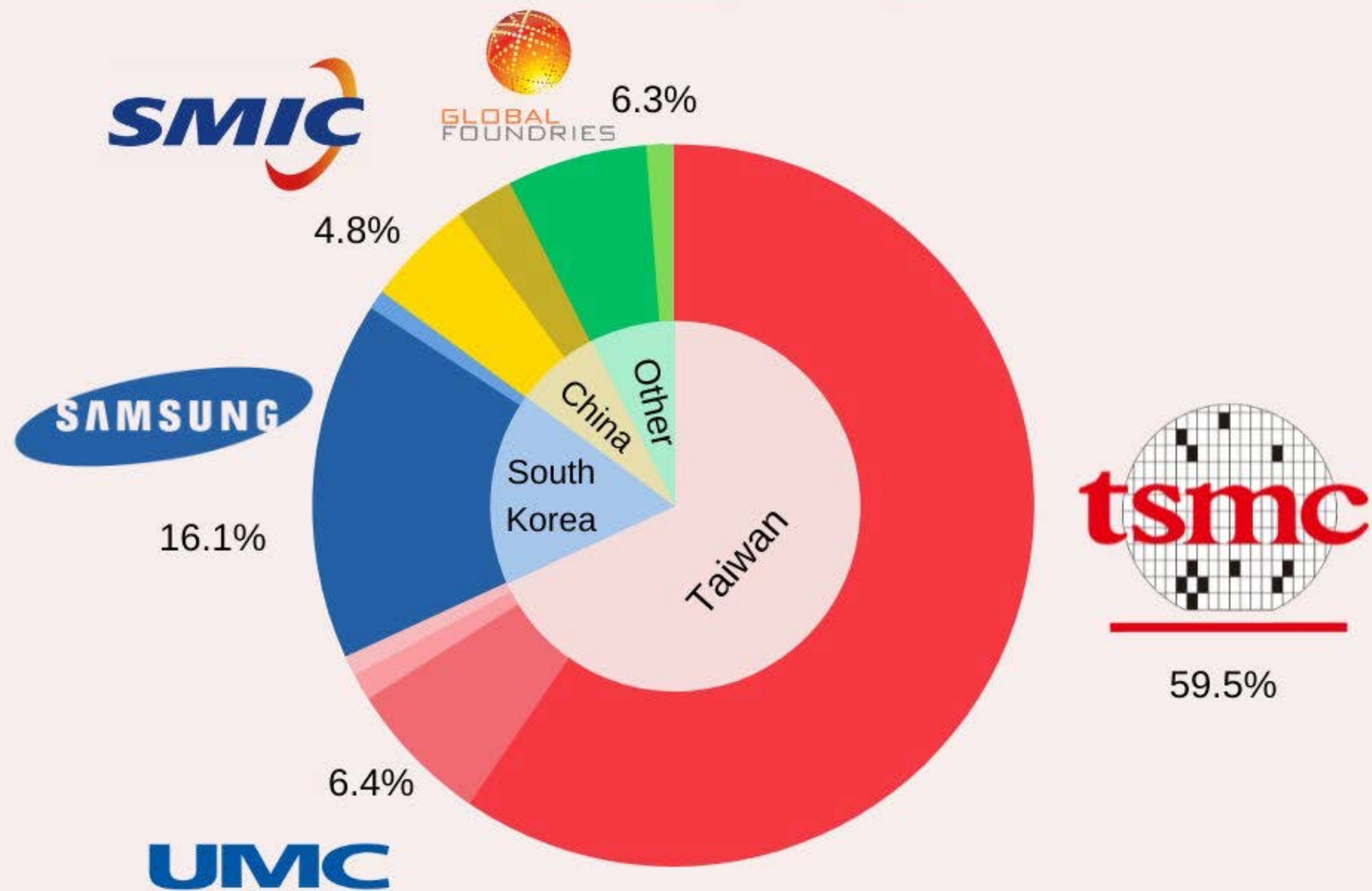
TSMC electricity consumption rate

年	2018	2019	2020	2021	2022
TSMC (GWh)	124.4	135.7	160.5	180.8	210.8
All Nation (GWh)	2665.5	2657.2	2712.3	2831.8	2794.5
TSMC rate (%)	4.6%	5.1%	5.9%	6.3%	7.5%

資料來源：經濟部能源局、台積電永續經營報告書 圖：法新社 製表：記者林菁樺

Expected to reach **12.5 % by 2025**

Largest Semiconductor Foundries in the World as % of Global Revenue

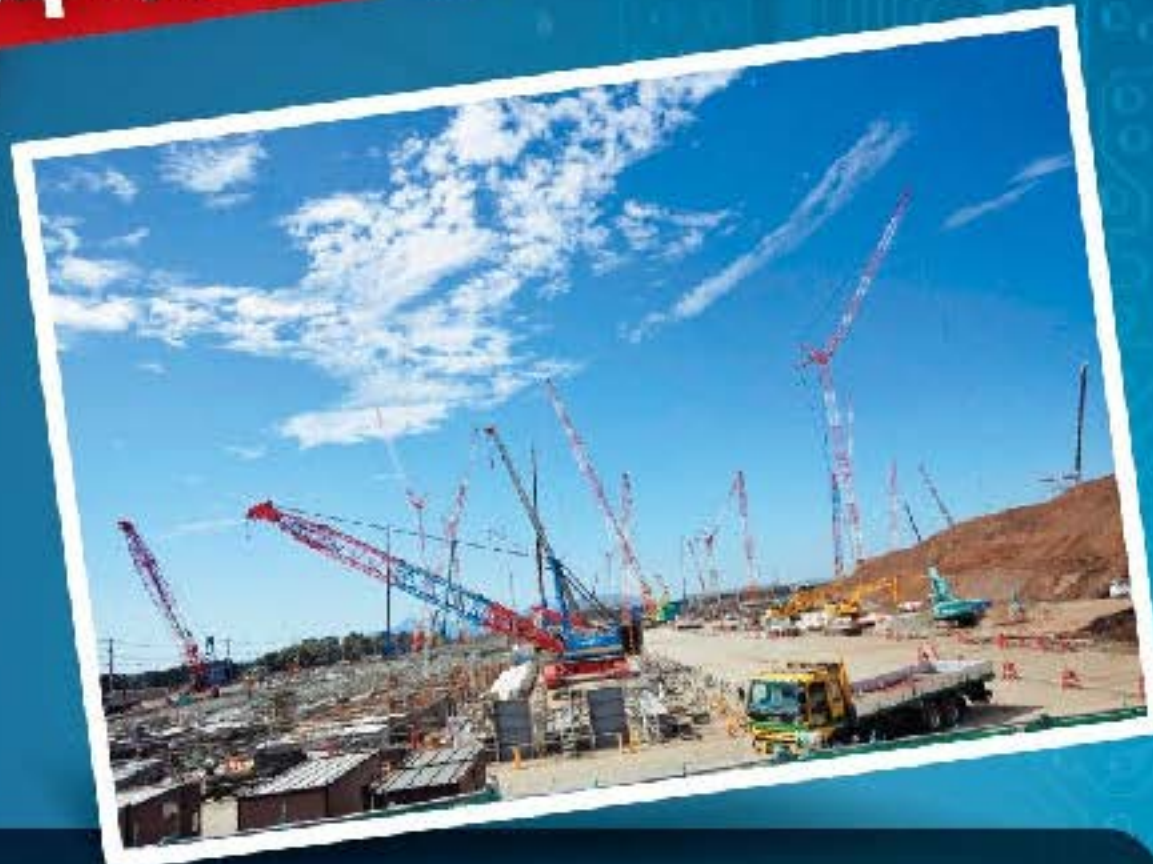


台積電全球布局



台積電來了！熊本設廠擦亮日本矽島招牌

2024年末に出荷を控える台湾積體電路製造 (TSMC) の新工場 (1月、熊本県菊陽町)



九州半導體群聚效應擴大

看懂產業聚落分布



日本半導體業紛插旗九州

近兩年主要投資案件

產業	企業	地點	投資額 (日圓)	投產年度
半導體	索尼集團	長崎縣諫早市	1000億	2021
	鎧 俠	三重縣四日市	1兆	2022
	羅 姆	福岡縣筑後市	200億	2022
	美 光	廣島縣東廣島市	130億美元	2022
	三菱電機	福岡市	45億	2023
	台 積 電	熊本縣菊陽町	86億美元	2024
	瑞薩電子	山梨縣甲斐市	900億	2024
半導體供應鏈	平田機工	熊本市	80億	2020
	京 瓷	鹿兒島縣霧島市	110億	2022
	SUMCO	佐賀縣伊萬里市	2015億	2023
	Ferrotec控股	熊本縣大津町	48億	2024
	東京威力科創	熊本縣合志市	300億	2024
東京應化工業	熊本縣菊池市	未定	未定	

註：除三重縣、山梨縣及廣島縣外，其餘投資案均在九州；投資額含補助金
資料來源：《日經Veritas》等日本媒體

資料來源：《日本經濟新聞》

2022/12/07

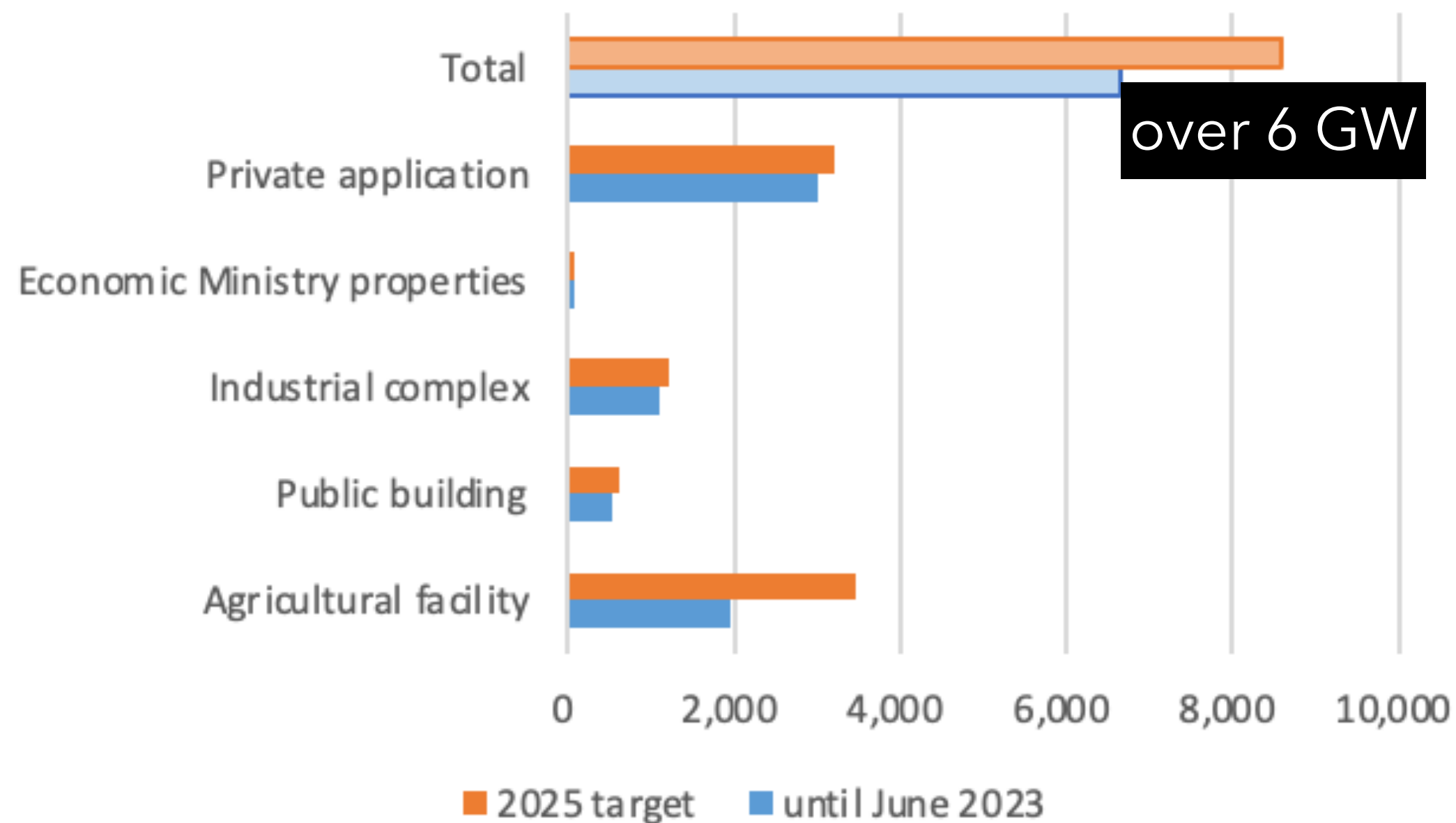


Land use conflicts of Solar

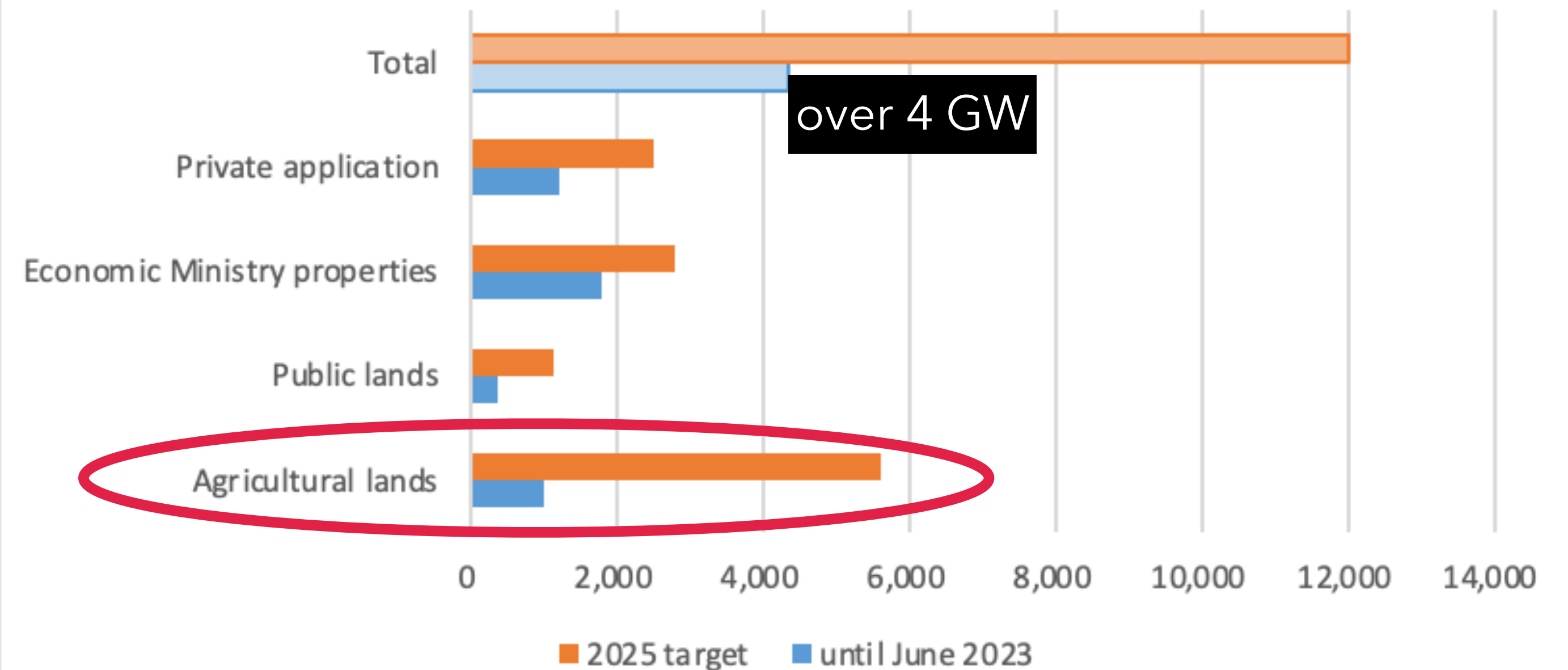
8 GW Rooftop PV + 12 GW ground-mounted PV = 20 GW 2025 Target



Installed Capacity of Rooftop PV (MW)



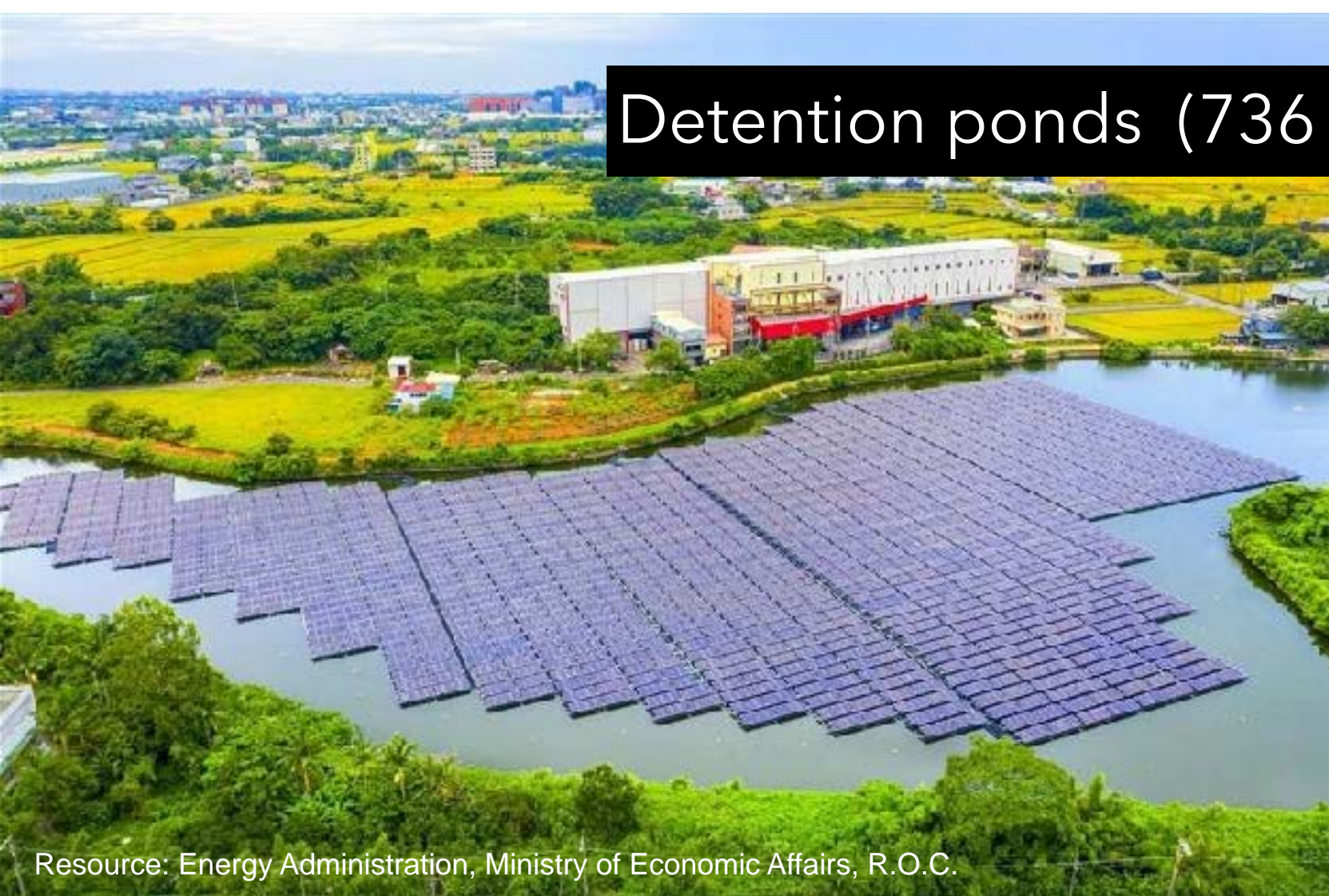
Installed Capacity of Ground mounted PV (MW)



Rooftop PV > 6GW



Ground-mounted PV > 4 GW

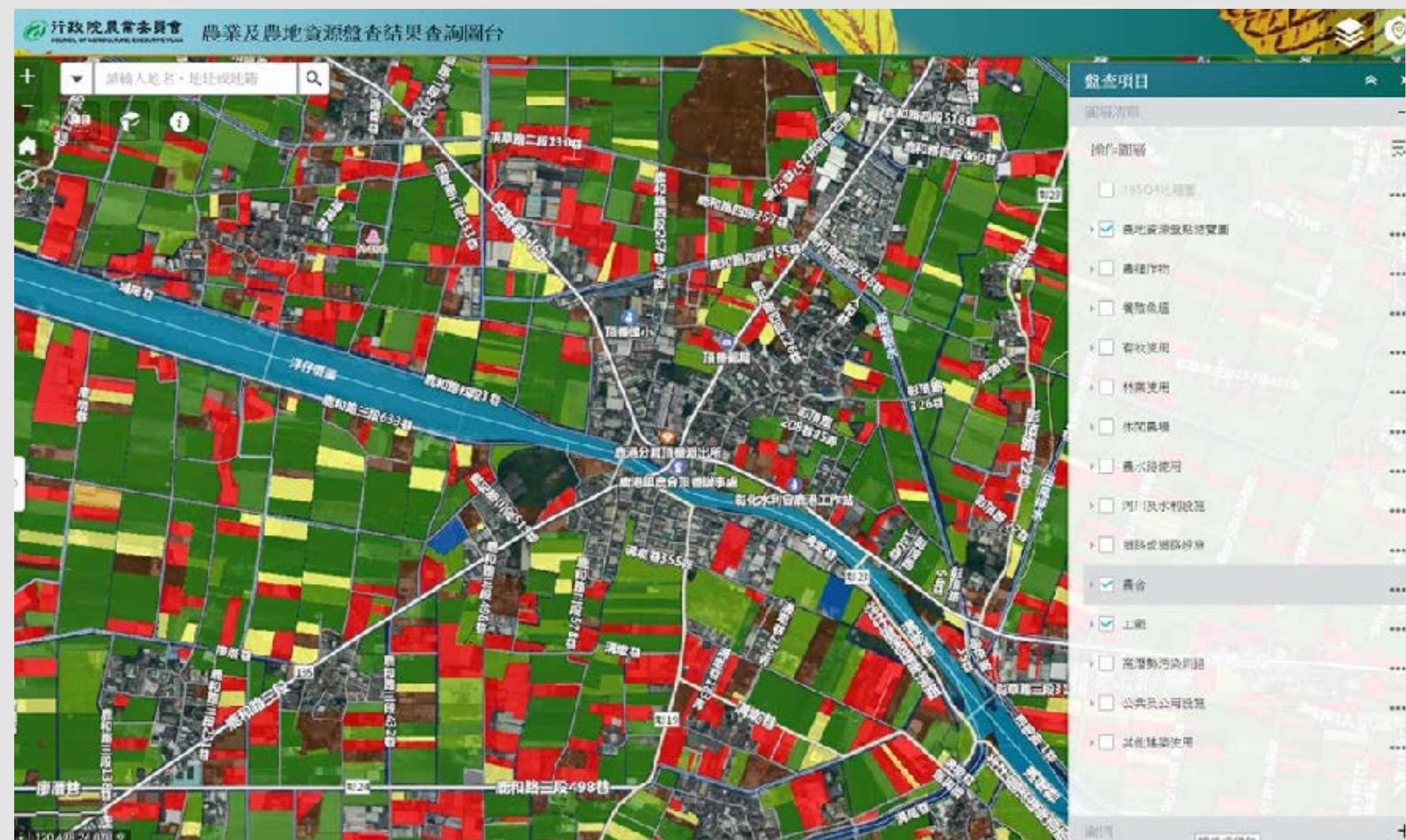


Existing issues of agricultural land

- Food sufficiency rate is 30-35% (CoA 2020): corn, soy and wheat are mostly imported.
- Agriculture threats: degradation of land, lack of labour and other capital.
- Loss of farmland (CoA)
 - Statutory arable land: 760,000 ha,
 - cultivable land: 570,000 ha,
 - cultivable flat farmland: 370,000 ha.

Total area of flat farmland occupied by **illegal factories** is more than 13,800 hectares, inhabiting over 52,000 factories, accounting for 1.8% of the statutory arable farmland in Taiwan.

- Solar industry wants 20,000 ha to achieve 20 GW goal.





2017

Ill designed / managed APV in 2013 - 2017

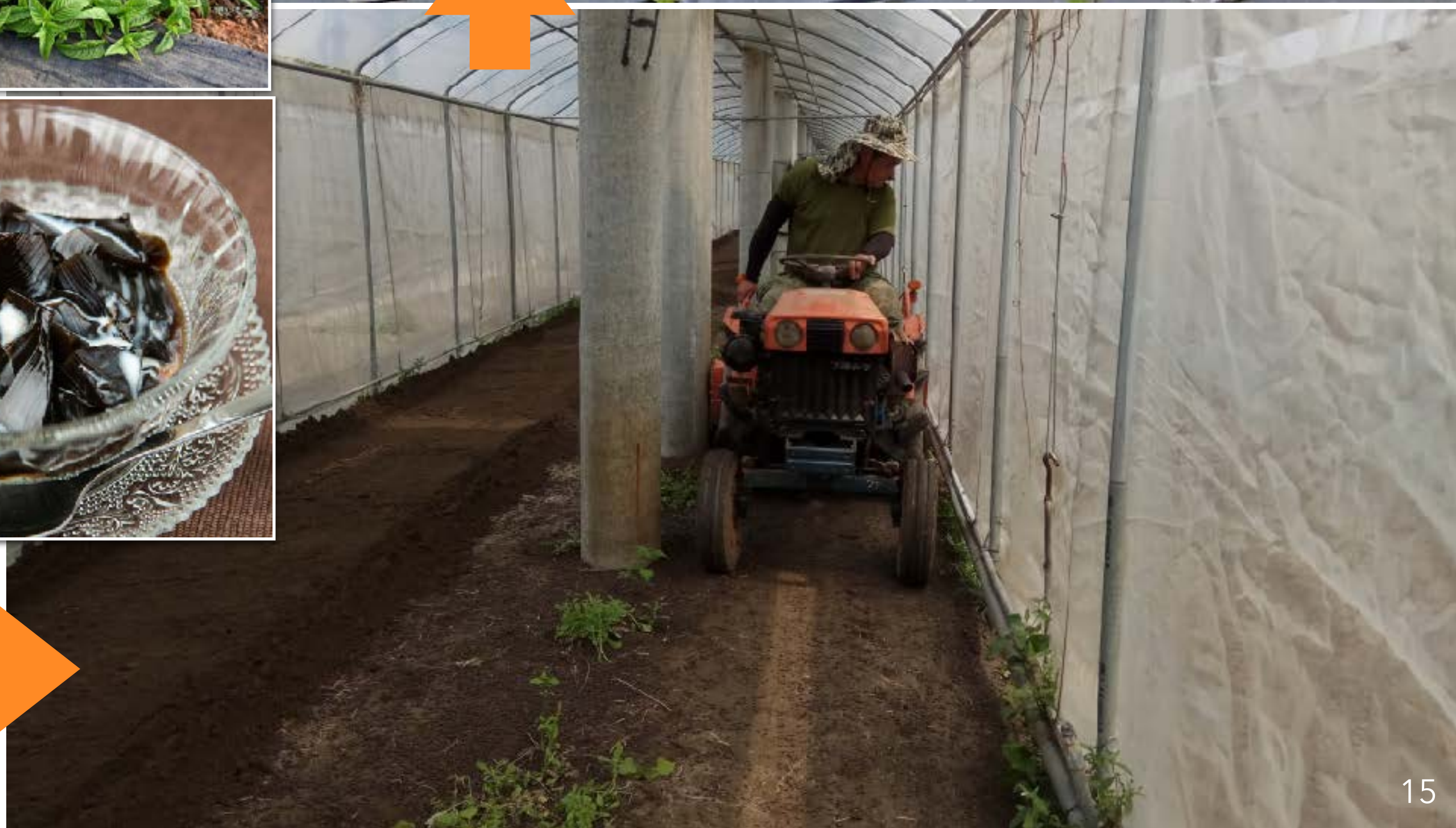
2023

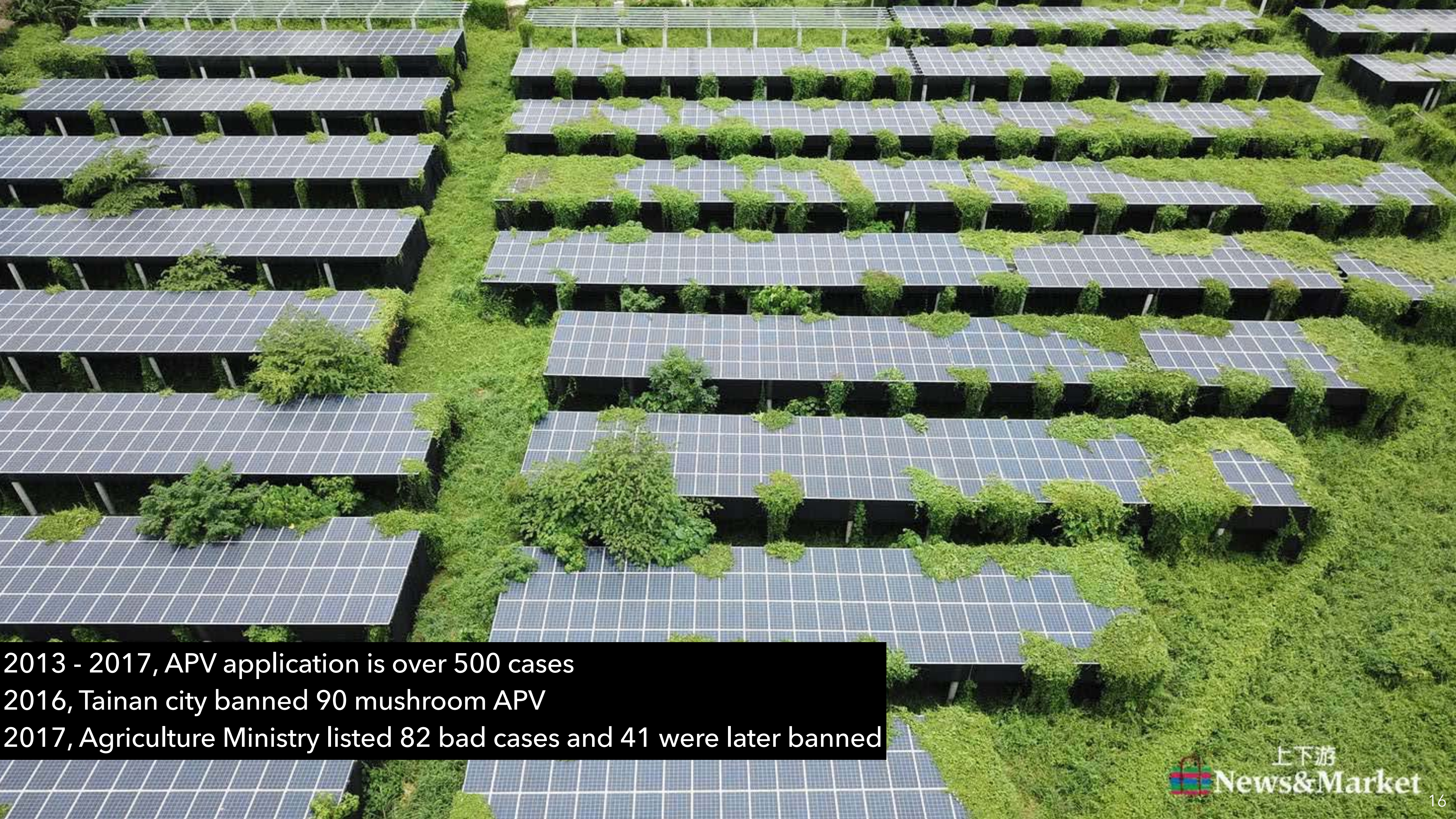


無花果 いちじく
2017, 雲林縣
0.38 ha govt. pilot project



仙草 ゼリー
2017, 雲林縣
0.25 ha govt. pilot project





2013 - 2017, APV application is over 500 cases
2016, Tainan city banned 90 mushroom APV
2017, Agriculture Ministry listed 82 bad cases and 41 were later banned



Mushroom

2018, 雲林縣

0.495 ha indoor facility

Among 18 rooms only 2-3 are functioning



Venilla

2016, 屏東縣

231 m² green house





Rotating model
Elephant grass, sweet potato

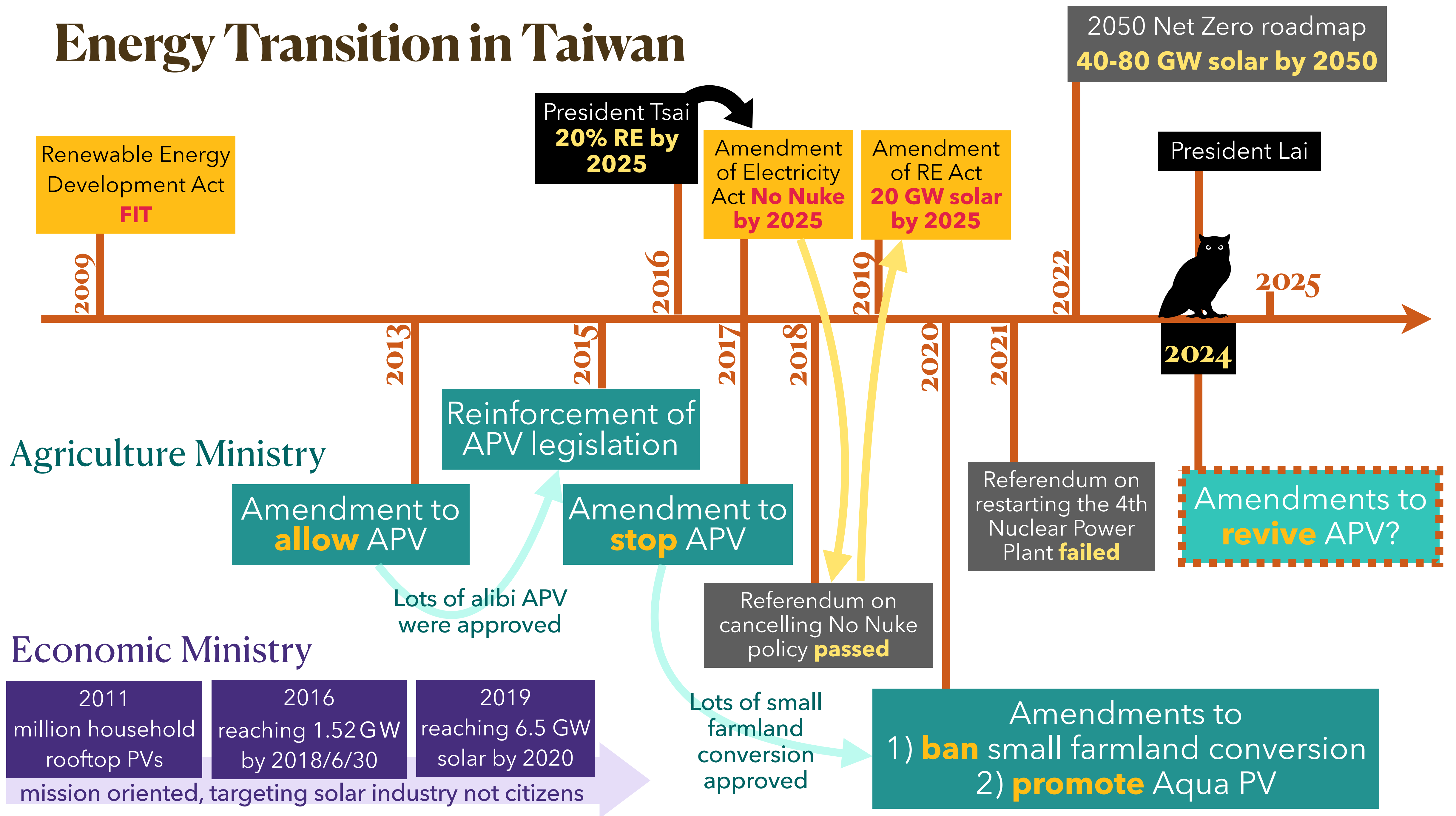
2022, 嘉義縣
Govt. pilot project



Fixed model (Japanese style)
mellow, squash, sweet potato



Energy Transition in Taiwan

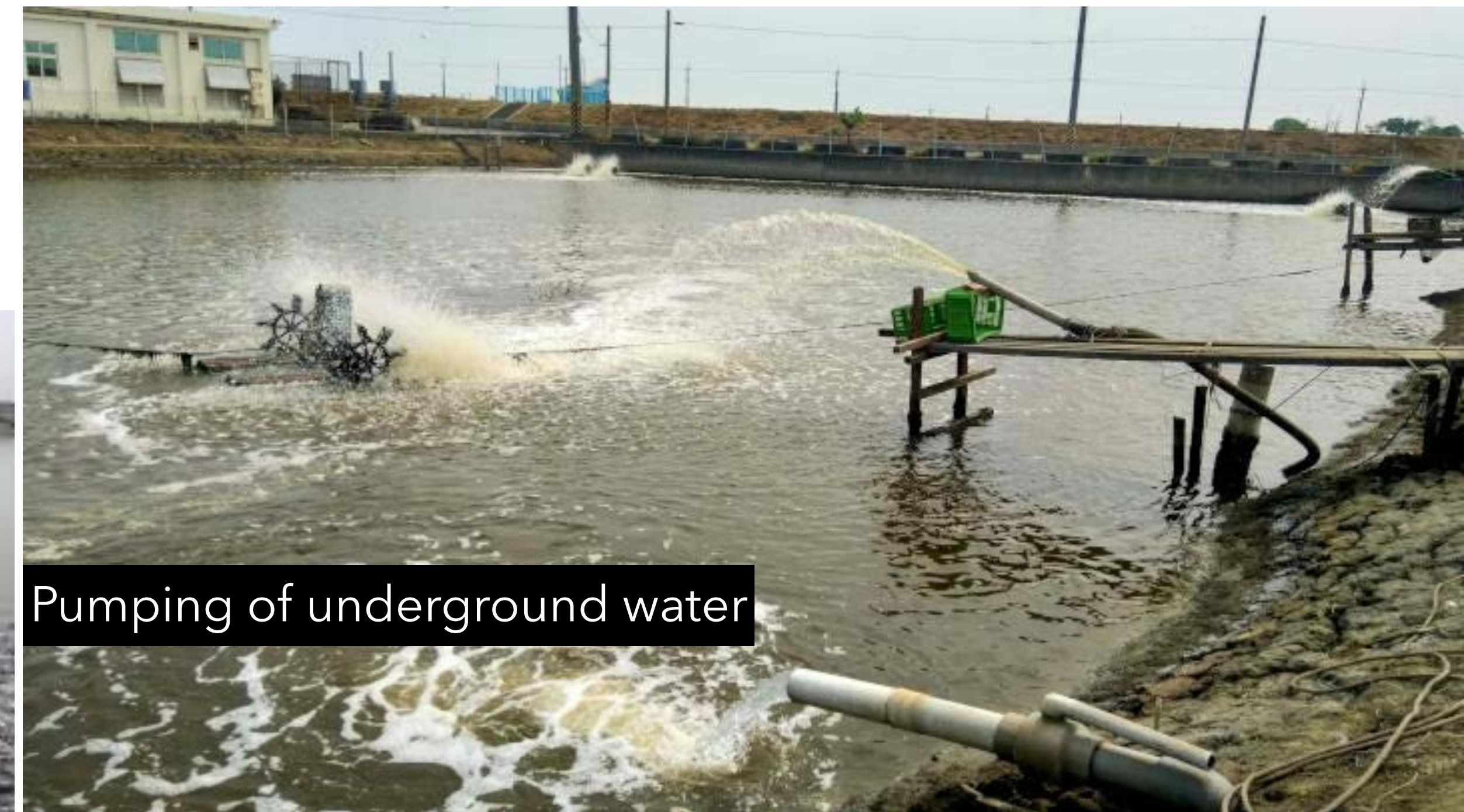


Aqua PV in Taiwan

- **Est. 45,481 ha** (35.6% fish, 64.4% shrimps & clams)
- Est. 100,000 farmers, mostly tenants
- High density aquaculture prone to disease
- Highly susceptible to weather and water quality
- Health and environmental issues
- **Less solar dependent than crops**

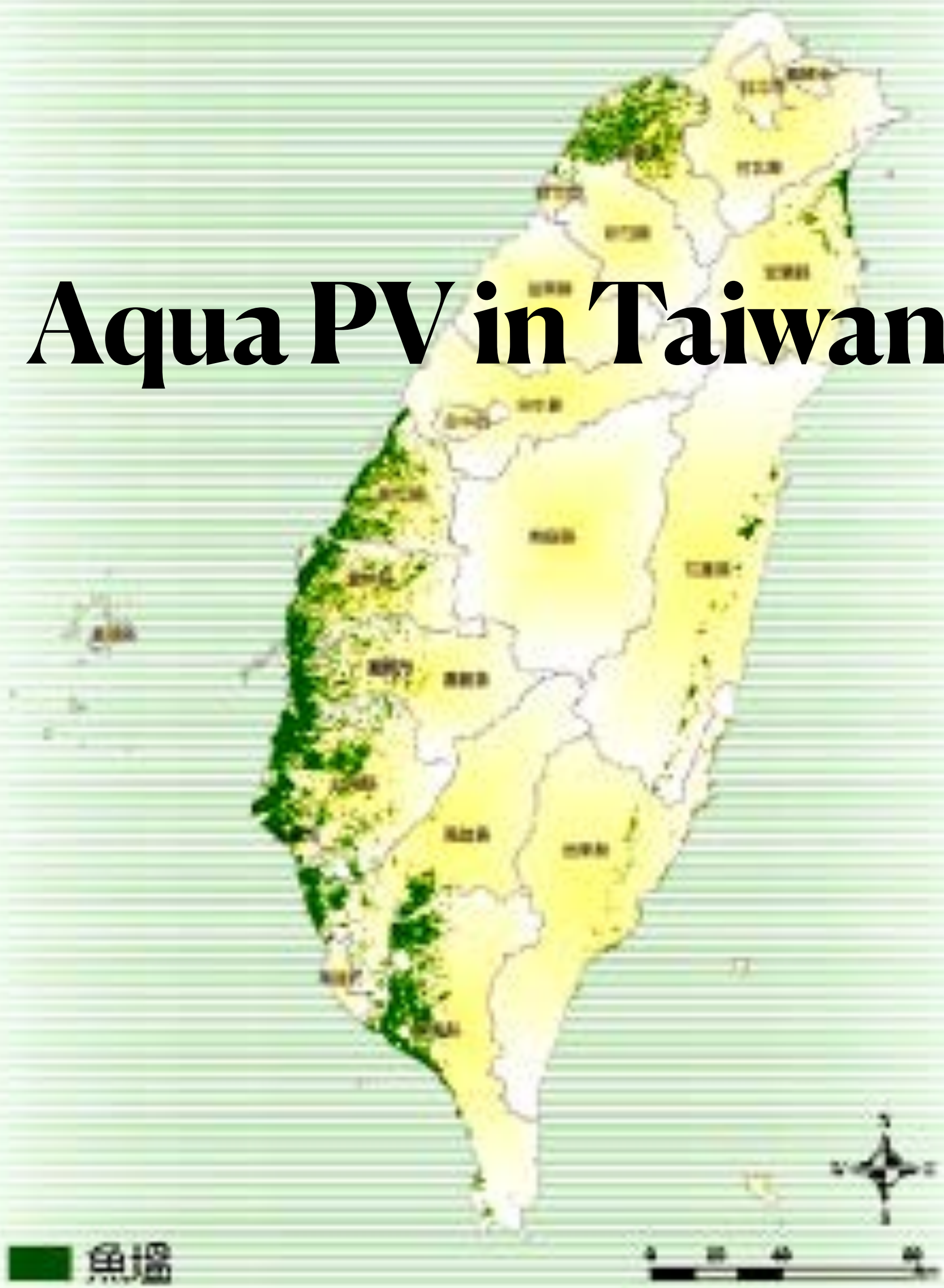


Farms over-flooded by rainstorm

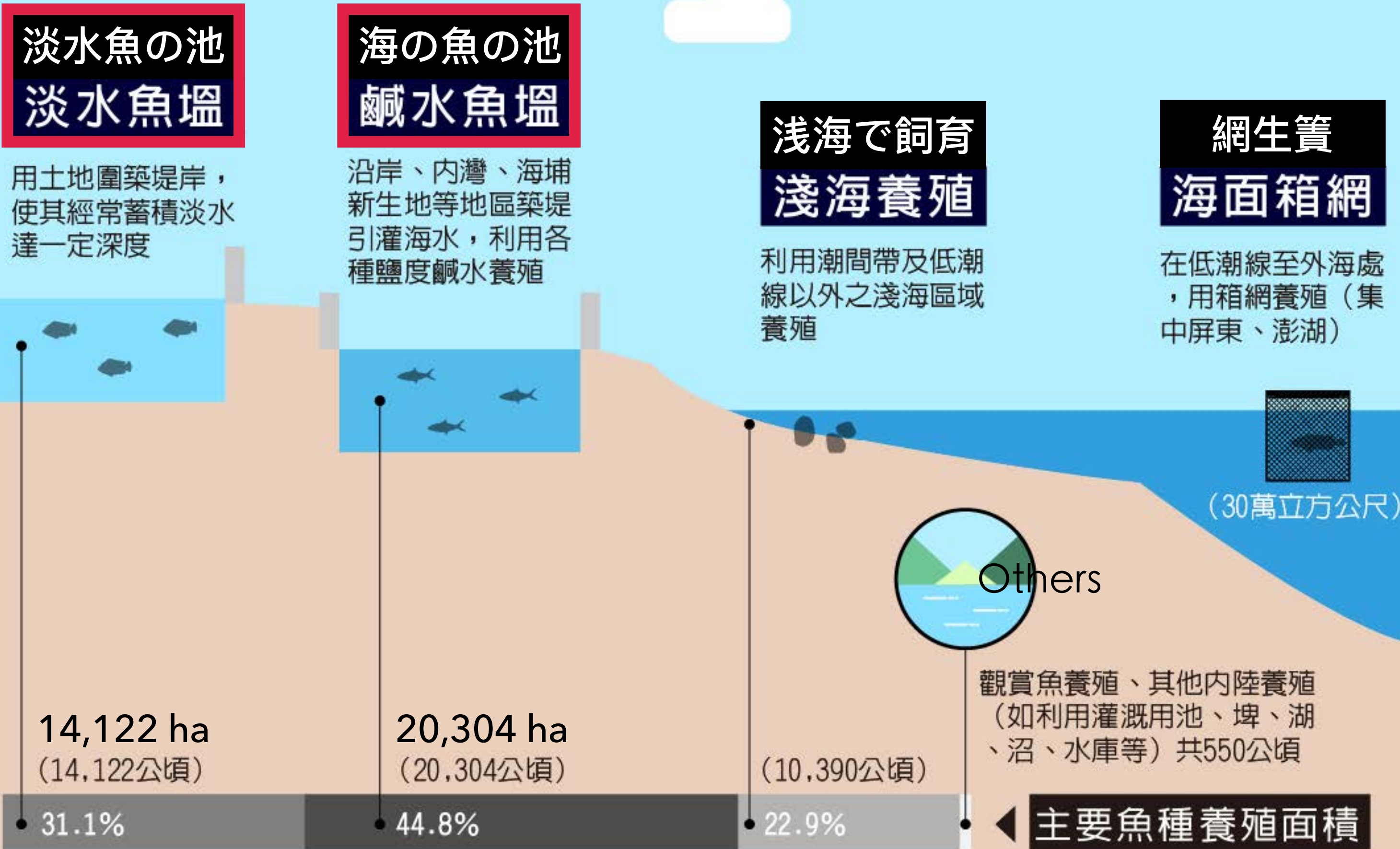


Aqua PV in Taiwan

Agricultural Ministry has announced **20,000 ha** of fish ponds eligible for AquaPV application, expecting **4.4 GW** of solar capacity by 2025.

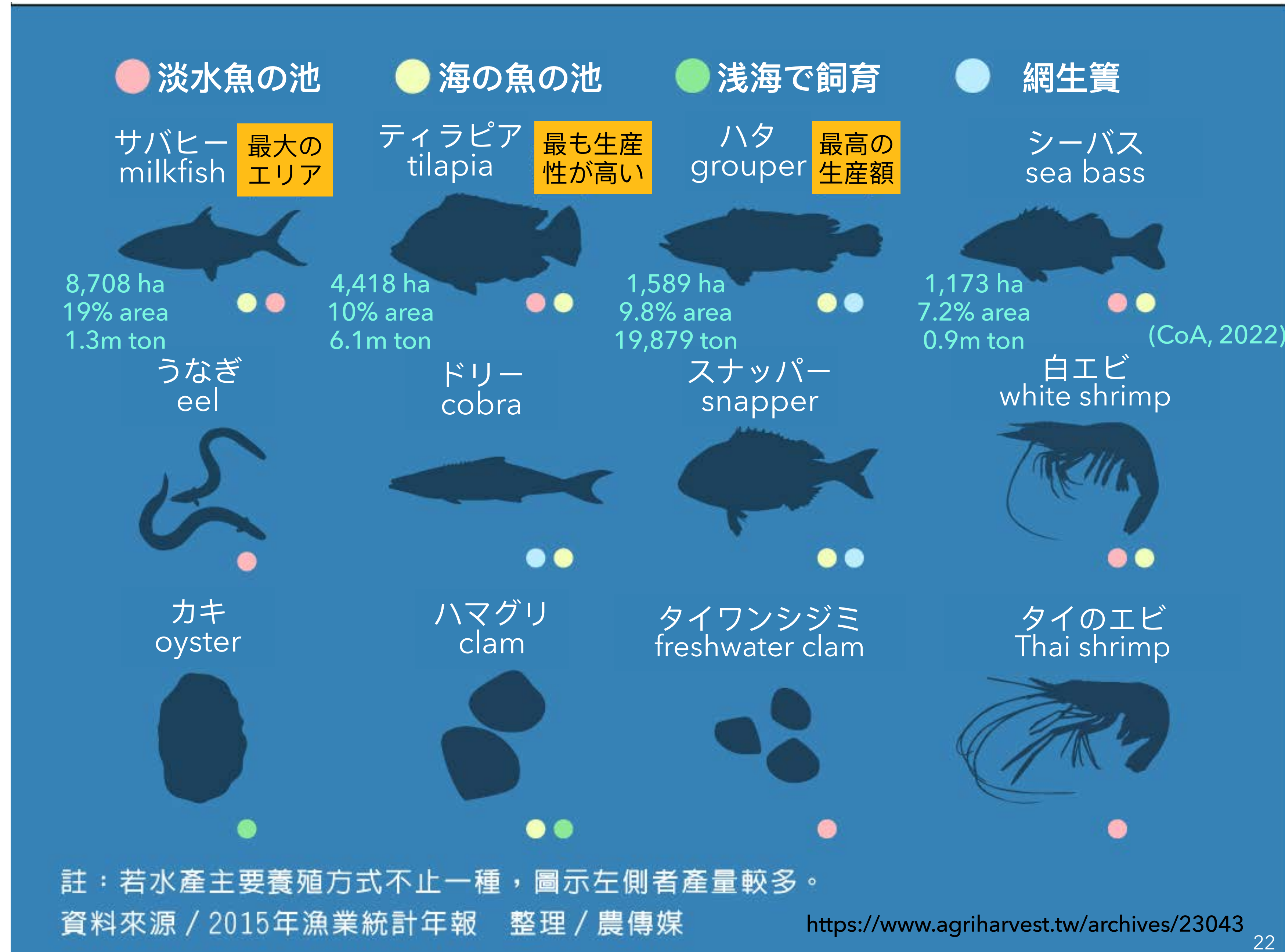
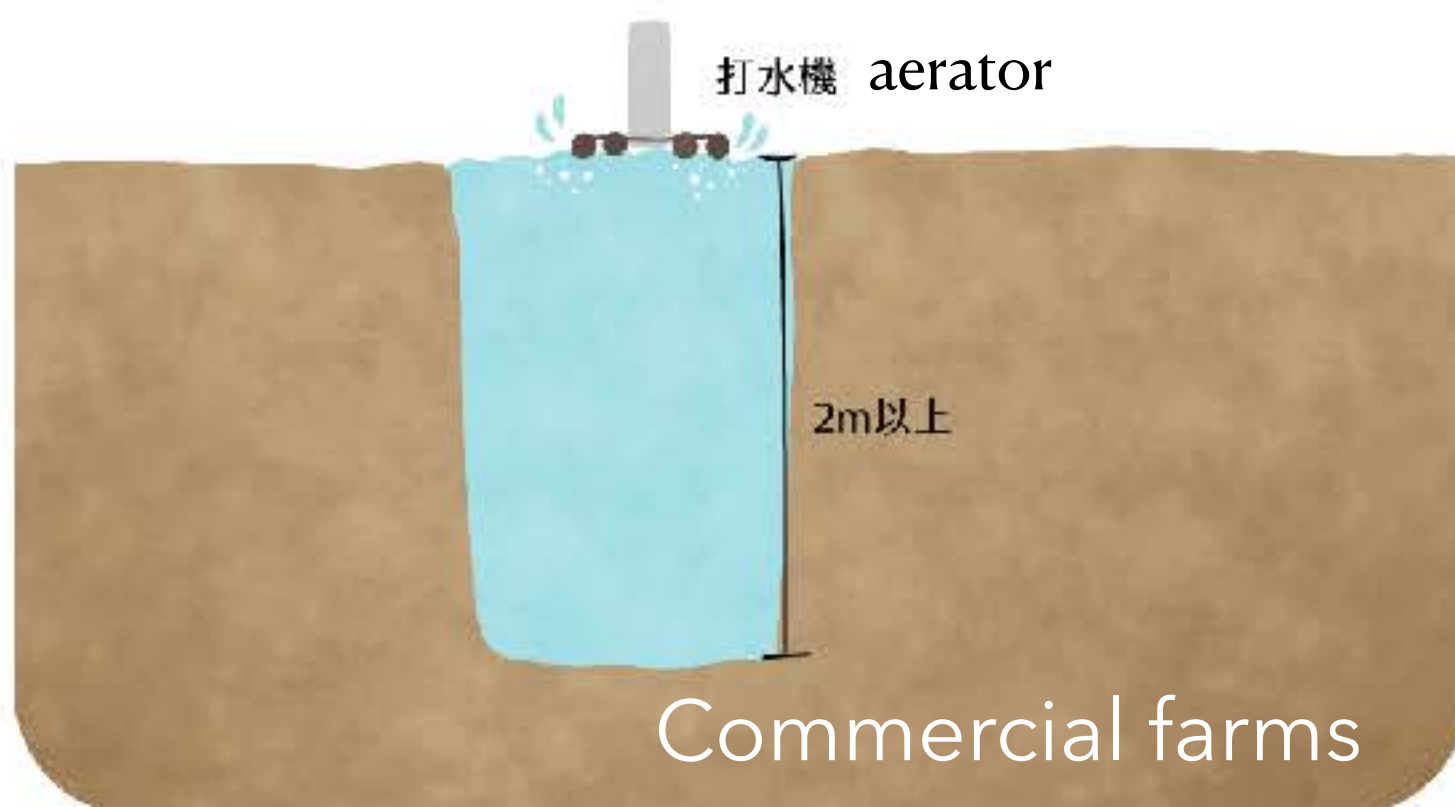


資料來源 / 2015年漁業統計年報 整理 / 農傳媒
<https://www.agriharvest.tw/archives/23043>



Common species of aquaculture and raising means

- Over 300 years of history.
- Modernization in the 60s (artificial propagation, feed and other technology)
- Total yield around 23m ton per year (27% export)



Societal aspects: Tenants & Feasibility

Infrastructure largely unimproved for decades.
Most farmers old without land or enterprise.



clam harvest



fish harvest

Environmental aspect: Bird conservation

Open fish farms are drained in the wintertime,
providing feeding sites for migratory birds.



Call for a new mechanism

No EIA? Do **ESA (Environmental & Societal Impact Assessment)**

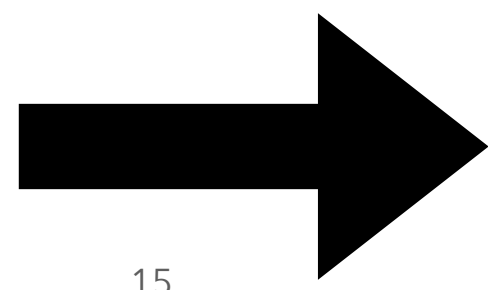
1. For the first 6 applications already passed

Conditional permission
Funding for conservation

2. For the 7th proposal under review

TE&P did a pilot ESIA

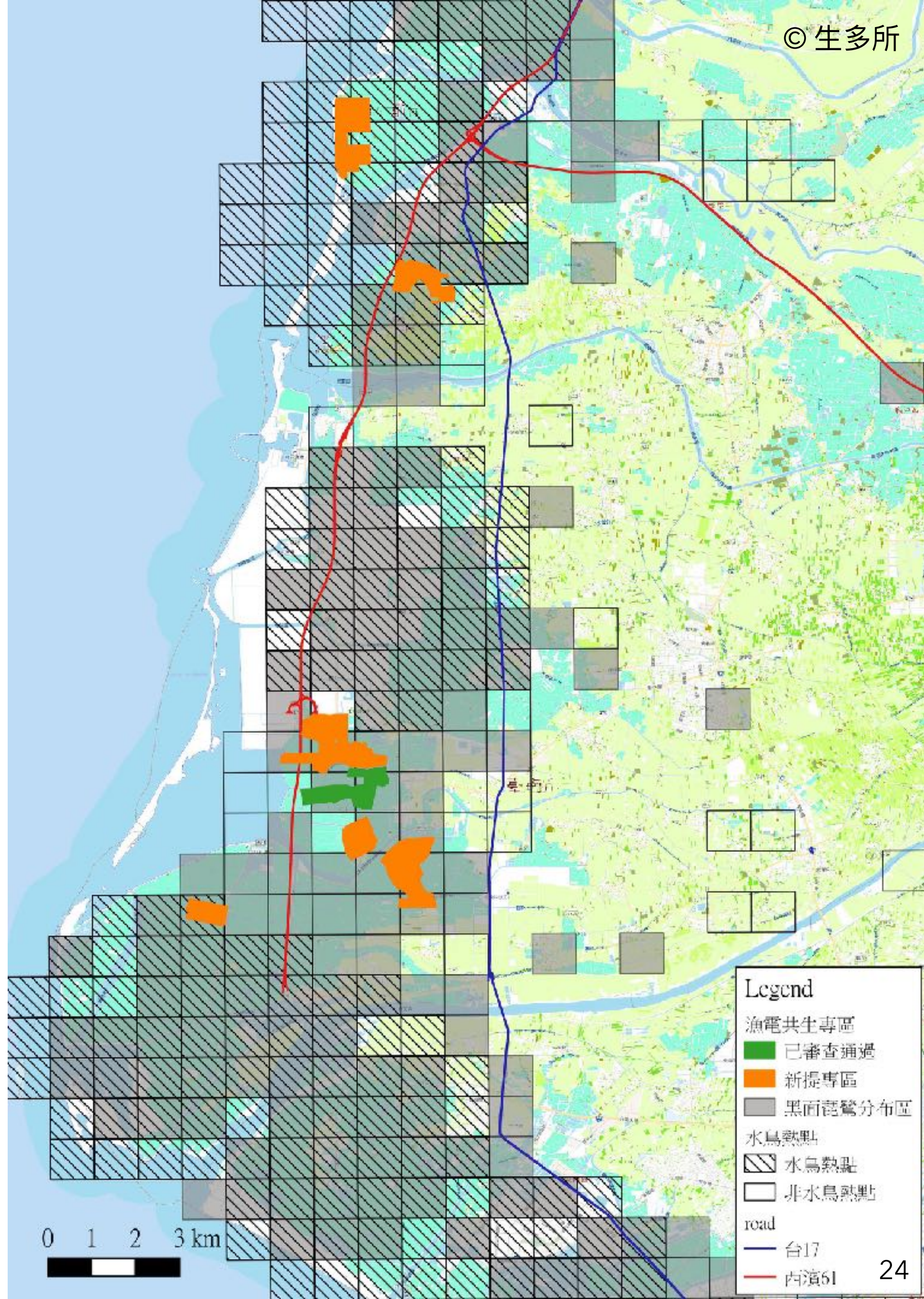
3. For all new aqua-PV proposals in the future...



15



Mitigation Hierarchy



We performed the first ESA (2020年10-12月)

Feasibility of Aqua PV

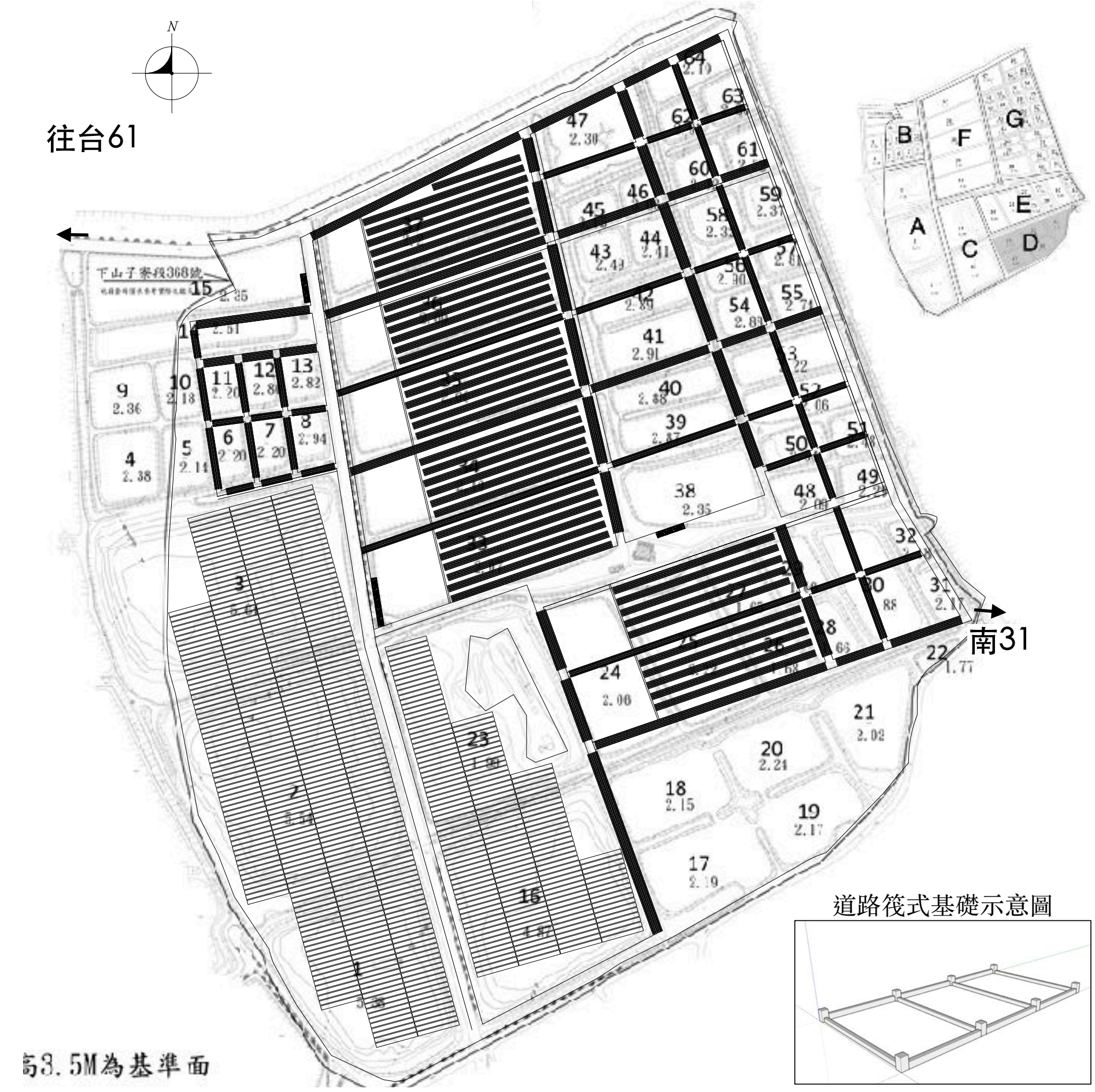
- PV coverage < 40%
- Annual yield > 70%
- Wind & Erosion
- Operational space



HDRE

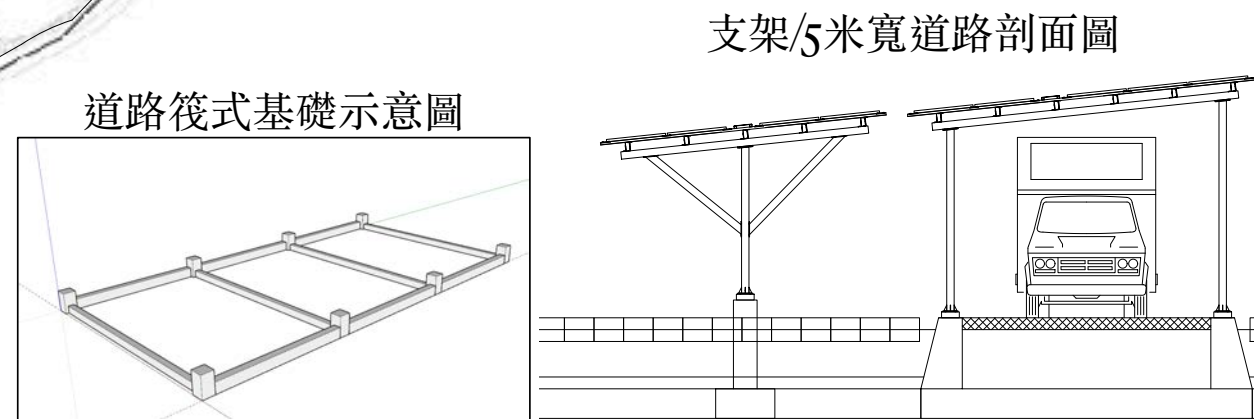


旭康七股下山子寮漁電共生專區空間配置示意圖



- 基地總面積：577,448m²
- 設施覆蓋率：28.40%
- 總建置容量：32,445.27KW
- 光電總片數：98,319pcs

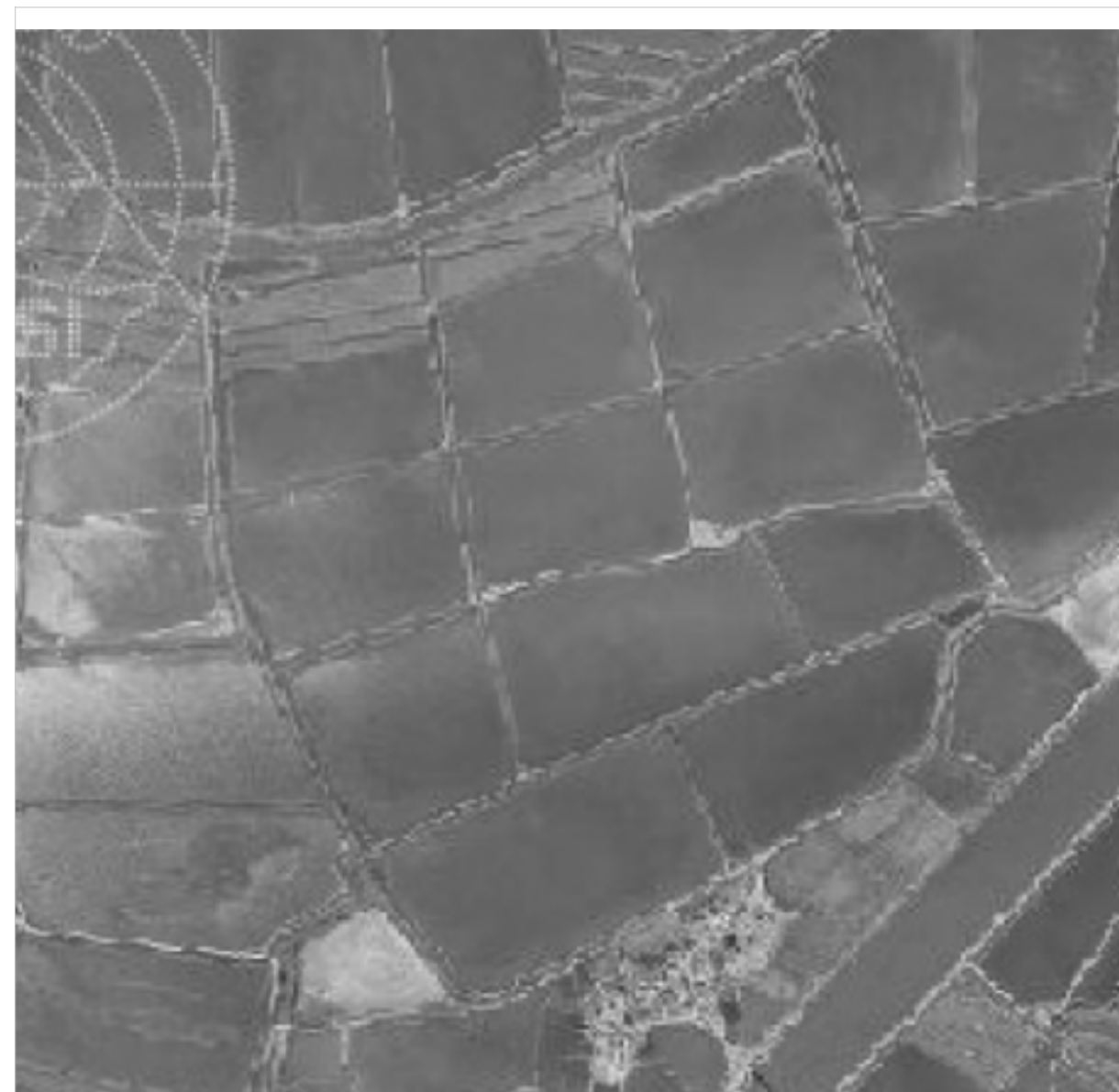
- 蓄水池(A/C) | 水面型**
建置容量14,652KW
高壓設備5套
使用面積73,706.52m²
- 深淺池(E/F) | 淺坪&聯通道
支架**
建置容量9,187.2KW
高壓設備4套
使用面積46,676.307m²
- 專養池(B/G) | 聯通道支架**
建置容量8,606.07KW
高壓設備2套
使用面積43,628.378m²



Land use changes

environmental baseline

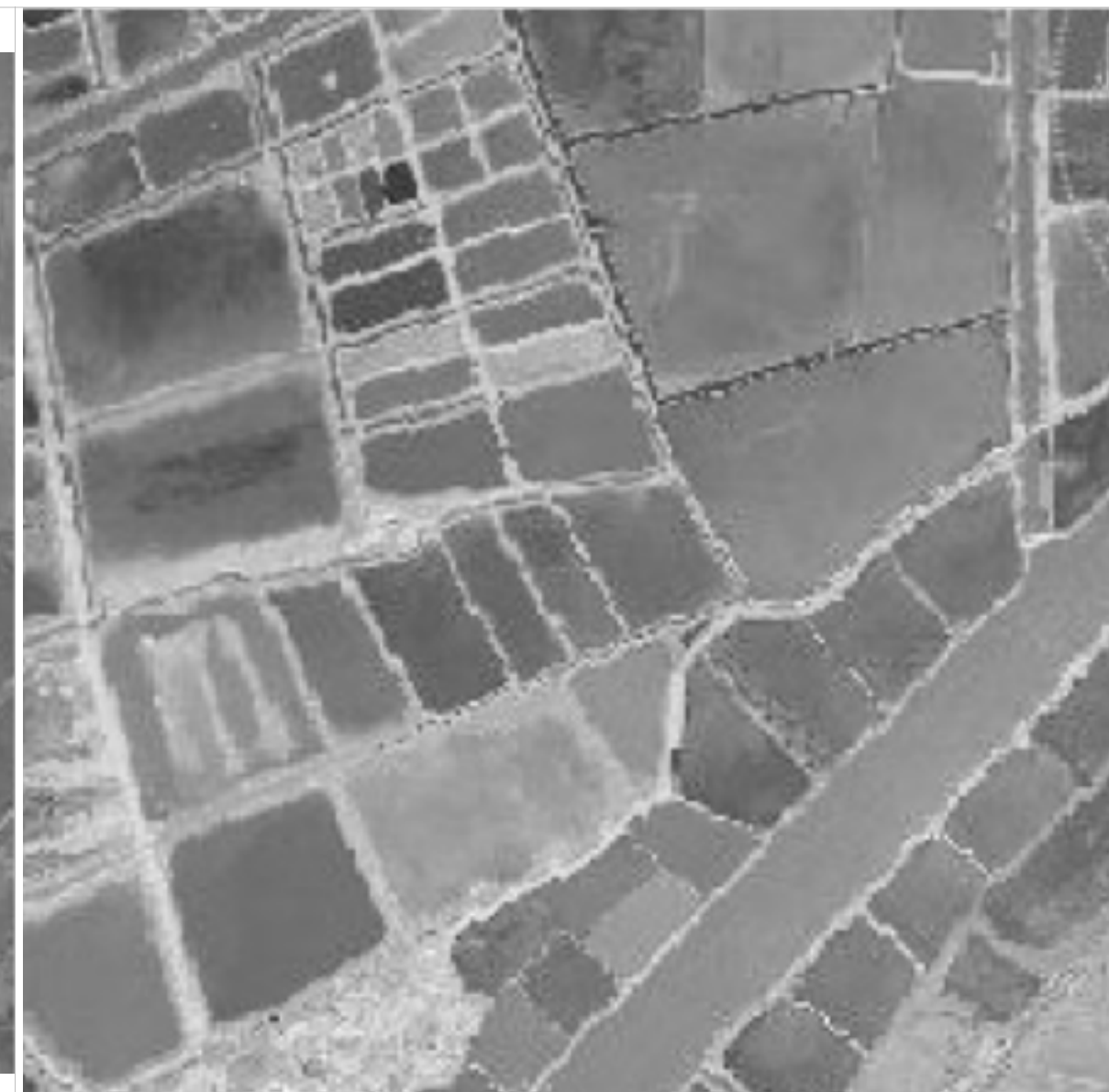
- Fish ponds appeared before 1947
- Change crops between 1985 and 1991
- Largely abandoned after 2011



1985年4月26日攝



1991年2月24日攝



1999年5月17日攝



2011年10月10日攝



Habitat Survey

ecological baseline

旭康七股下山子寮漁電共生專區生態情報圖



潮溝邊優勢種海茄冬



魚塢堤岸上優勢種裸花鹼蓬



2號池內有在地原生種卵葉鹽藻



23&16號池間有入侵種長穎星草



雁鴨喜愛的蘆葦叢優勢棲地



欖李(紅皮書NT)



高雄茨藻(紅皮書VU)



雁鴨群聚在人跡少且植生良好的塢池

“旭康七股下山子寮漁電共生專案計畫
可行性評估階段
在地意見蒐集會

直播預告
2020.12.21(一) 3pm

第三方平台促進溝通
歡迎線上旁聽

台灣環境規劃協會 #環社檢核 #在地參與



產-台南文蛤
蛤批發零售|...

海巨人/白蝦/
烏魚子/虱目魚

下七股中排水

南31

南31-1

七股溪

南31

海寮

七股區

南31-1

南31

南31

七股溪

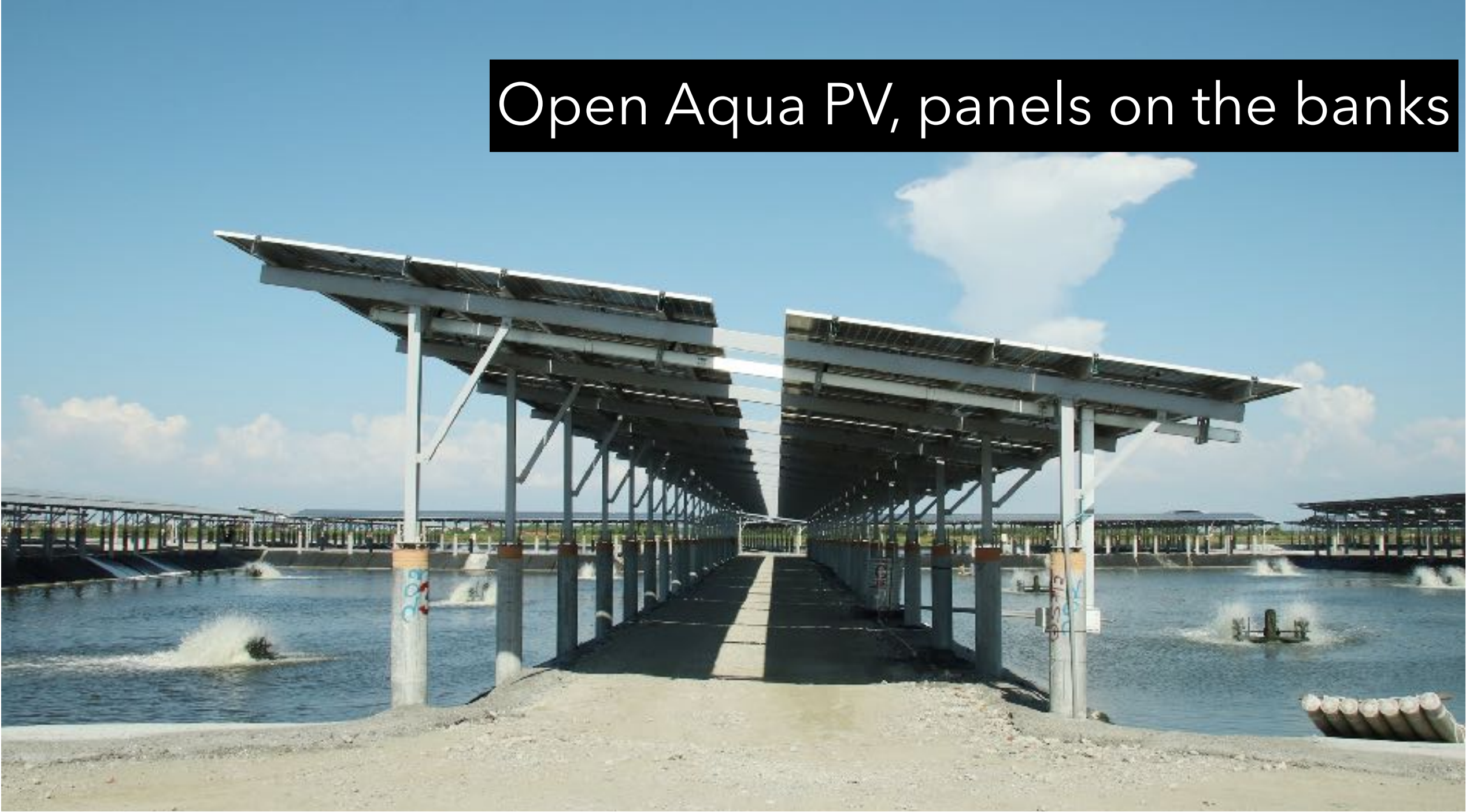
南31

十一分中排

守利開心魚塢



	Open Aqua PV	Indoor Aqua PV
PV coverage restriction	< 40 %	< 80 %
ESA requirement	Yes	No
Expected capacity by 2025	3,511 MW	916 MW
Total capacity by 2023/6	368 MW	138 MW
Area approved by 2023/5	638 ha	1,117 ha



Open Aqua PV, panels on the banks



Indoor Aqua PV facility



aquaculture operating corner

Aqua PV is socially unpopular

經濟部：漁電共生專區發電量力拚 4.4 GW

2022/05/08 · 聯合新聞網 · 經濟部、綠電、漁電

經濟部 7 日表示，除地面型光電外，規劃漁電共生 4.4GW 為推動目標，並在彰化、雲林、嘉義、台南、高雄、屏東已經公告 12,533 公頃漁電共生專區。

七股區光電有多密集

核備光電土地面積	Proposed area	1148.8公頃
現況佔七股區總面積比例	of total area	10.4%
現況佔台南市再生能源土地比例		10.07%
業者已整合土地		1500公頃
未來光電可能佔七股區總面積比例		24.09%

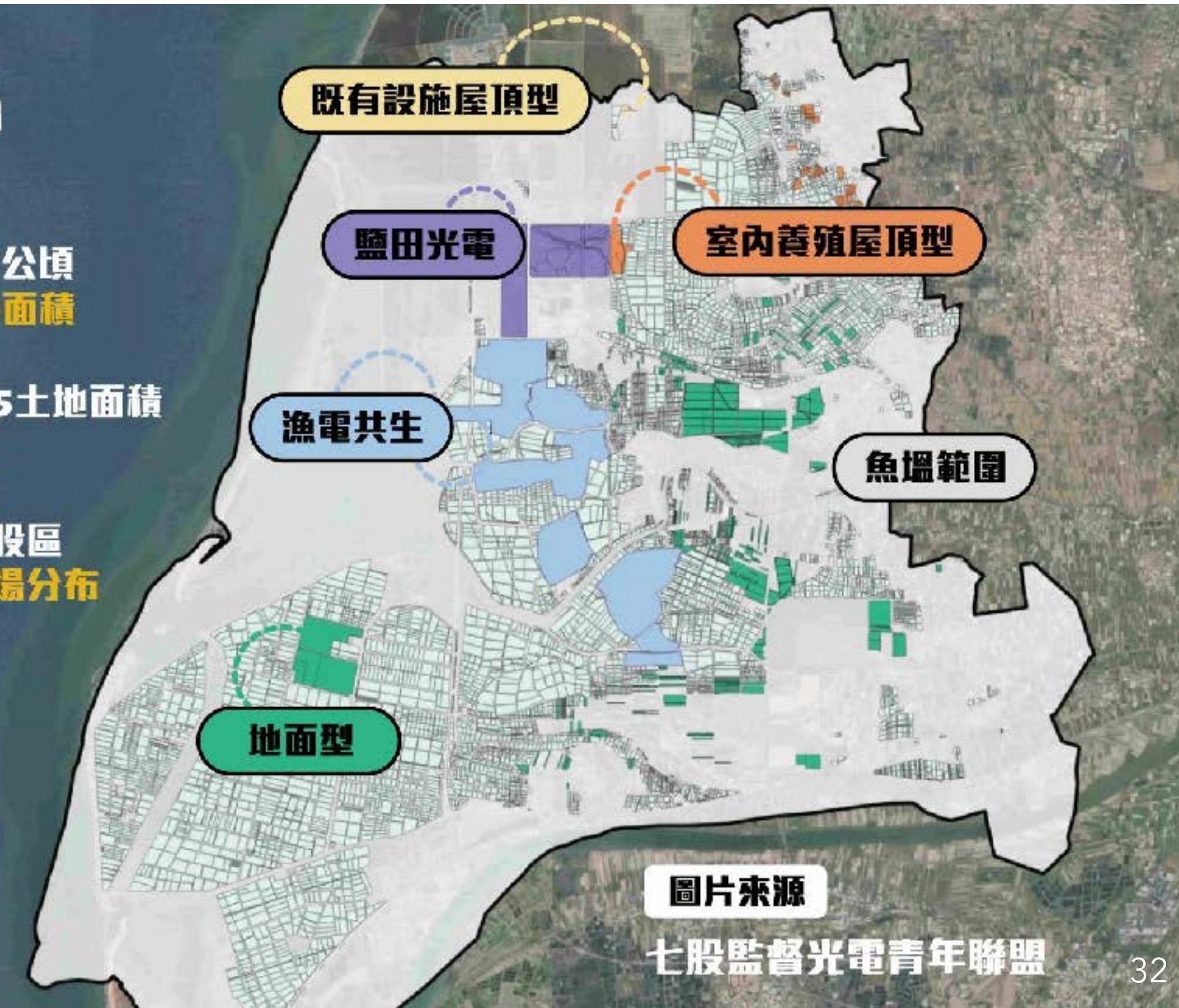
資料來源：七股監督光電青年聯盟 製表：洪敏隆

太報 Tai Sounds

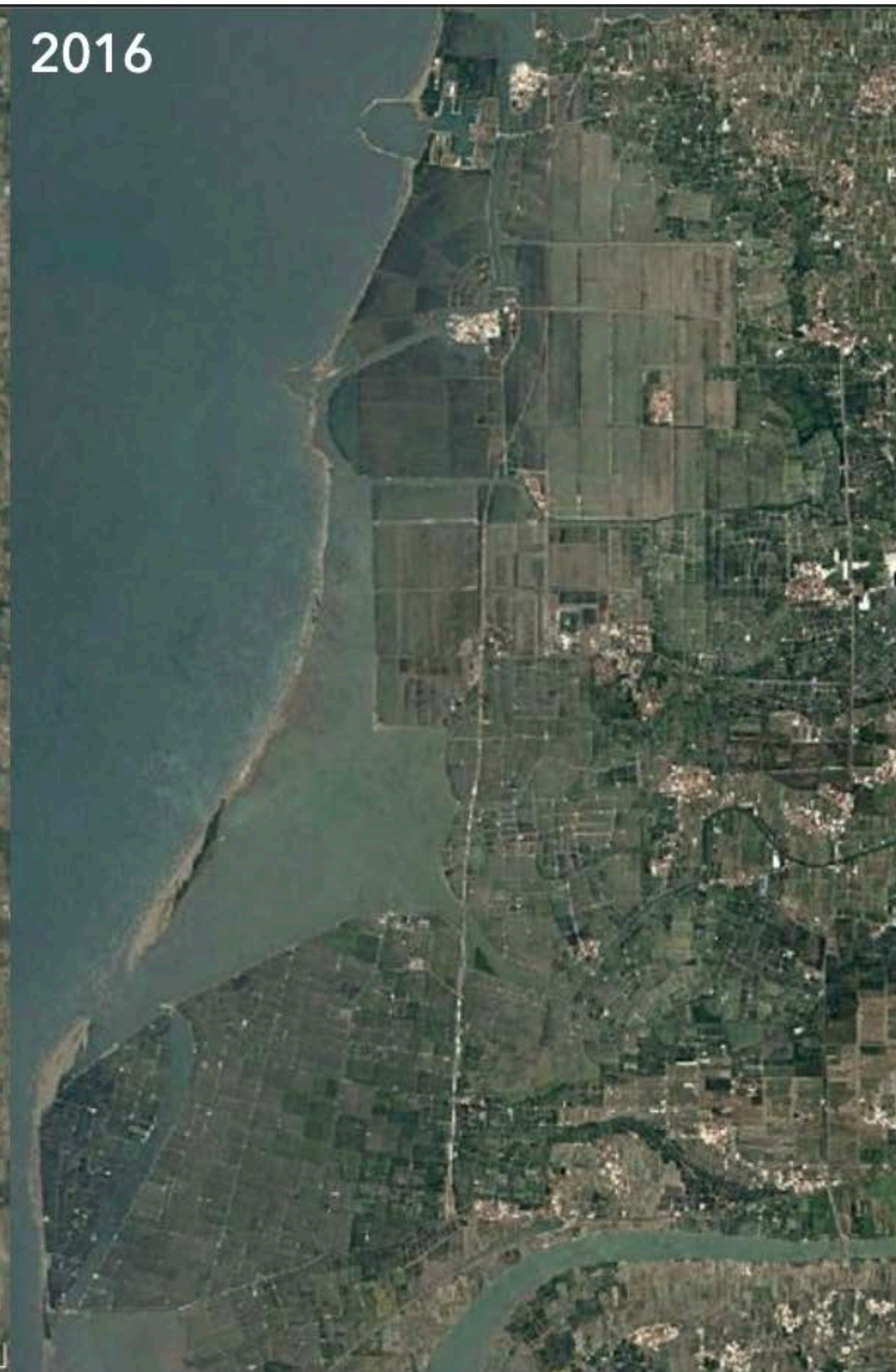


我們的島
our island

- 全區為11015公頃
約占1/10土地面積
- 未來恐將有1/5土地面積
被光電板覆蓋
- 圖中色塊為七股區
已通過光電案場分布



Landscape in the west coast changes dramatically due to recent solar development



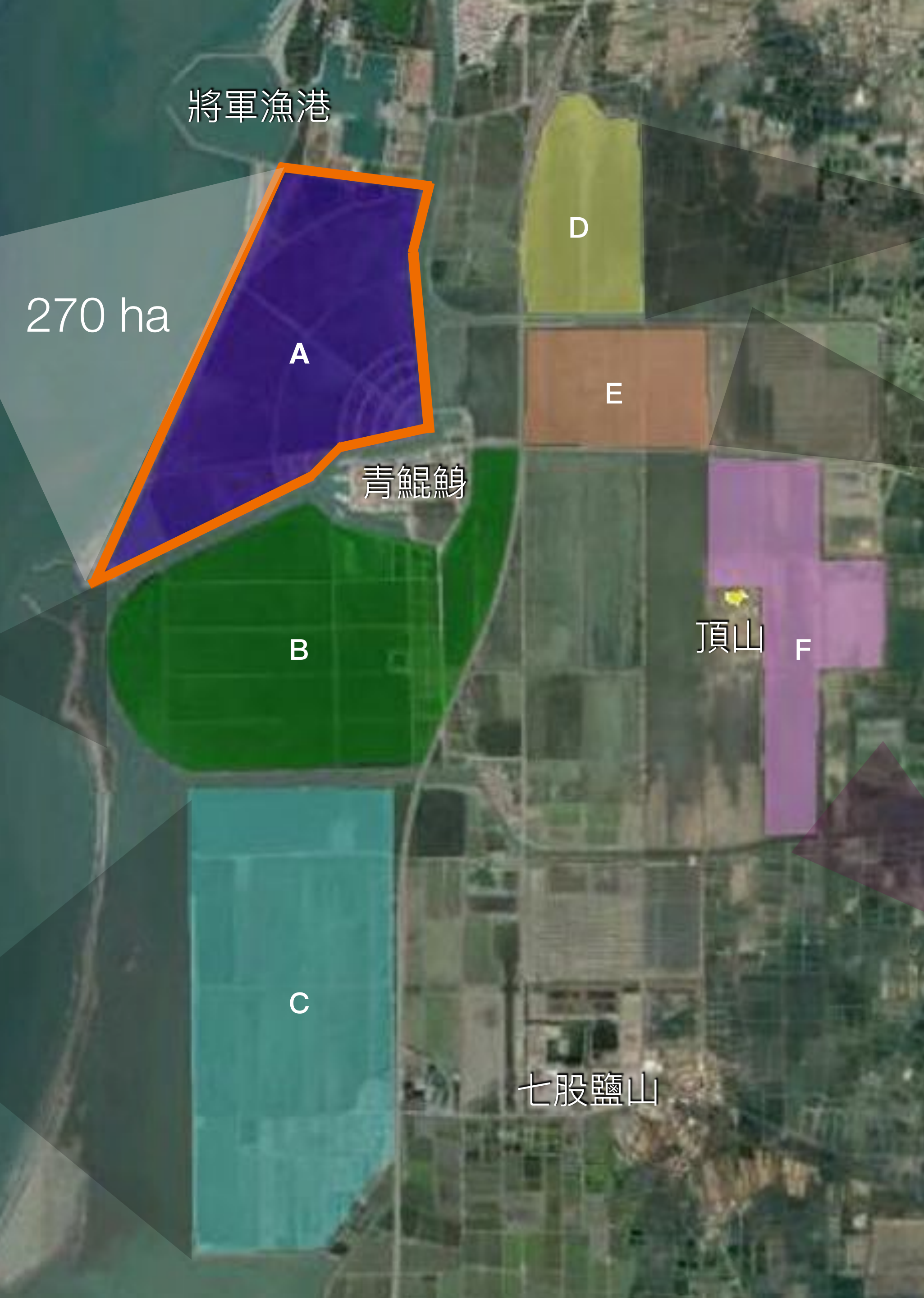
6 NGOs jointly adopted the old salt pans for habitat conservation in 2021



Red areas are of highest ecological value



台灣環境規劃協會





台灣環境規劃協會

Thank You!

ypchen@tep.org.tw



國泰金控

Cathay Financial Holdings



華南銀行

HUA NAN BANK



寶晶能源

INA ENERGY CORP



TPISA

太陽光電產業永續發展協會



Taiwan City

Engineering Consultants Ltd

台灣西堤工程顧問有限公司



HDRE

泓 | 德 | 能 | 源