

Taiwan Energy Transition : for the Harmonization of Economy, Energy, and Environment

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Part 1.

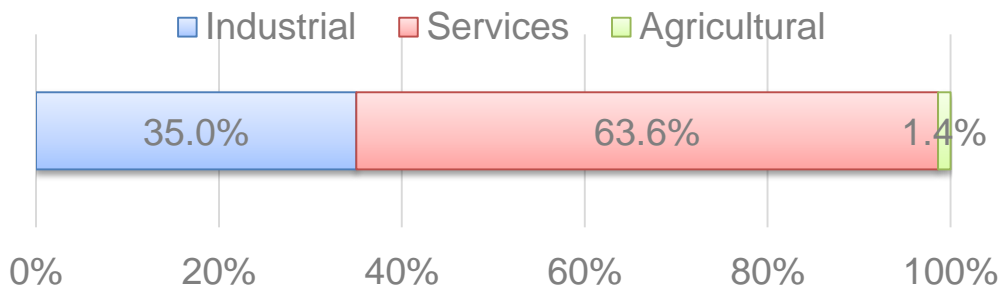
Energy Situation in Taiwan

Energy Situation in Taiwan (1/7)

Taiwan Basic Information

- Area: **36 thousand** km²
- Population: **23 million** persons
- 2015 GDP (nominal):
US\$ 523 billion
- 2015 GDP per capita
(nominal): US\$ 22 thousand
(ppp-IMF): US\$ 49 thousand

Structure of Taiwan GDP

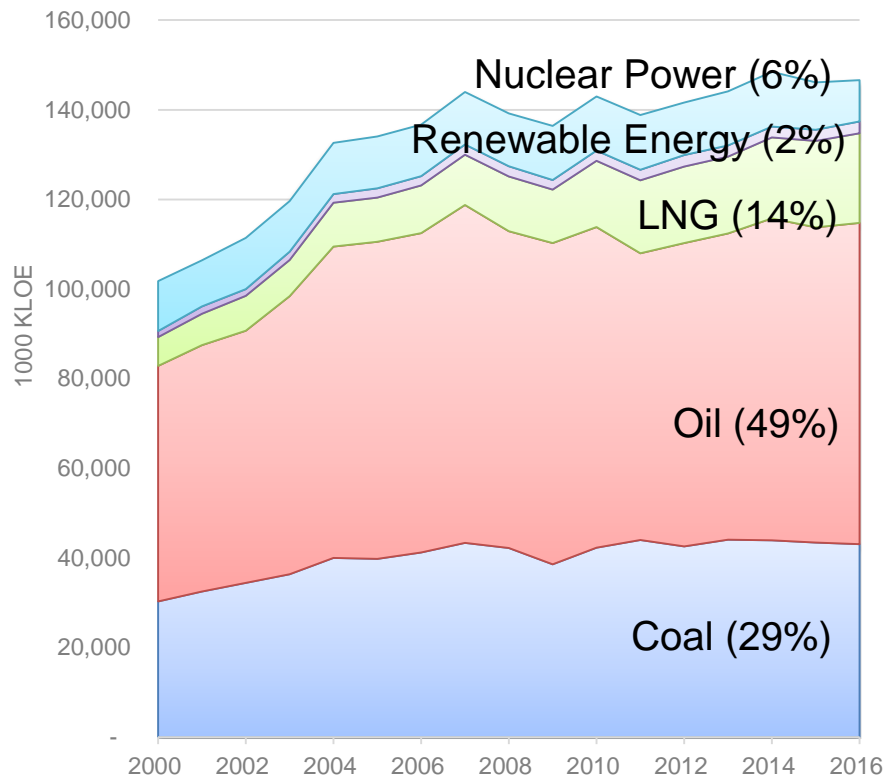


Source: ROC Yearbook

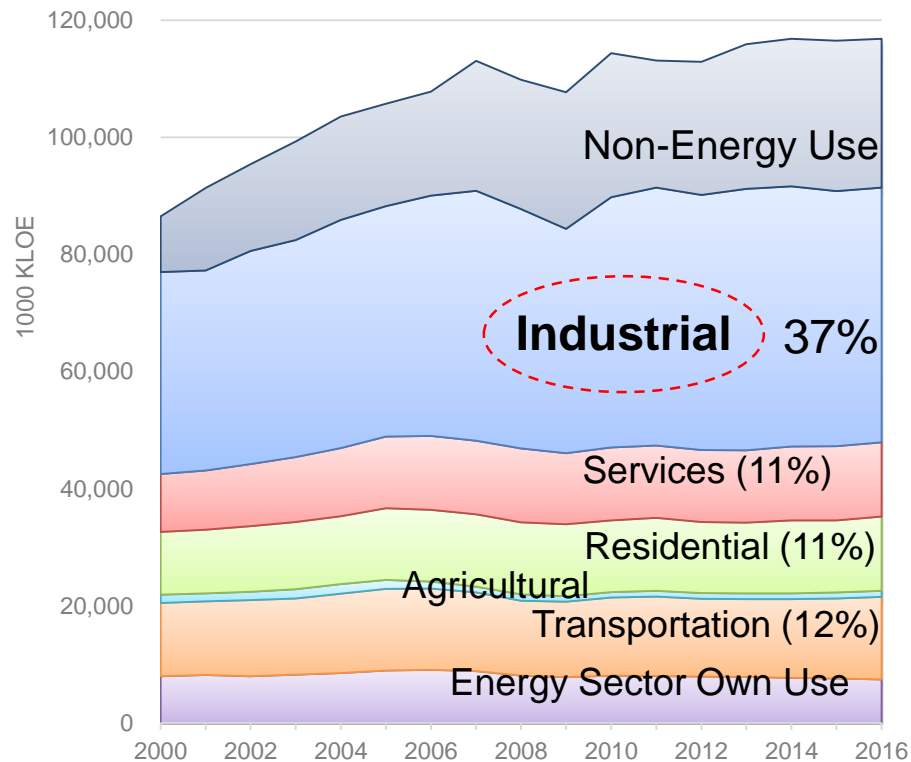
Energy Situation in Taiwan (2/7)

- **98%** of Taiwan's energy consumption are **imported**.
- Fossil energy accounts for nearly **90%** of energy supply.

**Total Energy Supply
(by Energy Form) from 2000-2016**



**Domestic Energy Consumption
(by Sector) from 2000-2016**

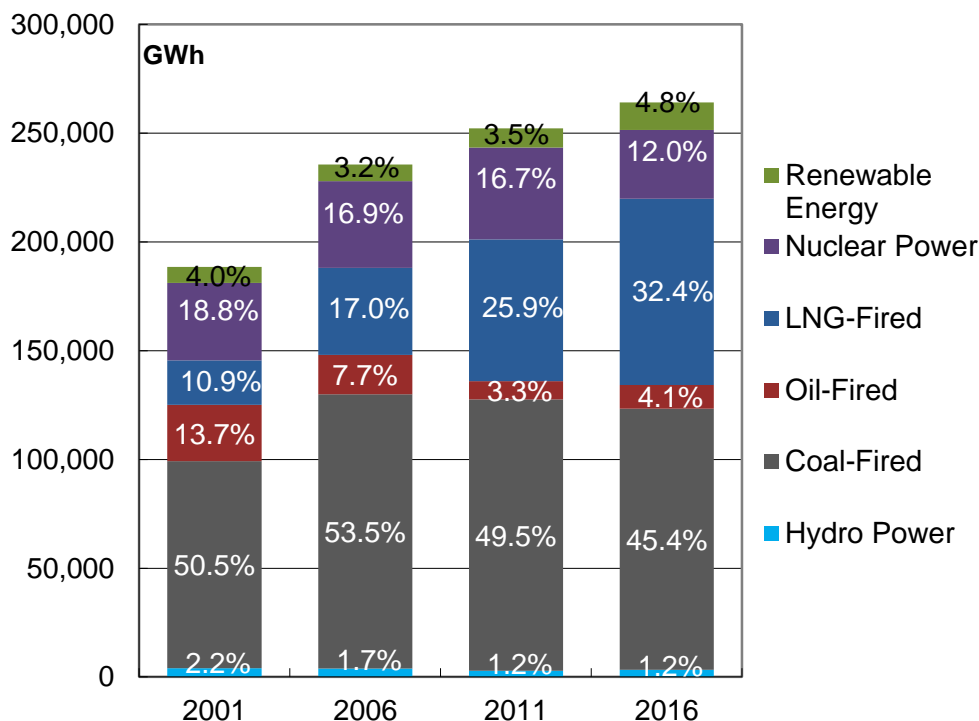


Source : Taiwan Energy Monthly Statistics, 2017.

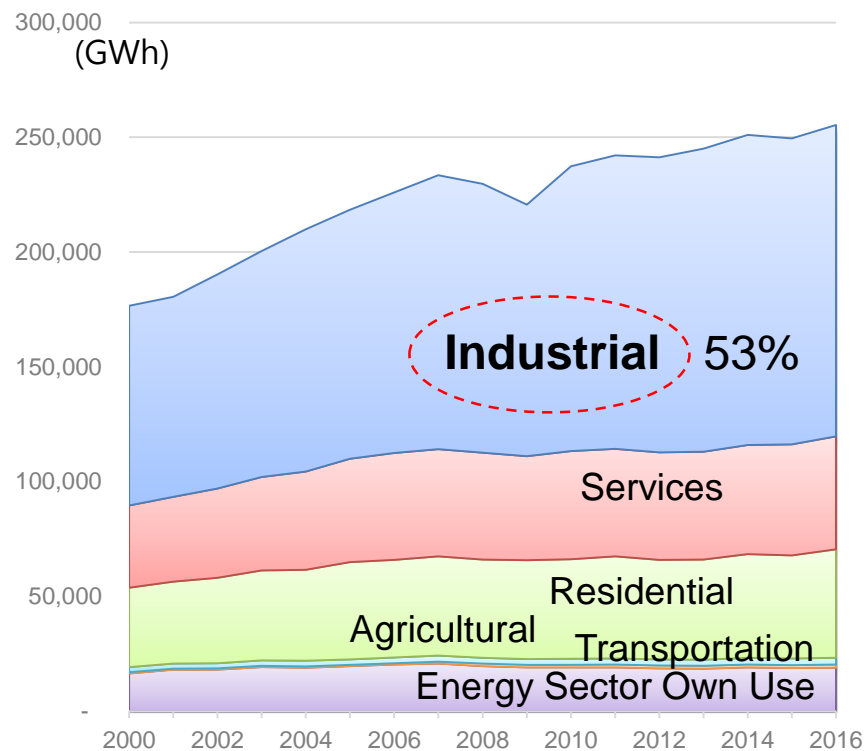
Energy Situation in Taiwan (3/7)

- In 2016, the share of **nuclear power** was decreased.
- **Industry sector** is the **primary consumer of electricity**.

**Electricity Supply
(by Fuel) from 2000-2016**



**Domestic Electricity Consumption
(by Sector) from 2000-2016**

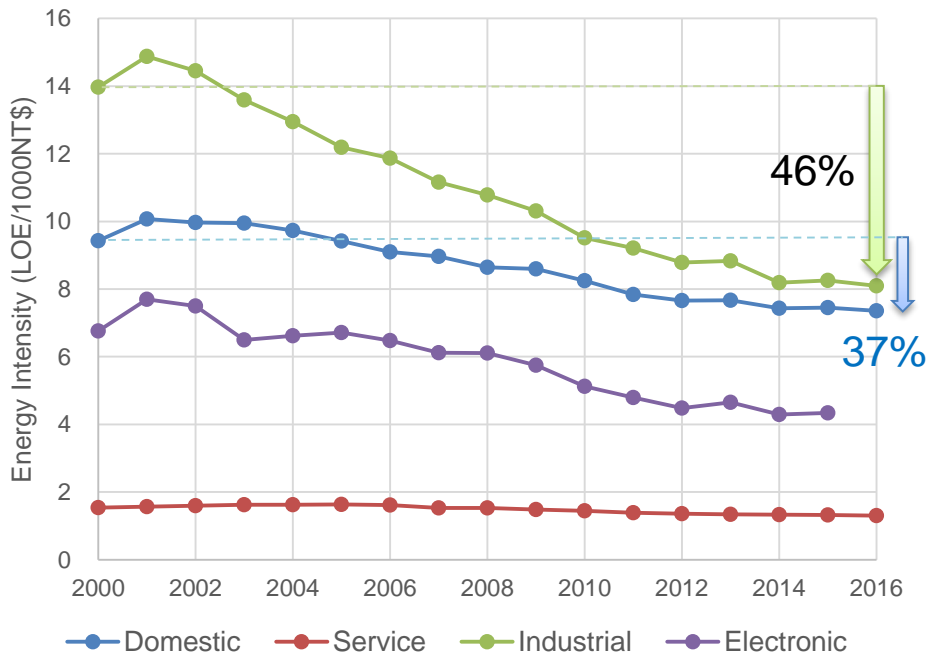


Source : Taiwan Energy Monthly Statistics, 2017.

Energy Situation in Taiwan (4/7)

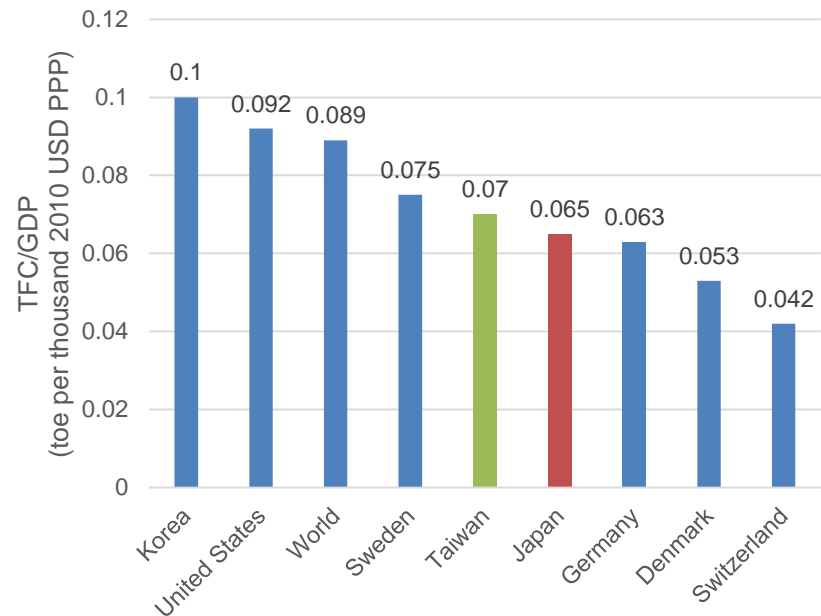
- The energy intensities in all sectors are continuously improving from 2001 to 2016.
- From 2001 to 2016, the **improvement of energy intensity** in industrial sector (**46%**) is better than that in Taiwan (**37%**).

Trend of Energy Intensity (by Sector) from 2000-2016



Source : Taiwan Energy Monthly Statistics, 2016.

Energy Intensity in 2015

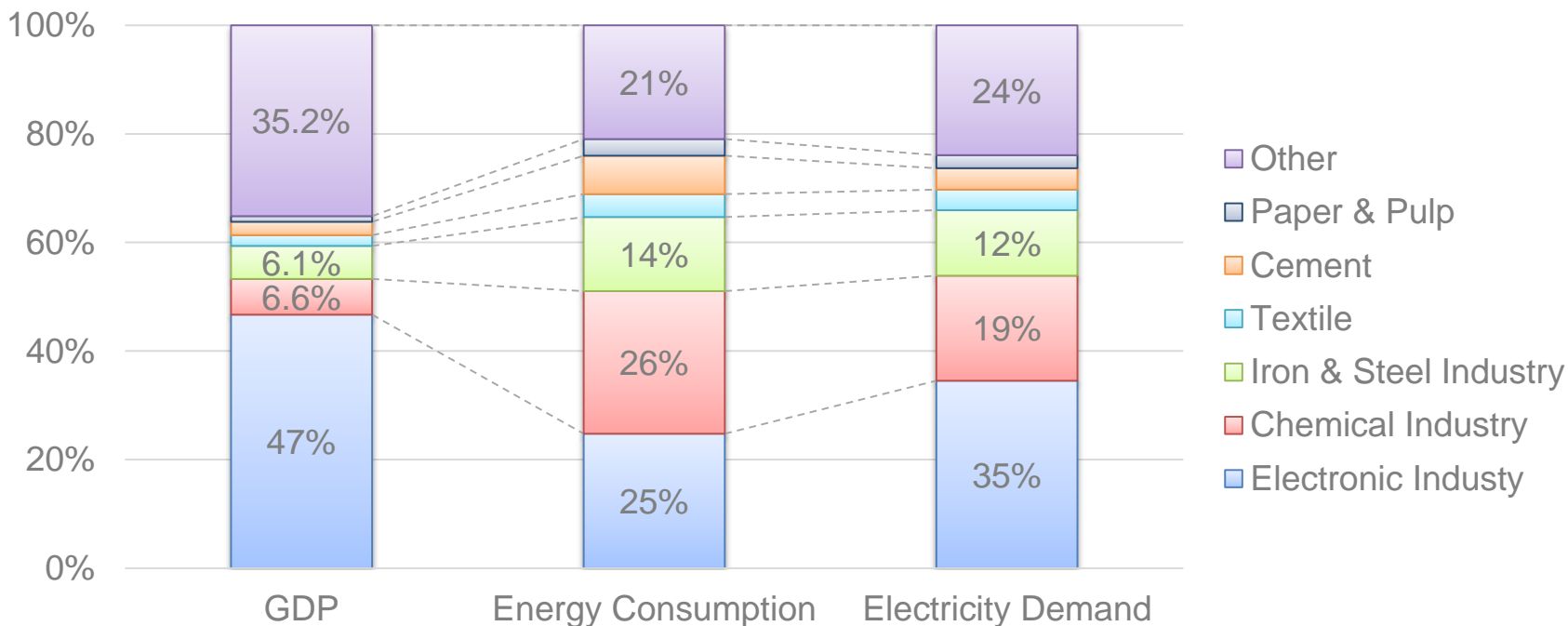


Source : IEA, World Indicator, 2017.

Energy Situation in Taiwan (5/7)

➤ **The electricity consumption in electronic industry** is obviously higher than other industries. The electronic industry also contributed the **greatest amount of GDP**.

**Structure of Industrial Sector
for GDP, Energy Consumption, and Electricity Demand in 2016**

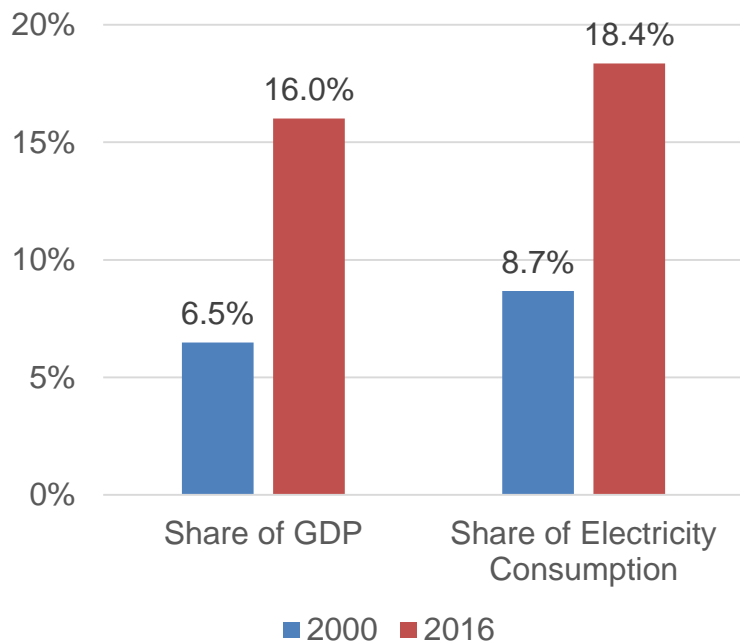


Source : Taiwan Energy Monthly Statistics, 2017.

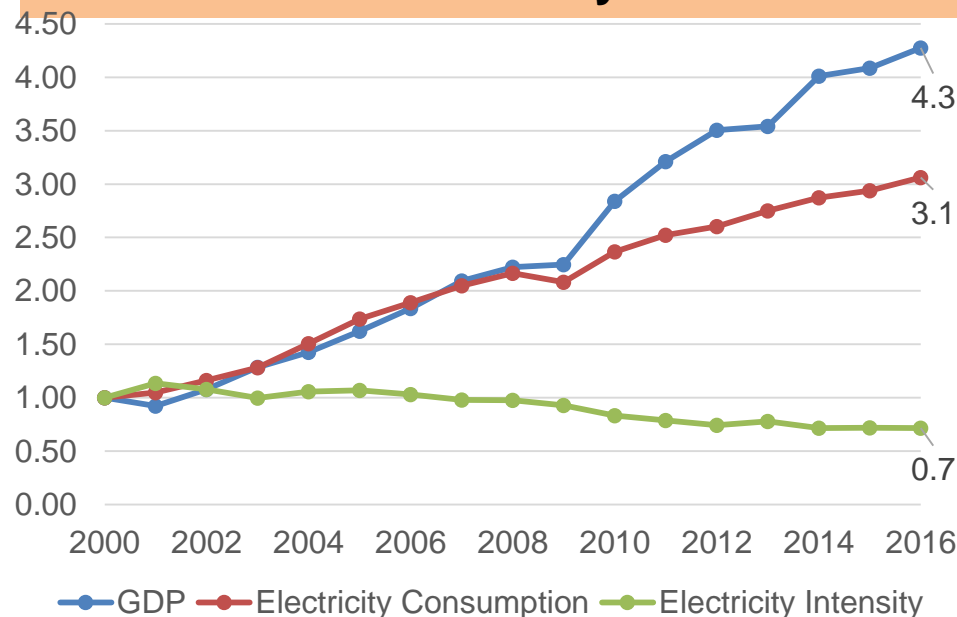
Energy Situation in Taiwan (6/7)

- The **GDP share of electronic industry** is continuously raising as well as electricity consumption share.
- Because of **electronic industry's** economic growth, the electricity demand in 2016 is three times more than it in 2000.

Share of GDP and Electricity Consumption for Electronic Industry



Trend of GDP, Electricity Consumption, and Electricity Intensity in Electronic Industry

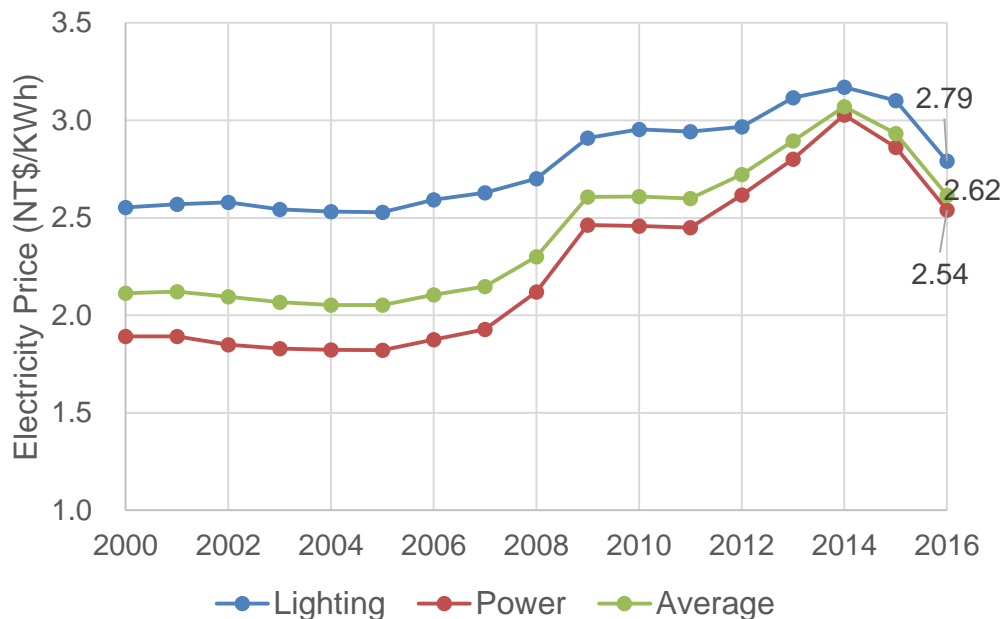


Source : Taiwan Energy Monthly Statistics, 2017.

Energy Situation in Taiwan (7/7)

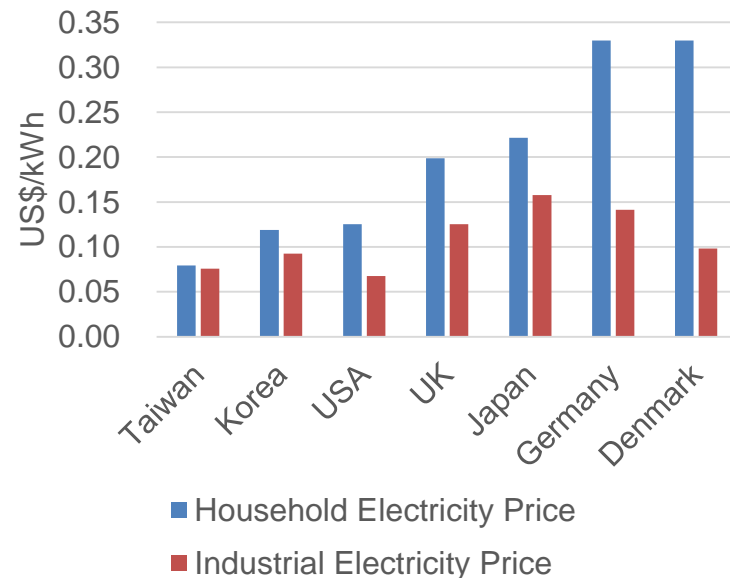
- The electricity price in Taiwan **fluctuates** with international fossil fuel price.
- The **low electricity prices** reduces the motivation of energy users to improve energy efficiency.

Trend of Electricity Price



Source : Taiwan Energy Monthly Statistics, 2017.

Electricity Price



Source : IEA

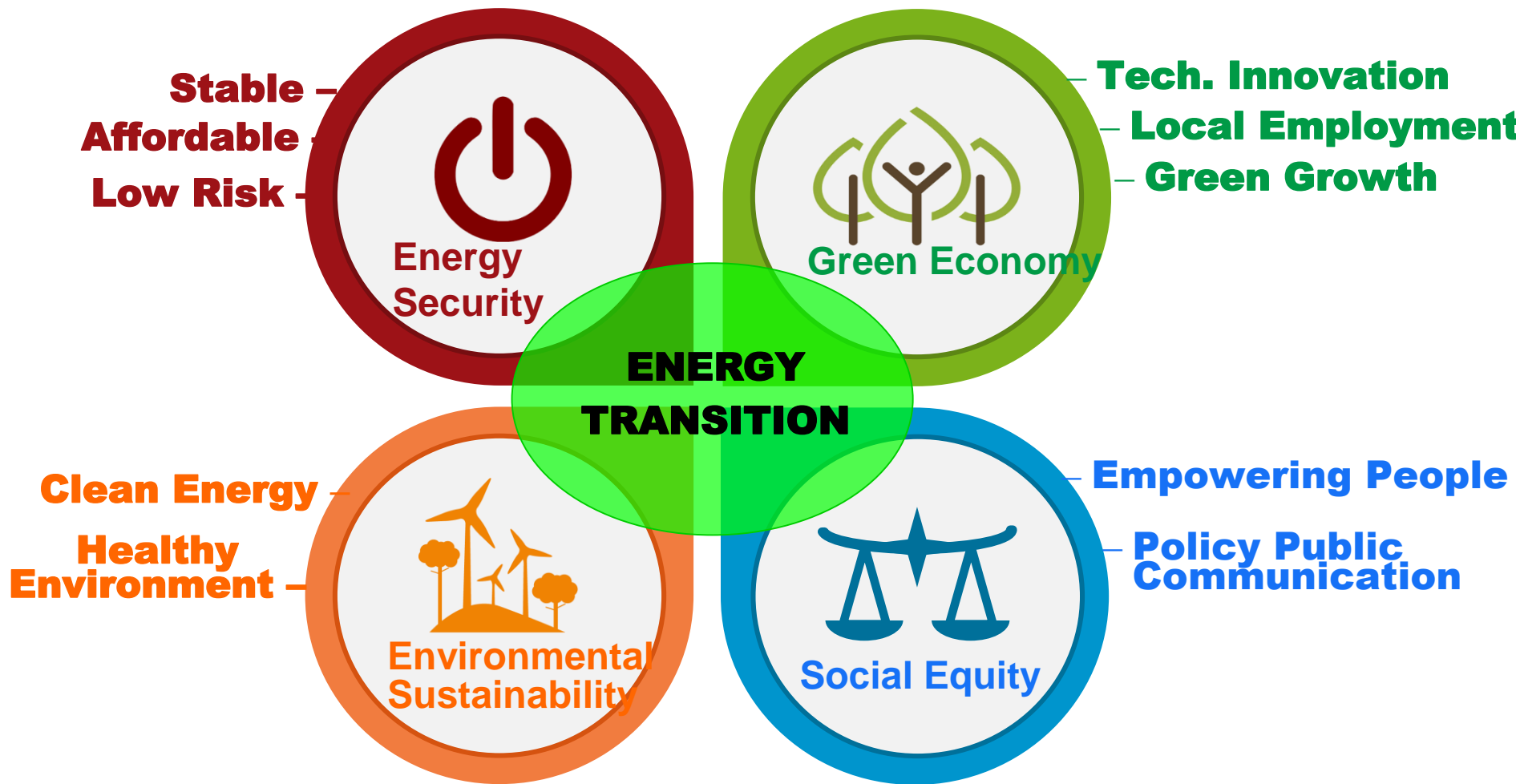
Part 2.

Goals of Energy Transition

1. Vision of Energy Transition
2. GHG Emissions Reduction Target
3. 2025 Nuclear Free
4. 2025 Electricity Portfolio (20-30-50)

1. Vision of Energy Transition

■ Core Value of Taiwan's Energy Transition

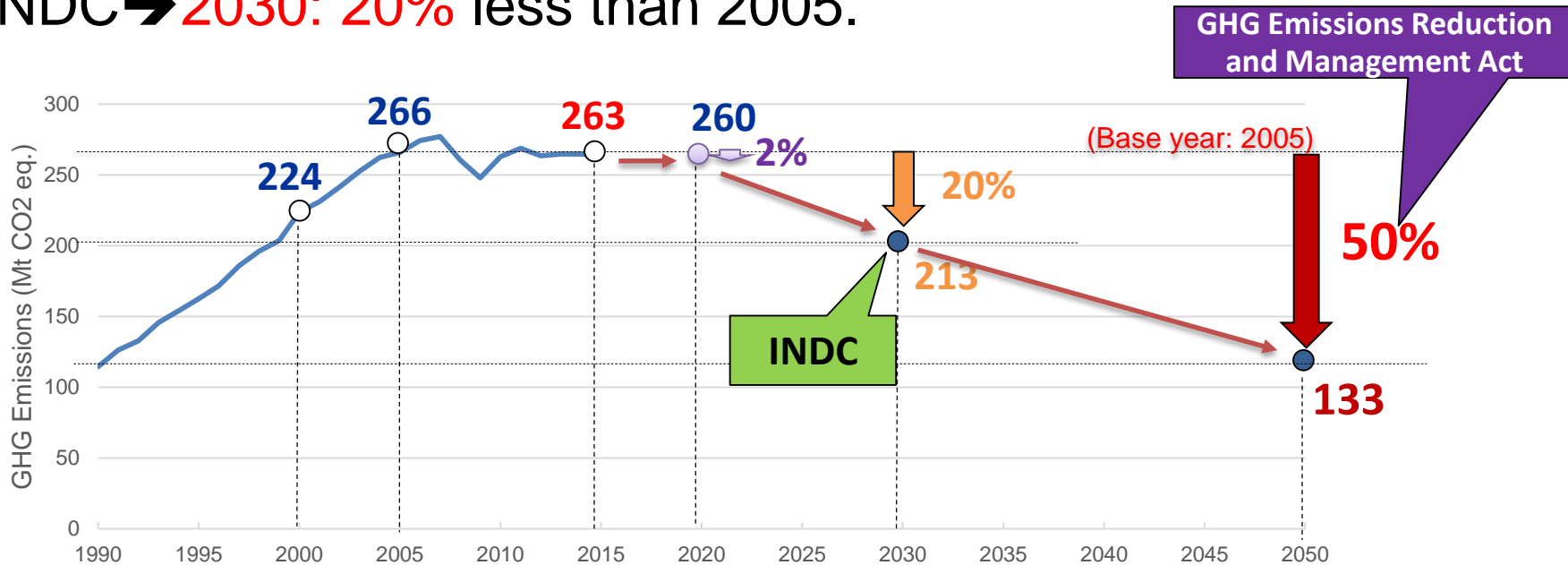


Source : 2017/9/19, BOE, 能源轉型與電力市場改革

2. GHG Emissions Reduction Target

Greenhouse Gas Emission Trajectory

- GHG Emission Reduction and Management Act
➔ **2050: 50%** less than 2005.
- INDC ➔ **2030: 20%** less than 2005.



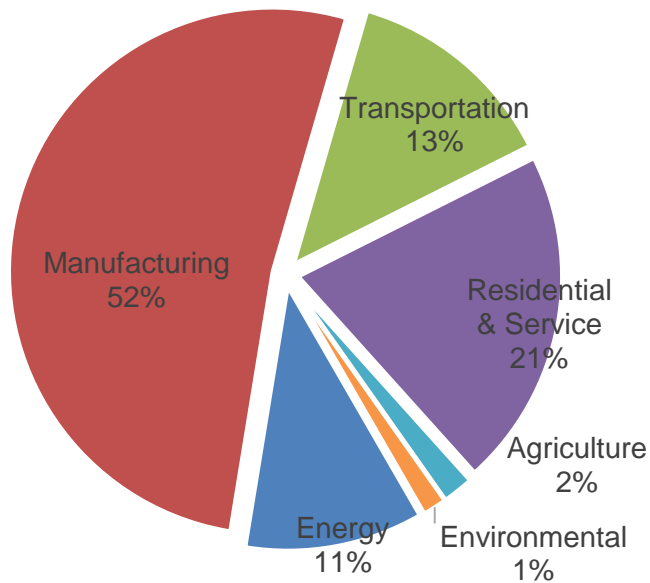
Note: The main source of GHGs emission is fuel combustion, which accounts for 87.55%, and the GHGs emission from industrial process accounts for 7.19%.

Source: Environmental Protection Administration, R.O.C.

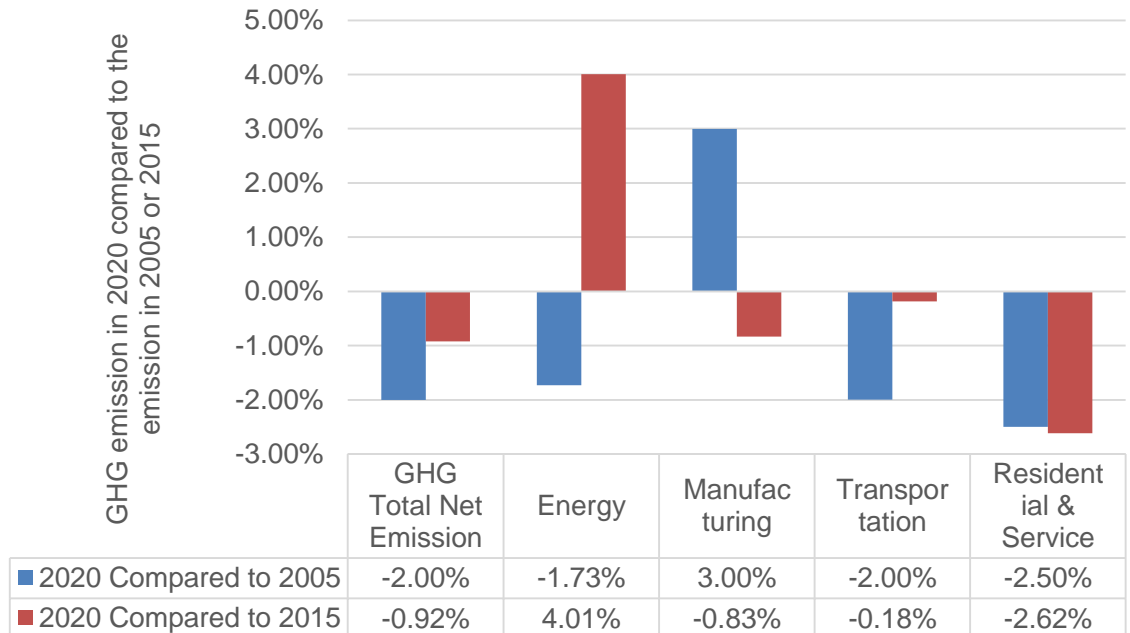
2. GHG Emissions Reduction Target

- In 2015, **manufacturing sector** contributed **52%** of GHG emission.
- In **2017/11/21**, Taiwan EPA announced the **Phase 1 GHG emissions goal**: 2% less than 2005 by 2020.

2015 GHG Emission Structure (by Sector)



2020 GHG Reduction Ratio (by Sector)



Source: 2017/11/23, EPA, 第一期溫室氣體階段管制目標(草案) 公聽研商會

3. Nuclear Free in 2025

➤ Basic Environment Act announced in 2002/12

- Article 23: The government shall establish plans to gradually achieve the goal of **becoming a nuclear-free country**.

➤ The Electricity Act revised in 2017/01

- Article 95 : The nuclear-energy-based power-generating facilities shall **wholly stop running by 2025**.

Name	Unit No.	Capacity	Capacity Share*	Commission Date	Decommission Date	Status
1st nuclear power plant	# 1	636 MW	1.3%	1978/12	2018/12	Maintenance (from 2014/12)
	# 2	636 MW	1.3%	1979/07	2019/07	Spent fuel pool is full.
2nd nuclear power plant	# 1	985 MW	2.0%	1981/12	2021/12	Operating
	# 2	985 MW	2.0%	1983/03	2023/03	Maintenance (from 2016/05)
3rd nuclear power plant	# 1	951 MW	1.9%	1984/07	2024/07	Operating
	# 2	951 MW	1.9%	1985/05	2025/05	Operating
4th nuclear power plant	# 1	1350 MW	--	Progress: 98%		Construction halted
	# 2	1350 MW				

* the nuclear unit share of total Taiwan electricity generating capacity (49.9GW)

4. 2025 Electricity Portfolio

- One of the major goals of Energy Transition is **20-30-50** electricity portfolio in **2025**.
 - **Renewable** energy will contribute **20%** of total electricity demand.
 - 2025: PV → 20 GW; On-shore wind → 1.2 GW; Off-shore wind 3 GW.
 - The share of electricity generated from **coal** will be reduced to **30%**.
 - The electricity generation share of **LNG** will be increased to **50%**.

	2016	2020	2025
Renewable Energy	5%	9%	20%
LNG-Fired	32%	36%	50%
Coal-Fired	45%	43%	30%
Other	18%	12%	0%

Source: 2017/11/23, EPA, 第一期溫室氣體階段管制目標(草案) 公聽研商會

Part 3.

Challenges of Energy Transition

1. Low Reserve Capacity in Recent Years
2. Insufficient Electricity Infrastructure
3. Environmental Conflicts

1. Low Reserve Margin (1/2)

➤ Reserve Margin

- A reserve margin is a measure of the amount of electricity imports and **in-state generation capacity** available over average **peak demand** conditions. (California Clean Energy Future Metrics)

- $$\frac{\text{Maximum planning supply capacity} - \text{Peak Demand}}{\text{Peak Demand}}$$

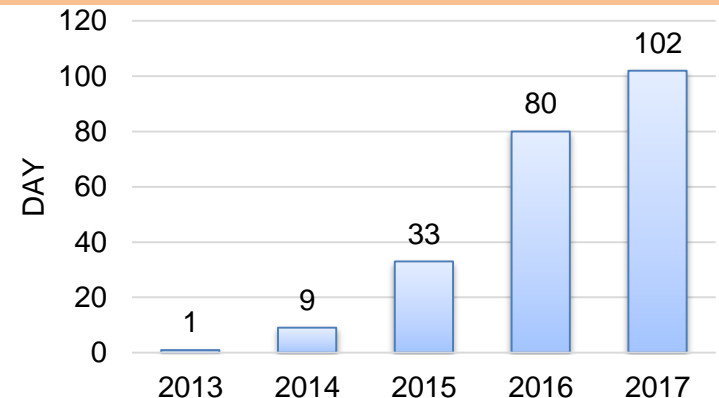
➤ Industrial sector is **worried** about the **power outage**.

- Chinese National Federation of Industries, American Chamber of Commerce in Taipei.

➤ 2017/11 Executive Yuan announced the targets:

- Reserve margin > 15%;
- Operating margin > 10%.

Days of Operating Margin below 6% in Taiwan



1. Low Reserve Margin (2/2)

■ LNG-Fired
 ■ Coal-Fired
 ■ Oil-Fired
 ■ Nuclear
 ■ Renewable

Decommission



通霄CC#1~#3 11月(76.4)		大林#5 11月(50)						興達#1 10月(50)	麥寮#1 6月(60)	麥寮#2 9月(60)	麥寮#3 10月(60)
大林#3 10月(37.5)		協和#1 12月(50)						興達#2 10月(50)	興達CC#1~#2 10月(89)		興達CC#3~#5 7月(133.6)
大林#4 10月(37.5)	核一#1 12月(63.6)	協和#2 12月(50)	通霄CC#4 11月(38.6)			台中GT#1 11月(7)		核二#2 3月(98.5)	協和#3 11月(50)	協和#4 11月(50)	台中GT#2 11月(7)
		核一#2 7月(63.6)	通霄CC#5 11月(38.6)	核二#1 12月(98.5)		台中GT#4 11月(7)		核三#1 7月(95.1)			台中GT#3 11月(7)
								核三#2 5月(95.1)			
2017	2018	2019	2020	2021	2022	2023	2024	2025			



林口新#2 3月(80)	大林新#1 2月(80)	林口新#3 7月(80)	通霄新CC#3 1月(89.3)	大潭CC#7-ST 7月(40)	大潭CC#8 7月(100)	興達新CC#1 7月(130)	興達新CC#2 7月(130)	深澳新#1 7月(60)			
大潭CC#7-GT 8月(60)	大林新#2 7月(80)	通霄新CC#2 7月(89.3)	IPP 1 (50)	IPP 2 (48)	太陽光電 (250)	太陽光電 (275)	大潭CC#9 7月(100)	台中CC#1 1月(130)			
太陽光電 (72)	通霄新CC#1 2月(89.3)	太陽光電 (150)	太陽光電 (200)	太陽光電 (225)	風力 (58.6)	風力 (58.6)	太陽光電 (300)	台中CC#2 7月(130)			
風力 (3.8)	太陽光電 (107)	風力 (12.5)	風力 (45.6)	風力 (51.7)	其它再生能源 (2.5)	其它再生能源 (2.5)	風力 (58.6)	協和新CC#1 7月(130)			
其它再生能源 (0.5)	風力 (3.3)	其它再生能源 (6.5)	其它再生能源 (13.7)	其它再生能源 (2.0)			其它再生能源 (2.9)	太陽光電 (300)			
	其它再生能源 (1.8)							風力 (59.1)			
								其它再生能源 (8.4)			

Additional

*For serve Margin: the PV peaking factor is 20%; the wind peaking factor is 6%.

	2017	2018	2019	2020	2021	2022	2023	2024	2025
Peak Load (GW)	36.2	36.5	37.0	37.5	38.0	38.6	39.1	39.7	40.3
Peak Supply (GW)	38.9	40.9	42.6	43.3	43.9	44.4	46.1	46.5	46.9
Reserve Margin (%)	7.5	11.8	15.2	15.5	15.6	15.1	17.7	17	16.3

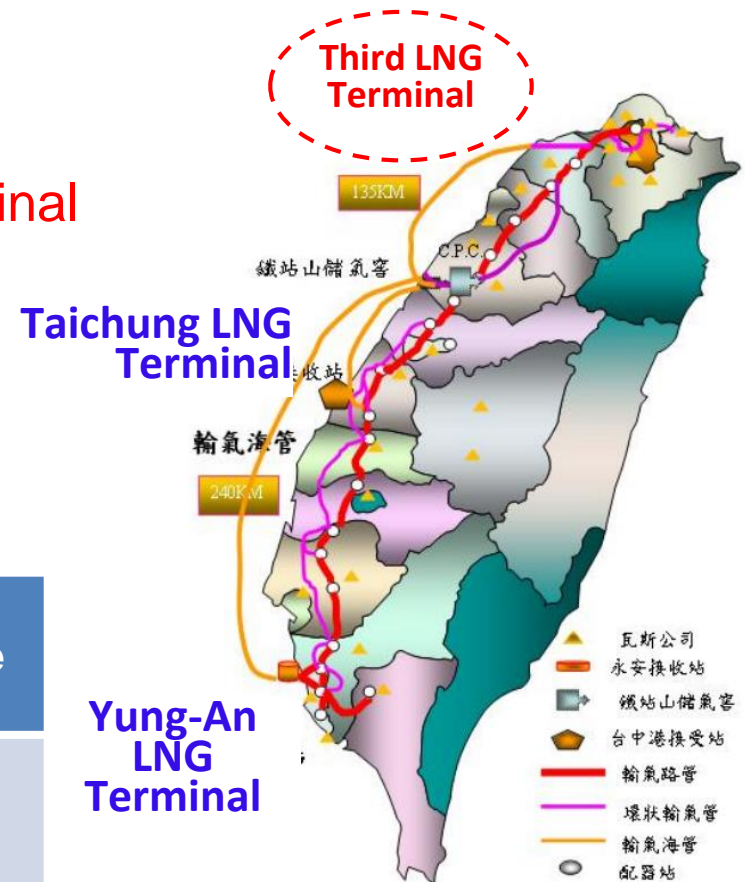
2. Insufficient Electricity Infrastructure (1/3)

LNG Terminal

- For increasing NG power generation, Government are building **No.3 LNG Terminal** (6 million tonne).
 - In the **Environmental Impact Assessment**, facing the ecological problem (crustose coralline algae)

	2016	2025	Increase
LNG-Fired Power Plant Capacity	15.25 GW	25.87 GW	1.7-fold
LNG Receiving Terminal Capacity	14 million tonne	32.7 million tonne	2.3-fold

Source: 2017/09/19, BOE, 能源轉型與電力市場改革簡報; 台灣中油照片



2. Insufficient Electricity Infrastructure (2/3)

Electricity Grid Challenge

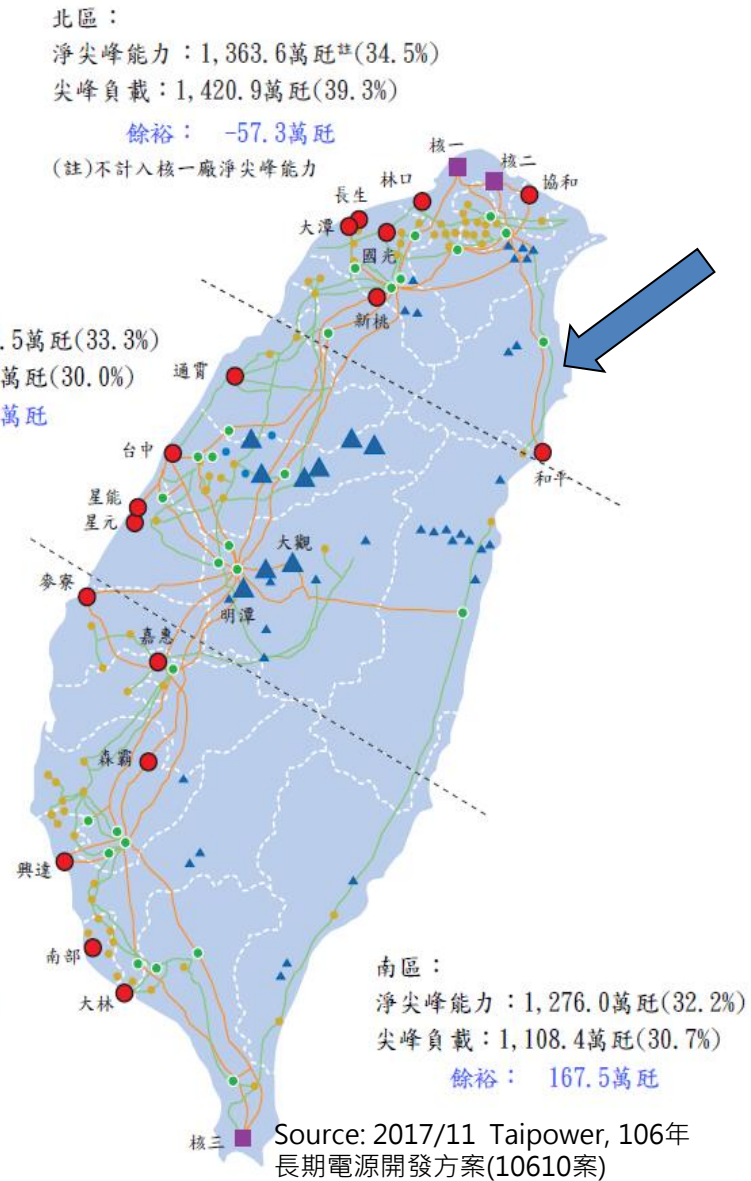
➤ Electricity Demand in north region is obviously higher than supply.

Region	Supply in Peak	Demand in Peak
North	34.5%	39.3%
Central	33.3%	30.0%
South	32.2%	30.7%

➤ In 2017/7/29, the typhoon caused a **transmission tower** collapsed, and prevented **1.3 GW** from Heping power station. (Loss 4% reserve margin)



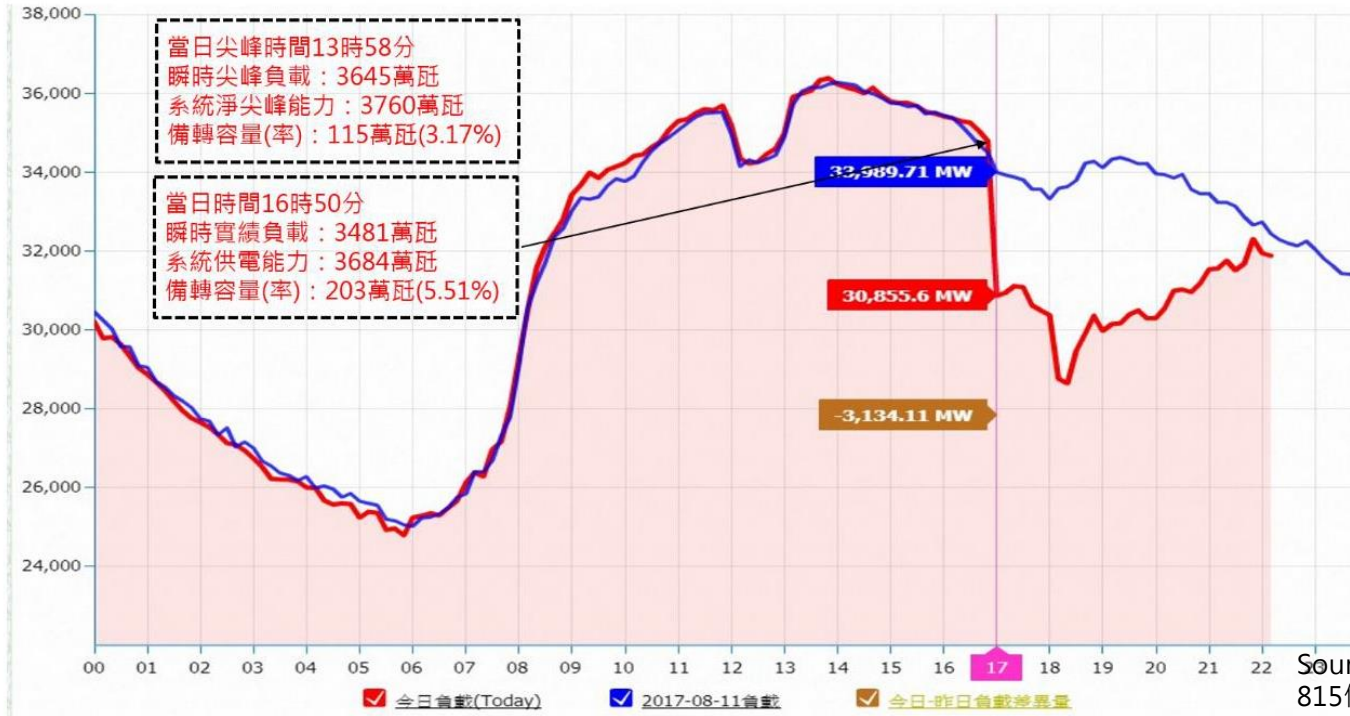
Source: Taipower



2. Insufficient Electricity Infrastructure (3/3)

815 Power Outage

- On August 15th at 4:51 p.m., an abrupt disruption in the natural gas supply at Taipower Datan Power Plant caused **6 power generators (4.38 GW) to shut down immediately**.
 - Reduced the nation's power supply by **12% (5.92 million users impacted)**
 - Fully restored power by 9:40 p.m.



Source: 2017/09/07 行政院
815停電事故行政調查專案報告

3. Environmental Conflicts (1/2)

Air Pollution from Coal-fired

- Taichung City and Yunlin County announced the bans on the use of **bituminous coal** and petroleum coke.
 - ➔ EPA hasn't approve the bans.

- 2017/11/30 Taichung City Government cuts Taichung power plant's coal use by **24%**.
 - ➔ Decrease annual power generation by **4.5 billion kWh**

- For avoiding worsening air quality, as **red air pollution alerts** were triggered at monitoring stations, the EPA will require Taipower to **reduce its load**.

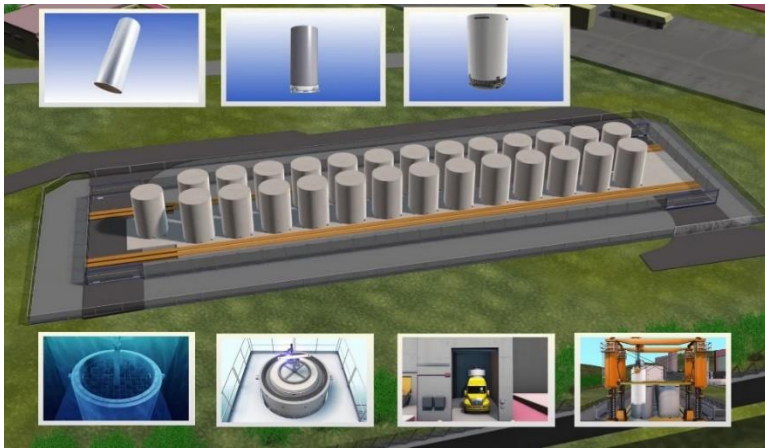
Air Quality Index (AQI)	0 ~ 50	51 ~ 100	101 ~ 150	151 ~ 200	201 ~ 300	301 ~ 500
Impact on Health	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy	Very Unhealthy	Hazardous
Status Color						

Source: EPA

3. Environmental Conflicts (2/2)

Nuclear Free Problem

- Difficult to set the site for **final disposal** of spent nuclear fuel.
- Local government doesn't allow to set the **dry cask storage** of spent nuclear fuel.
 - ➔ The spent fuel pool in 1st nuclear power station No. 2 unit is full.
- The construction of **4th Nuclear Power Plant** has been halted from 2015/07.



Source: Taipower

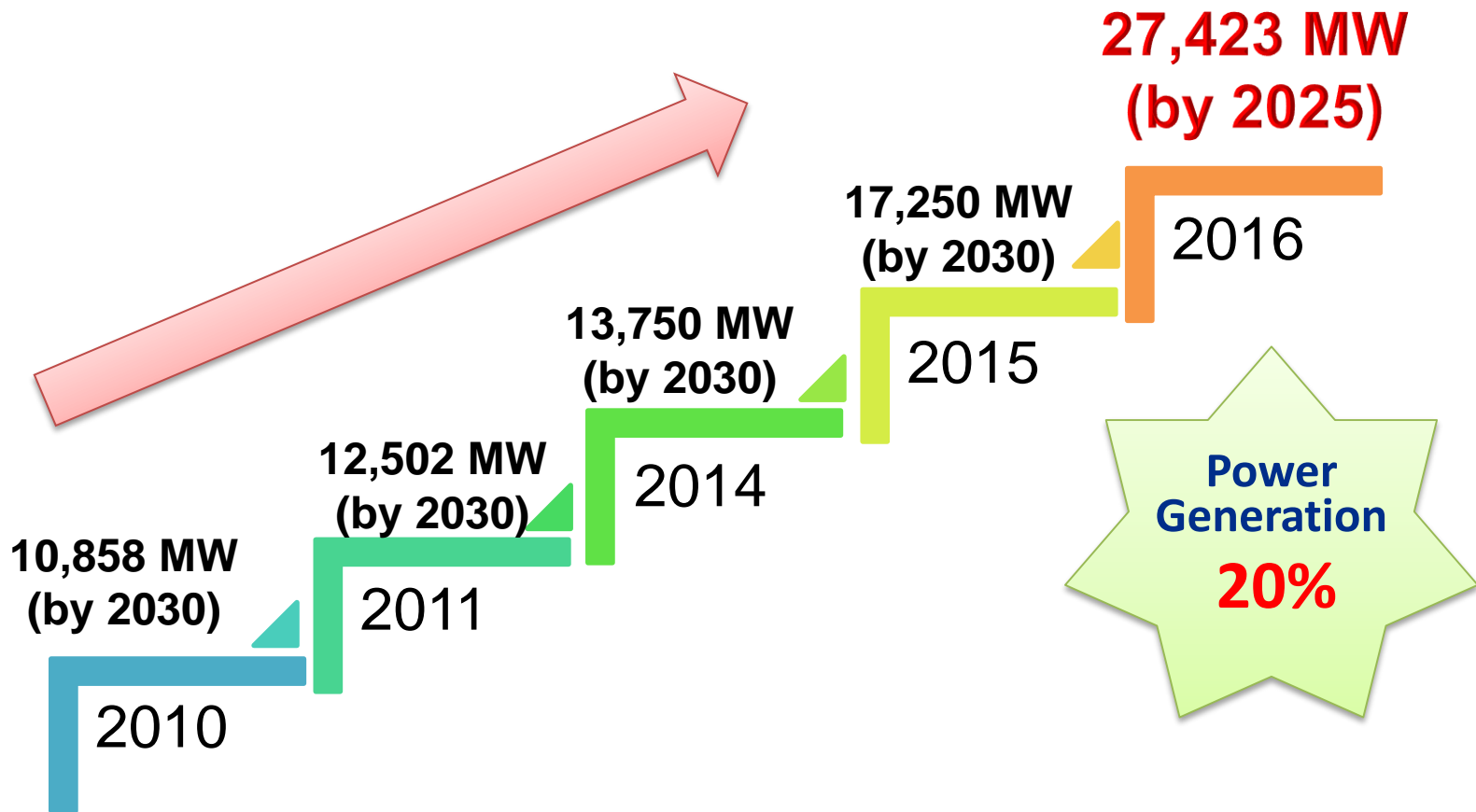
Part 4.

Key Measures for Energy Transition

1. Renewable Energy Development
2. Peak Load Management
3. Energy Conservation
4. Inter-Ministerial Cooperation

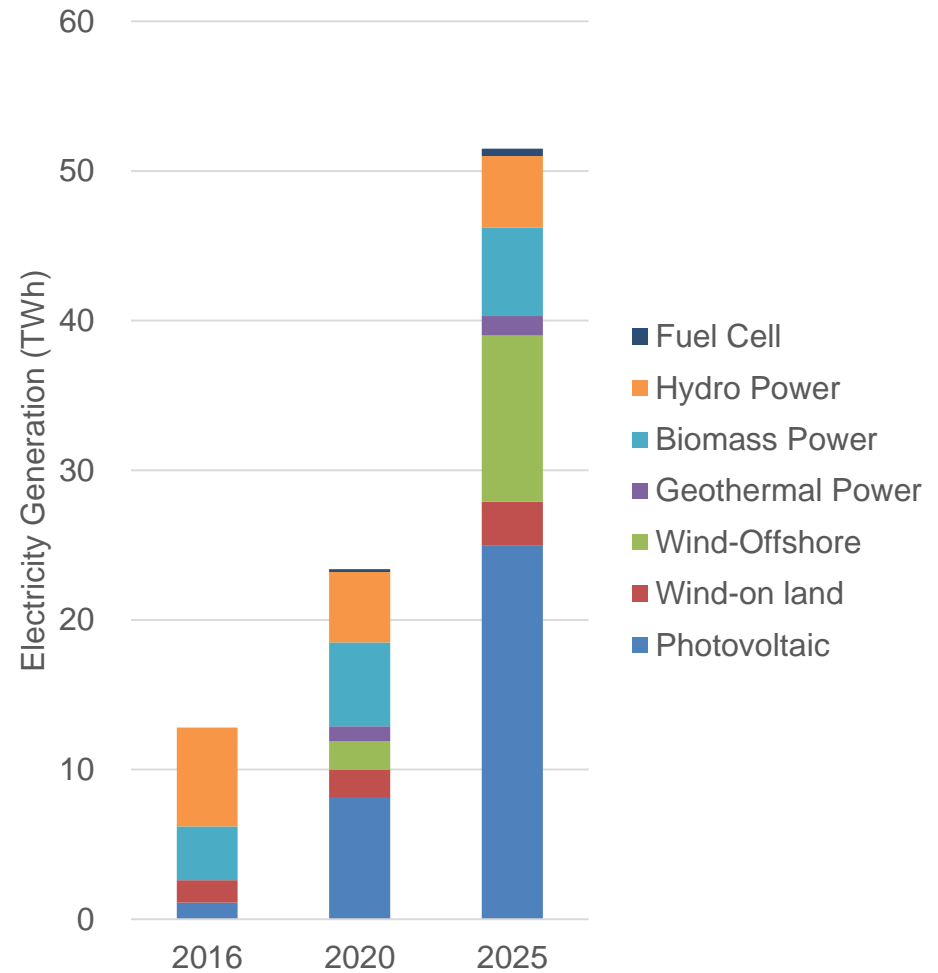
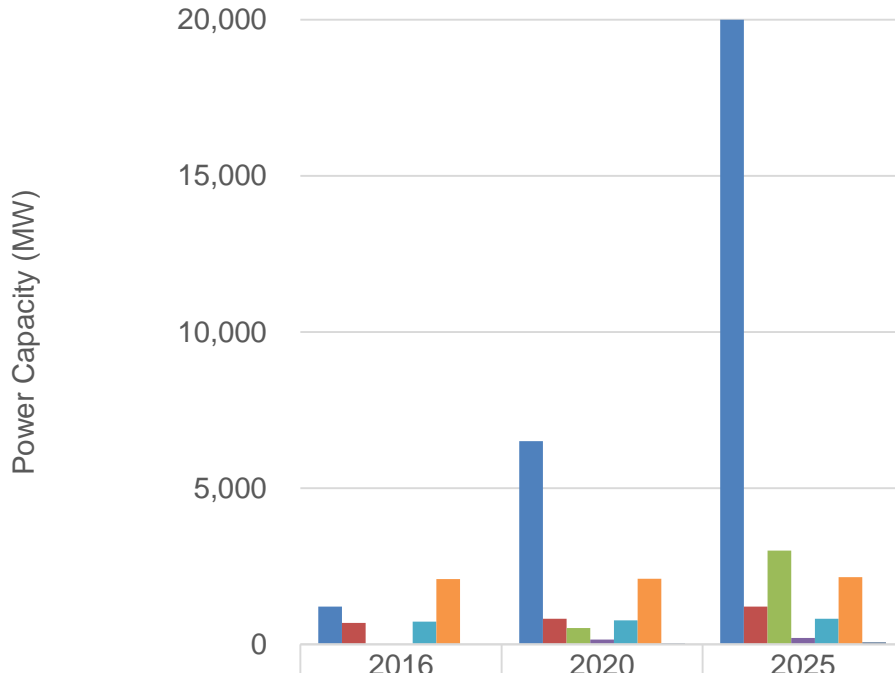
1. Renewable Energy Development (1/4)

Expand Renewable Energy Development Target



1. Renewable Energy Development (2/4)

Development Target of Key Renewable Energy



1. Renewable Energy Development (3/4)

■ Solar PV Development Target

Current
2016

1.34 GW

Short-Term

(2016/7~2018/6)

**2-Year Short Term Solar
PV Promotion Project**

→ Increase: **1.52GW**

Rooftop: 1,055 MW

- Factory
- Government Building
- Farmhouse

Ground: 465 MW

- Lakes and ponds,
- Salt-production land,
- Severe land subsidence areas,
- Landfills and contaminated land.

Long-Term

2025

Rooftop: 3 GW

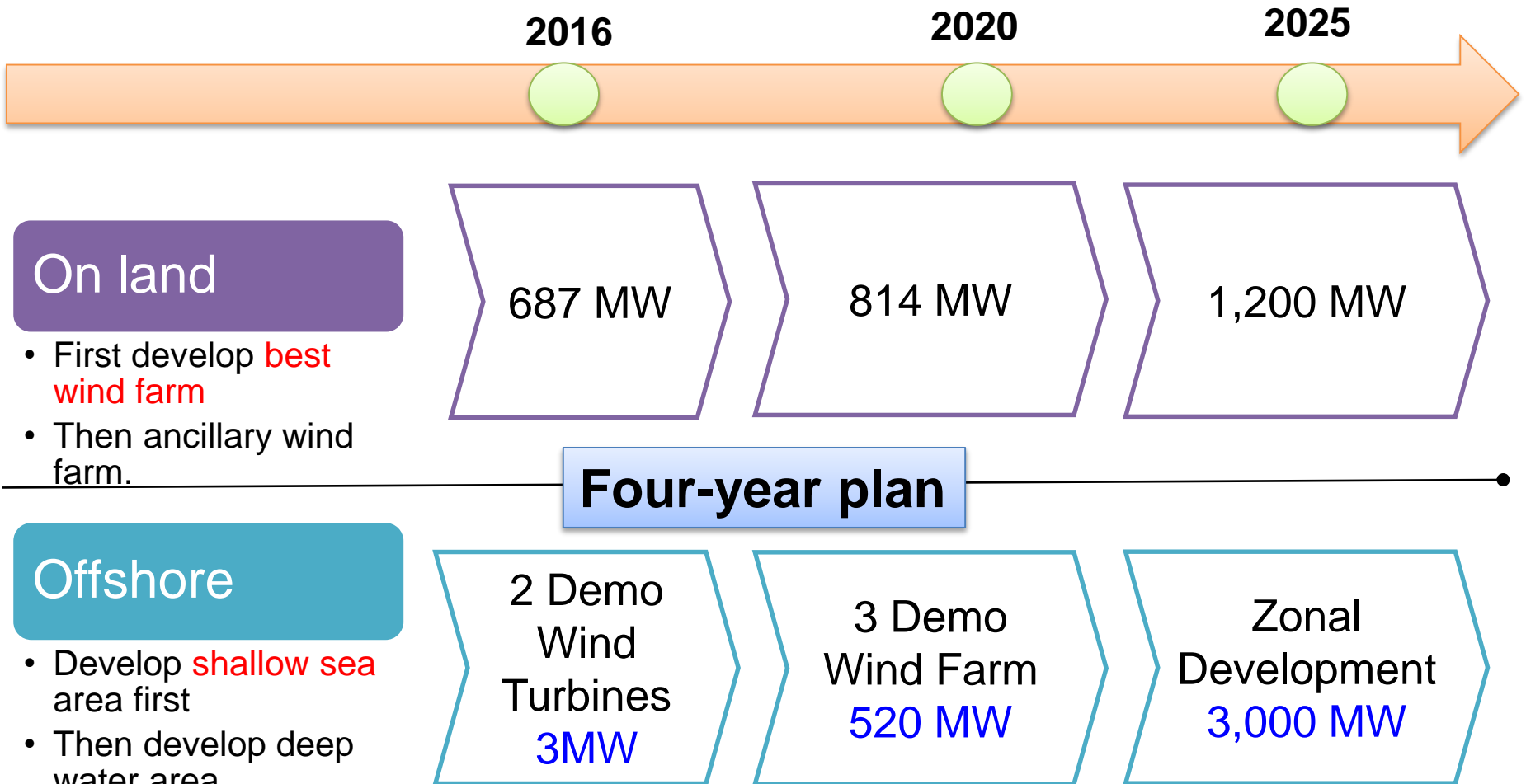
Ground: 17 GW



Source: 農委會 ·
<https://age.coa.gov.tw/index.php?theme=ws&id=2506774>

1. Renewable Energy Development (4/4)

Wind Turbines Development Target



2. Peak Load Management

■ Ensuring Electricity Supply

✓ Increasing Electricity supply, Raising Operating Reserve, Reducing Peak Load

Peak Load Management

Expand Time of Use Tariff

Broaden Demand Response Measures

Raising Residential and Commercial Sectors' Time-of-Use Tariff

Increasing Time-of-Use Tariff Participants

Promoting Virtual Power Plants and Aggregator

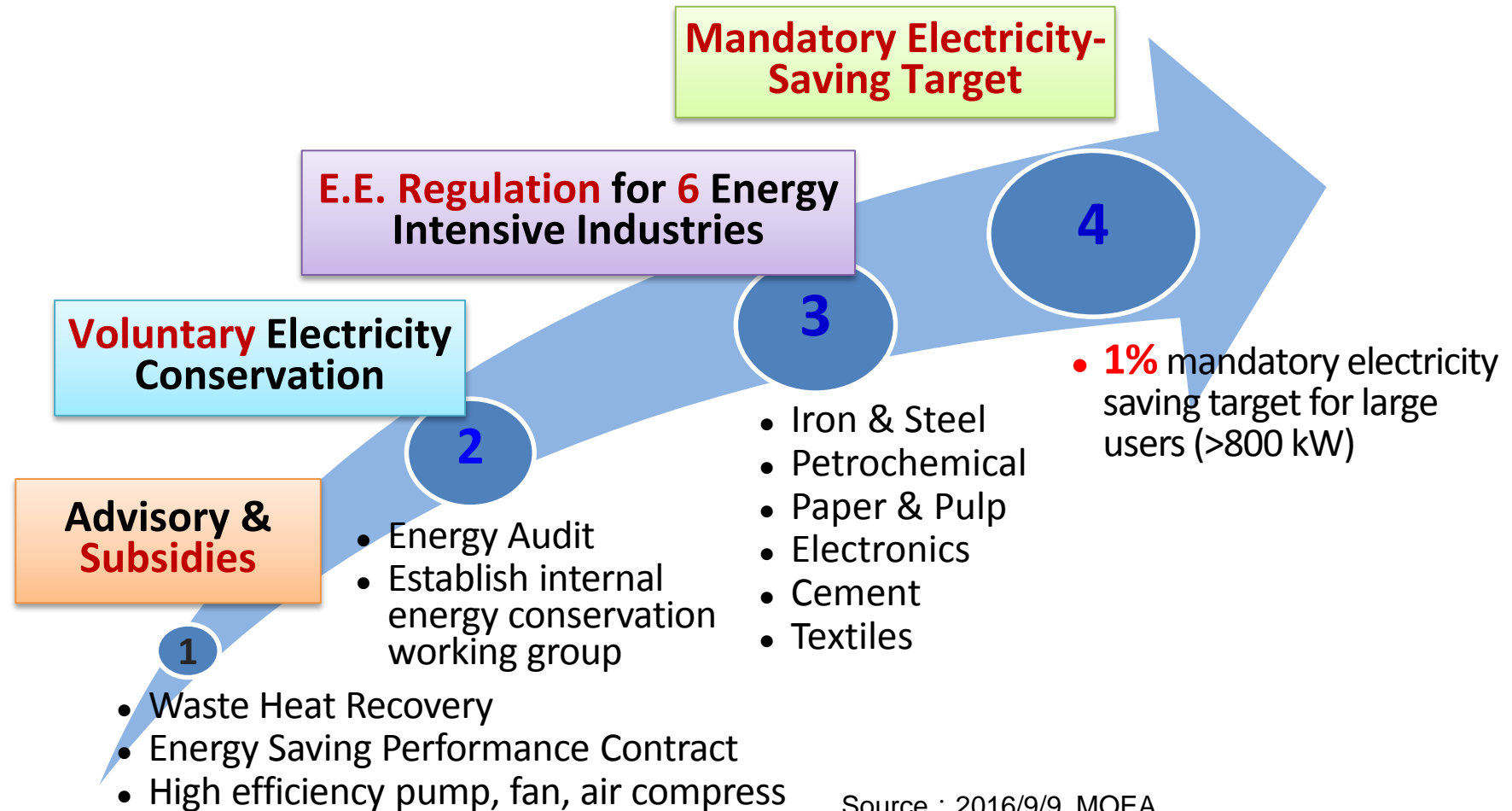
Expanding Demand Bidding Measures

Source : 2017/3/27. BOE

3. Energy Conservation (1/4)

Industrial Energy Efficiency Management

➤ Energy Intensity → 2025: 50% less than 2005



3. Energy Conservation (2/4)

■ Electricity Conservation by 1%

- Bureau of Energy (BOE) has mandated a target of 1% electricity saving for all large energy users (LEUs) with contract capacities higher than 800 kW.
- **Annual average electricity saving (S_i)** from 2015 to 2019 must exceed **1%** of the annual average total electricity consumption (C_i).

$$R_n = \frac{\sum_{i=2015}^n S_i}{\sum_{i=2015}^n (C_i + S_i)}$$

- Electricity saving from one **energy efficiency measure** will be counted only in **one year**.
- If the LEUs' annual average saving rate less than 1% **in 2019**, the LEU will be penalized by the BOE.

3. Energy Conservation (3/4)

Regulation for Energy Intensive Industries

Industry	Start date	Regulation for Energy Efficiency
Cement	2015.1.1	Maximum energy consumption per product for different manufacturing systems*
Iron & Steel	2015.1.1	Maximum temperature and oxygen concentration in the flue outlet
Pulp & Paper	2015.1.1	Maximum energy consumptions per product for different paper types*
Chemical	2015.1.1	Maximum temperature and oxygen concentration in flue outlet
Electronic	2015.11.1	Many Operation Requirements: such as freezer temperature, loss of dryer...
Textile	2016.1.1	Limit of temperature difference between inlet and exit water in chiller; Maximum temperature and oxygen concentration in flue outlet of coal stoke

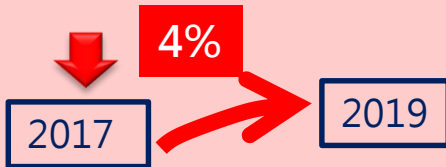
3. Energy Conservation (4/4)

■ Launching a New Electricity Saving Campaign



◆ Government Agency Energy Saving program

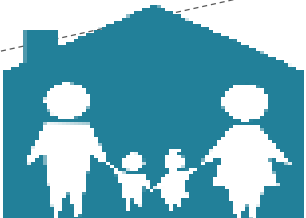
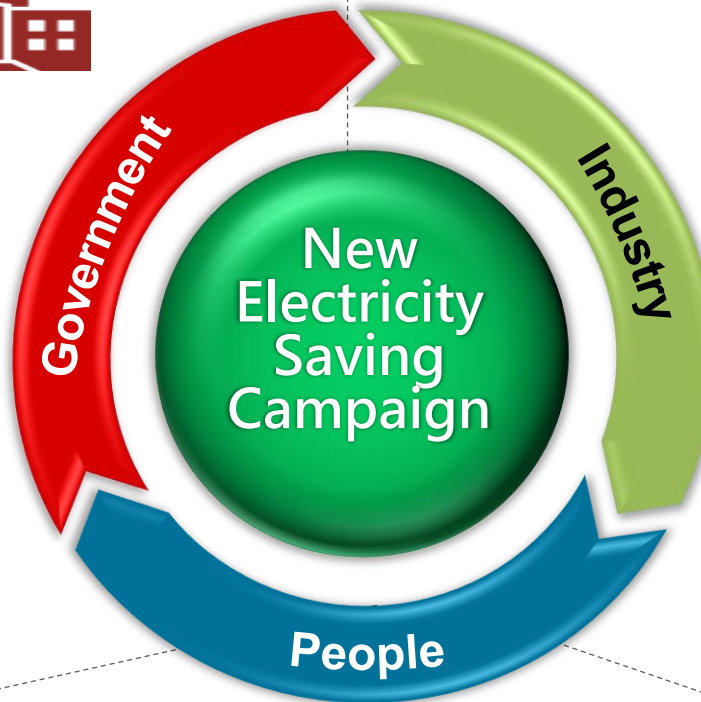
→ EUI Benchmark



◆ Energy Efficiency Upgrade Plan for Motor and Utility Facilities

→ Subsidy (2017~2018)

- Fan
- Pump
- Air Compressor
- System Optimization for Air Conditioning



◆ Building local energy governance capacity(2017)

→ Accredited Agency



→ Electricity Saving Volunteer



◆ Launch pilot program of interactive energy saving exhibition of AMI/HEMS

Source : 2017/9/19, BOE, 能源轉型與電力市場改革

4. Inter-Ministerial Cooperation

■ Committee on Energy and Carbon Reduction

Committee on Energy and
Carbon Reduction

Chair and Co-chair: Ministers without Portfolio
3 Vice Chairmen: Ministers of **MOEA**, **MOST**, and **EPA**

Committee Members (14-16 ministers)
(11 Minister, CEO of NEP, CEO of ECRO, 3-5 Experts)

Consultants

Energy and Carbon
Reduction Office (ECRO)

- ◆ Public Participation Platform
- ◆ Local Government Contact Person
- ◆ Policy Meeting
- ◆ Working Group



Energy
Security



Green
Economy



Environmental
Sustainability

Source: BOE · 2017

Closing Remark

Closing Remarks

- As highly dependent on the **imported energy** and **fossil energy**, Taiwan will encounter **serious challenges** while facing the global energy situation and GHG emission in the future.
- For achieving the vision of **low carbon** and **no nuclear**, the government announce the **energy transition policy**.
- In the process of energy transition, Taiwan might face the challenges of **low reserve margin**, **insufficient infrastructure**, and **environmental conflicts**.
- Great achievement to energy transition would require not only an **total-solution technology**, but also a successful **promotion policy**.



***Thank You
For Your Attention***