

附錄一、臺灣 $PM_{2.5}$ 控制的挑戰 (The challenge for $PM_{2.5}$ control in Taiwan) 論

文摘要及簡報資料

The challenge for PM_{2.5} control in Taiwan

Ciao-Kai Liang, Hung-The Tsai, Ping-Fei Shieh, Chih-Hsu Su, Yang-Hui Lee

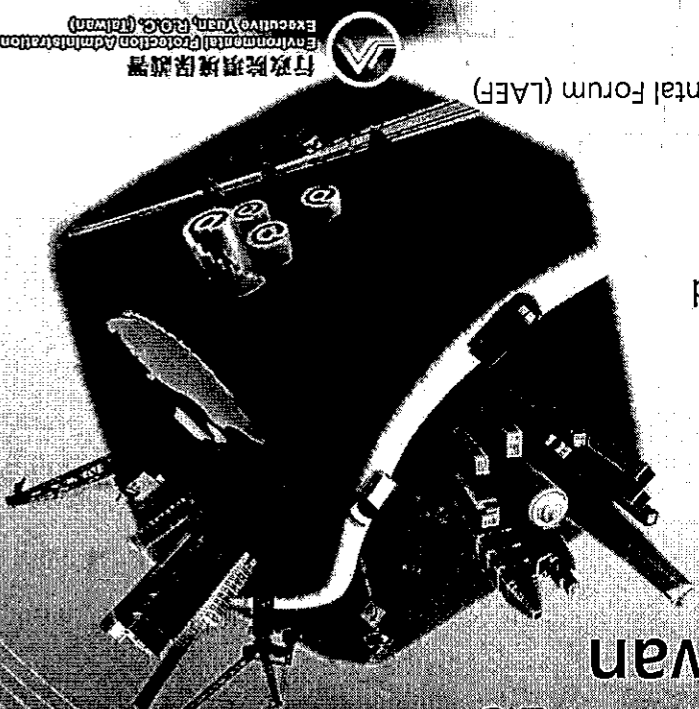
Department of Air Quality Protection and Noise Control, Environmental Protection Administration,
Taipei 10042, Taiwan

⁵Corresponding Author, Tel: +886 2-2371-2121# 1163, E-mail: ckliang@epa.gov.tw

Exposure to ambient air pollution was estimated to cause 4.2 million premature deaths worldwide in 2016. This mortality is due to exposure to small particulate matter of 2.5 microns or less in diameter (PM_{2.5}), which causes cardiovascular and respiratory disease, and cancers. PM_{2.5} air pollution in Taiwan is significantly created both domestic as well as blown over from China. According to the analysis results from the air quality model, 60% to 66% of the annual average concentration of PM_{2.5} is from the domestic pollution source ratio while 34% to 40% are transferred from China. To address PM_{2.5} problem, new PM_{2.5} air quality standards were promulgated in Taiwan on 14 May 2012 with annual average of PM_{2.5} by 15 µg/m³ and 24 hour of PM_{2.5} by 35 µg/m³. Taiwan Environmental Protection Administration (TEPA) made a commitment to reduce the annual mean PM_{2.5} to 18 µg/m³ by 2019. The number of red alert days (PM_{2.5} > 54 µg/m³) recorded by air quality monitoring stations in every city and county must be reduced by 20% – and by 50% within four years – to significantly reduce the chances of residents being exposed to the dangers of PM_{2.5}. To meet the target, a 14+N air pollution prevention strategy proposed by TEPA to implement 14 control measures and gradually increase implementation of +N projects was carried out in 2017. Current specific achievements include: The number of commercial boilers has been replaced or improved by 240. Approximately 2,800 fume-control equipment have been installed in the restaurant, and about 15,000 metric tons of loss papers have been burned in a centralized manner. Compliance rates for air pollution control facilities installation for construction projects reaches 87%, 99% reduction of open burning in the exposed area of straw, 99,500 kilometers of environmental cleanup after the flood season, replacement of approximate 10,000 diesel vehicles in Phase I and Phase II, 714 filters installed in Phase III diesel vehicles, and elimination of more than 500,000 two-stroke motorcycles and the 283 electrical fruit and vegetable transporters. It is expected that these measures combined decrease annual particulate matters (PM₁₀) emissions by 33,000 tonnes (22%), annual PM_{2.5} emissions by 17,000 tonnes (24%), annual SO_x emissions by 33,000 tonnes (28%), annual NO_x emissions by 174,000 tonnes (40%), and will lower national annual average PM_{2.5} emissions by 23.4%. Preliminary air quality monitoring results of 2017 released in January 2018 showed that the nation's air quality has improved significantly over the past 5 years. Annual mean PM_{2.5}, one of the pollutants that many citizens are concerned about, has improved by 20% while PM₁₀, SO₂, NO₂ and O₃ have all seen improvements ranging from 11% to 29%. The results attest to the effectiveness of the air quality improvement measures. TEPA will continue to work with related public institutions and local governments, and to encourage public participation as well to achieve the goal of air quality improvement. TEPA will keep promoting and improving the next stage's strategies when achieving the goal in 2019.



The challenge for PM_{2.5} control in Taiwan

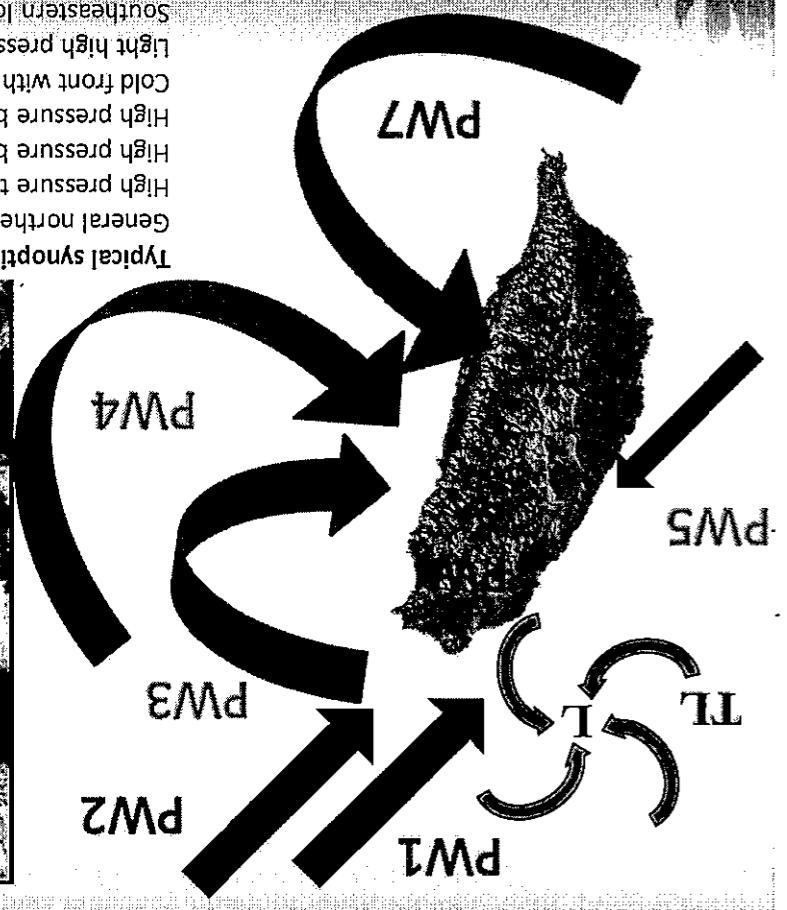


行政院環境保護署
Environmental Protection Administration
Executive Yuan, R.O.C. (Taiwan)

Giao-Kai Liang, Hung-The Tsai,
Ping-Fei Shieh, Chih-Hsu Su, Yang-
Hui Lee
Department of Air Quality Protection and
Noise Control, Environmental Protection
Administration, Executive Yuan, R.O.C.
(Taiwan)

SCCAEPA's 11th Los Angeles Environmental Forum (LAEF)
2018/08/11

Taiwan PM_{2.5} background



Typical synoptic weather system:

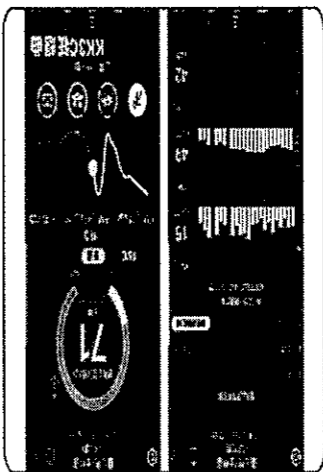
- General northeastern monsoon (PW1) 45%
- High pressure thrust (PW2) 20.2%
- High pressure back-flow with northeastern monsoon (PW3) 7.1%
- High pressure back-flow with southeastern monsoon (PW4) 5.1%
- Cold front with warm area (PW5) 7.4%
- Light high pressure hover (PW6) 3.3%
- Southeastern low pressure (PW7) 3.3%
- Low pressure (TL) 1.3%



迎接環保署30週年慶
2017.12.22

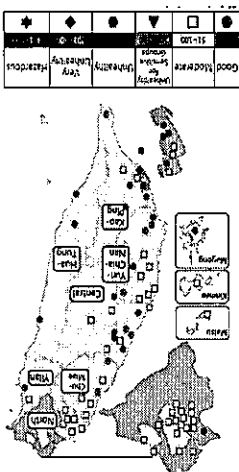
Taiwan PM_{2.5} level

Real time PM_{2.5} concentration



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| | |
|---------------------------|----------|
| AQI | 61 |
| AQI | Moderate |
| O ₃ average | 43 |
| O ₃ 8-hour | 45 |
| PM _{2.5} average | 20 |
| PM _{2.5} 24-hour | 22 |
| PM ₁₀ average | 28 |
| PM ₁₀ 24-hour | 31 |
| CO 8-hour | 0.20 |
| CO 24-hour | 0.13 |
| SO ₂ average | 1.1 |
| SO ₂ 24-hour | 1.7 |



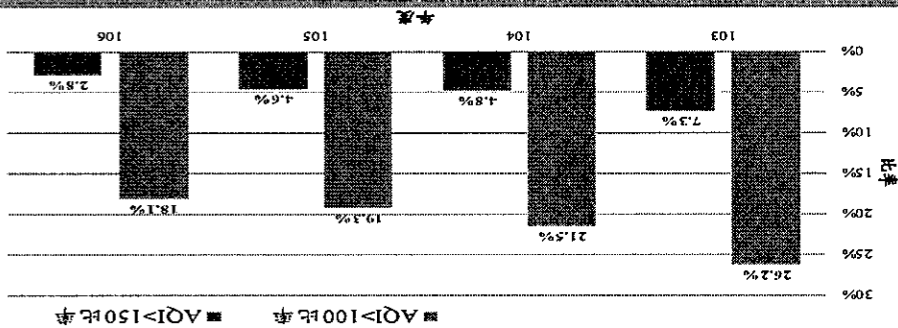
PM_{2.5} standard

| Pollutant | Averaging Time | Level | Unit |
|-------------------|----------------|-------|-------------------|
| PM _{2.5} | 24 hours | 35 | µg/m ³ |
| | Annual average | 15 | µg/m ³ |

PM_{2.5} Air Quality Index

| AQI | PM _{2.5} (µg/m ³) | Health Category |
|---------------|--|--------------------------------|
| 0.0 - 15.4 | 0.0 - 15.4 | Good |
| 15.5 - 35.4 | 15.5 - 35.4 | Moderate |
| 35.5 - 54.4 | 35.5 - 54.4 | Unhealthy for Sensitive Groups |
| 54.5 - 150.4 | 54.5 - 150.4 | Unhealthy |
| 150.5 - 250.4 | 150.5 - 250.4 | Very Unhealthy |
| 250.5 - 350.4 | 250.5 - 350.4 | Hazardous |
| 350.5 - 500.4 | 350.5 - 500.4 | Hazardous |

Historical AQI value



Taiwan PM_{2.5} level

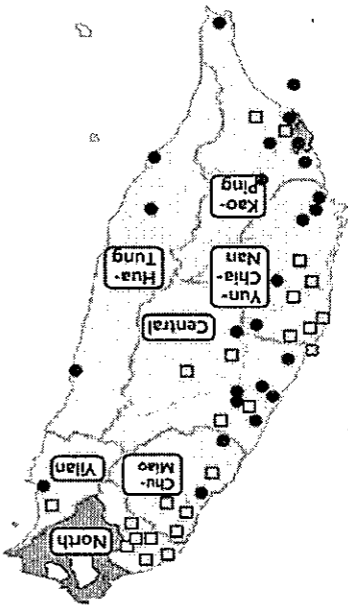
24-hr average (µg/m³)

| Region | 2013-2015 | 2014-2016 | 2015-2017 |
|-------------|-----------|-----------|-----------|
| Taiwan | 62.3 | 59.2 | 53.7 |
| Hua-Tung | 31 | 30.2 | 26.2 |
| Yilan | 41 | 41 | 37.3 |
| Kao-Ping | 72.9 | 65.4 | 61 |
| Yun-Chia-Na | 80.1 | 74.1 | 67.1 |
| Central | 71.9 | 65.8 | 57.4 |
| Chu-Miao | 56.6 | 56 | 50.3 |
| North | 49.2 | 52.2 | 48.8 |

Annual mean (µg/m³)

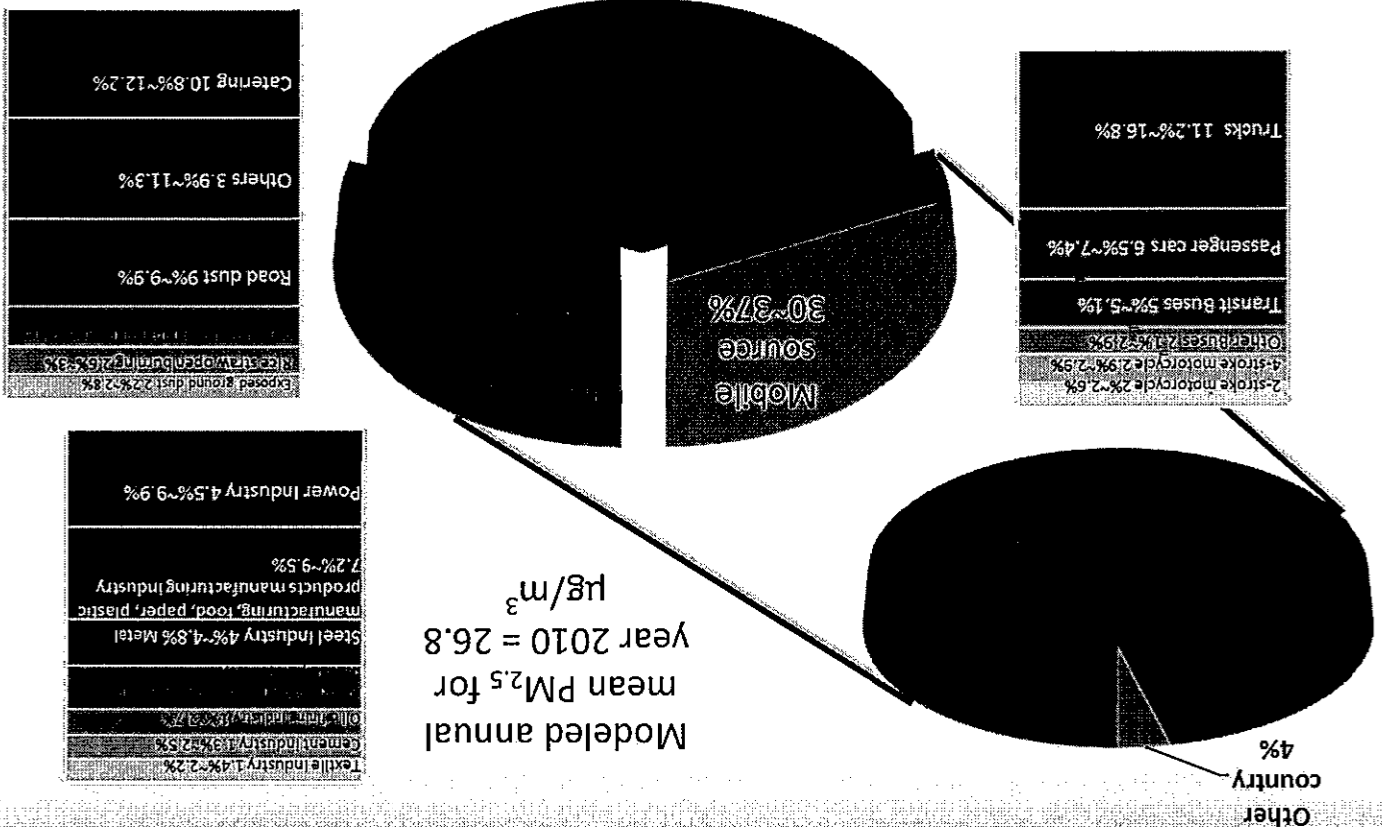
| Region | 2013 | 2014 | 2015 | 2016 | 2017 |
|-------------|------|------|------|------|------|
| Taiwan | 24 | 23.5 | 22 | 20 | 18.3 |
| Hua-Tung | 12 | 12.5 | 11.5 | 10 | 9 |
| Yilan | 15.3 | 15.2 | 15.2 | 12.5 | 11.8 |
| Kao-Ping | 26.2 | 25.1 | 23.5 | 20.6 | 20.9 |
| Yun-Chia-Na | 31.8 | 31.8 | 29.1 | 26.7 | 24.8 |
| Central | 27.5 | 27.1 | 25.8 | 23.1 | 20.3 |
| Chu-Miao | 22.4 | 22.5 | 20.7 | 19.6 | 16.9 |
| North | 19.6 | 19.3 | 18.7 | 17.2 | 15.2 |

| Pollutant | Averaging Time | Level | Unit |
|-------------------|----------------|-------|-------------------|
| PM _{2.5} | 24 hours | 35 | µg/m ³ |
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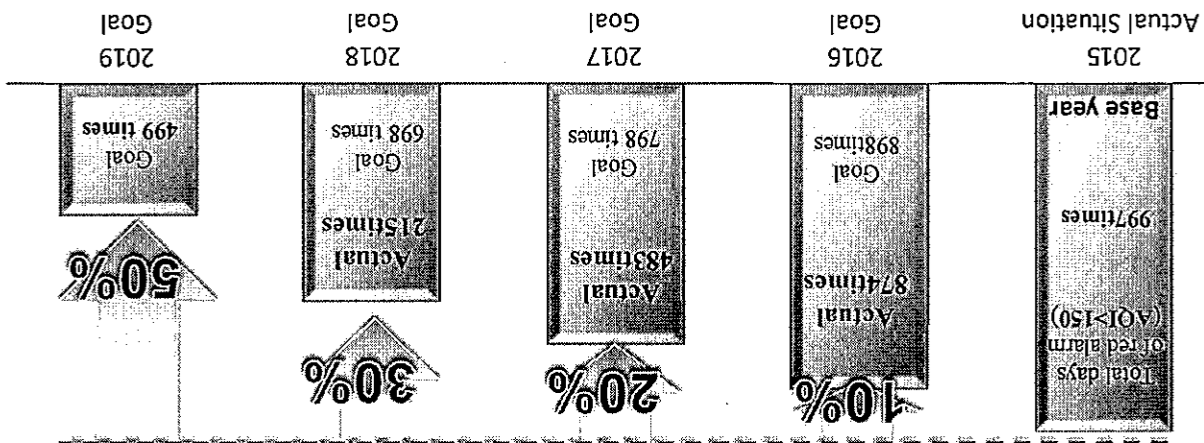
Taiwan PM_{2.5} sources

Modeled annual mean PM_{2.5} for year 2010 = 26.8 $\mu\text{g}/\text{m}^3$



Reference: Research results from TEPA commissioned "Analyze the composition and formation rate of PM_{2.5} in Taiwan," implemented by NCKU Prof. Yi-Lin Wu, "Strengthen the system of air quality model (second year)" implemented by NYUtech Prof. Ken-Hui Chang, based on emissions inventory (TEPS version 8.1).

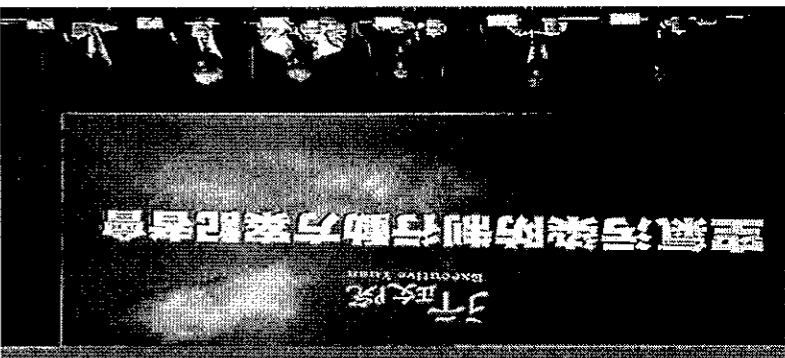
PM_{2.5} Control Targets



Performance Indicators: Average annual concentration of Particulate Matter (PM_{2.5})

19 $\mu\text{g}/\text{m}^3$ (2018)
18 $\mu\text{g}/\text{m}^3$ (2019)

Air Pollution Control Action Plan (APCAP)



| 14 + N Control Measures | |
|---------------------------------|---|
| Stationary and Fugitive Sources | 1. Air pollution reduction of state-owned enterprise and large enterprise |
| | 2. Boiler control |
| | 3. Cooking fume control |
| | 4. Burning of joss paper |
| | 5. Construction and dust control |
| | 6. Agricultural waste burning emission control |
| | 7. River bank dust control |
| Mobile Sources | 8. Phasing out phase I&II diesel trucks |
| | 9. Mandatory installed Particulate Filter in Diesel Vehicles |
| | 10. Eliminating 2-stroke motorcycles |
| | 11. Port area transportation control |
| | 12. Promoting electric fruit and vegetable transport trailers |
| | 13. Electrification of transportation equipment |
| | 14. New policy implement on traffic management |

Air pollution reduction of state-owned enterprise and large enterprise

- Target : Improving efficiency
- Strategies :

Control
(TEPA, Local Government)

Reduce
(Ministry of Economic Affairs)

- Set the tightened power industry emissions standard.
- Set the different seasonal rate of Air Pollution Fee.
- Promote to use low-pollution clean fuels.
- Eliminate old and high pollution generator sets.
- Installed air pollution control equipment on natural gas sets.
- Improve the air pollution control efficiency of generator sets.
- Load shedding in poor air quality.

Funding requirements : 101.19 Billions (Ministry of Economic Affairs, 2019) , 211.56 Billions (Ministry of Economic Affairs, after 2020)



Boiler control

➤ Target : 6,000 oil-fired boilers use clean fuel

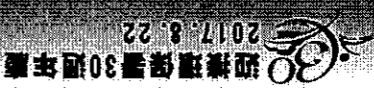
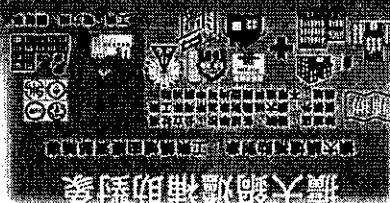
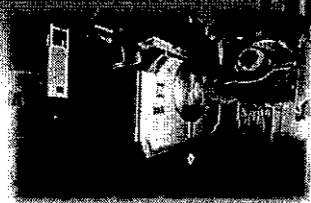
➤ Strategies :

1,000 commercial boilers
(TEPA、Local Government)

5,000 industrial boilers
(Ministry of Economic Affairs、
Local Government)

- Promote commercial boilers to use clean fuels such as natural gas.
- Add more subsidy to replace boiler by local government
- Set the tightened emission standard for burning boilers
- Improve energy consumption efficiency.
- Promote the Integration of Energy resources to reduce boiler use.
- Set up more natural gas pipeline.
- Counseling industries improve their boilers.

➤ Funding requirements : 4 Billions from TEPA in 2018, 20.8 Billions from MOE in 2019



Improvement of other pollution sources

Reducing 90% of burning straws beside highway

- ✓ Inspection and promotion (TEPA、Local Government)
- ✓ Resourcezation and recycling techniques (Council of Agriculture)
- ✓ Subsidize farmer research on-site treatment and rotten bacteria technologies (Council of Agriculture)

Agricultural waste burning emission control

Up to 90% of eligible pollution control equipment

- ✓ Regulation (TEPA、Local Government)
- ✓ Supervision and inspection (TEPA、Local Government)
- ✓ Budgeting truly air pollution control funds, serious check control measures(Public Construction Commission)

Construction and dust control

Setting pollution control equipment for 7,000 restaurants

- ✓ Setting control standard (TEPA、Local Government)
- ✓ Regional management (Ministry of the Interior、Ministry of Health and Welfare)
- ✓ Research and develop in techniques and equipment (Ministry of Economic Affairs)

Cooking fume control

Centralized burning joss paper amount 22,000 tonnes

- ✓ Promoting burning centralization and reduce firework using (TEPA、Local Government)
- ✓ Inspecting import joss paper (Ministry of Finance、Ministry of Economic Affairs)
- ✓ Design alternatives (Ministry of the Interior、Local Government)

Burning of joss paper

River bank dust control

➤ Target : Improving efficiency

• Dust prevention and control method (Water

Department, River Bureau)

• Security, Lin Xinzhi and Tending (Forest

Affairs Bureau, Forest District Management

Office)

• Central Local Coordination Platform (TEPA,

Local Government)

➤ Strategies :

Terraced farming cover method, straw

pavement, waterline and sprinkler

facilities, agriculture planting, reservoir

etc,



Waterline and sprinkler facilities



Terraced farming cover method



Straw pavement

GO 迎換環保署30週年慶
2017.8.22

Phasing out phase I&II diesel trucks

➤ Target : Retired 80,000 phase I&II diesel trucks (until 2019)

➤ Strategies :

✓ Strengthen the investigation and improving spot check

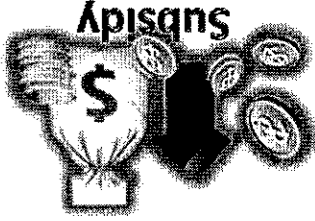
✓ Promote enterprises to using green cars

✓ Develop the subsidies of retiring old diesel vehicle,

✓ provide incentives to accelerate the elimination.

✓ Amending the law about air clean zone, prohibit or restrict old diesel vehicles entry.

✓ Raise penalties



Improving spot check

Hiring green cars

Eliminating phase I&II diesel trucks

Amending the law about air clean zone

Mandatory Installed Particulate Filter in Diesel Vehicles

➤ Goal : 38,000 diesel vehicles will be installed (until 2019)

➤ Strategies :

- ✓ Subsidizing 15 counties participate in the demonstration run to install garbage truck with particulate filters.
- ✓ Regulations of the subsidy of big diesel vehicles install with particulate filters.

➤ Funding requirements : 26 Billions (TEPA , 2017-2019)



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Eliminating 2-stroke motorcycles

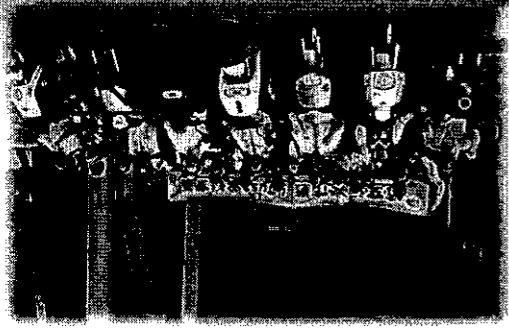
➤ Goal : Retiring 1.5 million 2-stroke motorcycles (until 2019)

➤ Strategies :

TEPA, Local Government

- ✓ Promoting the regulations of subsidy and scrap.
- ✓ Improving inspection and encouraging report.

➤ Funding requirements : 11.5 Billions(TEPA , 2017-2019)



Mobile Pollution Sources Control Strategies

| | |
|--|--|
| <p>Port area transportation</p> | <ul style="list-style-type: none"> ▶ Promoting reduce the pollution (Ministry of Transportation and Communications - Ministry of Finance) ✓ Setting shore power ✓ Controlling diesel vehicles to enter port ✓ Reducing the speed of ship |
| <p>Public transportation</p> | <ul style="list-style-type: none"> ▶ Carrying capacity of road public transportation reach 1.24 billion passengers (Directorate General of Highways - Local Government) |
| <p>Trail cargo</p> | <ul style="list-style-type: none"> ▶ The container rate of total should up to 15 (Ministry of Transportation and Communications) |
| <p>Electric trailers</p> | <ul style="list-style-type: none"> ▶ Promoting 2,100 electric trailers (TEPA - Council of Agriculture - Ministry of Transportation and Communications - Local Government) |

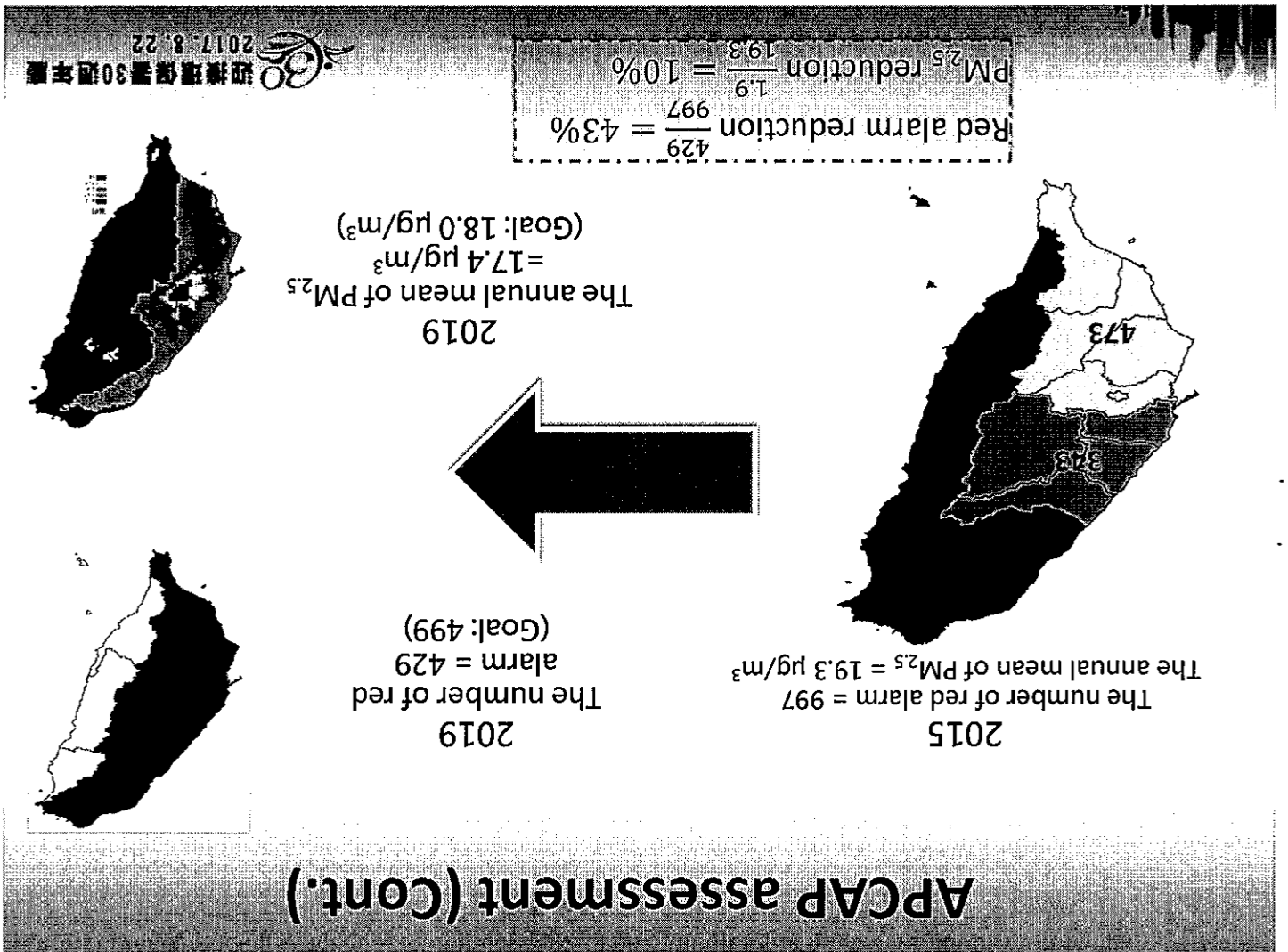
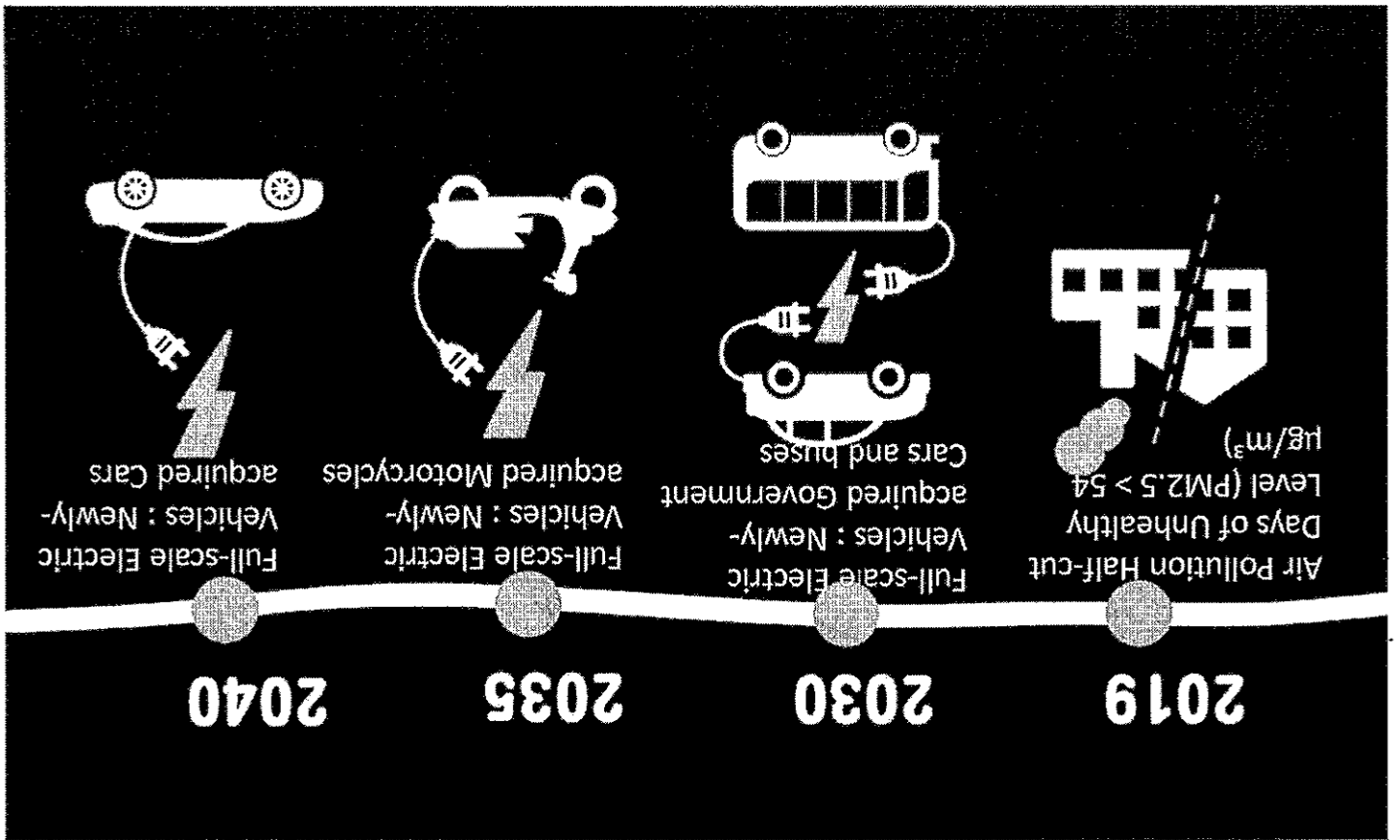
APCAP emission reduction

| Control plan | Budget (Billion) | Emission reduction (ton) | | |
|---|------------------|--------------------------|--------|---------|
| | | PM _{2.5} | SOX | NOX VOC |
| 1. Power plan control | 14.7 | 143 | 12,092 | 17,163 |
| 2. Air pollution reduction of state-owned enterprise and large enterprise | 18.3 | 129 | 1,948 | 1,214 |
| 3. Boiler control | 11.5 | 175 | 4,962 | 2,936 |
| 4. Cooking fume control | 0.94 | 788 | - | - |
| 5. Improvement on derivative problems from burning of joss paper | 0.21 | 95 | - | 30 |
| 6. Construction and dust control | 14.6 | 672 | - | - |
| 7. Processing and elimination of agricultural surplus materials | 0.3 | 466 | - | - |
| 8. River bank dust control | 0.58 | - | - | - |
| 9. Phasing out phase I&II diesel trucks | 186.3 | 5,395 | - | 71,149 |
| 10. Installing particulate filters on phase III Diesel vehicles | 9.44 | 243 | - | - |
| 11. Eliminating 2-stroke motorcycles | 40.15 | 457 | 1 | 260 |
| 12. Port area transportation control | 0.7 | 7 | - | 34 |
| 13. Promoting electric fruit and vegetable transport trailers | 0.2 | 801 | 16,385 | 2,123 |
| 14. New policy implement on traffic management | 10.9 | 410 | - | 2,587 |
| | | | | 5,315 |

Mobile Sources

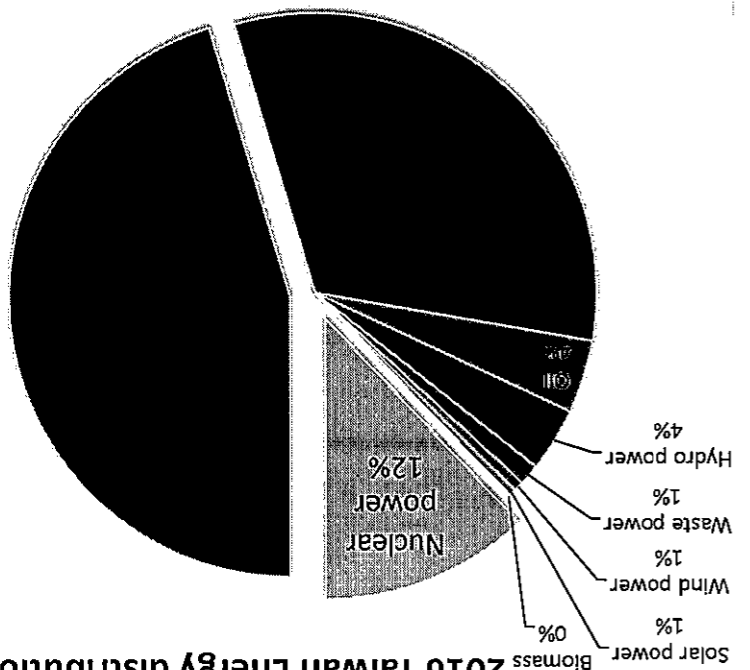
Stationary and Fugitive Sources

Taiwan long term policy (1)

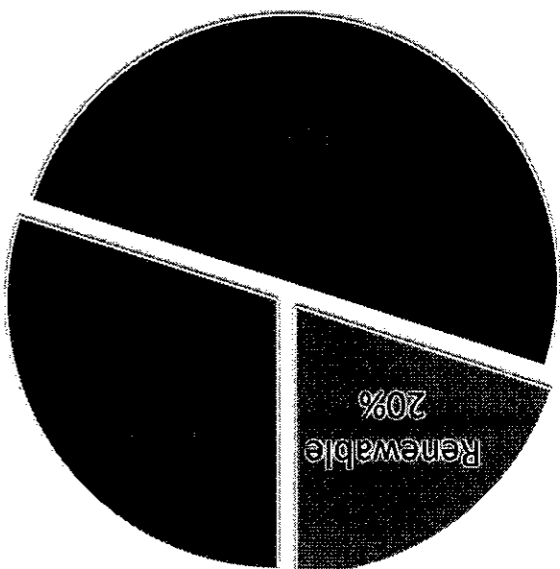


Taiwan long term policy (2)

2016 Taiwan Energy distribution



2025 Taiwan nuclear-free policy



Summary

- Considering the variety of air pollution sources, the effective works on improving air quality must be multi-pronged approach, which is not only to control large sources, such as power plants, but also need to implement control measures on medium & small boilers, construction activities, phase I&II diesel trucks, 2-stroke motorcycles, agricultural waste burning and people customs.
- Air quality improvement is our top priority. However, it should be step by step. And also need to input large amount of budget, and change public customs. TEPA works together with related public institutions and local governments, and encourages public participation as well to achieves the goal of air quality improvement.
- TEPA will keep promoting and improving the next stage's strategies when achieving the goal in 2019.

Thanks for your attention!

