



行政院環境保護署

Environmental Protection Administration
Executive Yuan, R.O.C. (Taiwan)



Taiwan's Air Quality Monitoring

Department of Environmental Monitoring and Information
Management, Taiwan EPA

Technical Specialist

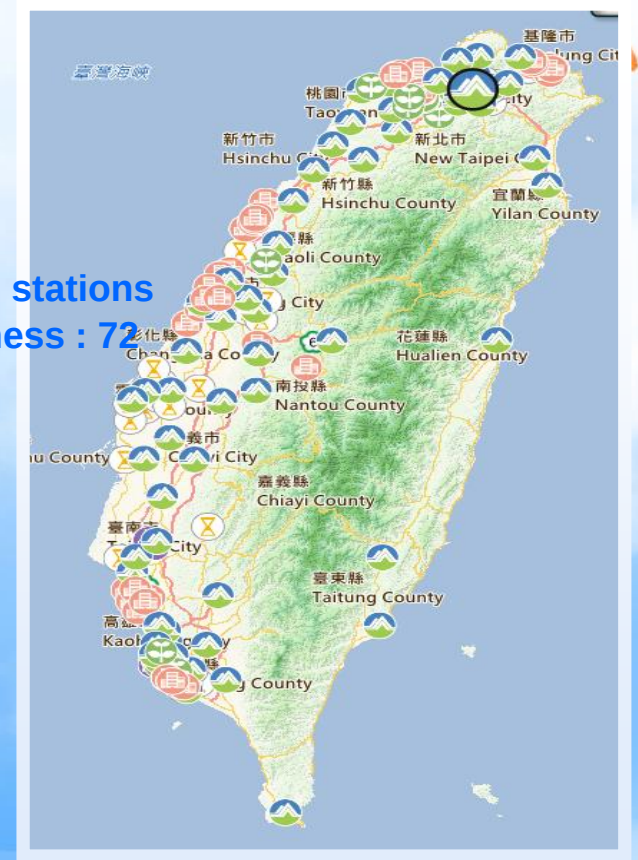
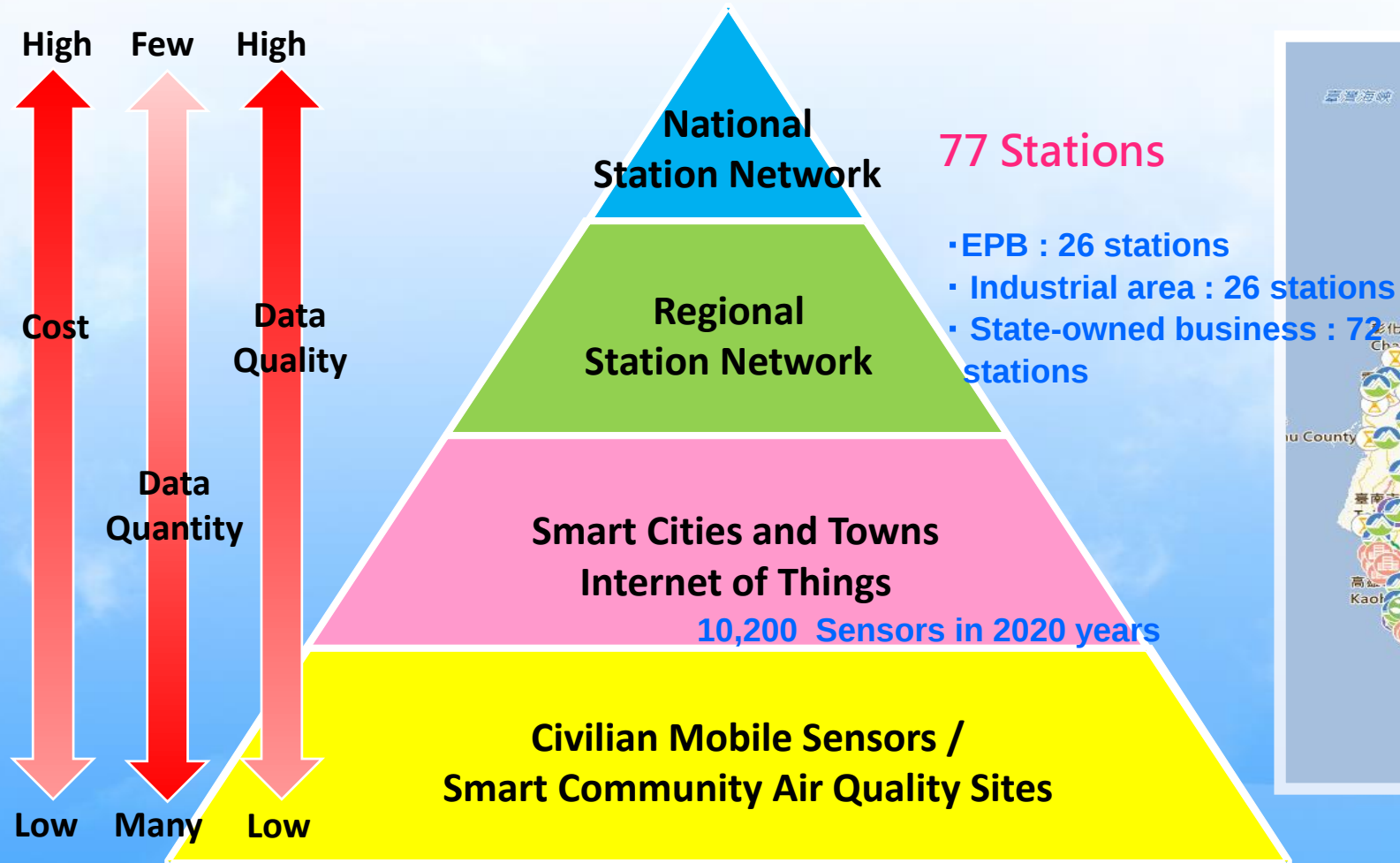
Hung-Po Hsu

Outline

- 1 **Air Quality Monitoring Network**
- 2 **Monitoring Data Sharing**
- 3 **Air Quality Sensor**
- 4 **TAiWAN projects**
- 5 **For the Future**



Multi-Class Air Quality Monitoring Network



Types of Air Quality Monitoring Station

Since 1994, our monitoring data update online at TAQMN on a hourly basis

- ⊕ Ambient air quality stations: 60
- ⊕ Industrial monitoring stations : 5
- ⊕ Traffic monitoring stations : 12
- ⊕ National park monitoring stations : 2
- ⊕ Air quality background stations : 4



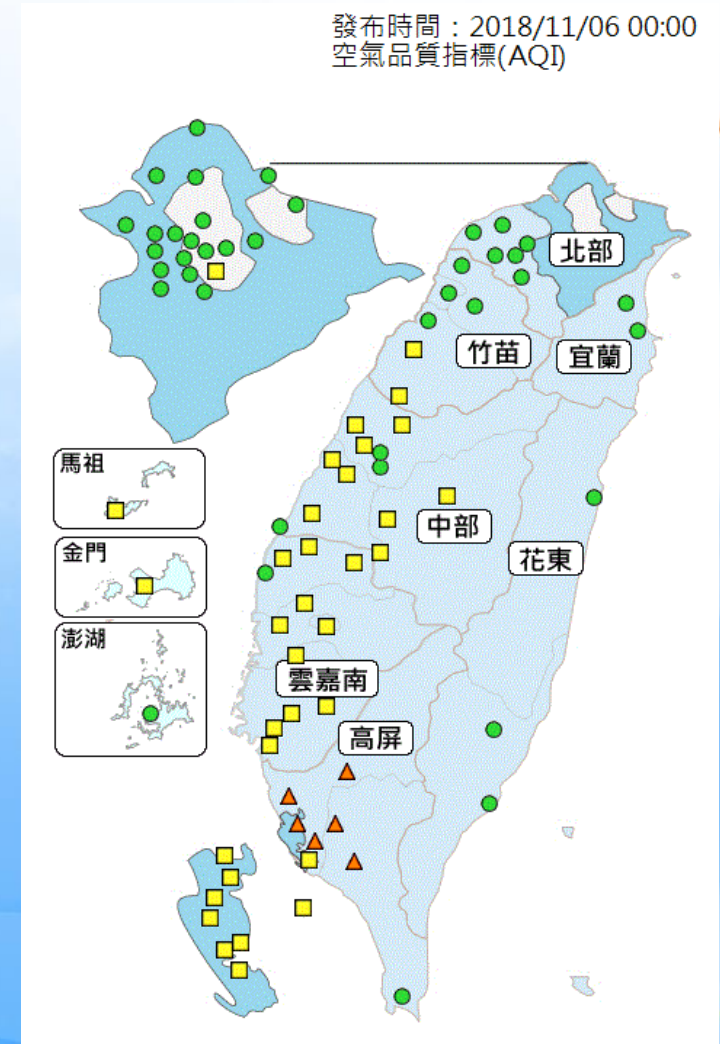
Particulate matter composition stations



The photo chemical stations



The mobile stations



Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy	Very Unhealthy
0~50	51~100	101~150	151~200	201~300
●	■	▲	◆	◆

Monitoring Items

▪ Automatic

Criteria Pollutants

- PM_{10} , $PM_{2.5}$
- CO
- SO_2
- NO_2
- O_3 , O_{3-8hr}

Meteorological Parameters

- Wind Speed
- Wind Direction
- Temperature
- Humidity
- Rainfall

Others

- Acid rain
- THC Total hydrocarbons
- CH_4 methane
- NMHC
- UVB UVA
- BTEX
- CO_2

▪ Manual

$PM_{2.5}$

$PM_{2.5}$ Chemical composition analysis

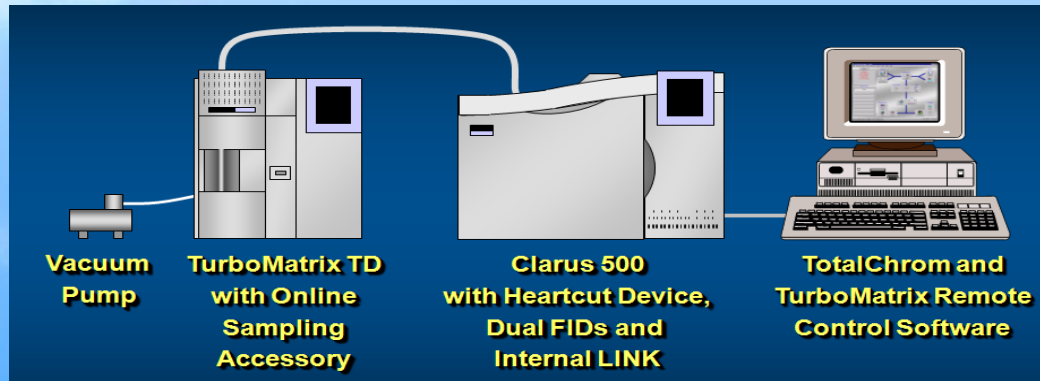


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Photochemical Assessment Monitoring Stations

- Photochemical Assessment Monitoring Stations(PAMS) : 11
- Monitoring items : 54 types of O₃ precursors



Ethane	2,3-Dimethylpentane
Ethylene	3-Methylhexane
Propane	2,2,4-Trimethylpentane
Propylene	n-Heptane
Isobutane	Methylcyclohexane
n-Butane	2,3,4-Trimethylpentane
Acetylene	Toluene
t-2-butene	2-Methylheptane
1-Butene	3-Methylheptane
cis-2-Butene	n-Octane
Cyclopentane	Ethylbenzene
Isopentane	m,p-Xylene
n-pentane	Styrene
t-2-pentene	o-Xylene
1-pentene	n-Nonane
c-2-pentene	Isopropylbenzene
2,2-dimethylbutane	n-Propylbenzene
2,3-dimethylbutane	m-Ethyltoluene
2-methylpentane	p-Ethyltoluene
3-methylpentane	1,3,5-Trimethylbenzene
Isoprene	o-Ethyltoluene
n-Hexane	1,2,4-Trimethylbenzene
Methylcyclopentane	n-Decane
2,4-Dimethylpentane	1,2,3-Trimethylbenzene
Benzene	m-Diethylbenzene
Cyclohexane	p-Diethylbenzene
2-Methylhexane	n-Undecane



QA/QC of Taiwan Air Quality Monitoring Network

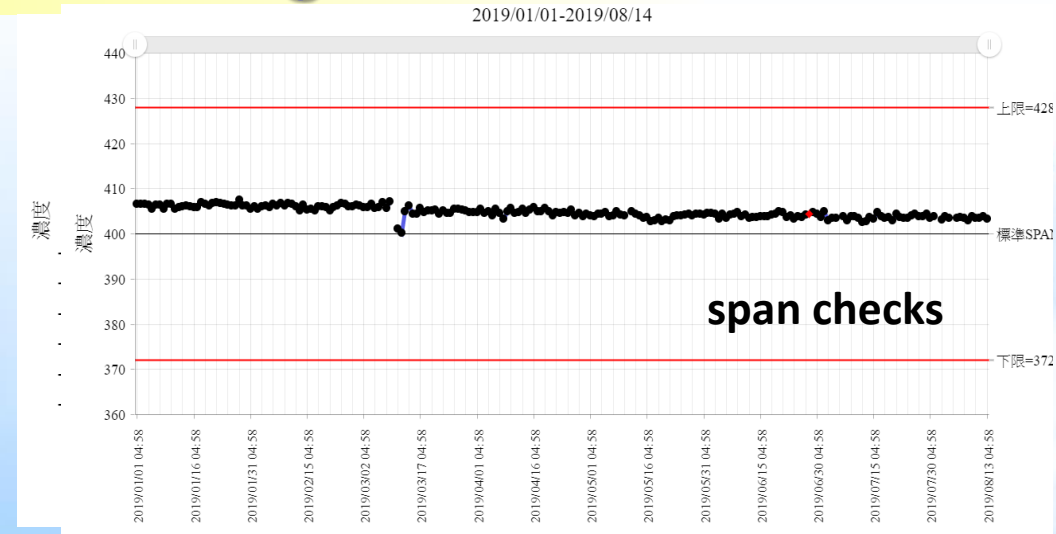
- ⊕ Scheduled quality control procedures
 - Daily zero and span checks
 - Biweekly precision checks
 - Quarterly multiple-point calibrations

- ⊕ Calibration standards

- CO, SO₂, and NO are traceable to the US NIST standards within $\pm 2\%$
- Ozone transfer standard is traceable to US NIST Standard Reference Photometer # 30 and #57

- ⊕ Quality assurance

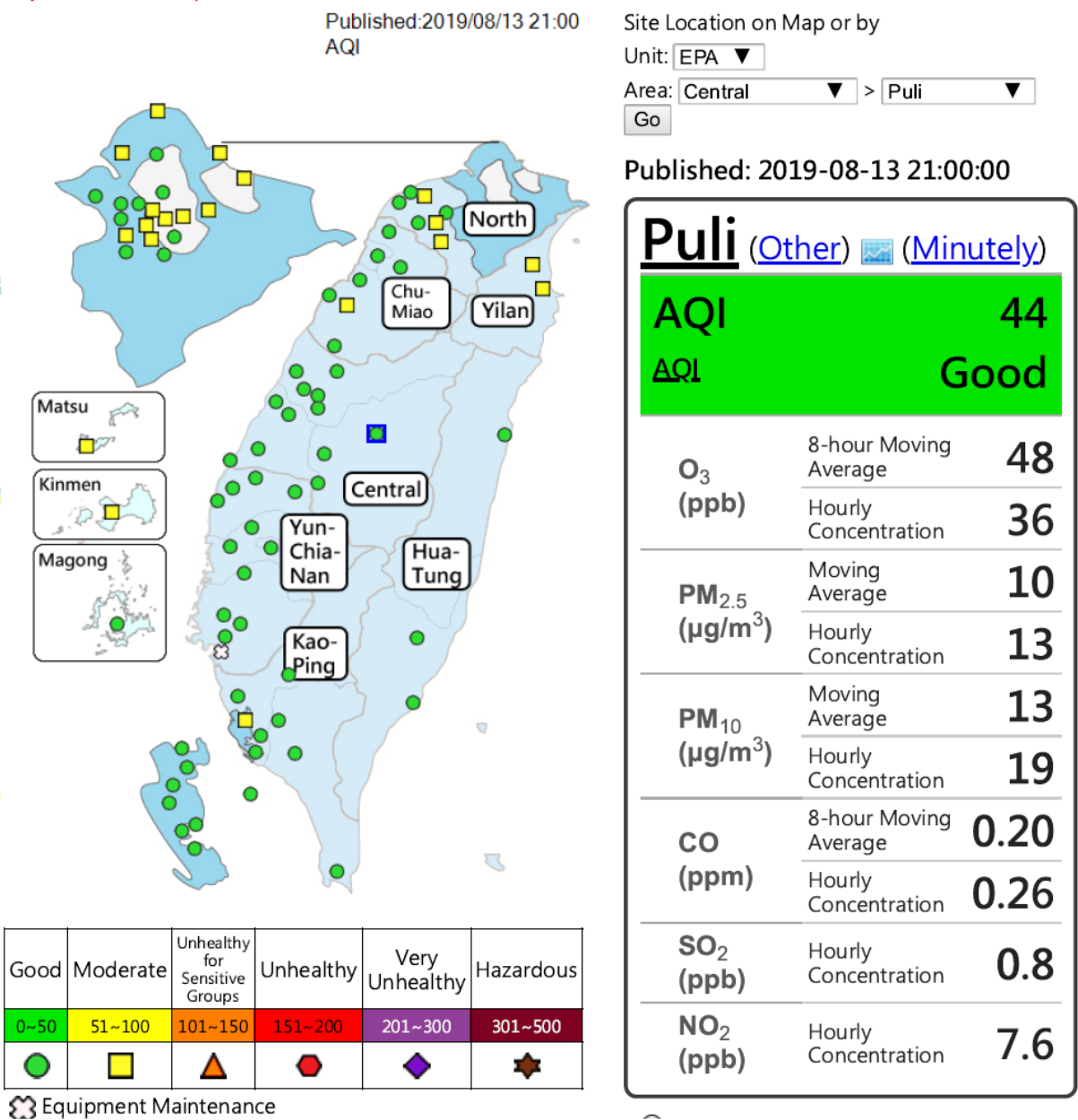
- Performance audit
- Functional checks
- Data validations



Long-term Trends of Air Quality

<http://taqm.epa.gov.tw>

AQI value and impact on health



- ✦ The country map displays the current AQI's colorful icon which is updated hourly
- ✦ Users can select a region to view detailed data

Air Quality Forecast

- 3-days-forecast
- Forecast video

AQI Forecast

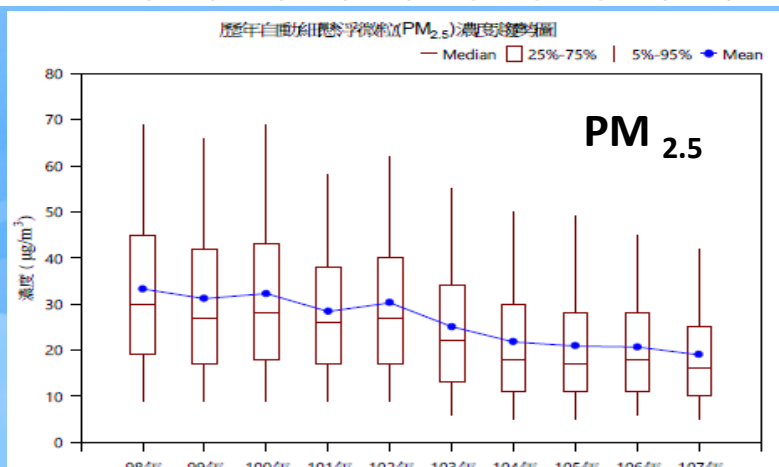
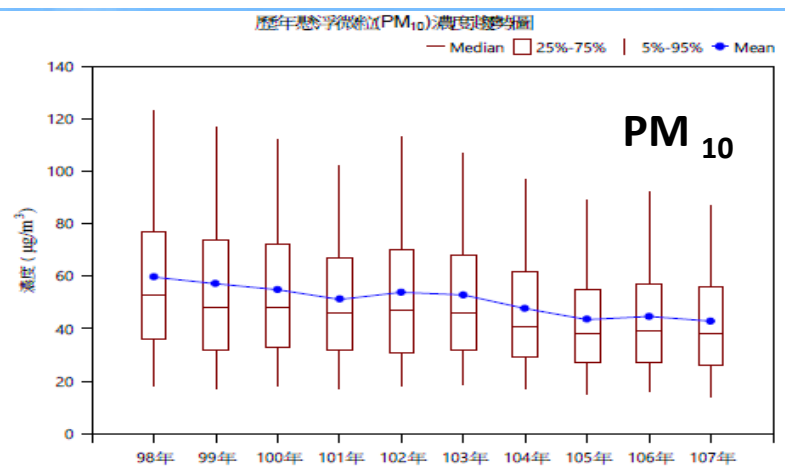
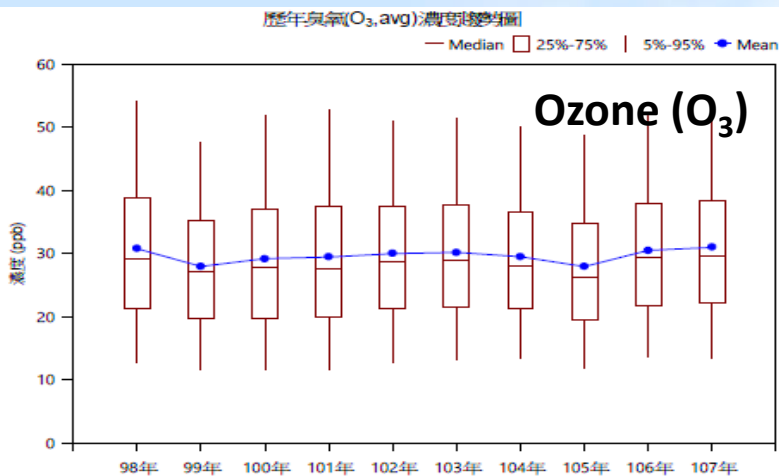
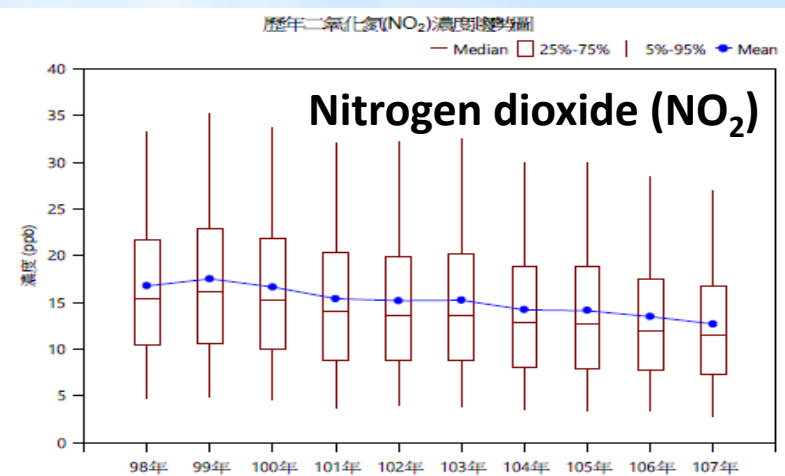
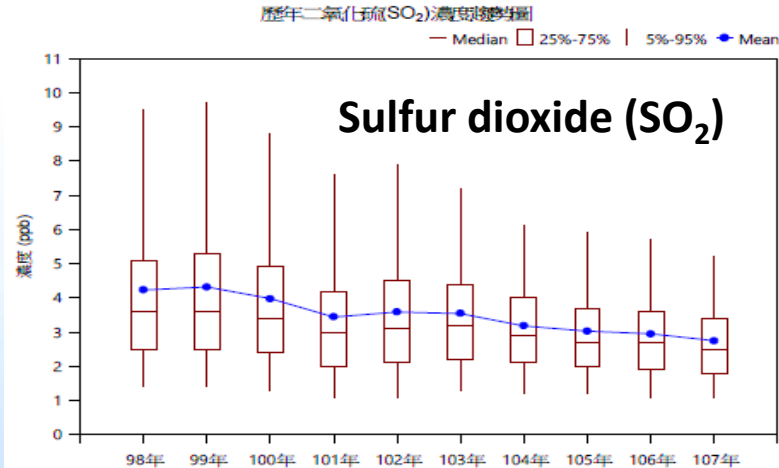
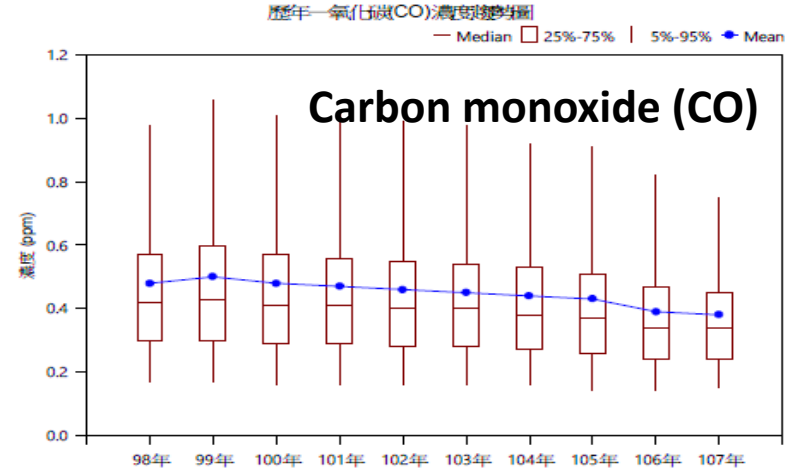
Date	04/23		04/24			04/25
Area	AQI	Pollutant	AQI	Pollutant	AQI	Pollutant
North	60	PM _{2.5} (60)	70	PM _{2.5} (70)	80	PM _{2.5} (80)
Chu-Miao	60	PM _{2.5} (60)	70	PM _{2.5} (70)	80	PM _{2.5} (80)
Central	70	PM _{2.5} (70)	80	PM _{2.5} (80)	85	PM _{2.5} (85)
Yun-Chia-Nan	80	PM _{2.5} (80)	105	PM _{2.5} (105)	90	PM _{2.5} (90)
KaoPing	70	PM _{2.5} (70)	105	PM _{2.5} (105)	85	PM _{2.5} (85)
Yilan	45		50		50	
Hua-Tun	40		50		50	
Matsu	55	PM _{2.5} (55)				
Kinmen	50					
Magong	50					

Health	Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy	Very Unhealthy	Hazardous
Index	0~50	51~100	101~150	151~200	201~300	301~500

明天 AQI 指標

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污染為細懸浮微粒。



Since 2009, the primary pollutants decrease except for O₃, the challenge is to conduct lower concentration monitoring and to find ways to decrease the concentration



Briefing the Lulin station



23.51°N, 120.92°E ; 2862 m



The Lulin Background station

On top of Mt.Lulin to track the trans-boundary transport of atmospheric pollutants



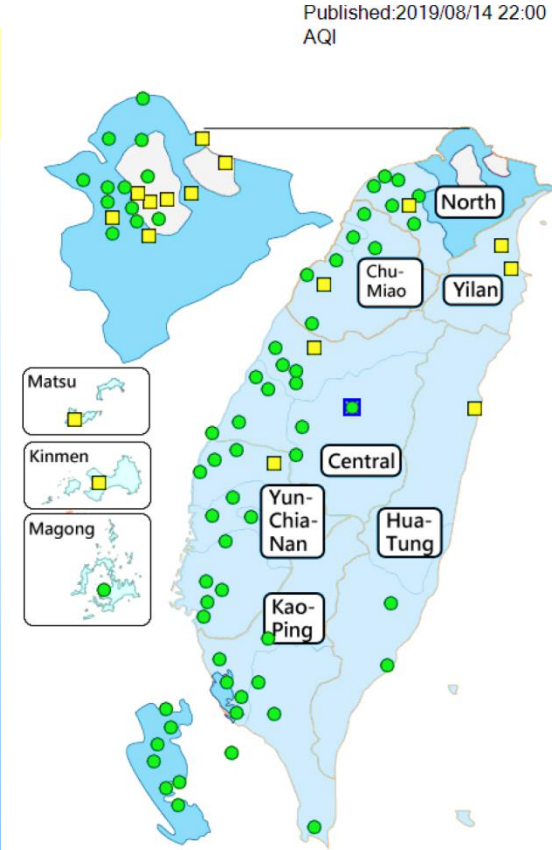
Monitoring Data

Transmit

Database Server

Primary analysis

- TAQMN(Taiwan Air Quality Monitoring Network)
 - Minute data(Gas items)
 - Hourly data
 - Historical data
- Environmental Instant Messages APP
- Data Open Platform



Good	Moderate	Unhealthy for Sensitive Groups	Unhealthy	Very Unhealthy	Hazardous
0~50	51~100	101~150	151~200	201~300	301~500

⚙ Equipment Maintenance

Published:2019/08/14 22:00
AQI

Site Location on Map or by
Unit: EPA ▾
Area: Central ▾ > Puli ▾
Go

Published: 2019-08-14 22:00:00

Puli (Other) (Minutely)				
TIME	O ₃	SO ₂	NO ₂	CO
22:57	14	2.3	8	0.2
22:56	14	2.3	8.2	0.2
22:55	14	2.8	8.4	0.2
22:54	14	2.6	8.7	0.2
22:53	14	2.4	8.8	0.1
22:52	14	2.2	8.8	0.1
AQI				34
AQI				Good
O ₃ (ppb)	8-hour Moving Average	33		
	Hourly Concentration	21		
PM _{2.5} (µg/m ³)	Moving Average	11		
	Hourly Concentration	11		
PM ₁₀ (µg/m ³)	Moving Average	14		
	Hourly Concentration	15		
CO (ppm)	8-hour Moving Average	0.30		
	Hourly Concentration	0.28		
SO ₂ (ppb)	Hourly Concentration	2.1		
NO ₂ (ppb)	Hourly Concentration	9.6		

APP - Environment Info Push

Instant and local environmental information

Information

- Past, now and future information on air quality
- Instant warnings such as air quality, heavy rain, flooding and earthquakes according to the user's location

GPS

Immediately show user neighborhood real-time environment information

Post

Users upload the air quality photos and moods of their locations



Slide Finger, Get Information So Easy

Air Quality Index(AQI)

Hourly Data

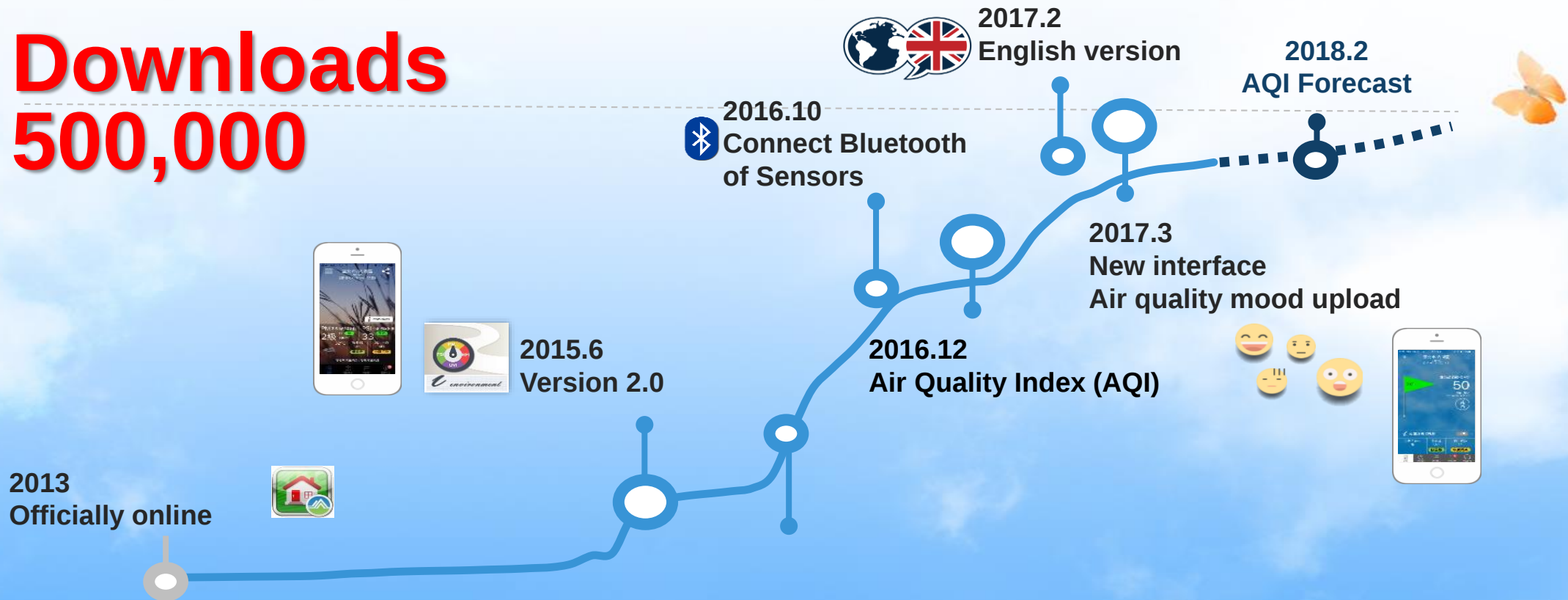
Activity Guidance



AQI Forecast (12hrs)

Update AQI forecast data
twice per hour

Downloads 500,000



Award

**2016 Geospatial Application
Geospatial World Excellence Award**



**2016 Internet of Things
Innovation Award**



**2017 Digital Government
Innovative Products Award**



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1. Instant Information

AQI, Air quality forecast, Weather, UV index, River Pollution Index..

3. Map Guide

AQI, PM_{2.5}, PM₁₀, O₃, SO₂...
in different spatial scales by map

5. Personalized warning

The warning value can be set according to personal preference

7. Mood Post

Users upload the air quality photos and moods

讓大家都能看到！

2. Trend

3 days historical data trend of every monitoring stations

4. Overview

Sorting AQI, PM_{2.5}, PM₁₀, O₃, SO₂...by values in national stations

6. Upgrade

Short description of every air quality and 3-days-forecast

Taiwan's OpenData - Air Quality Monitoring Data

(<http://opendata.epa.gov.tw/>)

The screenshot shows the OpenData.epa.gov.tw website. The header features the OpenData.epa logo and navigation links. The main content area is divided into three columns: Popular Data Sets (熱門資料集), Data Set Categories (資料集類別), and Data Statistics (資料統計). The Air Quality Monitoring Data section is highlighted with a red dashed box.

熱門資料集

- Air Quality Monitoring Data**
- 2016/08/26 空氣品質即時污染指標
提供單位：環境監測及資訊處
- 2016/08/26 紫外線即時監測資料
提供單位：環境監測及資訊處
- 2016/08/26 十分鐘雨量資料
提供單位：交通部中央氣象局
- 2016/08/26 空氣品質預報資料
提供單位：環境監測及資訊處
- 2015/01/01 空氣品質監測站基本資料(...)
提供單位：環境監測及資訊處

資料集類別

- 更多
- 大氣
列管事業污染源裁... 各縣市環保局柴油...
- 水
土石流潛勢溪流 安定區域性聯合滲...
- 地
土石流潛勢溪流 地質鑽探點位資料
- 林
全台保安林分布概... 林火預警資料
- 生態
自然保留區 自然保護區
- 生活環境與其他

資料統計

- 更多
- 資料集清單下載
- XML : 共 651 筆
- JSON : 共 645 筆
- CSV : 共 637 筆
- PDF : 共 108 筆
- KML : 共 28 筆
- 更多

Provides a platform for automatically tracking data lineage while monitoring workflow execution, supports tasks to systematically collect diverse monitoring data.

Total sensing solution of air quality sensor



Wall Mount



Street Light

Complete
Housing & Mounting
Solution

Multiple
Sensors



Diverse
Communications



NB-IoT



- Capable of measuring temperature, humidity, O₃, CO, PM_{2.5}, noise, and TVOC

- Components:

1. Main chassis: Equipped with a power supply module, backup battery, control board, radio transmitter module, memory card, and terminal panel.
2. Radiation shield: Equipped with a sensor board and various types of sensor components.
3. Mount: A U-shaped ring or stainless steel tube bundle is used to secure the sensor to the utility pole.
4. Power requirements: 110/220V AC, 1A.



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Data analytical service and alarming pushdown dialing

Deployment of pilot fields (3,300 fields in total)

- Provision of one sensing data, including temperature, humidity, and PM_{2.5}, every three minutes
- Coverage of 120 regional administrative areas, 44 industrial zones, and science parks
- Monitoring 3,8000 designated factories

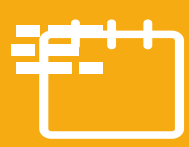


Data integration and AI analysis

- Inclusion of PRTR, CEMS, complaints of public nuisances, wind fields, and other related data, supplementing real-time analysis of potential pollutions and real-time alarming information
- Pinpointing polluting hot spots and times with big data
- Discovery of 47 enterprises in violation of environmental-protection laws/regulations



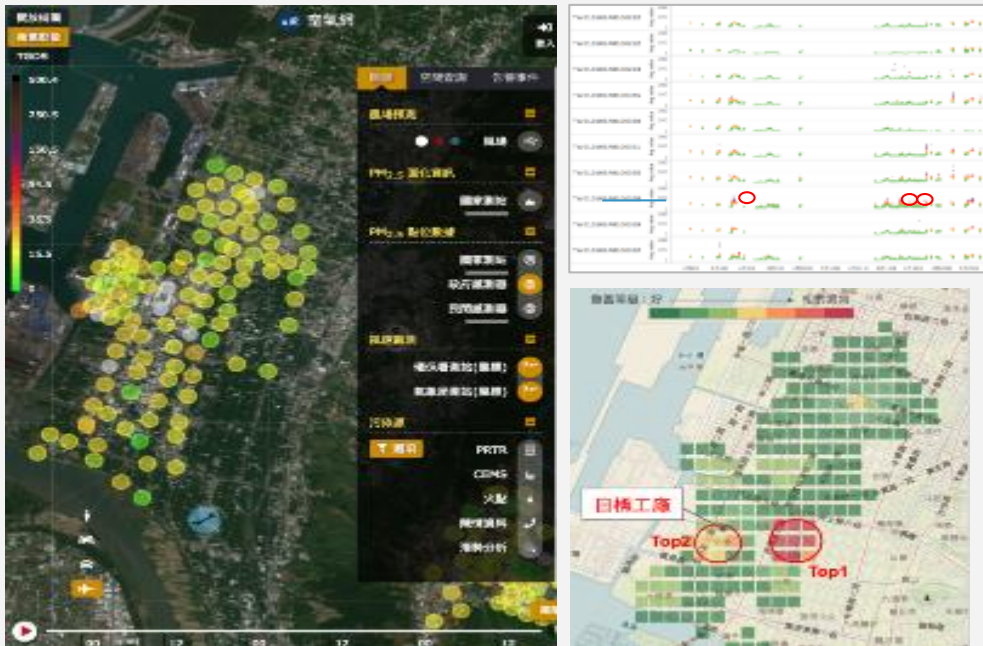
Application scenarios for smart law enforcement



Long-term auditing

- IoT sensor data can narrow suspicious area
- Continuing data monitoring grasp of abnormal behaviors of factories
- In combination with on-site auditing with scientific tools

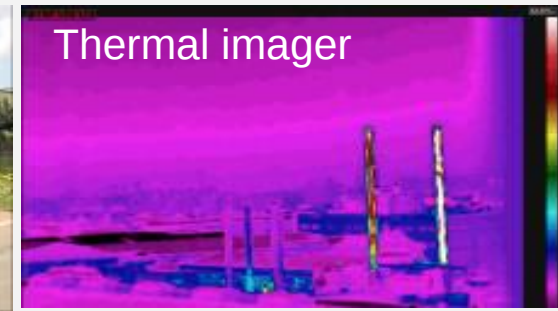
Pinpointing suspicious factories intensively with sensor data



On-site inspection with the assistance of scientific tools



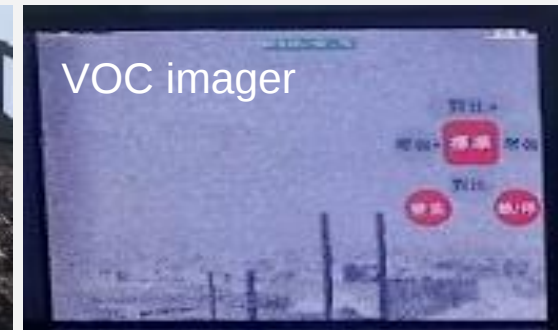
Intensive on-site inspection



Thermal imager



On-site sampling



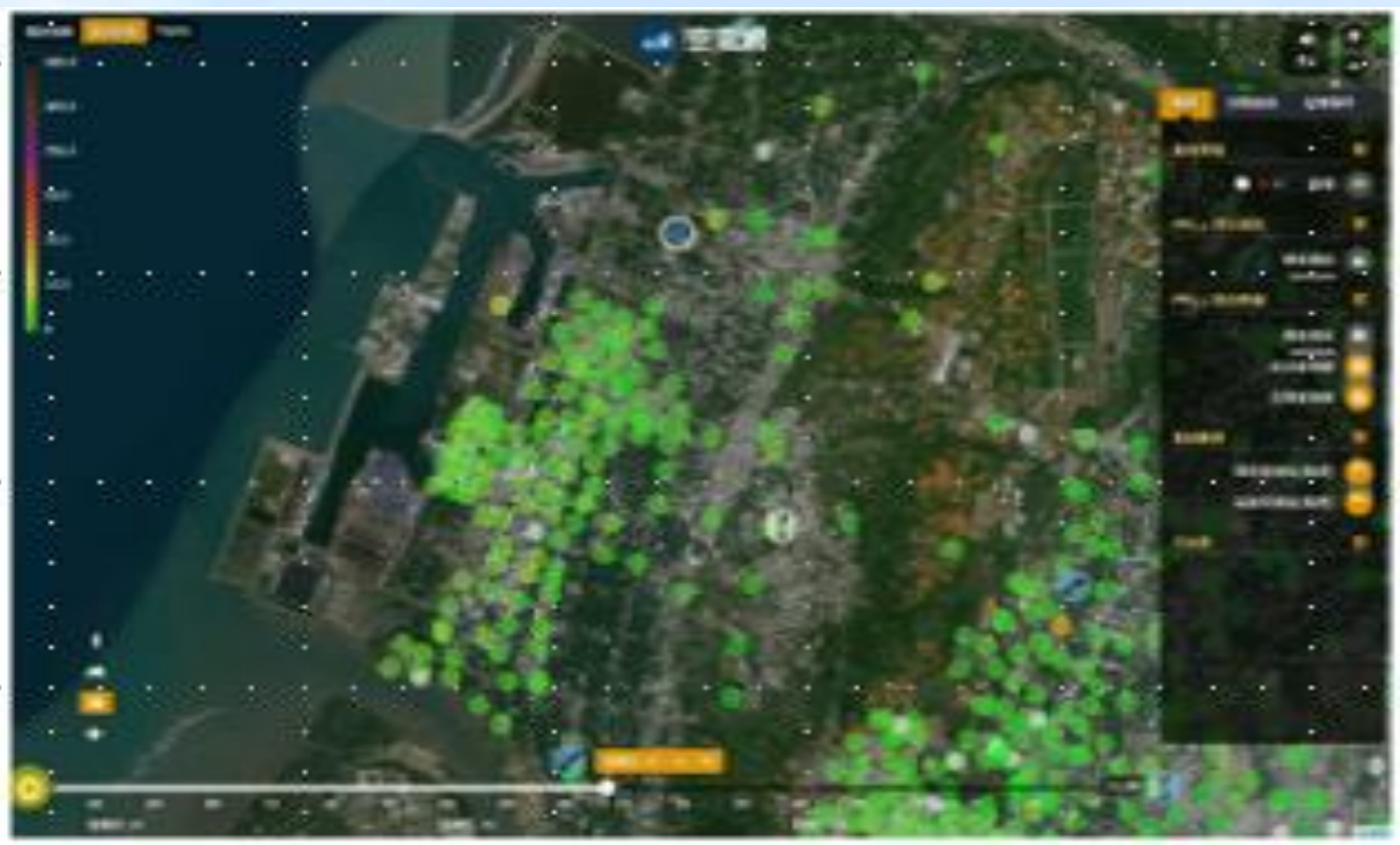
VOC imager





Short-term unexpected incidents

Fully automated computing of AI system assists environmental auditing units in grasping short-term unexpected incidents, as well as dissemination time and scope.



Incinerated wastes of factories



wastes of open-air incineration



TAiWAN projects



77 national-level standard sensing stations

10,000 smart urban & rural sensing points

10,000⁺ citizens' scientific sensing points

- ✦ Taiwan, as an IoT site, provides guidance on innovation and R&D
- ✦ Deploying a wide air quality network to control pollution and protect the environment
- ✦ Duplicating and exporting our services and experiences in software and hardware
- ✦ Improving our products and services for a sustainable

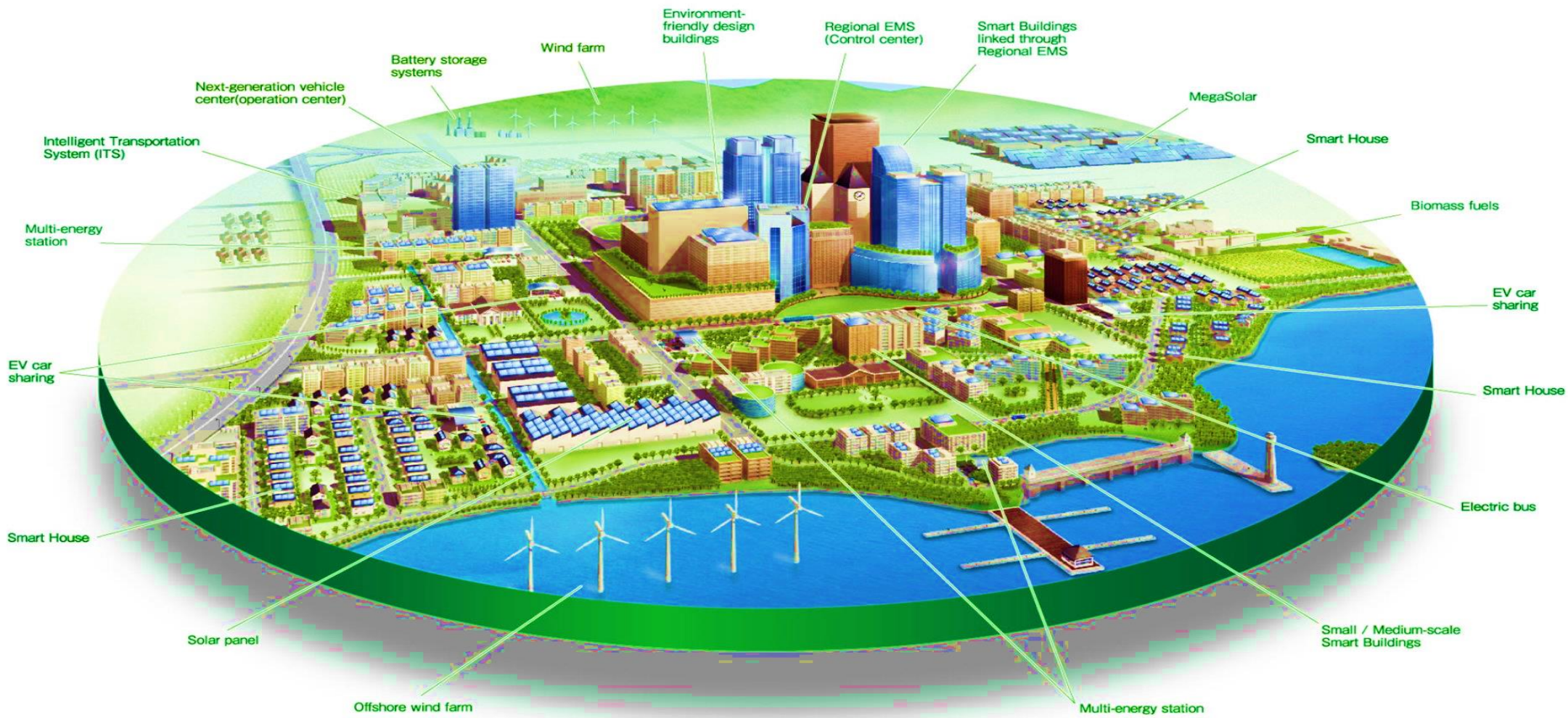
TAiWAN



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Smart City-Internet of Everything



For the Future

- Review TAQMN to meet the requirements of new air quality problems
- Provide more information about long-range and transboundary transport
- Look forward to further international cooperation in the future



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Many thanks for your attention!



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